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EFFECT OF GROWTH REGULATORS ON THE CROP LOAD MANAGEMENT, YIELD AND QUALITY OF FRUITS OF CV GALA DELICIOUS

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***Keywords**: apple; variety; growth regulators; fruit buds; inflorescence; yield.*

ABSTRACT

The study was conducted in the period 2016-2018 in the central area of the Republic of Moldova with the purpose to assess the effect of various crop load management practices on the Cv Gala Delicious, grafted on the rootstock M9, in an intensive system. The trees aged 8-10 years were trained according to improved slender spindle shape and planted at a distance of 3.5 x 1 m. The experiment was organized in 4 repetitions, the spraying was performed on 8 trees in each repetition, using 11 l of solution on 32 trees or 1000 l per hectare, respectively. The used growth regulators ensured a significant increase in the average weight of a fruit (135.4-144.4 g) and a significant increase in the diameter of fruits (over 85% of fruits have been classified in the category I and extra category), but significantly reduced the number of fruits per tree.

INTRODUCTION

In order to obtain high quality and constant yields, modern pomology recommends the use of manual and chemical fruit thinning, but the lack of labour force determined to put an emphasis on the use of growth regulators everywhere (Robinson et al. 1998). At present, the most commonly used chemicals for apple fruit thinning during the flower stage are 2-chloroethylphosphonic acid (ethephon), ammonium thiosulphate (ATS), oil and lime sulfur; Auxins, (NAA and NAD), cytokinins, (6-BA) and, in some cases, the insecticide carbaryl are applied during the fruit stage (Babuc et al. 2013). The efficiency of thinning varies depending on the dose and type of the preparation used, the climatic conditions and the cultivation system of the fruit species (Stopar & Tojnko 2005, Theron 2013, Peșteanu 2018). Obviously, practical argumentation of the crop load management practices in order to obtain sustainable fruit yield, represents a crucial problem for intensive apple orchard growing (Babuc et al. 2013). The purpose and objectives of the paper is to increase the productivity and efficiency of apple plantations by applying various fruit load management practices for Gala Delicious variety, grafted on the M9 rootstock, in an intensive apple orchard system.

MATERIAL AND METHODS

The study was conducted during the period 2016-2018. The influence of various thinning methods on the cv Gala Delicious was studied: **V1**-Untreated control variant; **V2**-Manual thinning of fruits was performed after the physiological drop, when the fruits reached a diameter of 16-18 mm; **V3**- Spraying with Urea solution 46% N, 6 kg/ha, at a temperature of 12-25^{o}C and air humidity of 65-80%, when 75% of the flowers are open until the petals of the first flowers dropped; **V4**- Spraying with Geramid New solution, 1.5 l/ha, at a temperature of 15-20 ^{o}C, when the central fruit reached a diameter of 4-7 mm; **V5**- Spraying with LG Dira Max solution, 2,l/ha at a temperature of 18-25^{o}C, when the central fruit reached a diameter of 10-15 mm.

The intensity of flowering, the stages of fruit development, the time before and after the application of treatment were analyzed. The experiment was organized in 4 repetitions, the spraying was performed on 8 trees in each repetition, using 11 l of solution on 32 trees or 1000 l per hectare, respectively. The authors calculated the number of red dotted buds (NBR), the number of inflorescence set (NIL), the average number of fruits per tree as well as the average weight and diameter of fruits. Based on the number of plants per unit area, the average number of fruits per tree and the average mass of a fruit, the yield was determined for each variant per tree and per hectare. Fruit yield was determined by the gravimetric and calculation method. Based on the number of plants per unit area, the average number of fruits per tree and the average weight of a fruit, it was established the yield on each variant per tree and per hectare. Statistical processing of the research results was performed by the method of monofactorial dispersion analysis, the method of correlation and regression.

RESULTS AND DISCUSSIONS

The cv Gala Delicious trees selected according to their vigour and uniform development, differentiated a satisfactory quantity of fruit buds and at the emergence of the red dotted buds constituted 179-213 pcs/tree in 2016, 284-312 pcs/tree in 2017 and 213-240 pcs/tree in 2018. The number of red dotted buds (NBR) convincingly shows that trees have a uniform load of reproductive organs and differ from year to year. Regarding the number of inflorescence set (NIL), it was determined that their number is uniform by variants and constitutes don average 90.8 pcs/tree in 2016, 142 in 2017 and 95.8 in 2018, which constitutes an insignificant difference compared to the control variant. Analyzing the NBR and NIL balance, we can conclude that the methods used to adjust the crop load did not influence the number of inflorescences in the tree crown, because the trees are under identical conditions of growth and development

The number of fruits per inflorescence. Data regarding the number of fruits per inflorescence convincingly show that in the untreated V1-Control variant, where the reproductive organs were not thinned, the fruits were more evenly distributed per inflorescences: by one (32.4 - 44.1%), two (36.5 - 46.2%) and three fruits (19.4 – 21.4%). Crop load management increased the number of fruits by one per inflorescence compared to those of two and three fruits per inflorescence. For example, in V2-Manual thinning, 72.6 - 81.2% of fruits were distributed by one and only 18.8 - 27.4% fruits per inflorescence. The number of fruits per inflorescence, when using growth regulators, has increased distinctly their number by one fruit per inflorescence, compared to the untreated control variant. In 2016, the number of fruits by one per inflorescence constituted 71.2% in V3-Urea 46% N, 6 kg/ha, 61.8%

in V4-Geramid New, 1.5 l/ha and 67.7% in V5 - Dira Max LG, 2 l/ha, and the number of fruits by two and three per inflorescence has decreased markedly and constituted 22.5 - 32.3% and 3.6 - 6.3% respectively.

In 2017, the number of fruits was significantly higher compared to 2016, but the distribution of fruits per inflorescence was similar. Thus, as a result of the manual thinning of fruits 72.6% of the fruits were distributed by one per inflorescence, while as a result of using growth regulators this index constituted 64.6% in V3, 70.1% in V4 and 62.9% in V5. When treating the trees with Urea 46% N at the dose of 6 kg/ha, 25.8% formed by one fruit per inflorescence and only 9.6% by three fruits per inflorescence. In 2018, the highest number of fruits distributed per inflorescence was recorded in the variants with manual thinning (V2) and sprinkling with Urea 46% N at 6 kg/ha (V3) and constituted 88.4% and 78.4% respectively.

Number of fruits. Considering the productive potential of the Gala Delicious variety plantations, with trees planted at a distance of 3.5 x 1 m and trained according to the improved slender spindle crown shape, it was determined the quantity of fruits (80-110 pcs/tree), which provides sustainable yields and the highest economic efficiency.The size of fruits represents a very important quality parameter, and the larger fruits also bring greater value on the market and on export. The number of fruits of the Gala Delicious variety varies from year to year. Thus, in 2016 the number of fruits constituted from 73 pcs/tree in variant 5 (Dira Max LG, 2 l/ha) up to 114 pcs/tree in the control variant. This decrease in the number of fruits in V3 is due to the use of the Urea solution 46% in a concentration of 0.6%. The number of fruits at harvest (72 pcs/tree) in V4 is also significantly smaller compared to the control variant.

In 2016, sprinkling with LG Dira Max solution (BA 4.0% + NAA 0.4%) in a concentration of 2 l/ha reduced the number of fruits (64 pcs/tree). The number of fruits (110 pcs/tree) in 2017 was also lower compared to the untreated control (V1) and the use of Urea 46% N, 6 kg/ha (V3). In 2018, the number of fruits per tree was at the level of 2016 and was from 73 pcs/tree in V4 and V5 variants up to 98 pcs/tree in V1 at the time of harvest. The number of fruits in the V2, V3, V4 and V5 is significantly lower compared to untreated control variant V1.

In conclusion, we'd like to mention that in order to obtain a profitable annual yield of cv Gala Delicious, i.e. the adequate number of fruits per tree can be achieved when the number of red dotted buds per tree crown, the number of fruit set per inflorescence as well as the number of fruits after the ovaries drop in June don't record fruit overload per tree.

The average weight of fruits. In 2016, the average weight of a fruit recorded values from 109.5 g in the control variant to 146.5 g in the V4, where the growth regulator Geramid New was applied in the dose of 1.5 l/ha, when the central fruit reached 4-7 mm in diameter. As for the variants V2, V3 and V5, the average weight of a fruit also significantly exceeds the control variant reaching the level of the V4.

In 2017, the average weight of a fruit was lower compared to 2016 and constituted from 102.9 g in the untreated control variant V1 to 142.3 g in V2, where the manual fruit thinning was done after the physiological drop, when the fruits reach in diameter 16-18 mm.

Similar findings result for the year 2018, i.e. the use of manual fruit thinning and growth regulators increase the average weight of a fruit, and the average weight gains of a fruit, in the studied variants, are distinctly significant compared to the fruits from the control variant.

Diameter of fruits. In 2018, the average diameter of a fruit recorded values from 47.5 mm in the control variant up to 74.7 mm in the V3, where Urea 46% N was applied at the dose of 6 kg/ha. In the V2, V4 and V5, where the manual thinning and the growth regulators Geramid New, 1.5 l/ha and Dira Max LG, 2 l/ha were used, the average diameter of a fruit also exceeds the control variant significantly and constitutes 71.7-74.5 mm (table 1).

Table 1.

The influence of the thinning method of the crop load on the fruit distribution of the Cv Gala Delicious according to fruit diameter.

Variant	Average diameter (mm)	Fruit diameter (mm)						
		<55	56-60	61-65	66-70	71-75	76-80	>80
		Fruit share (%)						
V1-	47.5	37.9	35.4	21.0	5.7	-	-	-
V2	74.5	-	-	12.9	10.3	58.2	14.1	4.5
V3	74.7	-	-	11.9	5.4	49.8	26.8	6.1
V4	71.7	-	-	13.6	19.4	56.0	11.0	-
V5	71.9	-	-	11.4	16.5	51.6	20.5	-
DL 5%	4.02							

Analyzing the data related to the average diameter of a fruit of cv Gala Delicious we can conclude that the use of manual thinning after the physiological drop in June, the use of Urea solution 46% N in the concentration of 0.6%, when 75% of flowers dropped and the use of the growth regulators Geramid New, 1.5 l/ha, when the central fruit reaches 4-7 mm in diameter and Dira Max LG, 2 l/ha, when the central fruit reaches 10-15 mm in diameter, ensure a significant increase in fruit diameter.

Fruit diameter of the cv Gala Delicious, when being harvested, is directly influenced by the treatments applied using growth regulators, which determine not only their number and weight but also the distribution of fruits by size. Based on the performed investigations related to the weight of fruits by diameter, it turns out that in the untreated control variant, most fruits (37.9%) have a diameter less than 55 mm and only 5.1% have a diameter of 66-70 mm. Consequently, the fruits from the control variant, because of their size, cannot be assigned to the Extra category and category I. In the case of manual thinning (V2), the number of fruits with a diameter greater than 71 - 75 mm has increased significantly and constituted 68.1%, while the number of fruits with a diameter of 76-80 mm and larger than 80 mm constituted 14.1% and 4.5% respectively. This is because the fruits were evenly distributed in the tree crown and only 12.9% have the diameter of 61-65 mm and 10.3% - 66-70 mm in diameter.

The use of growth regulators favored fruit growth. For example, when using Urea 46% N at the dose of 6 l/ha, when 75% of the flowers dropped, the highest share of 49.8% had fruits with a diameter of 71-75 mm, 26.8% of fruits were 76-80 mm, 6.1% were over 80 mm and only 17.3% of fruits were 61-70 mm. Thus, it appears that the use of Urea 46% N, in the flowering phase, has a double effect, both of flower thinning and for fruit growing. The highest number of fruits (82.7%) is classified in the extra category and category I.

In the V4, as a result of using Geramid New, at a dose of 1.5 l/ha, the fruits recording a diameter of 71-75 mm constituted 56.0% and only 33% had a diameter of 61-70 mm. A similar distribution of fruits, i.e. an increased number of fruits belonging to the extra category and category I, was also recorded when treating trees with the growth regulator Dira Max LG, at a dose of 2 l/ha, when the central fruit reaches 10-15 mm in diameter and constitutes over 72.1%.

Fruit yield. Analyzing the data on fruit yield (table 2) of the Gala Delicious apple tree variety we can mention that the highest yield, distinctly significant, was obtained in the control variant, compared to the manual thinning (V2) and the treatment with growth regulators (V3, V4, V5). In 2016, the fruit harvest in the control variant constituted 35.7 t/ha, while in the case of V2, where fruit thinning was performed after the drop in June, the yield constituted 29.8 t/ha. The variants treated with Urea 46% N, at a dose of 6 kg/ha (V3), Geramid New, 1.5 l/ha (V4) and Dira Max LG, 2 l/ha (V5) ensured a fruit yield of 28.7 – 32.3 t/ha.

In 2017, the average fruit yield increased significantly (40.9 t/ha) compared to 2016 when it reached only 31.2 t/ha. Regardless of the active substance of growth regulators, in all the treated variants, the fruit yield was significantly lower compared to the untreated trees. This is due to the fact that the number of fruits in the treated variants has decreased because of the manual fruit thinning, when the fruit reached 16-18 mm in diameter (V2), the thinning of the flowers when 75% of the flowers were open (V3) and the chemical fruit thinning, when the central fruit reached 4-7 mm (V4) and 10-15 mm (V5) in diameter.

Table 2.

Productivity of Gala Delicious apple plantations depending on how the thinning method of the reproductive organs

Variant	Average fruit weight (g)			Fruit production (t/ha)			Average (t/ha)
	Year 2016	Year 2017	Year 2018	Year 2016	Year 2017	Year 2018	
V1	109.5	102.9	105.7	35.7	46.8	39.5	40.7
V2	145.7	142.3	141.9	29.8	45.6	32.4	35.9
V3	146.5	144.2	139.3	32.3	47.2	34.3	37.9
V4	138.3	141.9	137.8	28.7	44.6	32.6	35.3
V5	137.9	142.1	138.1	29.1	45.1	33.9	36.0
LD 5%	4.7	16.8	7.9	3.1	1.2	2,6	-

Similar findings also result for the year 2018, when the use of manual fruit thinning and growth regulators determined the decrease of the fruit yield significantly by 13.2 – 17.0%. Thus, the yield in the untreated control V1 was of 35.4 t/ha and in the treated variants (V2, V3, V4, V5) it constituted 32.4 – 34.3 t/ha.

Analyzing the fruit yield over three years, it was found out that the Gala Delicious variety trees, grafted on the rootstock M9, of 8-10 years old, are constantly fruitful reaching the average yield of 37.1 t/ha. Manual fruit thinning reduced fruit yield by 10.2%, the use of growth regulators also reduced the fruit production by 5.2% using Urea 46% N, 6 kg/ha, by 11.8%, when treated with Geramid New, 1.5 l/ha and 9.9% at sprinkling with Dira Max LG solution, 2 l / ha., but the quality of fruits (87.1 – 88.6%), category I and extra category.

CONCLUSIONS

During the fruiting and growing period of trees (8-10 years), the use of Urea 46% N, 6 kg/ha has the effect of both fruit flower thinning and fruit growth, it is not a pollutant and can be used without taking into account fruit diameter and climatic conditions when performing the treatment and after it.

Gala Delicious apple trees, grafted on the rootstock M9, aged 8-10 years, bear fruit constantly (average yield 37.1 t/ha). Manual thinning of fruits reduced the yield by 10.2%, and the use of growth regulators also reduced fruit yield by 5.2 – 11.8%, but increased the share of fruits (72.1-82.7%) falling into the category I and extra category.

Urea 46% N, is an effective fertilizer for flower thinning, can be easily used in all types of orchards at a dose of 6 kg/ha, using 1000 l of water, allows the selection of fruit sets, which turn out into uniform fruits. It is applied when 75% of the flowers are open until the petals of the first flowers drop, destroying the stigma and pollen of the open flowers, crumbling the petals to the unopened ones.

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REFERENCES

Babuc V., Gudumac E., Peșteanu A., Cumpanici A. 2013. Producerea merelor. Manual Tehnologic, Chișinău, p.121-127.

Balan V., Vămășescu S., Peşteanu A., Balan P. 2019. Influența fertilizării foliare asupra răririi fructelor și recoltei la soiul de măr Gala Delicious. In: Ştiinţa Agricolă, nr. 1, p. 51-47.

Peşteanu A. 2018. The influence of growth regulators on increasing the degree of setting and fruit production in the Idared apple plantation. Analele Univ. din Craiova XXIII (LIX), 184-189.

Robinson T., Lakso A., Stover E., Hoying S. 1998. Practical apple thinning programs for New York. New York fruit quarterly, 6: p. 14-18.

Stopar M., Tojnko S. 2005. Small fruit appearance of 'Fuji'/M.9 apples thinned by the most known thinning agents. Gronn Kunskap 105, 1-4.

Theron K.I. 2013. Chemical thinning of apple: South African perspective. Acta Horticulturae, 998, 85-90.

Vămăşescu S. 2018. Sporirea cantităţii şi calităţii producţiei de mere prin aplicarea fertilizării şi normării încărcăturii cu rod. Autoreferatul tezei de doctor în agricultură. Chișinău, 29 p.

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LEAF AREA FORMATION IN THE NEW APPLE VARIETIES CULTIVATED IN THE REPUBLIC OF MOLDOVA

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Keywords: *apple; variety; leaf area; shoots; fruiting branches.*

ABSTRACT

This paper presents the leaf area was studied in the Gala Buckeye Simmons, Granny Smith, Red Velox, and Golden Delicious Reinders apple varieties, grafted on the M9 rootstock and aged 2-5 years. The inter-row spacing was 3,2 m and the intra-row spacing – 0,8 m The experiments were installed in the central area of the Republic of Moldova, in 4 random repetitions of 8 trees each one. The dynamics of leaf area formation in trees over time and during the vegetation period is correlated with the total length of shoots and the number of rosettes of leaves on the tree. During the growth stage of the trees, most of the leaf area (68.9-76.1%) is formed on shoots and only 23.9-31.1% - on spurs and bourse shoots. During the growth and fruiting stages of the trees, the leaf area on the tree registered identical values on the shoots and on the fruiting branches. The Granny Smith and Golden Delicious Reinders varieties registered a larger leaf area (8.85-8.34 m^2/tree), compared to the Gala Buckeye Simmons and Red Velox varieties.

INTRODUCTION

The subject regarding the foliar apparatus is quite controversial both in the specialized literature and in the fruit production practice (Babuc 2012, Cimpoieș 2012). Therefore, based on various studies, it is necessary to establish a direct connection between the cultivation system and the biological material used with the purpose to optimize the expression of the biological production potential. This kind research highlighted the fact that the coefficient of solar energy use depends on the foliar apparatus at the unit of land area. In many cases, the leaf area in fruit varieties registered values of 20-30 thousand m^2/ha (Balan 1997, 2009, Peșteanu 2008), and the further increase of the leaf area leads to shading inside the tree canopy and, respectively, to the decrease of the photosynthesis efficiency (Balan 2009a, Vămăşescu 2018). By introducing new high yielding varieties and economically advanced technologies, we will raise the interest of fruit producers in the cultivation of apples. Sustainable fruits can be obtained under favorable conditions for the development of photosynthetic processes. Therefore, the dynamic formation of the leaf area determines to a significant extent the performance of an orchard. The research undertaken in this field by Jackson (1980), Агафонов (1983), Cimpoieș (2000), Balan (2009) has shown that fruit plantations are imperfect biological systems for the efficient use of solar energy. A large amount of light energy (19%) is lost until the emergence of leaves on the trees. About 50-54% of the active light is not intercepted by the foliage, 20% is reflected back by the leaves, 10% is photosynthetically inactive, and 20% pass through the vegetative system of tree rows due to the inappropriate parameters of the plantation (Budan & Amzar 1992). Thus, the solution of these problems largely depends on planting trees at optimal distances and shaping simple, natural canopies, which allow the formation of a well-lit leaf surface, greatly reducing the effect of mutual shading, while increasing the fruit yield (Balan 2009).

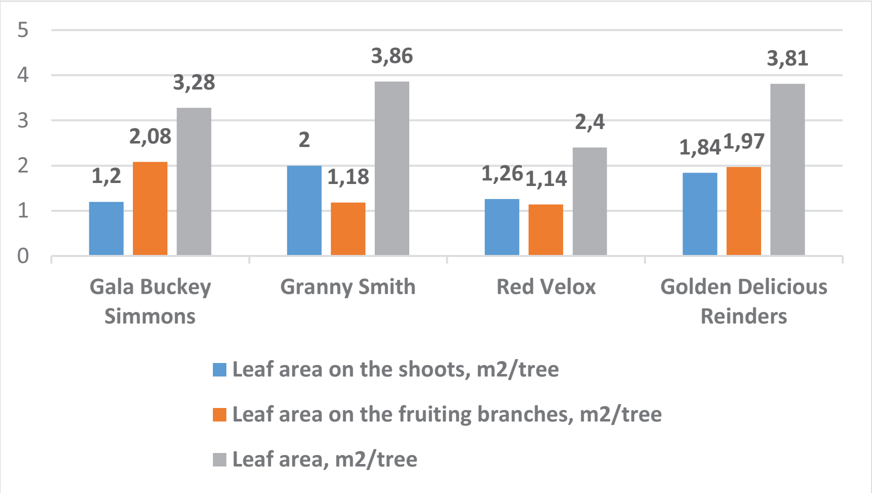
MATERIAL AND METHODS

The researches were carried out in the apple plantations established in 2014 at „Prodcar” Ltd. from Telenești district. The apple varieties Gala Buckeye Simmons, Granny Smith, Red Velox and Golden Delicious Reinders, grafted on the rootstock M9, were studied. The inter-row spacing was of 3.2 m and the intra-row spacing – 0.8 m. At planting, the grafting site was located 20 cm above the ground level. Until the planting of the orchard, it was installed a simple monoplane tree support system made of reinforced concrete pillars with a height of about 4 m above the ground and a metal wire installed at a height of 50 cm from the ground, which is also used as a support for the irrigation system. 5 more metal wires were installed in the first year of vegetation. The first 2 wires were fixed at the height of 80 cm from the ground at a distance of 40 cm from each other, the following wires were installed at 80 cm from each other.

The experiment was performed in 4 random repetitions of 8 trees each one. The counting of fruiting branches and their measurements were carried out both in open field conditions at 4 recorded trees of each variety and in lab conditions according to approved research methods in fruit growing (Мойсейченко 1988). The photosynthetic and growth potential of the trees was determined based on the number of fruits and emerging fruit buds and the measurements of the average and total length of the annual branches. Statistical processing of research results was carried out using the method of mono-factorial dispersion analysis (Доспехов 1985).

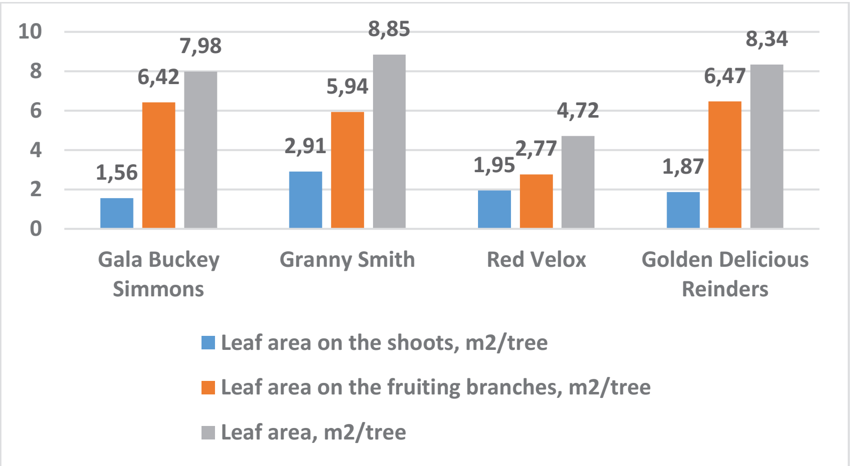
RESULTS AND DISCUSSIONS

The leaf area of the 3-year-old apple trees (fig.1), ranged from 2.40 m^2/tree for the Red Velox variety up to 3.86 m^2/tree for the Granny Smith variety. Gala Buckeye Simmons, Granny Smith and Golden Delicious Reinders varieties formed a distinctly larger leaf area compared to the Red Velox variety. We’d like to mention that the Granny Smith and Golden Delicious Reinders varieties formed a larger leaf area compared to the Gala Buckeye Simmons and Red Velox varieties, and they also recorded higher annual growths. As for the leaf area on the fruiting branches, it is established that the Gala Buckeye Simmons and Golden Delicious Reinders varieties formed more fruiting branches and leaves respectively (1.97-2.08 m^2/tree), compared to the Granny Smith and Red Velox varieties (1.14-1.18 m^2/tree). The foliar apparatus, relative to the field unit, is larger for the Gala Buckeye Simmons, Granny Smith and Golden Delicious Reinders varieties (31122-34515 m^2/ha), compared to the Red Velox variety (18408 m^2/ha). The latter situation can be explained by the fact that the Red Velox variety is weak in vigor and has lower growths.



LD, 5 %, 0.42 m^2/tree

Figure 1. Leaf area in the apple varieties depending on the biological peculiarities of the variety



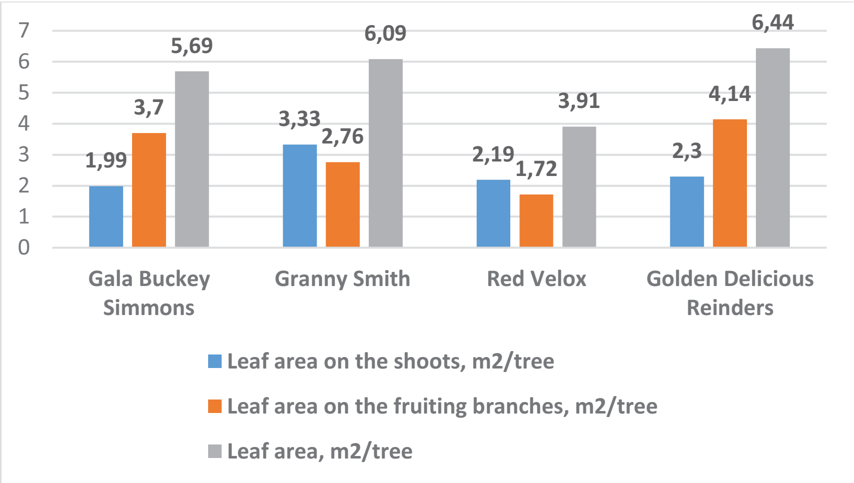
LD, 5 %, 1.15

Figure 2. Leaf area in the apple varieties depending on the biological peculiarities of the variety

The leaf area of 4-year-old trees (fig.2) ranged from 4.72 for the Red Velox variety to 8.85 m^2/tree for the Granny Smith variety. The foliar apparatus was formed mainly on the fruiting branches (2.77 - 6.47 m^2/tree) and only 1.56 - 2.91 m^2/tree was formed on the annual branches. This is due to the fact that once the trees bear fruits, the length of the annual growths decreases and the number of fruiting branches increases. If we refer to the variety, then the varieties Granny Smith and Golden Delicious Reinders registered a larger leaf area (8.85 - 8.34 m^2/tree and 34515 - 32526 m^2/ha respectively), compared to the varieties Gala Buckeye Simmons and Red Velox. Obtained data show that the varieties

Gala Buckeye Simmons, Granny Smith and Golden Delicious Reinders form a larger leaf area, significantly secured, compared to the Red Velox variety, which also has a more pronounced fruiting alternation.

In 2018 (fig.3), the leaf area on the shoots, at the end of vegetation stage was 1.99-3.33 m^2/tree. A higher increase of the leaf area on the shoots was recorded by the Granny Smith variety (3.33 m^2/tree), and a smaller one by the Gala Buckeye Simmons variety. On the other hand, the leaf area on the fruiting branches was the largest for the Gala Buckeye Simmons variety and the smallest for the Red Velox variety (1.72 m^2/tree).



DL, 5 %, 0.42

Figure 3. Leaf area in the apple varieties depending on the biological peculiarities of the variety

The leaf apparatus of a tree (3.91 - 6.44 m^2/tree) differs from one variety to another and depends on the leaf area on the shoots (1.99 - 3.3 m^2/tree) and on the fruiting branches (1.72 – 4.14 m^2/tree). The Golden Delicious Reinders variety recorded the largest leaf area (6.44 m^2/tree), and the Red Velox variety the smallest (3.91 m^2/tree) compared to the Gala Buckeye Simmons and Granny Smith varieties. A similar distribution of the leaf area by variety was recorded per unit area. Although the leaf area of trees in the studied varieties is optimal (Cimpoieș & Boțan 2005, Babuc & Croitoru 2008, Balan 2009), an important role is played by the dynamics of leaf area formation on the shoots and mainly on the rosettes (Palmer 1988). As a result, the photosynthetic potential of the canopy is correlated over time with the dynamics of leaf area formation on trees, including the intensity of shoot and rosette growth.

Analyzing the data on the leaf area of the studied varieties during the stages of growth and fruiting, we can conclude that the highest values were registered by the Golden Delicious Reinders and Granny Smith. Apple trees, aged 3 years, formed a leaf area of 9360 - 15054 m^2/ha (tab.1).

Table 1.
Leaf area in the apple varieties depending on the biological peculiarities of the variety

Variety	**Leaf area, m^2/ha**			
	year 2016	year 2017	year 2018	Average
Gala Buckeye Simmons	12792	31122	22191	22035
Granny Smith	15054	34515	23751	24440
Red Velox	9360	18408	15249	14339
Golden Delicious Reinders	14859	32526	25116	24167
Average	13016	29142	21576	21245

The plantations of Granny Smith and Golden Delicious Reinders varieties were characterized by forming a larger leaf area compared to Gala Buckeye Simmons and Red Velox varieties. In the 4th year of vegetation, the studied varieties formed the greatest photosynthetic potential. Thus, the Gala Buckeye Simmons, Granny Smith and Golden Delicious Reinders varieties also formed a larger leaf area (31122-34515 m^2/ha) compared to the Red Velox variety (18408). In 2018, the leaf area decreased significantly compared to 2017 and ranged from 15249 m^2/ha for the Red Velox variety to 25116 m^2/ha for Golden Delicious Reinders. This decrease in leaf area is due to the fact that the trees have fully entered in the fruiting stage, and the production potential of the orchard is optimal for modern high-density orchards (Агафонов 1983; Balan 2009). Therefore, the structure of the tree vegetative system should not exceed in size nor can fall below a certain limit. As a result, the photosynthetic productivity of the canopy is correlated in time with the active leaf area receptive to light energy, and the dynamics of leaf area formation on trees in ontogenesis and during the vegetation stage is correlated with the intensity of shoot growth and leaf rosettes growth (Balan 2009).

CONCLUSIONS

The photosynthetic productivity of the crown is correlated in time with the leaf area receptive to light energy, while the dynamics of leaf area formation in trees over time and during the vegetation stage is correlated with the intensity of growth of shoots and rosettes of leaves. During the growth stage of the trees, most of the leaf area (68.9 - 76.1%) is formed on shoots and only (23.9 - 31.1%) - on spurs, and bourse shoots. During the growth and fruiting stages of the trees, the leaf area on the tree registered identical values on the shoots and on the fruiting branches. The Granny Smith and Golden Delicious Reinders varieties registered a larger leaf area, compared to the Gala Buckeye Simmons and Red Velox varieties.

In 2017, the highest significantly distinct values of the leaf area of 76.7 - 87.5% were recorded by Granny Smith (34515 m^2/ha) and Golden Delicious Reinders (32526 m^2/ha) apple tree varieties compared to the Red Velox variety (18408 m^2/ha). In 2018, all the studied varieties, at the age of 4, made up a photosynthetic apparatus (15249 - 25116 m^2/ha) at the optimal level for intensive orchards.

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development of techniques of increasing fruit quality in Europe”. Project Director, Professor, Dr. Hab., Valerian BALAN.

REFERENCES

Babuc V. Pomicultura. 2012. Chișinău: Tipografia Centrală, 662 p.

Babuc V., Croitoru A. 2008. Caracteristicile fitometrice ale structurii plantației superintensive de măr în funcție de soi și modul formării coroanei de fus zvelt. Lucrări științifice, 16, 67-70.

Balan V. 1997. Sporirea productivității mărului în baza ameliorării structurii plantației și a tăierii pomilor. Chișinău, 24 p.

Balan, V. 2009. Metoda de determinare a suprafeței foliare la măr. Știința agricolă, 2, 35-39.

Balan, V. 2009a. Sisteme de cultură în pomicultură. Randamentul producției de fructe. Akademos, 4(15), 82-89.

Budan C., Amzar Gh. 1992. Cercetări de ecologie în pomicultură // 25 ani de activitate (1967-1992). ICPP Pitești-Mărăcineni. București, pp. 222-241.

Cimpoieș Gh. 2000. Conducerea și tăierea pomilor. Chișinău, 273 p.

Cimpoieș Gh. 2012. Cultura mărului. Bons Offices, 382 p.

Cimpoieș Gh., Boțan D. 2005. Creșterea și fructificarea mărului în funcție de soi și structura plantației. Știința agricolă, 1, 15-18.

Jackson J. E. 1980. Theory of light interception by orchard and a modeling approach to optimizing orchard design. Acta horticulturae,114, 69-79.

Palmer J.W. 1988. Annual dry matter production and petitioning over the first 5 years of a bed system of Crispin/M27 apple trees at four spacing. J. of Appl. Ecol. 25, 572.

Peșteanu A. 2008. Pretabilitatea soiurilor de perspectivă pentru sistemul superintensiv de cultivare a mărului. Lucrări științifice, 16, 77-80.

Vămăşescu S. 2018. Sporirea cantităţii şi calităţii producţiei de mere prin aplicarea fertilizării şi normării încărcăturii cu rod. Autoreferatul tezei de doctor în agricultură. Chişinău, 29 p.

Агафонов Н.В. 1983. Научные основы размещения и формирования плодовых деревьев. Москва, 173 с.

Методика полевого опыта. Москва: Агропромиздат, 351 с.

Мойсейченко В. 1988. Методика опытного дела в плодоводстве и овощеводстве. Киев, 141 с.

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APPLYING THE ANALYTICAL HIERARCHICAL PROCESS TO IDENTIFY THE MOST IMPORTANT GRAPEVINE VARIETIES FROM HILLS OF BANAT VITICULTURAL REGION

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***Keywords**: AHP, pairwise comparisons, grapevine cultivars, Region IV, sustainable viticulture*

ABSTRACT

The paper deals with the application of analytical hierarchical process (AHP) to identify and rank the most important grapevine varieties for wine from the Hills of Banat viticultural region, based on general criteria and expert's opinion. The results recommended Italian Riesling, Burgund mare and Cadarcă varieties as the valuable for this grapevine growing area. Considering that the Hills of Banat is the smallest viticultural region in Romania, it is located in one of the warmest wine zone according to EU wine zoning, and it is specialized in the production of table white and rosé wines, the present study can contribute to the establishment of a durable viticulture and the production of quality wines, of appropriate grapevine cultivars. The analyses were carried out using the Expert Choice Desktop software package.

INTRODUCTION

Hills of Banat viticultural region is located in the South-West of Romania, bordering Serbia and Hungary; it consists of insular vineyards, lying from Moldova Nouă, Caraş-Severin County, to Teremia Mare, Timiș County (Order No. 1205/2018) (Fig. 1). This region with six wine centers (Moldova Nouă, Tirol, Silagiu, Recaș, Jamu Mare, Teremia) has no vineyard in its structure but meets the conditions of a single vineyard (Stroe 2012, Antoce el al. 2013). Viticulture is practiced mainly at average altitudes of 231 me, between the Banat Mountains and plain areas. With a surface of 2962.43 ha, the Hills of Banat is the smallest wine region in România (Antoce & Călugăru 2017). In 2017, the distribution of Romanian vineyards by regions is: Moldova - 38%, Vallachia and Oltenia - 29%; Danube Terraces - 13%; Dobrogea - 9%; Crișana - Maramureș - 5%; Transylvania - 4%; Banat - 2% (Ştefan et al. 2017). According to the EU zoning, the Hills of Banat are located in the C I wine zone. Apart from the Hills of Banat, the C I Zone in România includes the regions of the Hills of Moldavia, Crişana and Maramureş, Vallachia and Oltenia - Ştefăneşti-Argeş, Sâmbureşti, Drăgăşani and Craiova (Bucur 2011).

European Union wine growing zones (A, B, C), used to regulate certain aspects of winemaking, differ in function of climate and reglementation required regarding grape maturity at harvest and allowed levels of valorization. Zone C, the warmest, is subdivided into C I, C II, C III a, C III b zones.

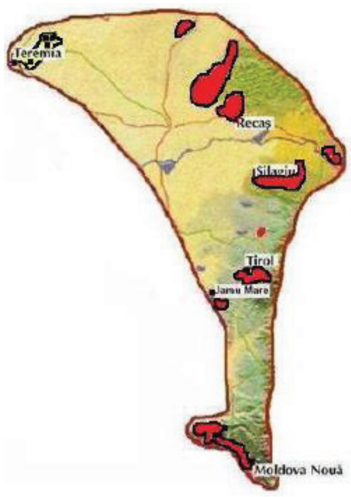

Figure 1. Banat Hills viticultural region (Stroe 2012)

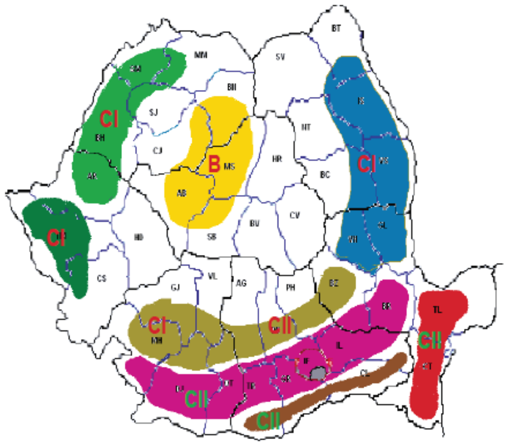

Figure 2. Romanian wine-growing regions according to EU zoning (Antoce et al. 2013)

Hills of Banat viticultural region resembles the Crișana and Maramures viticultural region from the North of Mureş, which is distinguished by much richer thermal resources, due to its more southern latitudinal position and the moderate continental climate with a sub-Mediterranean nuance much more clearly expressed here than in any another part of the country. The winters are mild, warm summers and long autumns. Heliothermal resources are high and relatively homogeneous throughout the region, leading to good ripening and even overripening of grapes, and water resources are superior to those of Moldova. Atmospheric precipitation has an annual average of 650 mm (550 mm in the low plains and 750 mm in the piedmont hills), and the annual potential evapotranspiration reaches the value of 700 mm, which leads to a balanced water regime for most part of the region, except the western plain (Teremia viticultural center). The average rainfall during the vegetation period approaching 395 mm (Stroe 2012). The main types of soil from Banat Hills Viticultural Region, defined according to SRTS - 2012 are the following: typical (calcareous) chernozem, gleic chernozem, batigleic chernozem, cambic chernozem, batigleic and/or saline and/or sodium aluvisol, eutricambosols, batigleic eutricambosols, preluvosaols, luvosols, vertisols, districambosols, stagnic luvisols, gleisols (Toti et al. 2017). Having a growing season of 200 days, this region makes possible the cultivation and production of both white and red wines of superior quality (Antoce et al. 2013). The representative varieties of white wine are: Creaţă of Banat, Majarcă albă, Steinschiller, Italian Riesling, Sauvignon; for red wine: Cadarcă, Burgund mare, Merlot and Pinot noir. The Hills of Banat viticultural region is specialized in the production of table white and rosé wines and, to a lesser exten,t of high quality white and red wines. The cultivation of table grape varieties has a lower share, and the varieties encountered are those with medium maturation: Chasselas doré, Muscat of Hamburg and Muscat d'Adda (Stroe 2012). The paper deals with the assessing and ranking some grapevine varieties of white, red and rosé wine grown in Banat Hills Viticultural Region by application of a hierarchical methodology (AHP) in order to culture the proper varieties for a durable viticulture in this area.

MATERIAL AND METHODS

AHP is one of the most used multicriteria decision making tool that allows ranking similar parameters by comparing and choosing between two parameters (pairwise comparisons) in each step. This objective and simple method relies on the judgments of experts to derive priority scales (Saaty 2008). The grapevine varieties (*Vitis vinifera* L.) studied by AHP in this paper are dedicated to white wine (Italian Riesling, Sauvignon blanc) and, red and rosé wine (Pinot noir, Cadarcă, Merlot, Burgund mare, Cabernet Sauvignon*)*. In order to determine the most important grapevine varieties, 12 criteria with a scale of 7 levels each were used in the AHP exercise, as follows: criterion 1 - harvesting period (from 1: the shortest harvesting period to 7: the longest harvesting period); criterion 2 - portfolio of derived products (from 1: the smallest number of derived products to 7: the highest number of derived products); criterion 3 - harvested quantity by one worker in 8 hours (from 1: the lowest quantity to 7: the highest quantity); criterion 4 - harvesting cost (from 1: the lowest cost to 7: the highest cost); criterion 5 - knowledge for recognition (from 1: most recognizable product to 7: hardest recognizable product); criterion 6 - knowledge for harvesting (from 1: the less knowledge necessary to 7: most knowledge necessary); criterion 7 - distribution range (from 1: lowest to 7: highest); criterion 8 - market potential (from 1: low to 7: high); criterion 9 - perishability (from 1: lowest to 7: highest); criterion 10 - "celebrity" of the product on the market (from 1: the least known to 7: the most popular); criterion 11 - biotic threats (from 1: the fewest threats to 7: the most threats); criterion 12 - abiotic threats (from 1: the fewest threats to 7: the most threats). The analyses were obtained by using the Expert Choice Desktop software (v. 11.5.1683). These criteria with a high degree of generality have been also used in other fields of research: forest fruits (Enescu & Dincă 2020), non-wood forest products (Blaga et al. 2019, Pleșca et al. 2019) and wild animals (Ciontu et al. 2018). An important contribution of this analyse registered in the study of climatic changes influencing the viticulture (Dincă et al. 2018).

RESULTS AND DISCUSSIONS

The AHP alternative ranking, based on expert's opinion, is presented in Table 1. According to the AHP results, the grapevine varieties of wine with the highest potential for the Banat Hills were: Italian Riesling, Burgund mare, Cadarcă (Fig. 3). Of these, in Order No. 225/2006 regarding the approval of Zoning noble grapevine species admitted in culture in Romania's viticultural areals are mentioned Italian Riesling and Burgund mare as being zoned for Hills of Banat.

The sum of active temperature in Banat Hills viticultural region being 3168°C and growing season of 200 days, the area is very suitable for the cultivation of selected grapevine varieties (Table 2).

Table 1

AHP alternative ranking

Criterion	Grapevine varieties						
	Italian Riesling	Sauvignon Blanc	Pinot Noir	Cadarcă	Merlot	Burgund mare	Cabernet Sauvignon
1	2	3	1	4	5	7	6
2	4	6	7	2	5	3	1
3	6	4	1	5	7	2	3
4	5	4	1	2	6	7	3
5	6	4	7	2	3	1	5

6	6	5	7	4	3	2	1
7	7	5	6	3	4	1	2
8	6	2	1	3	4	7	5
9	5	6	2	7	4	3	1
10	4	5	6	1	3	2	7
11	3	2	1	4	6	5	7
12	5	2	1	7	4	3	6

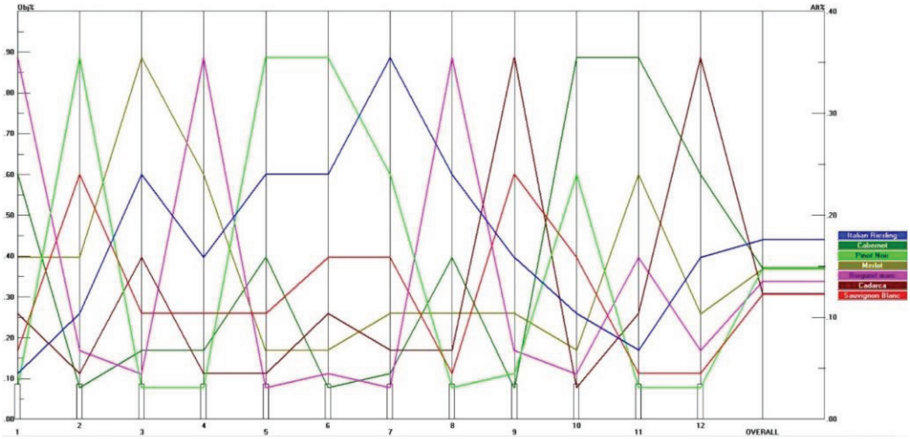

Figure 3. The ranking of the seven grapevine varieties for wine grown in Hills of Banat wine region

Table 2

Crossing the vegetation cycle for Italian Riesling, Burgund mare and Cadarcă grapevine varieties (adapted after Constantinescu et al. 1959, 1960).

Grapevine variety	Crossing the vegetation cycle	
	Temperature (°)	Days (No.)
Riesling Italian	2550 - 3650	166 - 210
Burgund mare	2055 - 3400	160 - 195
Cadarcă	2800 - 3400	181 - 195

Italian Riesling, Burgund mare and Cadarcă varieties show different resistance levels to biotic and abiotic stress factors. Italian Riesling variety is sensitive to drought and mites; has medium tolerance to cold, downy mildew, powdery mildew, gray mould and moths. Burgund mare variety is sensitive to downy mildew, resistant to powdery mildew, gray mould, mites and moths; has good tolerance to drought and low resistance to cold. Cadarcă variety is sensitive to drought and downy mildew; resistant to mites and moths, has low resistance to cold and good resistance to powdery mildew. The Italian Riesling variety reacts quite well to irrigation and Burgund mare variety can be damaged by the excess moisture (Constantinescu et al. 1959, 1960, Stroe 2012). (Constantinescu et al. 1959, 1960).

Italian Riesling variety produces high quality grapes on the sunny slopes of the vineyards. The production/vine in Silagiu was lower than in Teremia mare or in localities from other wine regions (Bucharest, Crăciunel, Drăgășani, Huși, Istrița, Miniș, Murfatlar, Odobești, Valea Călugărească). At Silagiu it was a minimum yield in must (59.7% by weight, corresponding to 53.9% by volume). Also, the production of grapes/ha, the amount of accumulated sugars/ha and the alcoholic degrees were higher in Teremia mare as compared to the registration to Silagiu (Constantinescu et al. 1960). Grape production of Burgund mare variety is influenced by the rootstock on which it is grafted. Although Burgund mare prefers fertile soils, it behaves satisfactorily even on poorer ones. It is grown on slopes with southern or south-eastern exposures that receive a lot of heat and light. In 1946, Cadarcă variety registered at Silagiu a maximum potential for sugar accumulation (232 g/L, the equivalent of 13°7 degrees alcohol) (Constantinescu et al. 1959).

Italian Riesling and Cadarca varieties behave well on calcareous soils where are grafted on Chasselas x Berlandieri 41 B rootstock. Grafted on Berlandieri x Riparia Teleki 8 B, Kober 5 BB or Crăciunel 2 rootstoks, Cadarcă variety adapts well to the terrain. Burgund mare variety behaves well on Berlandieri x Riparia Teleki 8 B and Kober 5BB rootstocks; it can also be grafted on Chasselas x Berlandieri 41 B. On terrain with low percentage of limestone it behaves well on Riparia Gloire, in this case having a shorter longevity (Constantinescu et al. 1959, 1960).

CONCLUSIONS

The AHP results based on pairwise comparisons of 12 subjective criteria with high degree of generality, Italian Riesling, Burgund mare and Cadarcă grapevine varieties for wine were selected as the most important for Hills of Banat, from a group of seven cultivars grown in this viticultural region (Italian Riesling Sauvignon blanc, Pinot noir, Cadarcă, Merlot, Burgund mare, Cabernet Sauvignon). Although these three varieties have different demands on eco-pedoclimatic factors and Hills of Banat is located in the C I wine zone according to the EU zoning (zone C being the warmest), they seem to make the best use of the characteristics of the area, in terms of good management of biotic and abiotic stress factors (fugus diseases, pests, drought, cold).

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REFERENCES

Antoce A.O., Călugăru L.L. 2017. Evolution of grapevine surfaces in Romania after accession to European Union - period 2007–2016. BioWeb of Conferences 9, 03018. 40th World Congress of Vine and Wine. DOI: 10.1051/bioconf/20170903018.

Antoce A.O., Nămoloșanu I., Dușa D., Mereanu D., Rebigan C., Nicolau V., Călugăru L.L. 2013. Some considerations regarding the grapevine variety assortment and wine categories in Romania in recent years. Bulletin de l'OIV, 85, 27-43.

Bucur G.M. 2011. Viticultură. Universitatea de Științe Agronomice și Medicină Veterinară București. Departamentul de Învăţământ la Distanţă, pp. 126-132.

Blaga T., Pleșca I.M., Dincă L. 2019. Selecting the most promising non-wood forests products for Bacau County using the analytic hierarchy process. Studii și Cercetări Științifice-Biologie, 28(1), 29-33.

Ciontu C.I., Dincă L., Bratu I. 2018. Analiza unor specii de interes cinegetic din judetul Calarasi. Revista de Silvicultura si Cinegetica, 43, 91-95.

Constantinescu G., Negreanu E., Lăzărescu Z., Poenaru I., Alexei O., Boureanu C. 1959. Amplelografia RPR, Vol. II. Soiurile raionate A-H. Editura Academiei RPR, București, pp. 233-244, 274-290.

Constantinescu G., Negreanu E., Lăzărescu Z., Poenaru I., Alexei O., Boureanu C. 1960. Amplelografia RPR, Vol. III. Soiurile raionate A-H. Editura Academiei RPR, București, pp.1906-1937.

Dincă L., Vizitiu D.E., Donici A., Popa L., Murariu G. 2018. The health dynamic of forest and vinicultural ecosystems from Romania during the last two decades in the context of current climatic changes. International Scientific Conference on EARTH and GEOSCIENCES-Vienna GREEN Scientific Sessions, 18, 789- 796.

Enescu R., Dincă L. 2020. An assessment of forest fruits from Arad County. Annals of the University of Craiova – Agriculture, Montanology, Cadastre Series, 49(2), 107-112.

Pleșca I.M., Blaga T., Dincă L., Breabăn I.G. 2019. Prioritizing the potential of non-wood forest products from Arad county by using the analytical hierarchy process. Present Environment and Sustainable Development,13(2), 225-233.

Saaty L. 2008. Decision making with the analytic hierarchy process. Int. J. Serv. Sci., 1(1), 83-98.

Stroe, M. 2012. Ampelografie. Facultatea de Horticultură. București, pp. 108-113, 259-261, 290-292, 307-308.

Ştefan P., Mann S., Fintineru G., Creţu R.C. 2017. Study regarding the situation of wine producers in Romania. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development 17 (3).

Toti M., Dumitru S., Vlad V., Eftene A. 2017. Atlasul pedologic al podgoriilor României. Publishing House Terra Nostra, Iași, pp 79-80.

*** Caiet de sarcini pentru producerea şi comercializarea vinului cu denumire de origine controlată ”Banat”. https://www.onvpv.ro/sites/default/files/caiet_de_ sarcini_ doc_banat_134ro.pdf.

*** European Union wine growing zones. https://en.wikipedia.org/wiki/ European _Union_wine_growing_zones.

*** Ordin nr. 225/2006 privind aprobarea Zonării soiurilor nobile de viță-de-vie roditoare admise în cultură în arealele viticole din România.

*** Ordin nr. 1205 din 22 iunie 2018 pentru aprobarea Nominalizării arealelor viticole şi încadrării localităţilor pe regiuni viticole, podgorii şi centre viticole.

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BIOTECHNOLOGICAL ASPECTS MET IN OBTAINING SWEET BREAD

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Keywords: *sweet bread, biotechnological aspects, fat.*

ABSTRACT

This study aims at an analysis of the biotechnological aspects during obtaining and storing a product highly appreciated by consumers: swet bread. In this sense, details are debated regarding the obtaining of the product. Sweet bread with walnut, as well as the biotechnological analysis of the product from the point of view of manufacturing defects. This aspect pursues two aspects: the biotechnological analysis of the product in terms of manufacturing defects and biotechnological aspects that can lead to biotechnological changes in the finished product.

INTRODUCTION

The confectionery cakes industry is in the top of preferences, being a category of products appreciated by a wide range of consumers, from babies to old people (Banu et al. 2000, Popa et al. 2007). The nutritional value of the sweet bread product is determined by the complete proteins (provided by eggs from the countertop and milk from the cream), associated with vegetable proteins from flour, easily assimilable lipids from butter or margarine, rich in fat-soluble vitamins (A and D) Spiere et al. (2007) as well as the simple carbohydrates provided by the three main semi-preparations: countertop, syrup, cream, chocolate, etc (Manailescu et al. 2003, Căpruciu 2011, 2013). Sweet bread is a product obtained from leavened dough, a dough in which, in addition to flour, liquids and other ingredients, baking yeast is added which, through the fermentation process (known as leavening), creates an accentuated porosity, an increased volume and a characteristic taste of the products (Pérez-Nieto et al. 2010, Farrera-Rebollo et al. 2012). Porosity is a means of facilitating digestibility, because it increases the area of action of saliva and gastric juice. In parallel with the porosity, the chemical reactions that take place in the dough, form a series of substances that improve the aroma of the preparations and degrade some components, making them more accessible to assimilation (Datta et al. 2007).

MATERIAL AND METHODS

The following raw materials were used to make the cake: flour, milk, sugar, eggs, yeast, salt, oil, vanilla, walnut and lemon peel.

The samples were formed with the following variants:

-variant 1- margarine / butter stored for 12 hours at a temperature of 4°C;

-variant 2 -margarine / butter stored for 12 hours at a temperature of 20°C;

The product "Sweet bread with walnuts" was obtained by the direct method which involves the concomitant mixing of all the components provided in the recipe, followed by fermentation. For the preparation of preparations with high porosity, it is necessary to use a larger amount of yeast. It has the advantage that it shortens the technological process, but also the disadvantage that it requires an extra amount of yeast, giving the preparation a more accentuated smell and taste of alcohol and lower porosity. The peroxide value is used in addition to other quality parameters, for determining the oxidation degree of a product which is composed of fat. This index is a measure unit for the oxygen content linked with peroxide in oils and fats and particularly for the hydroperoxides. The peroxide value was measured by determining the amount of converted iodide to iodine under the action of the active oxygen of the peroxide. The result was expressed as the number of milligrams of active O_2/kg of fat. There is only one principle for both methods of the peroxide value determination: the oxidation of iodides to iodine through the active oxygen of peroxide, and measuring the amount of free iodine by titration with 0.01 N sodium thiosulfate solution. An index expressed in milligrams of active O_2 higher than 20, indicates that fats are rancid. If this index is very low, it has no meaning, in this case a simple heating at 130°C is sufficient to destroy the peroxides (Căpruciu, 2011). Sensory examination of the product "Sweet bread with walnut" refers to the appearance, condition and appearance of the core, aroma, taste, signs of microbial spoilage. The external appearance was analyzed by visual examination of the whole pieces of cake, following the shape, surface condition, appearance and color of the shell. The external appearance of the cake was established by examining the whole piece, following the symmetry, a regularity of the shape and noting the normal or incorrect shape with the indication of shape defects. The porosity structure was determined by tracking the pore size and the uniformity of their distribution on the surface of the cut. The condition and appearance of the core was checked by examining the elasticity, for which purpose, after cooling, the cake was cut in half and then lightly pressed with the finger on the core, so as not to destroy the pore structure. If the core has a high resistance to finger pressure and deforms slightly it is compact, dense. At the same time, it is checked if the core is dry to the touch, it does not crumble and the pore structure is normal. The aroma and taste were verified by smelling the core and tasting both the core and the peel of the product. For their assessment, the whole samples were examined, then they were cut and their core was examined. The taste is established from the core and shell by chewing. It can be: normal, pleasant, sweet and slightly sour, sour, unsalted, bitter. You can also see the presence of foreign bodies by gnashing your teeth. The aroma is determined by the smell of the core.

RESULTS AND DISCUSSIONS

In the numerous attempts to obtain the product "Sweet bread with walnut" during the study, the main defects of the leavened dough were: the presence of foreign bodies in the composition of the dough due mainly to defective sieving, agglomerations of flour or yolk due to improper preparation of soda (too hot, the egg coagulated and did not mix properly with the sugar): the consistency of the dough is too small or too large (the amount of milk was too large or too small); strong smell of alcohol, excessive porosity (a large amount of yeast was used, the normal fermentation time was exceeded). Defects, causes and remediation processes encountered in the technological flow of obtaining the product "Sweet bread with walnut" are given in Table 1. As can be seen from Table 1, the only biotechnological defects that could not be remedied were the strong smell of alcohol and excessive porosity. Seen in the section, the product did not grow properly (it has small and dense pores), it is raw (the baking process is inadequate - the baking parameters were not observed, especially the temperature) table 2.

Table 1

DEFECTS OF YEAST DOUGH IN THE TECHNOLOGICAL FLOW OF OBTAINING THE PRODUCT "SWEET BREAD WITH WALNUT"

Defects	Causes	Remedies
the presence of foreign bodies in the composition of the dough	the primary processing was not performed correctly	the primary processing of unused food is done
agglomerations of flour or yolk	the soda was too hot, the sugar combined with the egg without mixing	agglomerations of flour are removed during kneading and those of egg by straining the solution
dough consistency too small or too large	too much or too little liquid was used	combine with a dough that has a stronger consistency or combine with liquid
strong smell of alcohol, excessive porosity	a large amount of yeast was used, the normal fermentation time was exceeded	cannot be remedied

Tabel 2

DEFECTS OF THE FINISHED PRODUCT "SWEET BREAD WITH WALNUT"

Defects	Causes	Remedies
The presence of foreign bodies	The primary processing was not performed correctly	The primary processing of raw materials is done.
Flour or yolk agglomerations	The soda was too hot. The sugar was combined with the egg without mixing	Flour clumps are removed during kneading, and egg clumps by straining soda.
The consistency of the dough is too soft or too hard	Too much or too little liquid was used	Combine with a dough that has a stronger consistency or add more liquid.
Strong smell of alcohol. Excessive porosity	Too much yeast was used. The normal fermentation time has been exceeded	It can't be fixed. Knead the dough, then shape
The surface of the baked dough has burns / deformations	The dough had too much yeast. The consistency of the dough was too soft. The temperature setting was too high at the beginning of baking.	It could be attenuated by covering it with a layer of powdered sugar.
In the section it is insufficiently baked	Baking time and temperature were not observed. The dough was too thick. It didn't have enough yeast or it wasn't good quality.	Cannot be remedied
Peeling of the core	Due to the oven being too hot, the upper shell becomes too compact before the volume growth process is completed. The vapors and gases formed press the dough into the dough, detaching it from the crust.	Cannot be remedied

As for the deformation / wrinkles on the surface of the baked dough, they are due to the dough that had too much yeast. Also the consistency of the dough was too soft or the temperature setting was too high at the beginning of baking. As a remedial process, it could be alleviated by covering it with a layer of powdered sugar. Laboratory analyzes were performed for both types of fat after unpacking (initial sample) and 12 hours after unpacking at different temperatures (4°C, 20°C) in the presence of air.

Table 3 shows that at the set temperatures the amount of active oxygen resulting from the calculation of the peroxide index is lower in margarine after 1 hour of storage, compared to the butter variant with differences of about 1 mEq / kg.

Table 3

MEASUREMENT OF THE OXIDATION DEGREE I.P. (mEq / Kg) FOR MARGARINE / BUTTER DEPENDING ON TIME AND STORAGE TEMPERATURE

Time storage	Temperature storage	I.P.(mEq/kg)	
		Fat variants	
		V_M	V_U
Samples after 1 hour of storage	4°C	5,3	6,2
	20°C	5,3	6,4
Samples after 12 hours of storage	4°C	6,1	6,8
	20°C	6,8	8,4

I.P. = peroxide index; VM = margarine variant, VU = butter variant

Major differences are observed after 12 hours of storage, the temperature and oxygen in the air directly influencing the degree of oxidation. Thus, in the margarine variant, an increase of I.P. depending on the duration of storage. Samples of margarine stored in the refrigerator (at 4°C) after 12 hours change their IP by 0.8 mEq / kg while samples kept at room temperature (20°C) show changes in IP of 1.5 mEq / kg compared of the initial test.

In the butter samples there is an increase of 0.2 mEq / kg for each temperature threshold studied. The experimental variants consisting of butter after 12 hours of storage are characterized by a rapid increase in the peroxide index with maximum values for samples maintained at 20°C (8.4 mEq / kg). Thus, the margarine used in the recipe for the product "Cozonac with walnut" undergoes an accentuated oxidation process when it is stored at room temperature (20 ° C) for a period of 12 hours, reaching a peroxide index of 6, 8mEq / kg. The difference between using margarine stored for 12 hours at 4°C and margarine stored for 12 hours at 20°C is the limitation of the consumption time of products obtained on the basis of this type of margarine. Following the experiment, it can be concluded from the determination of the degree of oxidation that the first variant of the cake, obtained on the basis of fats (margarine / butter) used immediately after removing the packaging, and the variant maintained for 12 hours at 4°C. Kept the organoleptic and physical properties intact (flavor, taste, smell) for about 14 days, while in the second variant (use of margarine and butter with modified peroxide index-samples kept 12 hours at 20°C) was perceived following the organoleptic analysis, different taste and smell, easy to oxidize, both products losing their flavor after about seven days from production. In comparison, butter oxidized faster than margarine, given that the one used in the study is freshly prepared without the addition of additives (Table 3). The increase in oxidation is directly correlated with the increase in temperature. If at storage temperature freshly prepared butter has an oxidation index of 6,2 mEq / kg, it is observed that with increasing temperature (20°C) and storage life (12 hours), the degree of oxidation increases significantly (8,4mEq / kg), the butter starting to change its general appearance. Following the organoleptic determination, the color change is observed, being easily perceived and the smell and taste slightly modified.

CONCLUSIONS

Some of the defects encountered in dough processing are also found in the finished product: the presence of foreign bodies, agglomerations of flour or yolk, the consistency of the dough too soft or too hard, strong odor of alcohol, excessive porosity. In addition, the surface of the baked dough has wrinkles / burns / deformations, the core comes off the crust.

A common defect was the crossing of the product and it was due to several causes. Of these we mention the different temperatures between the shell and the core; they are placed on cold metal surfaces and not on grills (immediately after removing from the oven); it is kept too long in the baking tray or it is cut after removing it from the oven. The process of remedying this defect is to place it on wooden grills immediately after removing it from the oven, bringing the product to room temperature and then cutting.

Among the defects of the finished product that cannot be remedied we list: insufficient baking in the section due to non-compliance with the baking time and temperature or the dough was too dense or did not have enough yeast or was not of good quality and detachment of the core due to mainly to some technical aspects of baking (the oven is too hot, the upper crust becomes too compact, before the process of increasing the volume is finished) or the vapors and gases formed press the dough mass detaching it from the crust.

In this sense, important indicators from a biotechnological point of view were determined to determine the freshness of the margarine and butter used in the recipe of the product "Sweet bread with walnut".

The instability of the butter samples was more obvious than that observed in the margarine samples, even in the determinations made one hour after opening the package.

Analyzing the above data it can be concluded that the use of different types of fats for direct consumption or as an addition to various preparations, is optimal only if they are kept at low temperatures (4°C), a certain time (preferably 12 hours if the packaging was undone), the biotechnological aspects being minimal in this case.

REFERENCES

Banu C., Butu N., Sahleanu V., Răsmeriță D., Stoicescu A., Hopulete T. 2000. Biotehnologii în industria alimentară. Editura Tehnică, București.

Căpruciu R. 2011. Tehnologii utilizate în industria uleiului, Editura Sitech. Craiova.

Căpruciu R. 2013. Implicarea biotehnologiilor în industria alimentară. Editura Sitech. Craiova.

Manailescu A., Nicolau E., Pantu G., Campean D., Constantinescu M. 2003. Tehnologia produselor de patiserie şi cofetărie, Bucureşti, Editura Didactica şi Pedagogica.

Popa A., Giurgiulescu L. 2007. Bazele biotehnologiilor în industria alimentară, Editura Universitaria, Craiova, 2007.

Spiere M.R., Rapacci M., Deboni S. 2007. Sweet bread produced by de lactic acid bacteria L. Brevis and the Yeast S. Cerevisiae, International Journal of Food Engineering, 3(5),1-15.

Farrera-Rebollo R.R., Cruz M.S., Chanona-Pérez J., Gutiérrez-López G.F., Beltrán L.A., Domínguez G.C. 2012. Evaluation of image analysis tools for characterization of sweet bread crumb structure. Food Bioprocess Technol, 5, 474–484.

Pérez-Nieto A., Chanona-Pérez J. J., Farrera-Rebollo R. R., GutiérrezLópez G., Alamilla-Beltrán L., Calderón-Domínguez G. 2010. Image analysis of structural changes in dough during baking. LWT Food Science and Technology, 43, 535–543.

Datta A. K., Sahin S., Sumnu G., Keskin S. O. 2007. Porous media characterization of breads baked using novel heating methods. Journal of Food Engineering, 79, 106–116.

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ANALYSIS OF THE QUALITY OF SOME VARIETIES OF GARDEN BEANS ACCORDING TO THE TIPE OF THE PACKAGING AND METHOD OF STORAGE

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Keywords*: garden beans, quality, packing, storage*

ABSTRACT

This study analyzes the quality of pods from 4 varieties of garden beans (Bergolo, Sonesta, Verba, Aurie de Bacău) stored in different containers (plastic mesh bags, perforated polyethylene bags, prepackaged in polyethylene pots) at the temperature and atmospheric humidity of the storage room (two variants) and the temperature of 4 - 6 °C in the cold room (4 variants). The duration of storage (hours) of fresh pods in undeveloped space was monitored, depending on the method of pre-packaging, the duration of storage (hours) of fresh pods depending on the variety, space and mode of pre-packaging and the duration of storage (no. hours) of the quality of the pods depending on the variety and method of prepackaging stored in arranged spaces.

INTRODUCTION

The bean crop was grown without fertilization, but the lettuce crop was treated with mineral, organic or foliar fertilization. The application of different fertilizer sources to the fore-crop resulted in high yields of the subsequent bean crop, with good quality parameters and without polluting the arable soil layer with fertilizer residues. Organic fertilization supplied during the cultivation of the previous crop had a stronger effect than mineral fertilization on certain quality parameters of the kidney bean plants, such as dry matter, vitamin C content, and the accumulation of nitrates. (Stancheva et al. 2004, Mitova et al. 2008). The storage of garden beans influences the preservation of quality parameters. The type of packaging used may also lead to qualitative changes during storage (Beceanu & Ghira 2003, Bucher et al. 2011, Gherghi1994, Doru et al. 1970, Dumitrescu et al. 1988, Lascu 2006, Mirghiş et al. 1980). Strategic changes in the food environment might therefore be potential measures to influence consumers’ food selection towards better nutrition, without affecting the consumers’ freedom of choice (Bucher et al. 2011).

MATERIAL AND METHODS

The experience was located in the experimental field of the discipline at S.D. Banu Mărăcine. The analyzed variants were:

Factor A (varieties) included 4 varieties of garden beans, two of the nanus variety and two of the communis variety, namely:

a 1 = Bergolo (determined growth, yellow pod);

a 2 = Sonesta (determined growth. green pods);
a 3 = Verb (indeterminate growth, green pod);
a 4 = Aurie de Bacău (indeterminate growth, yellow pod);

Factor B - bean pods from the 4 varieties were kept after harvest, in order to follow the evolution of quality elements, in 6 variants, namely:

b1 = stored in 2 kg plastic mesh bags at room temperature and atmospheric humidity; b2 = stored prepackaged in 1 kg perforated polyethylene bags at room temperature and humidity; b3 = stored prepackaged in 0.5 kg polyethylene pans at room temperature and humidity; b4 = stored in 2 kg plastic mesh bags at a temperature of 4 - 6^{o}C in the cold room;b5 = stored prepackaged in 0.5 kg perforated polyethylene bags at a temperature of 4 - 6^{o}C in the cold room; b6 = stored prepackaged in 1 kg polyethylene pans at 4 - 6^{o}C in the cold room

RESULTS AND DISCUSSIONS

Regarding the quality of the pods after harvest, in the climatic conditions of the vegetation period, according to the requirements provided in STAS-I SR 8948/2003 (chart no.1), it is found that the extra quality pods were between 22% for the bean variety climbing Verba and 42% of the Sonesta determined growth variety, representing, on average, 32.5% of the total, and almost half of the Ia quality (53.1% of the Ia quality). The first quality pods were between 52% for the Sonesta determined variety and 72% for the Aurie de Bacău climbing bean variety, representing an average percentage of 61.25% of the total for the four analyzed varieties. Category II pods were between 3 and 7%, representing only 3.25% of the total. The highest percentage of first quality pods was registered for the Aurie de Bacău variety with undetermined growth, being by 3805 percentage points higher than the Sonesta variety, by 24.1 percentage points higher than the Bergolo variety. and 14.3% higher percentage units than the Verba variety.

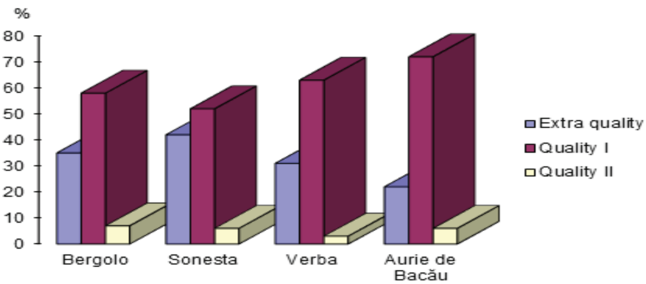

Figure1 Quality of pods in the analyzed varieties

Pre-packaging of bean pods in 0.5 kg polyethylene pans resulted, under the same storage conditions, in a decrease in duration only for dwarf varieties, Bergolo and Sonesta, with the same percentages as in the case of pre-packaging in 1 kg polyethylene bags. (33.3% and 20%, respectively), compared to pre-packaging in 2 kg plastic mesh bags. As such, in storage conditions in spaces not designed for directing the temperature and relative humidity of the air, the best results were recorded when prepacked in 2 kg plastic mesh bags, regardless of the bean variety.

If the temporary storage of garden bean pods in spaces with a temperature of 6 - 7oC, from figure no. 3 shows that the storage time increases by up to 325%

(b2 compared to b5) depending on the prepacking mode, which is a longer duration by up to 156 hours (6½ days), compared to storage in undeveloped spaces. Thus, the pre-packaged pods in 2 kg plastic mesh bags showed an increase in storage time in arranged spaces by 166% to 216%, depending on the variety, by 275% to 325%, depending on the variety , when prepacked in 1 kg polyethylene bags, and by 233% to 300%, depending on the variety, when prepacked in 0.5 kg polyethylene pans.

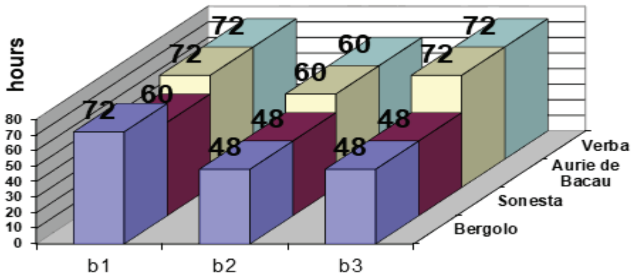

Figure 2 Shelf life (hours) of fresh pods in undeveloped space, depending on the method of prepackaging

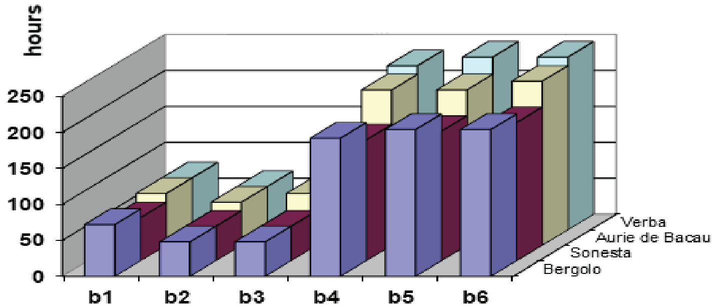

Figure 3 Shelf life (hours) of fresh pods in operation variety, space and method of prepackaging

Representing graphically the storage time in fresh condition depending on the variety and method of pre-packaging (figure 4) it is found that in the temperature conditions of 6 - 7 °C, the storage life was between 168 hours and 240 hours. The longest storage time in these conditions was the Verba climbing bean variety with green pods, flat, pre-packaged both in 1 kg perforated polyethylene bags and in 0.5 kg polyethylene pots. Prepackaging of bean pods in 1 kg perforated polyethylene bags resulted in a slight increase in shelf life of 5.3% to 6.3% for Bergolo, Sonesta and Verba varieties compared to pre-packaging in plastic mesh bags of 2 kg.

The pre-packaging of the bean pods in 0.5 kg polyethylene casseroles determined, under the same storage conditions, an increase in the storage time for all varieties, namely by 5.3 for the Verba variety, by 5.5% for the Aurie de Bacău variety, with 6.3% for the Bergolo variety and with 14.3% for the Sonesta variety, compared to the prepackaging in 2 kg plastic mesh bags. As such, in storage conditions in spaces arranged for temperature control (6 - 7°C), the best results were recorded when prepacked in 0.5 kg polyethylene pots, regardless of the bean variety.

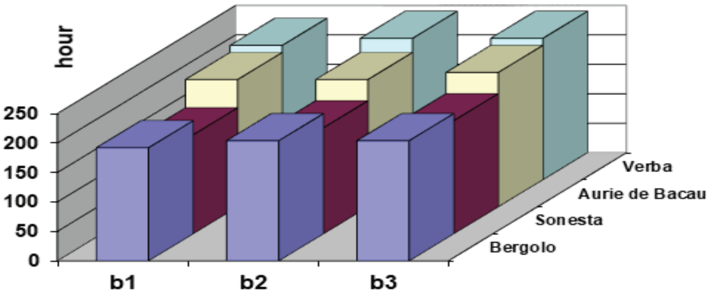

Figure 4 Shelf life (hours) of the quality of the pods in function variety and method of prepackaging stored in arranged spaces

Representing graphically the losses recorded for the analyzed bean varieties, established at the time of the first qualitative damage to the pods, from figure no. 5 it is found that regardless of the pre-packaging method, in case of temporary storage in space not arranged for temperature control, the most sensitive was the Sonesta variety with determined growth, green pods, cylindrical, and the most resistant was the variety Verba with undetermined growth, pods green, flat, the differences being between 50% to 64.2%, depending on the prepackaging method. In the case of storage in undeveloped spaces, it is found that the order of the varieties based on the decrease of the percentage of qualitative losses of the pods is Sonesta, Bergolo, Aurie de Bacău and Verba, regardless of the prepackaging method, the most sensitive being those with determined growth. It is also found that all these analyzed varieties showed an increase in losses on prepackaging in perforated polyethylene bags of 1 kg by 23.9% for the Bergolo variety, by 17% for the Sonesta variety, by 39.4% for the Aurie de Bacău soul and by 35.7% for the Verba variety, compared to their prepackaging in 2 kg plastic mesh bags. Prepackaging in 0.5 kg polyethylene pans also led to an increase in losses, ie by 52.2% for the Bergolo variety, by 47.2% for the Sonesta variety, and by 81.2% for the Aurie variety. Bacău also with 53.6% for the Verba variety, compared to their prepackaging in 2 kg plastic mesh bags. As such, in the case of temporary storage of garden bean pods in spaces not designed for temperature control, the best way to prepack is in 2 kg plastic mesh bags. In the case of storage in spaces arranged to maintain the temperature of 6 - 7oC, from figure no. 5 it is found that the order of the varieties based on the decrease of the percentage of qualitative losses of the pods is the same as in the case of storage in spaces not arranged for temperature control, namely: Sonesta, Bergolo, Aurie de Bacău and Verba, regardless of the prepackaging method, the most sensitive being those with determined growth.

In the case of pre-packaging in 2 kg plastic mesh bags, the quality losses were between 3.8% for the Verba variety, up to 6.8% for the Sonesta variety, the differences between varieties being between 15.8% and 78,9%. When pre-packed in 1 kg perforated polyethylene bags, the losses decreased by 11.7% for the Bergolo variety, by 11.8% for the Sonesta variety, by 4.5% for the Aurie de Bacău variety, and a increase by 26.3% for the Verba variety, compared to their prepackaging in 2 kg plastic mesh bags. Prepackaging in 0.5 kg polyethylene pans resulted in an increase in losses for all varieties analyzed, namely by 8.3% for the Bergolo variety, by 14.7% for the Sonesta variety, by 18.2% for the Aurie variety. of Bacău and by 15.8% for the Verba variety, compared to their prepackaging in 2 kg plastic mesh bags. As such, in the case of temporary storage of garden bean pods in spaces designed to control the temperature at 6 - 7oC, the best way to prepack is in 1 kg perforated polyethylene bags.

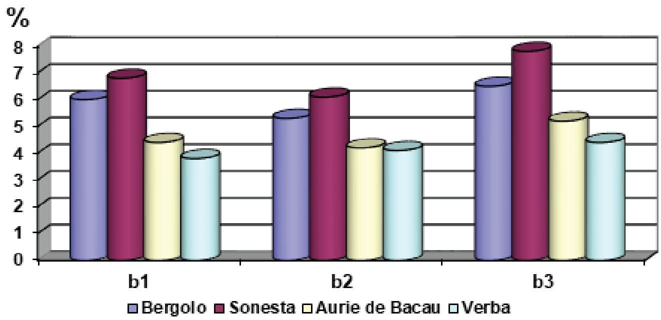

Figure 5 Losses recorded according to variety and method of packing the pods stored in arranged spaces

CONCLUSIONS

Based on the results obtained and their interpretation, the following conclusions were drawn:

After harvesting and conditioning the garden fossil pods from the 4 varieties studied, they were pre-packaged and temporarily stored for fresh recovery, according to the specifics of the B factor variants.

Graphically representing the fresh storage time depending on the variety and pre-packaging method, it is found that in the conditions of normal temperature and atmospheric humidity of the unarranged storage space, the storage life was between 48 hours and 72 hours.

Prepackaging of bean pods in 1 kg perforated polyethylene bags reduced the shelf life by 33.3% for the Bergolo variety, by 20% for the Sonesta variety, and by 16.7% for the Aurie de Bacău and Verba climbing varieties, compared with pre-packaging in 2 kg plastic mesh bags.

Under storage conditions in spaces not designed to control the temperature and relative humidity of the air, the best results were recorded when prepacked in 2 kg plastic mesh bags, regardless of the bean variety.

In the storage spaces arranged for temperature control (6 - 7oC), the best results were recorded when prepacked in 0.5 kg polyethylene pots, regardless of the bean variety.

Representing graphically the losses recorded for the analyzed bean varieties, established at the time of the first qualitative damage to the pods, it is found that regardless of the prepackage, in case of temporary storage in space not arranged for temperature control, the most sensitive was the Sonesta variety with determined growth, green pod, cylindrical, and the most resistant was the variety Verba with undetermined growth, green pod, flat, the differences being between 50% to 64.2%, depending on the prepacking method.

REFERENCES

Beceanu D., Ghira A. 2003. Tehnologia produselor horticole. Valorificarea în stare proaspătă şi industrializare, Editura Economică.

Bucher T., Klazine van der Horst, Siegrist M. 2011. Improvement of meal composition by vegetable variety. Public Health Nutrition, 14(8), 1357-1363.

Gherghi A. 1994. Tehnologia valorificării produselor horticole. Vol. II, Păstrarea produselor horticole în stare proaspătă. Editura Paideia, Bucureşti.

Doru G. 1970. Mazărea şi fasolea. Editura Ceres, Bucureşti.

Dumitrescu M. 1988. Producerea legumelor. Bucureşti.

Lascu N. 2006. Materii prime legumicole. Editura Sitech, Craiova.

Mirghiş E. şi colab. 1980. Indicatori fizico-chimici ai calităţii păstăilor de fasole verde pentru conserve şi dependenţa lor de anumiţi factori. Simpozionil Naţional Cultura mazărei şi fasolei, Vidra.

Mitova I., Dimitrov I., Atanasova E., Stancheva I. 2008. Effects of fore-crop fertilization on the yield and quality of kidney beans under vegetable crop rotation conditions. Acta Agronomica Hungarica, 56 (4).

Stancheva I., Mitova I., Petkova Z. 2004. Effects of different nitrogen fertilizer sources on the yield, nitrate content and other physiological parameters in garden beans. Environmental and Experimental Botany, 52 (3), 277-282.

*** 2003, STAS-I SR 8948.

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THE EFFECT OF REGLALG ON THE GERMINATION INDICES OF CUCUMBER SEEDS SUBJECTED TO GERMINATION AT POSITIVE SUBOPTIMAL TEMPERATURES

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Keywords: *Cucumis sativus L., Reglalg, positive low temperatures stress, seed germination*

ABSTRACT

Cucumber (Cucumis sativus L.), cultivar Concurent and hybrids as Plai, F1; ELITA, F1; ASSIA, F1; Viorel, F1 and Cernomor, F1 seeds treated with distilled water (control) or water solutions of Reglalg preparation (1/100 and 1/1000 dilutions) were germinated at 27°C (control) or at different positive low temperature (15°C, 13°C, 10°C, 8°C, 6°C and 4°C) to study germination parameters. Final germination percent of cultivar Concurent seeds and germination energy decreased, while the conditional number of days, required for germination of one seed increased with the decrease of temperature. The minimum temperature beyond which no cucumber seeds germination occurs was 13°C. Application of Reglalg, dilution 1/1000, had a beneficial effect on germination parameters at suboptimal temperature of 15 ^{0}C.

INTRODUCTION

Seed germination is a very complex process, being regulated by varies endo - and exogenous factors (Markovskaya et al. 2007). Plants, including cucumber (*Cucumis sativus* L.), originating from tropical and subtropical regions, when exposed to suboptimal temperatures below 12°C suffer various damages, which are reflected on the subsequent growth, development and productivity (Allen & Ort 2001). Cucumber (*Cucumis sativus* L.) seeds germinate well at an optimum of 24-28° C (Kłosińska et al. 2013). The optimum germination temperature of cucumber seeds depends on a range of factors (Markovskaya et al. 2007, Kłosińska et al. 2013). It has been shown that various procedures can be used to improve the germination and growth properties of cucumber plants under unfavorable temperature conditions, including application of plant growth regulators (Cauș & Dascaliuc 2019).

The aim of this study was to evaluate the effect of plant growth regulator *Reglalg* on germination indices of cucumber seeds subjected to germination at positive suboptimal temperatures.

MATERIAL AND METHODS

Seeds of cucumber *Cucumis sativus* L. variety Concurrent served as object of study. For comparison, seeds of different *Cucumis sativus* L hybrids (Plai, F1; ELITA, F1; ASSIA, F1; Viorel, F1 and Chernomor, F1) were also used. Prior to germination, seeds were soaked in distilled water (control) or *Reglalg* solution

(1/100, 1/1000 dilutions) for 24 hours, and subsequently placed for germination at air humidity of 70-80%, in the dark, at a temperature of 27°C (control) or at different doses of low positive temperatures (15°C, 13°C, 10°C, 8°C, 6°C and 4°C). Daily observations recorded the first seed germination, when its radicle was longer than 2 mm. The first germination was observed after one day for Concurent (27°C); 3 days for Concurent (15°C) and Plai, F1(13°C), and 5 days for Concurent (13°C). Germination energy (GE) was measured at the 1st (27°C), 4th (15°C) and at 6th (13°C) day of experiments and expressed as % using formula: GE% = total number of germinated seeds (A) / total seeds (N) × 100. Final germination rate (FGR) was expressed as % using the above formula on the 2nd (27°C) and 13th day of experiment. The equation for calculating the mean germination time (MGT)= conditional days for germinating of one seed is: $t = \Sigma(ni \times di) / \Sigma n$; where: t - mean germination time(days) to germinate 1 seed; ni is the % of newly germinated seeds after each period of incubation in days (di), and n is the total number of emerged seeds recorded by the end of the test. Statistical analysis of the results was expressed as percentage on the basis of the corresponding arithmetic means using the Microsoft Office software package, the Excel and STATISTICA 7.0 programs.

RESULTS AND DISCUSSIONS

Table 1 presents data on the influence of different doses of positive low temperatures (15°C, 13°C, 10°C, 8°C, 6°C and 4°C) on the germination indices of cucumber seeds *Cucumis sativus* L., variety Concurrent. It is seen that the percentage of final seed germination decreased with declining temperature.

Table 1

The influence of different doses of low positive temperatures on the germination indices of cucumber *Cucumis sativus* L. seeds, variety Concurrent.

Seed germination temperature	Final germination rate (%)	Germination energy (%)	The conditional number of days required to germinate 1 (one) seed
+ 27^{0}C (Control)	100)	84.62	1.15
+ 15^{0}C	100	64.29	4.66
+ 13^{0}C	50	10	9.2
+ 10^{0}C	0	0	0
+ 8^{0}C	0	0	0
+ 6^{0}C	0	0	0
+ 4^{0}C	0	0	0

At suboptimal temperature of 15°C, cucumber seeds, variety Concurrent demonstrated a final germination rate analogous to the control (100%), whereas the germination energy was approximately by 24% lower than in the control. At the same time, the number of days required for the germination of one seed at 15°C temperature was higher (4.66 days), compared to (1,15 days) in control (table 1). In addition, it can be observed that, of the suboptimal temperatures tested, the limiting temperature at which seeds of the cucumber variety Concurrent germinate is 13°C, showing significant differences in seed germination indices. At temperature of 13°C, the lowest percentage of final germination was recorded (50%), and the germination energy was ≈4.3 and 5.5 times lower than at temperatures of 15°C and 27°C (control), respectively. And the conditioned number of days required for the germination of one seed at low positive temperature of 13°C was 9.2 days, compared to (4.66) and (1.15) days in the variants with suboptimal temperature of 15°C and 27°C optimal temperature (control), respectively.

Since the literature data showed significant differences in the effect of suboptimal temperatures on the germination of cucumber seeds, which depend on varies factors (Kłosińska et al. 2013), we studied the germination parameters of different hybrids of *Cucumis sativus*. L. in comparison with variety Concurent at the minimum suboptimal germination temperature of 13°C. A comparative assessment of the germination indices of *Cucumis sativus* L. seeds of different hybrids (Plai, F1; ELITA, F1; ASSIA, F1; Viorel, F1 and Cernomor, F1) with those of variety Concurent at minimum suboptimal germination temperature of 13 °C have showed significant differences (Table 2).

Table 2

Indices of seed germination of cucumber *Cucumis sativus* L. variety Concurent and of some hybrids at minimum suboptimal germination temperature of 13°C.

Variety and hybrids of cucumber (*Cucumis sativus* L.)	Final germination rate at 13^{0}C (%)	Germination energy at 13^{0}C (%)	The conditional number o days required to germinat 1 (one) seed at 13^{0}C
Variety Concurent	50	10	9.2
Plai, F_1	75	50	7.6
ELITA, F_1	0	0	0
ASSIA, F_1	0	0	0
Viorel, F_1	0	0	0
Cernomor, F_1	0	0	0

It can be seen that, of the *Cucumis sativus* L. hybrids tested at the minimum suboptimal germination temperature (13°C), established for the variety Concurrent, only the seeds of the Plai, F_1 hybrid germinated. Seeds of this hybrid showed final germination rate and germination energy of 1.5 and 5 times higher, respectively, compared to the ones indices for the variety Concurent. The conditional number of days required for the germination of one seed of the Plai F_1 hybrid was lower - 7.6 days, compared to 9.2 days for the variety Concurrent (Table 2). Thus, the values of the germination indices of *Cucumis sativus* L. seeds are determined by the hybrids and variety of cucumber.

The results of the study on the use of *Reglalg* for seed treatment and the effect of these treatments on the germination parameters of cucumber seeds, variety Concurrent at suboptimal temperature of 15°C, are presented in Table 3. It can be observed that the seeds treated with *Reglalg*, 1/100 dilution, that germinated at temperature of 15^{0}C show lower germination energy (59.38%), compared to the control (64.29%) and the variant with *Reglalg* preparation, dilution 1/1000 (71.88%). For germination of one seed of the variant with application of *Reglalg*, 1/100 dilution, and germinating at temperature of 15°C, it takes more time (5.84) compared to (≈ 4.6) days for both control and using the *Reglalg* preparation, dilution 1/1000 (table 3).

Table 3

The influence of different doses of *Reglalg* preparation on the germination indices of *Cucumis sativus* L. seeds variety Concurrent at suboptimal temperature of 15^0C.

Seed treatment	Final germination rate at 15^0C (%)	Germination energy at 15^0C on day 4 (%)	The conditional number of days required to germinate 1 (one) seed at 15^0C
Control, H2O	100	64.29	4.66
Reglalg, 1/100	90.63	59.38*	5.84*
Reglalg, 1/1000	100	71.88	4.635

Also, in the variant with the cucumber seeds treatment with *Reglalg* preparation, dilution 1/1000, the conditional number of days required for germination of one seed at temperature of 15^0C is insignificantly lower (4.63) than in the control (4.66), and significantly less (5.84) days, than in the variant with the application of *Reglalg*, dilution 1/100. As well, in the variant with the application of *Reglalg*, 1/1000 dilution, a higher germination energy was demonstrated (71.88%), compared to the control (64.29%) and the application of the 1/100 dilution of *Reglalg* preparation (59.38%). Thus, seed treatment with *Reglalg* preparation, 1/1000 dilution, can be used to achieve increased germination under suboptimal temperature conditions.

CONCLUSIONS

The results of the research show that the germination indices of *Cucumis sativus* L. seeds are determined by the hybrids and variety of cucumber.

Minimum germination temperature for *Cucumis sativus* L. variety Concurrent seeds is 13°C.

Treatment of cucumber seeds variety Concurrent before germination with aqueous solution of *Reglalg* preparation, dilution 1/1000, had beneficial effects on the final germination rate, germination energy and the conditional number of days, required to germinate 1 (one) seed at suboptimal temperature of 15°C.

REFERENCES

Allen D.J., Ort D.R. 2001. Impact of chilling temperatures on photosynthesis in warm-climate plants. Trends Plant Sci., 6, 36–42.

Cauș M., Dascaliuc A. 2019. Influenţa biostimulatorului *Reglalg* asupra reacţiei plantulelor de castravete (C*ucumis sativus* L.) la şocul termic. Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţele vieţii, 2 (338), 85-95.

Kłosińska U., Kozik E.U., Nowicki M., Wehner T.C. 2013. Low temperature seed germination of cucumber: genetic basis of the tolerance trait. Journal Hort. Research., 21(2), 125-130.

Markovskaya *E.F.,* Sherudilo *E.G.,* Sysoeva *M.*I. 2007. Cucumber seed germination: Effect and after-effect of temperature treatments. Global Science and Biotechnology, 1(2), 25-31.

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AMINO ACID COMPOSITION AND INORGANIC CONSTITUENTS OF THE ASH OF SOYBEAN SEEDS RELATED TO METAL IONS APPLICATION

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Keywords: *soybean plants, root feeding, seeds, metal ions, amino acids, ash*

ABSTRACT

A greenhouse experiment with soil culture was conducted to investigate the influence of root feeding of soybean (Glycine max [L.] Merr.) plants, cv Lumina, at the phase of the first pair of trifoliate leaves with 0.01% solutions of ammonium molybdate salt and sulfate salts of Zn, Mg and Co on amino acids composition and metal ions contents in soybean seeds. Root feeding of soybeans with solutions of Zn, Mn, Co and Mo salts in the early periods of ontogenesis does not reduces the biological value of soybean seeds and contribute to the accumulation of essential amino acids in them. The concentrations of the studied metal ions in seeds of all variants were within the maximum permissible values.

INTRODUCTION

Soybeans have a large using in the national economy of many countries (Masuda & Goldsmith 2009). Worldwide soybean is intensively utilized for human food, livestock feed and also for industrial requests, due to its seeds with large amount of protein (30-40%), that is well balanced in the composition of essential amino acids (Liu 1997, Petibskaia, 2012, Medic et al. 2014, William Monte Singer et al. 2019). Soybean products are distinguished not only by the best composition of essential amino acids, but also contain oil, carbohydrates, mineral substances, including Ca, P, Na, I, Mo,Ni and as well vitamins (Liu 1997, Studentsova et al. 1999, Karr-Lilienthal et al. 2005, Petibskaia 2012, Medic et al. 2014). To obtain high yields of soybeans, it is necessary to create the necessary conditions for the accumulation of storage proteins in the seeds, which contain a lot of nitrogen. Therefore, appropriate technology should to be utilized for improving the level of nitrogen nutrition of plants, both by symbiotic N2 fixation and by applying of inorganic nitrogen fertilizers (Caus & Toma 1987, Novitskaya & Dzhemesyuk 2015). In addition to these procedures, application of micronutrient compounds, containing such metals ions as molybdenum, zinc, cobalt, manganese and others, is often undertaking to improve soybean nitrogen metabolism (Caus & Toma 1990, Novitskaya & Dzhemesyuk 2015). Previously our results (Caus 2008) on studying the influence of metal ions on soybean nitrogen fixation capacity and ammonia assimilation – the first stable product of this process through glutamine synthetase, demonstrated that application of root feeding with metal ions solutions of Mo and Co stimulates these processes, and the nodules and roots are not affected (Caus & Toma 1990). The purpose of the study was to determine both amino acid composition of the protein and inorganic components of soybean seeds associated with the application of metal ions solutions.

MATERIAL AND METHODS

Investigations were carried out with soybean seeds *Glycine max* (L.) Merr., cv Lumina. Before sowing soybean seeds were inoculated with effective (nod$^+$ fix$^+$) symbiotic N_2 fixing bacteria *Bradyrhizobium japonicum*, strain 9. A pot experiment with soil culture under the green house conditions with natural light was conducted to determine the influence of metal ions applications on the biological value of soybean seeds. Root feeding of plants was carried out at the phase of the first pair of trifoliate leaves with 0.01% solutions of ammonium molybdate salt and sulfate salts of Zn, Mg and Co separately according to the experiment scheme at the rate of 100 ml of solution per pot (6 kg of soil). Control plants were grown without metal ions salts. Soybean seed pods were collected at the end of the growing season. Preparation of samples for amino acid analysis was carried out according to Krishchenko (1978). The content of amino acids in soybean seeds was determined on an AAA-339 amino acid analyzer (Czechoslovakia).

RESULTS AND DISCUSSIONS

The results on the amino acids composition of soybean seeds are shown in Table 1 (The arithmetic mean values are given). They show that metal ions introduced as root feed at the beginning of ontogeny does not have a noticeable effect on the composition of amino acids, which is in agreement with literature data (Lvov 1989, Yagodin 1990, Hristozkova et al. 2007). It was found that in the variant with zinc there is a tendency to a decrease in the total content of amino acids in soybean seeds.

Considering that according to the literature, methionine is in particular the amino acid that limits the quality of soybean seeds (Zaprometov 1986, Dung Tien 2016, Chen Guoab et al. 2020), for us it was of particular interest to establish whether metal ions application influence the values of this parameter. Our results show that all studied root feeding with metal ions, except the variant with Co, do not have a significant effect on this index.

Data on the determination of the amino acid composition of soybean seeds allowed us to determine the value of their biological value. According to the materials presented in the literature on this subject, one of the main criteria by which the biological value of grain can be assess is its amino acid rate, expressed as a percentage relative to the standard aminogram of ideal proteins (FAO / WHO scale) or egg protein, taking into account the content of the first amino acid that limiting the quality of seeds (Oser 1959, Chernikov 1990).

As a reference for calculating the amino acid rate, we used the standard aminogram of egg protein (Zaprometov 1986, Skurikhin & Volgareva). The data on determination of the amino acid scoring are shown in Table 2. From the results presented in this table it can be observed that the most deficient essential amino acid for soybean seeds is methionine, the chemical quota of which in the control variant was 25%. Its lowest value (17 %) was observed in the variant with Co. From these data, it follows, that in all fed varieties, except for the variant with Mn, there is a tendency to a decrease in this index. It is possible, that the lower values of this parameter in our case are associated with the cultivar characteristics of plants, as well as with the influence of exogenous conditions, and, first of all, the nutrient regime of soils, as literature data show regarding the influence of these factors on seed quality (Goldflus 2006, Medic, Zolotarev et al. 2012, Assefa 2018).

Table 1

Analyze of amino acids composition of soybean seeds
(mg/ 1000 mg absolute dry weight; M)

Amino acids		Experiment variants				
		Control	+Zn	+Mn	+Co	+Mo
Essential	Lyz	19,86	14,08	18,88	20,74	19,46
	Met	1,87	1,44	2,22	1,31	1,72
	Tre	10,79	9,27	12,19	13,46	12,92
	I-leu	7,96	7,63	7,36	8,47	7,77
	Leu	24,83	22,54	23,32	25,65	24,14
	Phe	14,63	13,41	14,24	15,47	14,13
	Val	15,09	13,99	13,19	15,40	13,69
	Sum	**95,03**	**82,36**	**91,40**	**100,50**	**93,83**
Non essential	Asp	30,42	28,23	28,93	31,45	29,89
	Ser	14,74	13,18	14,90	15,83	15,45
	Glu	59,91	55,39	56,82	61,86	58,00
	Pro	21,84	17,28	21,87	23,06	22,50
	Gly	18,80	17,37	18,38	20,19	18,42
	Ala	11,36	9,55	9,80	9,27	10,71
	Tyr	9,34	8,43	9,19	9,70	9,43
	Hys	7,06	8,23	6,54	7,44	6,72
	Arg	19,58	17,39	18,73	20,55	9,11
	Sum	**193,05**	**175,05**	**185,16**	**199,35**	**180,23**
Total sum		**288,08**	**257,41**	**276,56**	**299,85**	**274,06**

It was also found that the second amino acid limiting the quality of soybean seeds is isoleucine, the amino acid scoring content of which was approximately the same (51-57%) in all variants, except for plants treated with Co.

Thus, from the analysis of the results on determining the amino acid rate of soybean seeds, it follows that root feeding with Mo, Co, Mn, and Zn of soybeans in the early periods of ontogenesis does not impair their biological value.

At the same time, the quality of soybean seeds and their nutritional value also depends on the content of minerals in them, and first of all, heavy metals, which, as follows from a literature review, can accumulate in them even to toxic concentrations

Therefore, the next study consisted in establishing the degree of accumulation in seeds of metal ions used by us for root feeding of plants in the early periods of ontogenesis, in order to identify their possible negative impact on the quality of soybean seeds. Obtained data were compared with the available reference values for the maximum permitted concentrations (Zaprometov 1986, Sichkar 1992).

Table 2

The rate of amino acids (%) in soybean seed proteins relatively to the standard monogram of egg proteins

Amino acids	Amino acids of egg proteins, g/16 g N	The rate of amino acids, %				
		Control	+Zn	+Mn	+Co	+Mo
Lyz	7.0	144	123	131	145	142
Met	4.0	25	22	28	17	21
Tre	4.3	128	126	150	149	156
I-leu	7.7	52	57	51	63	52
Leu	9.2	137	142	135	131	135
Phe	6.3	117	123	119	116	115
Val	7.2	106	112	105	102	97

From the presented data (table 3) on the determination of the ash content of soybean seeds, it follows, that its content (%) did not differ from the control values (4.9%) for all variants of the experiment (r < 0,05), and root feeding with 0,01% solutions of Zn, Mn, Co and Mo salts does not affect the value of this index. Determination of the content of metal ions in soybean seeds showed that none of the studied metal ions accumulate in them (table 3).

Table 3

Influence of root fertilizing with 0.01% solutions of metal ion salts at the phase of the first pair of trifoliate leaves on the mineral composition of soybean seeds, cv Lumina

Experiment variants	Ash (%)	Content, mg/kg				
		Zn	Mn	Mo	Mg	Co
Control	4.0±0.17	40.2±1.25	35.9±0.33	$6.9 \cdot 10^{-3}$±0.05	1822.0±7.8	< 0.2
Zn	4.7±0.06	36.9±0.29	35.3±1.02	$4.5 \cdot 10^{-3}$±0.06	1716.6±12.7	< 0.2
Mn	4.8±0.02	37.5±1.27	36.8±1.47	$3.7 \cdot 10^{-3}$±0.04	1749.8±79.0	< 0.2
Co	4.8±0.02	38.1±0.38	35.8±0.49	$3.2 \cdot 10^{-3}$±0.03	1784.8±27.2	< 0.2
Mo	4.9±0.12	40.0±1.00	35.9±1.02	$6.6 \cdot 10^{-3}$±0.07	1742.4±16.9	< 0.2

Considering that the nutritional value of plant materials, including soybean seeds, is judged on the basis of data on determining the concentration of metal ions, which should not exceed the maximum permissible concentration, we conducted a comparative analysis of our data with similar ones given in standard reference tables (Zaprometov 1986, Sichkar 1992). This allowed us to conclude that the concentrations of the studied metal ions in all variants were within the maximum permissible values.

Thus, based on the results of studies of the biological value of soybean seeds and the effect of root feeding with solutions of Zn, Mn, Co and Mo salts on it in the early periods of ontogenesis under soybeans, it can be concluded that the latter does not worsen the quality of soybean seeds, and the introduction of Mo, Co and Mn contributes to increase the content of essential amino acids.

CONCLUSIONS

Root feeding of soybeans with solutions of Zn, Mn, Co and Mo salts in the early periods of ontogenesis does not reduces the biological value of soybean seeds and contribute to the accumulation of essential amino acids in them.

REFERENCES

Assefa Y., Bajjalieh N., Archontoulis S. et al. 2018. Spatial characterization of soybean yield and quality (amino acids, oil, and protein) for United States. Scientific Reports, 8:146-153 | DOI:10.1038/s41598-018-32895-0.

Caus M. 2008. Impact of heavy metals on symbiotic nitrogen fixation by soybean nodules. Materials of the conference "Modern pedology in the development of modern agriculture", Chisinau. Vol. 2, pp. 167-172. (In Romanian).

Caus M.V., Toma S.I. 1987. Activity of glutamine synthetase in soybean roots and nodule bacteroids at the growing of plants on different doses of nitrogen fertilizers. In Toma S. I. & al (eds), Regulation of adaptive reactions and plant productivity by elements of mineral nutrition. Stiinta Press, Chisinau, 47-52. (In Russian).

Caus M.V., Toma S.I. 1990. Influence of root fertilizing with microelements on reduction and assimilation of atmospheric nitrogen in soybean nodules. Book of Abstracts of the International conference «Trace elements in biology and application in agriculture and medicine", Russia, Samarkand, pp. 291-292. (In Russian).

Chen Guoab, Xiujie Liuab, Li Chenab et al. 2020. Elevated methionine content in soybean seed by overexpressing maize β-zein protein. Oil Crop Science, 5(1), 11-16.

Chernikov M.P. 1990. New principles for determining the biological value of proteins. Applied biochemistry microbiology, 25(5), 591-597.

Dung Tien Le, Ha Duc Chu, Ngoc Quynh Le. 2016. Improving nutritional quality of plant proteins through genetic engineering. Current genomics, 17(3), 220-229.

Goldflus F., Ceccantini M., Santos W. 2006. Amino acid content of soybean samples collected in different Brazilian states – harvest 2003/2004. Brazilian Journal of Poultry Science Revista, 8(2), 105-111.

Hristozkova M., Geneva M., Stancheva I., Georgiev G. 2007. Nitrogen assimilatory enzymes and amino acid content in inoculated foliar fertilized pea plants grown at reduced molybdenum concentration. Journal of Plant Nutrition, 30(9), 1409-1419.

Karr-Lilienthal L.K., Grieshop C.M., Spears J.K., Fahey G.C. 2005. Amino acid, carbohydrate, and fat composition of soybean meals prepared at 55 commercial US soybean processing plants. J. Agr. Food Chem., 53, 2146-2150.

Krishchenko A.A. 1978. Method for determination of amino acids in various fractions of the nitrogen complex of plants. Proceedings of the USSR Academy of Sciences. Biological Series, 3, 405-410. (In Russian).

Liu K. 1997. Soybeans: chemistry, technology and utilization. Aspen publishers, Gaithersburg, Maryland, pp. 532.

Lvov N.P. 1989. Molybdenum in nitrogen assimilation in plants and microorganisms. Publishing house "Science", Moscow, pp.85. (In Russian).

Masuda T., Goldsmith P. D. 2009. World soybean production: area harvested, yield, and long-term projections. International Food and Agribusiness Management Review, 12 (4), 143–161.

Medic J., Atkinson C., Hurburgh C.R. 2014. Current knowledge in soybean composition. J. Am. Oil Chem. Soc., 91, 363–384.

Novitskaya N.V., Dzhemesyuk A.V. 2015. Soybean yield capacity depending on the technology elements on typical chernozems of the forest-steppe of Ukraine. Altai State Agrarian University Bulletin, 5(127), 11-16. (In Russian).

Oser B.L. 1959. An Integrated essential amino acid index for predicting the biological value of proteins. Albanese A.A. (Eds). Amino Acid Nutrition. Academic Press, New York, pp. 295-311

Petibskaia V.S. 2012. Soybeans. Chemical composition and utilization. Bocikariov N.I. (eds), OAO ”Poligraf- IuG”, Maikop city, pp.432.(In Russian).

Sichkar V.I. 1992. Variations in the amount of protein and amino acid composition in soybean. Physiology and biochemistry of cultivated plants, 24 (2), 153–158. (In Russian).

Skurikhin I.M, Volgareva M.N. 1987. Chemical composition of food. Reference tables of essential nutrient content and energy value of foods. Agropromizdat, Moscow, pp.224 (In Russian).

Studentsova N.A., Gerasimenko S.N., Kasianov G.I. 1999. Biological and technological aspects of the use of soybean in food production. Proceedings of the universities. Food technology, 4, 6-9. (In Russian).

William Monte Singer, Bo Zhang M.A. Rouf Mian, Haibo Huang. 2019. Soybean Amino Acids in Health, Genetics, and Evaluation [Online First], IntechOpen, DOI: 10.5772/intechopen.89497.

Yagodin V.A. 1990. Trace elements in the USSR. Zinate, Riga, 31, pp.114. (In Russian).

Zaprometov M.N. 1986. Chemistry and biochemistry of leguminous plants. Agropromizdat, Moscow, pp. 336 (In Russian).

Zolotarev S.V., Kobozev I.V., Kobozeva T.P. et al. 2012. Seed quality assessment of different Northern ecotype varieties of soybean for the purpose of their rational use. Bulletin of Altai State Agrarian University, 1(87), 8-14. (In Russian).

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NEW BIOFERTILIZERS – AGROCHEMICAL EFFECTS

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Keywords: *biofertilizers, algae, protein hydrolisate, grapevine*

ABSTRACT

This paper presents three experimental biofertilizers with organic substances: protein hydrolisates of vegetal origin (a mixture of peptides and free amino-acids), humic substances, an algae extract (Ascophyllum nodosum) which contains carbohydrates, organic acids, cytokines, auxins, gibberellins, vitamins, meso- and micronutrients (Mg, S, Mn, Fe, Cu, Zn, Mo, B) and the results of their agrochemical testing. A filed trial was carried out in order to investigate the effect of the biofertilizers on grapevine (cv Chasslas dore). Fertilizers – in concentrations of 0.5% – were applied by foliar spraying and there were obtained relative yields ranging between 12.1% and 15.7% as compared to the control. Experimental data indicated that application of the three foliar fertilizers had signifficant contribution to the increase of total pigments content as compared to the control.

INTRODUCTION

Fertilizers accepted in organic farming are used especially for extraradicular application, but also for fertigation in order to correct plant nutrition deficiencies. The use of these fertilizers is of interest from a practical point of view, both due to economic factors (high costs of organic fertilization or lack of compost) and the requirements regarding the chemical inputs imposed by the legislative framework from organic farming (Calvo et al. 2014, DiStasio & Oosten 2018). According to EU Regulation No. 2019/1009 there is a need to make use of recycled or organic materials for fertilising purposes. Harmonised conditions for obtaining fertilisers with such recycled or organic materials available on the entire internal market should be established in order to provide an important incentive for their further use. The products that have shown increased biostimulat activity are algae extracts, protein hydrolysates, humic substances and bacterial strains (Goni et al. 2018, Sestili et al. 2018, Oosten et al. 2017). Numerous studies demonstrated and recognized the beneficial effects of algae in improving plant growth. Products based on algae extracts improve seed germination, seedling development, enhance plant tolerance to the environment, and increase plant growth and quality (Zodape et al. 2008). Moreover, algae can be used as a soil modifier. Currently, one of the most promising applications of algae is their use as plant biostimulats. This influence of algae extracts is due to their complex content in substances that promote plant growth (i.e. cytokinins, auxins, gibberellins, alginic acid, abscisic acid, ethylene, polyamine, betaine, polyunsaturated fatty acids (omega-3), vitamins (group B), carotenoids and polyphenols. (antioxidants), polysaccharides, proteins and mineral elements)

(Michalak et al. 2016, Soad & Mohy 2015). Protein hydrolysates are mixtures of polypeptides, oligopeptides, and free amino acids derived from partial hydrolysis of agricultural by-products from animals and plants. Plant-derived protein hydrolysates (PHs) have gained prominence as plant biostimulants due to their potential to increase the germination, productivity and quality of a wide range of horticultural and agronomic crops. Application of protein hydrolysates can also alleviate the negative effects of abiotic plant stress due to salinity, drought and heavy metals (Colla et al. 2014, Colla et al. 2017). Humic substances (humic acid and fulvic acid) used as fertilizers ensure the development of plants, especially of the root system, through an auxin-type action. In addition to increasing the nutrient content of plants, humic substances act on cellular respiration, the Krebs cycle and, consequently, the synthesis of adenosine triposphate (ATP), but also help to preserve and improve the structure of the soil and its microbial activity (Canellas & Olivares 2014, Matuszak et al. 2017).

MATERIAL AND METHODS

The experimental biofertilizers based on nanostructures and biomaterials were formulated and structured by incorporating meso and micronutrients (Mg, S, Mn, Fe, Cu, Zn, Mo, B) into a matrix of natural organic substances with biostimulatory effect (auxins, betaines, cytokinins, gibereline, poly and oligo-sugars, phenols, carotenoids, fatty acids, amino acid, peptides) (Ciorоianu & Sirbu 2017, Tudor et al. 2017). Thus, there were obtained three variants of foliar fertilizers that were coded as follows:

- F1 variant - containing protein hydrolyzate, algae extract (*Ascophyllum nodosum*), meso and micro nutrients;
- F2 variant - containing algae extract (*Ascophyllum nodosum*), meso and micro nutrients;
- F3 variant - containing protein hydrolyzate, algae extract (*Ascophyllum nodosum*), humic substances, meso and micro nutrients.

The agrochemical tests were carried out on grapevine (cv *Chasselas dore*) cultivated on hortic anthrosol, in an intensive orchard and non-irrigation regime. The main physical, chemical and biological properties of the soil are presented in table 1.

The application of the experimental biofertilizers to grapevine was carried out in three foliar treatments (2.5 liters of biofertilizer/ha/treatment; 0.5% dilute solutions) by fine atomization on the entire foliar surface during the vegetation period, as follows: the first treatment - at flowering; the second treatment – at clusters formation; the third treatment - during the growth and development of the clusters.

The effects of the treatments were studied by analysis of variance (Fischer method) and Fischer's Least Significant Difference (LSD) test. All data are relative values as compared with the control (treated only with water) considered equal to 100%.

The results were considered significant and were noted for the following circumstances: *significant ($0.01 < p \leq 0.05$), **very significant ($0.001 < p \leq 0.01$), ***highly significant ($p \leq 0.001$).

Table 1

Physicochemical and biological properties of soil samples

Characteristic	Genetic horizons / Depth (cm)			
	Amho (0-20 cm)	Amho (20-40 cm)	AB (40-60 cm)	Bv (60-100 cm)
Clay (%)	38.8	40.2	40.6	45.5

pH (H_2O)	6.18	6.35	6.82	7.11
Organic matter (%)	3.16	2.00	0.71	0.11
N_t (%)	0.15	0.13	0.04	0.02
Available P (mg/kg)	40	35	30	27
Available K (mg/kg)	216	193	141	133
Saturation (%)	85	87	90	91
Dehydrogenase (mg formazan)	17.11	4.62	2.11	1.17

RESULTS AND DISCUSSIONS

The three samples of experimental fertilizers were obtained at laboratory scale, characterized and tested to establish agrochemical efficiency and effectiveness by foliar application to grapevine cultivation. The fertilizers contain: 70 – 210 g/l organic matter; 2 – 30 g/l organic nitrogen, 2 – 4 g/l phosphorus (P_2O_5); 9 – 30 g/l potassium (K_2O); 3 – 14 g/L meso and micro nutrients.

In order to test the biofertilizers there were studied the following parameters: relative yields, photosynthetic assimilation and macronutrients content in grapevine leaves.

Evolution of the relative yields depending on the fertilizer variant is presented in table 2. Highest yield was obtained by application of the F3 variant (31878 kg/ha) which contains protein hydrolyzate, algae extract (*Ascophyllum nodosum*), humic substances, meso and micro nutrients.

Table 2

Effect of the experimental fertilizers on grapevine (cv *Chasselas dore*) yield

Variants	Yield (kg/ha)	Productive efficiency		
		Difference kg/ha	Difference %	Significance
Control	27547	-	100	-
F1	30868	3321	112.1	**
F2	30805	3258	111.8	**
F3	31878	4331	115.7	***
LSD 5% - 2574 kg/ha LSD 1% - 3248 kg/ha LSD 0.1% - 3982 kg/ha				

Application of the three experimental fertilizers to grapevine (cv *Chasselas dore*) has led to a very significant increase of the relative yield (12.1%) in the case of F1 variant, a significant increase (11.8%) in the case of F1 variant, and a highly significant increase (15.7%) in the case of F3 variant as compared to the control.

Experimental data from tables 3 and 4 show that application of foliar fertilizers with organic substances determined an increase of the photosynthesis activity and a stimulation of the plants in order to increase the consumption of nutrients from the soil.

Table 3

Effect of experimental fertilizers on grapevine (cv *Chasselas dore*) leaf pigments content

Pigment	Variants			
	Control	F1	F2	F3
Chlorophyll a (mg/g)	0.837	1.002	0.983	1.053
Difference (mg/g)	-	0.165	0.146	0.216
Significance	-	***	***	***
Chlorophyll b (mg/g)	0.561	0.650	0.638	0.664
Difference (mg/g)	-	0.089	0.077	0.103
Significance	-	**	**	***
Carotene (mg/g)	0.438	0.518	0.514	0.530
Difference (mg/g)	-	0.080	0.076	0.092
Significance	-	**	**	***
Total pigments (mg/g)	0.836	2.169	2.134	2.247
Difference (%)	-	0.333	0.298	0.411
Significance	-	***	**	***

Chlorophyll a	Chlorophyll b	Carotene	Total pigments
LSD 5% - 0.059 mg/g	LSD 5% - 0.043 mg/g	LSD 5% - 0.045 mg/g	LSD 5% - 0.151 mg/g
LSD 1% - 0.081 mg/g	LSD 1% - 0.065 mg/g	LSD 1% - 0.066 mg/g	LSD 1% - 0.183 mg/g
LSD 0.1% - 0.113 mg/g	LSD 0.1% - 0.092 mg/g	LSD 0.1% - 0.082 mg/g	LSD 0.1% - 0.310 mg/g

Following the application of the experimental fertilizers during the vegetation period of grapevine it is observed very significant and highly significant increases, as compared to the control, for each assimilatory pigment (chlorophyll a, chlorophyll b, and carotene), as well for the total content of assimilatory pigments (table 3).

At the same time, the results obtained regarding the influence of foliar fertilization on the photosynthetic activity showed that the assimilatory pigments content increases are comparable to the production increases, thus the photosynthetic yield was directed both to increase grape production and to the plant cell in order to accumulate reserve substances**.**

The application of the three foliar treatments with the experimental fertilizers F1, F2 and F3 in critical periods and of maximum necessity for the plant nutrition positively influenced the content of grapevine leaf macronutrient content, as it is observed in table 4.

The experimental results show highly significant increases compared to the control in the case of nitrogen and potassium for all three experimental fertilizers and very significant increases in the case of phosphorus (table 4).

Table 4

Effect of experimental fertilizers on grapevine (cv *Chasselas dore*) leaf macronutrient content

Nutrient/Variant	Control	F1	F2	F3
Nitrogen (N, %)	0.718	0.855	0.850	0.866
Difference (%)	-	0.137	0.132	0.148
Significance	-	***	***	***
Phosphorus (P_2O_5, %)	0.469	0.515	0.518	0.512
Difference (%)	-	0.046	0.049	0.043
Significance		**	**	**
Potassium (K_2O, %)	0.577	0.664	0.671	0.679
Difference (%)	-	0.087	0.094	0.102
Significance		***	***	***
Nitrogen LSD 5% - 0.042% LSD 1% - 0.058% LSD 0.1% - 0.081%	Phosphorus LSD 5% - 0.025% LSD 1% - 0.034% LSD 0.1% - 0.051%		Potassium LSD 5% - 0.024% LSD 1% - 0.035% LSD 0.1% - 0.052%	

CONCLUSIONS

Three new biofertilizers containing a complex natural organic substances matrix with biostimulating effects and chelate forming properties (auxins, betaines, cytokinins, gibereline, poly and oligo-sugars, phenols, carotenoids, fatty acids, amino acid, peptides), meso and micro nutrients (Mg, S, Mn, Fe, Cu, Zn, Mo, B) were obtained, characterized, and tested on grapevine (cv *Chasselas dore*). Foliar application of the fertilizers has positively influenced productivity, leaf macronutrient content and photosynthesis activity indicators. Foliar treatments with organic substances considerably stimulate the biosynthesis of assimilating pigments, which also contributes to the reduction of the duration of the stages of organogenesis.

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REFERENCES

Calvo P., Nelson P., Kloepper J.W. 2014. Agricultural use of plant biostimulators. Plant Soil, 383, 3-41.

Canellas L.P., Olivares F.L. 2014. Physiological responses to humic substances as plant growth promoter. Chemical and Biological Technologies in Agriculture, 1(3).

Cioroianu T., Sîrbu C. 2017. Fertilizers with natural organic substances, physico-chemical and agrochemical characteristics. Journal of Environmental Protection and Ecology, 18(4), 1668-1675.

Colla G., Rouphael Y., Canaguier R., Svecova E., Cardarelli M. 2014. Biostimulant action of a plant-derived protein hydrolysate produced through enzymatic hydrolysis. Front. Plant Sci. 5, 448-458.

Colla G., Hoagland L, Ruzzi M., Cardarelli M., Bonini P., Canaguier R., Rouphael Y. 2017. Biostimulant action of protein hydrolysates: unraveling their effects on plant physiology and microbiome. Frontiers in Plant Science, 7, 1-14.

Di Stasio E., Oosten M.J., Silletti S., Raimondi G., dell'Aversana E., Carillo P., Maggio A. 2018. Ascophyllum nodosum – based algae extracts acts as enhancer of growth, fruit quality, and adaptation to stress in salinized tomato plants. Journal of Applied Phycology, 30(4), 2675-2686.

Goni O., Quille P., Connel S.O. 2018. *Ascophyllum nodosum* extract biostimulants and their role in enhancing tolerance to drought stress in tomato plants. Plant Physiology and Biochemistry, 126, 67-73.

Matuszak-Slamani R., Bejger R., Cieśla J. 2017. Influence of humic acid molecular fractions on growth and development of soybean seedlings under salt stress. Plant Growth Regul, 83, 465–477.

Michalak I., Thy L., Chojnacka K. 2016. Co-composting of *Algae* and effect of the compost on germination and growth of *Lepidium sativum*. Pol. J. Environ. Stud., 25(3),1107-1115.

Sestili F., Rouphael Y., Cardarell M., Pucci, A., Bonini P., Canaguier R. Colla G. 2018. Protein hydrolysate stimulates growth in tomato coupled with N-dependent gene expression involved in N assimilation. Frontiers in plant science, 9, 1233-1249.

Soad M., Mohy El-Din. 2015. Utilization of seaweed extracts as bio-fertilizers to stimulate the growth of wheat seedlings. Egypt. J. Exp. Biol. (Bot.), 11(1), 31–39.

Tudor E., Cioroianu T., Sîrbu C., Dumitru M., Grigore A., Parvan L. 2017. Fertilizers for the treatment of iron chlorosis. Physico-chemical and agro-chemical propertiers, Revista de Chimie, 68(1), 65-71.

Oosten M. J. V., Pepe O., Pascale S. D., Silletti S, Maggio A. 2017. The role of biostimulants and bioeffectors as alleviators of abiotic stress in crop plants. Chemical and Biological Technologies, 5, 1-12.

Zodape S.T., Kawarkhe V.J., Patolia J.S., Warade A.D. 2008. Effect of liquid seaweed fertilizer on yield and quality of okra (*Abelmoschus esculentus L.*). J. Sci. Ind. Res., 67, 1115-1117.

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QUALITATIVE ASPECTS CONCERNING THE BIOCHEMICAL COMPOSITION OF SOME LOCAL POPULATIONS OF *CAPSICUM ANNUUM SSP. GROSSUM* CULTIVATED ON SANDY SOILS OF OLTENIA

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Keywords: *bell pepper, sand, biochemical composition*

ABSTRACT

This paper presents the results obtained at RDSPCS Dăbuleni regarding the biochemical composition of bell peppers, depending on the cultivation method (protected/unprotected) and on the used cultivar.The obtained results highlighted the importance of studying the local populations of bell peppers as a source of germplasm. From a qualitative point of view, the variants cultivated in the open field were highlighted, compared to the variants cultivated in protected space (solar), (8.09% TDS, 6.68% SDS, 5.76% soluble carbohydrates, 0.67 g malic acid/100 g f.s. titratable acidity, 169.61 mg/100 g f.s. C vitamin, 14.12 µM TE/g antioxidant activity). Among the analyzed cultivars, the local populations of Dobrești and Amărăști stood out, compared to the control (Cornel variety), with a higher content of total dry substance, soluble carbohydrates, C vitamin and total phenolic compounds.

INTRODUCTION

Originally from Mexico, Guatemala and Peru, peppers were brought, like tomatoes, first to Spain and spread to other European countries since the sixteenth century (Ciofu 2003). In Romania, peppers began to be cultivated in the 19th century as an annual plant. The fruit is a berry whose size and shape is the criterion for classifying varieties and grouping them into varieties. Important and widespread are the varieties *grossum*, *longum* and *acuminatum*, but the data presented below will refer to *Capsicum annuum ssp. grossum*, whose fruits are used at physiological maturity, when the color of the fruit turns red. In Romania, the bell pepper has acquired a true tradition, becoming a niche in favor of local vegetable growers. Due to the high content of ascorbic acid, the presence of capsaicin and the diversity of the carotenoid range, pepper fruits are of particular interest for research. In Romania, but also worldwide, the role of local populations was reconsidered in order to enrich the assortment of bell peppers. The chemical composition of pepper fruits is very complex, emphasizing the economic importance of the crop. Because it is a good source of vitamins A and C, as well as of phenolic compounds, bell pepper is known for its antioxidant properties (Shotorbani et al. 2013).

Through its nutritional contribution, it is believed to prevent certain types of cardiovascular disease, atherosclerosis, cancer and hemorrhage (Marin et al. 2004). Numerous researches have highlighted the fact that the quality of bell peppers depends on the cultivation method, soil conditions, climate and cultivar. For these reasons, at RDSPCS Dăbuleni, researches were initiated regarding the quality of bell pepper production obtained in the pedoclimatic conditions specific to the southern area of Oltenia. The specific conditions of the sandy soils in the south of Oltenia determine differences in the different phenophases of growth and development, both between varieties and compared to the behavior of the same variety in different cultivation conditions (Ifrim & Buică 1994). By carrying out this study, the aim was to investigate the biochemical composition of some local *Capsicum annuum ssp. grossum* populations, depending on the applied cultivation method – protected and un-protected.

MATERIAL AND METHODS

In the conditions of the sandy soils from Dăbuleni, five cultivars of bell peppers, cultivated in open field and in solarium conditions have been studied. At bell peppers, depending on the cultivar and on the method of cultivation, determinations have been made regarding the quality of the fruit. The fruits were harvested at physiological maturity.

The following determinations have been performed into the laboratory:

- water and total dry substance (%) - gravimetric method;
- soluble dry substance (%) - refractometric method;
- vitamin C (mg/100 g fresh substance) - iodometric method;
- titratable acidity (g malic acid/100 g f.s.) - titrimetric method;
- carbohydrates (%) - Fehling-Soxlet method;
- total carotenoid content - colorimetric method;
- the content of total phenolic compounds (TPC) - colorimetrically at 765 nm by the Folin Ciocâlteu method, using gallic acid as standard; the results were expressed in µg gallic acid equivalent GAE/g f.s. (fresh substance).
- antioxidant activity (AO) - by the DPPH method (2,2-diphenyl-1-picrylhydrazyl). The ability of the extract to neutralize the 2,2-diphenyl-1-picrylhydrazyl radical was evaluated by the colorimetric method at 517 nm. A calibration curve with Trolox as a standard was used to calculate the results. The final results were expressed in µmol Trolox equivalent (TE) / 1g f.s.

All colorimetric determinations were performed with the Evolution 600 UV-Vis spectrophotometer, Thermo Scientific, England, with VISION PRO software.

The bifactorial experiment included the following variants:

A Factor – cultivation method:

a_1 – open field culture;

a_2 – protected culture in the solar

B Factor – the cultivar:

b_1 Local population of Amărăști;

b_2 Local population of Dobrești;

b_3 Local population of Grădinari;

b_4 Local population of Secui;

b_5 *Cornel* variety (control variant).

RESULTS AND DISCUSSIONS

Quality is a complex notion, which includes both the properties of the product to satisfy a certain need and the economic aspects related to the realization and use of the product. Taking into account the fact that the quality of a product is determined by the set of its useful characteristics that can be observed, measured or compared with a standard, at RDSPCS Dăbuleni, at the culture of some local populations of *Capsicum annuum ssp.grossum* were obtained differentiated results from a qualitative point of view, both depending on the cultivar, but also depending on the used cultivation method (table 1).

The total dry substance content was between 6.2% at the Grădinari population, cultivated in a protected space (solar) and 8.97% at the Dobrești population cultivated in the open field. At all unprotected variants the total dry substance content was higher compared to the variants grown in solar. The results are slightly higher than those obtained by Kumar et al., 2015, who, studying 15 genotypes of bell peppers, found in the fruits an average total dry substance content of 6.12% (5.63-6.35%). With the accumulation of total dry substance, the amount of water in the fruits decreases. The soluble dry substance was between 5.8% at the Grădinari population cultivated in solar and 6.9% at the Cornel variety and Amărăști population in unprotected system. At the unprotected variants, the soluble dry substance content was higher at all genotypes, compared to the variants grown in solar. At the variants in which the soluble dry substance showed higher values, the amount of soluble carbohydrates was also higher. Regarding the acidity of the fruits, the values were reduced, being in the range of 0.47-0.78 g of malic acid/100 g of fresh substance. With the exception of the control variant, all local populations of bell peppers showed higher acidity values under field cultivation conditions, compared with solar-grown varieties. Under the climate conditions and given consumers' preferences for bell peppers, the development of new hardy and high-yielding varieties is required. It is becoming increasingly difficult to produce good quality, high-yielding peppers due to various biotic (pests and diseases) and abiotic factors (precipitation, temperature, relative humidity and light intensity).Crops obtained by field cultivation of plants are often exposed to fluctuating levels of temperature, humidity and wind intensity (Kanwar et al., 2014), with consequences on the quality and quantity of the production obtained; obtaining some high yields could be related to the average surface of the pepper leaves (Ciucă et al, 2019); the physiological and biochemical processes could be also influenced by the environmental conditions specific to each cultivation method – open field/solar - but also by each cultivar (Paraschiv et al., 2019). The amount of vitamin C from bell peppers was in the range of 105.6 mg for Cornel variety, grown in solar and 217.56 mg for Dobrești local population, also grown in solar. Kumar, et al., 2015, on a study of 15 genotypes found in bell pepper fruits an average C vitamin content of 97.99 mg (83.13-111.97 mg). Marin et al., 2004, showed at different bell pepper cultivars that the C vitamin content increased as the pepper reached maturity. At physiological maturity, red fruits had a relevant impact on carotenoid content. Thus, green peppers had the highest content of polyphenols, while red ripe fruits had the highest content of C vitamin and provitamin A. If we analyze the average values of the studied indices, we find that, from a qualitative point of view, the variants cultivated in open field were highlighted, compared to the variants cultivated in protected space (solar), (table 1).

Table 1

Biochemical composition of bell peppers according to cultivation method and cultivar - 2019

Cultivation method	Cultivar	TDS (%)	Water (%)	SDS (%)	Soluble carbohydrates (%)	Titatrable acidity (g malic acid/100 g f.s.)	C vitamin (mg/100 g f.s.)	Carotene (µg/g)	TPC (µg GAE/g f.s.)	AO (µM TE/g f.s.)
Field culture	Local pop. Amărăști	7.80	92.20	6.9	5.95	0.77	178.39	157.03	2325.36	16.82
	Local pop. Dobrești	8.97	91.03	6.4	5.50	0.78	190.96	170.83	2381.15	16.75
	Local pop. Grădinari	7.95	92.05	6.7	5.80	0.64	168.96	189.70	1564.82	11.16
	Local pop. Secui	7.81	92.19	6.5	5.60	0.64	173.36	175.29	1971.03	13.17
	Cornel (control var.)	7.94	92.06	6.9	5.94	0.51	136.40	179.58	1754.63	12.71
AVERAGE (field culture)		**8.09**	**91.91**	**6.68**	**5.76**	**0.67**	**169.61**	**174.49**	**1999.40**	**14.12**
Protected culture	Local pop. Amărăști	7.65	92.35	5.9	5.12	0.64	155.76	167.16	2426.17	11.2
	Local pop. Dobrești	6.60	93.40	6.0	5.20	0.61	217.56	183.28	1584.61	8.11
	Local pop. Grădinari	6.20	93.80	5.8	5.00	0.54	129.36	158.88	1582.80	8.55
	Local pop. Secui	6.42	93.58	5.9	5.00	0.55	133.76	172.50	2632.83	15.36
	*Corne*l (control var.)	7.05	92.95	5.9	5.10	0.47	105.60	186.66	1802.98	8.47
AVERAGE (protected culture)		**6.78**	**93.22**	**5.90**	**5.08**	**0.56**	**148.41**	**173.70**	**2005.88**	**10.34**

Table 2

The influence of the cultivar on the biochemical composition of bell peppers - 2019

Cultivar	TDS (%)	Water (%)	SDS (%)	(%) Soluble carbohydrates	Titatrable acidity	C vitamin (mg/100 g f.s.*)	Carotene (µg/g)	TPC (µg GAE/g f.s.)	AO (µM TE/g f.s.)
L. p. Amărăști	7.73	92.28	6.40	5.54	0.71	167.08	162.10	2375.77	14.01
L. p. Dobrești	7.79	92.22	6.20	5.35	0.70	204.26	177.06	1982.88	12.43
L. p. Grădinari	7.08	92.93	6.25	5.40	0.59	149.16	174.29	1573.81	9.86
L. p. Secui	7.12	92.89	6.20	5.30	0.60	153.56	173.90	2301.93	14.27
Cornel variety (control)	7.50	92.51	6.40	5.52	0.49	121.00	183.12	1778.81	10.59

The studied populations differentiated from each other, and compared to the control variant, the local populations of Dobrești and Amărăști were highlighted, with a higher content of total dry substance, soluble carbohydrates, C vitamin and total phenolic compounds (table 2). All the studied local populations presented a higher amount of C vitamin compared to the Cornel control variant, so the fruits of these cultivars could be recommended as functional foods for vitamin C in the human diet. A positive correlation was established between the content of total phenolic compounds and the antioxidant activity, distinctly significant, noting in this aspect the local populations Amărăști and Secui (figure 1). The acidity of bell peppers increased in value with the increase of the total dry substance, after a positive polynomial correlation, with a significant correlation factor (figure 2).

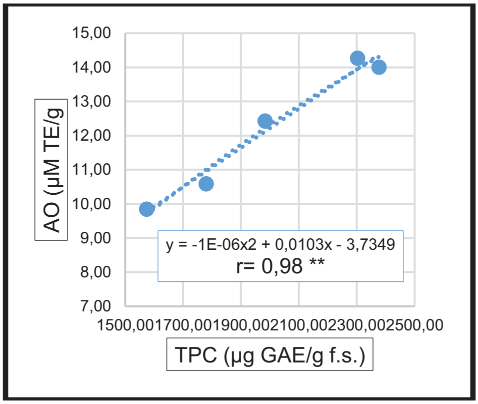

Figure 1. The correlation between the content of total phenolic compounds and the antioxidant activity of bellpeppers

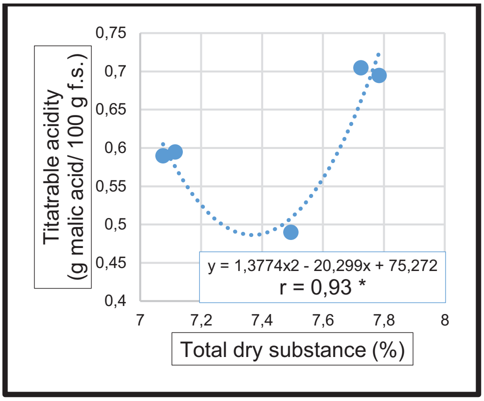

Figure 2. The correlation between total dry substance and the titatrable acidity of bell peppers

CONCLUSIONS

As a result of the carried out study, it can be concluded the followings, under the conditions of the obvious climatic changes:

- due to the high content of ascorbic acid, carotene and total phenolic compounds, the bell pepper grown on sandy soils in southern Oltenia is of particular importance from a scientific and nutritional point of view.
- it is recommended to choose the species and varieties with maximum potential, because they are drought tolerant and resistant.
- from a qualitative point of view, the variants cultivated in the open field were highlighted, compared to the variants cultivated in protected space (solar), (8.09% TDS, 6.68% SDS, 5.76% soluble carbohydrates, 0.67 g malic acid / 100g f.s. titratable acidity, 169.61 mg/100 g f.s. C vitamin, 14.12 µM TE/g antioxidant activity).
- the local populations of Dobrești and Amărăști were highlighted, with a higher content of total dry substance, soluble carbohydrates, C vitamin and total phenolic compounds.

- all the studied local populations presented a higher amount of ascorbic acid compared to the Cornel control variant; the fruits of these cultivars could be recommended as functional foods for C vitamin in the human diet.
- The higher the content of total phenolic compounds, the higher the antioxidant activity, establishing a positive, distinctly significant correlation between these two biochemical indices.

REFERENCES

Bodea C. 1984. Tratat de biochimie vegetală, Partea a II-a, vol. V, Edit. Academiei Republicii Socialiste România, București, pp. 82-97.

Ciofu R. 2003. Tratat de legumicultură, Editura Ceres, București, pp. 646-674.

Ciucă I. (Paraschiv) A.N., Diaconu A., Croitoru M., Popa D.V. 2019. Research on the behavior of some genotypes of Capsicum annuum ssp. grossum in the area of sandy soils in southern Oltenia. Annals of the University of Craiova, XXIV (LX), 552-561.

Ifrim A., Buică V. 1994. Cercetări privind comportarea unor soiuri și linii de pătlăgele vinete pe solurile nisipoase din sudul Olteniei. Lucrări științifice ale S.C.C.C.P.N. Dăbuleni, VIII, 111-117.

Kanwar M. S., Mir M. S., Lamo K., Akbar P. I. 2014. Effect of protected structures on yield and horticultural traits of bell pepper (Capsicum annuum L.) in Indian cold arids. African Journal of Agricultural Research, 9(10), 874-880.

Kumar V., Pathania N. K., Kumar N. 2015. Evaluation of bell pepper (Capsicum annuum L. var. grossum Sendt.) genotypes for quality traits in modified naturally ventilated polyhouse. Annals of Horticulture, 8(1), 69-72.

Marín A., Ferreres F., Tomás-Barberán F.A., Gil MI. 2004. Characterization and quantitation of antioxidant constituents of sweet pepper (Capsicum annuum L.), Journal of Agricultural and Food Chemistry, 52(12),3861–3869.

Paraschiv A.N., Dima M., Diaconu A., Ciuciuc E., Croitoru M. 2019. Research on the behavior of an assortment of bell pepper on the sandy soils in south-west Oltenia according to the cultivation method used, NORDSCI Conference on Social Sciences, 19-23 August, Novotel, Athens, Greece, Conference Proceedings, Book 2(2), 283-290.

Shotorbani N.M., Jamei R., Heidari R. 2013. Antioxidant activities of two sweet pepper Capsicum annuum L. varieties phenolic extracts and the effects of thermal treatment. Avicenna Journal of Phytomedicine, 3(1), 25-34.

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THE ASSESSMENT OF GENETIC RESOURCES USED IN IMPROVING TOMATOES IN THE CLIMATIC CONDITIONS FROM 2020 YEAR

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Keywords*: tomatoes, genotipes, sandy soils*

ABSTRACT

The average annual temperatures recorded in the area of sandy soils in southern Oltenia from Romania show a tendency to increase temperatures, and the absolute maximum temperature registers significant increases day after day with values over 30^0 C and sometimes even over 35^{0}C with unfavorable effects on tomato plants. In this context, it is necessary to create varieties and hybrids with genetic resistance to thermal and water stress factors. To this end, we proceeded to identify and collect genetic resources and use them in tomato breeding programs. Were followed five local populations and four tomato lines. Was determinations were made on the main characteristics of tomato fruit: fruit weight, fruit height, fruit diameter, pericarp thickness and shape index. The studied genotypes showed different fruits in size, shape, color. The average weight of a tomato fruit ranged from 29.8 to 309.2 g / fruit. The ratio between the height and the diameter of the fruits was different and was between 0.76-2.35 imprinting their shape from globular and globular flattened in most cases, to ovoid and even very elongated, pepper type.The height of the fruit was between 3.42-10.41 cm, and the diameter of the fruit had values between 3.64-8.96 cm. The thickness of the pericarp was between 4.8 -7 cm.

INTRODUCTION

The area of sandy soils in the south of Oltenia is a strong vegetable basin, a special place occupied by tomatoes grown both in the field and in solariums. Tomatoes are thermophilic plants, the optimal temperature required being about 22^{0}C, given that the other vegetation factors are all ensured at the optimal level. At over 30^{0}C the plants no longer bear fruit, because the pollen no longer germinates. If the temperature exceeds 32^{0}C, the plants stop growing, and at over 40^{0}C the plants die (Voican et al., 1998). One of the important factors of the technology is the variety, which through the genetic dowry can show a high adaptability to natural environmental factors, especially heat and water stress, so the creation of varieties adapted to the specific conditions of sandy soils has become a priority for research. In the conditions of climate change, many authors have concluded that it is necessary to decipher in detail the molecular mechanisms of thermal stress response (HSR) and thermotolerance and use this information to identify genotypes that will withstand adverse environmental conditions. After Zinn et al. (2010), the reproductive (gametophytic) phase in flowering plants is often highly sensitive to hot or cold temperature stresses, with even a single hot day or cold night sometimes being fatal to reproductive success. Ontinuous exposure of tomato 'Trust' to high temperatures (day/night temperatures of 32/26^0 C) markedly reduced the number of pollen grains per flower and decreased viability. The effect of heat stress on pollen viability was associated with alterations in carbohydrate metabolism in various parts of the anther during its development (Pressman et al. 2002). The sexual reproduction phase is considered as the most sensitive to heat and specifically pollen exhibits the highest sensitivity and frequently an elevation of the temperature just a few degrees above the optimum during pollen development can have detrimental effects for crop production (Bokszcanin 2013). The tomato production is severely affected by many diseases. The use of variety resistance is believed to be the most effective approach to control the pathogens. The collection of plant genetic resources involves the action of identifying valuable genotypes that have high adaptability to environmental factors, pathogen resistance genes and productivity and quality genes. The experience aims to collect, evaluate and preserve varieties and local populations in the southern part of Romania and especially in the south of Oltenia, genotypes adapted to the conditions of thermal and water stress. The collected genetic resources were introduced into the germplasm collection and evaluated for use as gene sources in the improving process.

MATERIAL AND METHODS

The research was conducted within Research-Development Sation for Plants Crops on Sandys Soils Dabuleni, on a sandy soil in the climatic conditions specific to 2020 year. In the initiation field were followed five local populations (*Horezu population, Visina population, Castranova population, Listeava population, Predesti population*) and four tomato lines (L - TKIT, L - 11/53, L - SP / 15, L - CM). The cultivation technology specific to unfinished tomatoes grown in the open field on the sandy soils in the south of Oltenia was applied, and the need for water was ensured by dripping. Was determinations were made on the main characteristics of tomato fruit: fruit weight, fruit height, fruit diameter, pericarp thickness and shape index. The arithmetic mean for each character and the standard deviation were calculated.

RESULTS AND DISCUSSION

The 2020 year was a special year in terms of climate, with very high temperatures and low rainfall, with a direct influence on the growth and development of tomato plants. In May the average temperature was 19.8^{0}C, with 2.3^{0}C higher than the multiannual average from the last 60 years, with a maximum temperature of 33^0 C, a minimum of 8^0 C and a rainfall of 59.2 mm (Table 1). Out of the total days, in 12 days temperatures over 25^{0}C were recorded, of which in 11 days the maximum temperatures were between 25-30^{0}C and in one day temperatures between 30-35^{0}C were recorded.

The month June was very warm, the monthly average being 22^{0}C, 1.60C higher than the multi-year average of 21.4^{0}C. In June, in 16 days temperatures were recorded between 25-30^0 C and in 10 days the maximum temperatures were between 30-35^{0}C. The maximum in June was 35^{0}C, and the amount of precipitation was 55.8 mm, of which 39.8 mm fell in a single day (June 17).

Table 1
The climatic conditions during May - August 2020, registered at the RDSPCSS Dăbuleni weather station

Specification	The month			
	May	June	July	August
Number of days with maximum temperatures between 25-30^0 C	11	16	10	5
Number of days with maximum temperatures between 30-35^{0}C	1	10	16	23
Number of days with maximum temperatures between 35^{0}C	0	0	3	3
The monthly average (^{0}C)	19.8	22.0	24.5	24.9
The monthly minimum (^{0}C)	8	6,7	14	12,9
The monthly maximum (^{0}C)	33	35	37	36,9
Rainfall (mm)	59.2	55.8	73.0	51
Multiannual average temperatures (1956-2019)	17.5	21.4	23.2	22.6

In July, the average monthly temperature was 24.5^{0}C, 1.3^{0}C higher than the multiannual average. In 10 days maximum temperatures were recorded between 25-30^{0}C, in 16 days the maximum temperatures were between 30-35^{0}C and in 3 days the temperatures were over 35^{0}C. The maximum in July was 37^{0}C. These temperatures can have negative effects on the process of growing and fruiting tomatoes. The amount of precipitation was 73 mm, of which 41.2 mm were recorded on July 18. August was particularly hot, with the average monthly temperature being much higher than the average multiannual temperatures. In August, in 5 days the maximum temperatures were between 25-30^{0}C, in 23 days temperatures were recorded between 30-35^{0}C and in 3 days the maximums exceeded 35^{0}C, the maximum of the month being 36.9^0 C, and the amount of precipitation it was only 51 mm distributed in very small quantities over several days. The average temperature of the month was 22.6^{0}C, 2.3^{0}C higher than the multiannual average.

The average annual temperatures recorded in the area of sandy soils in southern Oltenia show a tendency to increase temperatures, and the absolute maximum temperature registers significant increases day after day with values over 30^{0}C and sometimes even over 35^{0}C with unfavorable effects on tomato plants. In this context, it is necessary to create varieties and hybrids with genetic resistance to thermal and water stress factors. To this end, we proceeded to identify and collect genetic resources and use them in tomato breeding programs.

The studied genotypes showed different fruits in size, shape, color. The average weight of a tomato fruit ranged from 29.8 to 309.2 g / fruit (Table 2). The ratio between the height and the diameter of the fruits was different and was between 0.76-2.35 imprinting their shape from globular and globular flattened in most cases, to ovoid and even very elongated, pepper type.

Table 2

The variability of the main characters in the studied tomato genotypes

Genotype	The character	U.M	X	S	S%	Significance after s%
Horezu population	Fruit weight	g	92.5	22.78	24.70	Large
	Fruit height	cm	5.22	0.41	7.85	Small
	Fruit diameter	cm	5.81	0.46	7.92	Small
	Shape index		0.90	0.06	6.66	Small
	Pericarp thickness	mm	5.6	0.87	15.53	Small
Vișina population	Fruit weight	g	142.2	42.54	29.91	Large
	Fruit height	cm	6.09	0.57	9.36	Small
	Fruit diameter	cm	6.77	0.76	11.22	Medium
	Shape index		0.90	0.14	15.55	Medium
	Pericarp thickness	mm	6.2	0.83	13.38	Medium
Castranova population	Fruit weight	g	127.6	20.83	16.32	Medium
	Fruit height	cm	9.70	1.54	15.87	Medium
	Fruit diameter	cm	5.85	0.43	7.35	Small
	Shape index		1.66	0.38	22.89	Large
	Pericarp thickness	mm	6.7	1.49	22.23	Large
Lișteava population	Fruit weight	g	256.0	100.65	39.31	Very large
	Fruit height	cm	7.59	1.52	20.10	Large
	Fruit diameter	cm	7.97	1.15	14.43	Medium
	Shape index		0.95	0.07	7.37	Small
	Pericarp thickness	mm	5.3	0.58	10.94	Medium
Predești population	Fruit weight	g	107.4	24.15	22.48	Large
	Fruit height	cm	10.41	1.43	13.73	Medium
	Fruit diameter	cm	4.43	0.61	13.77	Medium
	Shape index		2.35	0.39	16.59	Medium
	Pericarp thickness	mm	5.0	0.64	12.8	Medium
L – TKIT	Fruit weight	g	29.8	5.89	19.76	Medium
	Fruit height	cm	3.42	0.28	8.18	Small
	Fruit diameter	cm	3.83	0.24	6.26	Small
	Shape index		0.89	0.06	6.74	Small
	Pericarp thickness	mm	5.6	1.24	22.14	Large
L – 11/53	Fruit weight	g	37.2	5.89	15.83	Medium
	Fruit height	cm	5.66	0.36	6.36	Small
	Fruit diameter	cm	3.64	0.38	10.44	Mijlocie
	Shape index		1.56	0.14	8.98	Small
	Pericarp thickness	mm	6.6	0.54	8.18	Small
L- SP/15	Fruit weight	g	52.6	17.37	33.08	Very large
	Fruit height	cm	4.42	0.49	11.08	Medium
	Fruit diameter	cm	4.97	0.76	15.29	Medium
	Shape index		0.89	0.17	19.10	Medium
	Pericarp thickness	mm	7.0	0.70	10.0	Medium
L – C.M	Fruit weight	g	309.2	101.14	32.7	Very large
	Fruit height	cm	6.83	0.64	93.7	Small
	Fruit diameter	cm	8.96	0.92	10.26	Medium
	Shape index		0.76	0.04	5.26	Small
	Pericarp thickness	mm	5.0	0.93	18.6	Medium

The height of the fruit was between 3.42-10.41 cm, and the diameter of the fruit had values between 3.64-8.96 cm. The thickness of the pericarp was between 4.8 -7 cm. The analysis of the variability of the characters in the Horezu population highlights a high variability for the weight of the fruits and a small variability for the other characters. The fruits had a globular flattened shape, an average weight of 92.5 g with a height of 5.22 cm and a diameter of 5.81 cm.

At the Visina population, the average weight of a fruit was 142.2 g, with a height of 6.09 cm and a diameter of 6.77 cm, giving it a flattened globular shape. The fruits showed high variability in weight, low variability in height and medium variability in diameter, shape index and pericarp thickness.

The population of Castranova presented fruits with an average weight of 127.6 g, height of 9.7 cm and diameter of 5.85 cm, the shape index being 1.66, which gives the fruits an elongated shape. The thickness of the pericarp is 6.7 mm.

From the analysis of the variability of the characters results an average variability for the weight and height of the fruit, small variety for diameter and large for shape and thickness index pericarp.

The analysis of the variability of characters in the Listeava population highlights a very high variability for fruit weight, average variability in fruit diameter and pulp thickness and low variability for shape index. The fruits had a globular shape, an average weight of 256 g with a height of 7.59 cm and a diameter of 7.97 cm and a pericarp thickness of 5.3 mm.

At the Predesti population, the average weight of a fruit was 107.4 g, a height of 10.41 cm and a diameter of 4.43, giving it a much elongated shape (the shape index has a value of 2.35). The fruits showed a high variability for weight medium variability for the other characters.

The genotype L - TKIT had the smallest fruits with an average weight of 29.8 g, the average height of a fruit was 3.42 cm and the diameter of 3.83 cm, with a pericarp thickness of 5.6 mm. From the analysis of the variability of the characters results an average variability for the weight of the fruit, small variability for height, diameter and shape index and high variability for the thickness of the pericarp.

The fruits of genotype L - 11/53 was an elongated shape, an average weight of 37.2 g, an average height of 5.66 cm and a diameter of 3.64 cm, with a pericarp thickness of 6.6 mm. They showed a medium variability in weight and diameter and low variability for height, shape index and pericarp thickness.

The L-SP / 15 genotype presented fruits with an average weight of 52.6 g, a height of 4.42 cm and a diameter of 4.97 and a pericarp thickness of 7 mm. From the analysis of the variability of the characters results a very high variability for the weight of the fruits, and medium variety for the other characters. The analysis of the variability of the characters at the L-C.M genotype highlights a very high variability for fruit weight, small variability for diameter and shape index and medium for fruit height and pericarp thickness. The fruits were large (309.2 g) of flattened goblet shape, with a height of 6.83 cm and a diameter of 8.96 cm and a pericarp thickness of 5 mm.

It can be seen that the weight of the fruit is influenced differently from the other characters of the fruit: fruit height, fruit diameter and pericarp thickness may have large fruits and small pericarp thickness as found at genotype L-C.M, Listeava population and Predesti population or small fruits and thickness large pericarp as found at genotype L-11/53

CONCLUSIONS

The nine genotypes studied differ by the size and shape of the fruit given by the ratio between height and diameter, by the thickness of the pulp and color.

The average weight of a tomato fruit was between 29.8-309.2 g. The tomato fruits showed a height between 3.42-10.41 cm and a diameter between 3.64-8.96 cm. The shape index had values between 0.89-2.35 giving the fruit the shape from flattened to very elongated. The pericarp thickness of a tomato fruit had values between 5-7 mm.

Among the genotypes studied, the L-C.M genotypes with 309.2 g / fruit and the Listeava population with 256 g / fruit were noted by the size of the fruits, and the L-SP / 15 genotype by 7 mm was noted by the thickness of the pericarp.

Each of these genotypes is a valuable material for the improvement of this species in sandy soil conditions.

ACKNOWLEDGMENT

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REFERENCES

Bokszczanin K. L., Fragkostefanakis S., Bostan H., Bovy A., Chaturvedi P., Chiusano M. L., Li H. 2013. Perspectives on deciphering mechanisms underlying plant heat stress response and thermotolerance. Frontiers in Plant Science, 4, 315.

Pressman E., Peet M. M., Pharr D. M. 2002. The effect of heat stress on tomato pollen characteristics is associated with changes in carbohydrate concentration in the developing anthers. Annals of Botany, 90(5), 631-636.

Voican V., Lacatuș V. 1998. Cultura protejată a legumelor în sere și solarii. Ed. CERES, București.

Zinn K. E., Tunc-Ozdemir M., Harper J. F. 2010. Temperature stress and plant sexual reproduction: uncovering the weakest links. Journal of experimental botany, 61(7), 1959-1968.

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RESEARCH STUDIES ON MAKING BEST USE OF PEDOCLIMATIC CONDITIONS SPECIFIC TO CRAIOVA PERI-URBAN AREA THROUGH GRAPEVINE CULTIVATION

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Keywords*: pedoclimatic conditions, peri-urban area, grapevine*

ABSTRACT

Peri-urban areas represent functional territorial units offering mutual and complementary advantages to components participating in their formation under condition of achieving an efficient territorial structure. This paper indicates the results of several studies on the cultivation of grapevine varieties in the peri-urban area of Craiova city.

INTRODUCTION

Studies on the vicinity of cities have been written ever since late nineteenth century when the urban phenomenon was in full expansion during the demographic explosion and industry and transport development. Later on, geographers, economists and sociologists have described such areas known as the”suburbs” (in the English literature), ”banlieue” (in the French literature) and ”Vorort” (in the German literature) (Clark 1990). The peri-urban area was characterised by consideration of three specific elements, namely the vicinity of the city; the very close relations with it; the aspect where the natural blends with the city itself (Knox & Agnew 1989). Romanian literature defines it as the space around cities and towns, delimited by specialised studies, where relations are created in economics, infrastructure, business travels, providing green areas, food products, entertainment areas, etc. (Legea nr. 350 /2001). The suburbs perform natural, social and economic roles deriving from the activities carried out in such areas. Research studies on making best use of the conditions specific to the peri-urban area of Craiova city through grapevine cultivation were also conducted by Buzatu & Mărăcineanu (2015), Costea et al. (2017), Cichi (2006), Cichi et al. (2016).

MATERIAL AND METHODS

Craiova is the most important city in South-West Oltenia with a total area of 8,141 hectares and a population of approximately 300,000 inhabitants. Craiova also includes Cernele, Făcăi, Izvorul Rece, Mofleni, Popoveni, Rovine and Şimnicu de Jos suburbs. The cooperation objectives between the city and surrounding areas are territorial, economic, social, cultural and environmental, being part of the metropolitan development plan.

Observations and determinations concerning the results of grapevine cultivation were made during 2018-2019 in a private 12-year-old vineyard located in

Cârcea village, where the trunk length of Syrah varieties was 80 cm and the pruning by Guyot training system was performed.

RESULTS AND DISCUSSIONS

The geomorphological features of Craiova area first and foremost result from the city location at the contact point between two landform levels, Piemontul Getic and Câmpia Română, on the large Jiu river passage. The urban establishment has expanded on the Jiu river terraces appearing under a coliseum-like form downstream the junction with Amaradia river. The city of Craiova has developed in an area approximately 70 - 75 m high (the altitude is 70 -75 m at meadow level and 140-150 m at the 5th terrace level). Piedmont hills (Bucovăţ, 165 m high; Cârligei, 160 m high; Balacita Piedmont) delimit the Jiu passage to the west and the hills of Olteț Piedmont (Viilor, 209,5 m high; Mlecăneşti, 203,5 m high and Cârcea, 191,5 m high), delimit the Easter side of the passage (Albă et al. 2018, 2019).

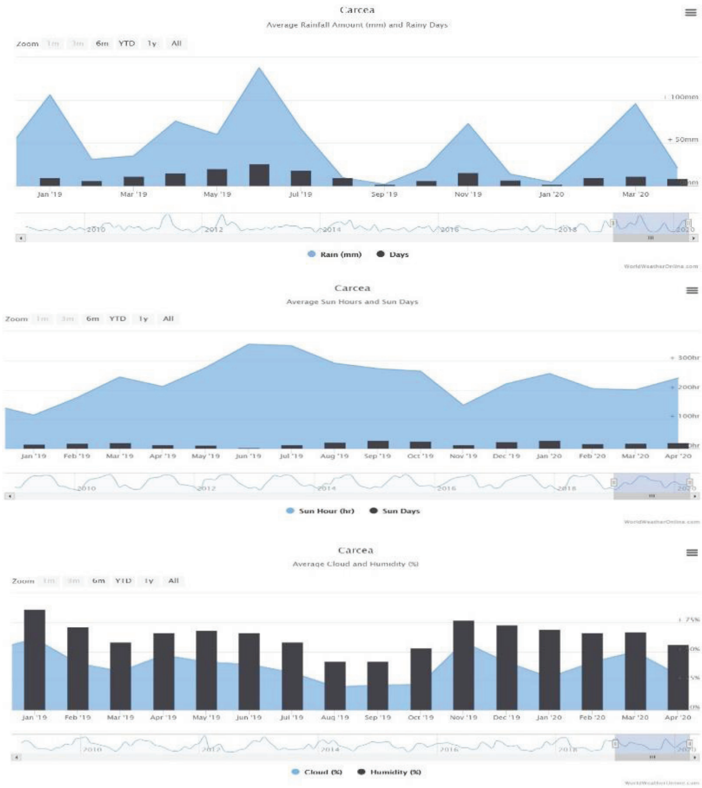

Figure 1. Climatic conditions during the experimental period (precipitations, number of sunlight hours, presence of clouds and wettability) according to https://www.worldweatheronline.com/carcea-weather-averages/dolj/ro.aspx

The climatic conditions were favourable to the proper evolution of physiological and biochemical processes, grapevine growth and fructification (fig 1).

Despite the fact that the values of climatic determinant factors indicated high temperature and sunshine levels, an almost total lack of precipitation in August and

September and average weekly temperatures of over 22.0°C during the maturation process, 2019 has turned out to be a good year for viticulture, after all. The low volume of precipitations during the grape maturation period has determined a precocity associated to a high rhythm of sugar accumulation.

It is important to notice that the lack of precipitations has had no negative impact on the maturation process in terms of quality. This can be explained by the existence of a large quantity of water in the soil as result of the significant volume of precipitations from in previous months (80% of the total annual volume of precipitations during the conventional vegetation period).

The argument for this is the content of sugars recorded at 15 September i.e. 233 g/l, under condition of 5.0 g/l H_2SO_4 acidity (table1).

Table 1

The evolution of the main quality parameters for Syrah variety

Date		6•08	13•08	20•08	27•08	3•09	10•09	17•09	24•09	30•09
Quality Parameter	G	-	105.1	113.0	116.0	121.4	128.5	136.2	138.0	132.5
	V	-	100	107	110	112	119	124	125	123
	Z	-	136.0	153.2	168.5	181.0	213.0	233.0	236.0	240
	A t	-	13.4	9.2	7.1	6.7	5.8	5.0	4.2	4
	Ant,	-	449	603	739	975	1118	1154	1209	1268

G = weight of 100 berries (g);
V = volume of 100 berries (ml)
Z = content of soluble sugars (g/l);
A t = titratable acidity (mg/l H_2SO_4)
Ant. = content of anthocyanins (mg/kg of grapes)

Syrah variety under study has showed a high accumulation potential, as the sugar parameter increased with 97.0 g/l during 06.08-17.09. As result of the maturation as an evolving phase characterised by complex morpho-anatomical and biochemical changes, the biosynthesis and storage of anthocyanins happens mostly in the berry epicarp. The accumulation of anthocyanins is somehow similar to sugars (figure 2).

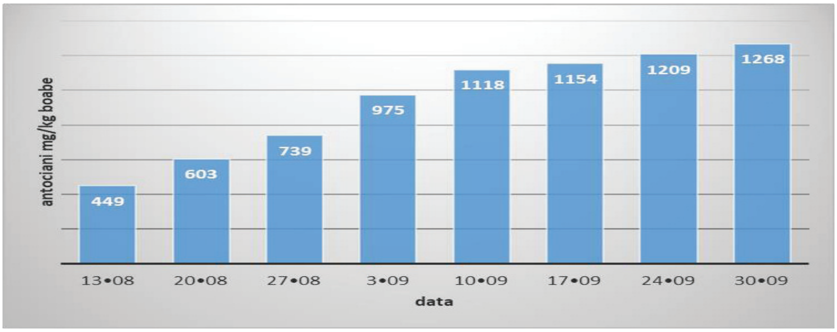

Figure 2 The dynamics of anthocyanins accumulations in Syrah grapes

The long sunshine period and the richness of thermal resources specific to the cultivation year have determined an increased growth rhythm of this quality parameter resulting a Syrah anthocyanin maturation of 1,268 mg/kg of berries.

CONCLUSIONS

The durable development of an area is a strategic action meant to provide the durable increase of individual productivity by rational and efficient use of available resources, by conservation, protection and valorisation of natural and cultural patrimony of the region, through human resources development.

The ecosystem specific to Carcea village where the case study was conducted provides heliothermic resources which, along with balanced precipitations, have created optimal conditions for a quality viticulture yield, fact also proved through the Syrah case study.

Grapevine cultivation can be a successful business in Craiova suburbs thanks to the favourable climate and tradition of high quality viticultural products in the region.

An overall analysis of the results obtained leads to the conclusion that the study has confirmed the favourability of the conditions specific to Banu Mărăcine viticultural area including Cârcea village for high quality viticultural products, turning grapevine cultivation into a profitable business for the local inhabitants of this area.

REFERENCES

Albă C. D., Boengiu S. 2019. Urban Geoheritage. The Secular Wells of Craiova, Romania. Quaestiones Geographicae

Albă C. D., Zamfir A. G., Boengiu S. 2018. Urban hydrography and Bluespots map of Craiova (Romania). Journal of the Geographical Institute ”Jovan Cvijic”, SASA, 68(3), 321-332

Audrey N. Clark, Dictionary of Geography Penguin 1990

Buzatu G.D., Mărăcineanu L.C. 2015. Evaluation of levels of climate favorability for viticulture in Breasta viticultural centre. ACTA Universitatis Cibiniensis, 67(1), 105–110.

Cichi D. D.. 2006. Modificările termice din ecosistemul viticol (cauze, efecte asupra viţei de vie). Editura Universitaria Craiova, pp. 280.

Cichi D. D., Costea D. C., Gheorghiu N. 2016. The cold hardiness of some varieties of grapevine cultivated in the viticultural area Plenita (Southwestern Romania). Annals of the University of Craiova -Agriculture, Montanology, Cadastre Series), XLVI, 62-67.

Costea D. C., Cichi D. D., Căpruciu R. 2017.The influence of applying summer pruning operations on the quantity and quality of Cardinal varieties. Analele Universitatii din Craiova, Seria Biologie, Horticultura, Tehnologia Prelucrarii Produselor Agricole, Ingineria mediului, XXII(LVIII), 89-94.

Knox P., Agnew J. 1989. The Geography of the World Economy. Londres, Edward Arnold, 410 p.

*** Legea nr. 350 /2001 privind Amenajarea Teritoriului şi Urbanismul

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RESEARCH ON REDUCING WEEDS BY HERBICIDE ON SWEET POTATO CROPS LOCATED ON SANDY SOILS

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Keywords: *herbicide, sweet potato,weeds,sandy soil*

ABSTRACT

The research was carried out in the period 2016-2018, on the crop located on sandy soils with low fertility within the RDSPCS DĂBULENI. The experiment aimed to influence the cultivation method and herbicides used to establish the sweet potato crop in the field and during the growing season to reduce weeding. The annual productions made between 2016-2018, were significantly higher for sweet potatoes grown on soil protected with PE mulch foil and herbicided with Dual Gold 960 EC (1.5 l / ha - immediately after planting) + Fusilade Forte (1.5 l / ha - during the vegetation period) compared to the productions obtained for cultivation on unprotected soil, regardless of the herbicide variants used.

INTRODUCTION

Weeds are a group of uncultivated plant species, without economic value, adapted to grow with cultivated plants, whose growing conditions worsen. In the current socio-economic conditions in which Romanian agriculture faces a multitude of problems, its primary role is to ensure the food stability of society and continue to create availability in the export of agricultural products, as a definite possibility to revive Romanian agriculture and of the national economy as a whole (Hogea, 1997). Weeds compete with crops for different resources: direct sunlight, soil nutrients, water and growing space, and are intermediate hosts for certain pathogens, including some vectors (especially aphids) of viruses. For this reason, the number of weeds must be reduced below the economic damage threshold, that degree of weeding that does not significantly influence the level of crops, and this is achieved by applying integrated methods of reducing land weeding. To reduce the degree of weeding, both preventive and curative methods (agrotechnical, chemical, physical and biological) are used, applied after a good knowledge of the sources of weeding (Popescu 1997). Farmers need to plan a full weed control program, integrated with mechanical, cultural methods, and the use of herbicides (Dittmar & Stall 1999). In the case of sweet potato cultivation, weed control during vegetation is essential for obtaining economical yields. Research mentions the major risk due to weed competition at the beginning of the season, when more emphasis should be placed on weed control. Research conducted by Glaze & Hall (1990) highlights the successful use of herbicides based on *fluazifop, metolachlor, metribuzin,* *napropamide, oryzalin and sethoxydin* applied after sweet potato transplantation. In Kentucky, *clomazone (Command 3ME) and DCPA (Dacthal W75*) herbicides are used for pre-emergence and immediately after shoots planting, *napropamide* based herbicide (*Devrinol 50DF*) and *flumioxazin (Valor 51 DG*). To control monocotyledonous weeds, during the vegetation period, herbicides based on *carfentrazone (Aim 1.9 EW), clethodim (Select Max*) are used (Vegetable production guide for commercial growers, 2017). In the SE region of the USA, herbicides based on *glyphosate, metam sodium (Vapam HL) and flumioxazin (Value 51 DG*) are recommended for sweet potato cultivation - before planting and based on *S-metolachlor (Dual magnum), clomazone Command 3ME), DCPA (Dacthal W75) and napropamide (Devrinol 50DF)* - applied 5 days after transplantation. In the post-emergence, herbicides based on *clethodim (Arrow, Select Max, Intensity), fluazifop (Fusilade Forte) and sethoxydim (Poast 1.5 EC)* were used to control annual and perennial monocotyledonous weeds. (Vegetable Crop Handbook for Southestern United States, 2016).

MATERIAL AND METHODS

The research was conducted at S.C.D.C.P.N. Dăbuleni between the years 2016-2018, the experience being located on a sandy soil with low fertility, according to the method of plots subdivided with two factors, in conditions of drip irrigation. Shoots of the K.S.P. 1 variety were used for planting. , the tubers of this variety being planted on March 15 in a solarium with double walls, in which the temperature and humidity of the air were controlled by frontal and lateral ventilation and by using micro-sprinkling when the temperature exceeded 28-30 ^{0}C.

The factors studied were:

A - cultivation method: a1 - Cultivation on soil protected with PE mulch foil
a2 - Cultivation on unprotected soil

B - Herbicides applied to vegetation:

- b1 - Untreated control;
- b2 - *Dual Gold 960 EC (metolachlor 960 g /* l), 1 l / ha immediately after planting before weeds appear;
- b3 - *Dual Gold 960 EC (metolachlor 960 g / l*), 1.5 l / ha immediately after planting, before the appearance of weeds;
- b4 - *Fusilade Forte 1,5 l / ha (fluazifop-p-butyl 150 g / l*), applied during the growing season to control monocotyledonous weeds;
- b5 - *Dual Gold 960 EC (metolachlor 960 g / l*), 1 l / ha immediately after planting before weeds + *Fusilade Forte 1.5 l / ha (fluazifop-p-butyl 150 g / l*) applied during vegetation to control monocotyledonous weeds;
- b6 - *Dual Gold 960 EC (metolachlor 960 g /* l), 1.5 l / ha immediately after planting, before weeds + *Fusilade Forte 1.5 l / ha (fluazifop-p-butyl 150 g / l)* applied during the vegetation period to control monocotyledonous weeds.

RESULTS AND DISCUSSIONS

Among the weeds that appeared in the group of experience during the three years of study, *Ambrosia artemisiifolia* was predominant (56.26% for variants located on unprotected soil and 46.42% for those located on soil protected with PE foil), followed by *Atriplex patula*, *Portulaca oleracea* and *Solanum nigrum*, *Amaranthus retroflexus* and *Xantium strumarium* have appeared in a few variants.

Among the monocotyledons, the only weed species present in the experimental field was *Digitaria sanguinalis*, remaining in the experimental field only in the control and herbicide variants with *Dual Gold* 1 l/ha and 1.5 l/ha applied in no more than 5 days after planting. The application of *Fusilade Forte* herbicide at a dose of 1.5 l/ha had maximum effectiveness on monocotyledonous weeds, their total drying occurring 15 days after application.

After harvesting the weeds 90 days after planting the sweet potato shoots, the correlation resulted between the amount of green mass weeds (kg/variant) harvested from the herbicide variants applied to the crop on soil protected with PE mulch and from those applied on unprotected soil was significant, which showed the need to mulch the soil with PE foil to reduce weeding (Figure 1).

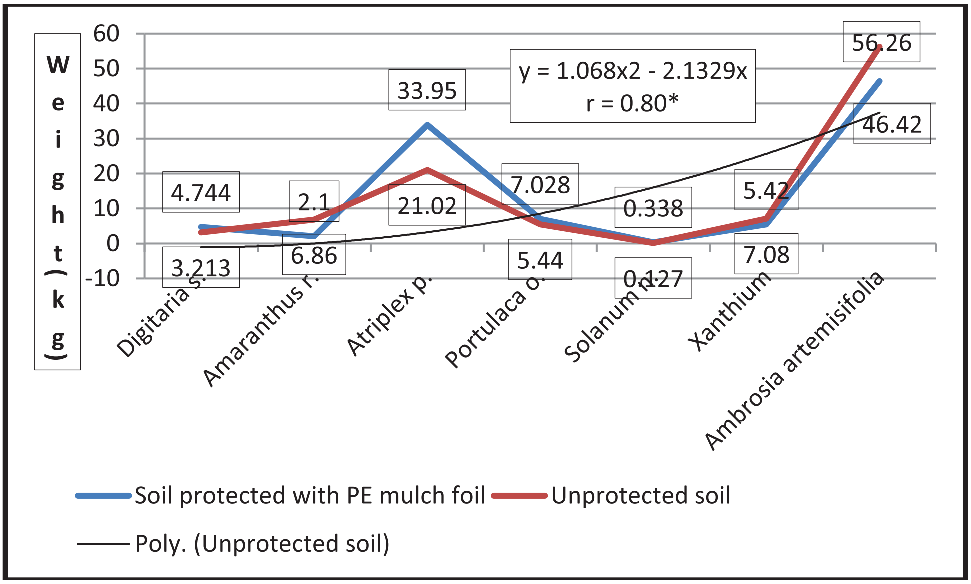

Figure 1. Percentage of green mass weeds at harvest

Weed control during the vegetation period significantly influenced the total production of sweet potatoes, but also the percentage of marketable tubers.

During the vegetation period of the sweet potato plants, there were no signs of phytotoxicity following the application of *Fusilade Forte* and *Dual Gold* herbicides, regardless of the applied dose (1 l/ha or 1.5 l/ha), so the two herbicides are selective for sweet potato. The degree of weeding had an average EWRS score of 4.11 on PE mulch-protected soil and 7.88 on unprotected soil (table 1).

The highest marketable production (20987 kg/ha in 2017) was recorded at the herbicide with *Dual Gold 960 EC* 1.5 l/ha applied immediately after planting + *Fusilade Forte* in a dose of 1.5 l/ha, applied at the appearance of monocotyledonous weeds, on soil mulched with PE foil, this variant having the best average production for the three years (18683.9 kg/ha), (Figure 2).

Table 1

Selectivity of herbicides and weed degree between 2016-2018 years

Cultivation method	Variant	Doses	Selectivity EWRS	Weed degree EWRS	Average production (kg/ha)
Soil protected with PE mulch foil	Untreated	-	-	6.33	11575.5
	*Dual Gold 960 EC**	1	1	4.33	14924.5
	Dual Gold 960 EC	1.5	1	4.33	14333.9
	Fusilade Forte	1.5	1	3.67	14913.24
	Dual Gold 960 EC +Fusilade Forte	1+1.5	1	3.67	15302
	Dual Gold 960 EC +Fusilade Forte	1.5+1.5	1	2.33	18683.9
Average				**4.11**	**14955.50**
Unprotected soil	Untreated		-	9	6601.18
	*Dual Gold 960 EC**	1	1	8.66	8426
	Dual Gold 960 EC	1.5	1	8.33	7102
	Fusilade Forte	1.5	1	7.33	8560.76
	Dual Gold 960 EC +Fusilade Forte	1+1.5	1	7.33	7982
	Dual Gold 960 EC +Fusilade Forte	1.5+1.5	1	6.67	8436
Average				**7.88**	**7851.32**

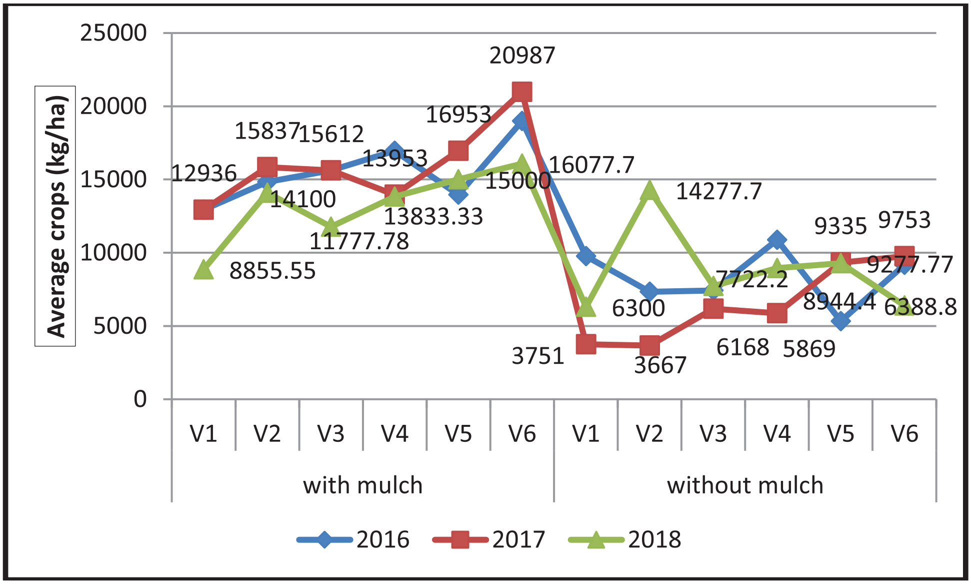

Figure 2. Average crops for 2016-2018

The method of cultivation on soil protected with PE foil mulch influenced quantitatively and qualitatively the production made in 2016-2018, for all herbicide variants. The difference between the average production made on mulched soil with PE foil and that made on unprotected soil was significant (table 2).

Table 2

Difference between cultivation method 2016-2018

Cultivation method	Average production (kg/ha)	Difference from control variant		Significa tion
		%	Kg/ha	
Soil protected with PE mulch foil	14955	190.4	7104	*
Unprotected soil	7851	Mt	100	

DL 5%=6419 kg/ha; DL 1%=14824 kg/ha

Herbicides applied to the sweet potato crop in order to control weeds have influenced both the production of tubers and their quality. In the herbicide variants, higher values were obtained for most of the quality components studied, compared to the control variant (control variant), and the best results were determined in the culture protected with PE mulch foil, in the variants treated with *Dual Gold 960 EC (metolachlor* 960 g/l), 1.5 l/ha, applied immediately after planting before the appearance of weeds. The product *Dual Gold 960 EC (metolachlor 960 g / l*), 1.5 l/ha, applied immediately after planting and before the appearance of weeds led to the accumulation of a higher content of total dry matter and implicitly a lower water content in tubers. From the analysis of the influence of the cultivation method between 2016-2018, better results were obtained in culture protected with PE mulch foil (table 3).

Table 3

Difference between cultivation method 2016-2018

Cultivation method	Soluble dry matter (%)	Water (%)	Soluble dry matter (%)	Soluble carbohydrates simple (%)	Starch (%)	C vitamin mg / 100g s.p (%)
Unprotected soil	35.73	64.27	11.63	9.68	12.54	10.80
Soil protected with PE mulch foil	36.10	63.90	11.72	9.75	12.87	12.54

CONCLUSIONS

From the analysis of the quantity (kg/ha), but also of the quality of the tubers obtained between 2016-2018, the positive influence of the protection method with PE foil mulch in reducing the density of weeds and implicitly, of the competition made by them to sweet potato plants was observed.

During the vegetation period of the sweet potato plants, no signs of phytotoxicity were evident following the application of the herbicides *Fusilade Forte* 1.5 l/ha and *Dual Gold*, regardless of the applied dose (1 l/ha or 1.5 l/ha), so the two herbicides were selective for the sweet potato plant, which requires their continued use but also the finding of new herbicides to control weeds, especially to control *Ambrosia artemisiifolia*.

REFERENCES

Dittmar P., Stall W. 1999. Weed Management in Sweet Potato. The Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date March 1999. Revised April 2013.

Glaze N. C., Hall M. R. 1990. Cultivation and herbicides for weed control in sweet potato (Ipomoea batatas). Weed Technology, 518-523.

Hogea C. 1997. Contribuţii privind combaterea buruienilor din cultura de cartof in condiţiile din N-E Dobrogei (Staţiunea de Cercetare si Producere a Cartofului - Tulcea). Teza de doctorat, USAMV Bucureşti.

Popescu V. 1997. Tehnologia erbicidării culturilor agricole și mașinile folosite , Ed. Drago print, București, pp.21.

***https://extension.tennessee.edu/.../2017%20Southeastern%20Vegetable%20Crop%20Han...Vegetable Crop Handbook for Southeastern United States, 2017.

***https://mccracken.ca.uky.edu/.../vegetable_production_guide_for_commercial_growers.. Vegetable production guide for commercial growers, 2017. University of Kentucky College of Agriculture, Food and Environment, Lexington, Kentucky.

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THE INFLUENCE OF LIGNOGUMAT PRODUCT ON SEED GERMINATION AND SEEDLING GROWTH OF *CUCUMIS SATIVUS* L. UNDER THE INFLUENCE OF SALINE STRESS

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Keyword: *Cucumis sativus* L., *Lignogumat, Germination Parameters, salinity*

ABSTRACT

Lignogumat is a humic fertilizer with high concentration (90%), with microelements in the form of chelates, which can be used as a growth biostimulant and anti-stress for plants. The experiment described in this paper examines a number of concentrations of this product under conditions of salinity stress (NaCl) in cucumbers. The effects of Lignogumat were significant regarding the germination rate (GR), germination index (GI), and seed vigor index (SVI). The concentrations of 1.5 g/l and 2.0 g/l had a significant stimulating effect on the studied elements.Therefore,Lignogumat could help seeds germinate and grow cucumber seedlings under conditions of abiotic stress.

INTRODUCTION

Soil salinity is one of the most important stress factors that reduces the productivity of agricultural plants in many regions of the globe. Thus, arid or desert areas represent 25% of the planet's land area and regarding some irrigated land, it is estimated that a third of them are currently affected by salinity. In our country, saline soils occupy 700.776.000 ha (Hera 2008). Salinity affects the germination, emergence and production of seedlings of many crop species, including cucumbers. Environmental factors present the highest impact on morphology and phenology of culture species and these allows their growing in different areas (Soare et al. 2018). The climate change is becoming a major constraint on horticultural production. Adaptation to salinity during seed germination as well as seedling growth is very important for plant development, because seed germination is a mechanism in which morphological and physiological changes lead to embryo activation. Before germination, the seeds absorb water, leading to the extension and elongation of the seed embryo. The germination period is the most critical stage in the life cycle, it is a crucial factor in determining the distribution of species because the seeds of most plant species have a high resistance to extreme stress conditions caused by environmental factors. The saline habitat is known as one of the most stressful habitats that affects physiological and ecological characteristics, such as growth, development, reproduction and geographical distribution of plants. It is proven that saline stress has a negative correlation with seed germination (Anaya et al. 2018). Higher saline stress inhibits seed germination, while low salinity causes dormancy (Rajabi et al. 2013).

Humic acid can be used as one of the ways to counteract the negative consequences of stressors (Aydin et al. 2012, Calvo et al. 2014, Khalesro et al. 2015). Kulikovaet et al. (2005) drew attention to the fact that humic acid could have anti-stress effects in various conditions of abiotic stress (unfavorable temperature, pH, salinity etc.). Studies that have focused on the use of these acids against salt stress are limited (Aydin et al. 2012, Khalesro et al. 2015). The activity of humic acids depends on their structural characteristics (Berbara & Garcia 2014). The application of humic substances has the effect of increasing the roots, leaves and shoots and stimulates the germination of different species of crops. The influence of humic acids (HA) on plant growth depends on a number of factors, e.g. the origin, concentration, molecular weight, method of application and species and stage of development of a plant (Nardi et al. 2009). Chemical fertilizers are commonly used for high production of vegetables, but can have negative effects on human and soil health. Thus, as an alternative for these products in recent years, research has focused on the use of humic acids as foliar fertilizers in various crops such as cabbage (Soare et al. 2018), carrots (Dinu et al. 2010), tomatoes (Dinu et al. 2013), tomatoes and sunflower (Parvan et al. 2013). Studies have been performed in which humic acids and humic substances have been used for seed germination in different horticultural species: pepper (Dinu et al. 2019), tomato (Bernardes et al. 2011), tomato, cucumber, zucchini (Dinu et al. 2014), lettuce (Bezerra et al. 2007), soybean (Benites et al. 2006).

The aim of this study was to highlight the influence of Lignogumat product on the germination processes of cucumber seeds under conditions of salinity stress.

MATERIAL AND METHODS

The research was carried out in 2019, in the laboratory of the Vegetable discipline of the Faculty of Horticulture from Craiova. It targeted the cucumber species, the hybrid Petit Vert de Paris following the influence of the ecological product Lignogumat on counteracting the effect of saline stress on seed germination and the growth and development of cucumber seedlings.

Cucumber seeds were moistened for 6 hours in distilled water (control), in Lignogumat solution according to the specifics of the variants. After wetting, they were wiped and placed in sterilized Petri-dishes, on filter paper, being allocated three pots for each variant. To the mentioned concentrations was added the stress factor, ie 10 ml NaCl (5 g/l) per each Petri-dish, including the control variant (Table 1). The Petri-dishes were placed in the germinator, at a temperature between 23°C – 25°C. The specificity of the variants in the research is presented in table 1.

The seeds were considered germinated when they had a root extension of more than 2 mm. The number of germinated seeds was recorded daily for up to 8 days. Several germination indices were calculated from the number of germinated seeds to investigate the effect of Lignogumat on counteracting the drought-induced salinity effect on cucumber seed germination processes and seedling growth. These indices are:

1. Germination percentage (GP%) was calculated according to the formula: GP = n/N*100, n – number of germinated seeds, N – total number of seeds from the pot.

2. Germination index (GI) was calculated as described by the Association of Official Seed Analysts (AOSA, 1983): GI = Σ(GT/Dt)
Gi = the seed germination speed of the species; Gt = seedling number at day t; Dt = the number of days when seedling numbers were recorded.

3. Coefficient of velocity of germination (CVG) was evaluated as follows: CVG = (G1+ G2+ …+Gn)/1xG1 = 2xG2+….+nxGn)x100, where *G* is the number of germinated seeds and *n* is the last day of germination.

4. Response index (RI)

RI = 1 - C/T (T>C)

RI = T/C- 1 (T<C)

RI ranges from -1 to +1, with positive values indicating stimulation by the treatments and negative values indicating inhibition relative to the controls. The absolute value of RI (RI) is the degree of inhibition and stimulation by the aqueous extracts.

5. Seed vigor index (SVI) was calculated as follows:

SVI = [Seedling length (cm) x GP (%)]

The length of the seedlings was determined on the 12^{th} day after placing to germinate.

The data recorded were statistically processed by using the analysis of the variance (ANOVA) with a significance level of $p < 0.05$ by Duncan's multiple range test.

Table 1.

The specifics of the variants

The specifics of the variant	The hybrid used
V_1 – Distilled water + NaCl (Control)	Petit Vert de Paris F_1
V_2 – Lignogumat 1.0 g/l water + Na Cl 10 ml	
V_3 – Lignogumat 1.5 g/l water + Na Cl 10 ml	
V_4 – Lignogumat 2.0 g/l water + Na Cl 10 ml	

RESULTS AND DISCUSSIONS

Analysis of variance showed significant effects of Lignogumat on the germination processes of cucumber seeds and on the growth of seedlings (Table 2).

Germination percentage (GP) represents the number of germinated seeds divided by the total number of seeds in the sample and multiplied by 100. From the data of table 2 it is observed that the product Lignogumat, at a higher concentration has a germination stimulating effect, the greatest effect being at V4 compared to the control, although all variants received the treatment to induce saline stress. In a previous study carried out by the same group of authors in which the same product was used to stimulate the germination of pepper seeds, it was found that at a dose of 2 g/l of Lignogumat water the germination rate of the seeds was 98.1% (Dinu et al. 2019). Humic acid-based products stimulate seed germination, a statement also confirmed by Prakash et al. (2014) in a study regarding radish seed germination in which higher values were recorded in the treated variants, compared to the untreated control.

Table 2.
The influence of Lignogumat on the germination indices of cucumber seeds under saline stress conditions

Specification	GP (%)	GI	CVG (%)	SVI (%)
V_1 – Distilled water + NaCl (Control)	50^{d}	5.35^{d}	15^{b}	32.68^{d}
V_2 – Lignogumat 1.0 g/l water + Na Cl 10 ml	60^{c}	9.37^{c}	17^{a}	58.84^{c}
V_3 – Lignogumat 1.5 g/l water + Na Cl 10 ml	75^{b}	10.73^{b}	16^{ab}	67.59^{b}
V_4 – Lignogumat 2.0 g/l water + Na Cl 10 ml	95^{a}	17.20^{a}	17^{a}	127.10^{a}
$LSD_{5\%}$	9.87	1.00	1.93	5.91

Germination index (GI) reflects the germination percentage each day of the germination period. Higher GI values indicate higher and faster germination (Kader, 2005). The shorter the average germination time, the faster a seed population germinated. In the present study, the germination index was higher than in the control in all three variants treated with Lignogumat. However, the highest GI was in variant 4, 17.20 compared to 5.35 in the control.

Coefficient of velocity of germination (CVG) provides an indication of the speed of germination. It increases when the number of germinated seeds increases and the time required for germination decreases. Theoretically, the highest possible CVG is 100. This would happen if all the seeds germinated on the first day (Kader & Jutzi, 2004). In the case of the present study it is observed that the CVG varied from 16 to 17 in the variants moistened with Lignogumat and was 15 in the control variant. The difference between the control and the moistened variants is not significant but considering the effect of salinity stress induced by NaCl we can say that there is still a positive difference in V_4 compared to V_1. Khalesro et al. (2015) found that salinity reduces CVG in species such as thyme, fenugreek, dill and *Dracocephalum moldavica* L. - Moldovan dragon's head.

The effect of Lignogumat on cucumber seed germination is shown in Table 3. It is observed that the germination percentage was greatly influenced at a dose of 2 g/l water of product. This product had the greatest effect on the seed germination index (GI) and on the seed vigor index (SVI) at doses of 1.5 and 2 g/l of water.

Table 3.
The effect of Lignogumat Product on Germination Percentage (GP), Germination Index (GI) and Seed Vigor Index (SVI)

Specification	GP (%)	RI of GP	GI	RI of GI	SVI (%)	RI of SVI
V_1 – Distilled water + NaCl (Control)	50^{d}	-	5.35^{d}	-	32.68^{d}	-
V_2 – Lignogumat 1.0 g/l water + Na Cl 10 ml	60^{c}	0.2	9.37^{c}	0.75	58.84^{c}	0.80
V_3 – Lignogumat 1.5 g/l water + Na Cl 10 ml	75^{b}	0.5	10.73^{b}	1.00	67.59^{b}	1.06
V_4 – Lignogumat 2.0 g/l water + Na Cl 10 ml	95^{a}	0.9	17.20^{a}	2.21	127.10^{a}	2.88

The absolute value of the response index (RI) is the degree of inhibition or stimulation by the extract used, in the present study the response index indicates a high degree of seed stimulation. RI ranges from -1 to +1, with positive values indicating treatment stimulation and negative values indicating relative inhibition to the control.

The vigor index of cucumber seedlings is very significant in variant 4 (127.10%) compared to the control variant (32.68%). This shows that salinity was counteracted by the effect of Lignogumat and that cucumber seedlings were not inhibited from growing. It is observed that in all three variants to which the product Lignogumat was applied, the growth of cucumber seedlings was higher than in the control (Table 3). The results in the present study are also supported by Matuszak-Slamani et al. (2017) who observed that molecular fractions of humic acids reduced or eliminated the influence of salt stress.

Seedling length increased by 8.25% in V_2 – Lignogumat 1.0 g/l water + Na Cl 10 ml) and up to 40.16% in V_4 – Lignogumat 2.0 g/l water + Na Cl 10 ml. In all variants, the concentrations with Lignogumat had a stimulating effect on seedling growth (Table 4). The application of products based on humic acids in appropriate concentrations may favour the growth of cucumber seedlings.

Table 4.

The influence of Lignogumat on the growth of cucumber seedlings under conditions of saline stress

Variant	Plant height	
	(cm)	(%)
V_1 – Distilled water + NaCl (Control)	12.35^{d}	100.00
V_2 – Lignogumat 1.0 g/l water + Na Cl 10 ml	13.37^{c}	108.25
V_3 – Lignogumat 1.5 g/l water + Na Cl 10 ml	15.61^{b}	126.39
V_4 – Lignogumat 2.0 g/l water + Na Cl 10 ml	17.31^{a}	140.16
LSD $_{5\%}$	0.14	-

CONCLUSIONS

The identification of biostimulators that can counteract the harmful effects of salinity stress during seed germination and plant seedling growth is of great importance. The use of techniques to moisten the seeds, with the product Lignogumat, before sowing or seedling production of cucumbers can increase their germination in conditions of salt stress. It was also observed that the salinity effect was not only counteracted but also improved at a dose of 2 g Lignogumat / l water. The seed vigor index (SVI) obtained in this study demonstrates that the dose of Lignogumat mentioned above is recommended both to improve seed germination and especially to counteract the effect of salinity. It is recommend performing similar studies on other vegetable species to see if this product has the same effect.

REFERENCES

AOSA. 1983. Seed vigor testing handbook. Contribution No.32 to handbook on seed testing. Association of Official Seed Analysis

Anaya F., Fghire R., Wahbi S., Loutfi K. 2018. Influence of salicylic acid on seed germination of Vicia faba L. under salt stress. Journal of the Saudi Society of Agricultural Sciences, 17, 1-8.

Aydin A., Kant C., Turan M. 2012. Humic acid application alleviate salinity stress of bean (*Phaseolus vulgaris* L.) plants decreasing membrane leakage. African Journal Agricultural Research, 7, 1073–1086.

Benites V.M., Polidoro J.C., Menezes C.C., Betta M. 2006. Foliar application of organo mineral fertilizer and solutions of humic acid in soybean under no-tillage. Embrapa, 35, 1-6.

Berbara R.L.L., García A.C. 2014. Humic substances and plant defense metabolism. In: Ahmad P, Wani MR (eds) Physiological mechanisms and adaptation strategies in plants under changing environment, vol 1. Springer, New York, pp 297–319.

Bernardes J.M., Reis J.M.R, Rodrigues J.F. 2011. Effect of humic substance application on tomato seedlings, Global Science Technology, 4, 92-99.

Bezerra P.S.G., Grangeiro L.C., Negreiros M.Z., Medeiros J.F. 2007. Use of biostimulant in the production of lettuce seedlings. Científica, 35, 46-50.

Calvo P., Nelson L., Kloepper J.W. 2014. Agricultural uses of plant biostimulants. Plant Soil, 383, 3–41.

Dinu M., Dumitru M.G., Cimpoiașu V.M. 2010. The use of organic products at culture of carrot in succession. Jurnal of Horticulture, Forestry and Biotechnologi, 14(1), 172-177.

Dinu M., Soare R., Dumitru M.G. 2013. Effect of the humic acids and their combination with boron and polyphenols extracted from the seeds of Vitis vinifera to culture of tomatoes in solar. Anals of the University of Craiova, Series: Biology, Horticulture, Food produce processig tehnology, Evironmental engineering, 17, 157-163.

Dinu M., Dumitru M.G., Soare R. 2014. The effect of antioxidant substances and humic acid on the seeds germination of some vegetable species. Anals of the University of Craiova, Biology, Horticulture, Food produce processig tehnology, Environmental engineering, 19(54), 155-160.

Dinu M., Soare R., Pană D., Becherescu D.A., Hoza G. 2019. The evaluation of the pepper seeds germination after applying the Lignogumated product. Annals of University of Craiova, Biology, Horticulture, Food products processing technology, Environmental engineering, 24(60), 79-87.

Hera C. 2008. Solul – garanţie a dezvoltării durabile şi siguranţei alimentare. Editura Ceres, București.

Kader M.A. 2005. A comparison of seed germination calculation formulae and the associated interpretation of resulting data, 2005. Journal and Proceeding of the Royal Society of New South Wales, 138, 65–75.

Kader M.A., Jutzi S.C. 2004. Effects of thermal and salt treatments during imbibition on germination and seedling growth of sorghum at 42/19°C. Journal of Agronomy and Crop Science, 190(1), 35–38.

Khalesro S., Salehi M., Mahdavi B. 2015. Effect of humic acid and salinity stress on germination characteristic of savory (*Satureja hortensis L.*) and dragonhead (*Dracocephalum moldavica L.*). Biological Forum, Research Trend 7(2), 554–561.

Kulikova N.A., Stepanova E.V., Koroleva O.V. 2005. Mitigating activity of humic substances: direct influence on biota. In: Perminova IV et al (ed) Use of humic substances to remediate polluted environments: from theory to practice, NATO Science Series IV: earth and environmental series. Kulwer Academic Publishers, USA, 285–309.

Matuszak-Slamani R., Bejger R., Cieśla J., Bieganowski A., Koczańska M., Gawlik A., Kulpa D., Sienkiewicz M., Włodarczyk M., Gołębiowska D. 2017. Influence of humic acid molecular fractions on growth and development of soybean seedlings under salt stress. Plant Growth Regulation, 83, 465–477.

Nardi S., Carletti P., Pizzeghello D., Muscolo A. 2009. Biological activities of humic substances. In: Senesi N, Xing B, Huang PM (eds) Biophysico-chemical processes involving natural nonliving organic matter in environmental systems. Wiley, Hoboken, pp 305–339.

Prakash P., Roniesha A.M., Nandhini S.R., Masilamani S. 2014. Effect of humic acid on seed germination of *Raphanus Sativus* L. International Journal of ChemTech Research, 6(9), 4180-4185.

Parvan L., Dumitru D., Sirbu C., Cioroianu T. 2013. Fertilizer with humic substances. Romanian Agricultural Research, 30, 205-212.

Rajabi M., Ahmadian M., Kalvandi R. 2013. Effects of salinity and salicylic acid pretreatment on germination and seedling growth of Artichoke (*Cynara scolymus* L.) Caspian. Journal of Applied Sciences Research, 2(11), 1-7.

Soare R., Dinu M., Băbeanu C. 2018. The influence of foliar fertilization with humic acids on the production of White Cabbage. Annals of the University of Craiova, Agriculture, Montanology, Cadastre Series, XLVII(2), 246-252.

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EVALUATION OF POLYPHENOL CONTENT AND ANTIOXIDANT ACTIVITY IN MANDARIN (*CITRUS RETICULATE*) LEAVES FROM DIFFERENT CULTIVARS GROWN IN GREECE

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***Keywords**: Antioxidant activity; total phenols; mandarin tree leaves*

ABSTRACT

Leaves of mandarin trees from ten varieties (Clementine Fina, Spinoso, Klausellina, Fortune, Sra 61, Encore, Murkott, Nova, Sra 63 and Sra 89) grown in Greece, were studied on polyphenol content and antioxidant activity, using ethanol extract. It was found that the total phenols content, ranged from 10.63 to 17.95 mg GAE g^{-1} DW, non-flavonoid phenols content ranged from 4.15 to 4.79 mg GAE g^{-1} DW, flavonoid phenols content ranged from 6.48 to 13.28 mg GAE g^{-1} DW and f-3-ols content ranged from 1007.4 to 3239.0 μg CE g^{-1} DW. In addition, total antioxidant capacity ranged from 947.9 to 1568.8 μg Trolox g^{-1} DW. The leaves of Sra 63 mandarin trees characterised by the highest total phenolic and flavonoid content, while the leaves of Klausellina mandarin trees characterised by the lowest total phenolic and flavonoid content. Also, the leaves of Clementine Fina mandarin trees characterised by the highest total antioxidant capacity (TAC), while the leaves of Nova mandarin trees characterised by the lowest TAC. The leaves of mandarin trees studied constitute a possible source of potent biologically active phenolic compounds for pharmaceutical purposes.

INTRODUCTION

The rapid production of free radicals in living organisms can oxidize biomolecules, leading in oxidative damage cell membranes, which cause the occurrence of diseases associated with cardiovascular diseases, diabetes, aging and cancer (Bravo 1998, Jung et al. 2005, Hadjaz et al. 2011). The antioxidant compounds can scavenge the harmful free radicals. However, synthetic antioxidants are toxic in animal organisms (Bouaziz et al. 2008). That's why there is a growing interest on natural antioxidants. Epidemiological investigations demonstrate that the oxidative destruction of biomolecules can be reduced by using natural antioxidants such as carotenoids, vitamin C and polyphenols, which are contained in various plants species, such as fruits, herbs and vegetables (Gardner et al. 2000, Valko et al. 2006).

The leaves of plant species contain polyphenols and essential oils, many of these are used as spices and as sources for the preparation of natural antioxidants, while others are used as forage (Benavente-Garcıa et al. 2000, Reddy and

Elanchezhian 2008). The leaf extracts of citrus trees it could be considered as a natural source for use in the food and pharmaceutical industries, due to the strong antioxidant and antibacterial properties (Ifesan et al. 2013). Lemon leaves (*Citrus limon*) has been used for reduction of fever and improving neurological diseases (Gulsen & Roose 2001). In addition, essential oil petitgrain extracted from the leaves of the bitter orange tree (*Citrus aurantium*) by distillation are used in perfumery. Also, orange leaves can be used as tea (Sackman 2005).

The objective of the present research is to evaluate the total phenolic content, phenolic fractions and antioxidant activity of mandarin tree leaves from some cultivars grown in Greece.

MATERIAL AND METHODS

Experimental: The present study, was conducted in mandarin orchards of Peloponnese region. These orchards are located in the village Kefalari of the sity of Argos (latitude $37^0$36'N and longitude $22^0$41'33.0''E, altitude 30m) Greece. The major portion of the mandarin orchards are more than 10 years old. The distance of orchards from the sea is 5 km. The area is characterized by a Mediterranean climate with cold dry winters and hot dry summers. Average winter temperature 8.6^0C, average summer temperature 24.1^0C and average annual precipitation 481 mm in 2019.

The ten cultivars of mandarin trees (*Citrus reticulate*) studied were: Sra 89, Spinoso, Klausellina, Fortune, Sra 61, Encore, Murkott, Nova, Sra 63 and Clementine Fina. The leaves were hand picked from the 1th of September to the 10th of September 2019 at the end of vegetation where it is accepted that the active photosynthesis activity of the leaves is reduced. The dried samples to the sun were ground in grain-size diameter < 0.15mm. The samples were stored at -18^oC and then were submitted in analysis.

Preparation of the ethanol extracts: Two g finely ground leaves was extracted two times by 20 ml of 80% aqueous ethanol at room temperature. More specifically, samples were incubated for 24 h in the extractant at stirring, the extract was gathered after centrifugation/filtration in a volumetric flask. The pellet was re-treated with aqueous ethanol for 2 h at stirring, the extract was gathered again after centrifugation/filtration in the same volumetric flask and the volume was made up to 50 ml with aqueous ethanol and used for chemical analyses (Kanner et al. 1994).

Methods of analyses: Total phenolic content (TP) was determined with the Folin-Ciocalteu (F.-C.) reagent according to the method of (Singleton and Rossi 1965) using the microvariant proposed by (Baderschneider et al. 1999) and were expressed as gallic acid equivalent (GAE) in mg g^{-1} dry weight (DW).

Nonflavonoid phenols (NFP) content was determined with the F.C. reagent after removing the flavonoid phenols (FP) with formaldehyde according to the method proposed by (Kramling and Singleton 1969) and was expressed as gallic acid equivalent (GAE) in mg g^{-1} DW. FP content were determined as a difference between the TP content and NFP. Their amount was evaluated as gallic acid equivalent in mg g^{-1} DW.

Total flavanols (catechin, epicatechin and procyanidins) were assayed using the p-DMACA reagent according to the method proposed by (Li et al. 1996) and were expressed as catechin equivalent (CE) in μg g^{-1} DW.

Total antioxidant capacity (TAC) was determined using the stable radical cation ABTS•+ (2,2-azinobis-(3-ethylbenzothiazolin-6-sulphonic acid), according to the method proposed by (Re et al. 1999) and expressed as Trolox equivalent in μg g^{-1} DW.

Statistical analysis: Data were analyzed using the MINITAB (Ryan et al. 2005) statistical package. The experiment had four replications. Analysis of variance was used to assess treatment effects. Mean separation was made using Tukey's testwhen significant differences (P = 0.05) between treatments were found. All presented numeric values are means of four measurements ± standard deviation (SD).

RESULTS AND DISCUSSIONS

Total phenols (TP) content in the leaves of mandarin trees from the cultivars studied ranges from 10.63 to 17.95 mg GAE g^{-1} DW (Figure 1). The cultivar Sra 63 are characterised by the highest TP content in the leaves of mandarin trees, equal to 17.95 mg GAE g^{-1} FW, while the cultivar Klausellina are characterised by the lowest TP content in the leaves of mandarin trees, equal to 10.63 mg GAE g^{-1} FW. TP content in the leaves of mandarin trees from the cultivars studied has the following sequence: Sra 63 > Sra 89, Sra 61, Spinoso > Fortune, Clementine Fina, Murkott, Encore, Nova > Klausellina.

Our results agree with the data obtained by other authors, who have established differences in TP content in leaves of different mandarin cultivars and different tree species. These values are higher than those which correspond to leaves of some other types fruit trees (Gougoulias 2015). In addition, according to (Mayr et al. 1994) the TP content and phenolic fractions content in the leaves of fruit trees varies and depends from the cultivar, the season, the climatic conditions and agricultural techniques.

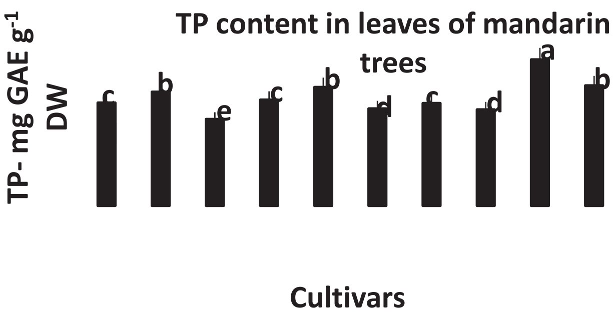

Figure 1. Total phenolic (TP) content in the leaves of mandarin trees from different cultivars; Bar values with the same letter on the top are not significantly different according to Tukey's test (P = 0.05).

Flavonoid phenols (FP) content in the leaves of mandarin trees from the cultivars studied ranges from 6.48 to 13.28 mg GAE g^{-1} DW (Table 1). The cultivar Sra 63 are characterised by the highest FP content in the leaves of mandarin trees, equal to 13.28 mg GAE g^{-1} FW, while the cultivar Klausellina are characterised by the lowest FP content in the leaves of mandarin trees, equal to 6.48 mg GAE g^{-1} FW. FP content in the leaves of mandarin trees from the cultivars studied has the following sequence: Sra 63 > Sra 61, Sra 89 > Spinoso > Fortune, Clementine Fina, Murkott > Encore, Nova > Klausellina. The FP content represents from 60.96 to 73.98 % of the TP amount (Table 1).

Non-flavonoid phenols (NFP) content in the leaves of mandarin trees from the cultivars studied ranges from 4.15 to 4.79 mg GAE g^{-1} DW (Table 1). The cultivars Spinoso and Murkott are characterised by the highest NFP content in the leaves of mandarin trees, equal to 4.79 mg GAE g^{-1} FW, while the cultivars Klausellina and Sra 61 are characterised by the lowest NFP content in the leaves of mandarin trees, equal to 4.15 mg GAE g^{-1} FW.

Flavanols or Flavan-3-ols (catechin, epicatechin and procyanidins) are included in the flavonoid fraction. Due to interest on antioxidant properties were determined as a separate fraction. Flavan-3-ols content in the leaves of mandarin trees from the cultivars studied ranges from 1007.4 to 3239.0 µg CE g^{-1} DW (Table 1). The cultivar Sra 63 are characterised characterized by the highest flavan-3-ols content in the leaves of mandarin trees, equal to 3239.0 µg CE g^{-1} DW, while the cultivar Nova are characterised by the lowest flavan-3-ols content in the leaves of mandarin trees, equal to 1007.4 µg CE g^{-1} DW.

Table 1

Flavonoid phenols (FP), Non-flavonoid phenols (NFP) and Flavan-3-ols contents in the leaves of mandarin trees studied

Cultivars	FP	NFP	Flavan-3-ols	FP % of TP amount
	mg GAE g^{-1} DW		µg CE g^{-1} DW	
Clementine Fina	8.48 ± 0.48^{cd}	4.17 ± 0.23^{b}	2457.9 ± 130.8^{b}	67.04
Spinoso	9.19 ± 0.52^{c}	4.79 ± 0.27^{a}	1701.2 ± 96.1^{c}	65.74
Klausellina-TP	6.48 ± 0.34^{f}	4.15 ± 0.23^{b}	1322.6 ± 72.2^{d}	60.96
Fortune	8.57 ± 0.47^{cd}	4.44 ± 0.26^{ab}	1748.6 ± 99.3^{c}	65.87
Sra 61	10.41 ± 0.53^{b}	4.15 ± 0.23^{b}	2676.1 ± 141.6^{b}	71.50
Encore	7.37 ± 0.39^{e}	4.56 ± 0.25^{ab}	1468.9 ± 78.9^{d}	61.78
Murkott	7.80 ± 0.46^{de}	4.79 ± 0.26^{a}	1444.5 ± 76.4^{d}	61.95
Nova	7.23 ± 0.37^{e}	4.58 ± 0.24^{ab}	1007.4 ± 51.9^{e}	61.22
Sra 63-TP	13.28 ± 0.72^{a}	4.67 ± 0.26^{ab}	3239.0 ± 189.4^{a}	73.98
Sra 89	10.33 ± 0.55^{b}	4.43 ± 0.24^{ab}	2550.6 ± 145.7^{b}	69.99

For each chemical property, the values in the columns of the table with the same letter do not differ significantly according to the Tukey's test (P = 0.05). All presented numeric values are means of four measurements ± standard deviation (SD).

Total antioxidant capacity (TAC) in the leaves of mandarin trees from the cultivars studied ranges from 947.9 to 1568.8 µg Trolox g^{-1} FW (figure 2). The cultivars Clementine Fina and Sra 63 are characterised by the highest TAC in the leaves of mandarin trees, equal to 1568.8 and 1432.2 µg Trolox g^{-1} FW respectively, while the cultivars Encore, Murkott, and Nova are characterised characterized by the lowest TAC in the leaves of mandarin trees, equal to 1050.7, 1038.4 and 947.9 µg Trolox g^{-1} FW, respectively. Total antioxidant capacity in the leaves of mandarin trees depends from the influence exerted by each one single component of the phenolic compounds and the synergy between of the individual compounds. The correlation between of TAC and of TP content in the leaves of mandarin tree as studied it was low, with correlation coefficient (r^2) equal to: 0.234.

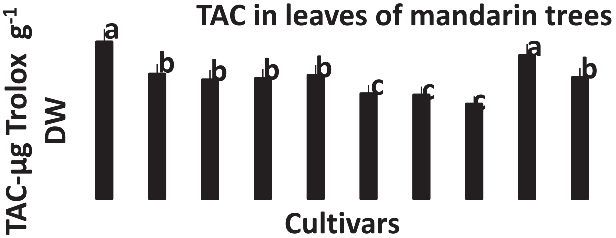

Figure 2. Mean values and SE deviation, (n) = 4 of total antioxidant capacity (TAC) in the leaves of mandarin trees from different cultivars. Bar values with the same letter on the top are not significantly different according to Tukey's test (P = 0.05).

CONCLUSIONS

These results confirm the differences on phenolic content and antioxidant capacity in the leaves of different cultivars of mandarin. The leaves of Sra 63 mandarin trees contain the highest TP content and the highest total antioxidant capacity. In addition, the leaves of mandarin trees can be regarded as potential sources of bioactive phenol compounds for pharmaceutical purposes, the ecological farming and the forage industry, due to the high phenolic content and the strong antioxidant capacity.

REFERENCES

Baderschneider B., Luthria D., Waterhouse A.L., Winterhalter P. 1999. Antioxidants in white wine (cv. Riesling): I. Comparison of different testing methods for antioxidant activity. Vitis, 38(3), 127-131.

Benavente-Garcıa O., Castillo J., Lorente J., Ortuno A., Del Rio J. A. 2000. Antioxidant activity of phenolics extracted from Oleaeuropaea L. leaves. Food Chemistry, 68(4), 457-462.

Bouaziz M., Fki I., Jemai H., Ayadi M., Sayadi S. 2008. Effect of storage on refined and husk olive oils composition: Stabilization by addition of natural antioxidants from Chemlali olive leaves. Food Chemistry, 108(1), 253-262.

Bravo L. 1998. Polyphenols: chemistry, dietary sources, metabolism, and nutritional significance. Nutrition reviews, 56(11), 317-333.

Gardner P. T., White T. A., McPhail D. B., Duthie G. G. 2000. The relative contributions of vitamin C, carotenoids and phenolics to the antioxidant potential of fruit juices. Food chemistry, 68(4), 471-474.

Gougoulias N. 2015. Evaluation of antioxidant activity and polyphenol content of leaves from some fruit species. Oxidation Communications, 38(1), 35-45.

Gulsen O., Roose M. L. 2001. Lemons: diversity and relationships with selected Citrus genotypes as measured with nuclear genome markers. Journal of the American Society for Horticultural Science, 126(3), 309-317.

Hadjaz F., Besret S., Martin-Nizard F., Yous S., Dilly S., Lebegue N., Chavatte P., Duriez P., Berthelot P., Carato P. 2011. Antioxydant activity of β-carboline derivatives in the LDL oxidation model. European Journal of Medicinal Chemistry, 46(6), 2575-2585.

Ifesan B.O.T., Fashakin J.F., Ebosele F., Oyerinde A.S. 2013. Antioxidant and antimicrobial properties of selected plant leaves. European Journal of Medicinal Plants, 465-473.

Jung C. H., Seog H. M., Choi I. W., Choi H. D., Cho H. Y. 2005. Effects of wild ginseng (Panax ginseng CA Meyer) leaves on lipid peroxidation levels and antioxidant enzyme activities in streptozotocin diabetic rats. Journal of Ethnopharmacology, 98(3), 245-250.

Kanner J., Frankel E., Granit R., German B., Kinsella J. E. 1994. Natural antioxidants in grapes and wines. Journal of Agricultural and Food Chemistry, 42(1), 64-69.

Kramling T.E. Singleton V.L. 1969. An estimate of the nonflavonoid phenols in wines. American Journal of Enology and Viticulture, 20(2), 86-92.

Li Y.G., Tanner G., Larkin P. 1996. The DMACA–HCl protocol and the threshold proanthocyanidin content for bloat safety in forage legumes. Journal of the Science of Food and Agriculture, 70(1), 89-101.

Mayr U., Batzdorfer R., Treutter D. Feucht W. 1994. Surfactant-induced Changes in Phenol Content of Apple Leaves and Fruit Skins. Acta Horticulturae, 381, 479 -487.

Re R., Pellegrini N., Proteggente A., Pannala A., Yang M., Rice-Evans C. 1999. Antioxidant activity applying an improved ABTS radical cationdecolorization assay. Free radical biology and medicine, 26(9-10), 1231-1237.

Reddy D. V., Elanchezhian N. 2008. Evaluation of tropical tree leaves as ruminant feedstuff based on cell contents, cell wall fractions and polyphenolic compounds. Cellulose (ADF-ADL), 14(21.58), 17-52.

Ryan B.F., Joiner B.L., Cryer J.D. 2005. MINITAB Handbook: Updated for release 14, 5th edition. Brooks/Cole-Thomson Learning Inc., Kentaky, KY.

Sackman D. C. 2005. Orange empire: California and the fruits of Eden. Univ of California Press.

Singleton V.L., Rossi S.A. 1965. Colorimetry of total phenolics with phosphomolibdic-phosphotungstic acid reagents. J Enol Viticult, 16, 144-158.

Valko M., Rhodes C., Moncol J., Izakovic M. M., Mazur M. 2006. Free radicals, metals and antioxidants in oxidative stress-induced cancer. Chemico-biological Interactions, 160(1), 1-40.

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GASTRONOMY TOURISM, LOCAL AGRICULTURAL PRODUCTS AND LOCAL DEVELOPMENT

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***Keywords**: Local agricultural products, local development, gastronomy tourism, tourism food consumption, local culture*

ABSTRACT

Recently alternative forms of tourism are gaining ground and popularity over societies and is believed that some forms of alternative tourism can enhance and promote local development. That is the case for the gastronomy to be considered as a tool that can be used by the local communities to attract tourists. It is also considered that gastronomy tourism can be a strong asset for the local communities to achieve local development, enhance the income, especially in rural areas, and help in the creation of a strong brand image for the community. In the present research paper, an effort to investigate and present the contribution of local agricultural products in the tourism package offered to tourists, as a way to gain attractiveness and become competitive in the tourism market. Furthermore, will be presented the effect on local producers and local community from gastronomy tourism.

INTRODUCTION

Tourism is one of the largest industries and major sectors of the global economy worldwide. Since the early 1960s, there has been a sharp increase in tourism demand and tourism has become a mass product.

Globalization, rising living standards of people in general, rising incomes, new technologies, the degree of maturity of tourists and the constant search for new forms of leisure, have led to the diversification of tourism and the segmentation of the tourism product. After all, as has been said many times, the tourism industry is one of the few industries that continues to generate income, create new jobs, maintain existing jobs, create and attract new ones even in times of crisis. investment, to create new trends, to support local communities and economies. Many academics, researchers and entrepreneurs, based on the above, have characterized tourism as a global phenomenon, with economic, social, political and environmental implications, which follows the trends and developments of modern reality.

Recently alternative forms of tourism are gaining ground and popularity over societies and is believed that some forms of alternative tourism can enhance and promote local development. According to Grande (2001), symbolizing and appreciation of local culture became a new trend and gastronomy started to considered as a symbolic value representing territories and culture in tourism. That is the case for the gastronomy to be considered as a tool that can be used by the local communities to attract tourists. It is also considered that gastronomy tourism can be a strong asset for the local communities to achieve local development, enhance the income, especially in rural areas, and help in the creation of a strong brand image for the community. In the literature gastronomy tourism isn't a new term, even though many definitions and several terms can be found. According to Kyriakaki, Zagkotsi & Trihas (2017), apart from gastronomy tourism, terms such as food tourism, cuisine tourism, culinary tourism and taste tourism can be considered as similar.

Several academics tried to define gastronomy tourism. According to the definition given by Wolf on 2002, gastronomy tourism is the travel that people do in order to search and find unique and memorable gastronomic experiences. Also, Long (2004), described gastronomy tourism, as the construction of tourists own unique experiences, by consuming, preparing and presenting food on their vacation. Additionally, many researchers, underline the synergy between tourism and local food consumption (Cohen & Avieli 2004; Hjalager & Richards 2002; Quan & Wang 2004), and as mentioned already, the taste of local agricultural products during vacations is essential for the tourism experience.

RESULTS AND DISCUSSIONS

Local Agricultural products as tool for local development through tourism

From what already mentioned in the present research paper, is clear that local agricultural food can become a strong local development tool, through tourism. This is not the first time that a research is claiming that. Goulas (2017), underlined the importance of local agricultural products and the aspect of quality and locality on these products, as a tool of development for the local economies and also as a unique asset to sustain competitiveness. Several researchers already underline the importance of local agricultural products on local development. According to Madaleno et al. (2018), the increasing demand on tourists for local products consumption, has direct and indirect economic effect, that those products can generate in that specific tourism destination. On the direct effects of the purchase of local products can be considered the stimulation on local trade and employment, the additional income for the local communities, and the generation of a multiplier effect that will benefit the local economy (Bessière 1998; Hsieh & Chang 2006; Sims 2009; Skuras et al. 2006; Telfer & Wall 1996). The fact is that many academics agree that by consuming local agricultural products during the vacation time, helps local trade with multiple effects that benefit local economy. Also, by consuming local agricultural products by tourist's during their vacation time, create new business opportunities for the local communities, based on the production, distribution, promotion and selling of those local agricultural products.

Furthermore, on the indirect economic effects that those products can generate, is the fact that tourists when they return to their own country, they can act as promoters of these products from abroad (Adongo, Anuga & Dayour 2015; Brau & Pinna, 2013), which in turn could promote their export (Fischer & Gil-Alana, 2009; Gil-Alana & Fischer, 2010; Madaleno et al. 2018). From this point of view, it can be claimed that, gastronomy tourism which is considered as an important factor for the development of destinations

(Henderson 2009) can also contribute to the sustainability by supporting local production (Karamustafa et al. 2018).

Research findings and discussion

For the needs of the present research paper a quantitative survey with a structured questionnaire was conducted to a sample of 300 tourists and a series of multivariate methods were employed to explore their perceptions towards local agricultural products and their experience on local agricultural products during their vacation. On figure 1 the sample of the survey is presented, which is consisted as mentioned before of 300 adult persons that did their vacations in Greece. All of the individuals responded on the survey were considered as representative. The research is based on primary data collected with the use of a survey, as mentioned before, and was delivered to the individuals through telephone interviews. The period of the research that took place on Panhellenic level, was from 1 September 2019 until 1 October 2019. The research findings have both theoretical and practical implications. The results underline the importance given by tourists to local agricultural foods and additionally indicate the key role that these foods may play on local development and sustainability.

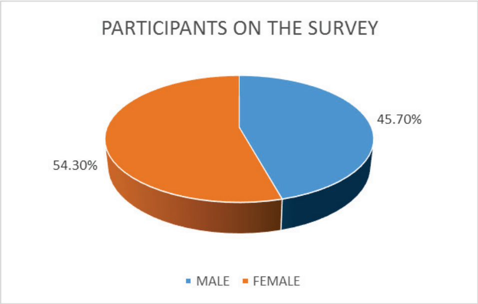

Figure 1. Participants on the survey

It is of great importance to mention in that point, that 73% of the responses of the tourists, combined their overall tourist experience with the consumption of unique, quality and tasty agricultural local products. Good gastronomy experience through their vacation is considered as good vacation choice. On figure 2 the responses on that question is presented.

Figure 2. Satisfaction on tourist experience combined with consummation of local products

Also, 60% responded that they brought back to their home some of that local agricultural products, to use them for themselves or to give them as gifts in friends and family. On figure 3, the result findings are presented. It is worth mentioning, that 24% wanted to buy local agricultural products to consume back home or use them as gifts for friends and family, but they couldn't transfer them back home. Finally a 16% of the tourists answered that they didn't bought local agricultural products for any use, after their vacation.

Figure 3. Tourist's reaction on local products

Those responses can easily underline the importance that local agricultural products have on touristic experience.

In future research papers the importance of the local agricultural products will be presented according to the survey conducted.

CONCLUSION

It is therefore of great importance for societies to re define their tourism model and create a modern tourism product capable of standing competitive in the global market. Furthermore, the differentiation of the tourism product from the existing model should seek to extend the tourist season as well as further development and support of other forms of thematic tourism. Citybreak tourism, medical tourism, religious tourism, conference tourism, agritourism, ecotourism, gastronomic tourism are some of the options that can be made and new strategic planning can be created based on these options. So the local communities themselves are often called upon to re define the way they treat the modern tourist, taking into account that the seasons have changed and the sun and the sea are not enough to attract visitors. Creating a package of tourist options, which can work in combination is the most appropriate option. In this way the options for potential tourists increase and consequently increase the days of stay in the area that is desired.

Gastronomy tourism, as mention in the present research paper can be considered as one of the strongest tools of the local societies in order to achieve economic sustainability. It is of great importance to make clear that, in the present research paper, the tourist experience is the core of tourism demand and destination competitiveness. The present research findings show that local agricultural products can boost the overal tourist satisfaction, and moreover tourism demand and destination competitiveness. Local agricultural products can help the tourist discover or re discover the desire for authenticity. By shopping those local agricultural products gives to the tourists a great opportunity to involve with the local culture and habbits and also take back home a piece of the place they visited and the experience they lived during their vacation. Also, as already mentioned before in the present research paper, by consuming local agricultural products by tourist's during their vacation time, create new business opportunities for the local communities, based on the production, distribution, promotion and selling of those local agricultural products. Local communities can gain directly and indirectly by promoting and investing on a tourism model based or combined local agricultural products.

REFERENCES

Adongo C. A., Anuga S. W., Dayour F. 2015. Will they tell others to taste? International tourists' experience of Ghanaian cuisines'. Tourism Management Perspectives 15, 57-64.

Bessière J. 1998. Tourism and food production in the Caribbean. Annals of Tourism Research, 10(4), 497-513.

Brau R., Pinna M. A. 2013. Movements of people for movements of goods?. The World Economy, 36(10), 1318-1332

Cohen E., Avieli N. 2004. Food in tourism: attraction and impediment. Annals of Tourism Research, 31(4), 755-778.

Fischer C., Gil-Alana L. A. 2009. The nature of the relationship between international tourism and international trade: The case of German imports of Spanish wine. Applied Economics, 41(11), 1345–1359.

Gil-Alana L. A., Fischer C. 2010. International travelling and trade: Further evidence for the case of Spanish wine based on fractional vector autoregressive specifications. Applied Economics, 42(19), 2417–2434.

Goulas A. 2017. Local products as a tool of development for the local economies. Acta horticulturae 1175, 1-4.

Grande I.J. 2001. Analysis of the cultural tourism offer. Estudios Touristicos, 150, 15-40.

Henderson J. C. 2009. Food tourism reviewed. British Food Journal, 111(4), 317-326.

Hjalager A.M., Richards G. 2002. Tourism and gastronomy. London: Routledge.

Hsieh A.T., Chang J. 2006. Shopping and tourism night markets in Taiwan. Tourism Management 27, 138-145.

Karamustafa K., Ulker M., Ulker P. 2018. The importance of local food in the formation of tourist experiences and its sustainability: a conceptual evaluation', the second international congress on future of tourism: innovation, entrepreneurship and sustainability (futourism 2018). Proceeding book, 27-29 september 2018, Mersin, Turkey.

Kyriakaki A., Zagkotsi S, Trihas N. 2017. Gastronomy, tourist experience and location. The case of the Greek Breakfast. Tourismos: an international Multidisciplinary Journal of Tourism, 11, 227-261.

Long M.L. 2004. Culinary tourism. USA, University press of Kentucky.

Madaleno A., Eusébio C., Varum C. 2018. Purchase of local food products during trips by international visitors. International Journal of Tourism Research, 20(1), 115-125.

Quan S., Wang N. 2004. Towards a structural model of the tourist experience: an illustration from food experience in tourism. Tourism management, 25(3), 297-305.

Sims R. 2009. Food, place and authenticity: Local food and the sustainable tourism experience. Journal of Sustainable Tourism, 17(3), 321-336.

Skuras D., Dimara E., Petrou A. 2006. Rural tourism and visitors: expenditures for local food products. Regional Studies, 40(7), 769-779.

Telfer D. J., Wall G. 1996. Linkages between tourism and food production. Annals of Tourism Research, 23(3), 635–653.

Wolf E. 2002. Culinary tourism: tasty economic proposition. www.culinarytourism.org, accessed on 28/08/2020.

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EVALUATION OF SOME QUALITATIVE PARAMETERS OF CORNICHONS PRODUCTION, IN PROTECTED CULTURE CONDITIONS

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Keywords*: greenhouse, production, quality, cucumbers*

ABSTRACT

The paper aims to present the results obtained after the evaluation of some indicators of the production of Cornichon cucumbers, cultivated in greenhouse conditions, in the first production cycle. Two cucumber hybrids were used that are suitable both for cultivation in the field and in protected areas in order to achieve this objective. This can be a solution for capitalizing the unheated greenhouses in order to ensure profitability. Each cultivated hybrid was observed in terms of the dynamics of fruiting, its earlyness, quantity and quality of production. The importance of the study is that based on the recorded data, those varieties and hybrids that best capitalize the technical and ecological conditions that characterize each culture can be promoted to be more cultivated.

INTRODUCTION

The research conducted in various countries has shown that the differences between the Cornichon cucumber hybrids are big in terms of morphological characteristics, biochemical composition, production potential and economic efficiency of the crop (Alexe et al. 1999, Okelola et al. 2018, Pradyumna Tripathy, 2019, Russo et al. 1991). In recent years, due to the fact that in some greenhouses the crops profitability can be achieved only by cold cultivation, the Cornichon cucumber offered the possibility to obtain two cycles of culture. This was possible because the Cornichon cucumber crop has a shorter vegetation period, ensures large yields for a staggered consumption over a long period of time (Mărăcineanu 2013, Stroescu 2005), which gives the crop a high economic value, also due to the commercialization of the production on the foreign market (Ciună 2001).

MATERIAL AND METHODS

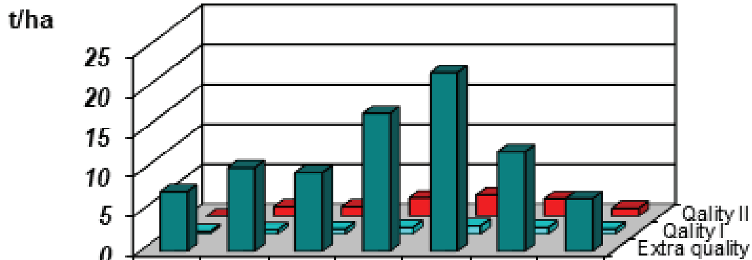
For conducting the research, two cucumber hybrids were studied that were suitable for crops in protected areas and in the fields, namely Mirabelle F1 and Kybria F1. The studied hybrids are parthenocarpic, of Cornichon type, with fruiting capacity on the main stem and a genetic resistance to the main pathogens.

The determinations were obtained at the Banu Mărăcine didactic resort, in unheated greenhouses, in the first cycle of culture. The data were recorded during the 2018 – 2019 period, the plants being cultivated in four repetitions.

Determinations were made regarding the quantity, earliness and quality of production in order to obtain the data.

RESULTS AND DISCUSSIONS

The graph of the absolute yields (t/ha) by calendar decades and qualities obtained from the Mirabelle F1 hybrid (figure 1) shows that the production records an increase from the second decade of May until the third decade of June, when there is recorded a maximum yield, after which it decreases in the first and last decade of July. From the point of view of production quality, the share is held by the Extra quality, which represents 85% of the total production, being much higher than those of other quality categories, in each harvest period (the 1st quality production represents only 3.8%, and the second quality is 11.2% of the total).



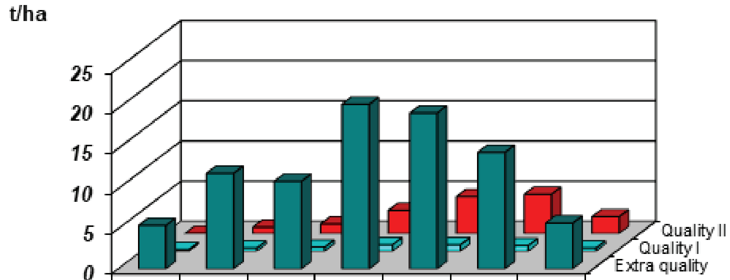
	May dec II	May decIII	June dec I	June dec II	June decIII	July dec I	July dec II
Extra quality	7,5	10,5	9,9	17,3	22,4	12,5	6,6
Qality I	0,3	0,5	0,6	0,8	1	0,8	0,6
Qality II	0	1,2	1,2	2,3	2,7	2,2	1

Figure 1 The absolute productions obtained by the Mirabelle F1 hybrid on calendar decades and Qualities

The graph of the absolute yields (t/ha) by calendar decades and qualities obtained from the Kybria F1 hybrid (figure 2), shows that the production records an increase from the second decade of May until the third decade of June, when it is recorded the maximum harvest, after which it decreases in the first and last decade of July.

In terms of production quality, the share is hold by the Extra quality, representing 81.3% of the total production, being much higher than that of the other categories of quality in each period of harvest (the 1st quality production represents only 3.5%, and the second quality is 15.2% of the total).

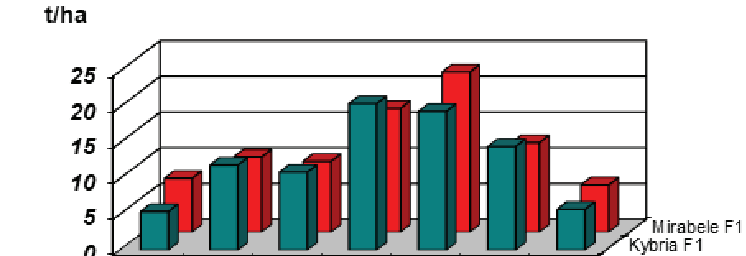
The graph of the absolute Extra quality productions (t/ha) of the two studied hybrids on calendar decades (figure 3) shows that the Kybria F1 hybrid recorded higher productions than those of Mirabelle F1 hybrid in four calendar periods out of seven.



	May dec II	May decIII	June dec I	June dec II	June decIII	July dec I	July dec II
Extra quality	5,4	11,9	10,9	20,5	19,4	14,5	5,7
Quality I	0,2	0,4	0,5	0,8	0,8	0,7	0,4
Quality II	0	0,8	1,2	2,9	4,6	4,9	2,1

Figure 2 The absolute productions (t/ha) of the Kybia F1 hybrid on the calendar decades and qualities

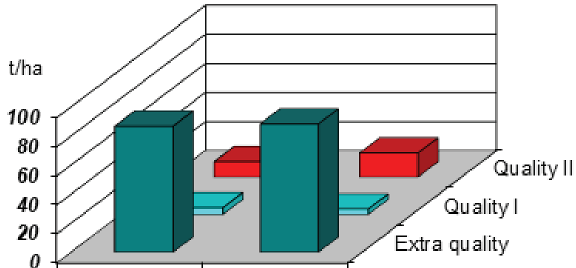
Thus, the Kybria F1 hybrid recorded higher yields than those of the Mirabelle F1 hybrid in the third decade of May, the first two decades of June, and the first decade of July, the differences being between 1 t / ha in the first decade of June up to 3.2 t / ha in the third decade of the same month, representing increases between 10.1% and 18.5%. The Mirabelle F1 hybrid recorded higher yields than those of the Kybria F1 hybrid in the first decade of May, the third decade of June, and the last decade of July, the differences being between 0.9 t/ha in the last decade of July up to 3 t/ha in the third decade of June, representing increases between 15.5% in the second decade of June up to 38.8% in the first decade of May, when the capitalization price was the highest.



	May dec II	May decIII	June dec I	June dec II	June decIII	July dec I	July dec II
Kybria F1	5,4	11,9	10,9	20,5	19,4	14,5	5,7
Mirabele F1	7,5	10,5	9,9	17,3	22,4	12,5	6,6

Figure 3 The Extra quality productions of the two hybrids (t / ha) per decade

The graph of the absolute yields (t/ha) of the two studied hybrids (figure 4) shows that the Kybria F1 hybrid recorded a total absolute yield of 108.6 t/ha, higher with 6.47% than those of the Mirabelle F1 hybrid (102 t / ha), but the Extra quality yields values are close for the two hybrids, namely 88.3 t/ha and 86.7 t/ha.

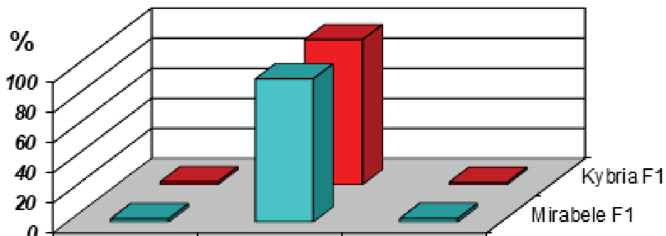


	Mirabele F1	Kybria F1
Extra quality	86,7	88,3
Quality I	4,7	3,8
Quality II	10,6	16,5

Figure 4 The total production (t/ha) obtained by the two hybrids

The higher total production recorded by Kybria F1 hybrid is due to the 2nd quality production, which is 16.5 t/ha as compared to Mirabelle F1 hybrid, which recorded a 2nd quality production of 10.7 t/ha.

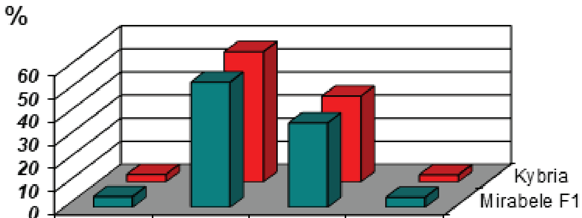
The graph in Figure 5 regarding the length of fruits at each harvesting of the two studied hybrids, show that this characteristic has three groups of calibration, namely 5 - 9 cm, 9 - 12 cm and 12 - 15 cm. Given the fact that for harvesting the basic criterion was the length of 9 - 12 cm of the fruit, it is normal that a higher share of the total production to be represented by those fruits with a length between 9 cm and 12 cm, reaching 96.5 % for the Kybria F1 hybrid and 95.3% for the Mirabelle F1 hybrid. The 6 -9 cm length fruits represented between 1.9 and 2.3% and those of 12 - 15 cm length represented between 1.6 and 2.4% in the two studied hybrids. It should be noted that the Kybria hybrid had the highest percentage of fruits with a length of 9 - 12 cm, and the lowest percentages of fruits with a length of 6 - 9 cm, and 12 - 15 cm respectively.



	6 - 9 cm	9 - 12 cm	12 - 15 cm
Mirabele F1	2,3	95,3	2,4
Kybria F1	1,9	96,5	1,6

Figure 5 The percentage of fruits per length categories

The Figure 6 shows the weight of the fruit at harvest in the two studied hybrids and that this feature has four groups, namely 50-75 g, 75-100 g, 100- 125 g and 125-150 g.



	50 - 75 g	75 - 100 g	100 - 125 g	125 - 150 g
Mirabele F1	4,7	54,3	36,6	4,4
Kybria	3,3	56,4	37,2	3,1

Figure 6 The percentage of fruits per weight categories

Since at each harvest the basic criterion was the 9 - 12 cm length of the fruit, the share of the total production should be represented by the fruits weighing in the group of 75-100 g, reaching 56.4% in the Kybria F1 hybrid, and 54.3% in the Mirabelle F1 hybrid, followed by those weighing between 100 and 125 g in a proportion of 37.2% and 36.6%, respectively. The fruits weighing between 50 and 75 g recorded percentages between 3.3 and 4.7%, and those with the 125 - 150 g weight recorded percentages between 3.1 and 4.4% at the two studied hybrids.

CONCLUSIONS

Based on observations and data recorded for the two studied hybrids, some conclusions are underlined:

The production of the two hybrids recorded per calendar phases, by quality and cumulatively categories recorded the highest share of the total in June, namely 57.1% at Mirabelle F1 hybrid or 56.7% at Kybria F1 hybrid.

The length of the fruits at harvest between 9 cm and 12 cm represented an overwhelming share of the total production, reaching 96.5% at the Kybria F1 hybrid, and 95.3% at the Mirabelle F1 hybrid.

Regarding the absolute productions (t/ha) of the two studied hybrids, the Kybria F1 hybrid presented a total absolute production of 108.6 t/ha, of which 81.3% of Extra quality (88.3 t/ha), and the Mirabelle F1 hybrid recorded 102 t/ha, of which 85% of Extra quality (86.7 t/ha).

REFERENCES

Alexe C., Bogoescu M., Costache I. 1999. Comportarea unor hibrizi de legume de solar în procesul valorificării. Rev. Hortinform, 19-21.

Ciună S. 2001. Politici şi strategii în exportul cu legume din bazinul Olteniei. Teză de doctorat, Universitatea din Craiova.

Okelola O.E., Korien B.N., Ariyo O.C., Korie C.I. 2018. Profitability of cucumber (*Cucumis sativus*) production in Udi Lga of Enugu State Nigeria. Proceedings of Annual National Conference Of Nigerian Association of Agricultural Economists, 699 – 704.

Pradyumna T., Debasish M., Abinita Sahoo, Basudev Behera, Singh A.K., Roul P.K. 2019. Real time cucumber production benefits farmers and consumers. Indian Horticulture, 14-18.

Russo W.M., Roberts B.W., Schatzer R.J. 1991. Feasibility of Trellised cucumber production. Hortsience, 26, 1156-1158.

Stroescu E. 2005. Studiu privind unele caracteristici manifestate de hibrizii de castraveţi Mathilde F1, Mirabelle F1 şi Aphina F1 cultivaţi în ciclul II/2003 în cadrul Întreprinderii de Sere Işalniţa. Hortinform, 7-8.

Mărăcineanu E., Mărăcineanu L.C. 2013. Studies regarding the effect of foliar fertilizers on production and nutrient solution consumption of the Cornichon cucumber protected culture. Analele Universităţii din Craiova, seria Biologie, Horticultură, Teh. Prel. Prod. Agric., Ingineria mediului, XVII (LIV), 547-553.

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THE EFFECT OF LONG-TERM FERTILIZATION WITH NP ON CHEMICAL CARACTERISTICS OF SOIL

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Keywords: *long-term experiments, nitrogen, phosphorus, potassium*

ABSTRACT

The paper presents the results obtained from the long-term experimental field placed at SCDA Turda, after 50 years nitrogen and phosphorus fertilization. Nitrogen from Nitrocalcar and phosphorus from superphosphate were applied at corn crops in 0, 40, 80, 120, and 160 kg/ha doses. Nitrogen fertilizers application ensured the highest yield gains and didn't generate statistically significant modifications of humus, nitrogen, and mobile phosphorus contents but soil mobile potassium level significantly decreased in the case of high nitrogen doses. Phosphorus fertilizers application ensured significant yield gains for corn grain and in higher doses (120 and 160 kg P/ha) significantly increased the soil phosphorus supply. Doses of phosphorus of up to 80 kg P/ha are maintenance doses that don't lead to soil mobile phosphorus supply adjustment. For high yields and phosphorus accumulation in soil doses must be at least 120 kg P/ha.

INTRODUCTION

Globally approximately 37% land surface is used for agriculture and a great part of these terrains were cultivated for hundreds of years following the abrupt increase of food demand along with XVII and XVIII centuries industrialization (FAO, 2017). Changing land use and initiating new crops, rotations and mechanization in this time had a significant impact upon carbon and other nutrients cycles. These disturbances accelerated following the Green Revolution of the 1950s and of the nitrogen and phosphorus fertilizers large scale insertion and of the growing transformation of terrains for agriculture (FAO, 2018). Degradation processes got head with population growth. Water erosion is the most important soil degradation type and affects circa 1,094 million ha or 56% of the total surface affected by human activities. Wind erosion affects 548 million ha or 38% of the degraded land, chemical deterioration manifests on 239 million ha (12%), while physical deterioration manifests on 83 million ha (4%) (Oldeman et al. 1991). In the Report of the Expert Group for Sustainable Development in February 2016, the UN Statistical Commission proposed the objective to unfold measures for desertification control by 2030, for degraded land rehabilitation, including land affected by desertification, drought, and flooding.

Nitrogen (N) and phosphorus (P) are essential nutrition substances for plants growth and their application is a key factor for crops yield improvement. The phosphorus problem in the world today is mainly concentrated in two aspects. One is the loss of phosphorus caused by the harsh environment. The other is the excessive use of phosphate fertilizers, which causes a large accumulation of phosphorus in the soil, and this part of phosphorus cannot be absorbed by plants. In addition, there is a lack of statistics on phosphorus pools worldwide. At present, a large number of researches on phosphorus focus on transportation, transformation, development of technologies, improving the efficiency of phosphate fertilizer application, and using our natural phosphate rock resources (Ying Zhao et al. 2020). Agrochemical study of agricultural land substantiates fertilizers and amendments rational use in order to obtain better both quantitative and qualitative yields while increasing soil fertility and protecting the environment. The different aspects of soils agrochemical evolution are highlighted by the results obtained following numerous long-term stationary experiments regarding nitrogen, phosphorus, and potassium contents (Borlan et al. 1994). Many coordinated measures are use to act towards both soil properties and environment conditions improvement in order to determine plants yield increase, through satisfying plants nutrition demands at the best as well as through a series of measures aimed to increase plants ability to assimilate substances and energy from the growing environment (Sala 2007). Long-term experiments play a vital role in analyzing crops yield steadiness, soil quality trends, technological progress, environment factors change, and the nutrient budget computing (Kunzova & Hejkman 2009). Researches with mineral fertilizers showed that in short-term experiments the results don't highlight statistically significant alterations of the physical, chemical, and biological soil characteristics, because of the soil resilience, except for the excessive fertilizers doses and sandy soils. As results highlighting that some mineral fertilizers long-term application leads to negative alterations of physical, chemical, and biological soil properties began to occur in literature Academician Cristian Hera decided to organize long-term experiments in a unique network, in different soil and clime conditions, with the same doses of nitrogen and phosphorus mineral fertilizers. Potassium was not included because the soils of Romania were assessed to have a good potassium supply at the time; in experiments with potassium applied as potassium chloride the yield gain level was low for cereal crops, production was low so the mobile potassium demand was met. Sixteen experiments were therefore organized in 1967 within the agricultural stations, in a unique system but in different soil and climate conditions. These experiments fundamentally contributed to the progress of agrochemical knowledge in our Country, through close collaboration between ICPA, ICCPT Fundulea, and agricultural stations network researchers who organized these experiments.

MATERIAL AND METHODS

The long-term experimental field was organized at SCDA Turda in 1967, in a five years crop rotation: wheat after soya, potato, (sugar beet, sunflower), wheat after maize. These long-term NP-type experiments are placed in randomized blocks with 25 variants and two factors: phosphorus in 0, 40, 80, 120, and 160 kg/ha doses, and nitrogen in 0, 40, 80, 120 and 160 kg/ha doses. Phosphorus need was ensured from superphosphate and the nitrogen one from Nitrocalcar. The soil was sampled after harvest on a 0-20 cm depth and the presented yield is what was obtained for the TURDA 332 maize cross-breed.

The soil type on which the experiment was initiated is a Vertic Luvic Chernozem with a neutral pH (6.8-7.0), a 3.12-2.14% humus content in the first 30 cm, and 51.8-55.5% clay (clayey-loamy structure).

Pest control treatments were applied prior to emergence with MerlinFlex 0.4 l/ha + Trend 1.5 l/ha and after emergence with Cerlit 1 l/ha + Trend 0.3 l/ha.

Soil analyses were performed by the following methods:

- humus - STAS 7184/21-82: volumetric through the wet oxidation method (Walkley-Black modified by Gogoaşă);
- pH: potentiometric analysis in aqueous suspension, soil:water ratio 1:2.5 using a combined glass-calomel electrode (pH units), STAS: 7184-13/2001;
- total nitrogen (N%): Kjeldahl method, STAS: 7184/2-85
- available (mobile) phosphorus: extraction after Ègner-Riehm-Domingo method, colorimetric determination with molybdenum blue after Murphy-Riley method (reduction with ascorbic acid), STAS: 7184/19-82;
- available (mobile) potassium: extraction after Ègner-Riehm-Domingo method and determination by flame photometry, STAS: 7184/18-20.

RESULTS AND DISCUSSIONS

A tendency of yield increase with the fertilizers doses occurs in years with rich rainfall at maize growth critical moments (Deac et al. 2017).

Nevertheless, nitrogen fertilization led to the highest yield gains in 2017; the best results were obtained by 160 kg/ha nitrogen fertilization. The yield differences between the N120 and N160 doses are not significant. Each kilogram of nitrogen from the fertilizer brought about yield gains of: 44.2 kg corn grain in the variants fertilized with 40 kg N/ha; 41.9 kg at the 80 kg N/ha dose; 31 kg at the 120 kg N/ha dose, and 23.3 kg at the 160 kg N/ha dose. All the nitrogen doses ensured very significant yield plusses. Phosphorus fertilization also ensured very significant yield plusses. The best results were obtained at the 80 kg P/ha dose. Each kilogram of phosphorus from the applied superphosphate ensured a 9.1 kg corn grain yield gain for the P40 fertilization, 3.7 kg for the P80 dose, 1.6 kg for the P120 dose, and 1.7 kg at the P160 dose. All NP doses ensured very significant yield plusses. The highest yield (9,623 kg/ha) was obtained in the variants fertilized with $N_{120}P_{120}$. The maximum potential following fertilization was not obtained in this experiment because potassium was not applied and because of climatic restrictions. Humus level in soil must be preserved in order to maintain physical, chemical, and biologic favorable soil characteristics. In the Turda long-term experiment NP mineral fertilizers application for 50 years didn't statistical significantly alter soil humus level. Only humus level decreases not statistically ensured can be noticed in the variants fertilized with 0, 40 and 80 kg P/ha against all nitrogen doses. It is possible that significant soil humus level decrease occurs in time at these mineral fertilizers' doses. Attention for maintaining the soil humus supply level is the more important as we are aware of not only its influence upon yield and physical, chemical, and biological soil characteristics but also of the level decrease trend due to very low intake of organic and mineral fertilizers, losses due to erosion, soil works, irrigations, climatic changes, agricultural production process intensification, etc. Researches carried out in the frame of the National Soil Quality Monitoring System highlighted that the humus supply level was as follows: extremely low in 0.74% of the sites, very low in 4.14% of the sites, low in 42.57% of the sites, average in 31.00% of the sites, high in 10.30% of the sites, very high in 3.29% of the sites, extremely high in 6.26%

of the sites, and excessive in 1.70% of the sites. Where the organic matter level decreases total nitrogen an organic phosphorus levels also decrease. The present chemical fertilizers intake is on an average 31 kg nitrogen, 12 kg phosphorus, and 4 kg potassium per hectare. Reaching the production potential of the new varieties impels fertilizers intake increase. In irrigation systems appropriate fertilization is mandatory for at least double production against the used water unit, prevent the dramatic depletion of soil nutritive elements levels, and avoid nutritional disequilibria setting. Irrigation without organic and mineral fertilizers leads to economic inefficiency and soil fertility decrease in the long run.

The nitrogen intake should increase at least as high as 1,500-2,000 t N a.s., the phosphorus one to 650-980 thousand t P_2O_5 a.s., and the potassium one to 500-700 thousand t K_2O a.s. by 2040 in order to ensure food security.

Practicing mining type sustenance agriculture on large areas (60% of the agricultural land) in which the nutrition elements extracted with the crop are not returned to the soil leads to soil nutritional elements supply and yields decrease (Table 1).

One of the Agrochemistry laws (Law 3 – nutrient bank) established by Lal (2012) shows that "it's not possible to take out of the soil more than you put in without degrading its quality".

Ștefanic (1999) showed that any attempt to increase yields without the needed soil fertility state amelioration or maintenance measures will lead to "agricultural mining" which will deplete the soil, will spoil its structure, and will lead to acidification and soil salinization.

Table 1

Soil fertility decrease in the 1990-2000 period (Dumitru, 2012)

Supply level	1990 (ha)	2000 (ha)	%
Low and very low **humus** supply	4,876,000	7,485,000	35
Low **nitrogen** supply	3,448,000	5,110,000	35
Low and very low **mobile phosphorus** supply	4,473,000	6,330,000	29
Low and very low **mobile potassium** supply	498,000	785,000	37
Moderately and strongly **acid** soils	2,369,000	3,424,000	31

The data presented in figure1 highlight a soil acidification tendency with the nitrogen fertilizers doses increase which becomes statistically ensured at the N_{160} dose although fertilization was done with Nitrocalcar. The different phosphorus doses that were applied didn't lead to soil reaction statistically significant modifications (figure 2). Application of 40 kg/ha P along with N_{120} and N_{160} significantly decreased soil pH level (figure 3).

In Table 2 the acidity degree and areas occupied by acid soils are presented. The areas with pH below 5.8 that need liming occupy 49.5% of the area and have a strong influence on agricultural yields level and nutritional elements valorization.

No statistically significant modifications of soil nitrogen level were noticed following 52 years nitrogen, phosphorus, or nitrogen plus phosphorus fertilization with 0, 40, 80, 120 and 160 kg/ha doses.

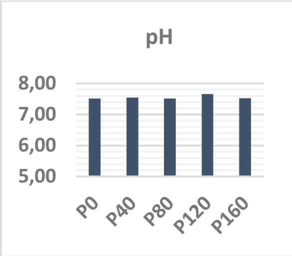
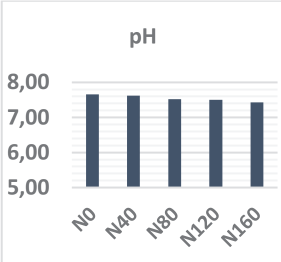


Figure 1.Influence of phosphorus dose of pH



Fifure 2. Influence of nitrogen dose of pH

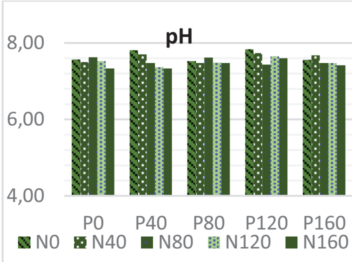


Figure 3. Influence of phosphorus and nitrogen dose of pH

Table 2

Areas with acid soils in Romania (Dumitru, 2012)

pH Class	pH limits	ha	%
1	pH ≤ 3.5	4,727,481	19.8
2	3.5 < pH ≤ 4.8	4,676,523	19.5
3	4.8 < pH ≤ 5.0	478,592	2.0
4	5.0 < pH ≤ 5.8	1,967,453	8.2
5	5.8 < pH ≤ 6.8	3,876,576	16.2
6	pH ≥ 6.8	8,195,746	34.3

The data in Table 1 highlight a 35% increase of the areas with low nitrogen level in the 1990-2000 period and that happens given the fact that soil nitrogen supply state is the one presented in Table 3 which shows that the area with very low and low total nitrogen supply level is 50.96%.

Table 3

Classes of total nitrogen supply and their weight within the land

Content Class	Soil nitrogen level	% of the land
Very low	<0.100	23.36 %
Low	0.101 – 0.140	27.60 %
Average	0.141 – 0.270	36.73 %
High	0.271 – 0.600	10.40 %
Very high	➢ 0.601	1.91 %

Nitrogen fertilization didn't significantly influence the soil phosphorus(figure 4). Phosphorus doses up to 80 kg/ha didn't produce statistically significant changes of the soil phosphorus level (figure 5). Phosphorus doses increase to 120 and 160 kg/ha lead to distinctly significant and very significant soil phosphorus accumulations and the values raised from 31 to 68 mg P/kg. The 80 kg P/ha dose is only a maintenance dose of the soil phosphorus level. Fertilization with at least 120 kg P/ha associated with a 160 kg N/ha dose is needed to increase maize yield and obtain a rectification trend of the soil phosphorus level figure 6).

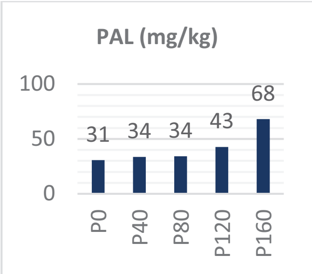


Figure 4. Long term phosphorus fertilization influence upon mobile phosphorus content

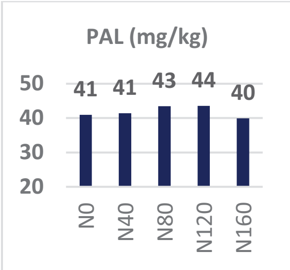


Figure 5. Long term nitrogen fertilization influence upon mobile phosphorus content

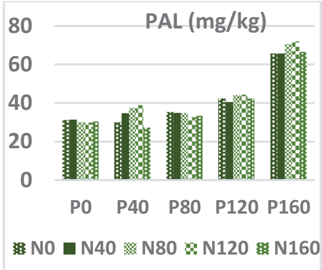


Figure 6. Long term nitrogen and phosphorus fertilization influence upon mobile phosphorus content

In view of the accumulation of soil phosphorus in the soil, on the one hand, fertilization should be targeted according to the characteristics of crops to avoid fertilizer waste; on the other hand, reasonable measures should be taken to improve the utilization efficiency of phosphate fertilizer. Meanwhile, studies have shown that combined application of inorganic phosphate fertilizer and organic fertilizer can increase the content of available phosphorus and other components in soil (Ding et al. 2020). Higher yields are only obtained with high nitrogen and phosphorus levels, able to also lead to a better degree of soil phosphorus supply.

High phosphorus doses application is essential for Romania where soil phosphorus level is low. Very low-low phosphorus supply degree is present on 65.41% of the land. Some data from literature show risk to increase level of Zn, Cu, Cr, Ni, Pb and Cd in top soil and plant after long-term application high doses of P fertilizers. Chen et al. (2020) show that is impractical to not apply P fertilizer in wheat production because P fertilization is considered an important approach to improve crop grain yield. Continous 10 year application of fertilizer in the range of 0-400 kgP/ha would not lead to direct pollution risks of soil and wheat grain with heavy metals. The application of 50 kgP/ha in wheat production is an acceptable rate that exerts no additional adverse effects.

Long-term fertilization with high nitrogen doses leads to soil mobile potassium level significant decrease while phosphorus fertilization only leads to a mobile potassium not statistically ensured decreasing tendency. High yields obtained following high nitrogen and phosphorus doses application decrease the soil mobile potassium level. The soil mobile potassium level decreasing trend leads to weak efficient valorization of the applied fertilizers.

CONCLUSIONS

Long-term nitrogen and phosphorus experiments led to the following conclusions:

Nitrogen fertilizers application ensured the highest yield gains and didn't determine humus, nitrogen, and mobile phosphorus contents statistically significant changes but the soil mobile potassium level significantly decreased at high nitrogen doses.

Phosphorus fertilizers application ensured significant corn grain yield gains and significantly improved the soil phosphorus supply at high doses (120 and 160 kg P/ha). The phosphorus doses up to 80 kg P/ha are maintenance doses that don't lead to soil mobile phosphorus supply level rectification. At least 120 kg P/ha is needed for high yields and phosphorus accumulation in soil.

A soil mobile potassium decreasing trend is noticed in the variants fertilized with nitrogen and phosphorus because no potassium fertilizers were applied which leads to yields level limiting and to a lower productive use index of the applied fertilizers.

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REFERENCES

Borlan Z., Hera C., Dornescu D., Kurtinecz P., Rusu M., Buzdugan I., Tănase Gh. 1994. Fertilitatea și fertilizarea solurilor (Compendiu agrochimic). Editura CERES, București;

Chen X. X., Liu Y. M., Zhao Q. Y., Cao W. Q., Chen X. P., Zou C. Q. 2020. Health risk assessment associated with heavy metal accumulation in wheat after long-term phosphorus fertilizer application. Environmental Pollution, 114348

Deac V., Ignea M., Ștefănescu M. 2017. Results of the research carried out at SCDA Turda regarding fertilizers rational use in long-term experiments. In ”Scientific research contributions to agriculture development”. Vol. VII, Reverential Volume – 60 years SCDA Turda, INTERARTE Turda Publishing House (published in Romanian);

Ding Z., Kheir A. M., Ali M. G., Ali O. A., Abdelaal A. I., Zhou Z., He Z. 2020. The integrated effect of salinity, organic amendments, phosphorus fertilizers, and deficit irrigation on soil properties, phosphorus fractionation and wheat productivity. Scientific reports, 10(1), 1-13.

Dumitru M. 2012. Agrochemistry. Present and?”. Scientific Papers of CIEC, September 5 2011, Bucharest, National Symposium ”Agrochemistry – Present and? Reverential Session on the 60 Years Anniversary of Agrochemistry in Romania”. NEW AGRIS-Reviste Agricole Publishing House (published in Romanian).

Dumitru M. et al. 2000, Soil Quality State Monitoring in Romania, GNP Publishing House, Bucharest (published in Romanian);

FAO FAOSTAT - Food and Agriculture Data, [WWW Document]. URL http://www.fao.org/faostat/en/#data (2018);

FAO The Global Land Outlook - Convention to Combat Desertification, (2017), Bonn, Germany;

Kunzova E., Hejcman M. 2009. Yield development of winter wheat over 50 years of FYM, N, P and K fertilizer application on black earth soil in the Czech Republic. Field Crops Research, 111(3), 226–234.

Lal R. 2012. Soils and food security. Carbon Management and Sequestration Center, The Ohio State University, Columbus, SUA;

Oldeman L. R., Hakkeling R. T. A., Sombroek W. G. 1991. Global assessment of soil degradation (GLASOD). World map of the status of human induced soil degradation. ISRIC, UNEP, Der Haag;

Sala F. 2007. Agrochimie, Editura EUROBIT Timișoara.

Ștrefanic G. 1999. Soil and Biologic Research for Sustainable Agriculture. In ”Sustainable – Top of the Range Agriculture”, C. Hera (Coord.), AGRIS Publishing House, Agricultural Journals Editorial Office, Bucharest, 261-264 (published in Romanian);

Zhao Y., Li Y., Yang F. 2020. Critical review on soil phosphorus migration and transformation under freezing-thawing cycles and typical regulatory measurements. Science of The Total Environment, 141614.

***STAS 7184/21-82;

***STAS 7184-13:2001;

***STAS 7184/2-85;

***STAS 7184/19-82;

***STAS 7184/18-20.

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ASPECTS REGARDING SOME PHYSIOLOGICAL DISEASES IN SOME CULTURE PLANTS IN THE CITY OF PITESTI

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Keywords*: physiological disease, abiotic factors, plants*

ABSTRACT

The notion of non-parasitic or physiological disease expresses disturbances of metabolism, growth delays or developmental abnormalities resulting from abiotic, non-transmissible alterogenic causes from one plant to another. Unlike parasitic diseases, produced by biotic agents on different stages of parasitism, physiological diseases are usually caused by the abiotic factors of the environment. However, there are also physiological diseases determined by internal factors, of genetic nature, which may be hereditary. The multitude of causes probably involved, raises with acute problem the diagnosis of the disease and the possible remedies, which is why in this paper we will present some important pathological changes induced by various abiotic factors of the cultivated plants.

INTRODUCTION

The notion of non-parasitic or physiological disease expresses metabolic disturbances, growth delays or developmental abnormalities resulting from abiotic alterogenic causes, not transmissible from one plant to another. There is a close link between infectious and non-infectious diseases, as they influence each other. However, they differ from each other both etiologically and symptomatically, pathogenetically and epidemiologically.

A first feature of non-parasitic diseases is the causes that cause them. Unlike parasitic diseases, produced by biotic agents at different stages of parasitism, physiological diseases are usually caused by abiotic factors in the environment. However, there are also physiological diseases caused by internal factors, of a genetic nature, which can be hereditary.

Every plant carries out its life cycle in certain conditions of the environment, to which the species to which it belongs has adapted during its evolution (Toma 2000). The limits of these environmental factors between which the normal existence of a species, variety, variety or biotype is possible designate its ecological value. In some cases, these limits are very wide, in others, on the contrary, they are narrow. Outside these limits, each ecological factor acts as a stress factor, causing disorders (dysfunctions) of varying degrees in the normal physiological and biochemical processes of plants (Hulea 1972).

Some climatic agents (temperature, water, wind, light, etc.) have always influenced plant life. Other abiotic diseases have seen a recent expansion: reactions to air pollutants, acid rain, pesticides, trophic imbalances, etc.

MATERIAL AND METHODS

The observations from the present study were made in different gardens in Arges country.The direct observation method was used.

The pH of the soil was determined with the help of the pH meter Optimus AT 89, and the qualitative analyzes regarding the soil macronutrients were performed at the pedology laboratory from the Pitesti Office of Pedological and Agrochemical Studies. The humid oxidation variant was used to estimate the humus content titrimetric dosing (after Walkley - Black in Gogoasa modification).

For the correct diagnosis of the disease, observation sheets were prepared in which the following information was written: the name of the host plant, applied agrophytotechnical measures, possible phytosanitary treatments, application or not of herbicides near the cultivation area the luminous intensity, degree of humidity.

RESULTS AND DISCUSSIONS

In conditions of excessive temperatures, the most characteristic symptoms are caused by evapotranspiration that exceeds the amounts of water supplied by the plant's governing system. In summer, when the temperature in solariums and greenhouses is between 40 and 60^0 C., the leaf blade curves towards the bottom to reduce water loss at the cellular level. The symptom is often confused in practice with the tomato leaf twisting virus (figure 1). Low temperatures, in this case the average daily was 5^0 C for three days, lead to alteration of the leaf tongue and growth tips. (figure 2).

Figure 1. Twisting the leaves due to high temperatures

Figure 2. The negative influence of low temperatures on seedling

The direct action of light radiation, following the "magnifying glass effect" of water droplets, causes local tissue burns to the above-ground organs (figure 3-4). Excess water, both in the soil and in the air, is felt as strongly on the plants as the lack of water. Excess water in tomatoes causes a wet rot that endangers the fruit (figure 5). During the ripening period of cabbage, excess water leads to cracking of the heads and considerable crop losses (figure 6).


Figure 3. Blackberry sunburn


Figure 4. Sunburn of pepper


Figure 5.Excess water in tomatoes


Figure 6. Negative influence of excess water on cabbage

The bitterness of apples and pears (bitter-pit) is a physiopathy that occurs in the orchard, but which worsens a lot during storage. It is manifested by the appearance on the fruit of deep spots, up to 1 cm in diameter. Next to them the flesh turns brown, becomes spongy and has a bitter taste. This disease has long been attributed to the action of pathogens or mechanical factors, but subsequent research has shown that it is a consequence of the water imbalance of trees during fruit ripening (figure 7) (https://www.gazetadeagricultura.info., accesed 2020).

Solar rays with wavelengths between 380 and 780 nm constitute the visible spectrum, which contributes to photosynthesis. The production of seedlings in improper conditions (high temperature about 28^0 C and low light, under 3000 lux) leads to their elongation and fall (figure 8). On the contrary, intense light, associated with a high temperature, can cause serious injuries, which can alter the protoplasm of epigynous organ cells, which causes large necrotic spots, burns or browning (Hulea 1972). Such symptoms, observed relatively frequently in plants grown in greenhouses, are followed by drying of flowers and fruits and an increased sensitivity to chemical treatments.

Figure 7.The bitterness of apples

Figure 8. Poor quality seedlings due to inconsistent lighting

In the present study, the concentration of calcium in the soil was determined indirectly by measuring the pH which was 5.4. This high value was due to excessive fertilization with organic and inorganic fertilizers with nitrogen, which led to a significant decrease in calcium in the soil. Symptoms of calcium deficiency consist of chlorosis of the leaves and reduced development of the root system and cracks of the epicarp in the fruit (figure 9) (https://www.horticultorul.ro, accesed 2020).

The analysis of soil samples indicated a pH of 8.5 due to the administration of calcium-based fertilizers, respectively dolomite. Under these conditions, the concentration of iron is very low, appearing the characteristic symptoms: leaf chlorosis, which can whiten completely except the nerves (figure 10).

Figure 9. Apical rot in tomatoes caused by lack of calcium

Figure 10. Iron deficiency in lemons

During fruit ripening, repeated administration of products based on neutralized copper sulfate in a concentration of 0.5% or insecticides containing chlorpyrifos in a concentration of 0.15% produce nets on the pericarp (figure 11). The fruits become depreciated from a qualitative point of view, the suberifications in question causing injury to the peicarp and creating entrance gates for bitter rot and moniliosis.

In vines, nearby herbicides with 2.4 D (2,4-dichloro phenoxyacetic acid) or dicamba acid produce phytotoxicity due to rainwater that transports the herbicide salt to the root of the plant. Morphological changes of the leaf tongue are induced, manifested by its reductions and wrinkles (figure 12), physiological change described by Tomoioaga in his work on diseases and pests of vines (Tomoiaga 2013). Sulfuric herbicides applied to corn in the 7-8 leaf phenophase at a dose of 1.2 liters per hectare produce chlorosis to leaf necrosis. In lettuce and spinach, the pre-emergence of the basic herbicides on pendimethalin in a concentration higher than 4 liters per hectare produce the phenomenon of albinism. Therefore, the application of film herbicides is not recommended for these crops.

Figure 11. Suberifications induced by the application of copper

Figure 12. Phytotoxicity in vines induced by 2.4 D salt

The most common symptom of nitrogen deficiency is leaf chlorosis, starting with those at the base of the stem, due to the translocation of available nitrogen to the young leaves (Davidescu 1988). During the vegetative growth period, water-soluble fertilizers in formula 20-20-20 NPK in a concentration of 0.5% foliar are applied to the raspberry. Lack of nitrogen causes chlorosis of the growth peaks (figure 13). Excess nitrogen in plants, due mainly the application of excess fertilizers, induces the appearance of habitus changes from the embossing of the growth tip to accentuated wrinkles and necrosis of the vegetative organs. Applying nitrogen fertilizers to the lawn during the summer at a dose of 4-5 kg per m^2 produces serious and irreversible burns, being necessary to reseed the lawn (figure 14).

Figure 13. Nitrogen deficiency in raspberries

Figure 14. Burning of the lawn caused by excess nitrogen

CONCLUSIONS

In the current context of plant protection, the knowledge of physiological diseases is of particular importance, in order to avoid, first of all, the unjustified application of phytosanitary treatments.

The current environmental conditions, the insufficient knowledge of the cultural exigencies of the cultivated plants, hybrids very sensitive to the harmful action of the environment contribute to the appearance of non-parasitic diseases with a complex symptomatology and a diagnosis difficult to make.

Sunburn, excess nitrogen, calcium deficiency and excessive application of herbicides are the most common causes that lead to parity of physiopathies in Arges County.

REFERENCES

Davidescu D., Davidescu Velicica, Lăcătuşu R. 1988. Microelementele în agricultură; Ed. Academiei RSR, Bucureşti

Hulea A.1972. Boli neparazitare la plante, prevenire și combatere. Edit. Ceres, Bucureşti, pp. 279.

Toma L. D., Jităreanu C. D. 2007. Fiziologie vegetală. Edit. "Ion Ionescu de la Brad", Iaşi

Tomoiaga L. 2013. Ghidul fitosanitar al viticultorului. Ed. A 2-a revizuită. Editura AcademicPres. Cluj, pp.104-106

***https://www.horticultorul.ro/legume/carenta-de-calciu-ca-la-tomate-rosii/

***https://www.gazetadeagricultura.info/pomicultura/598-pomi-fructiferi/17142-fertilizarea-completa-a-livezilor-de-mar.html

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THE INFLUENCE OF CERTAIN HORMONES ON THE CALLUSING ABILITY IN SOME ROOTSTOCKS FOR PLUMS

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Keywords*: Plum rootstock, cuttings, growth hormones*

ABSTRACT

The aim of the paper was to investigate the callusing ability of the woody cuttings in the plum rootstocks 'Miroval', 'Fortival', 'Plamval' and 'Brompton'. The experiment was placed in protected areas with basal caloric intake, using woody cuttings. The cuttings were treated with different hormones (IBA, ANA and Radistim 2) and reported for control. The best results were recorded in 'Miroval' rootstock, in which the cuttings untreated with hormones, have formed 100% callus.

INTRODUCTION

Callusogenesis is a healing process that can serve to study the factors that control tissue growth and differentiation from mesenchymal stem cells (García-Aznar et al. 2007). In the literature there are many studies in different species, which address the process of callusogenesis, both in vitro and in vivo, but also the influence of growth regulators on this process. Plant genotype and growth hormones can have important effects on regeneration (Tican et al. 2008, Peticilă 2009, Asănică et al. (2017). Kaur (2015) investigated the effect of different treatments with IBA (indole-3-butyric acid) on rooting and growth performance of peach cuttings and he observed that in woody cuttings treated with 3000 ppm IBA for 1-2 minutes, the results on rooting and growth were significantly better. The influence of two exogenously applied auxins, indole-3-acetic acid (IAA) and indole-3-butyric acid (IBA) on the root development of herbaceous cuttings, 'GiSelA 5' rootstock was investigated by Štefančič et al. (2005); IBA proved to be the most effective treatment and caused the formation of roots much earlier. Also the results obtained by Narula & Kaur (2018) showed that the treatment of cuttings with IBA 2000 ppm (stem cuttings) by quick immersion led to an improvement in rooting and shooting characteristics. Ătefančič et al. (2006) studied the influence of endogenous IAA level and exogenous IBA on the rooting and quality of herbaceous cuttings in 'GiSelA 5' and found that IBA inhibited callus formation and, consequently, influenced the quality of developed cuttings; callus formation prevented the root development, by reducing the number of initial roots and inhibited the growth of cuttings, by reducing the average total length of shoots formed by individual cuttings. Brits (1986) showed that genotype and temperature had the strongest influence on the rooting rate of Leucospermum cuttings. Mankessi et al. (2010) evaluated the propagation by rooted cuttings in Eucalyptus, noting that the number of adventitious roots issued was significantly influenced by genotype and cuttings type, as well as the interaction between these two factors throughout the rooting period. Kibbler et al. (2004) showed that the age and genotype of plants influenced the rooting of a woody species (*Backhousia citriodora*), commercially valuable, which has a reputation for being recalcitrant in the formation of adventitious roots, rooting of cuttings decreasing in mature plants and is strongly influenced by genotype. Hocevar et al. (1998) investigated the influence of different IBA concentrations on rooting level and rooting quality of cuttings in *Prunus pumila* L. rootstock; the basal cuttings had the highest level of rooting; all of them formed a well-developed root system; the IBA concentration did not influence the successful rooting of the cuttings. Ribeiro et al. (2010) evaluated the influence of indolyl-3-butyric acid in vegetative propagation in *P. laurocerasus*; the application of IBA significantly increased the rooting of cuttings, regardless of concentration. The effect of different rooting regulators was also tested in vitro. Spahiu et al. (2015) studied the effect of different explants of 'GF-677' rootstock on the regeneration potential by in vitro culture; organogenesis and proliferation were obtained on MS medium supplemented with GA3 (0.1mg / l) and BAP (0.35mg / l). Druart (1980) studied the regeneration of plantlets from the root callus of different Prunus species; callusogenesis was obtained in vitro on callus in *Prunus sp.*, *P. dawyckensis*, *P. canescens* and the hybrid *P. incisa* x *serrula*. The paper aimed to study the influence of rooting hormones on the callusing process of woody cuttings in four plum rootstocks.

MATERIAL AND METHODS

Four rootstocks ('Miroval', 'Fortival', 'Plamval', 'Brompton') located in the research field at the Research & Development Station for Fruit Tree Growing (SCDP) Vâlcea were studied. The cuttings were made of annual branches, with lengths between 5-6 cm, with 2-3 buds.

Table 1

Thermal and chemical stimulation of cuttings with basal caloric intake

<table>
<tr><th rowspan="2">Rootstock</th><th rowspan="2">Cutting dimension</th><th rowspan="2">Thermal stimulation (V1)</th><th colspan="3">Thermal + chemical stimulation</th></tr>
<tr><th>V2</th><th>V3</th><th>V4</th></tr>
<tr><td>Miroval (sin. MVL 2)</td><td rowspan="4">5-6 cm</td><td rowspan="4">20-22°C</td><td rowspan="4">20-22°C + indole-3-butyric acid (IBA 0,08%)</td><td rowspan="4">20-22°C + naphthaleneacetic acid (ANA 0,08%)</td><td rowspan="4">20-22°C + Radistim 2</td></tr>
<tr><td>Fortival (sin. H1-2V; Corval)</td></tr>
<tr><td>Plamval (sin. H19-5-85; Rival)</td></tr>
<tr><td>Brompton</td></tr>
</table>

The experiment with basal heating was placed at the University of Craiova. The experimental variants (table 1) were the following: V1 - thermal stimulation (20-22°C); V2-thermal stimulation (20-22°C) + chemical (IBA 0.08%); V3- thermal stimulation (20-22°C) + chemical (ANA 0.08%); V4 - thermal + chemical stimulation (Radistim No.2). The branches were disinfected with 0.2% Topsin solution and then hydrated for 48 hours. The cuttings were planted with a peat base (Jiffy pot), after previously applied the chemical stimulation with various hormones (IBA, ANA and

Radistim No. 2) and then placed on a heated platform (20-22°C). The cuttings were covered with foil to keep moisture. Cuttings were watered every 1-2 days and were disinfected with Topsin solution 0.4g/400ml water, once a week. After the leaves appeared, a light source was placed to produce photosynthesis. Observations were performed at 6-7 days intervals and aimed the formation of callus and root primordia, using the scale used by Staniene & Stanys (2004) to highlight callusogenesis.

RESULTS AND DISCUSSIONS

The rooting capacity of cuttings from plum rootstocks was investigated by thermal and chemical stimulation. The results obtained on callus formation are presented in Table 2. Saad & Elshahed (2012) stated that Indole-3-acetic acid (IAA) is the only natural auxin found in plant tissues. In tissue cultures, auxins are usually used to stimulate callus production and cell growth, in order to initiate shoots and rooting, to induce somatic embryogenesis, to stimulate the growth of shoots and stems. The callus appeared at about a month, the best results being obtained in 'Miroval' cuttings thata were not chemically stimulated, but thermally stimulated, while the weakest results were found in cuttings stimulated with Radistim. The cuttings from 'Miroval' rootstock gave the best results on callus formation also when they were stimulated with ANA, 0.08% concentration, and the cuttings from 'Brompton' rootstock, formed the callus, only when stimulated with the same regulator growth. Štefančič et al. (2005), Ătefančič et al. (2006) showed that IBA inhibited callus formation in *Prunus* cuttings. Since the callus rooting process was not recorded in the other rootstocks, compared to the 'Miroval' rootstock, in which the calluisng was produced also in the chemically unstimulated cuttings, we can talk about the influence of genotype on callusogenesis. Pérez-Jiménez et al. (2014) showed that in Prunus the somatic organogenesis capacity is strongly influenced by endogenous hormonal content of the studied genotypes. The influence of genotype on callusogenesis is also supported by other authors in both herbaceous and woody species (Brits 1986, Bordallo et al. 2004, Tican et al. 2008, Kibbler et al. 2004). Treatment of cuttings with Radistim No. 2 has totally inhibited callusogenesis. Ătefančič et al. (2006) showed that callus formation was the lowest in cuttings treated with high concentrations of IAA.

Table 2

Effect of IBA, ANA, Radistim No.2 on callusogenesis in plum cuttings*

Treatment	Callus after 30 days				Callus after 37 days				Callus after 43 days				Callus after 49 days			
	V1	V2	V3	V4	V1	V2	V3	V4	V1	V2	V3	V4	V1	V2	V3	V4
Miroval	+++	+	++	-	+++	++	++	-	+++	++	+++	-	+++	++	+++	-
Fortival	++	+++	++	-	++	+++	++	-	++	+++	++	-	++	+++	++	-
Plamval	-	+++	-	-	-	+++	-	-	-	+++	-	-	-	+++	-	-
Brompton	-	-	-	-	++	-	-	+	++	-	+++	+	++	-	+++	+

*+: low callusogenesis; ++: medium callusogenesis; +++: strong callusogenesis; -: without callusogenesis

The number of root primordia and leaves / cuttings varied depending on the hormone used and genotype. The results obtained are presented in table 3. The cuttings from 'Miroval' rootstock had the highest number of leaves and root primordia/ cutting, not chemically stimulated, followed in order by the cuttings from the 'Fortival', 'Plamval' and 'Brompton' rootstocks. Cuttings from the 'Brompton' rootstock had the lowest number of leaves on the shoot. None of the 3 variants of hormones determined the rooting of cuttings, within 49 days. All cuttings (100%) from 'Miroval' rootstock developed chemically unstimulated root primordia, and when stimulated with ANA, a percentage of 21.43% of cuttings have developed root primordia. Stimulated with IBA, a percentage of 14.29% of cuttings developed root primordia, and the cuttings that were stimulated with Radistim No.2 did not develop root primordia. Hocevar et al. (1998) investigated the influence of different IBA concentrations on the rooting level and rooting quality of cuttings on dwarf rootstock of *Prunus pumila* L. and showed that the IBA concentration did not influence the rooting of cuttings. Ătefančič et al. (2006) showed that IBA inhibited callus formation in *Prunus*, influenced the quality of cuttings by preventing root development, reduced the number of initial roots and inhibited the growth of cuttings, reducing the average total length of shoots formed by individual cuttings. Canli & Bozkurt (2009) showed that the treatment of 'Sarierik' plum cuttings with IBA promoted a significant increase in rooting percentage compared to control cuttings and the formation of roots did not depend on callus formation. The best rooting percentage (87.5%) was obtained by applying 1500 mg/l IBA, while the rooting percentage of untreated control cuttings was only 10.8%.

Table 3

Effect of temperature and growth regulators on the number of root primordia and leaves / cuttings

Descriptive statistics	No. of root primordia Miroval				No. of leaves/shoot			
	V1	V2	V3	V4	Miroval	Plamval	Fortival	Brompton
Mean	2.64	0.14	0.21	0	14.93	7.86	6.79	4.29
Standard deviation	0.50	0.36	0.43	0	1.54	1.41	1.05	0.83
Minimum	2.00	0.00	0.00	0	12.00	6.00	5.00	3.00
Maximum	3.00	1.00	1.00	0	17.00	10.00	8.00	6.00
% cuttings with root primordia / leaves	100	14.29	21.43	0.00	100	100	100	100

Vlad et al. (2013) in Romania, reported in some *Prunus* species (shrubs or trees) with ornamental value, their ability to root using different concentrations of IBA. Therefore, at a high concentration of 400 ppm AIB (P4) the number of roots exceeds 32 roots/cutting, with a length of 10-12 cm, while at the others it is 8-20 roots/cutting, depending on the increase of IBA concentration in powder. An intermediate dose has consistently improved root formation (Trueman & Richardson 2008).

CONCLUSIONS

The results obtained can be related to the influence of genotype, the 'Miroval' rootstock giving the best results, while 'Brompton' rootstock giving the lowest results. The application of IBA determined a lower percentage of cuttings with root primordia compared to the application of ANA. For relevant conclusions, the research will be continued to highlight the response of genotype to rooting, using thermal and chemical stimulation.

REFERENCES

Ătefančič M., Ătampar F., Osterc G. 2006. Influence of endogenous IAA levels and exogenous IBA on rooting and quality of leafy cuttings of Prunus 'GiSelA 5'. The Journal of Horticultural Science and Biotechnology 81(3), 508-512.

Asănică A., Tudor V., Sumedrea D., Teodorescu R.I., Peticilă A., Iacob A. 2017. The propagation of two red and black currant varieties by hardwood cuttings combining substrate and rooting stimulators. Horticulture 11, 175-181.

Bordallo P.N., Silva D.H., Maria J., Cruz C.D., Fontes E.P. 2004. Somaclonal variation on in vitro callus culture potato cultivars. Horticultura Brasileira 22(2), 300-304.

Brits G.J. 1986.The influence of genotype, terminality and auxin formulation on the rooting of leucospermum cuttings. Acta Horticulturae 185, 23-30.

Canli F.A., Bozkurt S. 2009. Effects of indolebutyric acid on adventitious root formation from semi-hardwood cuttings of 'Sarierik'plum. Journal of Applied Biological Sciences 3(1), 45-48.

Druart P. 1980. Plantlet regeneration from root callus of different Prunus species. Scientia Horticulturae 12(4), 339-342.

García-Aznar J.M., Kuiper J.H., Gómez-Benito M.J., Doblaré M., Richardson J. B. 2007. Computational simulation of fracture healing: influence of interfragmentary movement on the callus growth. Journal of Biomechanics 40(7), 1467-1476.

Hocevar I., Stampar F., Hudina M. 1998. Propagation of *Prunus pumila* L. rootstock with wood cuttings with use of IBA. Kmetijstvo http://agris.fao.org/agris-search/search.do?recordID=SI2002010293.

Kaur S. 2015. Effect of different treatments of Indole-3-butyric acid (IBA) on the rooting and growth performance of hardwood cuttings of peach (*Prunus persica* L. Batch). Agricultural Science Digest-A Research Journal 35(1), 41-45.

Kibbler H., Johnston M.E., Williams R.R. 2004. Adventitious root formation in cuttings of Backhousia citriodora F. Muell: 1. Plant genotype, juvenility and characteristics of cuttings. Scientia horticulturae 102(1), 133-143.

Mankessi F., Saya A.R., Toto M., Monteuuis O. 2010. Propagation of Eucalyptus urophylla × Eucalyptus grandis clones by rooted cuttings: Influence of genotype and cutting type on rooting ability. Propagation of Ornamental Plants 10(1), 42-49.

Narula S., Kaur G. 2018. Influence of growth regulators on the regeneration and survival of plum cv. Kala Amritsari through stem cuttings. International Journal of Agriculture Innovations and Research 7(3), 320-324.

Pérez-Jiménez M., Cantero-Navarro E., Pérez-Alfocea F., Le-Disquet I., Guivarc'h A., Cos-Terrer J. 2014. Relationship between endogenous hormonal content and somatic organogenesis in callus of peach (*Prunus persica* L. Batsch) cultivars and *Prunus persica* × *Prunus dulcis* rootstocks. Journal of Plant Physiology 171(8), 619-624.

Peticilă A.G., Stănică F., Dumitrașcu M. 2009. The quality of highbush blueberry (*Vaccinium corymbosum*) hardwood cuttings rooted in different substrates. Lucrări Științifice-Universitatea de Științe Agronomice și Medicină Veterinară București. Seria B, Horticultură 53, 493-494.

Ribeiro M.M., Collado L.M., Antunes M.A. 2010. The influence of indole-3-butyric-acid in *Prunus laurocerasus* vegetative propagation. Acta Horticulturae 885, 277-283.

Saad A.I., Elshahed A.M. 2012. Plant tissue culture media. Recent advances in Plant in Vitro Culture, 30-40.

Spahiu E., Rama P., Hodaj B. 2015. Callus induction and adventitious shoot regeneration from different explants of rootstocks GF-677 (Prunus amygdalus x P. persica). Albanian Journal of Agricultural Sciences 14(1), 36-40.

Staniene G., Stanys V. 2004. Plant regeneration from leaves of *Cydonia oblonga* cultivars. Acta Universitatis Latviensis 676, 231-676.

Štefančič M., Štampar F., Osterc G. 2005. Influence of IAA and IBA on root development and quality of Prunus' GiSelA 5'leafy cuttings. HortScience 40(7), 2052-2055.

Tican A., Chiru N., Ivanovici D. 2008. Use of unconventional methods to obtain somaclonal variations, with the purpose of creating new potato varieties that are resistant to diseases and pests.Studia universitatis vasile goldis seria stiintele vietii (life sciences series):18.

Trueman S.J., Richardson D.M. 2008. Relationships between indole-3-butyric acid, photoinhibition and adventitious rooting of *Corymbia torelliana*, *C. citriodora* and F1 hybrid cuttings. Tree and Forestry Science and Biotechnology 2(1), 26-33.

Vlad M., Vlad I., Vlad I.A. 2013. Acclimatization and multiplication capacity at some Prunus species (arbutuses or trees) with ornamental value. Analele Universității din Oradea, Fascicula Protectia Mediului 21, 298-307.

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EVALUATION OF THE INFLUENCE OF STERILIZATION FACTORS, THE TYPE OF EXPLANT ON MICROPROPAGATION OF SOME PLUM ROOTSTOCKS

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Keywords: *sterilization factors, type of explant, hormonal balance, survival rate*

ABSTRACT

The aim of this study is to investigate the effect of sterilization factors, concentration and time of exposure of explants on the survival rate of explants, the effect of rootstock and the type of explant on survival rate and development of explants in plum rootstocks. The survival rate of explants after sterilization with sodium hypochlorite indicated differences between the types of explant (shoot tip and node) in terms of response to sterilization process. The percentage of explants that survived was 100%, in case of both types of explants, in 'Plamval' rootstock. There were differences in the degree of response of the explants used in the growth rate of plants, depending on rootstock and type of explant. The best results were obtained in 'Miroval' and 'Plamval' rootstock.

INTRODUCTION

Prunus spp. is one of the most recalcitrant species of fruit trees in terms of micropropagation, especially when mature tissues are used as explants (Sabbadini et al. 2019). There has been a lot of research on micropropagation of rootstocks for plums, research on the type of explant, its length, hormonal balance, the culture medium used. The literature shows that various explants are used for micropropagation: root, cotyledon and pieces of hypocotyl (Nas et al. 2010), axillary buds (Călinescu et al. 2009, Asănică et al. 2016, Peticilă 2005), dormant buds (Tricoli et al. 1985), cotyledons (Arab & Shekafandeh 2016), dormant shoots tips and dormant buds (Bošnjaković et al. 2013), nodal explants (Jain & Babbar 2003, Abbasi et al. 2019), leaves (Liu & Pijut 2008, Zong et al. 2019). Nas et al. (2010) showed that cotyledon explants showed higher regeneration ratios than hypocotyl ones, and root explants were unsuitable for regeneration. Isac (1985) showed the potential of meristem crop in the in vitro propagation of plum cultivars 'Centenar', 'Carpatin' and 'Silvia'. There are studies that show that the length of explants is also important for micropropagation, the best results being obtained with explants that have a size of 0.3-0.5 mm (Calinescu et al. 2009) or 1-1.5 cm (Nas et al. 2010). Al Ghasheem (2019) states that the culture medium used in the cultivation of plant tissues is of great importance in plant propagation. There are studies in the literature focused on the culture media that gave the best results in the multiplication of species of *Prunus*:

McCown Woody Plant (WPM) (Sabbadini et al. 2019), Nas & Read (NRM) (Nas et al. 2010), Murashige and Skoog (MS) (Tricoli et al. 1985, Arab & Shekafandeh 2016, Jain & Babbar 2003, Al Ghasheem 2019, Al Ghasheem et al. 2018, Plopa 2014), QL (Plopa et al. 2012, Plopa et al. 2014). Hormonal balance is well studied in the literature. Phytohormones stimulate cell divisions and promote the formation of new buds or ensure the development of newly formed buds. García (2016) mentioned that the discovery of growth hormones offered great opportunities for in vitro culture of plant tissues. Saad & Elshahed (2012) state that plant growth hormones are important in the culture of plant tissues, playing vital roles in stem elongation, tropism and apical dominance, they determine the type and extent of organogenesis. Gaspar et al. (1996) report that auxins, abscisic acid, cytokinins, ethylene and gibberellins are the five main classes of plant hormones. Duță et al. (2008) highlighted the influence of BAP on the growth and micro-propagation of explants, showing that the reproduction rate increased as the cytokinin concentration increased, and the reduction of photoperiod determined the decrease of plant growth percentage and of micropropagation rate. The results obtained by Ancu et al. (2015) reveal that, regardless of the composition of basis medium, the best hormonal combination was composed of BAP (1.0 mg / L) and IBA (0.1 mg / L). The best rooting hormone reported by Vaez-Livari & Salehi-Soghadi (2005) was IBA. Perez-Tornero et al. (2000) showed that an IBA concentration between 0.5 and 0.6 mg/l (WP medium) produced an optimal number of shoots with a good length to be transferred to other subcultures. The rooting capacity expressed by the percentage of rooted plants was over 80%, but strongly depends on IBA concentration (Bošnjaković et al. 2013). The initiation of a rootstock culture for plums was successfully induced by Zou (2010), on WPM medium, supplemented with 0.05-0.1 mg/l IBA and 0.5-1.0 mg/l BA. There are studies that focus on the asepsis process, the substances used, the type of sterilant and the duration of action (Çölgeçen et al. 2009, Gogoi & Borua 2014, Abbasi et al. 2019, Al Ghasheem 2019). Bošnjaković et al. (2013) showed that in the asepsis process the contamination rate for cherries was between 40.0-86.7%, while for 'Mahaleb' it was 100% when shoot tips were used. A better source of early explants were dormant buds, where the contamination rate has not exceeded 13.3%. The aim of this study is to investigate the effect of sterilization factors, concentration and exposure time on survival rate of explants, the effect of rootstock and the type of explant on survival rate and development of explants in plum rootstocks.

MATERIAL AND METHODS

The study was conducted at the University of Craiova (INCESA - the Plant Biotechnology Laboratory). The branches were harvested from the rootstock collection of the Faculty of Horticulture Craiova, at the end of February and were placed in the laboratory for forcing. After 20 days, the shoots obtained were subjected to a sterilization protocol, by washing them with soap and water, followed by treatment with sodium hypochlorite (Domestos market product - 4.5g la 100g sodium hypochlorite, diluted with distilled water, in a ratio of 2: 5), ethyl alcohol 70% (15″), three consecutive washes with sterile distilled water. Top and nodal micro-cuttings of 5-6 mm were made from the shoots. The Murashige and Skoog culture medium (MS Sigma M 5519), to which 20 g of sucrose and 8 g of agar were added, was sterilized in an autoclave at 121° C and pressure 1 (2) atmospheres for 15-20 minutes. The pH was adjusted to 5.8 by means of NaOH solution, before the agar was added. The following conditions were ensured in the growth chamber:

temperature of 25ºC (±1) and a lighting regime of 16 hours' light/8 hours' darkness. After 30 days, observations and measurements were performed, which aimed at: the diameter and height of vegetative mass of explants, shoots and the number of leaves. All experiments were arranged in a completely randomized design. The duration of the culture varied between four and eight weeks, depending on the individual experiment. Statistical analysis. Data were statistically processed using EXCEL, DATA ANALYSIS.

RESULTS AND DISCUSSIONS

Results and discussions on the effect of sterilization factors, concentration and the time of exposure of explants on the survival rate of explants

Çölgeçen et al. (2009) reveal that the most essential stage in the culture of plant tissues is the correct sterilization of explants. Abbasi et al. (2019) used a 10% sodium hypochlorite solution for asepsis. Gogoi & Borua (2014) mention that the main surface sterilizing agents conventionally used in the tissue culture laboratory are sodium hypochlorite, calcium hypochlorite and mercury chloride. Their concentration and composition are adjusted so as to induce maximum sterilization and minimal damage to the explants. Being studied by many researchers, the sodium hypochlorite solution for superficial sterilization of the explant was effective and did not cause injury to the explants at the proper focus (Gertlowski & Petersen 1993). The results obtained on the effect of sterilization factors, concentration and exposure time on the survival rate of explants are presented in Table 1. The survival rate of explants after sterilization with sodium hypochlorite indicated differences between shoots and nodal explants in terms of response to sterilization process, this being 56% in case of shoot tips and 52% in case of nodal explants (Table 1). Al Ghasheem (2019) also reported a lower survival rate of internode explants after sterilization.

Table 1

Effect of sterilization factors, concentration and exposure time of explants on survival rate of explants

Sterilization factor	Concentration of sterilization factor	Exposure time	Survival rate of explants	
Sodium hypochlorite (Domestos market solution)	2p domestos: 5 p distilled water	30 minutes	From shoot tip	From internode and node
			56%	52%

These results are similar to those obtained by Hippolyte (2000), which states that sodium hypochlorite may be effective in sterilizing superficial explants cultured in vitro, but it may be accompanied by the death of explants. The study conducted by Al Ghasheem (2019) showed that there is an effect of the substances used in sterilization, sodium hypochlorite being the most effective treatment with a survival rate of 50% at 15% concentration, for 5 minutes and 60% at 10% concentration for 10 minutes, exceeding the other sterilizing agents.

Results and discussions on the effect of rootstock and type of explants on survival rate and development of explants. Many studies in the literature focus on the type of explant used for micropropagation (Tricoli et al. 1985, Jain & Babbar 2003, Liu & Pijut 2008, Calinescu et al. 2009, Nas et al. 2010). Nas et al. (2010)

showed that cotyledon explants showed higher regeneration ratios than hypocotyl ones, and root explants were unsuitable for regeneration. In the present study were used node explants with 0.3 cm diameter and 0.5 cm height and shoot tip explants with 0.6 cm diameter and 0.8 cm height. Contamination is a real problem facing tissue culture technology. A success in the in vitro culture protocol begins with an efficient sterilization of explants, depending on the type of explants (Dodds & Roberts 1985, Rezadost et al. 2013).

Table 2 shows the percentage of survival and contamination by rootstock and type of explant. Durkovic (2008) indicates a correlation between in vitro explants derived from adult plants and the high percentage of contamination. The best results were obtained in 'Plamval' rootstock, the percentage of explants that survived being 100%, in case of both types of explant. Chitra & Padmaja (2005) stated that genotype is a factor that affects regeneration. The effect of genotype on regeneration refers to differences in endogenous hormone levels (Schween & Schwenkel 2003), or genotypic differences in embryogenesis and regeneration resulting from differences in genetic material, both quantitatively and qualitatively (Henry et al. 1994). There were differences in the survival rate of explants from different rootstocks and depending on the type of explant, the explants from the shoot tip having the highest survival rate in 'Miroval' (80%), in 'Fortival '(40%), compared to nodal explants from the same rootstock, respectively 60% in 'Miroval' and 20% in 'Fortival'.

Table 2

Effect of rootstock and types of explants (shoots) on survival rate of explants*

Rootstock	Type of explant**	% survival
Prunus cerasifera (corcoduș) selection	a	60
	b	60
Miroval (sin. MVL 2)	a	80
	b	60
Plamval (sin. H19-5-85; Rival)	a	80
	b	100
Fortival (sin. H1-2V; Corval)	a	40
	b	20

***Data have been recorded after 4 weeks of culture; **a= shoot tip; b= node explant**

In the study conducted by Al Ghasheem (2019), in *Prunus*, in the initiation stage there was a statistically significant difference between the length of shoots and the number of leaves formed: the total length of shoots (2.95 cm) on explants from shoot tips, the average total length of shoots (2.47 cm) on nodal explants and the average total number of leaves formed (3.89 leaves) on explants from shoot tips compared to the average total number of leaves formed (4.76 leaves) on nodal explants. The age of the explants would have a critical effect on the success of micro-propagation, in case of several plants belonging to *Prunus* genus (Mante et al. 1989). Al Ghasheem (2019) also showed that there are differences in the degree of response of explants used in the growth rate of plants (length of shoots and number of leaves). The same fact is supported by Rezadost et al. (2013). In the present study, too, there were differences in the degree of response of explants used in the growth rate of plants. Table 3 shows the morphological characteristics of explants according to rootstock and type of explant. The best results were obtained in 'Miroval' and 'Plamval' rootstock, the average total length of the shoots, the average diameter of developed explants and the average number of leaves being above the average value of the analysed explants, both in case of explants from shot tips as well as in case of nodal ones. Regarding the type of explant, the best results of explants characteristics were obtained for the explants from shoot tips. For the total length of explants, the highest value (1.92 cm) was obtained in 'Plamval' rootstock, from the shoot tip, and the lowest value (0.91 cm) in 'sel. Corcoduș' rootstock from the shoot tip. As for diameter, the highest value was obtained in 'Fortival' (2.80 cm) from the shoot tip, while the lowest (1.04 cm) was in 'sel. Corcoduș' from nodal explant. The highest average number of leaves (10.80) was also obtained from the shoot tip in 'Fortival' rootstock, while the lowest (4.70) was from the nodal explant in 'sel. Corcoduș' rootstock.

Table 3

Influence of rootstock and type of explant on morphologic characteristics of explants over initiation stage*

Rootstock	Type of explant**	H (cm)	D (cm)	Average No. of leaves
Prunus cerasifera selection	a	0.91±0.19	1.53±0.71	5.00±2.67
	b	1.32±0.22	1.04±0.54	4.70±1.25
Miroval (sin. MVL 2)	a	1.84±0.16	2.05±0.63	8.30±2.11
	b	1.48±0.48	2.11±0.70	8.10±0.74
Plamval (sin. H19-5-85; Rival)	a	1.92±0.23	1.89±0.85	8.88±5.27
	b	1.49±0.42	1.47±0.50	8.48±2.55
Fortival (sin. H1-2V; Corval)	a	1.64±0.14	2.80±0.35	10.80±3.08
	b	0.99±0.01	1.78±0.13	9.40±1.14
Average value /type of explant	a	1.58±0.47	1.99±0.79	8.36±4.57
	b	1.42±0.43	1.57±0.67	7.74±2.48

*H: height of vegetative mass (cm); D: diameter of vegetative mass (cm); **a= shoot tip, b= nodal explant

CONCLUSIONS

There were differences in the percentage of survival of explants, the degree of response of explants to the growth rate of plants, depending on the rootstock and the type of explant. The best results were obtained in 'Miroval' and 'Plamval' rootstock, the average total length of shoots, the average diameter of developed explants and the average number of leaves being above the average value of the analyzed explants, both in case of explants from the shoot tip as well as in case of nodal ones. With regard to the type of explant, the best results of characteristics of explants were obtained in the explants from the shoot tip.

REFERENCES

Abbasi F., Khadivi A., Taghizadeh M., ValizadehKaji B. 2019. Micropropagation of *Prunus scoparia*, a suitable rootstock for almond under drought conditions. International Journal of Fruit Science 19(2), 221-230.

Al Ghasheem N. 2019. Efectul explantului, hormonilor de creștere și mediilor de cultură asupra microînmulțirii soiurilor de piersic. Teză de doctorat USAMV București.

Al Ghasheem N., Stănică F., Peticilă A. G., Venat O. 2018. In vitro effect of various sterilization techniques on peach (*Prunus persica* (L.) Batsch) explants. Scientific Papers 227, 227-234.

Ancu S., Isac V., Sumedrea D., Dutu I. 2015. In vitro propagation protocol for new stone fruit rootstocks. In III Balkan Symposium on Fruit Growing 1139, 335-340.

Arab M.R., Shekafandeh A. 2016. In vitro propagation of GF677 hybrid rootstock (*Prunus persica* × *Prunus amygdalus*) from mature cotyledons. The Journal of Horticultural Science and Biotechnology 91(3), 236-242.

Asănică A., Tudor V., Plopa C., Sumedrea M., Peticilă A., Teodorescu R., Tudor V. 2016. In vitro embryo culture of some sweet cherry genotypes. Agriculture and Agricultural Science Procedia 10, 172-177.

Bošnjaković D., Ognjanov V., Barać G., Ljubojević M., Pranjić A., Dugalić K. 2013. Micropropagation of low-vigorous rootstock selections for sweet and sour cherry. Voćarstvo 47, 121-128.

Călinescu M., Cosmulescu S., Plopa C. 2009. In vitro regeneration capacity of apricot varieties. Analele Universitatii din Craiova, seria Biologie, Horticultură, Tehnologia Prelucrării Produselor Agricole, Ingineria Mediului 14, 47-50.

Chitra D.S.V., Padmaja G. 2005. Shoot regeneration via direct organogenesis from in vitro derived leaves of mulberry using thidiazuron and 6- benzylaminopurine. Sci Hortic 106, 593-602.

Çölgeçen H., Ufuk Kocagülnur T. 2009. Influence of different sterilization methodson callus initiation and production of pigmented callus in Arnebia densiflora Ledeb. Turk J Biol.35, 513-520.

Dodds J.H., Roberts L.W. 1985. Experiments in plant tissue culture. Second edition. Cambridge University Press, New York, 232 pages.

Durkovic J., Misalova A. 2008. Micropropagation of temperate noble hardwoods: An overview. Funct Plant Sci Biotechnol 2, 1-19.

Duță M. 2008. Research concerning the behavior of the *Prunus serrulate* "Kanzan" variety in the process of in vitro reproduction. Bulletin of the University of Agricultural Sciences & Veterinary Medicine Cluj-Napoca Horticulture 65(1), 84-89.

García Borges A. 2016. Inducción y cultivo de células en suspensión de Daucus carota. Universidad de La Laguna. Facultad de Ciencias, Sección de Biología.

Gaspar T., Kevers C., Penel C., Greppin H., Reid D.M., Thorpe T.A. 1996. Plant hormones and plant growth regulators in plant tissue culture. In Vitro Cellular & Developmental Biology-Plant 32(4), 272-289.

Gertlowski C., Petersen M. 1993. Influence of the carbon source on growth and rosmarinic acid production in suspension cultures of *Coleus blumei*. Plant Cell, Tissue and Organ Culture 34(2), 183-190.

Gogoi G., Borua P.K. 2014. Standardization parameters for critical problems encountered in plant in vitro culture technique. Int. J. Curr. Res. 6(12), 10964-10973.

Henry Y., Vain P., Buyser J.D. 1994. Genetic analysis of in vitro plant tissue culture responses and regeneration capacities. Euphytica 79, 45-58.

Hippolyte I. 2000. In vitro rosmarinic acid production. *The Genus Salvia* 233.

Isac M. 1985. Obtaining plum varieties free of viruses by in vitro technique. In XIII International Symposium on Fruit Tree Virus Diseases 193, 213-216.

Jain N., Babbar S.B. 2003. Regeneration of juvenile plants of black plum, Syzygium cuminii Skeels, from nodal exp of mature trees. Plant Cell, Tissue and Organ Culture 73, 257-263.

Liu X., Pijut P.M. 2008. Plant regeneration from in vitro leaves of mature black cherry (Prunus serotina). Plant Cell, Tissue and Organ Culture 94(2), 113-123.

Mante S., Scorza R., Cordts J.M. 1989. Plant regeneration from cotyledons of *Prunus persica* L., *Prunus domestica* L. and *Prunus cerasus* L. Plant Cell Tissue Organ Cult 19, 1-11.

Nas M.N., Bolek Y., Sevgin N. 2010. The effects of explant and cytokinin type on regeneration of *Prunus microcarpa*. Scientia Horticulturae 126(2), 88-94.

Perez-Tornero O., Lopez J. M., Egea J., Burgos L. 2000. Effect of basal media and growth regulators on the in vitro propagation of apricot (*Prunus armenica* L.) cv. Canino. The Journal of Horticultural Science and Biotechnology 75(3), 283-286.

Peticilă A. 2005. Researches regarding the micropropagation results of dwarf peach hibrids. Lucrări ştiinţifice U.Ş.A.M.V. Seria B 48, 263-265.

Plopa C., Duțu I., Fodor M. 2012. In vitro propagation of the" Adaptabil" rootstock. Fruit Growing Research 28.

Plopa C. 2014. Elimination of PNRSV from Schattenmorelle sour cherry cultivar using in vitro technique. South-Western Journal of Horticulture Biology and Environment 5(1), 11-18.

Rezadost H.M., Sohan M.M., Hatamzadeh A., Mirzai R.M. (2013). In vitro regeneration of sour orange *Citrus aurantium* L. via direct organogenesis. Plant Knowledge Journal 2, 150-156.

Saad A.I., Elshahed A.M. 2012. Plant tissue culture media. Recent Advances in Plant in Vitro Culture, 30-40.

Sabbadini S., Ricci A., Limera C., Baldoni D., Capriotti L., Mezzetti B. 2019. Factors Affecting the regeneration, via organogenesis, and the selection of transgenic calli in the peach rootstock Hansen 536 (*Prunus persica* × *Prunus amygdalus*) to Express an RNAi Construct against PPV Virus. Plants 8(6), 178.

Schween G., Schwenkel H.G. 2003. Effect of genotype on callus induction, shoot regeneration, and phenotype stability of regenerated plants in the greenhouse of primula spec. Plant Cell Tissue Organ Cult 72, 53-61.

Tricoli D. M., Maynard C.A., Drew A.P. 1985. Tissue culture of propagation of mature trees of *Prunus serotina* Ehrh. I. Establishment, multiplication, and rooting in vitro. Forest Science 31(1), 201-208.

Vaez-Livari B., Salehi-Soghadi Z. 2005. In vitro rooting of hybrid GF677 (*Prunus dulcis* × *Prunus persica*). In IV International Symposium on Pistachios and Almonds 726, 171-178.

Zong X., Denler B.J., Danial G.H., Chang Y., Song G.Q. 2019. Adventitious shoot regeneration and Agrobacterium tumefaciens-mediated transient transformation of almond × peach hybrid rootstock ‘Hansen 536’. HortScience 54(5), 936-940.

Zou Y-N. 2010. Micropropagation of Chinese Plum (*Prunus salicina* Lindl.) using mature stem segments. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 38(3), 214-218.

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PHENOLOGICAL RESEARCH ON THE BEHAVIOR OF THE NEW INTRODUCED APRICOT VARIETIES IN THE SOUTHERN PART OF THE REPUBLIC OF MOLDOVA

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Key words:*Apricot, varieties, phases, bloom, maturation.*

ABSTRACT

The researches were carried out in the orchard of the company "Agroparc Management" LLC, during the years 2017–2019. The object of the research was the apricot trees Wonder Cot, Spring Blush, Magic Cot, Lilly Cot, Pinkcot, Perle Cot, Orange Red, Sweet Cot, Big Red, Kyoto, Faralia and Farbaly varieties, grafted on the rootstock Mirobalan 29C. Planting distance 5.0 x 3.0 m. Apricot trees were planted in the spring of 2015. During the research we studied the period of onset of the phases beginning to bloom and the maturation of fruit harvest, the period between these two phases at various apricot varieties. It was established that the biological particularities of the variety influence the period of onset of the beginning of flowering phases and the maturation of apricot fruit harvest, the period between these two phases.

INTRODUCTION

Apricots are in high demand among consumers and therefore apricot is one of the main fruit species grown in the world (Cimpoieş 2012, Chira et al. 2005, Cociu 1993). The largest production of apricots in the world comes from Asian countries and those in the Mediterranean basin (Cociu et al. 1993). The Republic of Moldova is located in a temperate zone, where there is a great potential to cultivate many fruit species as a result of a great variety of soil and environmental conditions. Apricot is one of them with an annual production that varies in the last 4-5 years from 9.50 to 21.50 thousand tons (Peşteanu et al. 2018). Large apricot areas in the Republic of Moldova are located in the southern and central part of the country, but due to climate change in the last 10-15 years; apricot cultivation is planted on large areas in the northern area (Peşteanu et al. 2018, Pîntea 2018). However, the main factors limiting the wider spread of apricot cultivation among fruit growers is: the disease of the generative organs of low temperatures at the end of the rest period and late spring (Abbas et al. 2016, Cociu et al. 1993), premature wilting of trees (apoplexy), infection with viruses (Cociu et al. 1993), the absence of a wide assortment of modern varieties and rootstocks that would allow to intensify the culture, to obtain productions high, constant and competitive (Balan et al. 2008, Cociu et al. 1993, Maria & Sosna 2006, Peşteanu et al. 2018). Among the varieties cultivated with apricots in the Republic of Moldova, there is an acute lack of valuable varieties with maturity from very early to very late. This would allow completing the assortment of varieties, ensuring a harvesting conveyor, the consumption of these fresh fruits and their industrial capitalization for a period of 50-60 days or even more (Negru 2018, Pîntea 2019).

The practical argumentation of some phenophases of fruit development in various apricot varieties were the main objectives of the research in question.

MATERIAL AND METHODS

The research was carried out during the years 2017-2019. The orchard was planted in the spring of 2015, with "Certificate" category trees produced in the "Battistini Vivai" fruit nursery, Italy.

The object of research was the trees of apricot varieties introduced from the world selection (Cot International, Escande, International Plant Selection, etc.), which, due to a preliminary theoretical study showed to be prospective for the Republic of Moldova as: Wonder Cot, Spring Blush, Magic Cot, Lilly Cot, Pinkcot, Perle Cot, Orange Red, Sweet Cot, Big Red, Kyoto, Faralia and Farbaly. The Kyoto variety, which has the same maturation period as the native Nadejda apricot variety, was taken as a witness. The rootstock Mirobalan 29C,trees crownwas conducted accordingto the open vase. Planting distance 5.0 x 3.0 m.

The soil between the intervals between the rows was maintained as a natural grass, the vegetal mass being mowed 3-4 times during the vegetation periods, when it reached 15-20 cm in height, and between the trees in a row the herbicide field. The experimental sector is not irrigated. Methodological principles and approved methods in genetic improvement and the study of fruit species were used for the research. The study of biological, phenological and production properties was carried out based on observations, determinations and analyzes regarding the development of apricot trees and fruits. Observations on the onset of early-flowering phenophases and harvest maturity were made taking into account the apricot landmark stages described by Baggiolini (1952).

RESULTS AND DISCUSSIONS

The requirements of apricot against heat are very dynamic and therefore each development phase has a certain optimum temperature and travel time. Analyzing the experimental data, we find that the varieties studied during the research recorded different periods of triggering the beginning of apricot tree flowering. Thus, an earlier beginning of flowering during research was recorded in 2019, which was later followed by 2017 and 2018. If, for example, in 2019, the beginning of flowering of Wonder Cot trees began at 23 March, then in 2017 it was registered on March 26, with a delay of 3 days, and in 2018 the phenomenon in question was recorded on April 7, is a detention of 16 and 13 days, respectively, compared to previous years (tab. 1).

Such a large gap between the beginning of flowering period in 2018 is explained by the registration during the optional rest period starting with March 18 during 8 days of low average daily temperatures (-0.2… -6.0^0 C). After this thermal stress, the trees during 4-5 days still could not return to normal physiological processes, because the average daily temperature was positive, but lower than the recommended biological threshold (+ 6.5^{0}C).

The period of onset of the phase beginning of flowering of apricot trees also depends on the biological characteristics of the variety and the average daily temperature recorded in that period.

Table 1
The influence of the biological particularities of apricot varieties on the onset of the early flowering phase of the trees

Variety	The beginning phase of the flowering of the trees				± Kioto, days
	2017	2018	2019	Average, days	
Wonder Cot	26.03	07.04	23.03	88	-5
Spring Blush	27.03	07.04	24.03	89	-4
Magic Cot	27.03	07.04	23.03	88	-5
Pinkcot	27.03	08.04	25.03	90	-3
Perle Cot	30.03	09.04	29.03	92	-1
Orange Red	28.03	08.04	26.03	90	-3
Sweet Cot	26.03	07.04	23.03	88	-5
Lilly Cot	27.03	07.04	24.03	89	-4
Big Red	29.03	09.04	27.03	91	-2
Kioto (w)	31.03	10.04	30.03	93	0
Faralia	29.03	09.04	27.03	91	-2
Farbaly	30.03	10.04	29.03	92	-1

The varieties studied according to the onset of the flowering period can be divided into three groups: early - with flowering at 88-89 days from the beginning of the year, medium - with flowering at 90-91 days from the beginning of the year and late - with flowering at 92-93 days from the beginning of the year. The Wonder Cot, Spring Blush, Magic Cot, Sweet Cot Lilly Cot varieties are assigned to the early flowering group, the Pinkcot, Big Red, Orange Red, Faralia varieties to the medium flowering groups, and the Perle Cot, Kyoto and Farbaly varieties with late flowering. The legitimacy in question was registered during the study period with some deviations registered in 2018, when the daily average during flowering was higher than + 14.0^0 C and the physiological processes within the trees accelerated and a more flowering was obtained in abundance (Ezzat et al. 2012, Szalay & Szabo 1999).

Basically, those mentioned above indicate that in 2018 the varieties studied began to bloom over 4 days, where the sum of the average daily temperature in that period was +57.7^0 C. In the case of 2017 and 2019, for the respective varieties, due to lower values of the sum of the average daily temperature, there was a staggering of the beginning flowering period as in the previous year, constituting 6 and 8 days, respectively, and the sum of the average daily temperature did not undergo major changes registering values of +60.0^{0}C and +55.0^{0}C, respectively.

Thus, the onset of the early flowering phase in apricot trees is correlated with the biological particularities of the variety and the temperatures recorded during the optional dormant period and those during flowering.

The duration of the early ripening phase of fruits differs significantly from the biological characteristics of the variety, being determined to some extent by weather conditions, especially temperature, which, having high values, accelerate ripening and vice versa (Babuc 2012).

The date of the beginning of the apricot fruits ripening is closely correlated with the period of the beginning of the flowering of the trees and the climatic conditions registered during the fruits growth. Thus, an earlier maturation of all apricot varieties studied was registered in 2018 (02.06.-21.07), then a retention of 7 days in 2019 (09.06-02.08) and the latest maturation of apricots was obtained in 2017 (12.06-13.08) (tab. 2).

Table 2

The influence of the biological particularities of apricot varieties on the onset of the fruits harvest period

Variety	The date of fruit ripening				± Kioto, days
	2017	2018	2019	Average, days	
Wonder Cot	12.06	02.06	09.06	159	-22
Spring Blush	13.06	02.06	08.06	159	-22
Magic Cot	23.06	11.06	18.06	168	-13
Pinkcot	24.06	12.06	17.06	169	-12
Perle Cot	27.06	14.06	23.06	172	-9
Orange Red	28.06	15.06	24.06	175	-8
Sweet Cot	28.06	15.06	23.06	173	-8
Lilly Cot	26.06	14.06	23.06	172	-9
Big Red	29.06	17.06	25.06	175	-6
Kioto (w)	06.07	22.06	01.07	181	0
Faralia	27.07	07.07	18.07	198	+17
Farbaly	13.08	21.07	02.08	213	+32

Further studying the consistency of fruits ripening in apricot varieties studied during the research, we record that large deviations from the harvest period that each variety possesses has not been recorded.

The study carried out on the period of fruits set in the apricot varieties studied shows that this phenophase began on average 159 days after the beginning of the year with the Wonder Cot variety and ended after the period of 213 days with the Farbaly variety. If we compare the ripening period of apricot fruits with the Kyoto variety, considered as a control, we register that all the varieties studied can be divided into 4 groups. The group Wonder Cot and Spring Blush are attributed to the group of extra-early ripening varieties, whose fruits harvesting started 22 days earlier compared to the control variety. The group of varieties with early maturation is assigned the varieties Magic Cot, Pinkcot, Sweet Cot Lilly Cot and Orange Red, whose difference in terms of triggering the harvest period compared to the control variant was 8-13 days. The medium-ripening varieties include the Big Red and Kyoto varieties, and the late-maturing varieties group the Faralia and Farbaly varieties, which recorded retention at the beginning of the harvest period compared to the control variant with 17 and 32 days, respectively.

The biological particularity of the variety and the sum of the active temperatures recorded in the period from the beginning of flowering to the start of harvesting of the varieties studied was different (fig. 1). A shorter period of days was required for this time period in 2018 compared to the other years studied. If, for example, in 2018, 56 to 102 days were required to cover this time period for the varieties studied, then in 2017 and 2019, this period was longer and amounted to 78-134 days and, respectively, 78-125 days. On average, during the research, this index was from 70 to 120 days, which is quite favorable for apricot growers to be able to make fresh fruit available to consumers and supply the raw material to the processing industry.

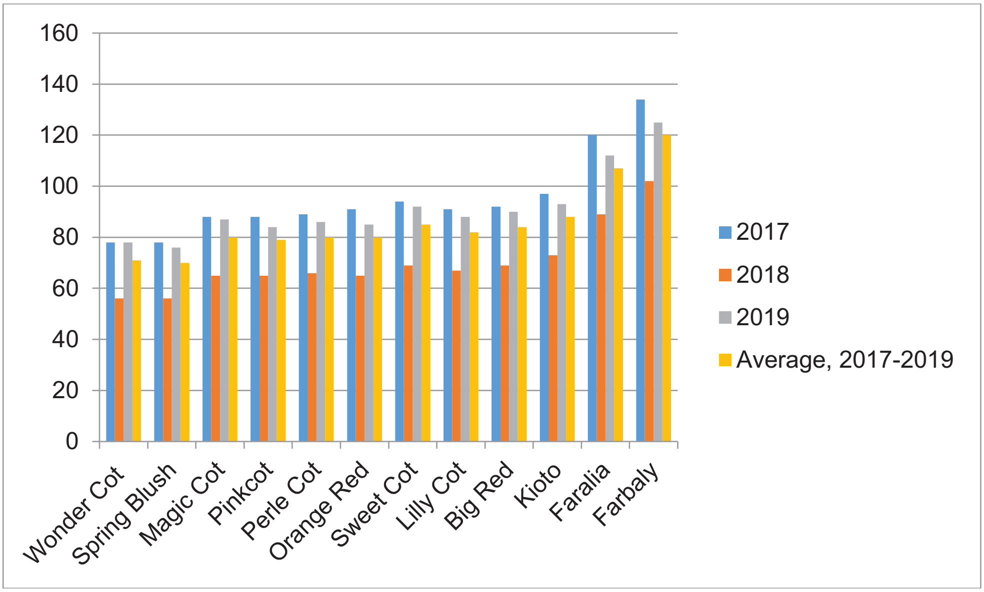

Figure 1. The influence of the biological particularities of apricot varieties on the period from the beginning of flowering of the trees until the ripening of the fruit harvest

The development of phenophases differs from one variety to another, and within the same variety, it differs depending on the weather conditions of each year.

CONCLUSIONS

The biological particularities of the varieties and the temperatures during the optional rest and the vegetation period influence the onset of the phenophase, the beginning of the flowering and the maturation of the harvest.

The Wonder Cot, Spring Blush, Magic Cot, Sweet Cot Lilly Cot varieties are assigned to the early flowering group, the Pinkcot, Big Red, Orange Red, Faralia varieties to the medium flowering groups, and the Perle Cot, Kyoto and Farbaly varieties with late flowering.

The beginning of the apricot fruits ripening is closely correlated with the period of the beginning of the flowering of the trees and the climatic conditions registered during the fruits growth.

The biological particularities of the variety influence the period of onset of the beginning of flowering phases and the maturation of apricot fruit harvest, and the period between these two phases.

REFERENCES

Abbas M. M., Bakhsh M. A., Sumrah M. A., Hussain A., Akhtar A. 2016. Evaluation of different apricot varieties under climatic conditions of Soon Valley. J Agric Res, 54(4), 727-735.

Babuc V. 2012. Pomicultura. Chişinău, p. 348-354.

Baggiolini M. 1952. Les stades repères de l’abricotier. Revue romande d’Agriculture et d’Arboriculture, 8(4), 28.

Balan V., Stănică Fl., Chira L. et al. 2008. Caisul şi caisele. Bucureşti, editura Ceres, pp 686.

Chira L., Cheraji V., Roman M. 2005. Caisul şi piersicul. Editura: MAST. Bucureşti, pp. 9-190.

Cimpoieş Gh. 2018. Pomicultura specială. Chişinău: Golograf-com, pp 336.

Cociu V. et al. 1993. Caisul. Bucureşti, Editura Ceres, pp 401.

Ezzat A., Amrisko L., Balazs G., Mikita T., Nyeki J., Soltesz M., Szabo Z. 2012. Variation between some apricot varieties in regard to flowering phenology in Boldogkôváralja, Hungary. International Journal of Horticultural Science 18(1), 7-9.

Maria L., M., Sosna I. 2006.Evaluation of several apricot cultivars and clones in the lower Silesia climatic conditions. J. Fr Orna Pl Res, 13, 39-48.

Negru I. 2018. Dezvoltarea pomilor de cais altoiţi pe portaltoiul Mirobalan 29C în funcţie de modul de formare a coroanei în perioada de creştere a plantaţiei. Lucrări ştiinţifice UASM. Chişinău Vol. 47. Horticultură, Viticultură și vinificație, Silvicultură și grădini publice, Protecția plantelor, pp 77-82.

Negru I., Peşteanu, A. 2019. Comportarea unor soiuri de cais din colecţia mondială cultivate în zona de sud a Republicii Moldova. In: Ştiinţa Agricolă. Chişinău 2, 52-59.

Peşteanu A., Manziuc V., Cumpanici A., Gudumac E., Braghiş A. 2018. Producerea caiselor. Manual tehnologic. Chişinău, pp 291.

Pîntea M. 2018. Date preliminare privind promovarea sortimentului de cais în Republica Moldova. Lucrări ştiinţifice Chişinău, 47, 25-28.

Pîntea M. 2019. Cercetări agrobiologice asupra sortimentului modern de cais. In: Lucrări ştiinţifice. Ştiinţa în Nordul Republicii Moldova: realizări, probleme, perspective. Bălti, pp 249-253.

Szalay L., Szabo Z. 1999. Blooming time of several apricot varieties. Int J Hort. Sci, 5(1–2), 16-20.

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EFFECT OF PINCHING AND CYCOCEL ON GROWTH OF *IRESINE HERBSTII* Hook. POTTED PLANTS

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Keywords: *Iresine herbstii, pinching, vegetative growth, cycocel, foliar application*

ABSTRACT

Iresine herbstii Hook. is a perennial plant highly appreciated for the bright purple-red colored leaves, that is usually grown in temperate areas as a summer patio plant or annual bedding plant, as well as an indoor foliage plant grown in pots. The paper presents the results regarding the influence of manual pinching and foliar treatments with Cycocel (1000 ppm) on the vegetative growth of plants, during seven months after planting the rooted cuttings in pots. The study aims to control the height and to improve the decorative aspect of plants. The greatest reduction of plant height and the highest number of shoots and leaves per plant as well as an intensification of foliage color were obtained at the variant where the plants were exposed to single pinching, followed by 1000 ppm cycocel foliar application at two weeks intervals. Plants have been dwarf and had a compact growth, which improved the aesthetic value of Iresine herbstii as an indoor potted plant.

INTRODUCTION

Iresine herbstii Hook. is an herbaceous perennial species in the Amaranthaceae family, native to tropical South America (Brazil), which can reach a height of up to 1.5 m in its natural habitat, but it is cultivated as an annual or indoor potted plant in temperate and cooler climates, that usually grows smaller, being pruned to 30-50 cm tall. It has red stems and simple, bright purple-red, arranged opposite, round to oval leaves, with a notched tip and prominent pink or light red veins. Some varieties have lanceolate leaves. The flowers are small, white-green and insignificant from the decorative point of view. There are cultivated the following cultivars: ‘Aureoreticulata’ (red stem and green leaves with yellow veins), '*Brilliantissima*' (bright red leaves with pink veins), ‘Wallisii’ (dwarf, with numerous small purple-black leaves), ‘Purple Lady’ (dark purple leaves and stems), ‘Ruby Glow’ (dark pink stems with ruby pink foliage), 'Blazin Rose' (deep red-purple leaves with lighter reddish pink veins), 'Blazin Lime' (bright light green leaves with yellow veins and red stems), etc.

It requires sunny places with fertile, rich in humus, moist, well-drained soils but it grows well in semi-shade. Doctor & Cababat (2014) reported that the aqueous extract of *Iresine herbstii* can be used as a soil pH indicator. Its vegetative propagation is done by tip cuttings of shoots and micropropagation in vitro (Zhong et al. 2007).

Iresine is one of the most popular ground covers in all subtropical countries (Richter & Weiland 2012). It is often used together with other plants, decorative through flowers or leaves, to create intricate patterns in mosaiculture or in public green spaces, giving a tapestry or carpet effect. It is used as an ornamental plant in flower beds, simple and mixed borders, flower bands, and as small hedges in parks and gardens. Grown in planters and pots in combination with silver foliage plants or variegated foliage with white, it brings color and contrast to flower compositions. *Iresine herbstii* contains several bioactive compounds and has therapeutic properties, in many countries is used in traditional medicine to treat various diseases. Dipankar & Murugan (2012) based on the results obtained in their studies reported that*, I. herbstii* has a significant potential to be used as a natural antioxidant and anticancer agent. They also studied the antibacterial activity of the leaf and stem extracts of this plant against pathogenic bacteria and the results indicated that the leaf extracts were found to be more effective than the stem extracts. Al-Fartosy & Abdulwahid (2015) reported that the *Iresine herbstii* flowers may be valuable natural antioxidant sources and are potentially applicable in both pharmacy and food industry. Leaves are used in wound healing (Schmidt et al. 2009), and the plant is also used in whooping cough, and as astringent, diuretic, spasmolytic, as well as an antimicrobial agent (Khare 2007). Tene et al. (2007) showed that leaves and flowers are used in decoction for fever and kidney problems. In terms of the production of ornamental plants grown in pots, one of the most important aspects is the control of the plant growth to obtain a desired visual quality. Numerous cultural techniques are used to control plant height and produce marketable plants, including manual pinching (removal of shoot tips) and/or application of plant growth regulators (PGRs). In a study conducted by Richards & Wilkinson (1984), pinching doubled the number of lateral shoots in *Camellia* and *Rhododendron*, and reduced shoot number and growth in miniature roses. Pinched plants were significantly shorter than non-pinched plants, while chlormequat chloride (CCC) was less effective than pinching in reducing the growth of *Nerium oleander* (Bañon Arias et al. 2001). Double pinching followed by 1500 ppm cycocel application at 14 day intervals determined significantly greater height reduction of shoots and the highest number of shoots in *Euphorbia pulcherrima* plants (Karunananda & Peiris 2010). Pinching and spraying the plants with paclobutrazol at 40 ppm decreased the height of the plant, being recommended for the production of dwarf plants (El-Sadek 2016). Ghormade et al. (2017) reported that, the double pinching at 15 and 30 days after transplanting and the cycocel treatment at 2000 ppm determined the minimum plant height and maximum stem diameter of African marigold. Pinching and paclobutrazol determined a reduction of *Antirrhinum majus* plant height, flowering delay and obtaining of shorter flower spikes (Wainwright & Irwin 1987). The plants of *Dianthus caryophyllus* treated with 1000 ppm cycocel were compact and dwarf with an increased number of shoots and the maximum number of flowers (Ahmad et al. 2007). The plants of *Callistephus chinensis* treated with cycocel recorded the highest number of flowers (Gowda 1990). The maximum number of flowers per plant at *Gaillardia pulchella*, were recorded through single pinching at 30 days after transplanting as well as through applying 1000 ppm cycocel (Moon et al. 2017). At the annual chrysanthemum, significantly more days to first flower bud initiation, opening of flower from bud initiation and blooming period were recorded in the pinching treatment at 45 days after transplanting and in foliar application of cycocel 1500 ppm (Taksande et al. 2017). This study was conducted to determine the effect of pinching and cycocel on the vegetative growth of *Iresine herbstii* Hook. plants, grown in pots, to obtain compact, well branched plants, with dense foliage and *high* aesthetic *value.*

MATERIAL AND METHODS

The biological material consisted of shoot tip cuttings collected in May, from vigorous and healthy mature plants of *Iresine herbstii.* The rooted cuttings were planted in 14 cm diameter pots, in a substrate composed of peat, manure and perlite (2:2:1), under greenhouse conditions, in June. Three foliar treatments with Cycocel were applied at two weeks interval and one mechanical treatment (manual pinching) was applied at 14 days after transplanting. The experimental variants were: V1 - control (no pinching and untreated plants); V2 (pinched plants); V3 (non-pinched plants treated with Cycocel 1000 ppm) and V4 (pinched plants and treated with Cycocel 1000 ppm). The research was carried out in the greenhouse of the Floriculture Department, Faculty of Horticulture from Craiova, between the 2017-2018 period.

To evaluate the influence of pinching and Cycocel treatments on the growth of plants, observations and biometric measurements regarding the plant height, the number of shoots/plant, the length of the shoots, the number and length of internodes, the length and width of the leaves were conducted, during 7 months from the beginning of the experiment.

RESULTS AND DISCUSSIONS

In the *Iresine herbstii* species recorded a reduction in plant height, in all variants, compared to control plants, this being more obvious in V_4 (pinching + Cycocel 1000 ppm) and in V_2 (only pinched plants), where average values of 19.8 cm and 24.4 cm respectively were recorded. The effect on plant height was lower in the variant in which only foliar treatments with Cycocel 1000 ppm were applied, obtaining an average value of 32.7 cm, close to that recorded in control plants (35.6 cm) (figure 1).

The obtained results showed that both manual pinching and cycocel increased the number of shoots per plant. The number of shoots increased with the decrease in plant height. Pinching in combination with cycocel 1000 ppm treatment produced more lateral shoots (12.5) and made the plants well branched, compact and attractive. Cycocel used in individual applications in this experiment was not effective in increasing the shoot number. An average number of 10.8 shoots/plant was recorded in the variant where the plants were only pinched, while no shoots were formed in the control variant (non-pinched and untreated plants). The average length of the shoots recorded at the end of the experiment, when the last measurements were made, was 15.5 cm at V_2 (pinched plants), 13.2 cm at V_4 (pinched + Cycocel 1000 ppm) and 11.3 cm in cycocel-treated and unpinched plants (figure 2).

Regarding the average number of internodes/plant, lower values than the control (14.0) were obtained in all variants, the lowest value being recorded by the pinched plants and treated with cycocel (8.2 internodes/plant) (figure 3).

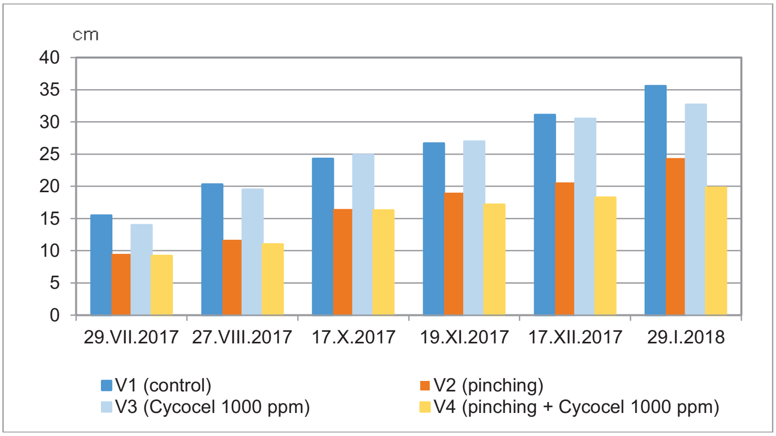

Figure 1. Effect of pinching and cycocel on the height of the plants

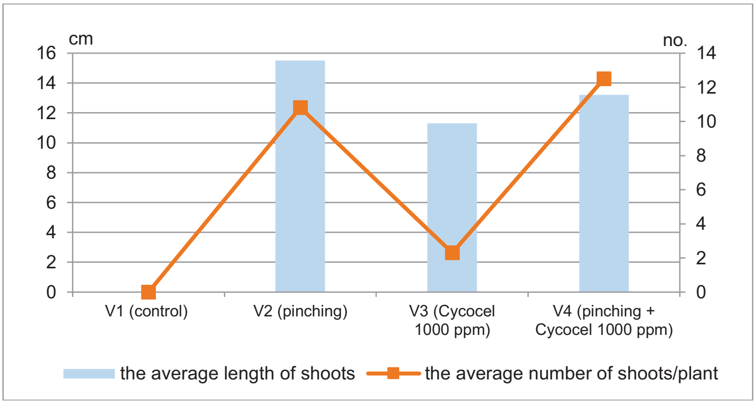

Figure 2. The number of shoots per plant and the length of the shoot at the end of the experiment

The average number of leaves per plant was higher in the pinched plants, treated with Cycocel 1000 ppm, recording an average value of 47.8 leaves/plant, compared to the other variants.The lowest value was obtained at V_3 (Cycocel 1000 ppm), the plants having an average number of 32.2 leaves (figure 3).

Regarding the average size of the leaves, the highest value of the average length and width of leaves at the end of the evaluation period of *Iresine herbstii* plants, was recorded at V_1 - control (5.3 cm, 5.6 cm respectively) and the lowest value was obtained at V_4 (4.5 cm, 4,6 cm respectively), as an effect of the interaction between pinching and cycocel treatments. The Cycocel alone did not influence significantly the size of the leaves, in comparison with the other variants, obtaining values close to those of the control variant (figure 4).

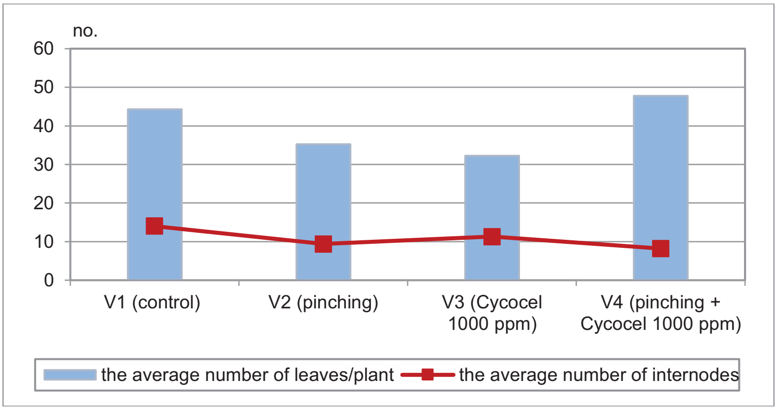

Figure 3. Effect of pinching and cycocel on number of internodes and number of leaves per plant

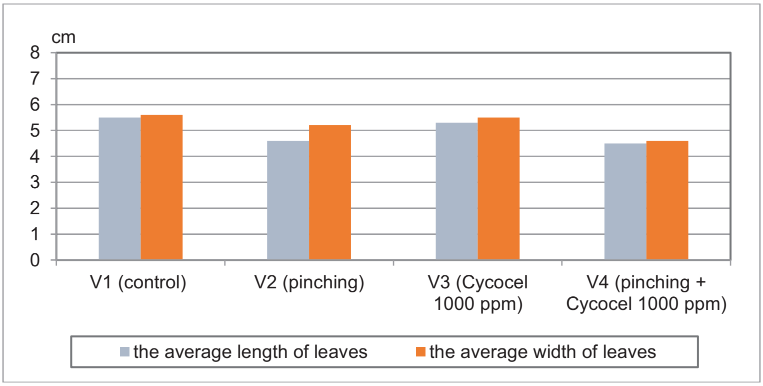

Figure 4. The size of the leaves at the end of experiment

CONCLUSIONS

Pinching the plants decreased the height of the plant and the number of the leaves, but increased the number and the length of the shoots. Pinching in combination with cycocel (1000 ppm) treatments reduced the plant height, which was due to the short distance between the internodes, but determined an increase in the number of shoots and number of leaves per plant, as well as an intensification of foliage color, resulting in a compact plant growth, which improved the aesthetic value of *Iresine herbstii* as an indoor potted plant.

REFERENCES

Ahmad I., Ziaf K., Qasim M., Tariq M. 2007. Comparative evaluation of different pinching approaches on vegetative and reproductive growth of carnation (*Dianthus caryophyllus*). *Pakistan* Journal of *Agricultural* Sciences, 44(4), 563-570.

Al-Fartosy A.J.M., Abdulwahid A.A. 2015. Antioxidant activity of anthocyanins extracted from Iraqi *Iresine herbstii* L. flowers after drying and freezing. American Journal of Analytical Chemistry, 6(5), 382-394.

Bañon Arias S., Antonio J., Leemhuis F., Fernández Hernández J.A., Ochoa Rego J., Benaente-García A.G. 2001. Growth and leaf colour responses of oleander

(*Nerium oleander* L.) to pinching and chlormequat chloride treatment. Acta Horticulturae, 559, 155-160.

Dipankar Chaudhuri, Murugan S. 2012. Investigation on phytochemicals and antibacterial activity of the leaf and stem extracts of *Iresine herbstii.* International Journal of Pharma and Bio Sciences, 3(4), 697-705.

Dipankar Chaudhuri, Murugan S. 2012. Phytochemical composition of the extracts from *Iresine herbstii* and its therapeutic use via antioxidant and cytotoxic potential by multiple *in vitro* assays. Int. Journal of Phytomedicine, 4, 477-485.

Doctor T.R., Cababat, RA.P. 2014. Blood leaf (*Iresine herbstii*) extract used as an indicator of soil pH. Journal of Scientific and Research Publications, 4(10), 1-5.

El-Sadek H.Z. 2016. Effect of pinching and paclobutrazol on *Hibiscus rosa-sinensis* L. cv."Yellow" plant. Scientific Journal of Flowers and Ornamental Plants, 3(4), 233-244

Ghormade N.G., Gajbhiye R.P., Borse H.G., Gobade N., Moon S.S. 2017. Growth and flowering of African marigold as influenced by pinching and cycocel. Journal of Soils and Crops, 27(1), 204-207.

Gowda J.V.N. 1990. Influence of pinching and cycocel on growth and flowering of China Aster (*Callistephus chinensis* (L.) Nees). Mysore Journal of Agricultural Sciences, 24, 238-245.

Karunananda D.P., Peiris S.E. 2010. Effects of pinching, cycocel and B-Nine treatments on branching habit of pot poinsettia (*Euphorbia pulcherrima* Willd). Tropical Agricultural Research, 21(3), 284-292.

Khare CP. 2007. Indian Medicinal Plants: An Illustrated Dictionary. Springer: New York, p. 12.

Moon S.S., Masram G. B., Gajbhiye R.P. 2017. Effect of pinching and Cycocel on flower yield and quality of Gaillardia. International Journal of Researches in Biosciences, Agriculture and Technology, 2, 1205-1208.

Richards D., Wilkinson R.I. 1984. Effect of manual pinching, potting-on and cytokinins on branching and flowering of *Camellia, Rhododendron* and *Rosa.* Scientia Horticulturae, 23(1), *75-83.*

Richter M., Weiland U. 2012. Applied Urban Ecology: A Global Framework. Blackwell Publishing Ltd.

Schmidt C., Fronza M., Goettert M., Geller F., Luik S., Flores E.M.M., Bittencourt C.F., Zanetti G.D., Heinzmann B.M., Laufer S., Merfort I. 2009. Biological studies on Brazilian plants used in wound healing. Journal of Ethnopharmacology,122, 523–532.

Taksande S., Raut V.U., Nagre P.K. 2017. Effect of pinching and Cycocel on flowering and flower quality of annual chrysanthemum. Journal of Soils and Crops 27(1), 75-79.

Tene V., Malagón O., Finzi P.V., Vidari G., Armijos C., Zaragoza T. 2007. An ethnobotanical survey of medicinal plants used in Loja and Zamora-Chinchipe, Ecuador. Journal of Ethnopharmacology, 111(1), 63-81.

Wainwright H., Irwin H.L. 1987. The effects of paclobutrazol and pinching on antirrhinum flowering pot plants. Journal of Horticultural Science, 62(3), 401-404.

Zhong Jia-ji, Zhou Hao, Wang Ying, Na Hai-yan. 2007. Vegetative propagation and cuttage of *Iresine herbstii* in vitro. Journal of Sichuan University, Natural Science Edition, 44(4), 907-911.

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FOOD SAFETY OF THE SUSTAINABLE AGRI-FOOD SUPPLY CHAIN

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Keywords: *sustainable development, public health, food security, agri-food production*

ABSTRACT

Food safety throught animal health, animal welfare, animal nutrition and plant health have in view the quality assurance of the agri-food products that consumed by consumer should not harm his health and by caring for animals and plants for human consumption, the environment is also protected because various actions are performed that have positive effects. The paper wants to emphasize the importance of food safety for the future of mankind while the sustainable development of the agri-food sector is taking place. One of the main objectives of agriculture is to build a sustainable agri-food system that ensures a high level of food safety and food security.

INTRODUCTION

The agricultural sector and the food industry are essential for the social and economic development of the whole world, having the role of providing sufficient food and nourishment to the population while ensuring an important economic activity, especially for the rural community. The main purpose of food is to feed the population, having a considerable nutritional value and satisfying the need for food, so the safety and food security of agri-food products consumed must be ensured to provide healthy, safe and sufficient food for the entire population. Currently, the agricultural sector is oriented towards a sustainable development that creates a synergy between social, economic and environmental aspects, because agriculture is based very much on natural resources and they must be protected to ensure the needs of the population having the ultimate goal to build a sustainable agri-food system that ensures a high level of food safety and food security. (Dragoi et. al. 2018). European Commission's Food Safety policy is to ensure a high level of protection of human health during food consumption and author Rabontu considers that food safety requires a complex approach to the entire agri-food chain and the risks that may arise in the stages of the chain must be reduced. The World Health Organization (WTO) promotes the concept of food safety through 5 key indicators that ensure safer food, being a responsibility that must be fulfilled by all actors in the agri-food supply chain: Keep clean, Separate raw and cooked, Cook thoroughly, Keep food at safe temperatures, Use safe water and raw materials.

Food safety contributes to the sustainable development of agriculture because it has the following impacts on the 3 pillars:

- Environment: encourages the use of organic substances intended for agricultural land and it protects long-term natural resources, using rationally.

- Social: ensures fresh agri-food products safe for human consumption without harming health.

- Economic: by adopting international standards ensures a competitive advantage to suppliers that can be capitalized on the market, thus improving the position of the producer in the agri-food supply chain and ensuring economic viability of agricultural companies.

According to Overbosch (2014) the largest contribution in the food industry is brought by the following initiatives on food safety and quality control of agri-food supply chain: HACCP - Hazard Analysis Critical Control Points, ISO 22000 - Food Safety Management, ISO 9001 - Quality Management Systems. The Economist Intelligence Unit (EIU) realized in 2019 the Global Food Security Index where 3 main categories regarding the agri-food sector from 113 countries were analyzed, in figure 1 being presented the results obtained by Romania which in total ranks 38th and following this result, it is necessary to develop strategies to improve food security and safety in the country. The quality and safety is the indicator with the lowest score registered by Romania out of the 3 indicators analyzed by EIU.

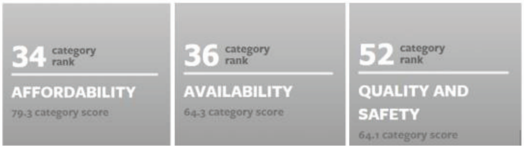

Figure 1. The results of Romania for Global Food Security Index in 2019
Source: EIU, 2019

Ensuring access to sufficient and safe food for the population is indispensable for any country, farmers having an important role when they produce fresh agri-food products, requiring increased attention from all parties involved in the supply chain to ensure the food safety.

MATERIAL AND METHODS

The quantitative analysis of the study consists in analyzing the data provided by the EIU regarding the indicators that determine the degree of food safety in Romania that target different actors in the supply chain. The research aims to identify strategic directions to ensure food safety, being realized a theoretical research of the concept of food safety and a descriptive study on food safety of the agri-food supply chain based on the results of the analysis performed.

RESULTS AND DISCUSSIONS

Analyzing the quality and safety indicator in an analysis of 113 countries, Romania ranks 52nd, registering a score of 64.2 points, a score that is above the average of the analyzed countries of 61 points. Table 1 presents an analysis of food safety indicators in Romania and the score obtined in 2019. Regarding the food safety indicator, Romania registered a maximum score, due to the sub-indicators that obtained the maximum value such as: agency to ensure the safety and health of food (by EIU qualitative score), percentage of population with access to potable water (a 100% share according to the World Bank) and the ability to store food safely (100% according to the United Nations).

Table 1

Global food security index - analysis of food safety indicators in Romania

Indicators	Remarks	Score 2019
QUALITY AND SAFETY		
Food safety	**Appropriate environment for food safety**	**100**
1) Agency to ensure the safety and health of food	The existence of a regulatory or administrative agency to ensure the food safety: 0 = No/1 = Yes	1
2) Percentage of population with access to potable water	% of population using at least basic drinking water services	100
3) Ability to store food safely	% of population with access to electricity in all areas	100
AFFORDABILITY		
Presence and quality of food safety net programmes	**Assessing the presence and nature of food safety-net programmes.**	**4**
1) Presence of food safety-net programmes	Evaluation of the present food safety programs	1
2) Funding for food safety net programmes	Assess the financial resources available for food safety programs	1
3) Coverage of food safety net programmes	Evaluation of the national coverage level and the product offer of the food safety programs	1
4) Operation of food safety-net program	Assessing the degree of government management of food safety programs	1

Source: Global food security index 2019

The Affordability indicator includes the sub-indicator Presence and quality of food safety net programs which analyzes, among other sub-indicators, the presence and quality of food safety net programs, which obtained a maximum score of 4 points. Food safety regarding the quality of all process of the agri-food supply chain, from raw materials to final product. There have been identified 5 important steps in the supply chain with agri-food products that must be observed by the actors involved but that must be constantly improved and adapted to the present needs to guarantee the food safety.

Traceability: The traceability of the product during all stages of the supply chain is considered and the final consumer can find out through it different details about the consumed product being a real-time guarantee of safety, increasing his confidence in the product but also in the supplier.

Certifications: Currently there are a number of internationally recognized voluntary certifications that guarantee in any state the safety of food produced and these certifications offer an extra confidence to consumers providing an assessment of the conformity of the product to adequate standards. Some exemples are Global GAP for crops, EU Organic farming, BRC Global standard for Food Safety, Food Safety System Certification 22000, International Food Standards.

Standards: Worldwide, the Codex Alimentarius has a list of 224 food standards that provide guidance for food safety and which must be respected exactly (FAO 2020)

Packaging, storage, transport: Maximum hygiene conditions are required for these 3 important actions that contribute to maintaining the characteristics of the products for a longer period. The stage regarding packaging, storage (in specific conditions of cold according to the product requirements) and transport (with cold) is an essential stage in the agri-food supply chain, mainly the storage and transport activities play an important role in maintaining the quality of fresh products.

Product monitoring and control: These two actions are important because they ensure that the final product meets the requirements and is in order for human consumption. Also, with increased attention can minimize or even prevent possible risks, continuous monitoring assesses the progress made so will ensure the entire amount of products without a change in the properties or characteristics of the product so an integrated farm management being necessary for monitoring and control of production.

Figure 2 illustrates the main stages of the agri-food supply chain, where it is presented that the standards apply throughout the entire chain, from producer to trader inclusive, respecting the legislation and standards, while the consumer must benefit of traceability of the consumed product.

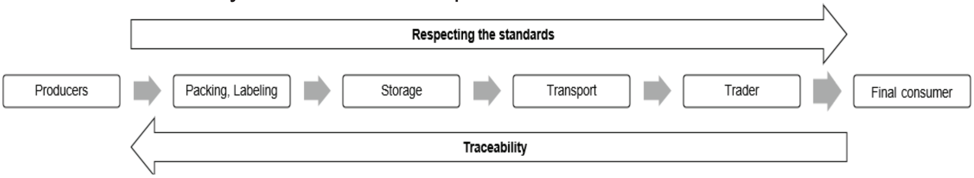

Figure 2. The stages of the agri-food supply chain
Source: creation of authors

There are major concerns aimed at ensuring food safety aimed at consumer satisfaction and each actor in the supply chain tries to make a positive contribution to the food product by ensuring actions designed to maintain the quality aspects of the product.

CONCLUSIONS

Romania, although it registers a score with 3.2 points above the average of the analyzed countries, it is in the first second half of the ranking (52nd place out of 113) in terms of quality and safety indicator, however the food safety sub-indicator recorded in Romania the score maximum. Also, the maximum score was obtained by the sub-indicator Presence and quality of food safety net programs.

Innovative models of food safety management through research, development and innovation to adapt to current requirements in order to guarantee the most efficient methods of obtaining quality and safe products for consumption. The increase of the performance of the specific activities destined to the protection of the quality of the products for the orientation of the agribusiness towards the consumer can be achieved through the sustainability of the implemented food safety process. Sustainable perspectives and farmers resilience strategies are drivers of change for the sustainable development of agriculture, ensuring solutions for food saftety.

REFERENCES

Dragoi M. C., Andrei J. V., Mieila M., Panait M., Dobrota C. E., Ladaru R. G. 2018. Siguranta si securitatea alimentara in Romania – o analiza econometrica in contextul transformarii paradigmei agricole nationale. Amfiteatru Economic, 20(47), 87-103.

Overbosch P., Blanchard S. 2014. Principles and Systems for Quality and Food Safety Management. Food Safety Management, 537-558.

Rabontu C. 2010. Food safety and its role in the evolution of food trade. Analele Universităţii "Constantin Brâncuşi" din Târgu Jiu, Seria Economie, 161-172

*** 2019, WTO - Promoting safe food handling, https://www.who.int/activities/promoting-safe-food-handling

*** 2019, The Economist Intelligence Unit - Global Food Security Index https://foodsecurityindex.eiu.com/Country/Details#Romania

*** 2020, FAO – Codex Alimentarius International Food Standards, http://www.fao.org/fao-who-codexalimentarius/codex-texts/list-standards/en/

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EFFECT OF ALTITUDE ON TOTAL PHENOLIC CONTENT AND ANTIOXIDANT ACTIVITY FIVE OLIVE FRUIT CULTIVARS GROWN IN CENTRAL GREECE

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***Keywords**: Antiradical activity DPPH; locations; olive fruits; phenols*

ABSTRACT

Five olive cultivars (Amfisis, Chalkidikis, Kalamon, Agrielia and Lefkolia Serron) grown in central Greece at different altitudes were studied on total phenolic content, phenolic fractions and the antioxidant activity DPPH. The olive cultivars Agrielia and Amfisis grown to an altitude of 500m are characterized by an highest TP content (13.32 and 6.12 mg GAE g^{-1} FW, respectively) and stronger antioxidant activity (175.68 and 112.11 µmol Trolox g^{-1} FW, respectively) compared with the same cultivars grown to an altitude of 130m,and which showed values on TP content equal to (9.53 and 4.22 mg GAE g^{-1} FW, respectively) and antioxidant activity equal to (124.84 and 85.78 µmol Trolox g^{-1} FW, respectively). The olive cultivars Kalamon and Lefkolia Serron grown to an altitude of 130m are characterized by an highest TP content (19.32 and 13.78 mg GAE g^{-1} FW, respectively) and stronger antioxidant activity (252.4 and 176.32 µmol Trolox g^{-1} FW, respectively) compared with the same cultivars grown to an altitude of 500m, and which showed values on TP content equal to (16.21 and 10.11 mg GAE g^{-1} FW, respectively) and antioxidant activity equal to (216.89 and 117.5 µmol Trolox g^{-1} FW, respectively). The results showed that the total phenolic content and antioxidant activity of olive fruits it depends strongly from the cultivar and altitude.

INTRODUCTION

The Mediterranean basin is the main region producing olives in the world. The Greece constitutes one of the most important countries in olive cultuvation. Mediterranean diet associated with a reduced risk of cardiovascular diseases and certain kinds of cancer, is rich in olive oil and table olives (Trichopoulou & Lagiou 1997, Panagiotakos et al. 2006). The olive fruits are natural reservoir of phenolic compounds (such as flavonoid phenols and phenolic acids) and secoiridoids, which exert high antioxidant activity. The rapid production of free radicals can lead to oxidative damage of the cell membranes which cause the occurrence of many diseases (Bravo 1998). Epidemiological investigations demonstrate that the oxidative destruction of biomolecules can be reduced by using endogen and exogenous antioxidants such as carotenoids, polyphenols, etc., which are contained in fruits and vegetables (Valko et al. 2006). The phenolic compounds contained in the olive fruits and olive oil, contribute to improving human health, with their ability to scavenge the harmful free radicals (Dağdelen et al. 2013). The composition of phenolic compounds and antioxidant activity in the olive fruits depends on many factors such as olive cultivar, agronomic techniques, harvest time and environmental conditions of area (Vinha et al. 2005, Arslan & Özcan 2011). The aim of the present research was to investigate and compare the total phenolic content and antioxidant capacity of five olive fruit cultivars, grown at two area of central Greece with different altitude.

MATERIAL AND METHODS

Experimental: The olive fruits were hand picked from the 20th of November to the 1th of December 2018 at the full maturation stage from two organic olive orchards of central Greece located at different altitudes. The olive orchard A is cultivated on the slopes of mount Pelion in Thessaly (latitude 39°22′34″ N, longitude 23°03′00″ E, altitude 500 m, distance from the sea 17 km). The area is characterized by a temperate mediterranean climate with mild winters and hot summers, with average winter temperature 4.8 ^{0}C, average summer temperature 23.2 ^{0}C and average annual precipitation 890 mm in 2018. The olive orchard B is cultivated in the plain of Larissa, Thessaly (latitude 39^{o}29'10.9" N, longitude 22^{o}36'23.12" E, altitude 130 m, distance from the sea 60 km). The area is characterized by a mediterranean climate with mild winters and hot summers, with average winter temperature 6.2 ^{0}C, average summer temperature 24.9 ^{0}C and average annual precipitation 425 mm in 2018. Two trees by each olive variety and by each olive orchard were chosen, the olive fruits were picked from all the orientations and without type of disease, one kilogram with four replicates from each tree. These samples were stored at -18 ^{0}C and were further subjected to analyses. The basic characteristics of olive fruits are shown in Table 1.

Table 1

Basic characteristics of the olive fruits studied

Cultivars	Size	Maturation color	Use	Origin
Amfisis	Medium	Violet	Table olives	Greece
Chalkidikis	Big	Yellowish-green	Table olives	Greece
Kalamon	Small	Black	Table olives	Greece
Agrielia	Small	Black	Oil production	Greece
Lefkolia Serron	Medium	White-green	Dual use	Greece

Preparation of the ethanol extracts: For each treatment, 50 g flesh were subjected to freeze drying for further extraction and determination of humidity. The dry mass was crushed and stored in clean bottles in refrigeration (Boskou et al. 2006). 500 mg dry sample was extracted with 50 mL 80% aqueous ethanol for 24 h at 150 rpm, the ethanolic extracts washed two times with 25 mL n-hexane in order to eliminate the oil of the ethanolic extract (Rigane et al. 2011). The separation of the phases was performed with separating funnels. Subsequently the ethanolic extract was evaporated under nitrogen, and the residue was dissolved in 50 mL 80% aqueous ethanol, stored in clean bottles in refrigeration in the dark until its use.

Methods of analyses: Total phenolic content (TP) was determined with the Folin-Ciocalteu (F.-C.) reagent according to the method by (Singleton and Rossi 1965) and the results were expressed as gallic acid equivalent (GAE) in mg g^{-1} fresh weight (FW).

Nonflavonoid phenols (NFP) content was determined with the F.-C. reagent after removing the flavonoid phenols (FP) with formaldehyde according to the method by (Kramling and Singleton 1969) and was expressed as gallic acid equivalent (GAE) in mg g^{-1} FW. Flavonoid phenols (FP) were determined as a difference between the content of total phenols and nonflavonoid phenols. Their amount was evaluated as gallic acid equivalent in mg g^{-1} FW.

The antiradical activity (DPPH•) of the ethanol extracts was determined according to the method by (Brand-Williams et al. 1995) using the stable free radical 2,2′-diphenyl-1-picrylhydrazyl DPPH•. The activity was evaluated as Trolox equivalent (TEAC) in µmol g^{-1} FW.

Statistical analysis: Data were analyzed using the MINITAB (Ryan et al. 2005) statistical package. The experiment had four replications. Analysis of variance was used to assess treatment effects. Mean separation was made using Tukey's testwhen significant differences (P = 0.05) between treatments were found.

RESULTS AND DISCUSSIONS

Total phenolic (TP) content in the olive fruit cultivars grown in the olive orchard A at altitude 500 m ranges from 6.12 to 16.21 mg GAE g^{-1} FW (figure 1). The cultivar Kalamon are characterised by the highest TP content with 16.21 mg GAE g^{-1} FW, while the cultivar Amfisis are characterised by the lowest TP content with 6.12 mg GAE g^{-1} FW. TP content in the olive fruit cultivars of the olive orchard A has the following sequence: Kalamon > Chalkidikis, Agrielia > Lefkolia Serron > Amfisis. TP content for the same olive fruit cultivars grown in the olive orchard B at altitude 130 m ranges from 4.22 to 19.32 mg GAE g^{-1} FW (figure 1). The cultivar Kalamon are characterised by the highest TP content with 19.32 mg GAE g^{-1} FW, while the cultivar Amfisis are characterised by the lowest TP content with 4.22 mg GAE g^{-1} FW. TP content in the olive fruit cultivars of the olive orchard B has the following sequence: Kalamon > Chalkidikis, Lefkolia Serron > Agrielia > Amfisis.

In addition, olive cultivars Agrielia and Amfisis are characterized by a highest TP content in the olive orchard A (13.32 and 6.12 mg GAE g^{-1} FW, respectively) compared with olive orchard B (9.53 and 4.22 mg GAE g^{-1} FW, respectively). On the contrary, olive cultivars Kalamon and Lefkolia Serron are characterized by a highest TP content in the olive orchard B (19.32 and 13.78 mg GAE g^{-1} FW, respectively) compared with olive orchard A (16.21 and 10.11 mg GAE g^{-1} FW, respectively). Finally, olive cultivar Chalkidikis did not show significant differences on TP content in the olive orchard A compared with olive orchard B (figure 1).

Our results agree with the data obtained by other authors, who have established differences on total phenols content in different olive fruit cultivars (Boskou et al. 2006). Also, from some authors differences on TP content have established for the same cultivars grown in different locations and altitudes (Ziogas et al. 2010, Arslan & Özcan 2011).

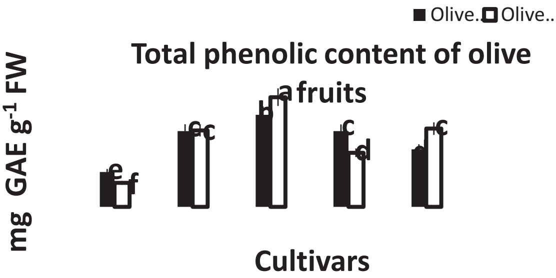

Figure 1. Effect of altitude on total phenolic content of olive fruits; Olive orchard A, altitude 500 m; Olive orchard B, altitude 130 m; Bar values with the same letter on the top are not significantly different according to Tukey's test (P = 0.05).

Flavonoid phenols (FP) content in the olive fruit cultivars grown in the olive orchard A at altitude 500 m ranges from 5.09 to 11.23 mg GAE g^{-1} FW (Table 2). The cultivar Kalamon are characterised by the highest FP content with 11.23 mg GAE g^{-1} FW, while the cultivar Amfisis are characterised by the lowest FP content with 5.09 mg GAE g^{-1} FW. FP content in the olive cultivars of the olive orchard A has the following sequence: Kalamon > Agrielia, Chalkidikis > Lefkolia Serron > Amfisis. The FP content represents from 69.3 to 83.2 % of the TP amount (Table 2). The flavonoid fraction is the major constituent of total phenols in the olive fruit varieties. FP content in the olive fruit cultivars grown in the olive orchard B at altitude 130 m ranges from 3.33 to 14.43 mg GAE g^{-1} FW (Table 2). The cultivar Kalamon are characterised by the highest FP content with 14.43 mg GAE g^{-1} FW, while the cultivar Amfisis are characterised by the lowest FP content with 3.33 mg GAE g^{-1} FW. FP content in the olive cultivars of the olive orchard B has the following sequence: Kalamon > Lefkolia Serron, Chalkidikis > Agrielia > Amfisis. The FP content represents from 69.4 to 78.9 % of the TP amount (Table 2).

Olive cultivars Agrielia and Amfisis are characterized by a highest FP content in the olive orchard A (10.12 and 5.09 mg GAE g^{-1} FW, respectively) compared with olive orchard B (6.61 and 3.33 mg GAE g^{-1} FW, respectively). Olive cultivars Kalamon and Lefkolia Serron are characterized by a highest FP content in the olive orchard B (14.43 and 10.83 mg GAE g^{-1} FW, respectively) compared with olive orchard A (11.23 and 7.22 mg GAE g^{-1} FW, respectively). Finally, olive cultivar Chalkidikis did not show significant differences on FP content in the olive orchard A compared with olive orchard B (Table 2).

Non-flavonoid phenols (NFP) content in the olive fruit cultivars grown in the olive orchard A ranges from 1.03 to 4.98 mg GAE g^{-1} FW. NFP content in the olive fruit cultivars grown in the olive orchard B ranges from 0.89 to 4.89 mg GAE g^{-1} FW. For both olive orchards, the cultivar Kalamon are characterised by the highest NFP content, while the cultivar Amfisis are characterised by the lowest NFP content (Table 2). Also, for the same varieties cultivated in the olive orchard A and B, the NFP content did not show significant differences.

The antioxidant activity DPPH in the olive fruit cultivars grown in the olive orchard A ranges from 112.11 to 216.89 μmol Trolox g^{-1} FW. The antioxidant activity DPPH in the olive fruit cultivars grown in the olive orchard B ranges from 85.78 to 252.40 μmol Trolox g^{-1} FW. For both olive orchards, the cultivar Kalamon exert the highest activity, while the variety Amfisis exert the lowest (figure 2). The olive cultivars

Agrielia, Chalkidikis and Amfisis exert the highest activity in the olive orchard A (175.68, 173.23 and 112.11 μmol Trolox g^{-1} FW, respectively) compared with olive orchard B (124.84, 144.57 and 85.78 μmol Trolox g^{-1} FW, respectively). On the contrary, the olive fruit cultivars Kalamon and Lefkolia Serron exert the highest activity in the olive orchard B (252.40 and 176.32 μmol Trolox g^{-1} FW, respectively) compared with olive orchard A (216.89 and 117.5 μmol Trolox g^{-1} FW, respectively) (figure 2). The correlation between of antiradical activity DPPH• and of TP content in the olive fruit varieties grown in the olive orchard A and olive orchard B it was high, with correlation coefficient (r^2) equal to: 0.89 and 0.92, respectively.

Table 2

FP and NFP content of the olive fruit cultivars studied

Cultivars	FP	NFP	FP % of TP amount
	mg GAE g^{-1} FW		
Olive orchards A (altitude 500 m)			
Amfisis	5.09 ± 0.29^{e}	1.03 ± 0.06^{d}	83.2
Chalkidikis	9.54 ± 0.52^{c}	4.11 ±0.24 ^{b}	69.9
Kalamon	11.23 ± 0.64^{b}	4.98 ± 0.27^{a}	69.3
Agrielia	10.12 ± 0.54^{bc}	3.20 ± 0.17^{c}	76.0
Lefkolia Serron	7.22 ± 0.41^{d}	2.89 ± 0.16^{c}	71.4
Olive orchards B (altitude 130 m)			
Amfisis	3.33 ± 0.18^{f}	0.89 ± 0.05^{d}	78.9
Chalkidikis	9.91 ± 0.54^{bc}	4.07 ± 0.24^{b}	70.9
Kalamon	14.43 ± 0.77^{a}	4.89 ± 0.25^{a}	74.7
Agrielia	6.61 ± 0.36^{d}	2.92 ±0.17^{c}	69.4
Lefkolia Serron	10.83 ± 0.59^{bc}	2.95 ± 0.17^{c}	78.6

For each chemical property, the values in the columns of the table with the same letter do not differ significantly according to the Tukey's test (P = 0.05), n = 4.

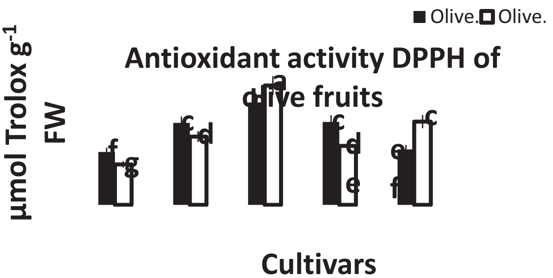

Figure 2. Effect of altitude on antioxidant activity DPPH of olive fruits; Olive orchard A, altitude 500 m; Olive orchard B, altitude 130 m; Bar values with the same letter on the top are not significantly different according to Tukey's test (P = 0.05).

CONCLUSIONS

The study on the olive fruits varieties studed shows that they are characterised by high total phenolic content and high antiradical activity. Total phenolic content and antiradical activity of olive fruits it depends strongly from the cultivar and altitude. The olive cultivars Agrielia and Amfisis are characterized by a highest TP content and antioxidant activity DPPH in the olive orchard of the higher altitude (500 m) compared with olive orchard of the lower altitude (130 m). On the contrary, the olive cultivars Kalamon and Lefkolia Serron are characterized by a highest TP content and antioxidant activity DPPH in the olive orchard of the lower altitude (130 m) compared with olive orchard of the higher altitude (500 m). Olive fruits studied are a source of bioactive components and could be included in functional foods composition.

REFERENCES

Arslan D., Özcan M. M. 2011. Phenolic profile and antioxidant activity of olive fruits of the Turkish variety “Sarıulak” from different locations. Grasas y aceites, 62(4), 453-461.

Boskou G., Salta F. N., Chrysostomou S., Mylona A., Chiou A., Andrikopoulos N. K. 2006. Antioxidant capacity and phenolic profile of table olives from the Greek market. Food Chemistry, 94(4), 558-564.

Brand-Williams W., Cuvelier M. E., Berset C. L. W. T. 1995. Use of a free radical method to evaluate antioxidant activity. LWT-Food science and Technology, 28(1), 25-30.

Bravo L. 1998. Polyphenols: chemistry, dietary sources, metabolism, and nutritional significance. Nutrition reviews, 56(11), 317-333.

Dağdelen A., Tümen G., Özcan M. M., Dündar E. 2013. Phenolics profiles of olive fruits (Olea europaea L.) and oils from Ayvalık, Domat and Gemlik varieties at different ripening stages. Food chemistry, 136(1), 41-45.

Kramling T. E., Singleton V. L. 1969. An estimate of the nonflavonoid phenols in wines. American Journal of Enology and Viticulture, 20(2), 86-92.

Panagiotakos D. B., Pitsavos C., Stefanadis C. 2006. Dietary patterns: A Mediterranean diet score and its relation to clinical and biological markers of cardiovascular disease risk. Nutrition, Metabolism and Cardiovascular Diseases, 16, 559–568.

Rigane G., Salem R. B., Sayadi S., Bouaziz M. 2011. Phenolic composition, isolation, and structure of a new deoxyloganic acid derivative from Dhokar and Gemri-Dhokar olive cultivars. Journal of food science, 76(7), C965-C973.

Ryan B. F., Joiner B. L., Cryer J. D. 2005. Minitab handbook: updated for release 14, 5* ed. Belmont: Thomson Brooks/Cole.

Singleton V. L., Rossi J. A. 1965. Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. American journal of Enology and Viticulture, 16(3), 144-158.

Trichopoulou A., Lagiou P. 1997. Healthy traditional Mediterranean diet: An expression of culture, history and lifestyle. Nutrition Reviews, 55, 383–389.

Valko M., Rhodes C., Moncol J., Izakovic M. M., Mazur M. 2006. Free radicals, metals and antioxidants in oxidative stress-induced cancer. Chemico-biological interactions, 160(1), 1-40.

Vinha A. F., Ferreres F., Silva B. M., Valentao P., Gonçalves A., Pereira J. A., Andrade P. B. 2005. Phenolic profiles of Portuguese olive fruits (Olea europaea L.): Influences of cultivar and geographical origin. Food chemistry, 89(4), 561-568.

Ziogas V., Tanou G., Molassiotis A., Diamantidis G., Vasilakakis M. 2010. Antioxidant and free radical-scavenging activities of phenolic extracts of olive fruits. Food chemistry, 120(4), 1097-1103.

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EVALUATION ON TOTAL PHENOLIC CONTENT AND ANTIOXIDANT ACTIVITY OF CHESTNUT FRUITS, SKINS AND LEAVES FROM CENTRAL GREECE

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***Keywords**: Antioxidant activity DPPH; chestnut; polyphenols*

ABSTRACT

In this study, total phenolic content, phenolic fractions and the antioxidant properties of chestnut (leaves, skins and fruits) from three different cultivars were evaluated. Total phenolic content in the chestnut leaves, skins and fruits from the samples studied ranges from 12.5 to 19.7, 52.8 to 70.5 and 2.59 to 3.28 mg GAE g^{-1} DW, respectively. Flavonoid phenols content in the chestnut leaves, skins and fruits ranges from 6.6 to 10.1, 37.5 to 49.4 and 1.57 to 1.97 mg GAE g^{-1} DW, respectively. Non-flavonoid phenols content in the chestnut leaves, skins and fruits ranges from 5.9 to 9.6, 15.3 to 21.1 and 1.02 to 1.31 mg GAE g^{-1} DW, respectively. DPPH activity in the chestnut leaves, skins and fruits ranges from 730.9 to 790.2, 4074.5 to 4190.3 and 157.9 to 197.4 µg Trolox g^{-1} DW, respectively. The chestnut skins for all cultivars revealed the best antioxidant properties, presenting much lower EC_{50} values. Furthermore, the highest TP, FP and NFP contents were found in the chestnut skins for all cultivars studied.

INTRODUCTION

Chestnut is an important plant, why its fruits are widely consumed throughout world because of their nutritional value (De Vasconcelos et al. 2010a). The chestnut fruits are used for manufacturing pastas and products confectionery (Kwon et al. 2004, Zivkovic et al. 2009, De Vasconcelos et al. 2010a). In addition, these are an important food source and for wildlife (Zivkovic et al. 2009). The specie Castanea sativa compared to other of Castanea species produces best quality fruits and has high consumption (Tan et al. 2006). The chestnut fruits contain important amounts of K and other macroelements, as well as and important amounts microelements such as Fe, Cu, Zn and Mn (Kwon et al. 2004, Zivkovic et al. 2009). Also, the chestnut fruits contain carotenoid compounds (such as beta-carotene, lutein and zeaxanthin), vitamin E and vitamin C, which exert high antioxidant activity (De Vasconcelos et al. 2010b). Significant amounts of phenolic compounds are contained in the chestnut fruits and leaves (Calliste et al. 2005, Hernández et al. 2012). According to Otles and Selek (2012) the processing of chestnut fruits affects their phenolic content. Specifically the total phenolic contents of roasted chestnuts is higher, compared with the corresponding of the boiled. The rapid production of free radicals can lead to oxidative damage of the cell membranes which cause the occurrence of many diseases (Bravo 1998). The oxidative destruction of biomolecules can be reduced with the endogen antioxidants produced during normal cell aerobic respiration against reactive oxygen species, and the exogenous antioxidants such as the carotenoids, polyphenols, etc., which are taken from the diet and are contained in the fruits and vegetables (Valko et al. 2006). The phenolic compounds contained in the chestnut fruits, contribute to improving human health, with their ability inhibit or delay the oxidation of free radicals (Barreira et al. 2008). The aim of the present research was to investigate the total phenolic content and antioxidant capacity of chestnut fruits, skins and leaves in three different cultivars from central Greece.

MATERIAL AND METHODS

Experimental: Three cultivars of chestnut trees are grown in the area of Ampelakia of the mount Kissavos, in central Greece (latitude 39°51′11″ N, longitude 22°33′20″ E, altitude 500 m). Namely, the Marron de Lyon cultivar (*Castanea sativa*), the Bournette CA 112 cultivar (*Castanea crenata* x *Castanea sativa*) and Piliou cultivar (*Castanea sativa*). The area is characterized by a mediterranean climate with cold winters and mild summers. The average temperature between 2014 and 2019 in the area was 12.6. Also, the average rainfall per year were 620 mm. The age of the chestnut trees ranged between 40 and 80 years. Five samples of chestnut fruits were collected from the 15th of September to the 30th of September 2018 by each cultivar at the maturation stage. The experiment had four replications. The leaves were hand picked from the 1th of September to the 15th of September 2019 at the end of vegetation where it is accepted that the active photosynthesis activity of the leaves is reduced. The shell and skin (endocarp) of chestnut fruits were removed, and the fruits were ground and homogenized. The dried samples of leaves and skin, were ground in grain-size diameter < 0.15 mm. The samples were stored at -18 ^{o}C and then were submitted in analysis.

Preparation of the ethanol extracts: Ten g finely ground chestnut fruits was extracted two times by 20ml of 80% aqueous ethanol at room temperature. More specifically, samples were incubated for 24h in the extractant at stirring, the extract was gathered after centrifugation/filtration in a volumetric flask. The pellet was re-treated with aqueous ethanol for 2h at stirring, the extract was gathered again after centrifugation/filtration in the same volumetric flask and the volume was made up to 50 ml with aqueous ethanol and used for chemical analyses (Kanner et al. 1994). Also, samples were taken to measure moisture. The same procedure was repeated with 0.500 g from fruit skin and leaves of chestnut trees.

Methods of analyses: Total phenolic content (TP) was determined with the Folin-Ciocalteu (F.-C.) reagent according to the method by (Singleton and Rossi 1965) and the results were expressed as gallic acid equivalent (GAE) in mg g^{-1} dry weight (DW). Nonflavonoid phenols (NFP) content was determined with the F.-C. reagent after removing the flavonoid phenols (FP) with formaldehyde according to the method by (Kramling and Singleton 1969) and was expressed as gallic acid equivalent (GAE) in mg g^{-1} DW. Flavonoid phenols (FP) were determined as a difference between the content of total phenols and nonflavonoid phenols. Their amount was evaluated as gallic acid equivalent in mg g^{-1} DW. The radical scavenging activities by antioxidants in the samples extracts were evaluated using the stable free radical 2,2′-diphenyl-1-pycrylhydrazyl radical (DPPH•), as a reagent, according to the method by (Brand-Williams et al. 1995) and the results were expressed as µg Trolox equivalent g^{-1} dry weight. The inhibition coefficient (IC_{50}), represents 50% reduction in the colour intensity of the DPPH radical by the total phenols in the studied extracts after plotting the dependence of the TP content on the bleaching of DPPH• solutions. The inhibition coefficient (IC_{50}) was calculated using the following equation:

$$\% \text{ inhibition} = [(E_0 - E_x)/E_0] \times 100$$

where E_0, is the extinction of the radical solution before the reaction and E_x, after polyphenols addition (Yen and Duh 1994), percent of extracts were used to determine of the inhibition coefficient (IC_{50}).

Statistical analysis: Data were analyzed using the MINITAB (Ryan et al. 2005) statistical package. The experiment had four replications. Analysis of variance was used to assess treatment effects. Mean separation was made using Tukey's testwhen significant differences (P = 0.05) between treatments were found.

RESULTS AND DISCUSSIONS

Total phenolic (TP) content in the chestnut leaves from the cultivars studied ranges from 12.5 to 19.7 mg GAE g^{-1} DW. The cultivar Marron de Lyon are characterised by the highest TP content, while the cultivar Piliou are characterised by the lowest TP content (figure 1). TP content in the chestnut skin from the samples studied ranges from 52.8 to 70.5 mg GAE g^{-1} DW. The cultivar Piliou are characterised by the highest TP content, while the cultivar Marron de Lyon are characterised by the lowest TP content. TP content in the chestnut fruits from the samples studied ranges from 2.59 to 3.28 mg GAE g^{-1} DW. The cultivar Piliou are characterised by the highest TP content, while the cultivar Marron de Lyon are characterised by the lowest TP content. Our results agree with the data obtained by other authors, who have established differences on total phenolic content between different varieties of chestnut fruit (Hernández et al. 2012). TP content in the leaves, skin and fruits of chestnut for all cultivars studied has the following sequence: skin > leaves > fruits.

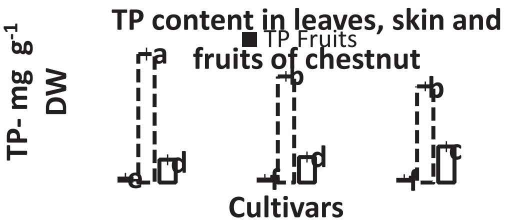

Figure 1. Total phenolic content in leaves, skin (endocarp) and fruits of chestnut; Bar values with the same letter on the top are not significantly different according to Tukey's test (P = 0.05).

Flavonoid phenols (FP) content in the chestnut leaves from the samples studied ranges from 6.6 to 10.1 mg GAE g^{-1} DW. The cultivar Marron de Lyon are characterised by the highest TP content, while the cultivar Piliou are characterised by the lowest TP content (figure 2). FP content in the chestnut skin ranges from 37.5 to 49.4 mg GAE g^{-1} DW. The cultivar Piliou are characterised by the highest FP content, while the cultivar Marron de Lyon are characterised by the lowest FP content. Also, FP content in the chestnut fruits ranges from 1.57 to 1.97 mgGAE g^{-1}

DW. The cultivar Piliou are characterised by the highest FP content, while the cultivar Marron de Lyon are characterised by the lowest TP content. FP content in the leaves, skin and fruits of chestnut for all cultivars studied has the following sequence: skin > leaves > fruits.

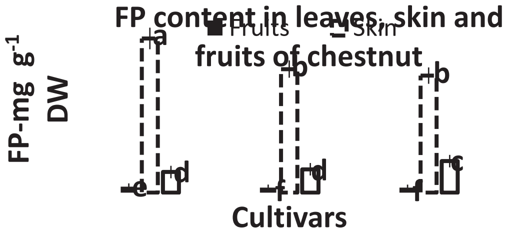

Figure 2. Flavonoid phenols content in leaves, skin (endocarp) and fruits of chestnut; Bar values with the same letter on the top are not significantly different according to Tukey's test (P = 0.05).

Non-flavonoid phenols (NFP) content in the chestnut leaves from the samples studied ranges from 5.9 to 9.6 mg GAE g^{-1} DW. The cultivar Marron de Lyon are characterised by the highest NFP content, while the cultivar Piliou are characterised by the lowest NFP content (figure 3). NFP content in the chestnut skin ranges from 15.3 to 21.1 mg GAE g^{-1} DW. The cultivar Piliou are characterised by the highest NFP content, while the cultivar Marron de Lyon are characterised by the lowest NFP content. In addition, the NFP content in the chestnut fruits ranges from 1.02 to 1.31 mg GAE g^{-1} DW. The cultivar Piliou are characterised by the highest NFP content, while the cultivar Marron de Lyon are characterised by the lowest NFP content. NFP content in the leaves, skin and fruits of chestnut for all cultivars studied has the following sequence: skin > leaves > fruits.

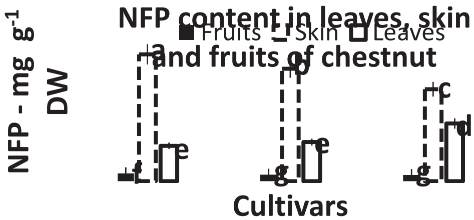

Figure 3. Non-flavonoid phenols content in leaves, skin (endocarp) and fruits of chestnut; Bar values with the same letter on the top are not significantly different according to Tukey's test (P = 0.05).

The antioxidant activity DPPH in the chestnut leaves from the samples studied ranges from 730.9 to 790.2 µg Trolox g^{-1} DW. The cultivar Piliou exert the highest activity, while the cultivar Bournette CA 112 exert the lowest (figure 4). DPPH activity in the chestnut skin ranges from 4074.5 to 4190.3 µg Trolox g^{-1} DW. The cultivar Piliou exert the highest activity, while the cultivar Bournette CA 112 exert the lowest. In addition, DPPH activity in the chestnut fruits ranges from 157.9 to 197.4 µg Trolox g^{-1} DW. Also, the cultivar Piliou exert the highest activity, while the cultivar Bournette CA 112 exert the lowest. Antioxidant activity DPPH in the leaves, skin and fruits of chestnut for all cultivars studied has the following sequence: skin > leaves > fruits. The IC_{50} values of radical scavenging activity in the leaves, skin and fruits extracts of chestnut for all cultivars studied are presented in Table 1. All cultivars studied in skin extract showed the highest activity. On the contrary, all fruit extracts they showed the lowest activity (Table 1).The lower inhibition concentration (IC_{50}) corresponds in the higher antioxidant capacity.

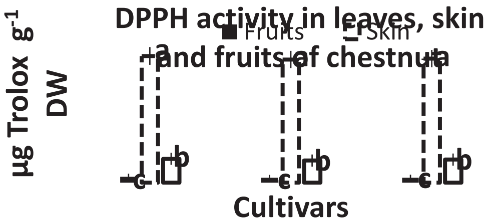

Figure 4. Antioxidant activity DPPH in leaves, skin (endocarp) and fruits of chestnut; Bar values with the same letter on the top are not significantly different according to Tukey's test (P = 0.05).

Table 1

Antioxidant capacity through IC_{50} values obtained (Inhibition concentration) for the chestnut extracts

Cultivars	**IC_{50} (µg ml^{-1})**		
	Leaves	Skin	Fruits
Piliou	190.2 ± 9.65^{a}	30.5 ± 1.77^{a}	>12000
Bournette CA 112	177.3 ± 9.23^{a}	33.3 ± 1.82^{a}	>12000
Marron de Lyon	171.8 ± 9.76^{a}	34.5 ± 1.80^{a}	>12000

The values in the columns of the table with the same letter do not differ significantly according to the Tukey's test (P = 0.05), n = 4.

CONCLUSIONS

The results obtained indicate the highest antioxidant activity values and the highest phenolic content in the chestnut skins for all cultivars studied. Chestnut skins, traditionally considered as byproducts, can be regarded as potential sources of bioactive phenol compounds for pharmaceutical purposes. Also, the consumption of chestnuts could be a contribution to the intake of antioxidant compounds such as of the polyphenols.

REFERENCES

Barreira J. C., Ferreira I. C., Oliveira M. B. P., Pereira J. A. 2008. Antioxidant activities of the extracts from chestnut flower, leaf, skins and fruit. Food chemistry, 107(3), 1106-1113.

Brand-Williams W., Cuvelier M. E., Berset C. L. W. T. 1995. Use of a free radical method to evaluate antioxidant activity. LWT-Food science and Technology, 28(1), 25-30.

Bravo L. 1998. Polyphenols: chemistry, dietary sources, metabolism, and nutritional significance. Nutrition reviews, 56 (11), 317-333.

Calliste C.A., Trouillas P., Allais D.P., Duroux J.L. 2005. Castanea sativa Mill. leaves as new sources of natural antioxidant: An electronic spin resonance study. Journal of Agriculture and Food Chemistry, 53, 282–288.

De Vasconcelos M.C.B.M., Bennett R.N., Rosa E.A.S., Ferreira-Cardoso J.V. 2010a. Composition of European chestnut (*Castanea sativa* Mill.) and association with health effects: fresh and processed products. Journal of Science Food Agriculture, 90, 1578-1589.

De Vasconcelos M.C.B.M., Nunes F., Viguera C.G., Bennett R.N., Rosa A.S., Ferreira-Cardoso J.V. 2010b. Industrial processing effects on chestnut fruits (Castanea sativa Mill.) 3. Minerals, free sugars, carotenoids and antioxidant vitamins. International Journal of Food Science and Technology, 45, 496–505.

Hernández S.M., Rodríguez G.B., Ríos M.D., Díaz R.C., Rodríguez R.E. 2012. Sugars, organic acids and total phenols in varieties of chestnut fruits from Tenerife (Spain). Food and Nutrition Sciences, 3 (6), 1-11.

Kanner J., Frankel E., Granit R., German B., Kinsella J. E. 1994. Natural antioxidants in grapes and wines. Journal of Agricultural and Food Chemistry, 42(1), 64-69.

Kramling T. E., Singleton V. L. 1969. An estimate of the nonflavonoid phenols in wines. American Journal of Enology and Viticulture, 20(2), 86-92.

Kwon J., Kwon Y., Byun M., Kim K. 2004. Competitiveness of gamma irradiation with fumigation for chestnuts associated with quarantine and quality security. Radiation Physics and Chemistry, 71, 41–44.

Otles S., Selek I. 2012. Effect of processing on the phenolic content and antioxidant activity of chestnuts. Quality Assurance and Safety of Crops & Foods, 4(5), e3-e11.

Ryan B. F., Joiner B. L., Cryer J. D. 2005. Minitab handbook: updated for release 14, 5* ed. Belmont: Thomson Brooks/Cole.

Singleton V. L., Rossi J. A. 1965. Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. American journal of Enology and Viticulture, 16(3), 144-158.

Tan Z., Wu M., Wang Q., Wang C. 2006. Effect of calcium chloride on chestnut. Journal of Food Processing and Preservation, 31, 298–307.

Valko M., Rhodes C., Moncol J., Izakovic M. M., Mazur M. 2006. Free radicals, metals and antioxidants in oxidative stress-induced cancer. Chemico-biological interactions, 160(1), 1-40.

Yen G. C., Duh P. D. 1994. Scavenging effect of methanolic extracts of peanut hulls on free-radical and active-oxygen species. Journal of Agricultural and Food Chemistry, 42(3), 629-632.

Zivkovic J., Mujic I., Zekovic Z., Vidovic S., Mujic A., Jokic S. 2009. Radical scavenging, antimicrobial activity and phenolic content of Castanea sativa extracts. Journal Central European Agriculture, 10, 175–182.

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THE INFLUENCE OF GERBA 4LG ON BRANCHING OF ONE-YEAR-OLD APPLE NURSERY TREES

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Key words: Apple, topping, spray, lateral shoots, growth regulator.

ABSTRACT

The object of the research was apple varieties Golden Delicious Reinders, Red Velox, Gala Buckeye and Red Jonaprince, grafted on M 9. The grafting method was chip budding. Planting distance was 80x35 cm. Planting of rootstocks was carried out in the spring of 2015. To determine the influence of the variety and of different intervention techniques on the degree of emission of the anticipated shoots were used: 1. Free eyelid growth (control); 2. Topping of apical leaves was combined with two treatments with Gerba 4LG at a dose of 25 ml/liter of water. It was established that the most reasonable garnishing of the crown formation with anticipated shoots at all studied varieties was obtained by topping the apical leaves in the apex area once when the graft reaches 65-70 cm height combined with twice the sprinkling Gerba 4LG at 25 ml/liter of water. The first treatment was done after breaking the apical leaves and the next at 5-7 days.

INTRODUCTION

The main characteristics of a modern apple plantation are: the implementation of state-of-the-art varieties and high-performance rootstocks, the use of branched planting material with high biological values, which, along with advanced technologies, ensure early entry of fruit trees and a high, constant productivity of qualitative fruits (Babuc et al. 2013, Cimpoieş 2012). If it is planned to form the crown from shoots anticipated on apple trees in the second field of the nursery, a decisive role is played by the hereditary ability of varieties to issue such shoots (Basak & Sozcek 1986, Peşteanu & Bostan 2019a). Topping of apical leaves and the spraying, in the nursery, of the apex of the trees during the vegetation period with various growth regulators increases the emission of the anticipated shoots and the differentiation of the fruit buds since the second field of the tree school of the fruit nurseries. These branches allow increasing the productivity from the first years after planting the trees in the orchard (Gastol et al. 2012, Hrotkó et al. 1996). The products used to form lateral shoots in the crown apple trees in many countries are: Promalin, Paturyl 10 WSC, Arbolin 36 SL, Arbolin Extra, Gerba 4LG etc. (Caglar & Ilgin 2009, Gastol et al. 2012, Peşteanu & Bostan 2019b, Wertheim & Estabrooks 1994). The aim of this study was to evaluate the behavior of four new apple varieties on the emission of the anticipated shoots at the base of the crown in trees in field II of the nursery, in the base of topping apical leaves in combination with spraying with Gerba 4LG growth regulator.

MATERIAL AND METHODS

The planting of rootstocks M 9 in the fruit nursery field I was carried out in the spring of 2015, in open wells with the help of the hydraulic drill. The grafting method used in field I of the nursery was chip budding. Planting distance - 80x35 cm. In order to determine the influence of the variety and of different intervention techniques on the degree of emission of the anticipated shoots, was organized an experience with the following gradation of factors:

Factor A - variety: A_1 - Golden Delicious Reinders (control); A_2 - Red Velox; A_3 - Gala Buckeye; A_4 - Red Jonaprince.

Factor V - the technique of crown formation in field II of the tree nursery: V_1 - free eyelid growth (control); V_2 - by topping the apical leaves in the apex area once when the oculus is 65-70 cm high, combined with the application of two treatments with the Gerba 4LG growth regulator (4.0% BA) at a dose of 25 ml/liter of water, per the upper part of the plant. The first application was made immediately after the topping of the apical leaves, and the second - at an interval of 5-7 days.

The research was carried out according to recommended methods for conducting field experiments in the orchard nursery. Each variant of the experiments included 4 repetitions of 20 plants. The main results obtained were statistically processed by the method of dispersive analysis.

RESULTS AND DISCUSSIONS

The smallest diameter in the rootstock area was recorded for the Red Velox variety - 14.4 mm, while for the Golden Reinders, Gala Buckeye and Red Jonaprince varieties the index in question was higher and ranged from 16.0 mm to 16.6 mm (tab. 1).

In the case of crown formation by breaking the apical leaves and treating the area with the Gerba 4LG growth regulator at a dose of 25 ml/liter of water, the given index increased by 5.4-15.9%. Higher values were recorded at the Golden Reinders (18.6 mm) and Gala Buckeye (18.0 mm) evenings.

Studying the development of the trunk diameter below the first branch of the crown, we notice that, in the control variant, higher values were registered for the Golden Reinders variety - 14.7 mm, then, decreasing, the Gala Buckeye varieties were placed - 13,1 mm and Red Jonaprince - 12.6 mm. The Red Velox variety did not form early branches in the control variant.

Interventions performed on the apex also influenced the subsequent development of apple trees. The highest values of the average diameter below the first branch of the crown were recorded in the version where the apical leaves were topping and the Gerba 4LG growth regulator was applied at a dose of 25 ml/liter of water - from 13.1 mm to 17.0 mm. In the given variant, lower values of the index under study were registered for the Red Velox variety - 13.1 mm, and higher for the Golden Reinders variety - 17.0 mm. Gala Buckeye and Red Jonaprince varieties recorded average values of 15.7 mm and 15.0 mm, respectively.

Table 1

The diameter in different areas of the tree according to the biological peculiarities of the variety and the method of crown formation, mm

Crown type	In the rootstock area	Under the crown	Above the last branch of the crown
Golden Reinders variety (c)			
V_1(c)	16.2	14.7	12.6

V_2	18.6	17.0	10.8
Red Velox variety			
V_1(c)	14.4	-	-
V_2	16.7	13.1	9.1
Gala Buckeye variety			
V_1(c)	16.0	13.1	11.8
V_2	18.0	15.7	10.9
Red Jonaprince variety			
V_1(c)	16.6	12.6	11.4
V_2	17.5	15.0	8.7

Lower values of the index under study on various areas of the tree were recorded in the case of intervention above the last branch of the crown, the results being in direct correlation with the biological characteristics of the variety. Lower values were recorded for the Red Jonaprince variety 8.7 - 11.4 mm, for the Gala Buckeye variety 10.9-11.8 mm, and for the Golden Reinders - 10.8-12.9 mm.

For the Red Velox variety, in the control variant, no measurements were made on the diameter of the shaft because no anticipated shoots were formed in this case. Higher values of the diameter of the central axis above the crowning area were recorded in the variant with topping the apical leaves and the treatment with the Gerba 4LG growth regulator was applied. The difference between the lower and upper diameter of the crown area was 6.2 mm for the Golden Reinders variety, 4.8 mm for the Gala Buckeye variety, 6.3 mm for the Red Jonaprince variety and 4.0 mm for the Red Velox variety.

The data obtained regarding the height of the trees show that the index in question is influenced by the biological peculiarities of the variety. In the control variant, lower values of tree height were recorded for the Red Velox variety - 149 cm. Next, in growth, there is the Golden Reinders variety - 169 cm, the Red Jonaprince variety - 172 cm and the Gala Buckeye variety - 184 cm (tab. 2).

Apart from the biological peculiarities of the variety, the height of the trees also depends on the way of intervening on their formation. In all the varieties studied, the highest height of the trees was recorded in the control variant, where it varied from 149 cm to 184 cm.

In variant V_2, where the apical leaves were broken plus the treatment with the growth regulator Gerba 4LG in a dose of 25 ml/liter of water, there was a decrease of the index in the study by 10.4-22.6% compared to the control variant. A larger difference was found in the Gala Buckeye variety, which is characterized by a higher growth force.

In all the varieties that formed lateral branches in the control variant (Golden Reinders, Gala Buckeye, Red Jonaprince), the height of the trunk in the nursery did not undergo essential changes and varied from 58 to 59 cm. In the version with topping of the apical leaves plus the treatment with the Gerba 4LG growth regulator in a dose of 25 ml/liter of water, the first branches at the bottom for the Golden Reinders, Red Velox and Gala Buckeye varieties start at a height of 55 cm, and for the Red Jonaprince variety - from 60 cm.

Table 2

The crown structure by height according to the method used for its formation, cm

Crown type	The tree height	The trunck height	The length of the crown formation area	The length of the arrow
Golden Reinders variety (c)				
V_1(c)	169	59	6	104
V_2	150	55	26	69
LDS 0,05	6.9	2.6	0.43	2.8
Red Velox variety				
V_1(c)	149	-	-	149
V_2	135	55	13	67
LDS 0,05	5.7	-	-	3.1
Gala Buckeye variety				
V_1(c)	184	58	10	116
V_2	150	55	29	75
LDS 0,05	7.2	2.7	0.46	3.7
Red Jonaprince variety				
V_1(c)	172	59	13	100
V_2	151	60	37	54
LDS 0,05	6.5	2.9	0.56	2.9

An obvious legitimacy on the influence of the method of crown formation was registered within the length of the crown formation area. Lower values of this area were observed in the control variant, where the index under study in the varieties Golden Reinders, Gala Buckeye and Red Jonaprince was 6-13 cm. These values depended directly on the degree of emission of the anticipated shoots of the studied varieties.

In the case of the variant with the breaking of the apical leaves plus the treatment with the Gerba 4LG growth regulator in a dose of 25 ml/liter of water, the studied index increased significantly, constituting 13 cm for the Red Velox variety, 26 cm for the Golden Reinders variety, 29 cm for the Gala Buckeye variety and 37 cm for the Red Jonaprince variety.

The longest arrow length was recorded in the control variant. Higher values of this index were obtained for the Red Velox variety - 149 cm and for the Gala Buckeye variety - 116 cm. For the Red Jonaprince and Golden Reinders varieties, the given index was 100 cm and 104 cm, respectively.

The lowest values for the arrow length were recorded in the second variant, where topping the apical leaves and treated with the Gerba 4LG growth regulator. Here, the given index was 54 cm for the Red Jonaprince variety, 67 cm for the Red Velox variety, 69 cm for the Golden Reinders variety and 76 cm for the Gala Buckeye variety.

Like in the case of the other indices studied, the number of anticipated branches and their average and total length depend on the biological peculiarities of the variety and on the method of crown formation. In the control variant, no side shoots were obtained in the Red Velox variety in the crowning area (tab. 3). In the case of the second variant, the number of branches in the area of crown formation was 5.0 pcs/tree.

Table 3

The number of anticipated branches, their average and total length within the crown of apple trees in field II of the nursery according to the method of crown formation

Crown type	The number of anticipated branches, pcs/tree	The length of anticipated branches	
		Average, cm	Total , cm/tree
Golden Reinders variety (c)			
V_1(c)	1.8	56.0	101
V_2	8.0	46.9	375
LDS 0,05	0.28	2.6	12.4
Red Velox variety			
V_1(c)	-	-	-
V_2	5.0	52.4	262
LDS 0,05	-	-	-
Gala Buckeye variety			
V_1(c)	2.8	45.1	126
V_2	10.0	42.5	425
LDS 0,05	0.34	2.1	13.7
Red Jonaprince variety			
V_1(c)	3.3	49.4	153
V_2	12.0	45.3	544
LDS 0,05	0.45	2.6	17.9

In the trees of the Golden Reinders variety, the number of branches obtained was increasing compared to the Red Velox variety, constituting, on the variants under study, 1.8-8.0 pcs/tree. A smaller number of anticipated branches of this variety were recorded in the control variant, where no intervention was performed with the occultant - 1.8 pcs/tree. When the graft was topping the apical leaves and spraying the area with the Gerba 4LG growth regulator, the number of anticipated branches in the tree crown formation area increased to 8.0 pcs/tree.

In the Gala Buckeye and Red Jonaprince varieties, the number of anticipated branches obtained in the crown formation area increased compared to the previous varieties and amounted to 2.8-10.0 and 3.3-12.0 pcs/tree, respectively. A higher number of anticipated branches for the given varieties were registered in the second variant - 10-12 pcs/tree.

A shorter average length of the anticipated branches was obtained for the Gala Buckeye variety (42.5-45.1 cm). Next, the Red Jonaprince variety (44.0-49.4 cm), the Red Velox variety (52.4 cm) and the Golden Reinders variety (46.9-56.0 cm) are growing.

Higher values of the average length of annual branches were recorded in the control variant (45.1-56.0 cm), where the number of anticipated branches was lower. In the variant which the topping of apical leaves and the treatment with the Gerba 4LG growth regulator, a decrease of the index in the study was registered by 5.8-6.5%.

In the Red Velox variety, no lateral branches were formed in the control variant. For trees of the Golden Reinders variety, the total length of the anticipated annual branches was 101 cm, for those of the Gala Buckeye variety - 126 cm, and for trees of the Red Jonaprince variety - 164 cm.

The picking of apical leaves plus treatment with Gerba 4LG growth regulator at a dose of 25 ml/liter of water increased the total length of annual branches from 262 cm to 544 cm per tree, depending on the variety.

CONCLUSIONS

A more favorable balance between the growth indexes of the trees and the way the crown base is formed in field II of the nursery was registered in the variant where the apical leaves were topping only once and the Gerba 4LG growth regulator was applied.

For a more uniform garnish in the area of crown formation, it is recommended to break the apical leaves in combination with the double application of the product Gerba 4LG with a dose of 25 ml/liter of water. The first treatment was done after topping the apical leaves and the next at 5-7 days.

REFERENCES

Babuc V., Peşteanu A., Gudumac E. 2013. Producerea materialului săditor de măr. Chişinău, 138 pp.

Cimpoieş Gh. 2012. Cultura mărului. Chișinău. 380 pp.

Basak A., Sozcek Z. 1986. The influence of promalin on branching of one-year-old apple nursery trees. Acta Hort. 179, 279-280.

Caglar S., Ilgin M. 2009. The effects of benzyladenine applications on branching of Mondial Gala apple nursery trees on MM106 in the first year growth. KSU J Nat Sci, 12(1), 66-70.

Gastol M. et al. 2012. The effect of different bioregulators on lateral shoot formation in maiden apple tree. Folia Hort 24/2, 147-152.

Hrotkó K., Magyar L. et al. 1996. Improved feathering on one-year-old 'Idared' apple trees in the nursery. Horticult Science, 28, 29-34.

Peşteanu A., Bostan M. 2019a. Perfecționarea unor elemente tehnologice la producerea materialului săditor pentru fondarea livezilor moderne de măr. Ştiinţa Agricolă 1, 52-59.

Pesteanu A., Bostan M. 2019b. The effect of bioregulator Gerba 4LG trearment on lateral shoot formation in maiden apple tree. Lucrări ştiinţifice USAMV Iaşi, Horticultură, 62 (1), 101-106.

Wertheim S.J., Estabrooks E.N. 1994. Effect of repeated sprays of 6-benzyladenine on the formation of sylleptic shoots in apple in the fruit-tree nursery. Sci Hort, 60(1-2), 31-39.

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BIOLOGICAL AND SEROLOGICAL TECHNIQUES FOR VIRAL EVALUATION OF APPLE MOTHER PLANTS

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Keywords: *viruses, phytoplasma, ELISA, biological test*

ABSTRACT

The objective is to test apple material selected for Prebase Candidate category according to the new legislation, for cvs: Romus 3, Generos, Aura and Frumos de Voinești. Viral evaluation was performed by two methods: biological and serological DAS-ELISA, according to EPPO recommendations. Biological field testing was made on the Lord Lambourne indicator to distinguish Ruberry wood, Flat limb, Chat fruit, Bumpy fruit of Ben Davis and ApMV, on the Golden delicious indicator for Green crinkle, Russet ring, Russet wart, Star crack, Rough skin, Horseshoe wound, and ApP, on the Starkrimson indicator for Apple scar schin and Apple dimple fruit viruses and on Malus platycarpa and R12740 7 A indicators for ACLSV; Virginia Crab indicator for ASPV, ASGV. The serological test was used to identify viruses: ACLSV, ApMV, ASGV, ASPV and ApP phytoplasma. Samples infected with ACLSV virus on the Generos cv. were identified by biological method and confirmed by DAS-ELISA.

INTRODUCTION

The demand of apple trees planting for orchards is very high lately for fresh consumption and processing as well. In order to reduce the economic losses caused by viral pathogens, the use of planting material certified according to the legislative rules for all fruit species is one of the main prophylactic measures. To increase the quality of propagating material, the European Protection Organization Plants (EPPO) has established standards, including viral testing methods ([PM 4/27 (1), 1999], OEPP/ EPPO,1999). The importance of producing and maintaining mother plants has led to the establishment of official institutions in some European countries like: CAV (Italy), INRA-CTIFL (France), NAKB (Netherlands). In Romania Research Institute for Fruit Growing Pitesti (RIFG Pitesti), as public institution, has the main responsabilities for maintenance of fruit propagation plants for fruit species. For apple, although the literature mentions over 40 viral pathogens (Nemeth, 1986), economically important viral diseases are *Apple chlorotic leaf spot virus (ACLSV), Apple mosaic virus (ApMV), Apple stem-grooving virus (ASGV), Apple stem-pitting virus (ASPV) (*Mink, 1989; Desvignes, 1999) to which is added the phytoplasma *Apple proliferation (ApP)* according to HG 563/2007.

The paper describes the use of biological test and serological one (test) for identification of viral pathogens mentioned in the new legislation in order to select mother plants Prebase – Candidate.

MATERIAL AND METHODS

The study was carried out in 2014-2020 at RIFG Pitești and the apple cvs. were Romus 3, Generos, Aura and Frumos de Voinești. The indicators used: Golden delicious, Lord Lambourne, Virginia Crab, *Malus platycarpa*, R12740 7A and Starkrimson. Biological test took account of the recommendations of the International Working Group on Fruit Tree Viruses, (Jelkmann, 2001). Grafting was made in the field using double oculation on MM 106 rootstock. The next year the shoot from the variety bud that was indexed under the indicator bud was eliminated, the evaluations being made in the years of observations, according with recommended diagrams, as follows:

- Golden Delicious (3/-/3c), for identify: *Green crinkle, Russet ring, Russet wart, Star crack, Horseshoe wound, Rough skin, ApP;*
- Lord Lambourne: (5/-/3y), for identify: *Ruberry wood*, *Flat limb;* (5/-/3c)- for *Chat fruit* and B*umpy fruit of Ben Davis;* (5/-/2y), for identify: *ApMV;*
- Starkrimson (3/-/3c), for identify: *Apple scar schin* și *Apple dimple fruit;*
- *Malus platycarpa* (3/-/2y), for identify: *ACLSV;*
- R12740 7 A (3/-/2y), for identify: *ACLSV;*
- Virginia Crab (3/-/3y), for identify: *ASPV, ASGV.*

In addition the scheme included: 2 repetitions combination indexing variety/ M106, 2 repetitions combination indexing biological indicator / MM106 (negative control). Serological test for viruses: *ACLSV, ApMV, ASGV, ASPV* and *ApP* phytoplasma, was performed by DAS-ELISA method (Clark and Adams, 1977), in accordance with the protocol recommended by the kit manufacturer. The test samples was performed in spring, in order to avoid high temperatures that would lead to a decrease in viral concentration.

RESULTS AND DISCUSSIONS

Biological test. The observations, after indexing on biological indicators, on the field established in 2014 (table 1), did not register symptoms that could be associated with viral diseases of Aura, Frumos de Voinești and Romus 3. On the indicator *Malus platycarpa*, at the repetitions where the indexing was done with the Generos / R7 P4 variety, it was found the appearance of some symptoms that consisted of malformations in the young leaves (figure 1).

Table 1

Visual evaluation of the test field established in 2014

No	Cultivar/ tree position	Biological indicators	Negative (-), positive (+) repetitions	Symptoms
1	Aura / R6 P13	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		Malus platycarpa	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
2	Aura / R6 P14	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		Malus platycarpa	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
3	Generos / R7 P3	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-

		Virginia Crab	(-),(-),(-)	-
		Malus platycarpa	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
4	Generos / R7 P4	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		Malus platycarpa	(+),(+),(+)	malformation of young leaves
		Starkrimson	(-),(-),(-)	-
5	Romus 3 / R7 P47	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		Malus platycarpa	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
6	Romus 3/ R7 P48	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		Malus platycarpa	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
7	Frumos de Voinești / R7 P63	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		Malus platycarpa	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
8	Frumos de Voinești / R7 P65	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		Malus platycarpa	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-

Figure 1. Symptoms induced by Generos cv. infected with *ACLSV* in *Malus platycarpa*

In the field of biological test established in 2017, during the visual inspections, did not observ symptoms of viral diseases (table 2). Serological test**.** The selected plants for biological test in 2014 were passed through serological test (table 3): Aura / R6 P13, Aura / R6 P14, Generos / R7 P3, Romus 3 / R7 P47, Romus 3 / R7 P48, Frumos de Voinești / R7 P63, Frumos de Voinești / R7 P65 and did not proved positive samples.

Table 2

Visual evaluation of the test field established in 2017

No	Cultivar/tree position	Biological indicators	Negative (-), positive (+) repetitions	Symptoms
1	Aura / R6 P13	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
2	Aura/ R6 P14	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
3	Aura/ R6 P15	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
4	Generos / R7 P1	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
5	Generos / R7 P2	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
6	Generos / R7 P3	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
7	Romus 3 / R7 P47	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
8	Romus 3/ R7 P48	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
9	Romus 3/ R7 P49	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
10	Frumos de Voinești / R7 P62	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-

No	Cultivar/tree position	Biological indicators	Negative (-), positive (+) repetitions	Symptoms
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
11	Frumos de Voinești / R7 P64	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-
13	Frumos de Voinești / R7 P65	Lord Lambourne	(-),(-),(-),(-),(-)	-
		Golden delicious	(-),(-),(-)	-
		Virginia Crab	(-),(-),(-)	-
		R12740 7 A	(-),(-),(-)	-
		Starkrimson	(-),(-),(-)	-

For Generos cv /R7P4 the absorbance value was 0.588 nm, at a cut-off value of 0.538 which indicates high concentration of the virus, compared to the negative control represented by the combination *Malus platycarpa* / MM106 wich recorded negative values , respectively 0.256nm, 0.256 and 0.263 nm, 0.261 nm. DAS-ELISA reconfirmed the biological test by stating that the symptoms presented on the *Malus platycarpa*-Generos / R7 P4-r1, *Malus platycarpa*-Generos / R7 P4-r2, *Malus platycarpa*-Generos / R7 P4-r3 were produced by *ACLSV* virus, recording an absorbance value of 0.711nm, 0.740 nm; 0.872 nm, 0.784 nm; 0.784 nm, 0.727 nm at a cut-off value = 0.553 (arithmetic mean of the negative control x 2.5, according to the reading program from the reading progamm from Microplate Reader) (figure 2). Also, the control (Generos / R7 P4 / MM 106) recorded high absorbance values at both repetitions, respectively 0.524 nm and 0.542 nm, at a cut-off value of 0.538 nm.

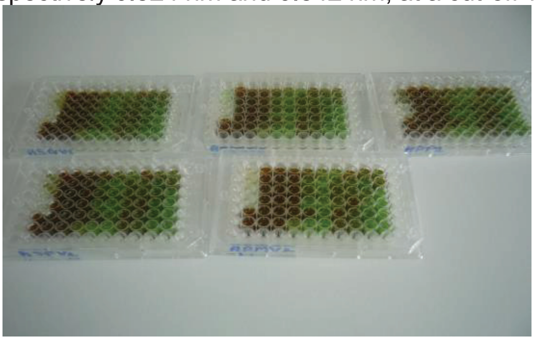

Fig. 2- NuncMaxiSorp *ELISA Plates* with antigen

Serological tests of plants selected in 2017: Aura-R6P13, Aura-R6P14, Aura-R6 P15, Generos-R7 P1 Generos-R7 P2 Generos-R7 P3, Romus 3-R7 P47, Romus 3-R7 P48, Romus 3-R7 P49 and Frumos de Voinești-R7 P62, Frumos de Voinești-R7 P64 and Frumos de Voinești-R7 P65, did not register positive values compared to the cut off 0.556 nm, the highest value identified being 0.254 nm and compared to the cut-off 0.589 nm, the highest value being 0.267 nm (table 4).

Table 3

Serological evaluation of plants selected from biological testing 2014

No	Sample	Virusuri									
		ACLSV		*ApMV*		*ASPV*		*ASGV*		*ApP*	
		Abs. value	*Cut-off*	*Abs. value*	*Cut-off*	*Abs. value*	*Cut-off*	*Abs. value*	*Cut-off*	*Abs. value*	*Cut-off*
1	Aura /R6 P13	0.304	**0.538**	0.308	***0.583***	0.300	**0.630**	0.296	**0.602**	0.316	**0.595**
2	Aura/ R6 P14	0.280		0,258		0.298		0.294		0.259	
3	Generos /R7 P3	0.258		0.256		0.303		0.290		0.282	
5	Romus 3 /R7 P47	0.335		0.251		0.309		0.299		0.294	
6	Romus 3/ R7 P48	0.342		0.259		0.307		0.297		0.293	
7	Frumos de Voinești /R7 P63	0.362		0.265		0.313		0.306		0.291	
8	Frumos de Voinești /R7 P65	0.368		0.266		0.286		0.309		0.264	
9	Generos /R7 P4	**0.588**		0.253		0.302		0.299		0.284	
10	Generos /R7 P4/MM 106-r1	**0.524**		0.270		0.301		0.272		0.264	
11	Generos /R7 P4/MM 106-r2	**0.542**		0.251		0.283		0.259		0.272	
12	*M.platycarpa*/MM 106 -r1	0.256; 0.256	**0.553**	0.268		0.294		0.265		0.266	
13	*M. platycarpa*/MM 106 –r2	0.263; 0.261		0.252		0.291		0.263		0.260	
14	*M. platycarpa*-Generos /R7 P4-r1	**0.711; 0.740**		0.240		0.291		0.268		0.265	
15	*M. platycarpa*-Generos /R7 P4-r2	**0.872; 0.784**		0.240		0.300		0.278		0.269	
16	M. platycarpa-Generos /R7 P4-r3	**0.784; 0.727**		0.248		3.316		0.283		0.283	

* The absorbance value and the cut-off value are measured in nanometers (nm).

Table 4

Serological evaluation of plants selected from biological testing 2017

No	Proba	Virusuri									
		ACLSV		*ApMV*		*ASPV*		*ASGV*		*ApP*	
		Abs. value	*Cut-off*	*Abs. value*	*Cut-off*	*Abs. value*	*Cut-off*	*Abs. value*	*Cut-off*	*Abs. value*	*Cut-off*
1	Aura /R6 P13	0.254	**0.556**	0.271	**0.583**	0.252	**0.560**	0.250	**0.561**	0.231	**0.590**
2	Aura/ R6 P14	0.240		0.288		0.260		0.245		0.234	
3	Aura/ R6 P15	0.245		0.267		0.249		0.242		0.242	
4	Generos /R7 P1	0.254		0.275		0.262		0.277		0.270	
5	Generos /R7 P2	0.239		0.215		0.246		0.243		0.210	
6	Generos /R7 P3	0.245		0.213		0.232		0.242		0.212	
7	Romus 3 /R7 P47	0.239	**0.589**	0.234		0.248		0.239		0.249	
8	Romus 3/ R7 P48	0.239		0.224		0.259		0.249		0.246	
9	Romus 3/ R7 P49	0,230		0.234		0.262		0.239		0.238	
10	Frumos de Voinești /R7 P62	0.248		0.227		0.265		0.251		0.254	
11	Frumos de Voinești /R7 P64	0.267		0.248		0.254		0.167		0.264	
12	Frumos de Voinești /R7 P65	0.250		0.235		0.248		0.263		0.258	

Figure 3. Results DAS-ELISA test

CONCLUSIONS

ELISA test indicates a higher viral concentration of Generos-*M. platycarpa*/MM 106 repeats, compared to the Generos/MM 106 repeats and the selected Generos R7 P4 plant, due to the increased sensitivity of the *M. platycarpa* indicator to the *ACLSV* virus;

The plants selected from the apple cvs. Aura, Generos, Romus 3 and Frumos de Voinești with negative samples to the biological and serological tests will be promoted as Candidate.

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REFERENCES

Clark M.F., Adams A.N. 1977. Characteristics of the micro plate method of enzyme-linked immunosorbent assay for the detection of plant viruses. J Gen Virol 34, 475-483.

Desvignes J.C. 1999. Virus diseases of fruit trees. Ctifl, Paris, 86-122.

Jelkmann W. 2001. International working group on fruit tree viruses. Acta Hortic, 550, 473-493.

Mink G.I. 1989. *Apple chlorotic leaf spot*. In: Virus and Viruslike Diseases of Pome Fruits and Simulating Noninfectious Disorders. (Ed. P.R. Fridlund), Cooperative Extension College of Agriculture and Home Economics Washington State University. Pullman, W.A., pp. 34-39.

Nemeth M. 1986. Virus, mycoplasma and ricketsia diseases of fruit trees. Kluwer Academic Publishers, Boston.

***OEPP. 1999. PM 4/27(1). Certification schemes pathogen-tested material of *Malus, Pyrus* and *Cydonia.*

***OEPP/ EPPO. 1999. Pathogen-tested material of *Malus, Pyrus* and *Cydonia* Bulletin O€PP/€PPO, Bulletin 29, 239-252.

***http://madr.ro/docs/fitosanitar/legislatie-nationala/HG-563-2007-versiune-consolidată.

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COMPARATIVE QUANTITATIVE ANALYSIS OF SOME CLASSES OF BIOACTIVE COMPOUNDS IN SIX GREEN TEA TYPES AVAILABLE ON THE ROMANIAN MARKET

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***Keywords**: green tea, carotenoids, flavonoids, phenolic compounds, essential oils*

ABSTRACT

Six green tea types, Bancha, Biluochun, Gaoji Longjiang, Gunpowder, Gunpowder “Temple of Heaven” and an organic Sencha variety were tested for chlorophyll, carotenoid, flavonoid, total phenolic and polyphenolic compounds and essential oil contents. Sencha had the highest chlorophyll content (1,387 mg/kg) and Gaoji Longjiang, the highest carotenoid concentration (312 mg/kg). Total phenolic content ranged highest in Gaoji Longjiang (56,205-49,382 mg/kg GAE), while flavonoids, specifically, reached the highest levels in Bancha (5,370 mg/kg). Total essential oils showed minor variations, with a 1,800 mg/kg maximum (Bancha).

INTRODUCTION

Tea is one of the most popular alimentary commodities sold worldwide. With over 5 million tonnes produced and consumed yearly by billions of people, tea is the second most popular drink after bottled water (FAO 2015). Tea is also used for cold drinks, desserts and various types of foods. The raw materials for tea production are the dried leaves of *Camellia sinensis* (L.) Kuntze (Fam. Theaceae). Depending on the processing method, and plant variety, there are numerous tea types. The main distinction is due to fermentation (oxidation), between white, yellow, green (minimally oxidized), black (fully oxidized) and Oolong (intermediary). Furthermore, teas can be flavoured with various dry fruits and aromatic plant mixtures. Green tea is one of the most popular types of tea, especially in Far Eastern countries, but also in Europe and America. Oxidation is kept at a minimal rate by steaming or heating the leaves after harvesting. Leaves can be used in their original, dry form, or as “gunpowder” pellets (Kamunya et al. 2019). Tea is known for a high content of bioactive compounds. Chlorophylls (a and b, in green algae and land plants) are the main photosynthetic pigments. They have anti-inflammatory properties and help wound healing. Studies show that they limit the alimentary uptake of some known carcinogens and inhibit calcium oxalate dihydrate accumulation (the precursor of kidney stones). Furthermore, together with carotenoids, they are important antioxidants, helping prevent oxidative stress-associated diseases (cancer, cardiovascular affections; Inanç 2011). Carotenoids (such as carotenes, lutein, lycopene and zeaxanthin) are accessory photosynthetic pigments found in all plants (mostly in leaves and reproductory organs: flowers, fruits). They are essential for the biosynthesis of retinol and melanin, key compounds for human eye and skin health. They are also known to be effective antioxidants and antiproliferative chemicals (Eldahshan & Singab 2013). Phenolic compounds are a wide variety of chemicals, functioning as plant pigments or as antimicrobials and antifungals. They include flavonoids, tannins and phenolic agents (Kivrak & Kivrak 2014). For human diet and health, they are important as the main class of antioxidant compounds, radical scavengers, lipid oxidation inhibitors and reducing agents (Zymonė et al. 2018). Flavonoids are some of the most valuable phenolic compounds (low-mass polyphenols), with antioxidant, antibacterial, antifungal, antiviral, anti-inflammatory and antiproliferative properties (Kivrak & Kivrak 2014). Volatile essential oils are aromatic mixtures of polyphenols (monoterpenes, sesquiterpenes, flavonoids), hydrocarbons and derivatives, alcohols, esters, aliphatic aldehydes etc., with over 90% being volatile. Besides giving the specific flavour to vegetable foods and beverages, they are antioxidant and antibacterial (Orphanides et al. 2011).

The objective of this paper was to comparatively assess the content of the above-mentioned compound classes in some green tea sortiments available to Romanian consumers.

MATERIAL AND METHODS

Six green tea types were acquired from local commerce.

Biluochun ("Green Snail Spring") is one of the most popular Chinese teas, brewed from plants grown in the Dongtiang mountains and other areas of the Jiangsu Province.

Gaoji Longjiang Lvcha ("Top Grade Dragon's Well Green Tea") consists of early-roasted (minimally-oxidized) leaves harvested from the Hangzhou region (Zhejiang Province).

Zhu Cha (*Gunpowder*) is originary from Zhejiang Province, and its leaves are steamed, rolled into small pellets and then dried. It is known to be rich in fluorides.

Gunpowder "Temple of Heaven" is a fine-quality Gunpowder tea, derived from the finest leaves and buds and rolled into very fine pellets.

Sencha is the most popular Japanese tea, consisting of entire leaves, steamed in an early phase of oxidation. An organic Sencha sortiment was analyzed in this paper.

Bancha is another Japanese tea, made from mature plants, collected during the second harvesting season (summer-autumn; after the harvesting season for *sencha*; Lachman et al. 2003, China Highlights 2020, It's More Than Tea 2020).

Chlorophylls and carotenoids were determined by acetone (80%) extraction, filtering and spectrophotometric absorption reading (S106 WPA spectrophotometer) at 663, 647, 470 nm (Popoviciu et al. 2019). Compound concentrations were derived using according to Lichtenthaler & Buschmann (2001).

Flavonoids were determined by water:methanol (4:8) extraction and spectrophotometric absorption reading at 340 nm wavelength (Szabo et al. 2012, Popoviciu et al. 2019).

The concentration of total phenolic compounds was assessed with a spectrophotometric version of the Folin-Ciocâlteu method was employed. Leaf tissue was extracted with methanol and reacted with Folin-Ciocâlteu reagent (10%) and sodium bicarbonate (7.5%) for 30 minutes. Absorbance was read at 765 nm. For the calibration curve, standard gallic acid concentrations were used (Stanković 2011, Siddiqui et al. 2017, Popoviciu 2019). Essential oils were determined gravimetrically.

Ground tea leaves were extracted with petroleum ether (25 g solvent per 5 g tissue). Extracts were evaporated at 35°C and the residue weighed (Orphanides et al. 2011). Triplicate samples were employed for each analysis.

RESULTS AND DISCUSSIONS

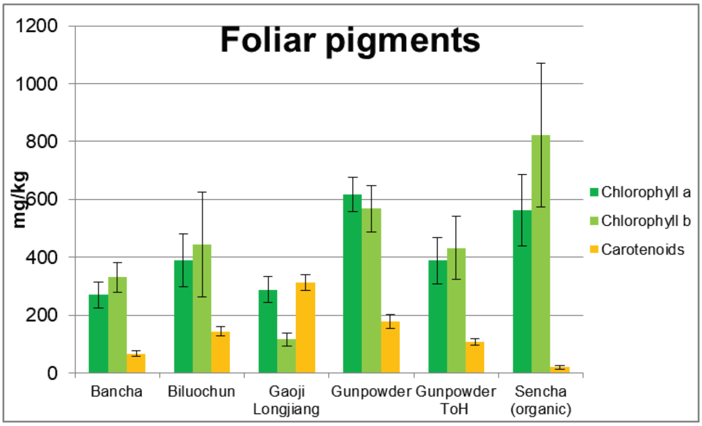

Figure 1. Concentrations of chlorophylls a and b and total carotenoid pigments in selected green tea types (average values; mg/kg).

Among the six sortiments, organic Sencha and Gunpowder had the highest chlorophyll concentrations, with a total of 1,387 and, respectively, 1,185 mg/kg (Fig. 1), values similar to those obtained by Ošťádalová et al. (2014): 1,240-1,980 and 1,460 mg/kg. Chlorophyll b was the dominant pigment, except for Gaoji Longjiang and Gunpowder. Gunpowder “Temple of Heaven” had lower pigment concentrations than plain Gunpowder.

While chlorophylls are considered indicators of tea quality, they are known to sustain major decreases due to prolonged storage (after 2-5 months, depending on sortiment (Ošťádalová et al. 2014).

Carotenoids varied between 19.55 (Sencha)-177.03 (Gunpowder) mg/kg. While this aspect is less studied, a research conducted on 31 Chinese tea cultivars found 324.80-528.80 mg/kg total carotenoids. However, the study involved freshly-harvested leaves (Wei et al. 2016).

Flavonoids varied between 2,627-5,370 mg/kg, with Bancha having the highest values (Fig. 2). There was a difference between Gunpowder and Gunpowder “Temple of Heaven”, with a higher concentration in the latter.

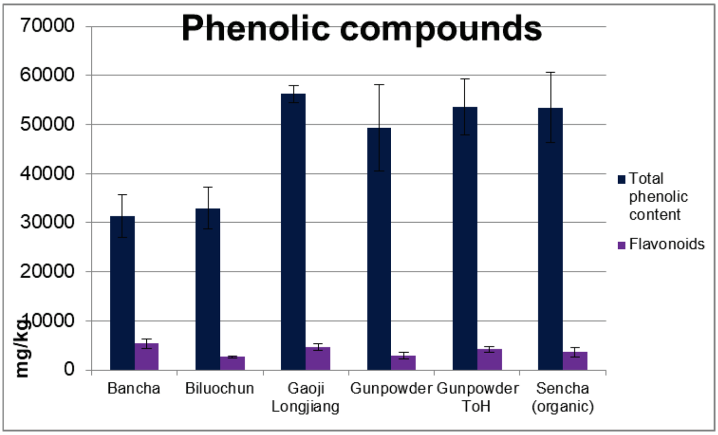

Figure 2. Concentrations of total phenolic and polyphenolic compounds and of flavonoids in selected green tea types (average values; mg/kg).

However, most phenolic constituents were non-flavonoids. Total phenolics ranged from 31,390 (Bancha) to 56,205 mg/kg gallic acid equivalent (Gaoji Longjiang). Both Gunpowder types and Sencha also had high phenolic contents.

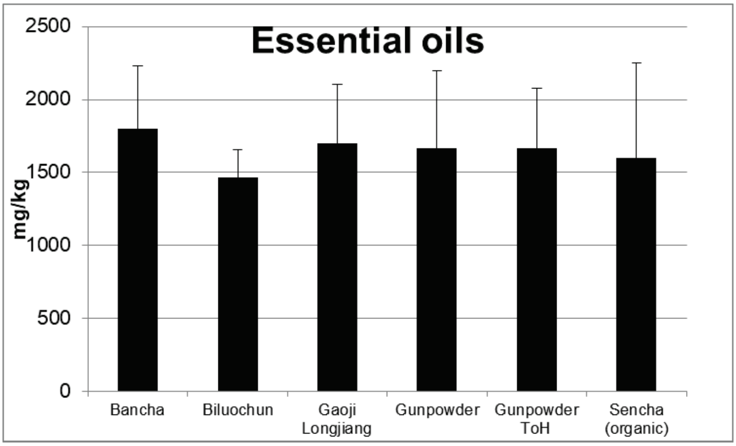

Figure 3. Concentrations volatile essential oils in selected green tea types (average values; mg/kg).

Green teas are known to contain highly variable total phenolic contents (TPC), ranging from below 19,000 mg/kg (Unachukwu et al. 2010) to over 100,000 mg/kg (Lachman et al. 2003). The main factors influencing the resulting phenolic content are leaf age (with young leaves usually having significantly higher values; Chan et al. 2007) and extraction time, which also operates during normal tea brewing. While, in theory, TPC in green teas can surpass 100,000 mg/kg, available phenolics that can be extracted after normal 3-5 minutes brewing range between 30,000-70,000 mg/kg, with Biluochun, Gunpowder and Bancha among the known high-yield sortiments (Lachman et al. 2003).

However, while total phenolics can range up to 30% of tea leaf dry weight, only 3-30% of them are, usually, flavonoids (Blumberg et al. 2015). Volatile oils concentrations ranged from 1,467 mg/kg (Biluochun) to 1,800 mg/kg (Bancha; Fig. 3). Essential oils in tea leaf tissues derive from oxidation reactions of carotenoids, lipids, terpene derivatives and glycosides. Their content is highly variable and depends on selected cultivar, fermentation degree, storage (Zheng et al. 2016). A study on black tea types, for instance, found 900-6,300 mg/kg total concentrations (Rehman et al. 2008).

CONCLUSIONS

Among the six green tea types, Sencha (1,387 mg/kg) and Gunpowder (1,185 mg/kg) had the highest average concentrations of chlorophylls, while Gaoji Longjiang (312 mg/kg) and Gunpowder (177 mg/kg) had the highest amounts of carotenoids.

Total phenolic compounds had their highest concentrations in Gaoji Longjiang, Gunpowder, Gunpowder "Temple of Heaven" and organic Sencha (56,205-49,382 mg/kg GAE), while flavonoids, specifically, reached the highest levels in Bancha (5,370 mg/kg), followed by the above-mentioned four types.

Total essential oils showed minor variations among tea types.

In conclusion, both Gunpowder varieties, followed by Gaoji Longjiang and Sencha had the maximum amounts of all classes of bioactive compounds. Further research is needed in order to predict their behavior under different storage conditions and periods.

REFERENCES

Blumberg J.B., Bolling B.W., Chen C.Y.O., Xiao H. 2015. Review and perspective on the composition and safety of green tea extracts. European J Nutr Food Saf, 5(1), 1-31.

Chan E.W.C., Lim Y.Y., Chew Y.L. 2007. Antioxidant activity of Camellia sinensis leaves and tea from a lowland plantation in Malaysia. Food Chem, 102, 1214-1222.

Eldahshan O.A., Singab A.N.B. 2013. Carotenoids. J. Pharmacogn. Phytochem, 2(1), 225-234.

Food and Agriculture Organization of the United Nations. 2015. World tea production and trade. Current and future development. FAO, Rome, 17 pp.

Inanç A.L. 2011. Chlorophyll: structural properties, health benefits and its occurrence in virgin olive oils. Akademik Gıda, 9(2), 26-32.

Kamunya S., Ochanda S., Cheramgoi E., Chalo R., Sitienei K., Muku O., Kirui W., Bore J.K.. 2019. Tea (*Camellia sinensis* (L.) O. Kuntze) Production and Utilization in Kenya. Tea Growers Guide 2019. Kenya Agricultural & Livestock Research Organization, Nairobi, 51 pp.

Kivrak I., Kivrak S. 2014. Antioxidant properties, phenolic profile and nutritional value for *Sorbus umbellata* fruits from Turkey. Austin J Nutr Food Sc., 2(8), 1043-1048.

Lachman J., Orsák M., Pivec V., Dudjak J., Krym O. 2003. Polyphenol content in green, black and oolong tea (*Camellia sinensis* /L./ Kuntze) infusions in different times of tea maceration. Sci Agric Bohem, 34(1), 22-28.

Lichtenthaler H.K., Buschmann C. 2001. Chlorophylls and carotenoids: Measurement and characterization by UV-VIS spectroscopy. In Wrolstad R.E. (ed.), Current Protocols in Food Analytical Chemistry, John Wiley & Sons Inc., Hoboken, F4.3: 1-8.

Orphanides A., Goulas V., Chrysostomou M., Gekas V. 2011. Recovery of essential oils from carobs through various extraction methods. In Mastorakis N., Mladenov V., Lepădătescu B., Karimi H.R., Helmis C.G. (eds.), Recent Advances in Environment, Energy Systems and Naval Science, WSEAS Press, Athens, 219-224.

Ošťádalová M., Tremlová B., Pokorná J., Král M. 2014. Chlorophyll as an indicator of green tea quality. Acta Vet Brno, 83, doi: 10.2754/avb201483S10S103.

Popoviciu D.R., Negreanu-Pîrjol T., Bercu R. 2019. Carotenoids, flavonoids and total phenolic compounds concentration in fruits of milkflower cotoneaster (*Cotoneaster lacteus* W.W.Sm.). Ann Univ Craiova, 24(60), 476-481.

Rehman S., Bhatti H.N., Iqbal Z., Rashid U. 2008. Essential oil composition of commercial black tea (*Camellia sinensis*). Int J Food Sci Technol, 43, 346-350.

Siddiqui N., Rauf A., Latif A., Mahmood Z. 2017. Spectrophotometric determination of the total phenolic content, spectral and fluorescence study of the herbal Unani drug Gul-e-Zoofa (*Nepeta bracteata* Benth). J Taibah Univ Med Sci, 12(4), 360-363.

Stanković M.S. 2011. Total phenolic content, flavonoid concentration and antioxidant activity of *Marrubium peregrinum* L. extracts. Kragujevac J Sci, 33, 63-72.

Szabo I., Vonhaz G., Fodor A., Bungău S., Țiț D.M. 2012. The quantitative analysis through spectrophotometry of flavonoids and polyphenols from vegetable products Hibisci trioni herba, radix and fructus. Analele Univ Oradea, Fasc Protecția Mediului, 18, 73-80.

Unachukwu U.J., Ahmed S., Kavalier A., Lyles J.T., Kennelly E.J. 2010. White and green teas (*Camellia sinensis* var. *sinensis*): variation in phenolic, methylxanthine, and antioxidant profiles. J Food Sci, 75(6), doi: 10.1111/j.1750-3841.2010.01705.x.

Wei X., Hou Y.J., Ye Y.L., Zhang Q.Y., Zheng H.W., Liang G.L., Tong H.R. 2016. Determination of carotenoid contents in 31 elite Chinese tea [*Camellia sinensis* (L.) O. Kuntze] cultivars. Academia Journal of Agricultural Research, 4(8), 525-533.

Zheng X.Q., Li Q.S., Xiang L.P., Liang Y.R. 2016. Recent Advances in Volatiles of Teas. Molecules, 21(3), doi: 10.3390/molecules21030338.

Zymonė K., Raudonė L., Raudonis R., Marksa M., Ivanauskas L., Janulis V. 2018. Phytochemical profiling of fruit powders of twenty *Sorbus* L. cultivars. Molecules, 23, 2593-2609.

***2020. 8 types green tea you should not miss. China Highlights, https://www.chinahighlights.com/travelguide/chinese-tea/green-tea.htm.

***2020. New to tea? Start here (Part 2: white and green tea). It's More Than Tea. Jill's Tea Blog, https://itsmorethantea.wordpress.com/2020/07/14/new-to-tea-start-here-part-2-white-and-green-tea/.

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RESEARCH ON THE CONTENT OF ESSENTIAL OILS, FLAVONOIDS, PHENOLIC AND POLYPHENOLIC COMPOUNDS IN PARSLEY (*PETROSELINUM CRISPUM* MILL.)

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Keywords: *parlsley, essential oils, polyphenolic and phenolic compounds, flavonoids*

ABSTRACT

This paper presents researches regarding the content of essential oils, flavonoids, polyphenolic and phenolic compounds in leaf parsley from an organic culture and the methods of extraction used for determinations. The obtained results highlight the medicinal properties of parsley, both the alimentary and economic importance, as a vegetable aromatic plant used for human consumption worlwide.

INTRODUCTION

Parsley (*Petroselinum crispum* Mill*., Apiaceae* family) is a herbaceuos vegetable plant with a tall stem, grown for its white tap roots and for the aromatic leaves, used in alimentation and popular medicine. Parsley is part of the group of aromatic and spicy vegetable plants (Ciofu et al. 2004). Parsley is usualy consumed fresh, also in different recipes and for canned food. It is used in particular at different cooked dishes, vegan salads and added in different sauces. It occupies the most important place in Romania among the aromatic plants, followed by lovage, dill, basil, thyme, coriander and oregano. Reaserches shown that parsley has four times more vitamin C than an orange, more proteins than two eggs and more iron than spinach (Ciofu et al. 2004). The essential oils and extracts have antioxidant, anti-inflammatory, calcium channel-blocking (in the intestine and uterus muscle), cancer preventive, laxative, and diuretic properties. Due to its essential oil content, parsley has great insect repellent potential and is always a good companion plant, repelling insects from nearby plants (https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/petroselinum-crispum).

MATERIAL AND METHODS

Material. For this research we used parsley leaves from an organic culture, variety Plaine Leaved 2.

Methods.The determination of the essential oil was carried out by solvent extraction (petroleum ether), the concentration of flavonoids was highlighted by the spectrophotometric method at a wavelength of 340 nm and for the amount of polyphenols and phenolic compounds in the plant material was determined the spectrophotometric absorbance at 765 nm (Stanković et al. 2011)

RESULTS AND DISCUSSIONS

Determinations of essential oil quantity, flavonoids, phenolic and polyphenolic compounds

1. Method of determining the quantity of essential oil in vegetable matter

Essential oils are aromatic substances, which are widely used in the perfume industry, the pharmaceutical industry and in the field of human nutrition. The common methods used so far are mainly based on solvent extraction and steam distillation.

We used 5 grams of chopped parsley for each of the 3 samples. The chopped vegetable material was placed in glass bottles, then we added 25 ml petroleum ether and the 3 bottles were vigorously stirred for 1 h. The extract was poured into pre-weighed glass crystallizers, then allowed to evaporate at 35 °C, for about 4 hours. The crystallizers were weighed again, determining the mass of the residue of essential oils (Szabo et al. 2012).

Figure 1. The quantity of green mass for essential oils extract

2. Method of determining the concentration of flavonoids in vegetable material

Flavonoids are plant compounds that color plants in vivid and intense shades (blue, purple or emerald green), they are found in leaves, flowers, roots and especially in fruits. Also, the yellow, red and orange pigments that are not due to the presence of carotenoids, are also part of the flavonoid family. (https://doc.ro/health/all-about-bioflavonoids-benefits).

In order to determine the concentration of flavonoids, we used 1 gram fresh and crushed vegetable material in a grinding mortar, then added 5 ml of methanol and sand granules for a more efficient grinding. After this process the extract was filtered. For the next step we used 0.5 ml of the resulting extract which was diluted in 4 ml of water and 8 ml of methanol and mix vigorously.

The absorbance of the resulting sample is measured spectrophotometrically at a wavelength of 340 nm, with a mixture of water and methanol at ratio 8:17.

The concentration of flavonoids in the sample is estimaded according to the formula:

$$F\ (mg/mL) = (A340-0,22)/4,71$$

Where:

F = flavonoid concentration in extract ;

A340 = absorbance at 340 nm

Subsequently, the concentration of flavonoids is reported per unit mass. (Szabo et al. 2012).

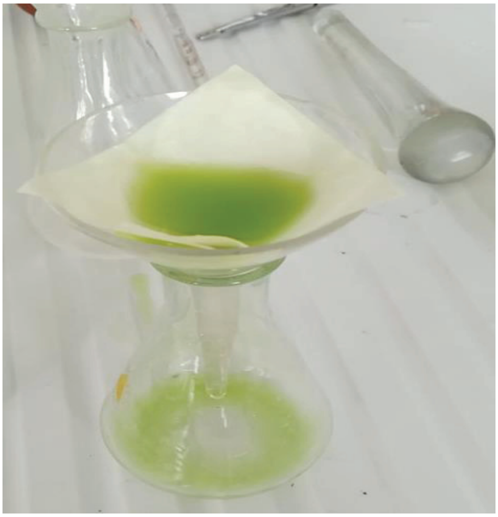

Figure 2. Filtering of the extract to determine the concentration in flavonoids

Method for the determination of the quantity of phenolic compounds and polyphenols in plant material

Polyphenols are some of the most numerous and important substances that have their origin in the plants. Along with vitamins C, E and A, are considered compounds that give fruits and vegetables all those properties well known to be beneficial to the human body. Phenolic compounds are aromatic substances, which contain one or more hydroxyl groups, linked to the carbon atoms of the aromatic nucleus. These substances are used as active principles of herbal medicinal remedies, are used in technology as natural dyes for textiles, in the preparation of ink, leather tanning, etc. This group of natural compounds are vegetable pigments, tannins, lignins, that require a complex investigation about their physiological functions in the plant.

In this method we used 1 gram of parsley leaves which were triturated in 10 ml of methanol. To 1 ml of methanolic extract was added 5 ml of Folin-Ciocâlteu reagent which was diluted 10 times and 4 ml of sodium bicarbonate (NaHCO375 g/l). It was allowed to react for 30 minutes after which the spectrophotometric absorbance was determined at 765 nm (WPA S106 spectrophotometer).

Calibration of the method was performed by applying the method to solutions with known concentrations of gallic acid (Szabo et al., 2012)

The calibration curve obtained was:

Y (conc. mg/L) = 11,4740537 + 281,1523463X (Abs.)

The correlation coefficient is: 0,9999491173

Figure 3. The extraction of polyphenolic compounds

To determine the amount of dry matter it was used 10 grams of green plant material that was introduced in an oven for 24 hours at a temperature of 105 °C, the result was a quantity of 1.36 grams dry weight.

Table 1

The quantity of flavonoids, phenolic and polyphenolic compounds and essential oils in parsley dry weight mass

Indicative sample	Dry weight (%)	Flavonoids (mg/kg)	Phenolic and polyphenolic compounds (mg/kg)	Essential oils (mg/kg)
Dry parsley	13.6	41565.19	65494.19	10294.11
Dry parsley	13.6	42931.19	59085.57	2941.17
Dry parsley	13.6	37662.36	65287.46	5882.35
Average		40719.58	63289.08	6372.54

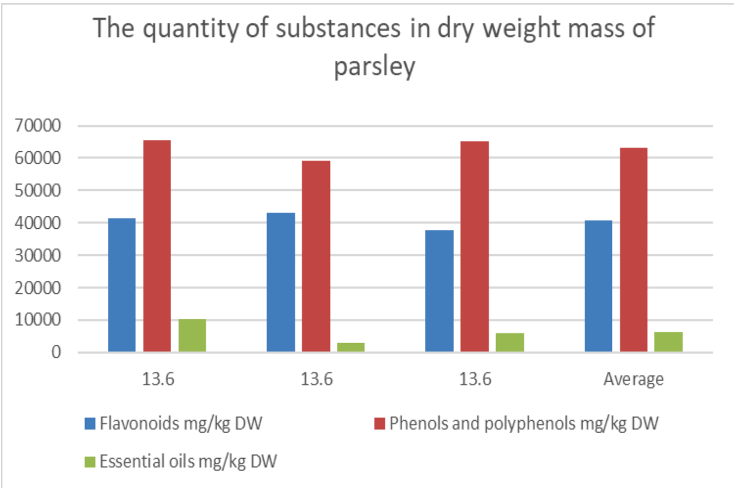

Figure 4. The quantity of flavonoids, phenolic and polyphenolic compounds and essential oils in parsley dry weight mass

Table 2

The quantity of flavonoids, phenolic and polyphenolic compounds and essential oils in parsley green weight mass

Indicative sample	Green mass (g)	Substances	Values (mg/kg)			Average
Fresh parsley	1	Flavonoids	5652.87	5838.64	5122.08	5537.86
Fresh parsley	1	Phenols and polyphenols	8907.21	8035.64	8879.09	8607.31
Fresh parsley	5	Essential oils	1400	400	800	8666,67

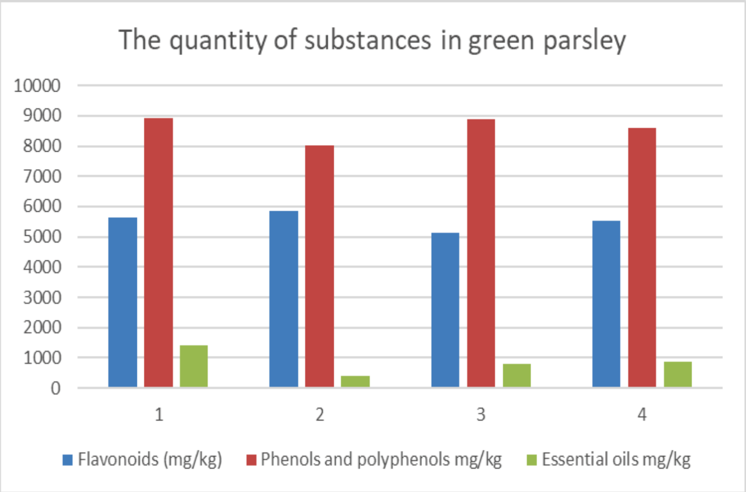

Figure 4. The quantity of flavonoids, phenolic and polyphenolic compounds and essential oils in parsley dry weight mass

CONCLUSIONS

Parsley (*Petroselinum crispum* Mill.) occupies the most important place in Romania among the aromatic plants, followed by lovage, dill, basil, thyme, coriander and oregano. The leaves contain vitamin C (200 mg %), vitamin A, B, folic acid, apiol, essential oils. This vegetable aromatic plant can be taken into consideration for cultivating in Romania, being consumed both fresh and added to different recipes. From parsley are consumed the white tap roots and the leaves.

Following the determinations and observations, it results that the parsley vegetable plant is economically important, due to the amount of green mass that is harvested, due to the great amount of essential oils, flavonoids, polyphenolic and phenolic compounds, which we could use in the pharmaceutical and cosmetics industry or in the canning industry and various preparations.

REFERENCES

Ciofu R., Stan N., Popescu V., Chilom P., Apahidean S., Horgoș A., Berar V., Lauer K.F., Atanasiu N. 2004. Tratat de Legumicultură. Edit. Ceres, București, pp. 961

Stanković, M.S., Niciforović, N.,Topuzović, M., Solujić, S. 2011. Total phenolic content, flavonoid concentrations and antioxidant activity, of the whole plant and plant parts extracts from *Teucrium montanum* L.var. *montanum*, f. *supinum* (L.) Reichenb., Biotechnol.&Biotechnol. Eq.,DOI: 10.5504/bbeq.2011.0020.

Szabo I., Vonhaz, G., Fodor A., Bungău S., Țiț D.M. 2012. The quantitative analysis through spectrophotometry of flavonoids and polyphenols from vegetable products Hibiscitrioniherba, radix and fructus. Analele Universității din Oradea, Fascicula Protecția Mediului, 18, 73-80

***https://www.sciencedirect.com/topics/agricultural-and-biological sciences/petroselinum-crispum.

***https://doc.ro/health/all-about-bioflavonoids-benefits.

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COMPARATIVE STUDIES ON THE ACCUMULATION OF SOME METABOLITES AT *THYMUS VULGARIS* PLANTS MULTIPLIED BY *IN VITRO* CULTURE AND BY CONVENTIONAL METHODS

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Keywords: *chlorophylls, carotenoids, carbohydrates, polyphenols, thyme*

ABSTRACT

The aim of this study was to carry out comparative studies concerning accumulation of primary and secondary metabolites at Thymus vulgaris plants obtained by "in vitro" culture and by conventional methods. Although biochemical investigations revealed some differences between the plants regenerated by the two culture technologies in terms of bioproductivity characteristics, we consider that both multiplication methods can be successfully used to obtain thyme plant material, a potential source of bioactive compounds.

INTRODUCTION

The use of medicinal and aromatic plants is increasing worldwide. Herbs belonging to the *Lamiaceae* family are rich in phytochemicals (Shan et al. 2005). *Thymus* is one of the most important genera of the *Lamiaceae* family and includes more than 400 perennial species of aromatic and medicinal shrubs or subshrubs. It is native to the Mediterranean region (Sáez 2001, Morales 2002). *Thymus vulgaris* (thyme) is an important medicinal plant, the dried leaves and flowering tops being used as flavouring agents for food and beverages, and as sources of essential oil for the pharmaceutical and cosmetic industries. The essential oils extracted from the plant, commonly known as thyme oils, have a wide range of therapeutic applications and properties including antirheumatic, antiseptic, antibacterial, carminative, diuretic and expectorant effects (Deans & Ritchie 1987, Tabak et al. 1996, Cosentino et al. 1999, Grigore et al. 2010, Mirzaei-Aghsaghali et al. 2012, Nikolič et al. 2014).

Considering the medicinal importance of this species, the researches conducted in this work were oriented in the direction of quantitative evaluation of some primary and secondary metabolites at *Thymus vulgaris* plants obtained by *in vitro* culture and by conventional methods.

MATERIAL AND METHODS

The biological material from *Thymus vulgaris* species has been multiplied *in vitro* and by conventional methods.

The plants regenerated by the two methods constituted two comparative lots: the lot with biological material obtained by micropropagation (V1) and the lot with biological material obtained by conventional techniques (V2).

For biochemical determinations was sampled the plant material from *herba*. The option for analysis of plant material from *herba* started from the presence of phytocomplex that characterizes it for a series of active principles that give the possibility of a comparative study of the obtained material (conventional cultures and plants regenerated *in vitro*).

The concentration of chlorophyllous and carotenoids pigments in thyme plants was spectrophotometrically evaluated in extracts with acetone 85 % (Holm, 1954).

The dosage of soluble carbohydrates and total polyphenols was performed in extracts obtained using a MAS-II microwave synthesis and extraction system (Hanon Instruments, Shanghai, China). The fresh plant material was triturated by gradually adding the extraction solvent (ethanol 70%, v/v). The plant material:solvent ratio was 1:10 (m/v). The microwave extraction was performed at 40°C for 10 min. The microwave power was controlled and maintained at 250W and magnetic stirring at 200 rpm. The plant extracts were then filtered. Dosing of soluble carbohydrates from the plant material was performed by the colorimetric method, with anthrone reagent (Pánczél & Eifert 1960).

Total phenolic content was determined by using the Folin-Ciocalteu method (Singleton & Rossi, 1965). Tannic acid was used as a standard and the results were expressed as tannic acid equivalents/fresh weight (mg TAE/g sample). Each biochemical analysis was performed in three repetitions.

RESULTS AND DISCUSSIONS

Among the most important vegetal compounds from biological point of view are vegetal pigments. The content in vegetal pigments depend on species, environmental conditions and culture technology.

The most spreading from the vegetable kingdom are the chlorophyllian and carotenoids pigments.

The content of chlorophyllian pigments varies depending on the species and phenophase, increasing from flowering period to maturing phase. The carotenoids pigments enter in the structure of photoreceptor antenna of the photosystem II, but it also accumulates in chromoplasts, contributing to the realization of the mature leaf color. The carotenoids pigments content has an upward dynamics during the growing season.

In the experiments carried out by us, in the first stage the content of the chlorophyllian pigments in the plants obtained by the two methods was determined. The results obtained shows that, in the case of biological material regenerated *in vitro* (V1), both chlorophyll *a* and chlorophyll *b* have lower average values (0.581 mg chlorophyll *a*/g green substance, respectively 0.290 mg chlorophyll *b*/g green substance) compared to the values registered at plants obtained by the conventional method (V2)(1.113 mg chlorophyll *a*/g green substance, respectively 0.436 mg chlorophyll *b*/g green substance) (Figure 1).

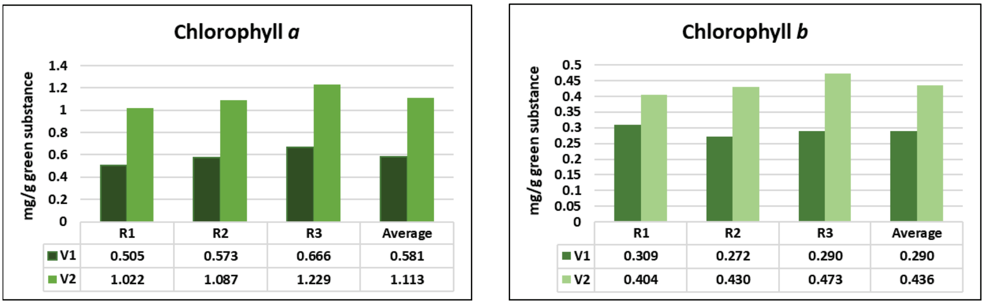


Figure 1. The chlorophyllian pigments content in the plant depending on the method of obtaining the biological material

The results of the quantitative evaluation of the carotenoids pigments in *Thymus vulgaris* plants depending on the method of obtaining the biological material are shown in figure 2. It is noted that, in average, the values obtained in the case of *in vitro* regenerated plants are lower (0.386 mg/g green substance) than those obtained in plants regenerated by conventional methods (0.775 mg/g green substance).

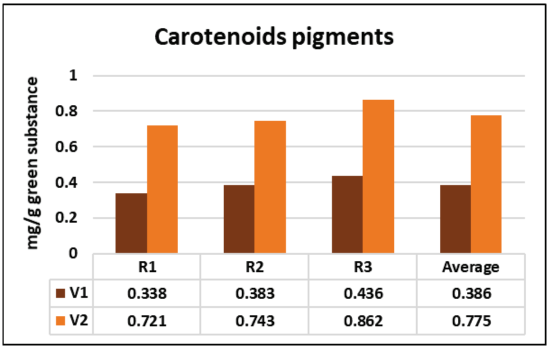


Figure 2. The carotenoids pigments content in the plant depending on the method of obtaining the biological material

In the case of both chlorophyllian pigments and carotenoids pigments, the values obtained in the case of plants regenerated *in vitro* were lower than those obtained in plants regenerated by conventional methods. The explication could be that, due to the nutrient substrate rich in carbohydrates, light conditions and lack of gas exchange, plants grown *in vitro* develop a reduced capacity for photosynthesis.

The main indicators of the chlorophyllian assimilation in plants were also calculated, namely the ratio between chlorophyll *a* and chlorophyll *b*, as well as the chlorophyll/carotene ratio. Generally, the chlorophyll *a*/chlorophyll *b* ratio has the maximum value at the beginning of the vegetation period and decreases towards its end, this change being due to the decrease of the chlorophyll *a* content during the vegetation period.

In the case of our experiences, both indicators showed the predominance of chlorophyll *a*, respectively of the chlorophyllian pigments in the analyzed plants (Figure 3).

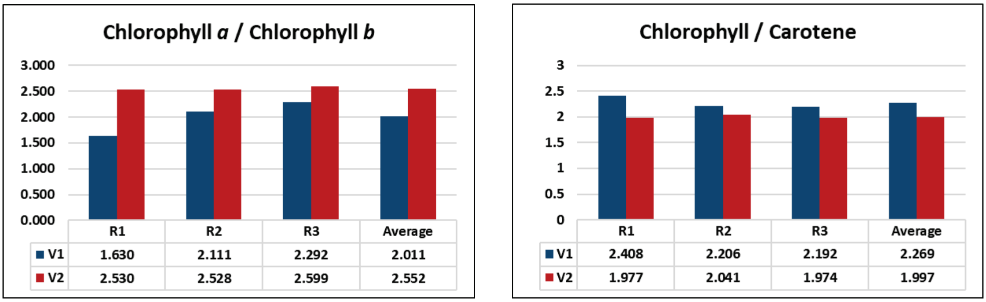


Figure 3. Indicators of the chlorophyllian assimilation within the two experimental variants

The glucides, primary products of photosynthesis, have been determined within of plants results from the two culture techniques. The values obtained were higher in samples from *in vitro* regenerated plants compared to those from conventional culture. This may be due to the nutrient substrate rich in carbohydrates in the case of plants grown *in vitro*. On average, the soluble carbohydrates content registered values of 194.608 mg/g green substance in the plants regenerated *in vitro* and 40.196 mg/g green substance in the plants obtained by conventional cultures (Figure 4).

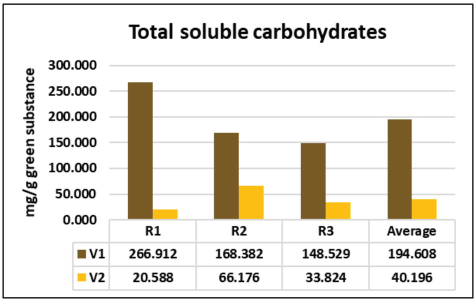


Figure 4. The soluble carbohydrates content in the plant depending on the method of obtaining the biological material

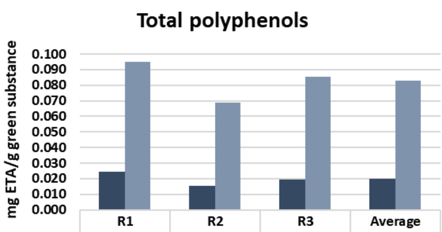
In addition to the primary metabolites, with a major role in maintaining the viability of the plant (proteins, carbohydrates and lipids) are synthesized a number of compounds that include terpenes, steroids, anthocyanins, anthraquinones, phenols and polyphenols which belong to the secondary metabolism.

Because the characteristics of bioproduction that interested to be kept especially at the thyme plants refers to the content in active principles, the ethanolic extracts derived from the plants investigated biochemically were analyzed quantitatively for evaluating the content in polyphenols.

Polyphenols are secondary metabolites widely distributed in the plant kingdom, currently being identified more than 8000 phenolic structures in all plant organs. Phenolic compounds such as phenolic acids, flavonoids and simple proanthocyanidins are some of the most important phytochemicals from plants. The main functions attributed to these compounds are related to protecting the plant against pathogens, limiting the damage caused by UV radiation and a strong antioxidant effect.

From the pharmaceutical point of view, polyphenols represent an important group of compounds. Recent nutrition studies have shown that regular consumption of polyphenolic antioxidants from vegetables, fruits and juices derived from them has a positive effect in the prevention and treatment of a wide range of pathologies, including cancer, stroke, coronary artery disease and neurodegenerative diseases, such as Alzheimer's disease (Francini and Sebastiani, 2013). Polyphenols, including those found in green tea and wine, have a wide range of biological activities, including antioxidant action, and therefore these bioactive compounds can be considered as therapeutic agents.

In the case of our experiments, the quantitative analysis of the total polyphenols in *Thymus vulgaris herb* showed higher average values for variant V2 (plants from conventional culture)(0.083 mg ETA/g green substance) compared to variant V1 (*in vitro* regenerated plants) (0.020 mg ETA/g green substance) (Figure 5).



	R1	R2	R3	Average
V1	0.025	0.015	0.020	0.020
V2	0.095	0.069	0.085	0.083

Figure 5. The total polyphenols content in the plant depending on the method of obtaining the biological material

In conclusion, we can say that the comparative study of the samples (*herba* from conventional culture and *in vitro* regenerated plants) revealed some differences in terms of bioproductivity characteristics. However, both cultivation technologies can be successfully used in order to obtain thyme plant material, a potential source of bioactive compounds.

CONCLUSIONS

The quantitative evaluation of chlorophyllian and carotenoids pigments in *Thymus vulgaris* plants depending to the method of obtaining biological material showed that, on average, the values obtained in the case of *in vitro* regenerated plants were lower than those recorded in plants obtained by conventional method.

The quantitative analysis of soluble carbohydrates from *Thymus vulgaris herba* showed lower values in the case of plants from conventional culture compared to those regenerated *in vitro*.

The obtained results confirm the superior bioproductive qualities in terms of the content in secondary metabolites (total polyphenols) of the material obtained by classical methods compared to *in vitro* regenerants.

Although biochemical investigations revealed some differences between in *vitro* regenerated plants and those obtained by conventional propagation in terms of bioproductivity characteristics, we consider that both culture technologies can be successfully used to obtain thyme plant material, a potential source of bioactive compounds.

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REFERENCES

Cosentino S., Tubeerso C.I.G., Pisano B., Satta M., Mascia V., Arzedi E., Palmas F. 1999. *In vitro* antimicrobial activity and chemical composition of Sardinian *Thymus* essential oils. Letters in Applied Microbiology, 29, 130-135.

Deans S.G., Ritchie G. 1987. Antibacterial properties of plant essential oils. International Journal of Food Microbiology, 5, 165-180.

Francini A., Sebastiani L. 2013. Phenolic compounds in apple (*Malus x domestica* Borkh.): compounds characterization and stability during postharvest and after processing. Antioxidants, 2(3), 181-193.

Grigore A., Parasachiv I., Colceru S., Babuneau C., Draghici E., Ichim M. 2010. Chemical composition and antioxidant activity of *Thymus vulgaris* L. volatile oil obtained by two different methods. Romanian Biotechnology Letters, 15, 5436-5443.

Holm G. 1954. Chlorophyll mutations in barley. Acta Agriculturae Scandinavica, 4, 457-471.

Mirzaei-Aghsaghali A., Alireza Syadati S., Fathi H. 2012. Some of thyme (*Thymus vulgaris*) properties in ruminant's nutrition. Annals of Biology Researches, 3(2), 1191-1195.

Morales R. 2002. The history, botany and taxonomy of the genus *Thymus*. In: Stahl-Biskup E.; Sáez F. (eds) Thyme, the genus *Thymus*. Taylor & Francis, London, pp. 1-43.

Nikolič M., Glamočlia J., Ferreria I.C.F.R., Calhelha C.R., Fernandes A., Markovič D., Markovič T., Giweli A., Sokovič M. 2014. Chemical composition, antimicrobial, antioxidant and antitumor activity of *Thymus serpyllum* L. *Thymus algeriensis* Boiss. and Reut and *Thymus vulgaris* L. essential oils. Industrial Crop Products, 52, 183-190.

Pánczél M., Eifert J. 1960. Die Bestimung des Zuckerund Stärkegehaltes der Weinrebe mittels Anthronreagens. Mitt. Klosterneuburg, 10, 102-110.

Sáez F. 2001. Volatile oil variability in *Thymus serpylloides* ssp. Gadorensis growing wild in Southeastern Spain. Biochemical Systematics and Ecology, 29, 189-198.

Shan B., Cai Y.Z., Sun M., Corke H. 2005. Antioxidant capacity of 26 spice extracts and characterization of their phenolic constituents. Journal of Agricultural and Food Chemistry, 53(20), 7749-7759.

Singleton V.L., Rossi J.A. 1965. Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. American Journal of Enology and Viticulture, 16(3), 144-158.

Tabak M., Armon R., Potasman I., Neeman I. 1996. *In vitro* inhibition of *Helicobacter pylori* by extracts of thyme. Journal of Applied Microbiology, 80, 667-672.

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THE QUALITY STATUS OF THE EUTRICAMBOSOL FROM GOEȘTI, DOLJ COUNTY

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Keywords: *eutricambosol, humus content, soil profile*

ABSTRACT

This paper presents the morphological and physico-chemical characteristics of Eutricambosol from Goesti, Dolj. The results obtained from the laboratory processing of soil samples indicated that this type of soil is a proxical-calcareous soil, strongly deep, moderately skeletal, with loamy / loamy-clay texture formed on slope disaggregation-alteration materials represented by deluvial materials - slope colluvial consisting of medium materials, eubasic rocks, arable, with moderate surface erosion. Eutricambosols have a medium fertility, being favorable for different field crops (wheat, corn, sunflower, potato, etc.), tree plantations and vines.

INTRODUCTION

Soil is the heart of all terrestrial ecosystems! Therefore, understanding the soil as a system is the key to success in creating and preserving a healthy and friendly environment through the efforts of human activity (Brady & Weil 2008). The evolution of agriculture, meaning the technological system of plant cultivation has been imposed over time, practically by the progress of industrialization. Due to the increasing practice of intensive agriculture, the soil is threatened by a number of factors including: erosion, loss of nutrient supply, pollution, aridization, decreased fertility, etc. The relief of Dolj county includes as forms of macrorelief, from south to north: the Danube Meadow area; the plain area recognized as the Oltenia Plain, represented by: - the western part of the Romanaţi plain, - the Desnăţui plain, - to the northeast of it the Sălcuţa field, - and to the west the eastern extremity of the Blahniţa plain and the Hill area - represented by the southern part of the Getic Piedmont. The altitude increases from 30 to 350 m above sea level, from south to north of the county, forming a large amphitheater open to the sun. Dolj County owns 3.9% of the total agricultural area of the country with 585,515 ha. The genesis, development and evolution of the soils of Dolj County, was done in time under the action of the main solification factors. The development of the relief in steps from south to north (meadow, terrace plain, high piedmont plain and piedmont) as well as the great variety of solification rocks, to which are added the changes in the county's climate in the same direction, explains the diverse range of soils and their geographical distribution. Hence the urgent need to periodically study the degree of soil fertility through its agrochemical properties, respectively its content in macroelements and microelements (Radu et al. 2019). Land quality assessment involves on the one hand the quantification of soil properties, and on the other hand the correlation with environmental factors in the context of land management strategy (Ţărău 2003). Detailed knowledge of soil types, as a support for plant growth and development, with all its morphological, physical and chemical properties is always a lever in achieving sustainable agriculture in Dolj County.

MATERIAL AND METHODS

The study was carried out in the central part of Goiești commune, Dolj county. The research methodology aimed at soil research in the field, in the laboratory, processing and interpretation of researched data. All soil samples collected from the field were physically and chemically analyzed according to the I.C.P.A. Bucharest (1987), at the laboratory of the Office of Pedological and Agrochemical Studies (OSPA) in Craiova.

RESULTS AND DISCUSSIONS

Goiești commune is located in Dolj county, Oltenia, Romania, at latitude 44°29'37 " N, longitude 23°45'35"E. and at an altitude of 126 m. The administrative territory of the commune is within the temperate-continental plain climate zone, with the average annual temperature of 10-11 °C. Currently, in the Oltenia area, due to global climate change, periods of drought and excessive rainfall have become more frequent (Radu & Bonea 2019, Bonea 2020, Bonea & Urechean 2020). The eutricambosol is encountered in the central part of Goiești commune on an area of 38.80 ha (0.82%), at an altitude of 109 m on hillsides with a slope of 10-15%.

Soil profile description

Their soil profile is of type: Am - A / B - Bv - B / C (Table 1, Figure 1).

Horizon Am = 0 - 27 cm, - gradual transition, dark gray color, (10YR4/3), clayey texture, polyhedral subangular structure, weak effervescence, plastic, adhesive, compact, dry.

Horizon A/B = 27 - 43 cm, - gradual transition, gray-brown color, (10YR 5/2), clayey texture, poorly developed polyhedral subangular structure, weak effervescence, plastic, adhesive, compact, dry.

Horizon Bv = 43 - 80 cm, gradual transition, gray-brown color, (7.5YR6/2), clayey texture, polyhedral subangular structure, weak effervescence, plastic, adhesive, compact, dry.

B/C horizon = 80 - 120cm, gradual transition, gray-brown color, (7.5 YR5/2), clayey texture, subangular polyhedral structure, moderate effervescence, plastic, adhesive, compact, recess.

The typical eutricambosol from Goiesti has a medium loamy texture in the Am horizon and clay-loamy in the A / B, Bv and B / C horizons.

Physical properties

Eutricambosol from Goiesti has the following physical and hydrophysical properties (Table 2):

The moderate apparent density (1.48-1.63 g / cm^3) also indicates a medium degree of settlement.

The total porosity is between 51.7-38.5% which indicates a satisfactory degree of aeration as well as the aeration with values of 13.6-5.12%.

The hygroscopicity coefficient (18.2-10.8% w / w) is satisfactory indicating that the soil is part of the clayey textural class on the surface and clay-clayey in depth.

Table 1

The granulometric composition of the typical Eutricambosol from Goiești

Horizons	Depth (cm)	Thick sand (%)	Fine sand (%)	Silt (%)	Colloidal clay <0,002 (mm)	Phisycal clay <0,01 (mm)	Textural class
Am	0-27	7,2	33,2	12,7	17,0	29,9	LL
A/B	27-43	5,4	17,0	11,1	11,0	55,5	AL
Bv	43-80	4,9	15,6	11,5	11,4	56,6	AL
B/C	80-120	5,6	19,7	11,0	11,3	52,4	AL

Figure 1. The soil profile

The wilting coefficient has values between 29.7-20.5 (% w / w), it indicates a higher value, therefore a higher water consumption.The water capacity of the soil in the field registers values on the four horizons between 29-7-20.5 (% w / w) and is satisfactory. The useful water capacity has high values.

Chemical properties

Eutricambosol from Goiesti has the following chemical properties (Table 3). The pH of the soil in the first two horizons Am and A / B has values of 7.6 and 7.8, respectively, the soil reaction being neutral. In the deep horizons bv and B / C the pH increases to 7.9 and 8.1 respectively, the soil reaction being weakly alkaline. The degree of insurance with humus and nitrogen is medium. The soil is medium provided with mobile phosphorus recording values of phosphorus content between 7.5 ppm P and 22.3 ppm P and medium supplied with mobile potassium. From the point of view of the cation exchange properties, the soil falls into the middle category and after the saturation in the bases it is eubasic.

CONCLUSIONS

Eutricambosol from Goiești is a proxical-calcareous soil, strongly deep, moderately skeletal, with loamy / loam-clayey texture formed on slope disaggregation-alteration materials represented by deluvial-colluvial slope materials consisting of medium materials, eubasic rocks, arable, with moderate surface erosion.

The soils are brown and podzolic brown, favorable to the development of vegetable crops, large agricultural crops (wheat, maize, sunflower etc) and fruit trees and viticultural plantations.

To combat erosion, it is recommended to choose the correct way of use and the execution of agricultural works along the contours.

Table 2

The main physical and hydric properties of the typical Eutricambosol from Goiesti

Horizon	Depth (cm)	DA (g/cm^3)	PT (%)	PA (%)	CH (% g/g)	CO (% g/g)	CC (% g/g)	EU (% g/g)	GT (%)
Am	0-27	1,48	51,7	13,6	7,16	18,2	29,7	33,0	3
A/B	27-43	1,46	45,1	6,73	12,12	17,3	26,3	35,4	15
Bv	43-80	1,58	40,4	4,46	13,32	15,8	22,7	28,7	23
B/C	80-120	1,63	38,5	5,12	12,47	10,8	20,5	20,5	25

Table 3

The main chemical properties of the typical Eutricambosol from Goiesti

Horizon	Depth (cm)	pH (H_2O)	Humus (Cx1,72) (%)	Nt (%)	P	K	SH	SB	T	V (%)
					ppm		me/100g sol			
Am	0-27	7,6	2,64	0,152	19,4	76,2	1,72	29,7	31,42	94,5
A/B	27-43	7,8	1,53	0,084	22,3	66,3	1,31	30,1	31,41	95,8
Bv	43-80	7,9	0,36	0,055	8,6	68,14	1,30	24,6	25,9	94,9
B/C	80-120	8,1			7,5	21,3	1,25	28,13	29,7	95,7

REFERENCES

Bonea D. 2020. Grain yield and drought tolerance indices of maize hybrids. Notulae Scientia Biologicae, 12(2), 376-386.

Bonea, D., Urechean, V. 2020. Response of maize yield to variation in rainfall and average temperature in central part of Oltenia. Romanian Agricultural Research, 37, 1-8.

Brady N. C., Weil R. R., 2008. The nature and properties of soil - fourteenth edition. Prentice-Hall, Upper Saddle River, New Jersey.

Dodocioiu A. M., Mocanu R. 2007. Agrochemistry, Editura Sitech, Craiova.

Radu V., Popa I., Dodocioiu A. M., Buzatu G. D. 2019. The quality status of the reddish preluvosol from ARDS Simnic. Annals of the University of Craiova, series Biology, Horticulture, Technology of Agricultural Products Processing, Environmental Engineering, 24, 213-217.

Radu V. L., Bonea D. 2020. Assessment of different sunflower hybrids under agro-climatic conditions of ARDS Simnic, Romania. Scientific papers. Series A Agronomy, vol LXIII(1).

ICPA. 1987. Methodology of elaboration of pedological studies - Part I, II, III. (N. Florea, V. Bălăceanu, C. Răuță, A. Canarache, coord.), Agrochemistry Pedology Research Institute, Ministry of Agriculture, Methods, Guidance Reports, no.20, Bucharest, 191+226 pp.

Ţărău D. 2003. Theoretical and practical bases of land reclamation and evaluation from a pedological perspective. Solness Publishing House, Timişoara, 358 p.

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THE ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF REGOSOL FROM BRĂDEȘTI, DOLJ COUNTY

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Keywords: *regosol, soil pH, soil profile*

ABSTRACT

This study was conducted to evaluate the morphological, physical and chemical properties of regosol in Dolj County. In this sense, representative soil samples were collected from Brădești commune. The results obtained showed that this type of soil had a weak alkaline reaction on the first two horizons (pH = 8.08-8.24), the humus content and the total nitrogen content (0.028-0.145% N) showed that the soil has a low level of nitrogen supply and lower fertility. The mobile phosphorus content (28.1 - 7.2 ppm P) and the mobile potassium content (91.7 - 31.0 ppm K) indicated that the soil is medium supplied with these elements. To increase the fertility of these soils it is recommended to use organic fertilizers.

INTRODUCTION

Soil has a decisive influence on the entire food chain, through its influence on food and water quality, being a source of nutrients for crops that enter human food, by transferring them from the soil to various vegetative organs of crops, and hence in the human body and of animals. Burcea (2002) defined the soil as follows: “three-dimensional natural body that contains, sustains, and maintains life; it is formed over time on the surface of the earth's crust due to the interaction of climatic, biological, hydrological, geological, mineralogical and geomorphological factors; has a three-phase composition (solid, liquid and gaseous) and polydisperse (molecular, ionic, colloidal); shows complex vertical differentiation; it has temporal dynamics, being modified by anthropic activity”. Dolj County is located in the SW of the country, in the Romanian Plain on both sides of the Jiu Valley. The major relief units in the county are: the Getic Piedmont in the N and the Oltenia Plain in the S. In this area, drought and heat are common, only two years out of ten being favorable to agricultural crops (Radu & Bonea 2020, Bonea & Urechean 2020, Bonea 2020). As about 80% of the territory of Dolj County has an agricultural destination, a detailed scientific knowledge of the soil resources in this county is required (Dodocioiu et al. 2007). The form of strongly intensified or industrialized agriculture, unfortunately for the most part, determined, on the one hand, many negative changes, thus making it absolutely necessary to evaluate, correct them, and on the other hand to promote new types of agriculture less aggressive and settled on a scientific basis through a better knowledge of the soil, of all other environmental resources.

From the multitude of factors involved in solving the problems of agricultural development, knowledge of the soil as a support for plant growth and development, with all its morphological, physical and chemical properties is always a lever in achieving sustainable agriculture in our country.

MATERIAL AND METHODS

The study was carried out in the central part of Brădeşti, Dolj county, Oltenia region (44°30′17 ″ N and 23°37′13 ″ E).

The research methodology required a study in three stages: soil research in the field, in the laboratory, processing and interpretation of researched data.

At all samples collected, physical and chemical analyzes were performed according to the I.C.P.A. Bucharest (1987), respectively:

- Particle size analysis (%) - by Kacinschi method;
- Hygroscopicity coefficient (%) - by Mitcherlich method;
- Apparent density (Da in g/cm^3) - was determined from samples collected in metal cylinders of 100 cm^3, in natural location and after drying in an oven for 24 hours at 110 °C;
- Specific gravity (D in g/cm^3) - was determined with the pycnometer, using benzene as inert liquid;
- Total porosity (%) - was determined by calculation using the values of bulk density and specific density;
- Water permeability (mm/hour) or saturated hydraulic conductivity in the laboratory, on samples in unmodified location collected in metal cylinders (by method I.C.P.A 1987);
- The resistance of the soil to penetration (RP in Kgf/cm^2) was determined on samples collected in cylinders with laboratory penetrometer, on samples collected in metal cylinders, the soil being brought to 50% of its capillary water capacity;
- pH - was determined in aqueous suspension with soil/water ratio = 1/2.5;
- Humus (H%) - was performed by the method of wet oxidation and titrimetric dosing after Walcley - Bllack in the Donut modification;
- Total nitrogen (N%) - was determined by the Kjeldhal method (soil mineralization is done by boiling with concentrated sulfuric acid in the presence of a catalyst) followed by distillation in an alkaline medium and capture of ammonium in boric acid;
- Sum of exchange bases (SB me/100 g soil) - by Kappen method;
- Total exchange acidity (SH me/100 g sol) - was determined by percolation at depletion with 1N potassium acetate solution, buffered (at pH = 8.3);
- The cation exchange capacity (T me/100g soil) was determined by calculating T = SB + SH
- The degree of base saturation (V%) at pH 8.3 - was determined by calculating: V = SB / T x 100;
- Mobile phosphorus (P ppm) - by the Egner Riehm Domingo method;
- Mobile potassium (K ppm) - by the Egner Riehm Domingo method;
- Total content of alkaline earth carbonates ($CaCO_3$) - by gas-volumetric method, Schleiber;
- "Mobile" exchangeable aluminum (Al me/100 g soil) - was determined by extraction with neutral 1N potassium chloride solution.

RESULTS AND DISCUSSIONS

The regosol is encountered in the central part of Bradesti commune (east of Lake Caraula) that is located in the area of the Getic Piedmont, respectively in the Olteț platform.

Soil profile description

Their soil profile is of type: Ao – A/C - C – Cca (figure 1, table 1).

Figure 1. The soil profile

Ao horizon, = 0-24 cm, - gradual transition, dark brown color (10YR-3/3), medium clayey clay texture, small glomerular structure, poorly developed, poor effervescence, plasticity, adhesiveness, porous, frequent roots.

Horizon A/C = 24-54 cm, - gradual transition, dark brown-gray color (10YR-4/2) medium clayey clay texture, glomerular structure and polyhedric subangular small-medium, well developed, weak effervescence, plasticity, adhesiveness fine pores, frequent thin roots, weakly compacted.

Horizon C = 54-80 cm, dark brown-yellow color (10YR-5/3), medium clayey clay texture, well-developed medium subangular polyhedral structure, moderate effervescence, plastic, weakly adhesive, fine pores, gradual passage.

Horizon Approx = 80-110 cm, light brown - yellowish color (10YR-6/4), medium clay texture, structured, moderately compacted, has alkaline-earth carbonates scattered throughout the soil in the form of efflorescence, strong effervescence towards the base.

Table 1

The granulometric composition of the regosol from Brădeşti

Horizon	Depth (cm)	Thick sand (%)	Fine sand (%)	Silt (%)	Colloidal clay <0,002 (mm)	Phisycal clay <0,01 (mm)	Textural class
Ao	0-24	**3,8**	**45,5**	**8,7**	**11,8**	30,2	LL
A/C	24-54	**2,3**	**36,9**	**10,6**	**14,8**	35,4	TT
C	54-80	**0,8**	**69,7**	**6,7**	**31,8**	51,0	AP
Cca	80-110	**0,2**	**70,3**	**8,1**	**5,6**	15,8	AF

The analysis of the data in table 1 indicates that Regosol from Brădeşti has an average loamy texture in Ao (LL), medium clayey clay in A / C (TT), clay-dusty in C and clay-fine in horizon C.

Physical properties

Regarding the physical and hydrophysical properties of the regosol from Brădeşti, it can be characterized as follows (Table 2):

- the apparent density has values between 1.22-1.42 g/cm^3 on the soil profile, being lower at the surface and higher at depth. The value of 1.30 g/cm^3 of the apparent density in the Ao (arable) horizon indicates a very small value and therefore a poor soil compaction. In depth, the values of this indicator are naturally higher, indicating a more pronounced settlement.
- the total porosity has values between 56.3% and 52.2% which shows a satisfactory degree of aeration, the soil being loose.

The values of the hygroscopicity coefficient 7.1-11.8% w/w show us that the soil is part of the clay class and clay clay.

The wilting coefficient with values between 10.7 and 18.2% w/w is high.

The values of 29.9-25.5% w/w of the field capacity highlight the fact that the soil has satisfactory values of this indicator.

The water capacity in the field registers values between 23.8 and 1.7% w/w and indicates the fact that in the surface horizon Ao high values.

The degree of compaction with values of 11-20 indicates a moderate compaction of the soil.

Table 2

The main physical and water properties of the regosol from Brădeşti

Horizon	Depth (cm)	**DA** (g/cm^3)	**PT** **(%)**	**PA** **(%)**	**CH** (% g/g)	**CO** (% g/g)	**CC** (% g/g)	EU (% g/g)	**GT** **(%)**
Ao	0-24	1,30	56,3	18,8	7,1	10,7	29,9	23,8	11
A/C	24-54	1,34	54,6	25,3	10,6	12,8	28,0	1,7	16
C	54-80	1,22	52,2	32,1	11,8	18,2	25,5	2,4	20
Cca	80-110	1,42							

Table 3

The main chemical properties of the regosol from Brădeşti

Horizon	Depth (cm)	pH (H_2O)	Humus (Cx1,72) (%)	Nt (%)	P	K	SH	SB	T	V (%)
					ppm		me/100g sol			
Ao	0-24	8,08	2,22	0,145	28,1	91,7	1,21	26,4	27,61	98,6
A/C	24-54	8,24	1,14	0,069	14,3	76	1,11	30,2	31,31	96,4
C	54-80	8,55	0,94	0,028	7,2	31	1,06	30,8	31,86	96,6
Cca	80-110	8,59	0,50							

Chemical properties

The chemical properties (Table 3) are characterized as follows:

The soil reaction is slightly alkaline on the first two horizons as the pH is between 8.08-8.24, and strongly alkaline on the horizon C and Cca with values of 8.55 and 8.59 respectively.

The soil from Brădeşti is weak to medium supplied with humus, the humus content varying between 0.50% in the horizon Cca and 2.22% in the surface horizon (A0) and poorly supplied with nitrogen (0.028-0.145% N).

The degree of supply with mobile phosphorus is medium, the phosphorus content registering the highest value in the surface horizon of 28.1 ppm P and the lowest value in the C horizon of 7.2 ppm P.

The degree of supply of mobile potassium is medium (91.7-31 ppm K).

From the point of view of the cation exchange properties, the soil falls into the middle category, and according to the degree of base saturation (SB) it is saturated with bases or eubasic.

CONCLUSIONS

The calcareous regosol from Brădești commune, Dolj county, is a proxicalcaric soil, with medium clayey/medium clayey clay texture, formed on disaggregation-alteration materials of slope represented by deluvial-colluvial materials made of medium materials, eubasic rocks, with strong erosion of surface.

Regosols have a low fertility due to the low content of nutrients being used for the cultivation of meadows, shrubs, trees and vines.

In order to increase the fertility of these soils, measures are required to prevent the accentuation of erosion, especially by terracing, performing soil works in the direction of contours, afforestation for the restoration of the soil cover or straw crops in strips with grassy strips.

It is also recommended to use organic fertilizers to increase the content of organic matter in the soil and improve the physicochemical properties.

REFERENCES

Bonea D. 2020. Grain yield and drought tolerance indices of maize hybrids. Notulae Scientia Biologicae, 12 (2), 376-386.

Bonea D., Urechean V. 2020. Response of maize yield to variation in rainfall and average temperature in central part of Oltenia. Romanian Agricultural Research, 37, 1-8.

Burcea G. 2002. General pedology. Piatra Craiului Publishing House, Bucharest.

Dodocioiu A. M., Mocanu R. 2007. Agrochimie, Editura Sitech, Craiova

ICPA, 1987. Methodology of elaboration of pedological studies - Part I, II, III. (N. Florea, V. Bălăceanu, C. Răuță, A. Canarache, coord.), Inst. Research. Pedology Agrochemistry, Min.Agr., Methods Reports Guidelines, no.20, Bucharest, 191 + 226 pp.

Radu V. L, Bonea D. 2020. Assessment of different sunflower hybrids under agro-climatic conditions of ARDS Simnic, Romania. Scientific papers. Series A Agronomy, vol LXIII (1).

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BEHAVIOR OF VINE VARIETIES WITH BLACK GRAPES FOR RED WINES ON SANDY SOILS IN SOUTHERN OLTENIA

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Keywords*: vine, negative temperature, abundant rainfall*

ABSTRACT

From the point of view of the minimum harmful temperatures for the vine, in four years out of the eight analyzed, the recorded temperature values did not cause bud losses. In two of the eight years, the scorching heat phenomenon manifested itself, the temperatures exceeding the value of 40 ^{0}C. The highest grapes production, in a single year, of 27645 Kg / ha, in 2019, and the highest average grapes production, of 15326 Kg / ha was achieved by the Novac variety. The weight of 100 grape berries recorded different values from one variety to another, but also depending on the year of study. The highest average weight was recorded by the Novac variety (252 g), with variation limits between 220 and 312 g. The lowest value for the average weight of 100 grape berries was recorded by the Arcaș variety (180 g). Depending on the sugar content of the grapes, the Novac variety was imposed, which accumulated an average of 201 g / l, with limits of variation from 180 to 212 g / l. The lowest average total sugar content was accumulated by grapes of Cristina variety (168 g / l). Regarding the total titratable acidity, all the varieties accumulated over 4.3 g / l H2SO4, and some varieties over the value of 5, determining the obtaining of balanced wines from the organoleptic and chemical composition point of view.

INTRODUCTION

Sandy soils, although low in fertility and with a low retention capacity for water and minerals, also provide optimal growing conditions for vine varieties with grapes for red wines. Studies have shown that sands can provide a natural environment conducive to the growth and fruiting of vines provided the adoption of agrotechnical works that meet the physiological and biochemical requirements of cultivated varieties (Olteanu I. et al. 2002). Red wines are richer in natural antioxidants as opposed to white wines (Halliwell 1987, Kinsellia et al. 1993, cited by Gougoulias et al. 2008).Their share in the assortment on sandy soils is lower than those with grapes for white wines. Although it has multiple microclimates and various soil types, the *Oltenia* region offers favorable conditions for obtaining a complete assortment of red wines (Diszy Marta et al. 2008), representing, from this point of view, a true miniature viticultural Romania (Popa et al. 2008). The resources explored by the cultivated varieties can be enhanced by the technologies used (Olteanu et al. 2001).

MATERIALS AND METHODS

The experiment was set up in 2010. The planting density was 3787 vines / hectare, a density that resulted from planting distances of 2.2 / 1.2 m.

The following varieties were planted: *Haiduc, Codană, Mamaia, Novac, Cristina, Pandur, Arcaş, Amurg.*

To compare the results we used the *Băbească neagră* variety, a traditional variety on the sandy soils in the south of the country.

Observations and experimental determinations were performed on the phenology of the stems, the fertility of the shoots, the grape production and its quality (weight of 100 grape grains, total sugar content and total titratable acidity).

RESULTS AND DISCUSSIONS

In the period 2012-2019, relatively favorable conditions for the cultivation of vines were manifested (table 1). From the point of view of the minimum temperatures harmful to the vine, in four years out of the eight analyzed, the recorded temperature values caused bud losses (figure 1). In two of the eight years, the scorching heat phenomenon manifested itself, the temperatures exceeding the value of 40 ^{o}C (figure 2). Similar research has been done by Enache et al. (2009).

Table 1

The main climatic data from 2012-2019

Year	Temperature (^{o}C)		Rainfall (mm)			Snow layer thickness (cm)
	Minimum	Maximum	Annual	Period April-September	Multiannual	
2012	-24.3	42.6	383.5	230.8	542.9	25
2013	-18.1	38.4	451.5	307.8	541.4	15
2014	-14.1	37.6	994	640.7	554.9	25
2015	-25.1	39.2	735.4	398	558.6	30
2016	-23.4	38	718.5	297.4	561.2	30
2017	-23.4	41.2	742	326.6	560.2	40
2018	-17.6	35.7	923.9	510.1	565.9	25
2019	-14.9	38.4	530.8	122.7	565.3	30

In terms of precipitation, they recorded values both below and above the multiannual average, which is around 550 mm. Higher precipitation values were recorded in 2014 (994 mm), and 2018 (923.9 mm), and precipitation values well below the multiannual limit were recorded in 2012 (383.5 mm). Precipitation is useful for vines when they exceed the value of at least 10 mm in a single rain but can also have a harmful effect when they exceed values of 30-50 mm in a single rain or 2-3 days in a row, as happened in 2014 and 2018, because they produce the phenomenon of puddles on the soil surface, and lead to the occurrence of diseases and the impossibility of carrying out phytosanitary treatments with terrestrial means of control (figure 3).

During the vegetation period, from 2014 (April - September), the recorded precipitations amounted to the largest quantity, 640.7 mm, compared to the multiannual monthly amount during the vegetation period of 1956 - 2014, of 311.4 mm, precipitation spread over a large number of days, namely 74. The effect is all the more detrimental when this phenomenon coincides with the critical phase in the vine for diseases, which is located before and after the flowering phenophase.

Figure 1. Effect of minimum harmful temperatures during the active rest period

Figure 2. Vine affected by drought and heat

Figure 3. Consequences of heavy rainfall and the fog phenomenon in July, 2014

Figure 4. *Novac* variety

The snow, in addition to helping to restore soil moisture, protects the vines from the base of the stem, in years with minimum temperatures below their resistance limit, especially the greater the thickness of the layer is.

The entry into vegetation of the studied varieties took place in the second and third decade of April, between 10-29, depending on climatic conditions, and especially on temperature (Table 2). The beginning of grapes ripening process took place towards the end of July - beginning of August and the ripening of the grapes in the second decade of September. Both the entry into ripening and the ripening of the grapes took place relatively simultaneously, with differences from one to five days, depending on the variety. The fertility of the shoots differs from one variety to another, and from one year to another, depending on climatic conditions (Table 3).

From the point of view of the fertility of the shoots, the *Novac* variety was noticed, which registered values of the relative fertility coefficient between 1.13 and 1.44 and values of the absolute fertility coefficient within the limits of 1.62-1.67. In fact, the number of inflorescences on a plant registers values within the limits 17 and 36. Regarding the production of grapes, it should be noted that in 2012, although it was the third year after planting, all varieties achieved a certain amount depending on the genetic potential of each variety, although the stumps were affected by the minimum negative temperatures from winter period (Table 4).

Table 2

The main phenological observations in some vine varieties with red grapes for red wines in the 2012-2019 period

Variety	Entry into vegetation	Beginning of the ripening	Grapes maturation
Băbească neagră	13-27.04	21.07-4.08	9-15.09
Haiduc	13-27.04	24.07-4.08	15-16.09
Codană	13-27.04	19.07-2.08	11-16.09
Mamaia	12-27.04	22.07-3.08	12-15.09
Novac	10-22.04	23.07-2.08	11-16.09
Cristina	12-28.04	19.07-4.08	14-16.09
Pandur	15-25.04	27.07-3.08	12-16.09
Arcaş	15-29.04	18.07-3.08	14-16.09
Amurg	15-24.04	22.07-1.08	12-14.09

Table 3

Fertility of shoots at vine varieties with red grapes for red wines in the 2012-2019 period

Variety	Total number of shoots/plant	Number of fertile shoots on the stump	Inflorescences number on the stump	Fertility coefficient	
				relative	absolute
Băbească neagră	17-21	12-15	12-22	0.94-1.05	1.36-1.47
Haiduc	15-20	11-15	10-27	0.83-1.15	1.33-1.80
Codană	14-21	12-18	16-26	0.85-1.24	1.31-1.44
Mamaia	15-24	13-16	10-20	0.83-0.85	1.25-1.31
Novac	19-25	18-22	17-36	1.13-1.44	1.62-1.67
Cristina	15-21	11-18	12-26	0.64-1.24	1.27-1.44
Pandur	15-20	10-14	11-25	0.90-1.25	1.54-1.78
Arcaş	18-26	16-20	12-42	0.97-1.41	1.26-2.10
Amurg	17-24	16-21	12-35	0.96-1.36	1.44-1.67

Table 4

Grape production at some vine varieties with grapes for red wines in the 2012-2019 period

Variety	Year				Production limits in the period 2012-2019 (Kg/ha)	The average (Kg/ha)
	2012	2013	2014	2019		
Băbească neagră	4136	20455	7953	24236	1363-24236	10580
Haiduc	6059	21212	7574	13633	6059-21212	11645
Codană	5680	22728	7953	18935	5680-22728	13373
Mamaia	2651	18940	7195	6816	2575-18940	8891
Novac	8331	21212	7574	27645	8331-27645	15326
Cristina	1136	21212	5680	9846	1136-21212	9250
Pandur	4272	21591	6816	10982	4272-21591	8994
Arcaş	1136	21212	7195	16662	1136-21212	10442
Amurg	3408	23106	8331	17798	3408-23106	11777

The *Novac* variety (figure 4), was noticed since the third year after planting, when it achieved a production of 8331 Kg / ha, superior to all other varieties, and with an important advance over some varieties, such as *Cristina*, *Arcaș* and *Mamaia*. The highest grape production, in a single year, of 27645 Kg / ha, in 2019, and the highest average grape production, of 15326 Kg / ha achieved the *Novac* variety. In terms of average grape production, it was followed by *Codană* (13373 Kg / ha), *Amurg* (11777 Kg / ha), and *Haiduc* (11645 Kg / ha). The lowest average grape production was achieved by the *Mamaia* variety (8891 Kg / ha).

In order to assess the quality of grape production, determinations were made on the weight of 100 grape grains, the total sugar content at harvest and the total titratable acidity (Table 5). The weight of 100 grape berries recorded different values from one variety to another but also depending on the year of study. The highest average weight of 100 grape berries was recorded in the *Novac* variety (252 g) with variation limits between 220 and 312 g. At the opposite pole was the *Arcaș* variety with an average weight of 100 grape berries of 180 g.

Table 5

The quality of grapes in some vine varieties with black grapes for red wines in the period 2013-2019

Variety	Weight of 100 grape berries (g)		Total content of sugars (g/l)		Total content of sugars (Kg/ha)		Total titratable acidity (g/l H_2SO_4)	
	Variation interval	The avera-ge	Variation interval	The avera-ge	Depending on the variety	The difference	Variation interval	The avera-ge
Băbească neagră	205-292	241	159-212	191	1414	Control variant	4.2-6.2	5.1
Haiduc	160-286	213	155-209	182	1483	+69	4.4-6.4	5.1
Codană	188-303	246	150-205	168	1572	+158	3.6-5.0	4.4
Mamaia	196-262	238	163-217	181	1126	-288	4.0-4.7	4.3
Novac	220-312	252	180-211	201	2156	+742	4.1-5.6	4.7
Cristina	192-266	203	156-206	159	1029	-385	4.5-5.5	4.4
Pandur	153-280	218	162-212	187	1177	-237	3.8-6.2	4.8
Arcaş	142-242	180	164-220	192	1403	-11	4.4-5.7	5.0
Amurg	134-341	219	180-208	189	1558	+144	3.7-5.6	4.4

In addition to being a character of the variety, the sugar content of grapes depends on climatic conditions, the production of grapes on a stump, the degree of diseases attack and the time of harvest. The values of the total sugar content of grapes, at harvest maturity, ranged from one variety to another and from one year to another. Depending on the sugar content of the grapes, the *Novac* variety was imposed, which accumulated an average of 201 g / l, with limits of variation from 180 to 212 g / l. The lowest average total sugar content was accumulated by the grapes of *Cristina* variety (168 g / l). From the point of view of the total sugar content of grapes, at the surface unit, the *Novac* variety with a value of 2156 Kg / ha of sugar was also imposed, exceeding the *Băbească neagră* variety with 742 Kg / ha of sugar. From this point of view, the control variant *Băbească neagră* exceeded four varieties and was also exceeded by four varieties. Regarding the total titratable acidity, all the varieties accumulated over 4.3 g / l H_2SO_4, and some varieties over the value of 5, determining the obtaining of wines with balanced taste. The highest average total titratable acidity value was registered at the varieties *Băbească neagră* and *Haiduc*, 5.1 g / l H_2SO_4, and the lowest (4.3 g / l H_2SO_4) was registered for the *Mamaia* variety.

CONCLUSIONS

From the point of view of the minimum temperatures harmful to the vine, in four years out of the eight analyzed, the recorded temperature values did not cause bud losses. In two of the eight years, the heat phenomenon manifested itself, the temperatures exceeding the value of 40 ^oC. *Novac* variety has been remarked since the third year of planting, when it achieved a production of 8331 Kg / ha, superior to all other varieties, and with an important advance over some varieties, such as *Cristina, Arcaș* and *Mamaia*. The *Novac* variety also achieved the highest grape production, in a single year, of 27645 Kg / ha, in 2019, and the highest average grape production, of 15326 Kg / ha.

The weight of 100 grape berries recorded different values from one variety to another but also depending on the year of study. The highest average weight of 100 grape berries was recorded at the *Novac* variety (252 g) with variation limits between 220 and 312 g. At the opposite pole was the *Arcaș* variety with an average weight of 100 grape berries of 180 g.

Depending on the sugar content of the grapes, the *Novac* variety was imposed, which accumulated an average of 201 g / l, with limits of variation from 180 to 212 g / l. The lowest average total sugar content was accumulated by the grapes of Cristina variety (168 g / l).

Regarding the total titratable acidity, all the varieties accumulated over 4.3 g / l H_2SO_4, and some varieties over the value of 5, determining the obtaining of wines balanced in taste.

REFERENCES

Diszy M., Popa A., Dunoiu A., Onescu J. 2008. Studies concerning the factors that decide the quality of red wines, obtained in Oltenia's vineyards. Analele Universității din Craiova, XII (XLIX), 5-10.

Enache V., Simion C., Donici A., Tabaranu G., Popescu A. 2009. Research concerning the global climate changes and their influence on viticultural ecosystem in Dealu Bujorului vineyard. The Journal of Enviromental Protection and Ecology (JEPE).

Gougoulias N., Papachatzis A., Vagelas I., Chouliaras N. 2008. Total phenols antiradical activity (DPPH) of red wines from different regions of Greece. Analele Universității din Craiova, XII (XLIX), 11-16.

Olteanu I., Cichi D., Mărăcineanu L.C., Costea D.C. Gavrilescu E. 2001. Dezvoltarea unei viticulturi durabile în Oltenia printr-un management care asigură calitatea produselor viti-vinicole. Analele Universității din Craiova, VI (XLII), 80-83.

Olteanu I., Costea D.C., Gavrilescu E., Giugea N., Mărăcineanu L.C., Cichi D. 2002. Contribuția cadrelor didactice de la catedra de viticultură la dezvoltarea unei viticulturi moderne. Analele Universității din Craiova, VII (XLIII), 198-205.

Popa A., Dunoiu A., Dicu C., Genoiu C. 2008. Studies ragarding the delimitation of the areals with vocation for obtaining high quality wines having controlled origin denomitation in Drăgășani vineyard. Analele Universității din Craiova, XII (XLIX), 25-34.

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STUDIES OF BEHAVIOR IN THE *IN VITRO* ROOTING PHASE AND *EX VITRO* ACCLIMATIZATION OF *FRAGARIA X ANANASSA* CV. MAGIC PLANTLETS

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Keywords: *Fragaria x ananassa, in vitro, 3-indolyl-butyric acid, subculture, acclimatization*

ABSTRACT

The cultivated strawberry (Fragaria x ananassa Duch.) is a very popular fruit, widely crop in all temperate regions of the world, which have a great economic and nutritive interest due to the high production potential and fruit quality. Considering that, the traditional propagation of the commercial strawberry plant is not always adequate due to the vulnerability and their susceptibility to pathological agents, in vitro micropropagation is the modern method to eliminate this inconvenience. The strawberry cultivar 'Magic' was micropropagated using shoot tip explants for three in vitro subcultures. In vitro rooting of shoots was performed after each subculture on the Murashige & Skoog (MS) basic medium supplemented with IBA (0.5 – 1.0 mg/L^{-1}), and GA$_3$ (0.1 mg/L^{-1}). The highest rooting percentage (88,88 %) of cv. 'Magic' was obtained after the second multiplication subculture at concentration of 0.5 mg/L^{-1} IBA. Shoots cultivated on the MS medium with 1.0 mg/L^{-1} IBA produced the higher number of roots (10 units) and the longest roots (2.55 cm). From the observation of the results it can be concluded that the acclimatization may be realized with success using the perlite substrate. 100% of the plants survived in this substrate. The present study was designed to investigate the influence of number of subcultures on multiplication stage and IBA concentration on in vitro rooting of strawberry cultivar 'Magic'.

INTRODUCERE

Fragaria x ananassa Duch., member of the *Rosaceae* Family, is a perennial species, which grows in the northern hemisphere in both, temperate and sub-temperate climates. Strawberry is cultivated all over the world, not just for its digestive and tonic properties, but also because of the nutritional value of its fruits; they are rich in natural antioxidants (Wang et al. 1996, Heinonen et al. 1998; Hannum 2004), with a crucial role in protecting human health (Wang & Jiao 2000, Hannum 2004, Malone 2014, Mezzetti et al. 2018). Traditionally, the strawberry propagates through vegetative runners (Biswas et al. 2008), the risk of transmitting diseases to offspring being very high. Therefore, this method is not suitable for commercial crops that require large quantities of healthy plants. Micropropagation of strawberry has been used widely for commercial propagation of elite selections and for analysis in a replicated trial of new genotypes (Graham 2005). Therefore, this alternative represented a very effective method to ensure the production of disease-free plants, but also for obtaining mass production in a relatively short time, of greater vigor and high genetic purity (Mohan et al. 2005, Calvete et al. 2009, Rekha et al. 2013, Ling & Wetten 2017, Diel et al. 2017, Juárez et al. 2019). The objectives followed in this study were to establish the ability of *in vitro* rooting of the shoots multiplied during subculturing, according to the concentration of auxin, and determining the *ex vitro* capacity acclimatization of the species *Fragaria x ananassa* cv. 'Magic'.

MATERIALS AND METHODS

The biological material consisted of meristems derived plantlets of *Fragaria x ananassa* cv. Magic, excised from runner tips of greenhouse-grown plants in the Tissue Culture Laboratory of the Research Institute for Fruit Growing, Pitești.

Disinfection of explants. Runner tips of cultivar 'Magic' were pre-sterilized by washing in tap water to which 2-3 drops of Domestos were added. Subsequently, they were disinfected successively with 96% ethanol for 5 minutes and with 6% calcium hypochlorite for 10 minutes. After sterilization, the biological material was rinsed in three baths of sterile distilled water.

Establishing culture for in vitro rooting. For rooting, microshoots multiplied were separated and transferred into glass jars of 350 ml containing 30 ml of culture medium MS 1/2n macroelements, LF 1/2n microelements and MS vitamins, supplemented with GA_3 and different concentrations of IBA (0.5 - 1.0 mg/L^{-1}). Iron was added to the medium as separate stock solution of ferric sodium salt EDTA (32 mg L^{-1}), and dextrose was used as carbon source in the culture media (40 g L^{-1}). For all experiments, the pH of the culture medium was adjusted to 5.7 with 0.1 N KOH before autoclaving for 20 minutes at 121 ^{0}C. The *in vitro* cultures were incubated in a growth chamber at 22-24°C, under a photoperiod of 16 hours light / 8 hours darkness, and a light intensity of 40 µmol m^{-2} /s^{-1}. To avoid major statistical errors and for a correct interpretation of the rooting results, 20 microshoots were inoculated in each glass jars, in three repetitions. Observations regarding rooting of shoots were made every four weeks. The effect of auxin concentration was studied both, for determining the rooting capacity of microshoots, and the number and length of the roots/plantlet after each subculture of multiplication, before transferring the seedlings under greenhouse conditions.

Acclimatization. *In vitro* rooting was followed by acclimatization to *ex vitro* conditions, four variants of substrates were tested, perlite, cocopeat jiffy, mineral wool and mixture of peat, manure and sand (1:2:1 v/v), for determination the acclimatization percentage, average number of leaves/plant and average length of shoots/variant. The rooted seedlings were removed from the culture medium, rinsed with sterile distilled water, dried on sterile paper towels and transferred to alveolar trays with diameter of 10 cm, filled with perlite, cocopeat jiffy, mineral wool and mixture of peat, manure and sand (1:2:1 v/v). Alveolar trays were transferred to the greenhouse and covered with clear polyethylene sheets to create a high relative humidity. Further, spraying with water under the plastic sheets were carried out every day while the irrigation took place 2-3 times a week. All the complete plants were cultivated under the same conditions of the establishment stage.

RESULTS AND DISCUSSIONS

In vitro rooting. After four weeks in culture, the percentage of microshoots rooted, number of roots and length of roots per culture was influenced by the different concentrations of auxins added in the rooting expression media and hormonal composition of the basal media used for explants micropropagation (Table 1 and Figure 1).

Table 1

Composition of the culture media used for *in vitro* rooting of meristem-derived plantlets in 'Magic' cultivar of *Fragaria x ananassa*

Components (mg/L^{-1})	Experimental variants					
	Subculture 1	Subculture 2	Subculture 3	Subculture 1	Subculture 2	Subculture 3
	V1	V2	V3	V4	V5	V6
Macroelements*	MS1/2	MS1/2	MS1/2	MS1/2	MS1/2	MS1/2
Microelements**	LF1/2	LF1/2	LF1/2	LF1/2	LF1/2	LF1/2
Vitamins	MS	MS	MS	MS	MS	MS
Dextrose (g/L^{-1})	40	40	40	40	40	40
Agar (g/L^{-1})	7	7	7	7	7	7
AIB (mg/L^{-1})	0.5	0.5	0.5	1.0	1.0	1.0
GA_3 (mg/L^{-1})	0.1	0.1	0.1	0.1	0.1	0.1
NaFeEDTA (mg/L^{-1})	32	32	32	32	32	32

*MS: Murashige&Skog (1962)
**LF: Lee Fossard (1977)

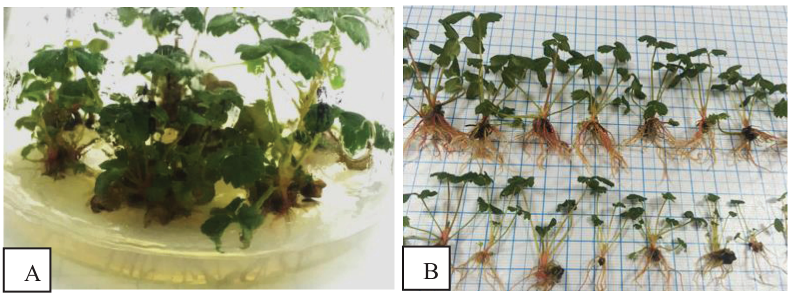

Figure 1. A, B: Root formation of regenerated shoots from meristem-derived plantlets in cv. ‘Magic’.

The Duncan's test showed that in this experimental variants of culture medium, IBA in concentration of 0.5 mg/L^{-1} proved to be the most suitable for root induction of shoots multiplied in subculture II, with 88,88% (Figure 2), and concentration of 1.0 mg/L^{-1} recorded a number of 10.04 ± 0.05 roots per explant with an average root length of 2.57 cm (Figure 3 and 4). Regarding the results obtained in the case of rooting percentage on MS culture medium supplemented with different concentrations of IBA (0.5 - 1.0 mg/L^{-1}) of shoots multiplied after each of the three subcultures, there were no significant differences.

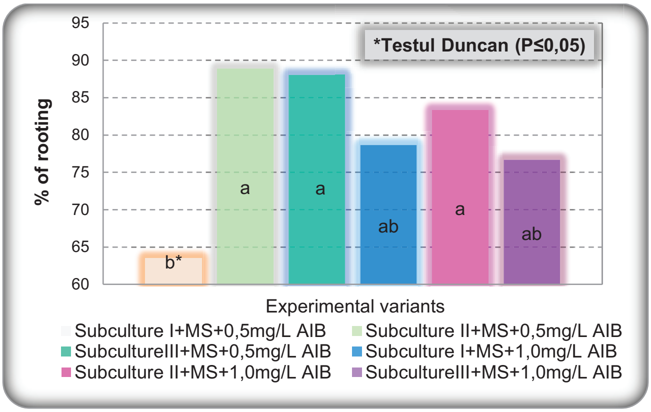

Figure 2. The influence of auxin concentration on the rooting percentage of shoots multiplied over the three subcultures

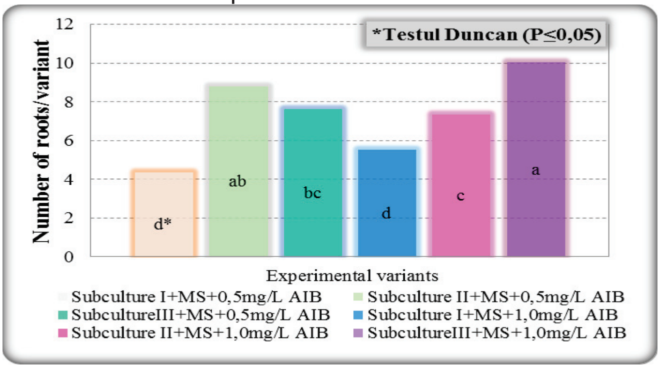

Figure 3. The influence of auxin concentration on the number of roots/variant of shoots multiplied over the three subcultures

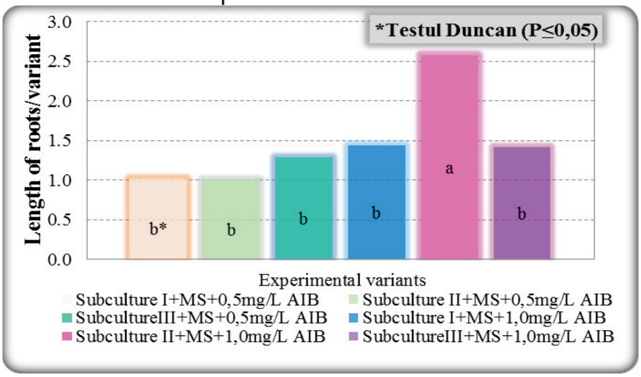

Figure 4. The influence of auxin concentration on the lenght roots/variant of shoots multiplied over the three subcultures

In what concerning the average number of roots and length of roots formed on MS media supplemented with different concentrations of IBA, the highest values of this parameters were obtained at concentration of 1.0 mg/L^{-1}, where significant differences were found between experimental variants with different concentrations when analyzed by Duncan's test (as showen in Figure 3 and 4).

However, Rattanpal et al. (2011) reported that IBA at 1 mg/L^{-1} concentration gave the highest rooting rate (92.3%), after four weeks of *in vitro* rooting, in the case of meristem culture. The same authors have proven that through incorporation of IBA in culture medium, induction of rooting, number of roots per plants and initiation of roots can be increased.

In contrast, Șuțan et al. (2009) showed that IBA at a concentration of 0.5 mg/L^{-1} caused a low rooting rate for the "Pink Panda" strawberry variety. Also, some authors have shown that auxin is required only in the initiation phase, becoming inhibitory in the case of rooting (Elhamdouni et al. 2000, Chalupa 2002).

Though, the results obtained in this study are in agreement with the work of many other scientists (Kaur et al. (2005), Sakila et al. (2007), Haddadi et al. (2010), Diengngan & Murthy (2014), Badal et al. (2018)), on other cultivars of strawberry in which they found that the use of IBA at 1 mg/L^{-1} gave best result for *in vitro* rooting of micropropagated shoots, which means that this concentration was optimal for effective rooting of tissue culture derived shoots of strawberry.

Acclimatization vitroplants. The best results for acclimatization phase in *Fragaria x ananassa* were achieved on the perlite substrate with 100% (Figure 5). The cocopeat jiffy substrate stimulated the elongation of the strawberry vitroplants with a maximum length stem of 3.43 cm, and number of leaves, 6.25, on perlite substrate (Figure 6).

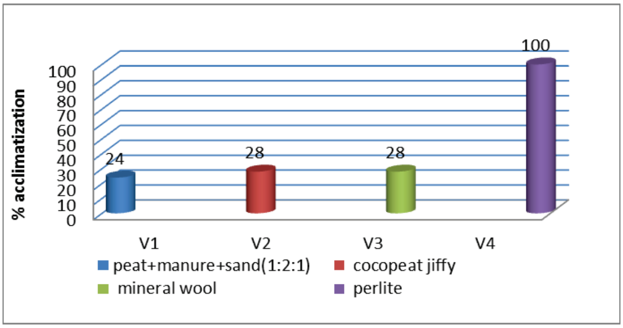

Figure 5. Effect of substrate nutritive variants on acclimatization percentage of strawberry vitroplants

Acclimatization of vitroplants to a greenhouse or field is essential because there is a significant difference between the artificial environment and the greenhouse or field environment (Hazarika et al. 2006).

Successful acclimatization procedure provides optimal conditions for higher survival, subsequent growth and development of micropropagated plants (Hazarika et al. 2006). Thus, Rajan (2007) reported that micropropagation was successful only when plants were transferred from culture condition to soil with high survival rate and better growth. The quality of transfer depends mainly on the type of substrate utilized.

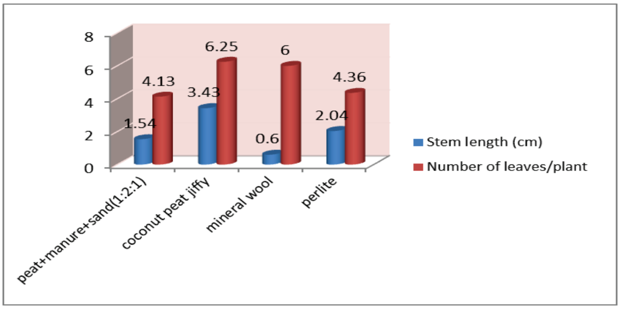

Figure 6. The effect of the nutritive substrate variants in the acclimatization phase, on the growth characteristics of the strawberry vitroplants

In this respect, some authors (Kampf et al. 1998, Moreira et al. 2006) suggested that adequate growth, more adventitious roots and a higher percentage of plant survival during acclimatization depend on the composition and quality of the substrate. The substrate must combine a light texture with adequate nutritive quality, good moisture-retaining capacity and good aeration.

It is very important to determine the factors affecting the *ex vitro* acclimatization of tissue cultured plants (Kumar & Rao 2012). One of the important factors affecting on survival percentage of transplants during acclimatization is the type of potting substrate (Wafaa & Wahdan 2017).

CONCLUSION

The microshoots of *F. x ananassa* cv. Magic multiplied *in vitro* in the subculture II, had the biggest rooting percentage in the culture media supplemented with 0.5 mg/L^{-1} IBA.

Regenerated shoots in the second subculture of multiplication stage showed the highest values of number and length of roots in the rooting media supplemented with 1.0 mg/L^{-1} IBA.

The vitroplants were successfully acclimatizated in perlite substrate.

Therefore, these results could contribute to facilitating the commercial production of strawberry plants obtained under *in vitro* conditions.

REFERENCES

Badal Md. N. U., Shoyeb Md., Sarkar Md. A. R., Rahman Md. S., Rahman S. M. 2018. Clonal propagation of strawberry (*Fragaria x ananassa* Duch.) through *In vitro* runner tip culture through incorporation of growth hormones. Article no.BJI.46235, 22(4), 1-9

Biswas M. K., Islam R., Hossain M. 2008. Micropropagation and field evaluation of strawberry in Bangladesh. J Agric Technol 4, 167-182.

Calvete O. E., Grando F. M., Gomide G D., Maran E. R., Suzin M., Nienow A. A., Cecchetti D. 2009. Desempenho *in vitro* e agronômico de cultivares micropropagadas de morangueiro em vários subcultivos. Rev. Bras. Frutic. Jaboticabal – SP, 31(4), 943-949

Chalupa V. 2002. *In vitro* propagation of mature trees of *Sorbus aucuparia* L. and field performance of micropropagated trees. Journal of Forest Science 48, 529-535.

Diengngan S., Murthy N. S. 2014. Influence of plant growth promoting substances in micropropagation of strawberry cv. Festival. The Bioscan 9(4), 1491-1493.

Diel M. I., Marques P. M. V., Cocco C., Thiesen L. A., Bruna Stringari A. B., Fontana D. C., Caron B. O., Testa V., Schmidt D. 2017. Artificial vernalization in strawberry plants: phyllochron, production and quality. Austr. J. Crop Sci. 11(10), 1315-1319.

Elhamdouni E. M., Lamarti A., Badoc A. 2000. Micropropagation des cultivars "Chandler" et "Tudla" de fraisier (*Fragaria x ananassa* Duch). Bulletin de la Société de Pharmacie de Bordeaux 139, 91-104

Graham J. 2005. *Fragaria* strawberry. In: Litz R (ed) Biotechnology of fruit and nut crop. Biotechnology in Agriculture Series No 29, CAB International. Wallingford, UK. pp: 456-474

Haddadi F., Abd Aziz M., Saleh G., Abd Rashid A., Kamaladini H. 2010. Micropropagation of strawberry cv. Camarosa: prolific shoot regeneration from *in vitro* shoot tips using thidiazuron with N6-benzylamino-purine. HortScience 45(3), 453-456.

Hannum S .M. 2004. Potential Impact of Strawberries on Human Health: A Review of the Science. Crit. Rev. in Food Sci. Nutr. 44(1), 1-17.

Hazarika B. N., Teixeira da Silva J. A., Talukdar A. 2006. Effective Acclimatization of *in Vitro* Cultured Plants: Methods, Physiology and Genetics, Floriculture, Ornamental and Plant Biotechnology Volume II, Global Science Books

Heinonen M. I., Meyer A. S., Frankle E. N. 1998. Antioxidant activity of berry phenolics on human low-density lipopreotein and liposome oxidation. J. Agric. Food. Chem. 46, 4107–4112.

Juárez M. C. V., López D. E., Espino L. F. D., Pérez E. G. 2019. *Ex vitro* acclimation of *Fragaria x ananassa* Duch seedlings. Rev. Mex. Cienc. Agríc. 10, 91-100.

Kampf A. N., Calvete E. O., Bellé S. 1998. Rooting media and plant acclimatization *ex vitro*. In: Combined Proceedings-International Plant Propagators Society. Univ. Washington. Int. Plant Propagation Soc. 48, 709-714.

Kaur R., Gautam H., Sharma D. R. 2005. A low cost strategy for micropropagation of strawberry (*Fragaria x ananassa* Duch.) cv. Chandler. Acta Horticulturae 696, 129-133.

Kumar K., Rao I. U. 2012. Morphophysiological problems in acclimatization of micropropagated plants in – *ex vitro* conditions – a review. J. Ornam. Hort. Plants 2, 271-283.

Lee E. C. M., de Fossard R. A. 1977. Some factors affecting multiple bud formation of strawberry *Fragaria x ananassa in vitro*. Acta Horticulturae 78, 187-195.

Ling A. C. K., Wetten A. 2017. *In vitro* regeneration of *Fragaria vesca* L. (Pertumbuhan semula *in vitro Fragaria vesca* L.). J. Trop. Agric. Food Sci. 45(1), 77-88.

Malone N. 2014. Strawberries: Cultivation, Antioxidant Properties and Health Benefits, Nutrition and Diet Research Progress. Nova Science Publishers, Inc., New York

Mezzetti B., Giampieri F., Zhang Yun-tao, Zhong Chuan-fei 2018. Status of strawberry breeding programs and cultivation systems in Europe and the rest of the world. Journal of Berry Research 8, 205–221.

Mohan R., Chui E. A., Biais L. A., Soccol C. R. 2005. Alternative *in vitro* propagation: use of sugarcane bagasse as a low cost support material during rooting stage of strawberry cv. Dover. *Braz Arch Biol Tech* 48, 37-42.

Moreira M., Carvalho J., G-Pasqual M., Borges F. V., Bortolotto A. Da.S. 2006. Acclimatization of micropropagated pineapple plants cv. "Pearl" substrate effect. Sci. and Agrotecnologia 30(5), 875-879.

Murashige T., Skoog F. 1962. A revised medium fo rapid growth and bioassays with tobacco tissue cultures. Physiologia Plantarum 15(3), 473-497.

Rajan S. 2007. Propagation of horticultural crops (Vol. 6). New India Publishing.

Rattanpal H. S., Gill M. I. S., Sangwan A. K. 2011. Micropropagation of strawberry through meristem culture. Acta Hort. 890, 149-153.

Rekha R., Mandave P., Meti N. 2013. Micropropagation of strawberry cultivar Sweet Charlie through axillary shoot proliferation. J. Appl. Hortic. 15(1), 71-73.

Sakila S., Ahmed M. B., Roy U. K., Biswas M. K., Karim R., Razvy M. A., Hossain M., Islam R., Hoque A. 2007. Micropropagation of strawberry (*Fragaria x ananassa* Duch.) A newly introduced crop in Bangladesh. American-Eurasian Journal of Scientific Research 2(2), 151-154.

Șuțan N. A., Popescu A., Isac, V. 2009. The effects of culture medium composition on *in vitro* rooting of two intergeneric hybrids *Fragaria x potentilla*. Analele Universității din Oradea, Fascicula Biologie, XVI / 2, 150-154.

Wafaa A. F., Wahdan H. M. 2017. Influence of substrates on *in vitro* rooting and acclimatization of micropropagated strawberry (*Fragaria x ananassa* Duch.). Middle East J. Agric. Res. 6(3), 682-691.

Wang S. Y., Jiao H. 2000. Scavenging capacity of berry crops on super oxide radicals, hydrogen peroxide, hydroxyl radicals and singlet oxygen. Journal of Agric. and Food chemistry 48, 5677-5684.

Wang H., Cao G., Prior R. L. 1996. Total antioxidant activity of fruits. Journal of Agricultural and Food chemistry 44, 701-705.

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IN VITRO ANTIOXIDANT ACTIVITY AND PHENOLIC CONTENTS OF THE ETHANOLIC EXTRACT OF ABUTILON THEOPHRASTI

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Keywords*: antioxidant activity, polyphenols, flavonoids, Abutilon theophrasti*

ABSTRACT

The present study was designed to determine Abutilon theophrasti's ethanolic extract antioxidant activity, total phenol compounds and flavonoids, using spectrophotometric methods, comparative with alcoholic extracts prepared from two species well known for their antioxidant potential, Camellia sinensis and Echinacea purpurea. The antioxidant activity was evaluated as the scavenger ability on DPPH radicals. We concluded that A. theophrasti extract presents intermediary content of total phenols and flavonoids between C. sinensis and E. purpurea extracts, but the total flavonols content was higher. The antioxidant activity of the studied extract was comparable with that of the two standard solutions. It can be said that A. theophrasti is an indigenous plant with real antioxidant potential, and therefore therapeutic, due to the high content of polyphenolic compounds, especially flavonols.

INTRODUCTION

Oxidative stress, first described by Sies in 1985, is an unbalance between the production of oxidative species and their epuration, in favor of the former, causing oxidative damage on the cell, including membrane phospholipids, proteins and DNA. It may be considered that it is the result of the unbalance between prooxidants and antioxidants in the redox homeostasis that may lead to the generation of reactive oxygen and nitrogen species, such as superoxide, hydroxyl radical, peroxynitrite (Sies 1986). There have been done lots of studies referring free radicals, oxidative stress and antioxidant activity of xenobiotics that demonstrated antioxidants role (Abourashed 2013). Oxidative stress and also chronic inflammation are involved in the etiopathogenesis of more than 50 diseases like the cardio-and cerebrovascular, metabolic, cancer and inflammatory ones (Liguori et al. 2018). Natural antioxidants present the main advantage that they are safe and economic, especially the ones obtain from indigenous vegetal sources (Wilson et al. 2017). *Abutilon theophrasti* is an indigenous plant included in the *Malvaceae* family, native from South Asia and spread in South-Eastern Europe and the Mediterranean area. The plant presents lots of therapeutic effects like antiulcerative, laxative, analgesic-antipyretic-antiinflammatory, diuretic, stomachic-carminative, being used in the treatment of rheumatic aches, arthrosis, dysentery, otitis (Warwick et al. 1988). Plant's phytochemical analysis proved the presence of phenolic acids, flavonoid compounds, sterols, triterpenes, tannins, vitamins, sugars. These active principles are well known for the depressant effect on the inflammatory processes, on the cellular proliferation, equilibration of the redox balance, and even for the anticancer effect due to the antioxidant activity (Mamadalieva et al. 2014).

In this study, we have assessed *Abutilon theoprasti's* extract antioxidant activity and phenolic contents compared with two plants well known for this effect, *Camellia sinensis* and *Echinacea purpurea.*

MATERIAL AND METHODS

Plant collection and preparation of extract. Abutilon theophrasti has been collected from "Alexandru Buia" botanical garden, from Craiova, in April-May 2018. We prepared the ethanolic extract using the aerial part and the fried roots and ethylic alcohol 70^{o} at an extraction ratio 1:5. We also prepared ethanolic extracts of *C. sinensis* and *E. purpurea* with the same concentration as control samples.

Chemicals. 2,2-diphenyl-1-picrylhydrazyl (DPPH) and dimethylsulfoxide (DMSO) were purchased from Sigma Aldrich (Steinheim, Germany). Folin-Ciocalteu's phenol reagent, ascorbic acid, gallic acid, quercetin, aluminum chloride, sodium carbonate and sodium acetate were from Merck Chemical Supplies (Darmstadt, Germany). Solvents (ethanol, methanol) were purchased from Chimreactiv SRL (Bucharest, Romania). All the chemicals used, solvents included, were of analytical grade.

Determination of total phenols content. Total phenolic compounds were determined by Folin-Ciocalteu's spectrophotometric method, using gallic acid as a standard. (Singleton & Rossi, 1965) 0.2 mL extract have been added to 2 mL Folin-Ciocalteu's phenol reagent 0.2 N and 0.9 mL Na_2CO_3 75 g/L. The solution was incubated in the dark for two hours at 25^{0}C. The absorbance was recorded against reagent blank at 760 nm using a Beckman DU65 spectrophotometer. We integrated the result on the gallic acid calibration curve (concentrations between 0-500 µg/mL). The results were expressed as µg gallic acid equivalents/mL.

Determination of total flavonoid compounds. Total flavonoid content was measured spectrophotometrically, using $AlCl_3$ as a color reagent, with quercetin as a standard. (Woisky & Salatino, 1988) 0.5 mL extract sample have been added over 1.5 mL methanol, 0.1 mL $AlCl_3$ 10%, 0.1 mL CH_3COONa 1M and 2.8 mL distilled water. The solution was incubated for 30 minutes at 25^{0}C, the yellow color appeared indicating the presence of flavonoids. The absorbance was recorded at 415 nm. We integrated the result on the quercetin calibration curve (0-50 µg/L). The results were expressed as µg quercetin equivalents/mL.

Determination of flavonol compounds. Flavonol content was measured using also $AlCl_3$ as a color reagent and quercetin as a standard. (Oiedemy et al, 2010) 0.5 mL extract sample have been added over 0.5 mL $AlCl_3$ 2% solution in methanol and 0.75 mL CH_3COONa 50 g/L. The solution was incubated 2.5 hours at 20^{o}C. The absorbance was measured at 440 nm. We integrated the result on the quercetin calibration curve (0-50 µg/L). The results have been expressed in µg equivalent quercetin/mL.

Determination of the in vitro antioxidant activity. was done using DPPH method, based on the sample's ability to scavenge the DPPH radical. (Blois, 1958) Different sample volumes (2-20µL) have been added over 40 µL DMSO and 2.96 mL DPPH 0.1 mM. The absorbance was measured at 517 nm, after 20 minutes of incubation in the dark, at 25°C. The calibration curve was plotted using ascorbic acid (concentrations between 0-200 µg/mL). Sample's inhibitory effect was calculated after the following formula:

% inhibition = 100x(Acontrol - Asample)/Acontrol

All the measurements for this experiment were done in triplicate.

RESULTS AND DISCUSSIONS

Abutilon theophrasti ethanolic extract has a great content of polyphenolic compounds than *E. purpurea* extract and lower than the one obtained from *C. sinensis* (Table 1 and Figure 1). *E. purpurea* is well known for its antioxidant activity and that is due to its polyphenolic compounds, so we can say that the extract analyzed could have a higher antioxidant activity than the *E. purpurea* extract. Epidemiological studies suggest that a diet rich in plant polyphenols protects against cardiovascular and neurodegenerative diseases, diabetes, cancer and osteoporosis (Scalbert et al. 2005). The polyphenolic compounds are substances with free radical scavenger activity, this explaining their antioxidant activity (Hermann 1989).

Table 1

Total phenols and flavonoid contents of the extracts analyzed

Vegetal product	Total phenolic content (µg GAE/mL +/- SD)	Total flavonoid content (µg QE/mL +/- SD)
Abutillon theoprasti Medik.	75.38+/-2.16	11.43+/-0.6
Echinacea purpurea	31.33+/-1.58	4.75+/-0.15
Camellia sinensis	96+/-1.43	7.39+/-0.12

SD - standard deviation

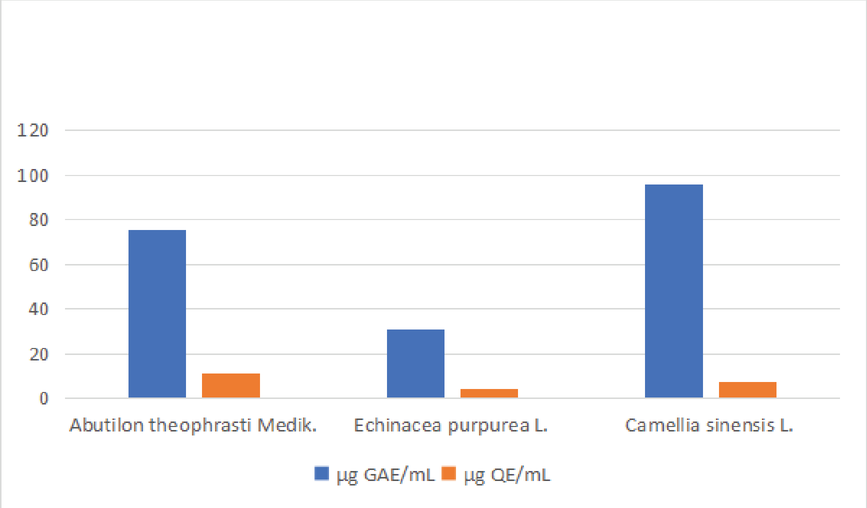

Figure 1. Total phenols and flavonoid contents of the extracts analyzed

Flavonoids represent a class of polyphenolic compounds omnipresent in plant kingdom, that include substances like quercetin, genistein, catechin, epigallocatechin, that not only present antioxidant activity, but also immunomodulatory, anti-inflammatory, antiviral, antibacterial activity (Heim et al. 2002, Brodowska 2017). Flavonoids' antioxidant activity is assured by the phenolic hydroxyl groups, their antioxidant activity being higher with the increase of the degree of hydroxylation. This is why they can act as superoxide and hydroxyl scavengers, an also as metal scavengers (Russo 2018).

We have obtained that total flavonoid content is higher in *A. theophrasti* extract than in *E. purpurea* and *C. sinensis* extracts (Table 1, Figure 1). This is why we can assume that the tested extract may present a stronger positive effect in pathologies like cardiovascular and neurodegenerative diseases, bacterial and viral infections, and also in immune disorders than *E. purpurea* extract.

Flavonols are a subclass of flavonoids that include quercetin, rutin, kaempferol, myricetin. Especially quercetin is widely spread in plants. It presents many positive actions, like antioxidant activity, inhibition of LDL oxidation, prevention of neuronal oxidation, platelet antiaggregant effects. That is why the intake of quercetin is associated with the decrease of cardiovascular heart diseases (Perez & Duarte 2010).

It is remarkable the fact that *A. theophrasti* extract contains a higher amount of flavonols than both *E. purpurea* and *C. sinensis.* That is why we can say that *A. theophrasti* may be used as a solid source of quercetin, more solid than *C. sinensis* and also *E. purpurea,* and could be used for the isolation of flavonols.

Table 2

Total flavonol content of the extracts analyzed

Vegetal product	Flavonols (µg QE/mL +/- SD)
Abutillon theoprasti Medik.	20.87+/-1.64
Camellia sinensis	11.65+/-1.35
Echinacea purpurea L.	12.53+/-0.26

DPPH is an oxidant compound that has a purple coloration. When it comes in contact with a substance able of donating electrons (antioxidant), DPPH is reduced, the intensity of the purple color decreases and implicitly its absorption (Manzocco et al. 1998). The concentration of an antioxidant necessary to decrease the initial DDPH concentration by 50% (IC50) was used to assay the antioxidant activity of our extracts, with high IC50 values indicating lower antioxidant activity (Matuszewska et al. 2018).

Regarding *in vitro* antioxidant activity, IC50 for *A. theophrasti* extract allows us to say that it is a little bit more efficient than the one of *E. purpurea* and *C. sinensis* (Table 3, Figure 2), even if it has a lower content of polyphenols. Instead, the flavonols content of *A. theophrasti* extract is higher and could sustain its antioxidant potential.

Table 3

IC50 values in the DPPH-radical scavenging assay of the ethanolic extracts

Extract	IC50 (inhibitory concentration 50) (µg/mL)
Abutilon theoprasti Medik.	25.62+/-1.83
Echinacea purpurea	31.97+/-2.27
Camellia sinensis	31.16+/-1.67

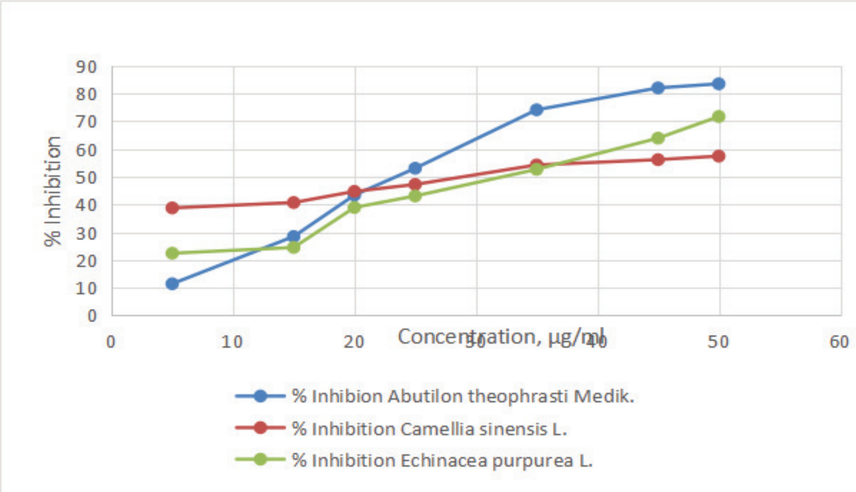

Figure 2. Variation of the antioxidant activity for the extracts analyzed. Results plotted as mean at various concentrations

CONCLUSIONS

Overall, we can say that *A. theophrasti* extract presents notable antioxidant activity sustained by the level of compounds with antioxidant properties, i.e the ability to scavenge reactive species. It is necessary to test the *in vivo* antioxidant activity, and also other effects, such as the immunomodulatory and antimicrobial ones, to sustain its medicinal use.

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REFERENCES

Abourashed E.A. 2013. Bioavailability of Plant-Derived Antioxidants. Antioxidants (Basel), 2(4), 309–325.

Blois M.S. 1958. Antioxidant determinations by the use of a stable free radical. Nature, 181, 1199–1200.

Brodowska K. 2017. Natural Flavonoids: Classification, Potential Role, and Application of Flavonoid Analogues. European Journal of Biological Research, 7, 108-123.

Heim K.E., Tagliaferro A.R., Bobilya D.J. 2002. Flavonoid antioxidants: chemistry, metabolism and structure-activity relationships. The Journal of Nutritional Biochemistry, 13(10), 572-584.

Hermann K. 1989. Occurrence and content of hydroxycinnamic and hydroxybenzoic acid compounds in foods. Critical Reviews in Food Science and Nutrition, 28(4), 315-347.

Liguori I., Russo G., Curcio F., Bulli G., Aran L., Della-Morte D., Gargiulo G., Testa G., Cacciatore F., Bonaduce D., Abete P. 2018. Oxidative stress, aging, and diseases. Clinical Interventions in Aging, 13, 757–772.

Mamadalieva N.Z., Sharopov F., Girault J.P., Wink M., Lafont R. 2014. Phytochemical analysis and bioactivity of the aerial parts of Abutilon theophrasti (Malvaceae), a medicinal weed. Natural Product Research, 28(20), 1777-1779.

Manzocco L., Anese M., Nicoli M.C. 1998. Antioxidant properties of tea extracts as affected by processing. LWT – Food Science and Technology, 31(7-8), 694–698.

Matuszewska A., Jaszek M., Stefaniuk D., Ciszewski T., Matuszewski L. 2018. Anticancer, antioxidant, and antibacterial activities of low molecular weight bioactive subfractions isolated from cultures of wood degrading fungus *Cerrena unicolor.* PLoS ONE,13(6), e0197044.

Oiedemy S.O., Bradley G., Afolayan A. 2010. *In vitro* and *in vivo* antioxidant activities of aqueous extract of *Strychnos henningsii gilk*. A*frican Journal of Pharmacy and Pharmacology*; 4, 70-78.

Perez Viscaina F., Duarte J. 2010. Flavonols and cardiovascular disease. Molecular Aspects of Medicine, 31(6), 478-494.

Russo D. 2018. Flavonoids and the Structure-Antioxidant Activity Relationship. Journal of Pharmacognosy and Natural Products, 4, 1.

Scalbert A., Manach C., Morand C., Rémésy C., Jiménez L. 2005. Dietary Polyphenols and the Prevention of Diseases. Critical Reviews in Food Science and Nutrition, 45(4), 287-306.

Sies H. 1986. Biochemistry of oxidative stress. Angewandte Chemie International Edition, 25(12), 1058–107.

Singleton V.L., Rossi J.A. 1965. Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. American Journal of Enology and Viticulture, 16(3), 144-158.

Warwick S.I., Black L.D. 1988. The biology of canadian weeds.: 90. *Abutilon theophrasti*. Canadian Journal of Plant Science, 68(4), 1069-1085.

Wilson D.W., Nash P., Buttar H.S. 2017. The Role of Food Antioxidants, Benefits of Functional Foods, and Influence of Feeding Habits on the Health of the Older Person: An Overview. Antioxidants (Basel), 6(4), 81.

Woisky R., Salatino A. 1998. Analysis of propolis: some parameters and procedures for chemical quality control. Journal of Apicultural Research, 37, 99-105.

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ORGANIC FERTILIZER – AGROCHEMICAL EFFECTS IN POMICULTURE

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Keywords*: bio-fertilizers, algae, protein hydrolysate, foliar application, apple*

ABSTRACT

The paper is focused on a new range of bio-fertilizers with organic substances based on plant-derived protein hydrolysates (a mixture of peptides and free amino-acids) and algae extract (Ascophyllum nodosum), used in pomiculture. These extracts are rich in carbohydrates, organic acids, cytokines, auxins, gibberellins, vitamins, and trace elements. The experimental fertilizer was tested in the orchard on apple by foliar application, in a concentration of 1%, during the vegetative phase. The trials were performed in comparison to a non-fertilized control. The use of the foliar fertilizer led to yield increases of 19.7% compared to the control. The application of the two foliar treatments with the experimental fertilizer increased the process of photosynthetic assimilation to apple tree, cultivated in the orchard on cerno-cambic hortic anthrosol with 19 - 21%.

INTRODUCTION

Climate change can have a big impact on the emerging food safety risks at different stages of the food chain, from primary production to consumption. The climatic factors can have an impact on food safety by means of: changes in temperature and precipitation patterns, increased frequency and intensity of extreme weather conditions, global warming and changes in contaminant transport pathways. Given the risks related to climate change, the use of growth regulators (biostimulants) represents a solution for sustainable agriculture, as they provide an alternative to conventional products.

In general, a product with a biostimulator effect on plants can be defined as any substance or microorganism applied to plants in order to increase nutritional efficiency, tolerance to abiotic stress and /or quality properties of crops, regardless of its nutrient content. It has been noticed, that these complex bio-fertilizing formulas are well assimilated by plants, and can contribute to the increase of the production and its quality.

Algae extracts, humic and fulvic acids, protein hydrolysates are often used and have many positive effects on plants, as they increase: production, photosynthesis, absorption rate and nutrients use, and resistance to biotic and abiotic stress (DaMatta et al. 2010, Van Olsten et al. 2017, Rouphael & Colla 2018, Battacharyya et al. 2015, Halpern et al. 2015). Protein hydrolysates are mixtures of polypeptides, oligopeptides, and free amino acids derived from partial hydrolysis of agricultural by-products from animals and plants. Plant-derived protein hydrolysates

(PHs) have gained prominence as plant biostimulants due to their potential to increase the germination, productivity and quality of a wide range of horticultural and agronomic crops. Application of protein hydrolysates can also alleviate the negative effects of abiotic plant stress due to salinity, drought and heavy metals (Van Olsten et al. 2017, Colla et al. 2017, McCarthy et al. 2013, Amirkhani et al. 2016, Trevisan et al. 2019).

Depending on the formulation, algae-based products are used as organic fertilizers or components of organo-mineral fertilizers, soil improvers, biostimulants and pesticides. Algae is one of the richest biological resource, that contains bioactive compounds, such as: polyunsaturated fatty acids (omega-3), vitamins (group B), carotenoids, polyphenols (antioxidants), as well as compounds like auxins, gibberellins and cytokinins, polysaccharides, proteins and minerals that enhance the natural growth of plants (Yokoya et al. 2010, Zhang & Ervin 2008). The application of algae-based products determines disease resistance. These fertilizers improve seed germination, root development, increase the plant tolerance to the environment, ensure increased frost resistance, resistance and reduced incidence of insect attack, and enhance plant growth. Moreover, algae is used as a soil modifier (McCarthy et al. 2013). Currently, one of the most promising applications of algae is its use in biostimulant products. This is due to its composition (cytokinins, auxins, gibberellins, micronutrients, etc.) essential in plant metabolism (Khan et al. 2009, Jayaraj et al. 2008, Stirk et al. 2003, Michalak et al, 2016, Sharma et al. 2014, Uysal et al. 2015, Tudor et al. 2017).

MATERIAL AND METHODS

Ecoaminoalga is a growth stimulating bio-fertilizer with the following composition: organic nitrogen 30 g/L, potassium 60 g/L, organic matter 45-48%, algae extract (*Ascophyllum nodosum*) and amino acids (Lysine, Histidine, Arginine, Hydroxyproline, Threonine, Acid Aspartic, Serine, Proline, Acid Glutamic, Glycine, Alanine, Cysteine, Valine, Methionine, Isoleucine, Leucine, Tyrosine, Phenylalanine, Tryptophan) from plant-derived protein hydrolysate. Due to the complex organic structure, Ecoaminoalga activates the biochemical processes in plant tissues and has a direct influence on the vital functions of cells and their activity.

The trials were performed by applying the Ecoaminoalga (1% solution) to the apple tree in the intensive orchard. The experiment consisted of two foliar treatments performed with solution by fine atomization on the entire foliar surface, as follows: the first treatment - after the flowering phenophase; the second treatment – during the fruit growth phase.

The main physical, chemical and biological properties of the cerno-cambic hortic anthrosol were: a fine clay soil texture (38.8% and 45.5% clay); pH – weakly acidic (6.18 pH units) at the surface and neutral (6.82 - 7.11 pH units) below 60 cm depth; humus 3.15%; total nitrogen (0.148 - 0.131%); mobile phosphorus 40 - 35 ppm at the surface and 27 - 25 ppm below 40 cm depth; mobile potassium 216 - 193 ppm at the surface and 140 -100 ppm below 40 cm depth, and base saturation of 85% at the surface and 90% below 40 cm depth.

The effects of the treatments were studied by analysis of variance (Fischer method) and Fisher's Least Significant Difference (LSD) test. All data are relative values as compared with the control (treated only with water) considered equal 100%.

The results were considered significant and were noted for the following circumstances: *significant ($0.01 < p \le 0.05$), **very significant ($0.001 < p \le 0.01$), ***highly significant ($p \le 0.001$).

RESULTS AND DISCUSSIONS

The bio-fertilizer (Ecoaminoalga) was characterized and tested in order to establish the agrochemical efficiency to the apple in the intensive non-irrigated orchard. The experimental fertilizer contained plant-derived protein hydrolysate, algae extract (*Ascophyllum nodosum*) and secondary elements (Mg, S, Fe, Cu, Zn, Mn). Based on the physicochemical analyses, Ecoaminoalga presented the following composition: organic nitrogen 3.6%, potassium 8.3%, and 45.3% organic matter.

The agrochemical trials assessed the evolution of production and the production yields, the process of photosynthetic assimilation, and the macronutrients content (NPK) present in foliar metabolism after fertilization. The evolution of production, production yields, photosynthesis activity, nutrient content and production quality are presented in Tables 1–3. The productive efficiency resulted after the foliar application of Ecoaminoalga to apple in intensive orchard, on cerno-cambic hortic anthrosol is presented in Table 1.

Table 1

Productive efficiency (kg/ha) after foliar fertilization with Ecoaminoalga on apple (Idared) in intensive orchard, on cerno cambic hortic anthrosol

Variant	Dose L/ha/ treatment	No. of treatments	Average prod. (kg/ha)	Yield	
				kg/ha	%
Control	-	-	10818	-	100
Ecoaminoalga	2.5	2	12948	2130**	119.7

DL 5% - 1524 kg/ha; DL 1% - 2071 kg/ha; DL 0.1% - 3039 kg/ha

The foliar treatments during the vegetative phase (periods of maximum nutritional consumption) with Ecoaminoalga fertilizer (1% solution) to apple determined an increase in photosynthesis activity and in the consumption of nutrients from soil.

The obtained results (Table 2) show a statistically significant yield compared to the control, for each assimilatory pigment and for the total content of assimilatory pigments after the two foliar treatments (1% solution). The results also showed that the increase of the photosynthesis was supported by the production yields. The photosynthetic efficiency promoted the increase of the production and the absorption of substances by the plant cell.

It can be noticed (Table 3), that the application of two foliar treatments with Ecoaminoalga in the critical periods and of maximum necessity for plant nutrition at apple, has a positive influence on the macronutrients content (NPK) present in the foliar metabolism.The experimental results showed statistically assured yields, significant compared to the control for phosphorus content and very significant for nitrogen and potassium contents (Table 3).

Table 2

Influence of foliar fertilization with Ecoaminoalga fertilizer on photosynthesis in apple leaves (Idared) in intensive non-irrigated orchard

Indicators / Experimental variant	Control	Ecoaminoalga
Chlorophyll a (mg/g fresh substance)	0.816	0.986
Difference compared to the control (mg/g fresh substance)	-	0.170
Difference compared to the control (%)	100	120.83
Statistical significance	-	**
Chlorophyll b (mg/g fresh substance)	0.4514	0.5495
Difference compared to the control (mg/g fresh substance)	-	0.0981
Difference compared to the control (%)	100	121.73
Statistical significance	-	*
Carotene (mg/g fresh substance)	0.4341	0.5176
Difference compared to the control (mg/g fresh substance)	-	0.0835
Difference compared to the control (%)	100	119.24
Statistical significance	-	*
Total pigments (mg/g fresh substance)	1.702	2.053
Difference compared to the control (mg/g fresh substance)	-	0.351
Difference compared to the control (%)	100	120.62
Statistical significance	-	**

Chlorophyll a	Chlorophyll b	Carotene	Total pigments
DL5%: 0.101 mg/g	DL5%: 0.0832 mg/g	DL5%:0.0735 mg/g	DL5%: 0.254 mg/g
DL1%: 0.147 mg/g	DL1%: 0.1165 mg/g	DL1%:0.1155 mg/g	DL1%: 0.303
DL0.1%:0.203 mg/g	DL0,1%:0.1658 mg/g	DL0.1%:0.1578 mg/g	DL0.1%:0.522 mg/g

Table 3.

Influence of foliar fertilization with Ecoaminoalga fertilizer on mineral nutrition in apple leaves (Idared) in intensive non-irrigated orchard (dry matter)

Indicators / Experimental variant	Control	Ecoaminoalga
Total nitrogen (Nt %)	1.563	1.698
Difference compared to the control	-	0.135
(%)	100	108.6
Statistical significance	-	**
Phosphorus (P_2O_5 %)	0.1573	0.1942
Difference compared to the control	-	0.0369
(%)	100	123.5
Statistical significance	-	*
Potassium (K_2O %)	1.0253	1.0844
Difference compared to the control	-	0.0591
(%)	100	105.8
Statistical significance	-	**

Nt (%)	P_2O_5 (%)	K_2O (%)
DL5% - 0.0974%	DL5% - 0.0311%	DL5% - 0.0315%
DL1% - 0.1156%	DL1% - 0.0524%	DL1% - 0.0521%
DL0.1% - 0.1416%	DL0.1% - 0.0732%	DL0.1% - 0.0726%

According to the results, the use of Ecoaminoalga bio-fertilizer led to the increase of: mineral assimilation, chlorophyll content and cellular multiplication.

Consequently, this led to: strong development of the foliar surface; better regulation of fruit differentiation; improved quality and quantity of production; increased resistance to stress and temperature variations; faster absorption and translocation in plant; increased resistance to diseases and pests.

CONCLUSIONS

The use of the foliar Ecoaminoalga bio-fertilizer led to yield increases of 19.7% compared to the control. The two foliar treatments determined statistically significant yields compared to the control for the carotene content in leaves and very significant for the content of chlorophyll pigments, as well as for the total content of assimilatory pigments, in the range of 19.2% and 21,7%. The foliar fertilization had a positive influence on the productivity and quality indicators, as well as on the photosynthesis activity. The foliar fertilization also stimulated the biosynthesis of assimilatory pigments, by decreasing the extent of the organogenesis stages

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REFERENCES

Amirkhani M., Netravali A. N., Huang W. 2016. Investigation of soy protein–based biostimulant seed coating for broccoli seedling and plant growth enhancement. Hortscience, 51, 1121–1126.

Battacharyya D., Babgohari M.Z., Rathor P., Prithiviraj B. 2015. Seaweed extracts as biostimulants in horticulture. Scientia Horticulturae, 196, 39–48.

Colla G., Hoagland L., Ruzzi M., Cardarelli M., Bonini P., Canaguier R., Rouphael Y. 2017. Biostimulant action of protein hydrolysates: unraveling their effects on plant physiology and microbiome. Frontiers in Plant Science, 7, 1-14.

DaMatta F., Grandis A., Arenque B., Buckeridge M. 2010. Impacts of climatic change on crop physiology and food quality. Food Research International, 43, 1814-1823.

Halpern M., Bar-Tal A., Ofek M., Minz D., Muller T., Yermiyahu U. 2015. The use of biostimulants for enhancing nutrient uptake. Advances in Agronomy, 130, 141–174.

Jayaraj J., Wan A., Rahman M., Punja Z.K. 2008. Seaweed extracts reduces foliar fungal disease on carrot. Crop Protection, 27,1360-1366.

Khan W., Rayirath U.P., Subramanian S., Jithesh M.N., Rayorath P., Hodges D.M., Critchley A.T., Craigie J.S., Norrie J., Prithiviraj B. 2009. Seaweed extracts as biostimulants of plant growth and development. Journal of Plant Growth Regulation, 28, 386–399.

McCarthy A. L., O'Callaghan Y. C., O'Brien N. M. 2013. Protein hydrolysates from agricultural crops-bioactivity and potential for functional food development. Agriculture, 3, 112-130.

Michalak I., Tuhy L., Chojnacka K. 2016, Co-Composting of algae and effect of the compost on germination and growth of Lepidium sativum. Polish Journal of Environmental Studies, 25, 1107-1115.

Rouphael Y., Colla G. 2018. Synergistic biostimulatory action: Designing the next generation of plant biostimulants for sustainable agriculture. Frontiers in Plant Science, 9, 1 – 17.

Sharma S.H.S., Fleming C., Selby C., Rao J.R, Martin T. 2014. Plant biostimulants: a review on the processing of macroalgae and use of extracts for crop management to reduce abiotic and biotic stresses. Journal of Applied Phycology, 26, 465–490.

Stirk W.A., Novaik O., Strnad M., Van Staden J. 2003. Cytokinins in macroalgae. Plant Growth Regulation, 41, 13-24.

Trevisan S., Manoli A., Quaggiotti S. 2019. A novel biostimulant, belonging to protein hydrolysates, mitigates abiotic stress effects on maize seedlings grown in hydroponics. Agronomia, 9, 1-16.

Tudor E., Cioroianu T., Sîrbu C., Dumitru M., Grigore A., Parvan L. 2017. Fertilizers for the treatment of iron chlorosis. physico-chemical and agro-chemical properties. Revista de Chimie, 68, 65-71.

Uysal O., Ozdemir O. F., Ekinci K. 2015. Evaluation of microalgae as microbial fertilizer. European Journal of Sustainable Development, 4, 77-82.

Van Olsten M.J., Pepe O., DePasacle S., Silletti S., Magio A. 2017. The role of biostimulants and bioeffectors as alleviators of abiotic stress in crop plants. Chemical and Biological Technologies, 4, 1-12.

Yokoya N.S., Stirk W.A, Van Staden, J., Novak O., Tureckova V., Pencik A., Strnad M. 2010. Endogenous cytokinins, auxins, and abscisic acid in red algae from Brazil. Journal of Phycology, 46, 1198-1205.

Zhang X.Z., Ervin E.H. 2008. Impact of seaweed extract-based cytokinins and zeatin riboside on creeping bentgrass heat tolerance.Crop Science, 48, 364-370.

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EVALUATION OF POLYPHENOLS CONTENT AND ANTIOXIDANT ACTIVITY IN MANDARIN JUICE FROM DIFFERENT FRUIT CULTIVARS GROWN IN GREECE

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Keywords: *Mandarin juice; total phenols; phenolic fractions; DPPH activity; FRAP activity*

ABSTRACT

In this study, the phenolic content and antioxidant activity in ten mandarin juices from different fruit cultivars (Sra 89, Spinoso, Klausellina, Fortune, Sra 61, Encore, Murkott, Nova, Sra 63 and Clementine fina) grown in Greece, was evaluated. The total phenolic, non-flavonoid phenols and flavonoid phenols contents ranged from (204.5 to 322.1, 38.9 to 71.2 and 158.3 to 267.3) mg GAE L^{-1} juice, respectively. The antioxidant activity FRAP in the mandarin juices ranged from 7.3 to 12.5 mM FRAP. The cultivar Encore characterized by the highest TP content and highest antioxidant activity FRAP, while the cultivar Klausellina characterized by the lowest TP content and lowest antioxidant activity FRAP. The intake of natural antioxidant phenols through daily consumption of mandarin juice may provide additional protection against the oxidative damage, which causes many chronic diseases.

INTRODUCTION

The rapid production of free radicals in living organisms can oxidize biomolecules, leading in oxidative damage. Oxidative damage causes many chronic diseases, such as cardiovascular diseases, diabetes, aging and cancer (Hadjaz et al. 2011, Sies 2015). In addition, oxidized LDL-cholesterol leads to oxidant stress that injures endothelial cells (Berliner & Heinecke 1996), and the intracellular triglycerides increase the formation oxidative radicals leading to oxidant stress (Fenster et al. 2002).

Antioxidants may prevent oxidative damage with scavenging of free radicals. Epidemiological investigations demonstrate that Intake of natural antioxidants is associated with preventing many chronic diseases (Huang et al. 2003). Citrus juices contain an array of potent antioxidants, such as flavonoids, hydroxycinnamic acids, carotenoids and vitamin C, which contribute significantly to the preventive effects of fruits against cancer, diabetes, aging and heart disease (Asplund 2002, Valko et al. 2006). Mandarins is an important source of organic acids and phenolic compounds which affect their taste and organoleptic characteristics (Gattuso et al. 2007). Flavonoid phenols of Citrus have shown therapeutic properties with anti inflammatory, antihypertensive, diuretic and analgesic effect (Monforte et al. 1995). According to some authors (Belajova´ and Suhaj 2004), on the content of hydroxycinnamic acids and the flavanone in the citrus juices, this depends from the cultivar, type of citrus, their ripeness and the technological processes of juices production.

The objective of the present research is to investigate and compare of the total phenolic content, phenolic fractions and antioxidant activity in mandarin (*citrus reticulate*) juice from different fruit cultivars grown in Greece.

MATERIAL AND METHODS

Experimental: The present study, was conducted in two adjacent orchards of Peloponnese region. These orchards are located in the village Kefalari of the sity of Argos (latitude $37^{0}36'N$ and longitude $22^{0}41'33.0''E$, altitude 30m) Greece. The major portion of the mandarin orchards are more than 10 years old. The distance of orchards from the sea is 5 km. The area is characterized by a Mediterranean climate with cold dry winters and hot dry summers. Average winter temperature 8.6 ^{0}C, average summer temperature 24.1 ^{0}C and average annual precipitation 481 mm in 2019. Five mandarin cultivars (*citrus reticulate*) such as Sra 89, Spinoso, Klausellina, Fortune and Sra 61 are cultivated in the orchard A, while other five cultivars such as Encore, Murkott, Nova, Sra 63 and Clementine fina are cultivated in the orchard B. Ten mandarin fruits from each tree at the maturation stage were collected from all the orientations and without type of disease from the 1th of September to the 20th of September 2019. The experiment was performed with four repetitions for each cultivar. The fruits were squeezed by a domestic juicer and the juice obtained, is filtered and used immediately for chemical analyses.

Methods of analyses: Soil texture was determined by the bouyoucos hydrometer method (Bouyoucos 1962). Soil was analyzed using the following methods which are referred by (Page et al. 1982). Organic matter was analyzed by chemical oxidation with 1 mol L^{-1} $K_2Cr_2O_7$ and titration of the remaining reagent with 0.5 mol L^{-1} FeSO4. Soil pH and electrical conductivity, measured in the extract (1 part soil: 5 parts H_2O). The calcium carbonate was determined by the method Bernard. Inorganic nitrogen was extracted with 0.5 mol L^{-1} $CaCl_2$ and estimated by distillation in the presence of MgO and Devarda's alloy, respectively. Available P forms (P-Olsen) was extracted with 0.5 mol L^{-1} $NaHCO_3$ and measured by spectroscopy. Exchangeable form of potassium was extracted with 1 mol L^{-1} CH_3COONH_4 and measured by flame Photometer (Essex, UK).

The pH, the Brix degrees and the total acidity were measured in the mandarin juice. The Brix degrees by a Zeiss refract meter, while the total acidity by titration with 0.1N NaOH solution and were expressed as citric acid equivalent in g per 100 ml mandarin juice.

Total phenolic (TP) content in the mandarin juice was determined with the Folin-Ciocalteu (F.-C.) reagent according to the method of (Singleton and Rossi 1965) using the microvariant proposed by (Baderschneider et al. 1999), and were expressed as gallic acid equivalent (GAE) in mg L^{-1} juice. Non-flavonoid phenols (NFP) content in the mandarin juice was determined with the F.-C. reagent after removing the flavonoid phenols (FP) with formaldehyde according to the method proposed by (Kramling and Singleton 1969) and was expressed as gallic acid equivalent (GAE) in mg L^{-1} juice. FP content in the mandarin juice was determined as a difference between the TP content and NFP content. Their amount was evaluated as gallic acid equivalent in mg L^{-1} juice.

DPPH-scavenging activity in the mandarin juice was evaluated using the stable free radical 2,2′-diphenyl-1-pycrylhydrazyl radical (DPPH•), as a reagent, according to the method by (Brand-Williams et al. 1995) and the results were expressed as percentage decrease against control. The reaction mixture contained 4mL 10^{-4}M DPPH• methanolic solution and different amounts of mandarin juice. The inhibition percentage for each sample was calculated using the following equation:

$$\% \text{ inhibition} = [(E_0 - E_x)/E_0] \times 100$$

The E_0, is the extinction of the radical solution before the reaction and E_x, after polyphenols addition of juice solution (Yen and Duh 1994).

The inhibition coefficient (IC_{50}), represents 50% reduction in the colour intensity of the DPPH radical by the total phenols in the studied mandarin juices. Percent inhibition curves versus of sample volume were used to determine of the inhibition coefficient (IC_{50}). Ferric reducing antioxidant power assay (FRAP) in the mandarin juice: The ferric reducing antioxidant power of the mandarin juice was evaluated according to the method by (Benzie and Strain 1999) and the results were expressed as mM FRAP.

Statistical analysis: Data were analyzed using the MINITAB (Ryan et al. 2005) statistical package. The experiment had four replications. Analysis of variance was used to assess treatment effects. Mean separation was made using Tukey's test when significant differences (P = 0.05) between treatments were found. All presented numeric values are means of four measurements ± standard deviation (SD).

RESULTS AND DISCUSSIONS

The soil of the two orchards is characterized as sandy clay loam (SCL), the soil chemical properties are shown in the Table 1. Table 2 shows the physicochemical characteristics of mandarin juices in the maturity stage of the fruits.

Table 1

Soil chemical properties of orchards

Soil properties	Mandarin orchard A		Mandarin orchard B	
Soil depth	(0-30) cm	(30-60) cm	(0-30) cm	(30-60) cm
Texture	SCL	SCL	SCL	SCL
pH	6.7 ± 0.32	6.9 ± 0.34	7.2 ± 0.34	7.4 ± 0.37
EC (dS m^{-1})	0.3 ± 0.02	0.1 ± 0.01	0.4 ± 0.02	0.1 ± 0.01
Organic matter (%)	2.2 ± 0.11	1.4 ± 0.07	1.8 ± 0.09	1.1 ± 0.05
$CaCO_3$ (%)	4.7 ± 0.25	6.8 ± 0.32	3.9 ± 0.20	5.8 ± 0.26
N-inorganic (mg kg^{-1})	95.3 ± 5.78	54.3 ± 3.21	78.7 ± 4.58	47.8 ± 2.81
P-Olsen (mg kg^{-1})	22.4 ± 1.27	8.9 ± 0.50	18.6 ± 1.01	6.4 ± 0.37
K-exchangeable (mg kg^{-1})	177.4 ± 8.63	95.6 ± 4.39	207.8 ± 9.92	84.9 ± 3.91
Na-exchangeable (mg kg^{-1})	142.6 ± 6.66	77.3 ± 3.72	90.7 ± 4.60	66.9 ± 3.50

Electrical conductivity, EC and soil pH is determined in (1:5) soil / water extract; Data represent average means and SE deviation, (n) = 4.

Table 2

Physicochemical characteristics of mandarin juice on the maturity stage of the fruits

Cultivars	pH	Brix degrees	Total acidity (g citric acid /100ml juice)
Clementine Fina	3.52 ± 0.19	12.7 ± 0.60	1.13 ± 0.06
Spinoso	4.29 ± 0.23	12.2 ± 0.56	0.64 ± 0.03
Klausellina	4.03 ± 0.22	11.2 ± 0.54	0.84 ± 0.05
Fortune	4.21 ± 0.22	10.8 ± 0.50	0.73 ± 0.04
Sra 61	4.59 ± 0.25	13.9 ± 0.65	0.55 ± 0.03
Encore	4.23 ± 0.23	10.7 ± 0.54	0.70 ± 0.04
Murkott	3.94 ± 0.22	12.2 ± 0.56	0.94 ± 0.05
Nova	4.02 ± 0.22	13.0 ± 0.61	0.86 ± 0.05
Sra 63	4.37 ± 0.25	13.6 ± 0.66	0.61 ± 0.04
Sra 89	4.58 ± 0.25	13.4 ± 0.66	0.69 ± 0.04

Data represent average and SE deviation. (n) = 4.

Total phenolic (TP) content in the fresh mandarin juices from the cultivars studied ranges from 204.5 to 322.1 mg GAE L^{-1} juice (Table 3). The cultivars Encore, Sra 89 and Spinoso are characterised by the highest TP content equal to 322.1, 313.0 and 306.2 mg GAE L^{-1} juice, respectively. The cultivars Nova, Klausellina and Fortune are characterised by the lowest TP content equal to 204.5, 205.6 and 219.8 mg GAE L^{-1} juice, respectively. TP content in the mandarin juices from the cultivars studied has the following sequence: Encore, Sra 89, Spinoso > Clementine Fina, Murkott, Sra 61, Sra 63 > Fortune, Klausellina, Nova. These values are lower from those reported by other authors for some mandarin cultivars (Wase-Satsuma, Satsuma, Ponkan, Bendizao, Manju, Hybrid 439 and Zhuhong) cultivated in China. These authors found that the TP content in the mandarin juices ranged from 950 to 1555 mg GAE L^{-1} juice (Xu et al. 2008). On the contrary, our results are higher from those reported by other authors for Robinson, Fremont and Satsuma mandarin cultivars cultivated in Turkey. These authors found that the TP content in the mandarin juices ranged from 36 to 132 mg GAE L^{-1} juice (Kelebek and Selli 2014). In addition, it has been established that the total phenolic and phenolic fractions content in the fresh citrus fruit juices, varies and depends from the cultivar, colection season of fruits, climatic conditions, cultivation techniques and technological processes of the production of juices (Belajova´ and Suhaj 2004). Flavonoid phenols (FP) content in the fresh mandarin juices from the cultivars studied ranges from 158.3 to 267.3 mg GAE L^{-1} juice. The cultivars Encore, Sra 89 and Spinoso are characterised by the highest FP content, while the cultivars Fortune, Nova and Klausellina are characterised by the lowest FP content (Table 3). The FP content in the mandarin juices studied represents from 72.0 to 85.3 % of the TP amount (Table 3). Non-flavonoid phenols (NFP) content in the fresh mandarin juices from the cultivars studied ranges from 38.9 to 71.2 mg GAE L^{-1} juice (Table 3). The cultivars Sra 63, Sra 61 and Murkott are characterised by the highest NFP content, while the cultivars Fortune, Nova and Clementine Fina are characterised by the lowest NFP content.

The DPPH-scavenging activity expressed as inhibition coefficient (IC_{50}) is demonstrated in Table 3. The cultivars Encore and Sra 89 showed the lower IC_{50} values (96 and 103 µL juice) characterised by the highest antioxidant potential. The antioxidant potential of the juices depends from the monomeric polyphenols contained in the juices and the synergy between of the individual compounds. The antioxidant activity FRAP in the mandarin juices from the varieties studied ranges from 3.1 to 9.5 mM FRAP. The cultivar Encore characterised by the highest antioxidant activity FRAP in the juices, while the cultivar Klausellina characterised by the lowest antioxidant activity FRAP in the juices (Table 3). The correlation between of TP content and antioxidant activity FRAP or IC_{50} in the mandarin juices studied it was high, with correlation coefficient (r^2) equal to: 0.933 and 0.917, respectively.

Table 3

TP, FP and NFP contents, DPPH-scavenging activity and antioxidant activity FRAP in the mandarin juices studied

Cultivars	TP	FP	NFP	*IC_{50}	FRAP
	mg GAE L^{-1} juice			**µL juices	mM
Clementine Fina	266.7 ± 13.3^{b}	227.5 ± 11.6^{b}	39.2 ± 2.3^{d}	117 ± 5.4^{b}	7.5 ± 0.4^{b}
Spinoso	306.2 ± 14.1^{a}	257.2 ± 12.9^{ab}	49.0 ± 2.5^{c}	109 ± 6.2^{b}	7.8 ± 0.4^{b}
Klausellina	205.6 ± 9.7^{c}	158.3 ± 8.2^{d}	47.6 ± 2.6^{c}	197 ± 9.3^{e}	3.1 ± 0.2^{f}
Fortune	219.8 ± 11.5^{c}	175.8 ± 9.9^{cd}	44.0 ± 2.4^{cd}	162 ± 8.6^{d}	4.9 ± 0.2^{d}
Sra 61	254.8 ± 12.9^{b}	188.5 ± 9.6^{c}	66.3 ± 3.8^{a}	137 ± 7.1^{c}	6.1 ± 0.3^{c}
Encore	322.1 ± 15.3^{a}	267.3 ± 12.8^{a}	54.8 ± 2.8^{bc}	96 ± 5.6^{a}	9.5 ± 0.5^{a}
Murkott	254.3 ± 14.3^{b}	190.7 ± 9.8^{c}	63.6 ± 3.6^{ab}	131 ± 7.1^{c}	6.2 ± 0.4^{c}
Nova	204.5 ± 10.4^{c}	165.6 ± 8.1^{d}	38.9 ± 2.1^{d}	184 ± 9.9^{e}	4.0 ± 0.2^{e}
Sra 63	254.3 ± 13.5^{b}	183.1 ± 8.9^{c}	71.2 ± 3.8^{a}	143 ± 7.2^{c}	6.1 ± 0.3^{c}
Sra 89	313.0 ± 16.1^{a}	261.4 ± 12.3^{a}	51.6 ± 2.5^{bc}	103 ± 4.8^{ab}	8.2 ± 0.5^{b}

*IC50, Inhibition coefficient; **µL juices, Volumes of mandarin juice yielding 50% inhibition of the radical absorbance (IC50); For each chemical property, the values in the columns of the table with the same letter do not differ significantly according to the Tukey's test (P = 0.05); Data represent average and SE deviation. (n) = 4.

CONCLUSIONS

These results confirm that the differences of TP content in the mandarin juices studied is significantly affected by the variety. The antioxidant potential of the mandarin juices, may be attributed in the TP content and the synergy between of the individual antioxidant compounds. The mandarin juices studied are characterized from relatively high antioxidant activity and high TP content. The intake of natural antioxidant phenols through daily consumption of mandarin juice may provide additional protection against the oxidative damage, which causes many chronic diseases.

REFERENCES

Asplund K. 2002. Antioxidant vitamins in the prevention of cardiovascular disease: a systematic review. Journal of internal medicine, 251(5), 372-392.

Baderschneider B., Luthria D., Waterhouse A.L., Winterhalter P. 1999. Antioxidants in white wine (cv. Riesling): I. Comparison of different testing methods for antioxidant activity. Vitis, 38(3), 127-131.

Belajova E., Suhaj M. 2004. Determination of phenolic constituents in citrus juices: method of high performance liquid chromatography. Food Chemistry, 86, 339–343.

Benzie I.F., Strain J.J. 1999. Ferric reducing/antioxidant power assay: direct measure of total antioxidant activity of biological fluids and modified version for simultaneous measurement of total antioxidant power and ascorbic acid concentration. Methods in enzymology, 299,15-27.

Berliner J. A., Heinecke J. W. 1996. The role of oxidized lipoproteins in atherogenesis. Free Radical Biology and Medicine, 20(5), 707-727.

Bouyoucos GJ. 1962. Hydrometer method improved for making particle size analysis of soils. Agronomy Journal, 54(5), 464-465.

Brand-Williams W., Cuvelier M.E., Berset C.L.W.T. 1995. Use of a free radical method to evaluate antioxidant activity. LWT-Food science and Technology, 28(1), 25-30.

Fenster C. P., Weinsier R. L., Darley-Usmar V. M., Patel R. P. 2002. Obesity, aerobic exercise, and vascular disease: the role of oxidant stress. Obesity research, 10(9), 964-968.

Gattuso G., Barreca D., Gargiulli C., Leuzzi U., Caristi C. 2007. Flavonoid composition of citrus juices. Molecules, 12(8), 1641-1673.

Hadjaz F., Besret S., Martin-Nizard F., Yous S., Dilly S., Lebegue N., Chavatte P., Duriez P., Berthelot P., Carato, P. 2011. Antioxydant activity of β-carboline derivatives in the LDL oxidation model. European Journal of Medicinal Chemistry, 46(6), 2575-2585.

Huang H. Y., Alberg A. J., Norkus E. P., Hoffman S. C., Comstock G. W., Helzlsouer K. J. 2003. Prospective study of antioxidant micronutrients in the blood and the risk of developing prostate cancer. American Journal of Epidemiology, 157(4), 335-344.

Kelebek H., Selli S. 2014. Identification of phenolic compositions and the antioxidant capacity of mandarin juices and wines. Journal of Food Science and Technology, 51(6), 1094-1101.

Kramling T.E., Singleton V.L. 1969. An estimate of the nonflavonoid phenols in wines. American Journal of Enology and Viticulture, 20(2): 86-92.

Monforte M. T., Trovato A., Kirjavainen S., Forestieri A. M., Galati E. M., Lo R. C. 1995. Biological effects of hesperidin, a citrus flavonoid.(note II): hypolipidemic activity on experimental hypercholesterolemia in rat. Farmaco, 50(9), 595-599.

Page A.L, Miller R.H., Keeney D.R. 1982. Methods of Soil Analysis. Part 2, Chemical & Microbiological properties. Agronomy (9), ASSSA, Mad. Wisc. USA.

Ryan B.F., Joiner B.L., Cryer J.D. 2005. MINITAB Handbook: Updated for release 14, 5th edition. Brooks/Cole-Thomson Learning Inc., Kentaky, KY.

Sies H. 2015. Oxidative stress: a concept in redox biology and medicine. Redox biology, 4, 180-183.

Singleton V.L., Rossi S.A. 1965. Colorimetry of Total Phenolics with Phosphomolibdic-phosphotungstic Acid Reagents. J EnolViticult, 16, 144-158.

Valko M., Rhodes C., Moncol J., Izakovic M. M., Mazur M. 2006. Free radicals, metals and antioxidants in oxidative stress-induced cancer. Chemico-biological Interactions, 160(1), 1-40.

Xu G., Liu D., Chen J., Ye X., Ma Y., Shi J. 2008. Juice components and antioxidant capacity of citrus varieties cultivated in China. Food chemistry, 106(2), 545-551.

Yen G.C., Duh P.D. 1994. Scavenging effect of methanolic extracts of peanut hulls on free-radical and active-oxygen species. Journal of Agricultural and Food Chemistry, 42(3), 629-632.

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WOODEN GREENHOUSES WITH GEOTHERMAL HEATING SUPPORT

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Keywords: *Geothermal energy, wooden greenhouse*

ABSTRACT

Scientist make efforts to provide innovative solutions in everyday agricultural business problems such as fossil fuel alternatives, energy consumption and management, climate change through sustainable use of natural and economic resources. Intense horticulture depletes energy resources so fast; wooden greenhouse technologies are part of the proposed solutions. Evolving in a precise and scientific way wood technology in greenhouse construction materials leads to better energy and cost adjustments in crop yields and food security.

INTRODUCTION

Horticultural greenhouses are compatible structures with low-enthalpy energy systems (e.g. geothermal ones) which can accommodate hydroponic nutrient delivery systems (Domingues et al. 2012). Wood as greenhouse construction material can accommodate and manage energy flow at low cost. Greek climate conditions and low wood pricing policies allow the standardization of fully-wooden and wooden-steel structures as greenhouse skeletons in a fully automated production line. Physical properties of wood (e.g. good heat conductor) are in accordance to greenhouse plastic cover mechanical properties when mechanical tensions apply (cover tensions during initial setup and wind). In contrast wood can be attacked by humidity and natural decomposers such as insects, microorganisms (fungi and bacteria), therefore it cannot be used as structural material for greenhouse roof vent (Von Elsner et al. 2000). Geothermal energy is derived by absorption of solar radiation, is stored from the earth's surface up to depth 200 m with a temperature of 10-18 °C, while obtained from the shallow ground to hot water and is exploited with the heat pumps (Hähnlein et al. 2013; Alhamid et al. 2016). The environmental thermal energy is used by heat pumps, which are now an important tool for energy savings and reduction of polluting fuels (Papageorgakis, 1992). Geothermal energy provides economic benefits, and contributes to a reduction of greenhouse gases (Bloomfield et al. 2003, Loredana et al. 2010, Kalfountzos et al. 2014, Gougoulias et al. 2015).

This work investigates the design of a durable wooden frame geothermal greenhouse with reduced energy consumption, low operating and construction costs, sustaining increased crop yield coupled with intense farming and product quality.

MATERIAL AND METHODS

A horticultural greenhouse designed was set up (fig. 2). In the past, suitable wood material was found among fir, chestnut, pine and cypress trees for greenhouse frame structure; in this work chestnut and oak wood were selected for use, due to their resistance to natural decomposers (fungi). The wooden elements were dried under natural conditions with no conditional exposure to high humidity and direct sunlight. Air circulation was arranged at low speed to not induce shape distortions and wood strakes while drying process carried on.

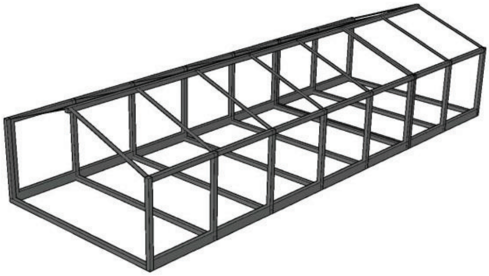

Figure 1. Greenhouse design

Figure 2. Greenhouse with wooden frame was built.

RESULTS AND DISCUSSIONS

The suggested greenhouse type meets intense farming standards with fast and low construction costs in comparison to other known types. Wood as core structural material for greenhouse skeleton emerges several advantages such as low pricing cost, manageable mechanical tensions on plastic cover, limited oxidation and low thermal losses during night in comparison to steel and steel like products.

Geothermal energy exploitation is on expansion mode as greenhouse sustainable heating solution, minimizing carbon footprint. Irrational use of solid/conventional fuels eventually leads to the exhaustion of limited natural reserves.

Additionally, combustion of fossil fuels is responsible for greenhouse gases emission effect, air pollution and degrading acid rain. For these reasons researchers are focused on renewable energy sources that are naturally replenishing, virtually inexhaustible in duration and environmentally friendly. It is worldwide accepted that the use of renewable energy sources like sun, wind and geothermal energy is critical factor for climate change and some environmental issues management.

Geothermal energy is the most favorable option for greenhouse heating compared to other methods while re-introduction of pumped geothermal fluid in the reservoir minimizes human footprint as environmental impact in energy management.

CONCLUSIONS

Current global priority is the production of high quality greenhouse vegetables via minimal energy use, low construction costs and robust structures which respect environment and natural resources reserves such as water. Greenhouses with wooden frame due to low building cost seems ideal for producers. Proposed type of greenhouse supported with geothermal energy as heating source is highly recommended for farming at low operating costs.

REFERENCES

Alhamid M.I., Daud Y., Surachman A., Sugiyono A., Aditya H.B., Mahlia T.M.I. 2016. Renewable and Sustainable Energy Reviews, 53, 733-740.

Bloomfield K.K., Moore J.N., Neilson R.N. 2003. Geothermal energy reduces greenhouse gases, Geothermal Resources Council Bulletin 32, (2), 77-79.

Domingues D.S., Takahashi H.W., Camara C.A., Nixdorf S.L. 2012. Automated system developed to control pH and concentration of nutrient solution evaluated in hydroponic lettuce production. Computers and Electronics in Agriculture, 84, 53-61.

Gougoulias N., Papachatzis A., Vyrlas P., Kalfountzos D., Karaboula A. 2015. Evaluation of Certain Qualitative and Quantitative Characteristics of Hydroponic Tomato Grown to a Geothermal and a Conventional Greenhouse. Annals of the University of Craiova, XX (LVI), 433-438.

Hähnlein, S., Bayer P., Ferguson G., P. Blum P. 2013. Energy Policy, 59, 914-925.

Kalfountzos D., Gougoulias N., Papachatzis A., Angelakis T., Pateras D. 2014. Study on greenhouse tomato crop in stone wool substrate, under conventional hydroponics and closed system using geothermal energy. Annals of the University of Craiova, XIX (LV), 481-486.

Loredana D, Papachatzis A, Murceal B. 2010. Achievement of closed greenhouses sysyems, anecessity to promote renewable energy sources in agriculture. Analele Universităţii din Craiova, seria Agricultură - Montanologie – Cadastru, XXXX, 392-399.

Papageorgakis I. 1992. Heating-Cooling buildings with shallow geothermal energy in Greece 4^0 National Conference on Renewable Energies (Proceedings Volume II) p. 250-263, Xanthi, Greece.

Von Elsner B., Briassoulis D., Waaijenberg D., Mistriotis A., Von Zabeltitz C., Gratraud J., Suay-Cortes R. 2000. Review of structural and functional characteristics of greenhouses in European Union countries, part II: Typical designs. Journal of Agricultural Engineering Research, 75(2), 111-126.

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PRELIMINARY RESULTS ON PI WATER – USEFULL IN CUTTINGS PROPAGATION

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Keywords*: bio stimulatory,edible roses propagation, organic agriculture*

ABSTRACT

Pi water, discovered in 1964 by Prof. dr. Akihiro Yamashita and researched by Prof. dr.Fülöp László and Marioara Godeanu can be an important bio stimulatory in plant propagation by cuttings. This paper presents the preliminary results of a study regarding the influence of Pi water on edible rose cuttings rooting and growth. The experiment was made on three edible roses cultivars with rooting hormones and two water types used (normal and Pi water). The results present significant differences regarding the influence of Pi water on rooting and growth. This study aims to present the preliminary results on an easy to produce and use tool for plant propagation and growth.

INTRODUCTION

Structured water (Pi water) discovery was made in 1964 by Dr. Akihiro Yamashita, a professor at the Agricultural Department at Nagoya University. He tried to find out why some buds bloom and others do not, and the answer led to the identification of a Fe salt in the buds, active-ferric oxide, which breaks some hydrogen bonds and causes the formation of smaller groups of water molecules. (clusters) with increased biological activity (http://www.ibe-techno.com/en/about_pi/description.html). Since then, many studies have been done on Pi water in various fields, and today its use is widespread in the medical industry, cosmetics, agriculture, etc. (Attila & Munteanu 2003). Pi water is very similar to the liquid in living bodies. According to Shinji Makino's patent, Pi water was created by adding Ferro-ferric salt (Fe_2Fe_3) to water through ceramic balls. When Fe_2Fe_3 is added to ordinary tap water, it quickly breaks down chlorine and suppresses the growth of excessive free radicals; it also breaks down the water cluster to a much smaller size. Pi water provides the following functions: better hydration, better oxygenation, anti-oxidation effects, Ion-negative effect, the structure of the water molecule (Fülőp, manuscript). The Japanese inventor Makino Shinji applied for IBE CoLtd for the registration of the patent entitled ”Bioactive agent, pharmaceutical product, cosmetic product, freshness keeping agent, and plant and animal growth- promoting agent”, which was published under number 20110294665. International publications of the same patent in China, Korea, the European Community and the USA are: CN102159222, EP2380578, JPWO2010073642, KR1020110105782, US20110294665.

The patent specifies the production technology of PI water and is the basis for the manufacture of a whole range of Pi water processors produced by the IBE company from Japan. One of the models is COSMO BALANCE Standards (http://www.ibe-techno.com/en/products/water_filter/cb_standard_01.html). It offers 6.0-7.0 l / min at a total capacity of 50,000 l, after which it needs to be completed with patented ceramic granules. Currently, processors are produced in Japan and under license in Korea, China and the USA. In the USA, the AP 560 model (http://www.pi-water.com/new/en_product_ap550.html) is produced with a capacity of 7,000 gallons, at a flow rate of 1 gallon/min. PI water processors bring changes to the classic technology, ensuring a more severe control of the quality parameters of the technological finishing water, without additional addition of drugs or treatment chemicals (Velcea et al. 2002a, 2002b). In horticulture, the positive influence of Pi water was studied on the *in vitro* propagation on fig or apple (Gâlă et al. 2003, Stănică et al. 2002), vegetables (Hoza et al. 2002), or ornamentals (Petruș-Vancea and Cochiță-Cosma, 2009). Godeanu et al. (2003), Godeanu et al. (2002) had exteded researches on Pi water influences on seeds germination and plant growth on different species.

This study aims to present the preliminary results on an easy to produce and use tool for plant propagation and growth, Pi water studied on edible rose propagation by cuttings.

MATERIAL AND METHODS

The research was conducted in the Research greenhouse, part of the Research Center for Studies of Food and Agricultural Products Quality within USAMV Bucharest.

The biological material consisted of cuttings from three edible roses cultivars from the organic field, 'Crown Princess Margareta', 'Brother Cadfael' and 'Falstaff'.

A three factorial experience was established, one factor being the water used (V1-Pi water and V2- normal water), the second the rose cultivar (Vn1-3, n=1 (Pi water) or 2 (normal water)) and the last the rooting hormone (Radistim or simple, Vnm1-2, were n=1 or 2, m=1 ('Crown Princess Margareta' cultivar), 2 ('Brother Cadfael' cultivar) or 3 ('Falstaff' cultivar)).

Cuttings from rose cultivars were placed in the greenhouse at the end of April 2020 (after field rose pruning), using perlite with a sand substrate (50%-50%), basal heating (23-24°C) and artificial fog. Pi water was produced at equipment produced by Nikken for domestic use.

After two months the rooted and viable cuttings were placed in containers under artificial fog for a minimum of seven days. After 45 days shoots growth was measured.

RESULTS AND DISCUSSIONS

Significant differences were observed between Pi water variants and normal water. 'Crown Princess Margareta' cultivar cuttings with Pi water treatment presented the highest values for rooting. At 'Brother Cadfael', Pi water combined with rootings hormones and at 'Falstaff' cultivar normal water with Radistim presented the best results on rooting.

Pi water combined with Radistim variants led to the highest percentage for total viable cuttings, 39% for 'Crown Princess Margareta' cultivar, 39% at 'Brother Cadfael' and 41% at 'Falstaff' cultivar.

After 45 days, significant differences between total viable plant variants were registered, Pi water variants being much numerous than normal water ones (Figure 1).

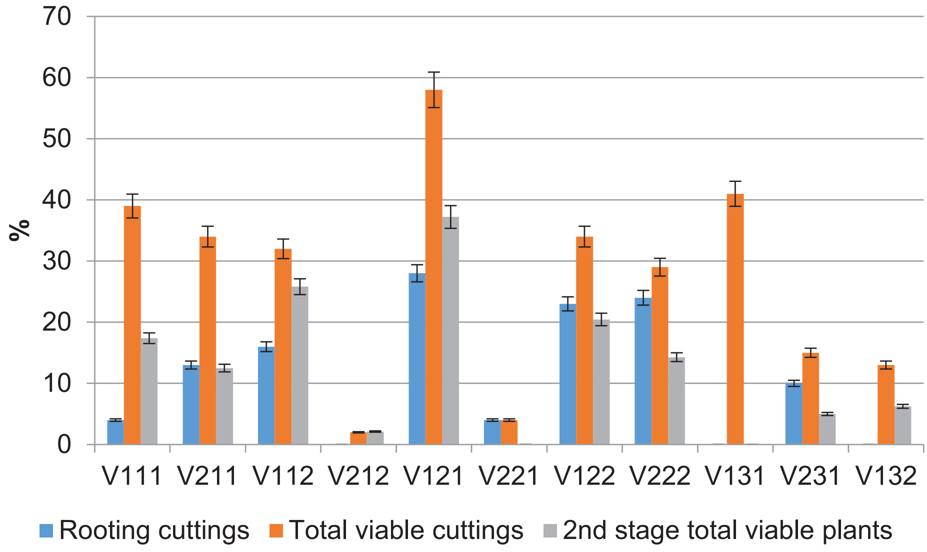

Figure 1. Rooting and viable percentage of rose cuttings

The biggest average shoot length was at Pi water variants at 'Crown Princess Margareta' and 'Brother Cadfael' and at normal water for 'Falstaff' variants (Figure 2). Several new plants, for all cultivars, presented flowers at the transplantation moment, being a quality parameter for propagation methods.

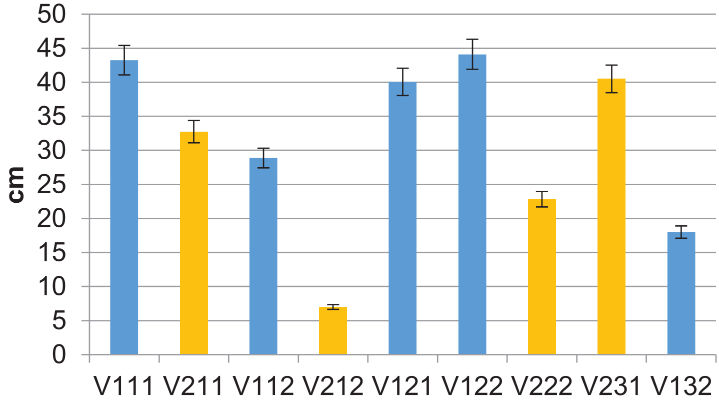

Figure 2.Total plants growths per variants

CONCLUSIONS

Plant propagation by cuttings can include bio stimulatory Pi water, being quite simple to obtain. The preliminary results presented on the three climbing edible roses are promising for further researches.

REFERENCES

Attila A., Munteanu L. 2003. Apa Pi și aplicațiile ei; Locul și rolul apei Pi în societatea modernă. Simpozionul Internaţional „Apa un miracol” Ediţia aIIIa, Bucureşti, 20-21.

Fülőp L. The history of the life water (book manuscript).

Gâlă R., Velcea M., Stănică F., Diaconescu O. 2003. Influenţa apei Pi asupra înmulţirii *in vitro* a smochinului (*Ficus carica* L.). Simpozionul internaţional „Apa un miracol” Ediţia aIIIa, Bucureşti, 24-25.

Godeanu M., Ciobeica C., Avădanei I., Duță P. 2003. Influența apei Pi asupra germinării, creșterii și biosintezei de pigmenți la unele specii de plante. Simpozionul Internaţional „Apa un miracol”, Ediţia aIIIa, Bucureşti, 22.

Godeanu M., Ghiță L., Avădanei I., 2002. Influența apei Pi asupra realizării patului germinativ din rumeguș. Simpozionul Internaţional ”Apa un miracol” Ediţia aIIa, Bucureşti, 12.

Hoza G., Velcea M., Petra O. 2002. Cercetări privind folosirea apei Pi la producerea răsadurilor de castraveți. Simpozionul Internaţional ”Apa un miracol” Ediţia aIIa, Bucureşti, 13.

Petruș-Vancea A., Cachiță-Cosma D. 2009. The effect of Pi or Deuterium depleted water on foliar stomata of *Saintpaulia ionantha* L. exvitroplantlets sprinkled foliar or radicular. Studia Universitatis “Vasile Goldiş”, Seria Ştiinţele Vieţii, 19 (2), 309-312.

Stănică F., Gâlă R., Velcea M., Diaconescu O. 2002. Rezultate preliminare privind folosirea apei Pi la microînmulţirea *in vitro* a unor soiuri de măr. Simpozionul Internaţional „Apa un miracol” Ediţia aIIa, Bucureşti, 12.

Velcea M., Popescu M.N., Duță P., Bucur C. 2002a. Franciza Apa Pi, o cale de success în afaceri. Simpozionul Internaţional ”Apa un miracol” Ediţia aIIa, Bucureşti, 7.

Velcea M., Popescu M.N., Duță P., Bucur C. 2002b. Proiectul Apa Pi în Romania, o invitație la un succes comun. Simpozionul Internaţional ”Apa un miracol” Ediţia aIIa, Bucureşti, 9.

***http://www.ibe-techno. com/en/ products/water_filter/ cb_standard _01 .html

***http://www.ibe-techno.com/en/about_pi/description.html

***http://www.pi-water.com/new/en_product_ap550.html

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METHODS AND SYSTEMS FOR DETECTING WATER STRESS IN VITICULTURE

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Keywords*: soil, grapevine, irrigation, tensiometer, phytonomonitoring*

ABSTRACT

In Romania the climate is temperate continental, but climate change from recent times fragmenting this climate into one with nuances of excess. This is due to large temperature variations between the hot and cold seasons, but also of large temperature differences between day and night. In addition to these aspects, the uneven distribution of precipitation as well as extremely large variations in their total quantity registered from one year to another negatively influences the growth and fruiting of grapevine plants. This paper presents methods and systems for detecting water stress in viticulture. Among the most commonly used instruments are tensiometers and soil psychrometers to measure directly the capillary tension or energy with which water is withheld by the soil.

INTRODUCTION

Water supply is very important for the grapevine during budburst and flowering, but irrigation near the harvest, after a period of prolonged drought, should be avoided because it can cause berries cracking and grey rot and the appearance of the grey mould. Lack of water in the soil causes difficulties for grapevine plants in the supply of the nutrients. The growth and fruiting of the grapevine plants depend on the state of the tissues hydration. When the leaves are hydrated to an optimal level, the stomata open and allow CO_2 to enter, thus being stimulated the photosynthesis and the production of the organic compounds. When the water supply is better the vegetative growth and grape production are higher. In periods of severe water stress, the photosynthesis is negatively influenced primarily, because, in order to limit water loss, the stomata close and no longer allow CO_2 to enter, which leads to the early cessation of the shoots and berries growth, as well as to a decrease of the sugars and aromatic compounds accumulation (Irimia 2012).

Over the next century, the viticulturists are likely to face to a rising temperatures and a changing of the precipitation regime, which will have an important impact mainly on soil water availability and grapevine phenophases. These conditions can have a decisive influence on the quality and quantity of grapevine production. Regarding phenophases, it is expected that the growth stages will advance affecting the grapes composition (sugar concentration and acidity) and the aromatic profile (Quénol 2016).

MATERIAL AND METHODS

In this study are presented the research regarding the methods and systems for detecting water stress in viticulture. For determining the soil moisture content the researchers divided the techniques in classics (thermo-gravimetric and calcium carbide technique) and modern (soil resistivity sensor, tensiometers, infrared moisture balance, dielectric techniques, Time Domain Reflectometry (TDR), Frequency Domain Reflectometry (FDR) and capacitance technique, heat flux soil moisture sensors, micro-electro mechanical systems and optical techniques) (Su et al. 2014). To evaluate the irrigation management in vineyards can be useful the phytomonitoring system (Quezada et al. 2020).

RESULTS AND DISCUSSIONS

In the context of climate change and its impact on plant physiology, the optimizing water use and improving irrigation practices play a crucial role in crops management. For viticulture, the adapting to climate change is a major challenge. Adaptation strategies and policies must approach the potential impacts, both in the short and long term, while spatial, local adaptation and specific context are essential. It should be noted that each wine region consists of unique contexts, the knowledge and understanding of contextual factors and their interaction with the regional climate are absolutely necessary to identify and prioritize initiatives of adaptation to the different temporal and spatial scales.

The amount of water required to a grapevine plantation vary significantly depending on the density, age of grapevine, variety, rootstock-to-scion interaction, cover crops, climate (rainfall and evaporation) (Goldammer 2018). Measuring the soil moisture is essential for estimating the level of water stress on grapevines plants. Soil moisture should be measured to the full depth of the root, to avoid premature irrigation and water loss. Also, after rain, it is impossible to decide objectively when to irrigate without measuring soil moisture over the entire root zone.

Soil water availability can be determine either by volumetric methods (water percentage in a given volume of soil - time-domain reflectometer and neutron probe) or by tensiometric methods (physical force holding water in the soil - tensiometer, gypsum blocks, and granular matrix soil moisture sensor). There is a multitude of different sensor types and suppliers with different systems, some reading water suction directly and most using indirect measuring systems via electric currents. Among the most commonly used instruments are tensiometers and soil psychrometers to measure directly the capillary tension or energy with which water is withheld by the soil (Centeno et al. 2010, Mullins 2001 cited by Rienth & Scholasch 2019). Tensiometers measure the waters metric potential from the soil and show how hard the plants musts work to draw water from the soil (Holler 2008). There are two main types of psychrometers; namely, thermocouple psychrometer and thermistor or transistor psychrometer (Pan et al. 2010).

As soils or growing mediums dry out and are rewetted by irrigation or rainfall, tensiometers will follow and continue to read the soil suction directly, measured in kilopascal (kPa). Low readings nearer zero mean wetter soils while higher suction readings mean drier soils (Table 1).

Table 1

Interpretation of Soil Suction Readings (adapted after http://www.skyeinstruments.info/index_htm_files/Soil%20Guidance%20Notes.pdf)

Soil suction (kPa readings)	**Signification**
0	The soil is completely saturated with water. A zero reading for long periods may cause the diseases occurrence and can indicates poor drainage conditions.
1-10	A water surplus in the soil. The low readings persistent may indicate poor drainage conditions.
10-20	The soil contains plenty water and air for growth of healthy plants. When these readings are reached it is advisable to stop irrigation, as additional water may leak and be wasted.
20-40	The water and air from the soil is adequate for plant growth. In sandy soils, irrigation may be recommendable.
40-60	In fine or clay soils is adequate water for plant growth. Irrigation may be advisable in medium soils, but in sandy soils it is required.
60-80	Irrigation is required for fine and medium soils because readily available water is scarce; are an exception the heavy clay soil. In sandy soils, plant damage can occur.
80-100	It is not recommended to let the soil dry out, because the plant damage may not be reversible.

When soil water content is between 5 and 60 kPa the water is easily extracted by the grapevine plants and is less easily extracted when the water is held between 60 and 200 kPa (Proffitt & Campbell-Clause 2017).

Soil moisture can be used to determine the extent of the irrigation pattern. Short irrigations are recommended to watering a small volume of soil and to manage water stress (drought).

Irrigation time must be adjusted according to soil moisture from the middle and bottom of the main area of the fibrous root.

Irrigation scheduling must be adjusted according to the performance of the grapevine plants by measuring growth indicators, such as the amount of wood resulted from cutting and the size of the berries. Similarly, plant performance should be monitored during drought, so that the irrigation strategy can be modified if is necessary.

If water supply is limited, the best strategy to avoid production losses is as follows:

- it is irrigated deeply before budburst if the soil is dry to cover root zone as large as possible;
- irrigation is applied regularly to minimize the stress during flowering and fruit formation;
- irrigation at the veraison, if there is no summer rain, to reduce stress, but maintain moderate stress (for example, not fully irrigated) for the next four weeks;
- irrigation in the area of the superficial fibrous root after harvesting to avoid strong water stress.

In recent years, new optical remote sensing techniques have become widespread, because they allow an assessment of water stress dynamics from plants in a timely manner. Aerial vehicles without a pilot (UAVs) are currently one of the most advanced platforms for remote sensing applications. Matese et al. (2018) recommend the use of thermal indices, such as CWSI and the linear thermal index in achieving of the precision irrigation scheduling depending on the specific physiological condition of the grapevine plants.

Cifre et al. (2005) considers that plant determinations for the detection of water stress must involve several approaches: sap flow meters (to collect direct and accurate data about plants and water lost by them, without affecting the leaves area); linear transducers of displacement (continuously measures the diameter of the stem, which can be correlated with the water supply or physiological condition of the plant); infrared thermometry (the foliage temperature is highly dependent on the rate of transpiration and can therefore be used as an indicator of stomatal opening); image and photographic cameras which determine the canopy reflectance (measures plant performance); chlorophyll fluorescence indices (can be measured with laser-based fluorometers or using sun-induced chlorophyll fluorescence)(Ounis et al. 2001, Moya et al. 1998).

Another method that contributes to the determination of water stress is the modified cell pressure probe method. This was used by Thomas et al. (2006) to measure the pressure in grape mesocarp cells at different depths (100-2500 μ).

Also in order to detect water stress Gutiérrez et al. (2018) conducted a study on the Tempranillo grapevine variety using 3 types of irrigation in 4 randomized blocks (12 combinations). Each variant was represented by 25 plants, but only 15 from the middle have been taken into account, the rest acting as a buffer zone for the edges. Irrigation was done 2 hours a day, 5 days a week, from July to September. The measurements were made with a thermal camera that was mounted on the front part of an all-terrain vehicle at a height of 1 m connected to an industrial computer. The researchers consider that thermography and machine learning algorithms can be used for a more precise application of irrigation.

In order to improve grape production, the phytomonitoring system may be used, because it observes the situation of the plants in real time and provides the grower essential information about the physiological conditions of the crops, helping it to reduce deterioration or loss of the production. This technology combines the data acquisition system based on specific sensors, as well as data processing software, which presents measurement information regarding plant physiology and agronomy (Ton et al. 2001). Phytomonitoring has three main functions: initiate a customized set of measured values and their derivatives used by a grower in daily control productive, early detection of unexpected disequilibrium in plants and decision support-system. It is useful to evaluate the irrigation management in vineyards, because it provides information in real time of crop water status and allow to make a feedback between culture and viticulturist to improve the irrigation control (Quezada et al. 2020).

CONCLUSIONS

Measuring soil moisture is essential for estimating the level of water stress on grapevines. Soil water availability can be determined by volumetric or tensiometric methods. Currently exists on the market a multitude of different sensor types and suppliers with different systems, some reading water suction directly and most using indirect measuring systems via electric currents. Among the most commonly used instruments are tensiometers and soil psychrometers.

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REFERENCES

Centeno A., Baeza P., Lissarrague J. R. 2010. Relationship between Soil and Plant Water Status in Wine Grapes under Various Water Deficit Regimes. HortTechnology, 20(3), 585-593.

Cifre J., Bota J., Escalona J. M., Medrano H., Flexas J. 2005. Physiological tools for irrigation scheduling in grapevine (Vitis vinifera L.): An open gate to improve water-use efficiency? Agriculture, Ecosystems & Environment, 106(2-3), 159-170.

Goldammer Ted. 2018. Grape Grower's Handbook. A Guide to viticulture for wine production. Third Edition, ISBN (13): 978-0-9675212-5-1, p.482 Apex Publishing house.

Gutiérrez S., Diago M. P., Fernández-Novales J., Tardaguila J. 2018. Vineyard water status assessment using on-the-go thermal imaging and machine learning. PloS one, *13*(2), e0192037.

Holler M. 2008. High density, multiple depth, wireless soil moisture tension measurments for irrigation management, American Journal of Enology and Viticulture 59(3).

Irimia L.M. 2012. Biologia, ecologia și fiziologia viței-de-vie, ”Ion Ionescu de la Brad” Iași publishing house, ISBN: 978-973-147-106-8, p. 260.

Matese A., Baraldi R., Berton A., Cesaraccio C., Di Gennaro S.F., Duce P., Facini O., Mameli M. G., Piga A., Zaldei A. 2018. Estimation of Water Stress in Grapevines Using Proximal and Remote Sensing Methods. Remote Sens. 10, 114.

Moya I., Camenen L., Latouche G., Mauxion C., Evain S., Cerovic Z. 1998. An instrument for the measurement of sunlight excited plant fluorescence. In: Garab, G. (Ed.), Photosynthesis: Mechanisms and Effects, vol. V. Kluwer Academic Publishers, Dordrecht, p. 4265–4270.

Ounis A., Evain S., Flexas J., Tosti S., Moya I. 2001. Adaptation of a PAM-fluorometer for remote sensing of chlorophyll fluorescence. Photosynth. Res. 68, 113–120.

Pan H., Qing Y., Pei-yong L. 2010. Direct and Indirect Measurement of Soil Suction in the Laboratory, Electronic Journal of Geotechnical Engineering, 15, Bund. A, http://www.ejge.com/2010/Ppr10.009.pdf.

Proffitt T. and Campbell-Clause J. 2017. Water management for wine grapes in a drying environment - Developed by AHA Viticulture and the Wine Industry Association of WA (Wine Industry Association of Western Australia), http://www.foodfuture.com.au/wp-content/uploads/2017/01/Water-management-for-wine-grapes-in-a-drying-environment-LR.pdf.

Quénol H. (coord). 2016. *Adapting viticulture to climate change. Guidance manual to suport wine growers' decision-making*. [online]. Available at: http://www.adviclim.eu/wp-content/uploads/2015/06/B1-deliverable.pdf.

Quezada C., Merino R., Chandía A., Cassanova M. 2020. Use of phytomonitoring to evaluate the irrigation scheduling in vineyards (*Vitis vinifera* L.) of Itata valley, Chile. Horticult Int J. 4(5):169-172.
Rienth M., Scholasch T. 2019. State-of-the-art of tools and methods to assess vine water status. *OENO One*, *53*(4).
Su S. L., Singh D.N., Baghini M.S. 2014. A critical review of soil moisture measurement. Measurement 54, 92-105.
Thomas T. R., Matthews M. A., Shackel K. A. 2006. Direct in situ measurement of cell turgor in grape (*Vitis vinifera* L.) berries during development and in response to plant water deficits. Plant, Cell & Environment 29(5), 993-1001.
Ton Y., Nilov N., Kopyt M. 2001. Phytomonitoring: the new information technology for improving crop production. Acta Horticulture, 562, 257-262**.**
***http://www.skyeinstruments.info/index_htm_files/Soil%20Guidance%20Notes.pdf - Soil moisture measurement guidance notes.

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XANTHOMONAS EUVESICATORIA JONES *ET AL*. (2004) A POSSIBLE NEW PATHOGEN IN ROMANIA

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Keywords: *analysis, detection, identification*

ABSTRACT

Responsible for the production of the disease "Bacterial spot on tomato and pepper" is the bacteria generically called Xanthomonas campestris pv. vesicatoria. Following the reclassifications of the genus Xanthomonas, in 2004, Jones et. al established that this phytobacteriosis is caused by 4 distinct bacterial species: Xanthomonas vesicatoria, Xanthomonas euvesicatoria, Xanthomonas gardneri and Xanthomonas perforans. Since of December 2019, these species are classified as ORNC, regulated harmful organisms that are not quarantine for the Union, in accordance with Commission Implementing Regulation (EU) 2019/2072, establishing uniform conditions for the implementation of Regulation (EU) 2016/2031 of the European Parliament and of the Council. In order to detect and identify these pathogens, the provisions of the working protocol of EPPO PM 7/110 (1) from 2013 are followed. In Romania, the laboratory authorized to perform analyzes for ORNC is the National Phytosanitary Laboratory. According to the database of the European Plant Protection Organization, Xanthomonas campestris pv vesicatoria is present in Romania, without knowing exactly which of the 4 species attacks the tomato and pepper crops. This study reflects the results of laboratory tests on a bacterial strain analyzed in the 2020.

INTRODUCTION

Bacteria *Xanthomonas campestris* pv. *vesicatoria* is systematically classified in the Kingdom of Monera, Phylum Proteobacteria, Class Gamma Proteobacteria, Order Xanthomonadales, family Xanthomonadaceae, Genus *Xanthomonas*, Species *Xanthomonas euvesicatoria* Jones *et al*. (2004), *Xanthomonas vesicatoria* (e.g. Doidge 1920) Vauterin et al. (1995), *Xanthomonas perforans* Jones et al. (2004) and *Xanthomonas gardneri* (e.g. Šutic1957) Jones et al. (2004) (OEPP PM7 / 110 (1), 2013, EFSA PLH Panel, 2014).

The re-evaluation of this quarantine pathogen according to the new European legislation was necessary to establish the current situation of quarantine organisms at Union level, and on this occasion, for the first time in the legislation, the generic name of *Xanthomonas campestris* pv. *vesicatoria* was not used, insteand being used the names of the 4 species established by Jones *et al.* in 2004 as being responsible for the production of the disease "Bacterial spot of tomato and pepper". Thus, these species are currently listed in Annex IV, Part D, F, I of Regulation 2019/2072/EC which contains the list of non-quarantine harmful organisms for the Union, as regards plant propagating material intended for planting, for ornamental purposes, as seed for planting and as a propagating and planting material for vegetables, excluding seeds.

Plants listed in the new Regulation, considered important for the 4 bacterial species are *Lycopersicon lycopersicum* and *Capsicum annuum* (Official Journal of the European Union, 2019).

This study presents the results of laboratory analyzes performed in the 2020 monitoring campaign on a sample of bell pepper, Buzău 10 variety, an early variety grown in protected areas and in the field, suitable for fresh consumption but also for industrialization, often found in crops in Romania. The sample consisted in parts of plant that showed specific symptoms of bacterial infection caused by species of the genus *Xanthomonas* pathogenic to tomato and pepper, respectively spots of different sizes and shapes, surrounded or not by necrotic halo (fig.1.).

The symptoms present on the analyzed sample were similar to those described in the literature (Severin and Iliescu, 2006 and Aiello et al., 2013).

Fig. 1. Symptom on pepper leaves (original)

MATERIAL AND METHOD

The sample analyzed in 2020 came from internal production and was taken during the Monitoring Program by phytosanitary inspectors from the Olt County Office, in Dobrosloveni, on an area of 1000 m^2 cultivated with bell peppers, Buzău variety 10.

The analyzes were realized in the bacteriology laboratory of the National Phytosanitary Laboratory which is responsible for performing the analyzes for these pathogens, and the analysis methods for detection and identification were in accordance with the national and European legislation in force, respectively with the provisions of EPPO protocol PM7 / 110 (1) of 2013 on the detection and identification of *Xanthomonas* spp. (*Xanthomonas euvesicatoria*, *Xanthomonas vesicatoria, Xanthomonas perforans* and *Xanthomonas gardneri*) causing bacterial spot of tomato and pepper.

The analysis methods were IFI - indirect immunofluorescence, isolation on non-selective culture media YPGA and NA and semiselective medium mTMB agar, multiplex PCR, biochemical tests performed on the BIOLOG identification system, pectolytic and amylolytic activity, tobacco hypersensitivity and pathogenicity test in the quarantine greenhouse on sensitive tomato plants of the Moneymaker variety.

RESULTS AND DISCUSSIONS

The initial screening method was IFI - indirect immunofluorescence and was performed on the sample extract and consisted in staining antibodies to the target bacterium (fig. 2). Polyclonal antisera from LOEWE-Germany were used for staining, complying with the requirements of the diagnostic protocol OEPP PM 7/97 (1) Indirect immunofluorescence test for plant pathogenic bacteria from 2009.

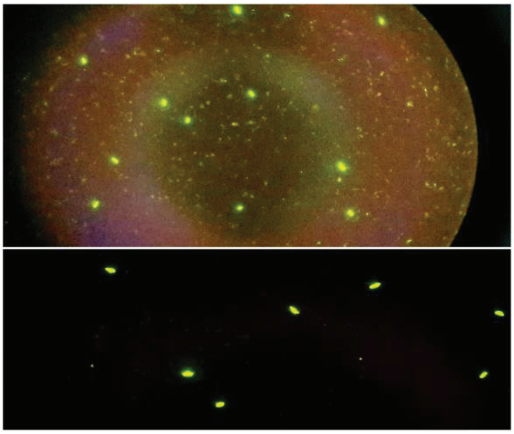


Figure 2. Bacterial cells seen at epifluorescence microscope (original)

The positive result of the immunofluorescence test was confirmed in the next stage by the results from the isolation on non-selective culture media NA - nutrient agar and YPGA - yeast-pepton-glucose-agar (Severin & Cornea, 2009) and semiselective culture medium mTMB agar (fig.3.).

These colonies showed cultural differences: on the YPGA developed mucoid and slightly convex colonies, moist, circular, with full edge, bright yellow and glossy, and on NA the colonies were yellow, round, with fringed edge, smooth, glossy, prominent, convex and had about 1 cm after 96 hours of incubation at 27^0C.

On non-selective culture media have developed bacterial colonies similar to those described by Patel et al. in 1950 and Severin and Iliescu in 2006.

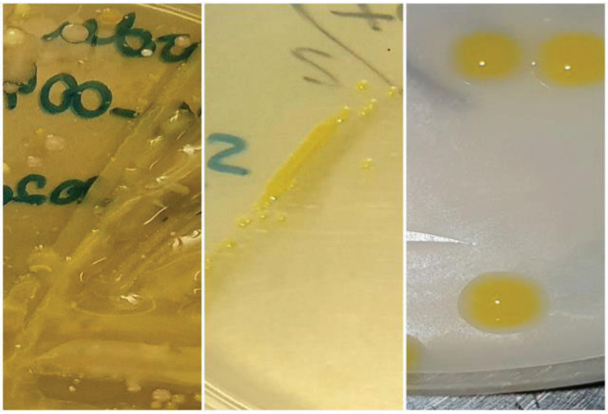
On the semiselective culture media mTMB agar developed yellow, convex, round, weakly mucoid bacterial colonies, similar to those presented by McGuire et al. in 1986.

Differences were observed between the colonies of the positive control NCPPB 3315 of *Xanthomonas campestris* pv. *vesicatoria* and the colonies from the suspected sample, in terms of size, appearance and color.

Isolation on culture media was the starting point for the following analyzes that made it possible to identify the bacteria responsible for the infection, this method of analysis being used for both detection and identification.

Suspected bacterial colonies grown on culture media were analyzed in molecular biology to confirm the results of screening tests by the multiplex PCR test, following the protocol developed by Özdemir in 2009 for the simultaneous detection of several pathogenic bacteria on tomato and pepper (*Clavibacter michiganensis* subsp.

michiganensis, Xanthomonas campestris pv*. vesicatoria and Pseudomonas syringae* pv.*tomato*), the result being positive for *Xanthomonas campestris* pv*. vesicatoria*.



a. b. c.

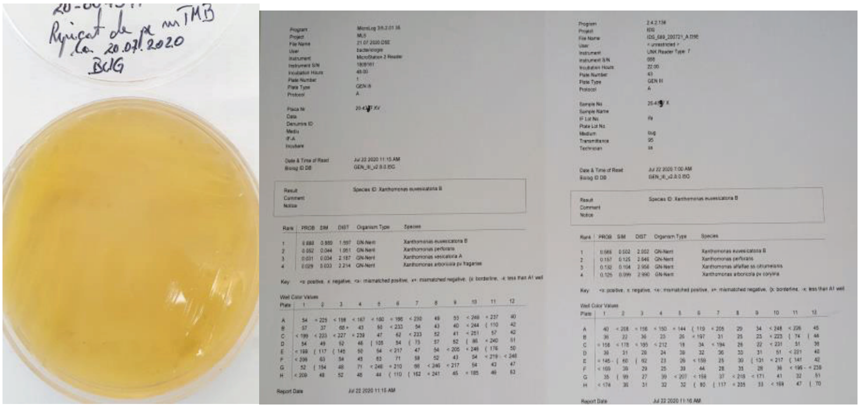
Figure 3. Bacterial colonies of the suspicious sample on culture media YPGA (a), NA (b) and mTMB agar (c)

Positive results on indirect immunofluorescence and multiplex PCR tests, but also cultural differences of bacterial colonies developed on the culture media of the test sample and the reference control, led to the suspicion that the test sample and the reference control could be two different species of genus *Xanthomonas*. Thus, appear the opportunity to establish the bacterial species extracted from the analysed sample and additional tests were performed, mentioned in the literature, able to differentiate the 4 species of pathogenic *Xanthomonas* on tomato and pepper (EPPO,PM7/110(1), 2013).

The suspicious bacterial colonies, positive to the molecular biology test, were repicated on BUG Agar (Biolog Universal Growth Agar) to be analyzed for the use of carbon sources using the BIOLOG microorganism identification system. After 24 hours of isolation on BUG Agar, one pure colony from the reference control and one from the suspicious sample were diluted in the special inoculation fluid of the identification system and two microplates were charged with these suspensions.

After microplates incubation for 22 hours at 30^0C, *Xanthomonas euvesicatoria B* was identified in the suspicious sample, both in the OmniLog system that makes optical readings and in the Microstation that performs spectrophotometric readings (fig. 4).

The suspected sample was worked in parallel with the reference control NCPPB 3315, which is in the NCPPB collection from 1984, the year before the reclassifications of the genus, with the scientific name of *Xanthomonas campestris* pv. *vesicatoria* valid at the time of introduction into the collection, the reference control being identified in our laboratory by the BIOLOG system as *Xanthomonas vesicatoria.*



a. b.

Figure 4. a.Petri dish with BUG Agar environment
b.the result generated by the system for the suspicious sample

Following these results, tests were performed for pectolytic and amylolytic activity, hypersensitivity to tobacco, and pathogenicity to young tomato plants of the Moneymaker variety, sensitive to this phytobacteriosis, to determine whether all the differences mentioned in the EPPO protocol PM 7/110 (1) of 2013 on the detection and identification of *Xanthomonas* spp. (*Xanthomonas euvesicatoria, Xanthomonas vesicatoria, Xanthomonas perforans* and *Xanthomonas gardneri)*.

For all these tests, observations were made and the differences between the control and the analyzed sample were noted.

The pectolytic activity representing the hydrolysis of pectins was verified on potato rounds sterilized with 70% ethyl alcohol and inoculated with bacterial suspension of sample and positive control NCPPB 3315. On potato, pectolysis occurred beyond the inoculation point after 24 hours at 22^{0}C indicated a positive result.

Regarding the pectolytic activity, a difference was observed between the two strains. At 24 h, the positive reference control NCPPB 3315 showed pectolytic activity, while the suspicious sample did not produce any modification of the potato slices, so without pectolytic activity (fig.5.).

Amylolytic activity consists in the ability of bacteria to hydrolyze starch by transforming it into glucose and maltose. For this, the bacterial colonies grown on NA medium - nutrient starch enriched with soluble starch, at 30^{0}C in 72 hours, were immersed with Lugol iodine solution. The appearance of clear areas around the bacterial colonies indicated the hydrolysis of starch, so a positive amylolytic activity.

Thus, it was observed that the control NCPPB 3315 showed amylolytic activity, during the suspicious sample it did not hydrolyze the starch, the bacterial colonies immersed in Lugon iodine not showing clear areas around themThus, it was observed that the control NCPPB 3315 showed amylolytic activity, during the suspicious sample it did not hydrolyze the starch, the bacterial colonies immersed in Lugon iodine not showing clear areas around them.

a. b.

Fig.5. Pectolytic activity

a. reference strain NCPPB 3315 b. suspicious sample (original)

The hypersensitivity test was performed on tobacco plants, Xanthi variety, in the stage of 5 true leaves, by injecting into the internervurial space of lamina using a hypodermic syringe with a bacterial suspension of approximately 10^8 CFU / mL obtained from a pure colony for 24 to 48 hours. The injected leaves were labeled and the test readings were performed at 24 hours.

In the suspicious sample, necrotic spots were observed, which led to a positive interpretation of the hypersensitivity test, while in the reference control the hypersensitivity reaction was very weak, forming small necrotic spots only at the site of the stings (fig.6.)

The pathogenicity test to confirm the positive results was performed in the quarantine greenhouse by inoculation with a bacterial suspension of at least 10^7 cfu / mL young and sensitive tomato plants of the Moneymaker variety, recommended by the EPPO protocol PM 7/110 (1) from 2013. The plants were grown at a temperature of 25^0C and humidity of 70-80% for 3 weeks.

Periodic examinations were performed and it was noted how the two bacterial strains developed, the reference control and the suspicious sample.

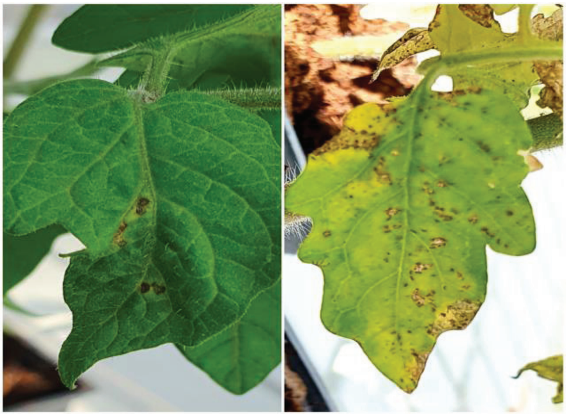
Thus, it was observed that the shape, size and color of the spots showed differences between the sample and the positive control (fig.7.)

The pathogenicity test plants were re-analyzed by isolation on culture medium and indirect immunofluorescence, the results being positive.

Analyzing all the results obtained regarding the analyzed sample and the reference control NCPPB 3315, and corroborating with other observations of the positive samples for *Xanthomonas campestris* pv. *vesicatoria* previously found in the bacteriology laboratory, differences were observed, leading to the conclusion that the detected bacterium may be the species *Xanthomonas euvesicatoria*, one of the four pathogenic species on tomato and pepper that produce the disease “Bacterial spot in tomato and pepper ”.

a. b.

Figure 6. Hypersensitivity to tobacco
a. reference strain NCPPB 3315 b. suspicious sample (original)



a. b.

Figure 7. Pathogenicity on tomato in the greenhouse
a. reference strain NCPPB 3315 b. suspicious sample (original)

CONCLUSIONS

The analyzes performed according to the working scheme of the working protocol of EPPO PM 7/110 (1) from 2013 allowed the detection in the laboratory of this pathogenic phytobacteriosis on tomato and pepper.

Thus, the positive results of all laboratory tests and pathogenicity tests performed in the quarantine greenhouse, followed by re-isolation and detection by a screening method of bacteria in the test plants were interpreted as a positive result.

Regarding the identification of a new species of *Xanthomonas* in our country, these encouraging initial results must be complemented by additional tests of molecular biology, with working protocols and specific primers that allow the exact identification of its genus or sequencing.

REFERENCES

Aiello D., Scuderi G., Vitale A., Firrao G., Polizzi G. And Cirvilleri G. 2013. A pith necrosis caused by Xanthomonas perforans on tomato plants. European Journal of Plant Pathology 137 (1): 29-41.

Doidge E.M. 1920. A tomato canker. Annals of Applied Biology, 7: 407-430.

Jones J.B., Lacy G.H., Bouzar H., Stall R.E., Schaad N.W. 2004. Reclassification of the xanthomonads associated with bacterial spot disease of tomato and pepper. Systematic Applied Microbiology, 27*:* 755-762.

McGuire R., Jones J.B., Sasser M. 1986. Tween media for semiselective isolation of Xanthomonas campoestris pv. vesicatoria from soil and plant material. The American Phytopathological Society - Plant Disease, Vol. 70, No. 9: 887-891.

Severin V., Iliescu C.H. 2006. Bolile bacteriene ale plantelor. Ed. Geea, București, 19: 163-168.

Severin V., Călina Petruța Cornea. 2009. Ghid pentru diagnoza bolilor plantelor, Ed. Ceres, București, pp. 205-206.

Šutic G. 1957. Bakterioze crvenog patlidzana (Tomato bacteriosis). Posebna Izd. Inst. Zast. Bilja Beograd (Spec. Edit. Inst. Plant Prot. Beograd), 6, pp. 1-65. English summary: Review of Applied Mycology, 36: 734-735.

Vauterin, L., Hoste, B., Kersters, K., Swings, J. 1995. Reclassification of Xanthomonas. International Journal of Systematic Bacteriology, 30, pp. 472-489.

***EFSA PLH Panel (European Food Safety Authority Panel on Plant Health). 2014. Scientific Opinion on the pest categorization of *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye. EFSA Journal 12(6):3720: 1-26.

***EPPO (European and Mediterranean Plant Protection Organization). 2009. EPPO Standards Diagnostics PM 7/97 (1) Indirect imunofluorescence test for plant pahogenic bacteria. EPPO Bulletin 39*:* 413-416.

***EPPO (European and Mediterranean Plant Protection Organization). 2013. EPPO Standards Diagnostics PM 7/110 (1) *Xanthomonas* spp. (*Xanthomonas euvesicatoria, Xanthomonas gardneri, Xanthomonas perforans, Xanthomonas vesicatoria*) causing bacterial spot of tomato and sweet pepper. EPPO Bulletin 43(1)*:* 7-20.

***Jurnalul Oficial al Uniunii Europene. 2019. Regulament de punere în aplicare (UE) 2019/2072 al Comisiei din 28 noiembrie 2019 de stabilire a unor condiții uniforme pentru punerea în aplicare a Regulamentului (UE) 2016/2031 al Parlamentului European și al Consiliului în ceea ce privește măsurile de protecție împotriva organismelor dăunătoare plantelor, de abrogare a Regulamentului (CE) nr. 690/2008 al Comisiei și de modificare a Regulamentului de punere în aplicare (UE) 2018/2019 al Comisiei, pp. 319/1-319/51.

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ON THE CADDISFLY (TRICHOPTERA) LARVAE FAUNA OF OLTENIA (ROMANIA)

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Keywords*: Trichoptera larvae, Oltenia, Hydropsyche angustipennis*

ABSTRACT

This paper presents the current state of knowledge of the caddisfly larvae fauna in Oltenia: a checklist of species and their geographical distribution derived from the available literature. The paper also records the presence of Hydropsyche angustipennis (Curtis, 1834) (Hydropsychidae, Philopotamoidea, Annulipalpia) larvae in the water course of Romanescu Park – Craiova Municipality.

INTRODUCTION

The caddisfly larvae are an important component of the freshwater habitats. Their distinctive character is the construction of portable cases, nets (filtering nets, tangle traps), fixed shelters, in most species (Wallace, 2003).

Data on the Trichoptera larvae of Oltenia were published in a series of faunal and bioecological works starting with the 1940s - Băcescu - 1948, Buşniță and collaborators - 1961, Mălăcea and collaborators - 1954, Murgoci - 1966 (Murgoci, 1968), works that, unfortunately, are not accessible. Botoșăneanu is the undisputed specialist of the group, with numerous descriptions of new species based on adults and larvae. The last synthesis work on the fauna of the Trichoptera larvae from Oltenia belongs to Murgoci (1968). Data on the fauna of Trichoptera larvae from the Oltenia Plain also appear in ecological works and faunal catalogs (Rogoz, 1979; Ciubuc, 2017).

In this paper, the Oltenia region is delimited between the rivers Danube and Olt and the corresponding southern chain of the Meridional Carpathians (Oslea Mt., Vâlcan Mt., Parâng Mt., Căpățânii Mt., Lotru Mt.). The region formed by the Retezat and Mehedinți Mts. is excluded, region for which Botoșăneanu (1959) uses the name of Banatic massif, after Emm. De Martonne.

The study of Trichoptera is important for many reasons: the precise determination of species geographical distribution, water quality assessment, taxonomic importance.

MATERIAL AND METHODS

The faunistic inventory of the caddisfly larvae for Oltenia region is based on published references. The larvae from the watercourse of Romanescu Park were directly collected from the underside of the immersed stones on 14 July and 5 August

2020. The larvae were identified using Waringer & Graf (2011); they are preserved in 80º ethanol as author private collection.

RESULTS AND DISCUSSIONS

The species inventory and their geographical distribution in Oltenia region as resulted from the available references is presented in alphabetical order in the synthetic Table 1. The table includes both the adults and larvae, as expected once the adults were collected nearby a water, the larvae should be present in the water.

Table 1

List of Trichoptera species in Oltenia

No.	Species	Locality	Reference	ad	L
1	*Adicella filicornis* (Pictet)	-	Murgoci 1968		L
2	*Adicella sp.*	Jiu-Zăval	Rogoz 1979		L
3	*Agapetus ochripes* Curtis	Motru-Cloșani	Ciubuc 2010	ad	
4	*Agapetus. sp.*	-	Murgoci 1968		L
5	*Agraylea sexmaculata* Curtis	Dăbuleni	Ciubuc 2017	ad	
6	*Agrypnia pagetana* Curtis	Dăbuleni	Ciubuc 2017	ad	
7	*Allogamus dacicus* Sch.	Câmpu lui Neag-Jiul V	Ciubuc 2017	ad	
8	*Apatania motasii* Bots.	-	Murgoci 1968		L
9	*Athripsodes albifrons* (Linné)	Cloșani	Ciubuc 2012	?	
10	*A. annulicornis* Steph.	-	Murgoci 1968		L
11	*Beraea pullata* (Curtis)	-	Murgoci 1968		L
12	*Beraea. sp.*	-	Murgoci 1968		L
13	*Brachycentrus montanus* Klapálek	-	Murgoci 1968		L
14	*Chaetopteryx cissilvanica* Bots.	-	Murgoci 1968		L
15	*Ch. sisestii* Bots.	-	Murgoci 1968		L
16	*Chaetopteryx sp.*	-	Murgoci 1968		L
17	*Chaetopterygopsis sisestii* Botoșăneanu	Motru-Cloșani	Ciubuc 2012	ad	
18	*Drusus romanicus* Murgoci & Botășăneanu	-	Murgoci 1968		L
19	*Drusus sp.*	-	Murgoci 1968		L
20	*Ecclysopteryx madida* (McLachlan)	- Câmpu lui Neag-Jiul V	Murgoci 1968 Ciubuc 2017	 ad	L
21	*Ecnomus tenellus* (Rambur)	- Dăbuleni	Murgoci 1968 Ciubuc 2017	 ad	L
22	*Ernodes vicinus* (McLachlan)	Gorj	Ciubuc 2012	ad	
23	*Glossosoma boltoni* Curt.	-	Murgoci 1968		L
24	*Gl. discophorum* Klapálek	Runcu-Gorj	Ciubuc 2010	ad	
25	*Gl. vernale* Pict.	-	Murgoci 1968		L
26	*Glyphotaelius pellucidus* (Retzius)	-	Murgoci 1968		L
27	*Goera pilosa* (Fabricius)	-	Murgoci 1968		L
28	*Halesus digitatus* (Schrank)	Câmpu lui Neag-Jiul V	Ciubuc 2017	ad	

29	*Hal. tesselatus* (Rambur)	-	Murgoci 1968		L
30	*Halesus. sp*	-	Murgoci 1968		L
31	*Hydropsyche angustipennis* (Curtis)	- Dăbuleni	Murgoci 1968 Ciubuc 2010; 2017	 ad	L
32	*H. bulbifera* McLachlan	Dăbuleni	Ciubuc 2010; 2017	ad	
33	*H. bulgaromanorum* Malicky	Dăbuleni	Ciubuc 2010; 2017	ad	
34	*H. contubernalis* McLachlan	- Jiu – Zăval Dăbuleni	Murgoci 1968 Rogoz 1979 Ciubuc 2010; 2017	 ad	L L
35	*H. fulvipes* (Curtis)	Tismana, Runc	Ciubuc 2010	ad	L
36	*H. guttata* Pictet	-	Murgoci 1968		L
37	*H. modesta* Navas	Dăbuleni	Ciubuc 2010; 2017	ad	
38	*H. ornatula* McLachlan	- Jiu – Zăval S-România - uncertain	Murgoci 1968 Rogoz 1979 Ciubuc 2010	 ad	L L
39	*H. pellucidulla* (Curtis)	-	Murgoci 1968		L
40	*H. saxonica* McLachlan	-	Murgoci 1968		L
41	*H. tabacarui* Botoșăneanu	- N. Oltenia	Murgoci 1968 Ciubuc 2010	 ad	L
42	*H. tismanae* Murgoci	Tismana River	Murgoci 1968		L
43	*H. sp. (scaphicephala)*	-	Murgoci 1968		L
44	*Hydropsyche sp.*	-	Murgoci 1968		L
45	*Hydropsyche sp.*	Topolnița, Drincea, Balasan, Desnățui, Baboia, Gioroc, Olteț, Teslui, Gologan	Rogoz 1979		L
46	*Hydropsyche sp.*	Cetate, Potelu – spring brooks	Rogoz 1979		L
47	*Hydroptila sp.*	-	Murgoci 1968		L
48	*Isogamus aequalis* (Klapálek)	-	Murgoci 1968		L
49	*I. czarnohorensis* (Dziedz.)	Câmpu lui Neag-Jiul V Parâng-Câlcescu	Ciubuc 2017 Ciubuc 2012	ad ?	
50	*Lasiocephala basalis* Kol.	-	Murgoci 1968		L
51	*Lepidostoma hirtum* (Fabricius)	-	Murgoci 1968		L
52	*Leptocerus tineiformis* Curtis	Dăbuleni	Ciubuc 2017	ad	
53	*Limnephilus affinis* Curtis	- Dăbuleni	Murgoci 1968 Ciubuc 2017	 ad	L
54	*L. auricula* Curtis	-	Murgoci 1968		L
55	*L. bipunctatus* Curtis	Dăbuleni	Ciubuc 2017	ad	
56	*L. decipiens* (Kolenati)	- Dăbuleni	Murgoci 1968 Ciubuc 2017	 ad	L
57	*L. flavicornis* (Fabricius)	Mofleni, Ciliboaia ponds Dăbuleni	Rogoz 1979 Ciubuc 2017	 ad	L
58	*L. flavospinosus* (Stein)	-	Murgoci 1968		L
59	*L. griseus* (Linné)	Câmpu lui Neag-Jiul V	Ciubuc 2017	ad	
60	*L. ignavus* McLachlan	Câmpu lui Neag-Jiul V	Ciubuc 2017	ad	
61	*L. vittatus* (Fabricius)	-	Murgoci 1968		L

62	*Limnephilus sp.*	Vrata, Băilești, Piscu Sadovei, Brăneț, Balș Gârcov – ponds, lakes	Rogoz 1979		L
63	*Melampophylax nepos triangulifera* Botoșăneanu	Parâng Mt.	Ciubuc 2012	ad	
64	*Micrasema sp.*	-	Murgoci 1968		L
65	*Micropterna sequax* McLachlan	Câmpu lui Neag-Jiul V	Ciubuc 2017	ad	
66	*Mystacides azurea* (Linné)	-	Murgoci 1968		L
67	*My. longicornis* (Linné)	Dăbuleni	Ciubuc 2017	ad	
68	*Neureclipsis bimaculata* (Linné)	- Jiu – Zăval Dăbuleni	Murgoci 1968 Rogoz 1979 Ciubuc 2017	 ad	L L
69	*Odontocerum albicorne* (Scopoli)	-	Murgoci 1968		L
70	*Oecetis furva* (Rambur)	- Mofleni	Murgoci 1968 Rogoz 1979		L L
71	*O. lacustris* (Pictet)	Dăbuleni	Ciubuc 2017	ad	
72	*O. ochracea* (Curtis)	Dăbuleni	Ciubuc 2017	ad	
73	*Oecetis sp.*	-	Murgoci 1968		L
74	*Parachiona picicornis* (Pictet)	-	Murgoci 1968		L
75	*Philopotamus montanus* (Donovan)	-	Murgoci 1968		L
76	*Ph. variegatus* (Scopoli)	-	Murgoci 1968		L
77	*Plectrocnemia conspersa* (Curtis)	Câmpu lui Neag-Jiul V	Ciubuc 2017	ad	
78	*Plectrocnemia sp.*	-	Murgoci 1968		L
79	*Potamophylax cingulatus* (Stephens)	Câmpu lui Neag-Jiul V Cloșani, Runcu	Ciubuc 2017 Ciubuc 2012	ad ad	
80	*Po. latipennis* (Curtis)	- Câmpu lui Neag-Jiul V	Murgoci 1968 Ciubuc 2017	 ad	L
81	*Po. millenii* (Klapálek)	-	Murgoci 1968		L
82	*Po. stellatus* Curt.	-	Murgoci 1968		L
83	*Po. pallidus* (Klapálek)	Câmpu lui Neag-Jiul V	Ciubuc 2017	ad	
84	*Potamophylax sp.*	-	Murgoci 1968		L
85	*Psychomyia pusilla* (Fabricius)	-	Murgoci 1968		L
86	*Rhyacophila aquitanica* McLachlan	- Petroșani	Murgoci 1968 Ciubuc 2010	 ad	L
87	*R. armeniaca* Guerin-Ménéville	-	Murgoci 1968		L
88	*R. carpathica* Botoșăneanu	between Olt and Dunăre	Ciubuc 2010	ad	
89	*R. fasciata* Hagen	-	Murgoci 1968		L
90	*R. fischeri* Botoșăneanu	-	Murgoci 1968		L
91	*R. hageni* McL.	-	Murgoci 1968		L
92	*R. mocsaryi* Klapálek	-	Murgoci 1968		L
93	*R. nubila* (Zetterstedt)	-	Murgoci 1968		L
94	*R. obliterata* McLachlan	- Câmpu lui Neag-Jiul V	Murgoci 1968 Ciubuc 2017	 ad	L
95	*R. polonica* McLachlan	Câmpu lui Neag-Jiul V	Ciubuc 2017	ad	

96	*R. torrentium* Pictet	Câmpu lui Neag-Jiul V	Ciubuc 2017	ad	
97	*R. tristis* Pictet	- Câmpu lui Neag-Jiul V	Murgoci 1968 Ciubuc 2010	 ad	L
98	*Sericostoma timidum* Hag.	-	Murgoci 1968		L
99	*Sericostoma sp.*	-	Murgoci 1968		L
100	*Setodes punctata* (Fabricius)	-	Murgoci 1968		L
101	*Silo pallipes* (Fabricius)	-	Murgoci 1968		L
102	*S. piceus* (Brauer)	-	Murgoci 1968		L
103	*Stactobia sp.*	-	Murgoci 1968		L
104	*Stenophylax permistus* McLachlan	Câmpu lui Neag-Jiul V	Ciubuc 2017	ad	
105	*Synagapetus slavorum* Botoşăneanu	Runcu-Gorj	Ciubuc 2010	ad	
106	*Thremma anomalum* McLachlan	-	Murgoci 1968		L
107	*Tinodes sp.*	-	Murgoci 1968		L
108	*Triaenodes bicolor* (Curt.)	-	Murgoci 1968		L
109	*T. kawraiskii* Mart.	-	Murgoci 1968		L
110	*Wormaldia occipitalis* (Pictet)	-	Murgoci 1968		L
111	*Ylodes kawraiskii* (Martynov)	Ploştina-Motru (Gorj)	Ciubuc 2012	ad	
112	*Y. simulans* (Tjeder)	Cloşani	Ciubuc 2012	?	

The larvae collected from the water course of Romanescu Park reveal the morphological features of *Hydropsyche angustipennis* larva according to Waringer & Graf (2011). The main morphological characters of the collected larvae are illustrated in Figures 1 and 2.

Figure 1. *Hydropsyche angustipennis* – Romanescu Park: left – habitus, right – the head in dorsal view

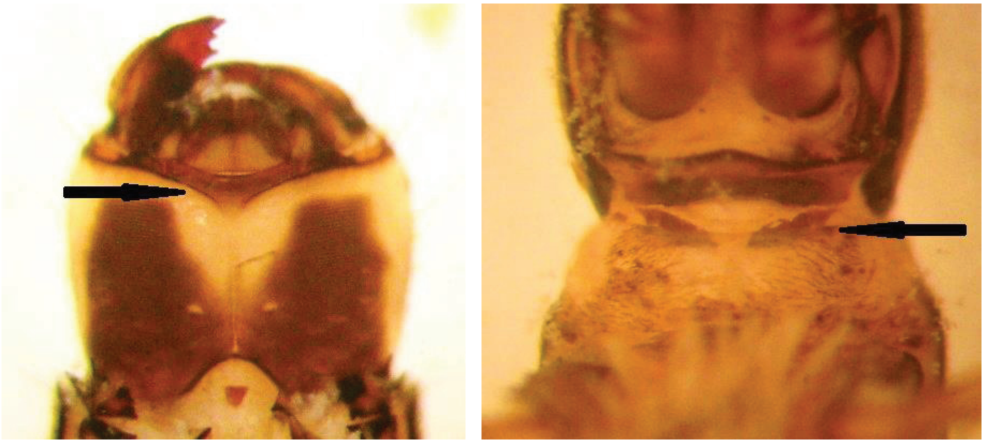

Figure 2. *Hydropsyche angustipennis* – Romanescu Park: left – submentum, right – prosternites

Discussions

The list in Table 1 includes many unidentified species, also, identified species without geographical localization.

Hydropsyche angustipennis "prefers considerably eutrophicated lowland streams", with a SI (species specific saprobic index) = 2,3 (Waringer & Graf, 2011), thus, being a bio-indicator of the water quality in the Romanescu Park. For the Romanescu Park, the presence of *Hydropsyche angustipennis* is the first record of a Trichoptera species.

CONCLUSIONS

The caddisfly larvae fauna of Oltenia region is poorly known and requires further studies as pointed out by Murgoci in 1968.

The investigation of some taxa validity is also of interest.

REFERENCES

Botoşăneanu L. 1959. Cercetări asupra Trichopterelor din Masivul Retezat și Munții Banatului. Biblioteca de Biologie animală. Edit. Academiei R.P.R., pp. 165.

Ciubuc C. 2010. Trichopterele din România, vol. I. Edit. MiniEd, pp. 299.

Ciubuc C. 2012. Trichopterele din România, vol. II. Edit. MiniEd, pp. 415.

Ciubuc C. 2017. The Catalogue of "Constantin Ciubuc" Trichoptera (Insecta) Collection of "Grigore Antipa" National Museum of Natural History. Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa", 60 (1): 7-371.

Murgoci A. 1968. Contribution à l'étude des Trichoptères des eaux de la province Oltenia (Roumanie). Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa", 8: 1013-1020.

Rogoz I. 1979. Ecologia faunei acvatice din Cîmpia Olteniei. Edit. Academiei R.S.R., pp.178.

Wallace I. 2003. The Beginner's Guide to Caddis (Order Trichoptera). Bulletin of the Amateur Entomologists' Society, 62: 15-26.

Waringer J., Graf W. 2011. Atlas der Mitteleuropäischen Köcherfliegenlarven (Atlas of Central European Trichoptera Larvae). Edit. Erik Mauch Verlag, pp. 468.

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REPORT ON APICOMPLEXA – GREGARINASIDA IN OPILIONES (ARACHNIDA) HOSTS

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Keywords*: gregarines, trophozoites, Opiliones,*

ABSTRACT

In this paper it is reported the presence of unidentified and unnamed Apicomplexa, Gregarinasida, Eugregarinorida, Septatorina in five Opiliones hosts – Ischyropsalis manicata L. Koch, 1865, Platybunus pallidus Šilhavý, 1938, Zacheus crista (Brullé, 1832), Egaenus convexus (C.L.Koch, 1835) and Mitopus morio (Fabricius, 1799).

Some stages hosted by the Opiliones intestine are illustrated: mobile and fixed trophozoites, syzygy.

INTRODUCTION

Gregarines are large apicomplexan parasites especially in large invertebrate hosts. Their taxonomic diversity is little known, being estimated that "the potential gregarine fauna from over 99% of the known invertebrate world remains to be discovered" (Clopton 2000).

All known Apicomplexa parasites of Opiliones belong to Septatorina Eugregarines (Cokendolpher 1993). Septatorina is defined by the gamont or trophozoite divided into protomerite and deutomerite by a septum (Clopton 2000). The life cycle is characterized by the occurrence of both sexual and asexual stages (gamogony and sporogony), by the lack of merogony and by the formation of couple of individuals named association (developmental event) or syzygy (a reproductive event) (Clopton 2000). The host gets infection by ingesting the oocysts. Once in the lumen of the gut, the parasites attach to the intestinal epithelium through an epimerite; this stage is known as the cephalin in Romanian literature (Firă 1974). After the feeding period, the parasite cell breaks or detaches at the level of the epimerite, giving rise to the stage of free, mobile sporadine (Firă 1974) in the intestinal lumen. Both the attached cephalin and the free, motile sporadine represent vegetative stages named *trophozoite*. The sporadines once entered the syzygy to begin the gametogenic cycle are named gamonts (Clopton 2000). The gametocysts resulted from the gamonts pass through the feces into the external environment where they dehisce and release the infective oocysts which re-initialize the life cycle (Cokendolpher 1993).

The knowledge of the parasite gregarines in Opiliones at the level of species is deficient due to fact that few parasitologists are trained as arachnologists and vice versa (Cokendolpher & Mitov 2007). Thus, many parasite gregarines in Opiliones remain unidentified in unpublished or published records (Gruber 1993), Tsurusaki – 1986, Hunt – 1979 (Cokendolpher 1993).

The gregarine species parasites in Opiliones hosts are provided by Clopton (2000), Cokendolpher (1993) and Cokendolpher & Mitov (2007).

MATERIAL AND METHODS

The opilionid species to which the presence of gregarines is reported in this paper were collected from Romania in the period 1997 – 2012. The presence of gregarines was found by analysis of the intestinal contents and with the occasion of histological studies. The photos were taken with Nikon camera (for the histological sections), Sony cyber-shot camera and Levenhuk microscope digital camera.

RESULTS AND DISCUSSIONS

Various observed intestinal stages are illustrated in five Opilionid species:

1. *Ischyropsalis manicata* – host, young adult

Unidentified gregarine - cephalin and syzygy – fig. 1

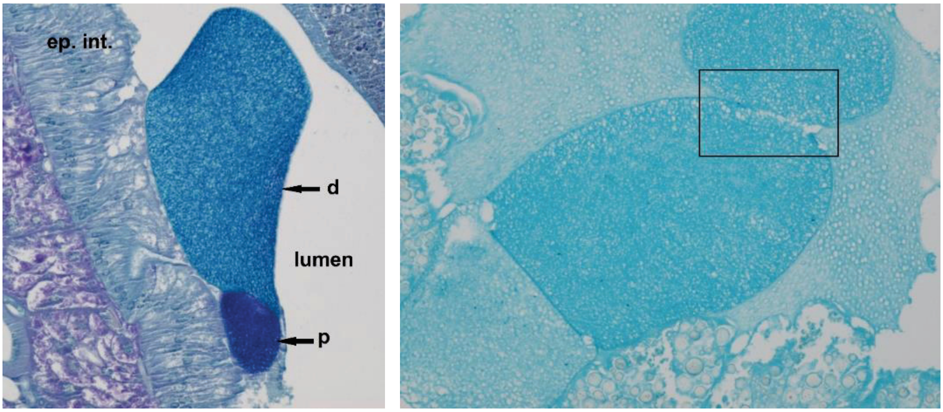

Fig. 1 Unidentified gregarine in *Ischyropsalis manicata*, histological sections: left – mobile stage (PASA-stain), right – syzygy (AB-stain); d – deutomerite, ep. int – intestinal epithelium, l – intestinal lumen, p – protomerite,

2. *Platybunus pallidus* – host, subadult

Unidentified gregarine - fixed trophozoite – fig. 2

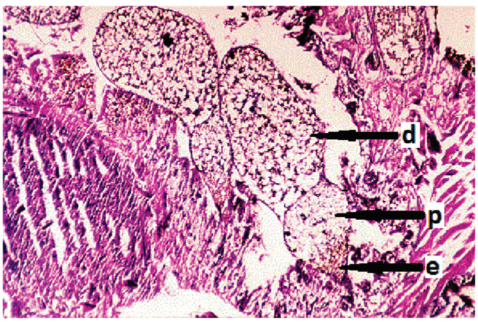

Fig. 2 Unidentified gregarine in *Platybunus pallidus*, histological section (HE-stain), cephalin stage; d – deutomerite, e – epimerite, p – protomerite

3. *Zacheus crista* – host, young adult
Unidentified gregarine – fig. 3

Fig. 3 Unidentified gregarine in *Zacheus crista*: closeup of a cephalin (photo – Levenhuk microscope digital camera)

4. *Egaenus convexus* – host, young adult
Unidentified gregarine – fig. 4

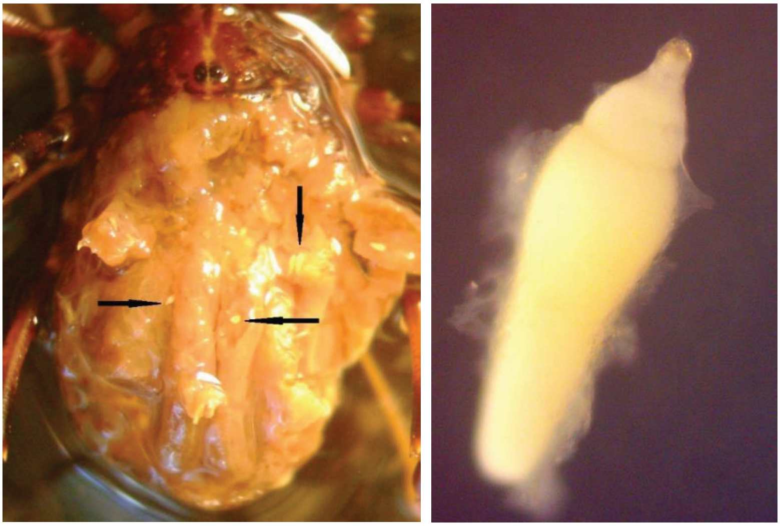

Fig. 4 Unidentified gregarine in *Egaenus convexus*: left – dorsal view of a dissected opilion, tergites removed, revealing small fixed trophozoites; right – closeup of a cephalin (photo – Levenhuk microscope digital camera)

5. *Mitopus morio* – host, subadult
Unidentified gregarine – fixed and mobile trophozoites – fig. 5

Discussions

The author is unaware of the existence of literature on gregarine infestation in *Ischyropsalis manicata*, *Platybunus pallidus* and *Egaenus convexus*.

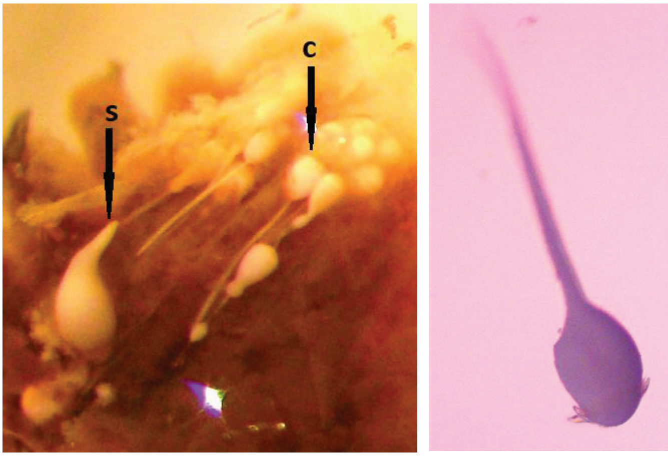

Fig. 5 Unidentified gregarine in *Mitopus morio*: left – trophozoites; right – closeup of a cephalin (Levenhuk photo); c – cephalin fixed stage, s – sporadin mobile stage

For *Zacheus crista*, the literature reports infestation with unidentified gregarines while *Mitopus morio* is infected with more than one gregarine species: *Anthorhynchus longispora*, *Anthorhynchus sophiae*, *Doliospora repelini*, *Sciadiophora caudata* and *Sciadiophora phalangii* (Cokendolpher & Mitov 2007).

Zacheus crista and *Egaenus convexus* analyzed in this paper, share the same habitat (leaf litter) with overlapping phenology. Future studies will determine whether the two species of opilionids are infested with the same gregarine species.

Solely based on the appearance of the trophozoites illustrated in this paper, it is not possible to assign the gregarines to any species or even genera. Considering the fact gregarines are stenoxenous even to stadium-specificity within a single host, for instance in *Tenebrio molitor* (Clopton et al. 1992), one can expect that at least some of the here reported gregarines may belong to new taxa.

CONCLUSIONS

The scarcity of knowledge on parasitic gregarines in Opiliones (and not only) gives special attractiveness to this interesting protozoan group.

REFERENCES

Clopton R. E. 2000. Order Eugregarinorida Léger, 1900, In Lee J. J & al. (eds.), An illustrated guide to the Protozoa, Allen Press Inc., KS, USA. Vol. 1: 205-288.

Clopton R. E., Janovy J. J., Percival Cook T. J. 1992. Host Stadium Specificity in the Gregarine Assemblage Parasitizing *Tenebrio molitor*. Journal of Parasitology, 78 (2): 334-337.

Cokendolpher J. C. 1993. Pathogens and parasites of Opiliones (Arthropoda: Arachnida). Journal of Arachnology, 21: 120-146.

Cokendolpher J. C., Mitov G. P. 2007. Chapter 9 Natural enemies, In Giribet G. & al. (eds.), Harvestmen: The biology of Opiliones, pp. 339-373.

Firă V. 1974. Zoologia nevertebratelor, I Protozoa. Centrul de Multiplicare al Universității București, pp. 1-215.

Gruber J. 1993. Beobachtungen zur Ökologie und Biologie von *Dicranolasma scabrum* (Arachnida: Opiliones). Teil I. *Annln naturh. Mus. Wien*, 94/95B: 393–426.

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RESEARCH ON THE INFLUENCE OF NUTRITION ON THE PRODUCTION OF BIOMASS OBTAINED FROM SUGAR SORGHUM ON SANDY SOILS FROM SOUTHERN OLTENIA

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Keywords: *biometrics, leaf index, production, sugar content*

ABSTRACT

The research carried out in the period 2018-2020, for sugar sorghum cultivated in the conditions of sandy soils in southern Oltenia, aimed at optimizing biomass production depending on root fertilization and the size of the plant's nutrition area. The obtained results highlight significant differences in plant height, stalk diameter, leaf surface index, stalk sugar content and biomass production depending on the technological factors studied. Thus, the fertilization of sugar sorghum with a dose of $N_{150}P_{80}K_{80}$*, by ensuring the sowing of the density of 20 germinating grains/m*^{2}*, led to the registration of the maximum production of 110.06 tons/ha, with a difference of 71.56 t/ha, compared to unfertilized. Production correlated significantly positively with the leaf area index (0.796 **).*

INTRODUCTIONS

Research conducted worldwide has highlighted the positive response of the sugar sorghum plant to the application of nutrients with B, Zn and S, on the yield and quality of juice (Srinivasa Rao et al. 2011b). In drought conditions, sorghum does not react significantly to the application of nitrogen fertilizers (Cosentino et al. 2012). Research conducted at the Audubon Sugar Institute, Louisiana State University Agricultural Center, found that sugar sorghum had a sugar content of 11.8%, 45% cellulose, 27% hemicellulose, and 21% lignin and a theoretical ethanol production of 5,804 kg/ha (Kim M & Day DF 2010). In other studies, it has been shown that sorghum can achieve an ethanol production between 5077 l / ha and 7619 l / ha (Daniel E. Ekefre et al. 2017). In a study conducted in Missouri, on different variants of fertilization with nitrogen doses, showed that the sugar content (Brix degrees) of the juice varied between 10.7% and 18.9% (Rolanda Y. Holou & Gene Steven S. 2012). Nitrogen fertilization has improved the sugar content of the juice. There was a negative correlation between sugar concentration and juice yield. The yield of sugar in the juice showed significant differences depending on the years, the dose of nitrogen and the type of soil. The importance of the element nitrogen in the nutrition of the sugar sorghum plant was highlighted by Almodares et al. 2009, which conducted a study evaluating the effects of four doses of nitrogen (50, 100, 150 and 200 kg urea/ha) on the production of biomass, crude protein, soluble carbohydrates and crude fiber content in three types of feed (corn, sweet sorghum and grains sorghum). The results obtained for sugar sorghum showed that the application of 200 kg / ha urea led to the highest biomass production (64.80 t/ha) and a maximum percentage of protein (8%) and a minimum amount of soluble carbohydrates (12.80%) and fiber (31.90).

MATERIALS AND METHODS

The research carried out in the period 2018-2020, for sugar sorghum cultivated in the conditions of sandy soils in southern Oltenia, aimed at optimizing biomass production depending on root fertilization and the size of the plant's nutrition area. The experiment was designed according to the method of plots subdivided with two factors, in field conditions, in irrigated system. Were studied 3 densities of sowing (10, 15, 20 germinating seeds/m^2) and 7 agrofunds fertilization (Unfertilized, N_{50}, $P_{40}K_{40}$, $N_{50}P_{40}K_{40}$, $N_{80}P_{80}K_{80}$, $N_{100}P_{80}K_{80}$, $N_{150}P_{80}K_{80}$). The sugar sorghum crop was placed under irrigation conditions on a sandy soil with a pronounced chemical nonuniformity. Soil quality analyzes revealed a nitrogen content between 0.035% and 0.13%, values that indicate a low soil supply state, an extractable phosphorus content between 59 ppm and 115 ppm, values that characterize the soil as being well supplied in phosphorus and a percentage of 24 ppm and 62 ppm in exchangeable potassium, which shows a low to medium supply state. Organic carbon showed values in the range of 0.19% to 0.65%, which indicates a reduced state of soil supply of organic matter, with portions to the middle, and the pH of the soil ranged between 4.83 and 6, 13, values showing a moderately strong acid to weakly acid reaction. At flowering, the leaf area and the height of the plant were determined, and in the soft dough phase of the grain, determinations were regarded the stalk diameter, the sugar percentage and the biomass production. The results were interpreted by the method of variance analysis (ANOVA) and with the help of mathematical functions.

RESULTS AND DISCUSSIONS

The results obtained at sugar sorghum showed a differentiation of plant development depending on the factors studied. Was recorded an average value of plant height of 274.55 cm, with limits between 239.9-316.5 cm and an average value of stalk diameter of 18.84 mm, with limits between 15.6-22.9 mm (Figure 1). Ensuring a fertilization of 150 kg/ha N+80 kg/ha P_2O_5 and 80 kg/ha K_2O, led to an increase in diameter by 5.9-6.7 mm and plant height by 26.6-73.23 cm, compared to unfertilized. For normal growth and development, sugar sorghum plants need an optimal supply of macro and micronutrients in the growth environment to fulfill their standard physiological functions. The literature emphasizes that a low leaf area as well as a low chlorophyll content of the leaves lead to decreased biomass production (Kalacska M. et al. 2015). The foliar surface index registered values of 5.3-12.2, with an average of 7.8, being influenced by the fertilization regime and the number of plants per unit area (Figure 2). Sugar sorghum made the best use of the nutrition space corresponding to the density of 20 g.s./m^2, registering significant increases by fertilizing with the three macronutrients (nitrogen, phosphorus and potassium) in doses of 150 kg/ha N+ 80 kg/ha P_2O_5 and 80 kg/ha K_2O.

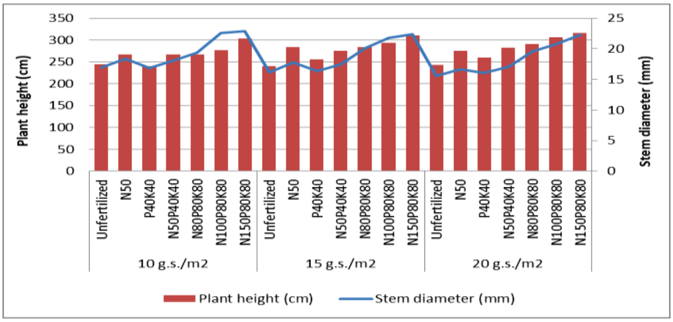

Figure 1. Influence of fertilization, according to plant density on some biometric determinations in sugar sorghum

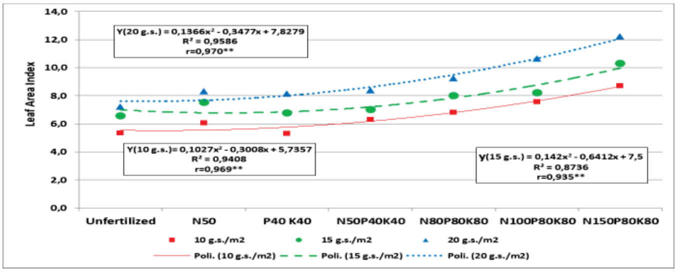

Figure 2. Correlations between fertilization and leaf surface index in sugar sorghum sown at different densities

Determinations of the sugar concentration in the stalk, were carried out in the soft dough phase of the grain, with a hand type refractometer. Refractometer with a scale 0 - 32% BRIX and temperature compensation in the range of 10-30 Celsius degrees, highlighted values of 13.4-17.8%, with a maximum recorded by ensuring a sowing density of 15 germinating grains/square meter and a fertilization with $N_{150}P_{80}K_{80}$ (Figure 3). The sugar content was significantly influenced by the nutritional regime of the plant, regardless of the density provided at sowing, (r = 0.931...0.962). The results obtained in some sugar sorghum hybrids cultivated in southwestern Romania showed a total sugar content between 14.02% and 15.87%, of which a higher percentage high 67.74% to 79.43% is represented by non-reducing sugar (Babeanu 2017, Matei 2016). Optimizing plant density plays an essential role in agricultural crop management practices (Sipoș et. al. 1981). The results obtained for sugar sorghum highlighted the variant in which 20 germinating seeds per square meter were ensured by sowing, and an average production of 65.47 t/ha was achieved, with a distinctly significant production difference of 10.47 tons/ha, compared to providing sowing of 10 g.s./m^2 (Table 1). Similar results were obtained on sandy ground in Ordos, Inner Mongolia, China, which shows that plant height, leaf surface index, leaf surface density (LAD) and biomass yield increased as plant density increased and stalk diameter increased and net assimilation rate decreased (Chaochen Tang et al. 2018)

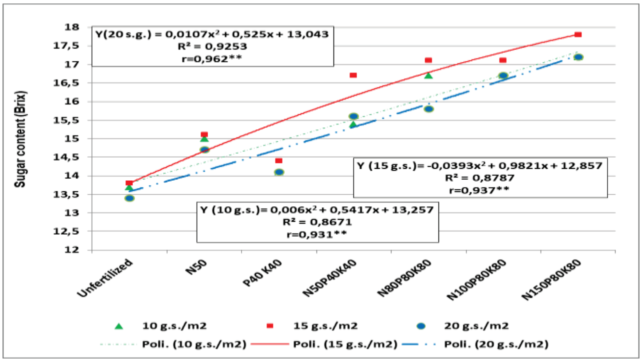

Figure 3. Correlations between fertilization and sugar content of sugar sorghum stalks sown at different densities

Table 1

The influence of plant density on biomass yield obtained at sugar sorghum

Experimental variants	Biomass yield			Leaf Area Index
	To/ha	The difference compared to the control (t/ha)	Signification	
10 germinating seeds/m^2	55.00	Control	Control	6.5
15 germinating seeds/ m^2	60.70	5.7	*	8.3
20 germinating seeds/ m^2	65.47	10.47	**	10.9

LSD 5%=3.85 to/ha; LSD 1%=6.37 to/ha; LSD 0.1%=11.92 to/ha

The differentiation of the plant fertilization regime had a very significant influence on the production results obtained (Table 2). The total biomass production varied between 37.87-100.34 t/ha, reaching the maximum when fertilizing sugar sorghum crop with 150 kg/ha N+80 kg/ha P_2O_5 and 80 kg/ha K_2O.

Table 2

The influence of fertilization on the yield of biomass obtained at sugar sorghum

Experimental variants	Biomass yield			Leaf Area Index
	To/ha	The difference compared to the control (t/ha)	Signification	
Unfertilized	37.87	Control	Control	7.0
N_{50}	46.82	8.95	***	7.7
$P_{40}K_{40}$	42.28	4.41	*	7.2
$N_{50}P_{40}K_{40}$	53.31	15.44	***	7.8
$N_{80}P_{80}K_{80}$	64.05	26.18	***	8.1
$N_{100}P_{80}K_{80}$	78.02	40.15	***	9.1
$N_{150}P_{80}K_{80}$	100.34	62.47	***	10.9

LSD=4.19 to/ha; LSD 1%=5.61 to/ha; LSD 0.1%=7.4 to/ha

For normal growth and development, sugar sorghum plants require an optimal supply of macro and micronutrients in the growth environment to fulfill their standard physiological functions. The literature emphasizes that a low leaf area as well as a low chlorophyll content of the leaves lead to decreased biomass production (Kalacska et al. 2015). The functional link between the leaf surface index and the biomass yield obtained from sugar sorghum is shown in Figure 4 and underlines a distinctly significant positive correlation (r = 0.876 **).

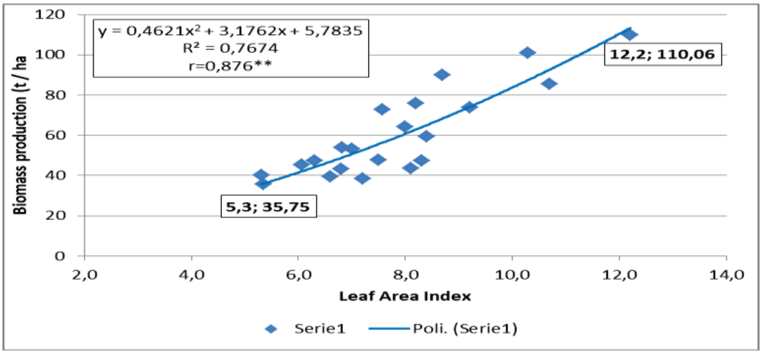

Figure 4. Correlations between biomass yield and leaf surface index at sugar sorghum

CONCLUSIONS

The results obtained for sugar sorghum showed a plant height of 239.9-316.5 cm and a stalk diameter of 15.6-22.9 mm. being positively influenced by the fertilization regime.

The leaf area index recorded values of 5.3-12.2. with a maximum recorded by sowing 20 g.s./m^2 and fertilizing with the three macroelements (nitrogen, phosphorus and potassium) in doses of 150 kg/ha N + 80 kg/ha P_2O_5 and 80 kg/ha K_2O.

The sugar content was between 13.4-17.8%, and was significantly influenced by the nutritional regime of the plant, regardless of the density provided at sowing. (R = 0.931...0.962).

The total biomass production varied between 37.87-100.34 t/ha, reaching the maximum when fertilizing sugar sorghum crop with 150 kg/ha N+80 kg/ha P_2O_5 and 80 kg/ha K_2O.

Total biomass production was distinctly significant correlated with leaf area index (r = 0.876 **).

ACKNOWLEDGEMENT

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REFERENCES

Almodares A. M., Jafarinia, M.R., Hadi. 2009. The Effects of Nitrogen Fertilizer on Chemical Compositions in Corn and Sweet Sorghum. American-Eurasian J. Agric. & Environ. Sci.. 6 (4): 441-446.

Babeanu Cristina. Matei Gheorghe, Dodocioiu Ana Maria. 2017. EVALUATION OF SUGAR CONTENT IN STEM JUICE FROM SWEET SORGHUM HYBRIDS GROWN IN SOUTH WEST OF ROMANIA. Analele Universităţii din Craiova. Seria Agricultură – Montanologie – Cadastru (Annals of the University of Craiova - Agriculture. Montanology. Cadastre Series) Vol. XLVII: 25-29.

Chaochen Tang, Chuandong Sun, Fu Du. Feng Chen, Asif Ameen, Tongcheng Fu, Guang Hui Xie. 2018. Effect of Plant Density on Sweet and Biomass Sorghum Production on Semiarid Marginal Land. Sugar Tech volume 20: 312–322.

Cosentino SL., Mantineo M., Testa G. 2012. Water and nitrogen balance of sweet sorghum (Sorghum bicolor Moench (L.)) cv. Keller under semi-arid conditions. Ind Crops Prod 36: 329–342.

Daniel E., Ekefre, Ajit K. Mahapatra, Mark Latimore Jr., Danielle D. Bellmer, Umakanta Jena, Gerald J. Whitehead, Archie L. Williams. 2017. Evaluation of three cultivars of sweet sorghum as feedstocks for ethanol production in the Southeast United States. Heliyon. vol. 3: 1-18.

Kalacska M., Lalonde M., Moore TR., 2015. Estimation of foliar chlorophyll and nitrogen content in an ombrotrophic bog from hyperspectral data: scaling from leaf to image. Remote Sensing of Environment. 2015;169: 270–279. doi: 10.1016/j.rse.2015.08.012. [CrossRef] [Google Scholar].

Kim M., Day DF., 2010. Composition of sugar cane. energy cane. and sweet sorghum for suitable ethanol production at Louisiana sugar mills. J Ind Microbiol Biotechnol. 2011 Jul;38(7): 803-7. doi: 10.1007/s10295-010-0812-8. Epub 2010 Aug 29.

Matei Gh., 2016. Study on yield features of sweet sorghum hybrids grown in South West of Romania. 16th International Multidisciplinary Scientific GeoConference SGEM 2016. www.sgem.org. SGEM 2016 Conference Proceedings. ISBN 978-619-7105-68-1 / ISSN 1314-2704. June 28 - July 6. 2016. Book6 Vol. 1: 783-790 pp DOI: 10.5593/SGEM2016/B61/S25.104.

Rolanda Y. Holou & Gene Steven S. 2012. Juice. sugar. and bagasse response of sweet sorghum (Sorghum bicolor (L.) Moench cv. M81E) to N fertilization and soil type. GCB Bioenergy (2012) 4. 302–310.

Srinivasa Rao P., Jayalakshmi M., Kumar CG., Kamal A., Reddy BVS , 2011b. Response of fertilizer treatment on agronomic and biochemical traits in main and ratoon crops of sweet sorghum (Sorghum bicolor (L) Moench) cultivar ICSV 93046. Balancing Sugar and Energy Production in Developing Countries: Sustainable Technologies and Marketing Strategies. In: Proceedings of the 4th IAPSIT international sugar conference IS-2011. Hotel Parkland Exotica. New Delhi. pp 160–164. 21–25 November.

Sipoş Gh., D. Scurtu, Gh. Sin, I. Moga. 1981. Densitatea optimă a plantelor agricole. Ed. Ceres. Bucureşti.

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APPLIED WATER AND IRRIGATION COSTS OF SOME FIELD CROPS IN KONYA PROVINCE, TURKEY

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Keywords: *Irrigation cost, Field crops, Modern irrigation systems, water shortage regions.*

ABSTRACT

The aim of present study was to analyze irrigation practices for some field crops under irrigated farms taking water from groundwater by usage of electrical power supply at semi-arid Konya, Turkey. In results, average seasonal applied water for sugar beet, alfalfa, maize, sunflower, and wheat/barley were calculated as about 1000, 900, 920, 500, and 305 mm, respectively. Irrigation costs in sugar beet, alfalfa, and maize varied from 770 USD/ha to 1534 USD/ha depending on water pumping depths. They were about 256-500 USD/ha, and 256-428 USD/ha for sunflower, and wheat/barley, respectively. Irrigation cost had maximum share in whole production inputs, e.g., irrigation energy costs in grain-maize farming for water positions of groundwater as 70 m and 210 m were 50%, and 65%, respectively. Enhancing irrigation efficiency is the most important strategy for reducing irrigation energy cost as well as conserving of groundwater resources. In addition, government should also subsidize low water consuming crop production more such as cereal and sunflower farming for sustainable usage of water resources in water scant ecologies.

INTRODUCTION

It is estimated that food requirement of human being will be about 60% more by the year of 2050. Energy saving technologies is great interests for all sectors such as agriculture (FAO, 2016). Irrigation is the greatest energy using activity within all crop-growing processes especially in water scant regions (Yavuz et al. 2014). There is no doubt that irrigation is the single most important agro-practice increasing crop yield, and even is almost impossible for farmers to get economical outputs with no irrigation particularly in semi-arid Konya region (Yavuz et al. 2015 a,b; Yavuz et al. 2019). Selection of crop cultivars with low water use such as pumpkin (Seymen et al. 2019), improvement of irrigation efficiency (Yavuz et al. 2016; Exposito & Berbel 2017) and 25%-deficit irrigation for some crops could be tackled as practical solutions for minimizing irrigation cost (Acar et al. 2014; Yavuz et al. 2018a; Yavuz et al. 2020). Drip and sprinkler irrigation system have needed energy during the processes of water taking for crops in case of water resources being below irrigation farms (Belaud et al. 2019; Ahmad & Khan, 2017).

The quality of pumps, water pumping depth, irrigation systems and types power supplies have effect on irrigation cost (Smajstria et al. 2002; Martin et al.

2010), and more than 21 million pumping plants operating by electric have used for irrigation in south Asia (Shah et al. 2004). The reasons behind low performance of pumps are aging, improper selection of pumps, changes in pumping usages such as replacement of sprinkler irrigation to drip irrigation, incorrect design and disproportion of operating conditions (Zaccaria, 2016; Brati et al. 2018).

Tarjuelo & Moreno (2017) suggested establishment of irrigation advisory service (IAS) for managing of farmers in some agro-issues such as fertilizer program, correct design and operation of irrigation systems and training them particularly about water-energy savings. Qing-tao et al. (2013) reported that proper irrigation program is efficient way for better irrigation energy profitability.

Rodriguez Diaz et al. (2011) classified regions in accordance of energy utilizations; more than 1000 kWh/ha is high; 600-1000 kWh/ha is moderate, and less than 600 kWh/ha is low; more than 0.41 kWh/m^3 is high; between 0.30-0.40 kWh/m^3 is moderate, and less than 0.30 kWh/m^3 is low.

In this study, applied water and irrigation costs were examined in some irrigated field crops by sprinkler or drip systems in semi-arid Konya province, Turkey.

MATERIAL AND METHODS

The study region is situated at Middle Anatolian Region of Turkey. Annual rainfall is about 323 mm and rainfall at vegetation period for 2017 and 2018 were about 87 mm, and 63 mm, respectively (Yavuz et al. 2020). The soil texture within research environment is clay dominated mostly. In such region, canals and wells are used for irrigation purposes. The data relevant to irrigation number, duration, depths of wells, were obtained from representative eight farmers by face-to-face survey technique. Seasonal irrigation water was calculated by using practical irrigation scheduling. In this study, irrigation costs for five different field crops irrigated via sprinkler and drip systems were estimated at water taking from groundwater by pumps working electric power supply. In research farms, sugar beet, alfalfa, and wheat / barley have irrigated by sprinkler irrigation system. Maize and sunflower have irrigated by both sprinkler and drip irrigation systems. In our study region, sprinkler irrigation systems had spacing (12x12) m, discharge of 2 m^3/h, and nozzle diameter of 4.5mm/2.8 mm. In drip system using for irrigation of sunflower and maize, lateral diameter, emitter spacing, and emitter discharge were 22 mm, 25 cm, and 1.8 L/h, respectively. The data were relevant to 2019 growing season (1 USD = 6.5 TL, Turkish Lira).

RESULTS AND DISCUSSIONS

In research site, water depths of wells were minimum as about 70 m and maximum as about 200 m and rarely 220 m (Figure. 1). In some parts of the research region, there is a gradual depletion in groundwater level due to the over water extractions from the groundwater reservoir. Possibly, one of the most important reasons of water level reduction is increase of farmlands in favor of high water consuming crops without control. In can be recommended that crop pattern should be reorganized in accordance of current water supply.

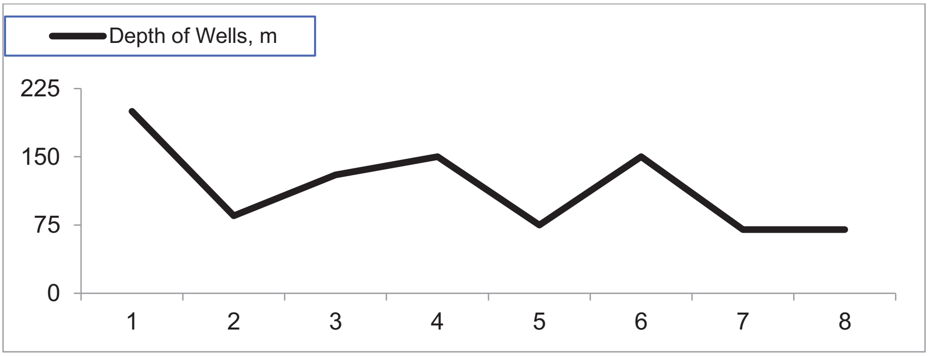

Figure 1. Depths of wells for examined farms

A. Irrigation number and duration

Sugar beet: It is one of the most important and well-adopted industrial field crops to our region. Irrigation number varied from 8 to 12, with general 10. It is suggested 6-7 irrigation events and one or two extra irrigation processes will be beneficial (Anonymous 2020); 15-17 irrigation by Süheri et al. (2007); 14 irrigation for Kırşehir province (Kıymaz & Ertek 2017). Duration was found between 5 h and 10 h.
Alfalfa: Number of irrigation was as 8 with duration between 5 h and 10 h. Animal breeding is one of the most popular agro-activities since our region is first rank in regard to animal population in Turkey. In Erzurum province of Turkey, number of irrigation varied from 7 to 11 for sprinkler-irrigated alfalfa crop (Kuşçu et al. 2010).
Maize: That crop has growth for both grain and silage production. Such crop is almost 1/3 of all field crops in regard to farming area and production in region. Number of irrigation for sprinkler and drip irrigated corn varied from 9 to 12 and from 8 to 11, respectively. Durations for sprinkler and drip irrigation were 7-10 h, and 24 h, respectively. In study of Okay & Yazgan (2016), number of irrigation was stated as 7 for drip-irrigated corn plant under Bursa province, Turkey.
Sunflower: Number of irrigation for both sprinkler and drip-irrigated sunflower was as 4. The durations for sprinkler and drip irrigation sunflower plant were 6 - 8 h, and 24 h, respectively.
Wheat / Barley: Irrigation number varied from 2 to 4 with duration between 5 h and 8 h. In water shortage climates such as Middle Anatolia Region of Turkey, at least three irrigation processes at critical growth stages of wheat can be recommended for obtaining satisfactory economical returns (Gültekin et al. 2011).

B. Irrigation water and yield analysis

In current study, seasonal applied water for sugar beet varied from 680 mm to 1380 mm with average 1000 mm (Figure 2). Average fresh root yield was as about 100 t/ha for sprinkler-irrigated sugar beet. Almost similar results were mentioned in elsewhere 80 t/ha (Süheri et al. 2007), and 76 t/ha (Kıymaz & Ertek 2017), and 93 - 102 t/ha (Zarski et al. 2020).

The irrigation water of alfalfa crop was between 552 mm and 1104 mm with average of 900 mm, and is lower than results of Selenay & Kadayıfçı (1999) as 1484

- 1671 mm, higher than Kuşçu et al. (2010) as 350 to 550 mm, and almost inline with (Djaman et al. 2020) as about 800 mm. In our study, yield of fresh forage yield was about 20-25 t/ha (for 4 cuts). The finding obtained from present study is almost agreement with Cavero et al. (2017) as 20 t/ha at semi-arid Mediterranean, and Djaman et al. (2020) as 11-25.6 t/ha at New Mexico conditions.

Seasonal applied water for maize was found as average of 900-1000 mm with average of 920 mm. They were reported 1007 mm by Kuşçu & Demir (2012), 864 mm by Kuşçu et al. (2013), and 711 mm by Okay & Yazgan (2016). In current study, grain yield was found as average of 17 t/ha. In some studies, those were 18.53 t/ha (Okay & Yazgan 2016), 20.52 t/ha (Kuşçu & Demir 2012), 15.92-16.48 t/ha (Kuşçu et al. 2013), 14.6 t/ha (Kresovic et al. 2018), and 5.53 t/ha (Admasu et al. 2019). The yield differences in those studies could be from changes in cultivar, water management, irrigation systems, cultural practices, growing environments, and so on.

Irrigation water of sunflower was found as average of 500 mm. It was determined as 678 mm in one study for similar environment (Yavuz et al. 2018b). In this study, seed yield for oil production was 3.5 t/ha. Those seed yields were mentioned as 5.74 t/ha by Yavuz et al. (2018b), and 3.3 t/ha by Elsheikh et al. (2015).

Seasonal irrigation water for wheat was about 305 mm. The finding of present study is almost conformity with Gültekin et al. (2011). In present study, grain yield of wheat was 7.25 t/ha, and is greater than those findings of Gültekin et al. (2011) as 5.49 t/ha, and Zhou et al. (2007) as 5.67 t/ha.

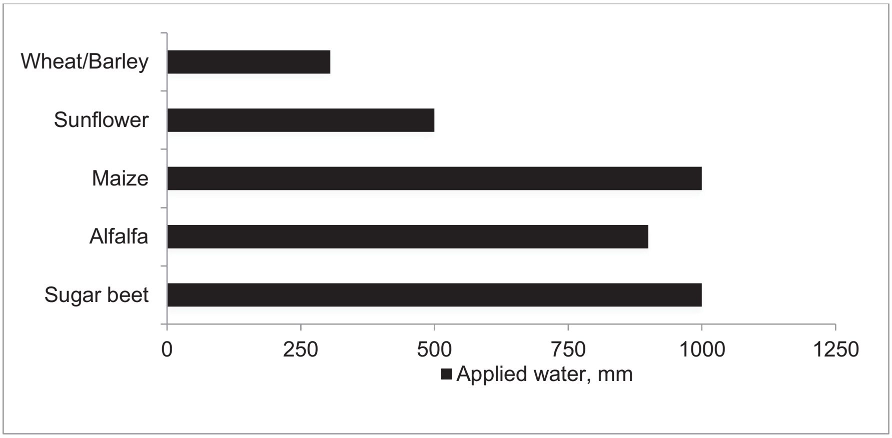

Figure 2. Seasonal applied water for examined field crops

C. Irrigation Costs: An Example Net Return of Maize

Irrigation energy costs for sugar beet, alfalfa, and maize varied from 770 to 1534 USD/ha. They were between 256 and 500 USD/ha, and 256 and 428 USD/ha for sunflower and wheat, respectively. There is direct relationship between irrigation costs, and water depths of wells, irrigation number and duration e.g. for sugar beet, irrigation energy costs of 770 USD/ha and 1534 USD/ha, for water depths of 70 m and 210 m, respectively for similar applied water. The reasons of low irrigation energy cost for sunflower and wheat were practicing less number of irrigation and duration for water taking from same ground water level.

In examining net return of grain-maize production for different groundwater depths; irrigation costs for water levels of 70 m, and 210 m were 770 USD/ha and 1534 USD/ha, respectively. Total other whole production costs was calculated as 800 USD/ha so total production costs of maize; 1570 USD/ha (770+800) for 70 m, and 2334 USD/ha (1534 + 800) for 210 m water depths, respectively. The market price of grain was 2830 USD/ha at 2019. In that regard, net returns of grain-maize were about 1260 USD/ha, and 500 USD/ha for water taking from 70 m and 210 m depths, respectively. The shares of irrigation energy costs for grain-maize production were about 50%, and 65% within whole production inputs, for groundwater positions of 70 m and 210 m, respectively. By addition of government subsidize to the current net return, grain-maize production has resulted good benefits for farmers.

CONCLUSIONS

The yields of examined field crops were found satisfactory. The reason behind could be that farmers are always following advances or innovations worldwide in agriculture. Irrigation energy cost is very high within all crop production inputs in Turkey. Improving irrigation efficiency is necessarily prerequisites for both water and energy savings as well as conserving of water resources particularly in water shortage environments. The size of farmlands using modern irrigation technologies can be widen for enhancing water application efficiency. In addition, low water consuming crops such as wheat, barley, and sunflower should be cultivated in more farmlands for sustainable usage of current water resources in such environments. The other practical solution for reducing irrigation cost is application 25%-deficit irrigation, resulting not notable yield drops, for some crops such as sugar beet, maize, and sunflower in regions having water scant environments. Water is the backbone of the agricultural production so conservation of water resources is necessarily prerequisites for sustainable irrigation at arid and semi-arid climates. It is suggested that government subsidize should be increased for farmers who are producing low water consuming crops such as cereals particularly in water scant regions.

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REFERENCES

Acar B., Topak R., Yavuz D., Kalender M.A. 2014. Is drip irrigation technique sustainable solution in agriculture for semi-arid regions? A case study of Middle Anatolian Region, Turkey. International Journal of Agriculture and Economic Development, 2 (2): 1-8.

Admasu R., Michael AW., Hordofa T. 2019. Effect of moisture stress on maize (*Zea Mays* L.) yield and water productivity. Int J. Environ Sci Nat Res., 16 (4): 83-87.

Ahmad A., Khan S. 2017. Water and energy scarcity for agriculture: is irrigation modernization the answer? Irrig. and Drain., 66: 34-44.

Anonymous. 2020. Şeker Pancarı Üretim Tekniği. https://www.adaseker.com.tr/pancar-uretim-teknigi/ (Access August 3, 2020).

Belaud G., Mateas L., Aliod R., Boisson MC., Faci E., Gendre S., Ghinassi G., Perea RG., Lejars C., Marujols F., Zapata N. 2019. Irrigation and energy: issues and challenges. Irrig. and Drain., DOI: 10. 1002/ird. 2343.

Brati H., Khaledian M., Biglouel M., Rizi AP. 2018. Assessment of energy efficiency in pump stations of pressurized irrigation systems (case study: Qazvin and Kermanshah provinces). International Journal of Agricultural Management and Development, 8 (3): 389-396.

Cavero JF., Faci JM., Medina ET., Martinez,-Cob A. 2017. Alfalfa forage production under soild set sprinkler in a semi-arid climate. Agwat, 191: 184-192.

Djaman K., Smeal D., Koudahe K., Allen S. 2020. Hay yeild and water use efficiency of alfalfa under different irrigation and fungicide regimes in a semiarid climate. Water, 12: 1721; doi:10.3390/w12061721

Elsheikh ERA., Schultz B., Adam HS., Haile AM. 2015. Crop water productivity for sunflower under different irrigation regimes and plant spacing in Gezira Scheme, Sudan. Journal of Agriculture and Environment for International Development, JAEID, 109 (2): 221-233.

Exposito A., Berbel J. 2017. Agricultural irrigation water use in a closed basin and the impacts on water productivity: the case of the Guadalquivir River basin (Southern Spain). Water, *9*, 136; doi:10.3390/w9020136

FAO 2016. Energy, Agriculture and Climate Change, Towards Energy Smart Agriculture. www.fao.org/climate-change.

Gültekin İ., Arısoy Z., Taner A., Kaya Y., Partigöç F. 2011. The effect of different irrigation systems and sowing method on wheat yield. II. Ulusal Toprak ve Su Kaynakları Kongresi, 22-25 Kasım, Ankara, 231-237.

Kıymaz S., Ertek A. 2017. Appropriate irrigation scheduling for sugar beet (*Beta vulgaris* L.) in Kırşehir conditions. Journal of Agric. Faculty of Gaziosmanpaşa Univ., JAFAG, 34:113-121.

Kresovic B., Gajic B., Tapanarova A., Dugalic G. 2018. How irrigation water affects the yield and nutritional quality of maize (*Zea Mays* L.) in a temperate climate. Pol. J. Environ. Stud., 27 (3) : 1123-1131.

Kuşçu Y., Sahin U., Tunç T., Kızıloglu FM. 2010. Determining water-yield relationship, water use efficiency, seasonal crop and pan coefficients for alfalfa in a semiarid region with high altitude. Bulgarian Journal of Agricultural Science, 16 (4): 482-492.

Kuşçu H., Demir A.O. 2012. Responses of maize to full and limited irrigation at different plant growth stages. Journal of Agricultural Faculty of Uludag University, 26 (2): 15-27.

Kuşçu H., Karasu A., Oz M., Demir AO., Turgut I. 2013. Effect of irrigation amounts applied with drip irrigation on maize evapotranspiration, yield, water use efficiency and net return in a sub-humid climate. Turkish Journal of Field Crops, 18 (1): 13-19.

Martin DL., Kranz WL., Dorn TW., Melvin SR., Corr AJ. 2010. Reducing the Cost of Pumping Irrigation Water. Proceedings of the 22 nd Annual Central Plains Irrigation Conference, Kearney, NE, February 24-25, 2010, Available from CPIA, 760 N. Thompson, Colby, Kansas, 44-50.

Okay D., Yazgan S. 2016. The effect of different irrigation levels on maize yield. Journal of Agricultural Faculty of Uludağ University, 30 (1): 1-12.

Rodriguez Diaz JA., Poyato EC., Perez MB. 2011. Evaluation of water and energy use in pressurized irrigation networks in Southern Spain. Journal of Irrigation and Drainage Engineering, 644-650.

Shah T., Scott C., Kishore A., Sharma A. 2004. Energy-Irrigation Nexus in South Asia. Improving Groundwater Conservation and Power Sector Viability, Research Report 70, IWMT, Revised Second Edition, 29 pp.

Smajstria AG., Gastro BF., Clark GA. 2002. Energy Requirements for Drip Irrigation of Tomatoes in North Florida. BUL 289, One of a series of the Agricultural and Biological Engineering Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Qing-tao Z., Qing X., Liu CCK., Geng S. 2013. Technologies for efficient use of irrigation water and energy in China. Journal of Integrative Agriculture, 12 (8):1363-1370.

Selenay MF., Kadayıfçı A. 1999. Evapotranspiration of alfalfa for Ankara conditions. Tarım Bilimleri Dergisi, 5 (1): 71-76 (In Turkish).

Seymen M., Yavuz D., Dursun A., Kurtar ES., Türkmen Ö. 2019. Identification of drought-tolerant pumpkin (*Cucurbita pepo* L.) genotypes associated with certain fruit characteristics, seed yield, and quality. Agricultural Water Management, 221: 150-159.

Süheri S., Topak R., Yavuz D. 2007. The effects of different irrigation regimes on yield and water use efficiency of sugar beet. Selçuk Üniv., Ziraat Fak. Dergisi, 21 (43): 37-45 (In Turkish).

Tarjuelo JM., Moreno MA. 2017. Reducing Energy Use and Costs in Irrigation Systems. Barcelona, April 2017.

Yavuz D., Topak, R., Yavuz N.. 2014. Determining energy consumption of sprinkler irrigation for different crops in Konya Plain. Turkish Journal of Agricultural and Natural Sciences, 1 (3): 312-321.

Yavuz D., Yavuz N., Seymen M., Türkmen, Ö. 2015a. Evapotranspiration, crop coefficient and seed yield of drip irrigated pumpkin under semi-arid conditions. Scientia Horticulturae, 197: 33-40.

Yavuz D., Seymen M., Yavuz N., Turkmen, Ö. 2015b. Effects of irrigation interval and quantity on the yield and quality of confectionary pumpkin grown under field conditions. Agricultural Water Management, 159: 290-298.

Yavuz D., Süheri S., Yavuz N. 2016. Energy and water us efor drip-irrigated potato in the Middle Anatolian Region of Turkey. Environmental Progress & Sustainable Energy, 35 (1): 212-220.

Yavuz D., Acar B., Yavuz N., Çiftçi N. 2018a. Irrigation in various growth strategies effect on yield and water productivity of drip-irrigated sunflower in semi-arid Konya environment, Turkey. International Journal of Agriculture and Economic Development, 6 (2): 7-17.

Yavuz N., Yavuz D., Çiftçi N., Acar B. 2018b. Deficit irrigation affect on yield performance of sunflower plant in semi-arid Konya region, Turkey. IJANS, 1 (2): 165-168.

Yavuz N,., Çiftçi N., Yavuz D. 2019. Effects of different irrigation interval and plant-pan coefficient applications on yield and quality parameters of oil sunflower grown in semi-arid climate conditions. Arabian Journal of Geoscienses. https//doi.org/10.1007/s12517-019-4867-1

Yavuz D., Seymen M., Süheri S., Yavuz N., Türkmen Ö., Kurtar, ES. 2020. How do rootstocks of citron watermelon (*Citrullus lanatus* var. *citroides*) affect the yield and quality of watermelon under deficit irrigation? Agricultural Water Management, 241 (2020) 106351.

Zaccaria D. 2016. Irrigation Systems and Energy Efficiency. Surface Irrigation Efficiency Workshop. US Kearney Agricultural Center, June 3 rd, University of California Agriculture and Natural Sciences.

Zarski JZ., Kusmierek-Tomaszewska R., Dudek S. 2020. Impact of irrigation and fertigation on the yield and quality of sugar beet (*Beta vulgaris* L.) in a moderate climate. Agronomy, 10, 166; doi:10.3390/agronomy10020166

Zhou X.B., Li Q.Q., Yu S.Z., Wu W., Chen Y.H. 2007. Row spacing and irrigation effects on water consumption of winter wheat in Taian, China. Can. J. Plant Sci. 87: 471-477.

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THE ROLE OF AMELIORATIVE PLANTS AND ORGANIC MULCH IN SOIL FUNGI DIVERSITY

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***Keywords**: Aspergillus sp., Fusarium sp., Penicillium sp.*

ABSTRACT

Increasing soil activity is one of the important parts of organic technology. This paper presents the results of a two-year study regarding the influence of ameliorative plants (Sinapis alba L., Phacelia tanacetifolia L. and Tagetes patula L.) combined with two organic mulches used (wood chips and wool) on the soil fungi diversity. Fungi taxa increased from 15 in the first stage (March 2015) to 36 (July 2015), 39 (November 2015) and 54 (November 2016) respectively. Of the total taxa identified, 62% were fungi with positive influence, 20% neutral influence and 18% negative influence.

INTRODUCTION

Increasing soil activity is one of the important parts of organic technology. This paper presents the results of a two-year study regarding the influence of ameliorative plants (*Sinapis alba* L., *Phacelia tanacetifolia* L. and *Tagetes patula* L.) combined with two organic mulches used (wood chips and wool) on the soil fungi diversity (Butcaru et al. 2019, Butcaru et al. 2017, Matei et al. 2017).

Norvell et al. (1999) showed the role of Trichoderma harzianum Rifai 1295-22 (T-22) in plant growth, having a role in the biocontrol of pathogens. Aghaalikhani & Ehteshami (2008) mentioned the role of bacteria and fungi in the agricultural agrosystem, being an important factor in reducing inputs. Vegetative material from green manures, respectively ameliorating plants has a role in reducing soil pathogens and diseases (Wang et al. 2009). Several plants have soil-enhancing and disinfecting properties. Some of them are also found in the list of plants used as green manures. Berca (2011) defines ameliorative plants as that set of crops that bring within the ecosystem a surplus of both nutritional and biological, microbiological or ecological nature.

MATERIAL AND METHODS

The research was conducted between 2015-2017, in the experimental plot of USAMV Bucharest. To establish an organic climbing edible rose culture in 2015, three ameliorative plants were used to increase soil activity (*Sinapis alba* L., *Tagetes patula* L. and *Phacelia tanacetifolia* L.) combined in seven variants: V1 *Sinapis*, V2 *Sinapis* + *Phacelia*, V3 *Phacelia*, V4 *Sinapis* + *Tagetes*, V5 *Sinapis* + *Tagetes* + *Phacelia*, V6 *Tagetes* + *Phacelia*, V7 *Tagetes* and V8 control.

In the summer of 2016, two organic mulch variants were applied for each initial variant (Vn), on the rose rows: Vn.1 wood chips and Vn.2 wool, while the control Vn.3, was represented by un-mulched soil (Butcaru et al. 2018) (Figure 1).

For analysis of the soil microbiological activity, samples were collected before and after planting the organic rose culture: I - from the total area (March 2015), from each variant Vn, II- in July and III- in October 2015 and IV- from each sub-variant Vn.1, Vn.2 and Vn.3 (November 2016).

The microbiological analysis studied the number of microscopic fungi determined by dispersing soil suspension on PDA medium. Taxonomical identification was carried out based on the cultural, morphological and/or physiological characteristics following the determinative manual of fungi in agricultural soils (Domsch & Gams, 1972).

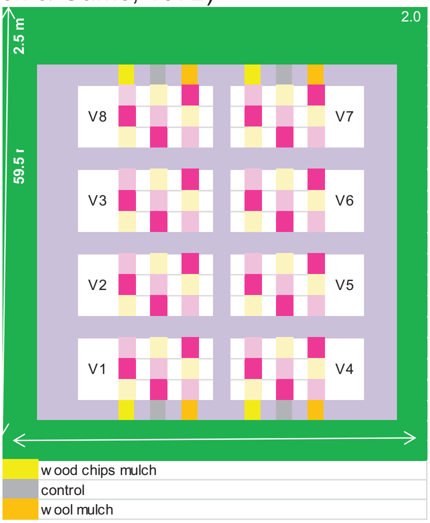


Figure 1. Experimental plot design

RESULTS AND DISCUSSIONS

Fungi diversity influenced by the organic technology applied in an edible rose culture is presented in Figures 2 and 3. The variation of the pathogenic fungi rate is highlighted in Table 1. At the end of the study, 18% of soil fungi were pathogens, 20% with neutral influence and 62% beneficial soil fungi.

Excepting IV.1 (4^{th} stage – wood chips row), the control plot (V8) had the highest percentage of pathogenic fungi (Figure 4) between the 2015-2016 period.

Alternaria alternata, *Fusarium avenaceum*, *F. culmorum*, *F. culmorum var. roseum*, *F. pallidoroseum*, *F. poae*, *F. solani*, *F. sporotriehioides*, *F. verticilloides*, *F. tricinctum*, *Helminthosporium sp.*, *Phytophthora sp*. and *Pythium periplocum* were the pathogenic fungi identified in the experiment.

Actinomucor elegans, *Aspergillus sp.*, *Cladosporium cladosporioides*, *C. herbarum*, *C. sphaerospermum*, *Cunninghamella elegans*, *Epicoccum nigrum*, *Fumago sp.*, *Fusarium oxysporum*, *Humicola grisea*, *Myrothecium sp.*, *Paecilomyces sp.*, *Penicilium sp.*, *Stachybotrys chartarum*, *Trichoderma harzianum*, *T. viride* were identified as fungi with beneficial action.

Fungi	I	V1 - *Sinapis*					V2 - *Sinapis* + *Phacelia*					V3- *Phacelia*					V4 - *Sinapis* + *Tagetes*					- *Sinapis* + *Tagetes* + *Phace*					V6 - *Tagetes* + *Phacelia*					V7 - *Tagetes*					V8 - Control				
				IV					IV					IV					IV					IV					IV					IV					IV		
	I	II	III	V1.1	V1.2	V1.3	II	III	V2.1	V2.2	V2.3	II	III	V3.1	V3.2	V3.3	II	III	V4.1	V4.2	V4.3	II	III	V5.1	V5.2	V5.3	II	III	V6.1	V6.2	V6.3	II	III	V7.1	V7.2	V7.3	II	III	V8.1	V8.2	V8.3
Acremonium strictum	2					2																			2	2		2			2				2						
Actinomucor elegans	1																1					1																			
Alternaria alternata			3	3	3		3			3		3	3				3						3				3	3						3			3	3		3	3
Aspergillus carneus																																				1					
Aspergillus clavatus																			1																						
Aspergillus flavipes				1																																					
Aspergillus flavus										1											1																		1		
Aspergillus fumigatus						1						1							1			1										1									
Aspergillus melleus			1																																						
Aspergillus niger	1	1	1					1	1			1					1				1	1						1					1	1							
Aspergillus ochraceus	1														1						1				1							1				1					
Aspergillus oryzae												1																													
Aspergillus parasiticus							1	1																			1	1													
Aspergillus sydowi										1																						1									
Aspergillus tamarii			1							1																					1			1							
Aspergillus terreus	1		1		1	1	1	1				1		1	1	1	1			1			1		1	1	1	1				1	1	1			1	1			
Aspergillus sp.		1	1										1																						1		1	1			
Aspergillus ustus							1														1						1					1	1					1			
Aspergillus versicolor			1							1		1						1			1								1									1	1		
Aspergillus wentii																						1															1				
Cladosporium cladospirioides		1										1	1			1		1				1																			
Cladosporium herbarum		1	1	1	1	1	1	1	1		1	1		1	1	1	1			1		1	1			1	1	1	1				1			1	1	1		1	1
Cladosporium sphaerospermum			1																																						
Cunninghamella elegans					1			1						1				1					1					1										1			
Epicoccum nigrum	1	1										1							1											1				1							
Fumago sp.			1										1																												
Fusarium avenaceum												3																				3									
Fusarium culmorum			3	3											3								3					3			3						3	3		3	
Fusarium culmorum var. Roseum	3	3			3							3					3																				3	3			
Fusarium oxysporum	1	1	1	1		1	1	1		1	1	1		1	1			1	1		1	1		1	1	1	1	1	1			1		1	1	1	1				
Fusarium pallidoroseum			3										3															3					3								
Fusarium poae			3																									3													
Fusarium solani																					3																				
Fusarium sporotrichioides			3										3					3					3									3								3	
Fusarium verticilloides	3							3												3								3			3		3					3			3
Fusarium tricinctum									3																	3			3	3	3								3		3

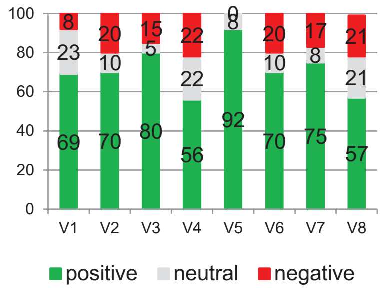
Figure 2. Influence of organic technology applied on soil fungi diversity

Fungi		V1 - *Sinapis*					V2 - *Sinapis + Phacelia*					V3- *Phacelia*					V4 - *Sinapis + Tagetes*					- *Sinapis + Tagetes + Phace*					V6 - *Tagetes + Phacelia*					V7 - *Tagetes*					V8 - Control				
				IV					IV					IV					IV					IV					IV					IV					IV		
	I	II	III	V1.1	V1.2	V1.3	II	III	V2.1	V2.2	V2.3	II	III	V3.1	V3.2	V3.3	II	III	V4.1	V4.2	V4.3	II	III	V5.1	V5.2	V5.3	II	III	V6.1	V6.2	V6.3	II	III	V7.1	V7.2	V7.3	II	III	V8.1	V8.2	V8.3
Geotrichum candidum		2				2															2															2	2				
Helminthosporium sp.						3																																			
Humicola grisea												1																					1								
Mycelia sterilia											2																														
Myrothecium roridum													1																	1				1							
Myrothecium verrucaria	1		1					1					1					1			1							1				1	1								1
Myrothecium sp.																							1																		
Mucor hiemalis									2																																
Paecilomyces elegans																									1																
Paecilomyces marquandii	1					1		1						1				1			1							1								1					
Paecilomyces sp.										1																					1										
Penicilium aurantiogriseum	1															1																									
Penicillium brevicompactum			1																				1																		
Penicillium chrysogenum	1											1																				1		1	1					1	
Penicillium citrinum			1																																						
Penicillium griseofulvum												1										1																			
Penicillium janthinelum																						1																			
Penicillium sp.		1	1			1	1	1				1	1				1	1			1		1				1	1	1	1		1					1	1	1		1
Penicillium verrucosum		1				1		1				1										1						1					1				1				
Phyalophora fastigiata						2					2		2	2																											
Phiallophora hoffmanii				2												2													2					2					2		
Phytophthora sp.				3			3												3		3						3							3							
Pythium periplocum																		3												3			3		3				3	3	
Rhizopus stolonifer		2					2	2					2			2	2			2				2			2	2									2				
Scolecobasidium terreum																										2															
Scopulariopsis brevicaulis					2																																2				
Stachybotrys chartarum												1																		1				1	1						
Trichocladium asperum,																			2																						
Trichoderma harzianum	1	1				1	1			1		1						1	1			1			1		1		1				1				1				
Trichoderma viride				1							1			1	1				1				1							1						1			1		
Trichoderma sp.																																			1						
Trichotecium roseum									2																																
Verticillium leccani	2							2		2		2					2					2		2	2				2		2		2	2							
Verticillium sp.		2	2			2																	2									2				2					2
Verticillium tenerum																		2					2										2					2			
Total	**15**	**13**	**20**	**8**	**6**	**13**	**10**	**13**	**5**	**9**	**5**	**20**	**11**	**7**	**6**	**6**	**9**	**11**	**8**	**4**	**12**	**12**	**12**	**3**	**7**	**6**	**10**	**17**	**8**	**7**	**7**	**12**	**13**	**12**	**7**	**8**	**14**	**12**	**7**	**6**	**7**

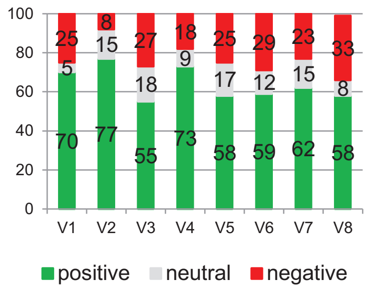
Figure 3. Influence of organic technology applied on soil fungi diversity (cont.)

Table 1

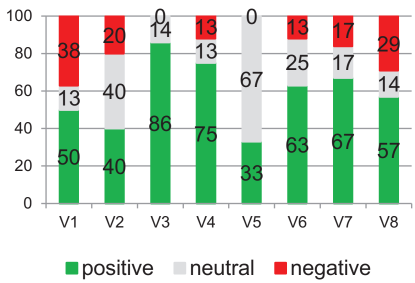
Evolution of percentage by type of fungi in the forth stages



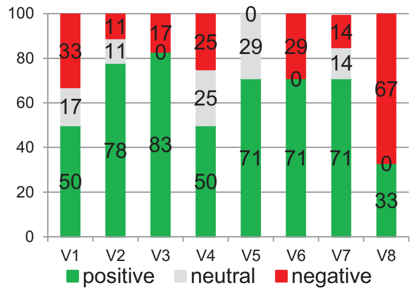
Evolution by type of fungi in the second stage



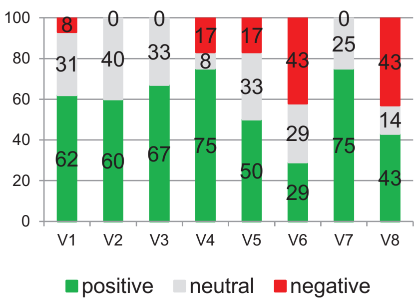
Evolution by type of fungi in the third stage



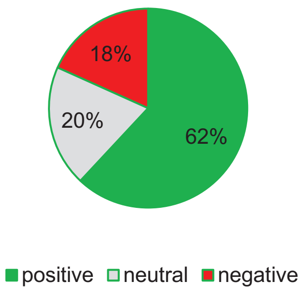
Evolution by type of fungi in the 4th stage - woodchips



Evolution by type of fungi in the 4th stage - wool



Evolution by type of fungi in the 4th stage – un-mulched



Evolution by type of fungi in the 4th stages

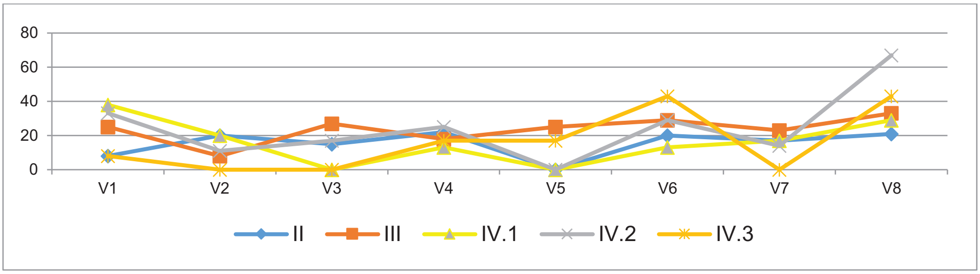


Figure 4. Pathogenic fungi rate variation between 2015 – 2016 period

CONCLUSIONS

The influence of ameliorative plans incorporated in soil (*Sinapis alba* L., *Phacelia tanacetifolia* L. and *Tagetes patula* L.) combined with organic mulches as wood chips and wool were beneficial for the soil. At the end of the study, 82% of the total fungi identified were with positive or neutral influence both on soil and plant growth.

REFERENCES

Aghaalikhani M., Ehteshami S. M. R. 2008. Biological profitability of maize inoculation with selected rhizosphere micro organisms (*Pseudomonas fluorescens* and *Glomus intraradices*) under Water Deficit Stress, archived at http://orgprints.org/view/projects/conference.html.

Berca M. 2011. Agrotehnică – transformarea modernă a agriculturii. Ceres Publishing House, Bucharest.

Butcaru A. C., Stănică F., Matei G. M., Matei S. 2019. Influences of soil ameliorative plant species on the organic edible rose culture. Acta Horticulturae, 1242, 107-114.

Butcaru A. C., Stănică F. 2018. Cultivation technology of organic roses for petal production, Scientifique Papers, Series Horticulture, LXII, 203-210.

Butcaru A. C., Stănică F., Matei G. M., Matei S. 2017. Soil microbial activity in an organic edible rose crop, Scientifique Papers, Series Horticulture, LXI, 107-112.

Domsch K. H., Gams W. 1970. Fungi in agricultural soils. T&A Constable Ltd., Edinburg, London, 290p.

Norvell A. W. A., Bjorkman T., Harman G. E. 1999. Solubilization of Phosphates and Micronutrients by the Plant-Growth-Promoting and Biocontrol Fungus Trichoderma harzianum Rifai 1295-22, applied and environmental microbiology, 65(7), 2926–2933.

Matei G. M., Dumitru S., Matei S., Butcaru A. C., Stănică F. 2017. Microbiological aspects in soil microbiome composition and activity under the influence of organic mulches. Conference Proceedings Vol. 17, Nano, Bio, Green and Space-Technologies for a Sustainable Future Issue 61, Micro and Nano Technologies, Advances in Biotechnology, 813-820.

Wang D., Rosen C., Kinkel L., Cao A., Tharayil N., Gerik J. 2009. Production of methyl sulfide and dimethyl disulfide from soil-incorporated plant materials and implications for controlling soilborne pathogens. Plant Soil, 324,185–197.

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DIVERSITY OF SOIL BACTERIA IN ORGANIC EDIBLE ROSE CULTURE

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Keywords: *Actinomycetes, Bacillus sp., Pseudomonas sp.*

ABSTRACT

Technologies in organic agriculture must include specific actions for increasing soil activity. This paper presents the results of a two-year study regarding the influence of ameliorative plants (Sinapis alba L., Phacelia tanacetifolia L. and Tagetes patula L.) combined with two organic mulches used (wood chips and wool) on the soil bacteria diversity. At the end of the study, 95% of the total bacteria identified were with positive or neutral influence both on soil and plant growth.

INTRODUCTION

Soil microbial activity, the rate of beneficial versus pathogenic bacteria for plant development are important aspects of organic agriculture.

The role of microorganisms was highlighted by numerous researchers (Norvell et al. 1999, Neață 2002, Bettiol et al. 2002, Grebenişan 2007, Aghaalikhani & Ehteshami 2008, Lipșa et al. 2008, Wang et al. 2009, de Araújo și de Melo. 2010, Pacwa-Płociniczak et al. 2013, Velivelli et al. 2015).

Increasing soil activity requires specific activities, ameliorative plants and organic mulch being part of them (Butcaru et al. 2019, Butcaru et al. 2017, Matei et al. 2017).

This paper aims to present the diversity of soil bacteria taxons, influenced by the organic technology applied in edible rose culture.

MATERIAL AND METHODS

The research was conducted between 2015-2017, in the experimental plot of USAMV Bucharest. To establish an organic climbing edible rose culture in 2015, three ameliorative plants were used to increase soil activity (*Sinapis alba* L., *Tagetes patula* L. and *Phacelia tanacetifolia* L.) combined in seven variants: V1 *Sinapis*, V2 *Sinapis* + *Phacelia*, V3 *Phacelia*, V4 *Sinapis* + *Tagetes*, V5 *Sinapis* + *Tagetes* + *Phacelia*, V6 *Tagetes* + *Phacelia*, V7 *Tagetes* and V8 control.

In the summer of 2016, two organic mulch variants were applied for each initial variant (Vn), on the rose rows: Vn.1 wood chips and Vn.2 wool, while the control Vn.3, was represented by un-mulched soil (Butcaru et al. 2018) (Figure 1).

For analysis of the soil microbiological activity, samples were collected before and after planting the organic rose culture: I - from the total area (March

2015), from each variant Vn, II- in July and III- in October 2015 and IV- from each sub-variant Vn.1, Vn.2 and Vn.3 (November 2016).

The microbiological analysis studied the number of heterotrophic bacteria determined using the dilution plate method - by dispersing soil suspensions on the nutrient agar medium. Taxonomical identification was carried out based on the cultural, morphological and/or physiological characteristics following bacteria Identification Manual (Bergey 1994).

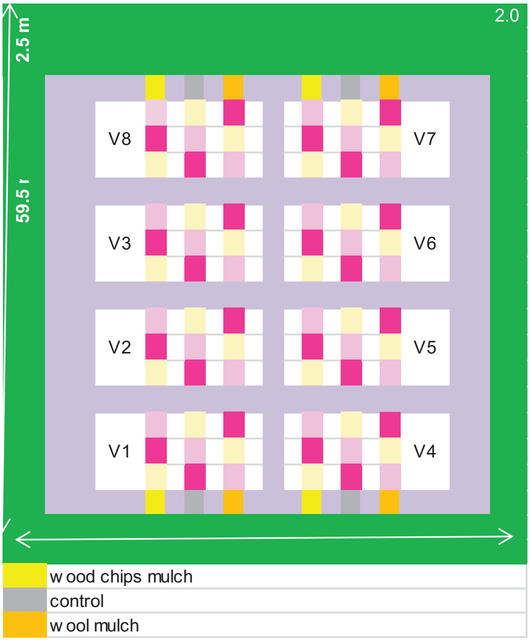


Figure 1. Experimental plot design

RESULTS AND DISCUSSIONS

This study brings important details about bacteria diversity influenced by the organic technology applied in an edible rose culture (Figure 2). Soil is a living organism, the variation of beneficial bacteria being highlighted in Table 1 and Figure 3. At the end of the study, 5% of soil bacteria were pathogens, 40% with neutral influence and 55% beneficial soil bacteria.

Pseudomonas aeruginosa and *Pseudomonas syringae* were identified as bacteria with negative influence. *P. syringae* was found only in the control plot (V8), in the III stage and remained active in the wool mulched rows (V8.2). *P. aeruginosa* was found in the IV stage only, in V4.2, V5.3, V6.1 and V6.3.

Actinomycete Series Albus, *Ceoruleo-Griseus*, *Griseus*, *Fuscus*, *Luteus*, *Ruber*; *Arthrobacter citreus*, *A. globiformis*, *A. oxydans*, *A. simplex*; *Bacillus circulans*, *B. megaterium*; *Paenibacillus sp*, *Pseudomonas aurantiaca*, *P. fluorescens*, *P. lemonnieri*, *P. putida*, bacteria with positive influence in soil and plant growth, were identified beginning with the incorporation of ameliorative plants and after organic mulch using.

Bacteria	I	V1 (*Sinapis*)					V2 (*Sinapis + Phacelia*)					V3 (*Phacelia*)				
		II	III	IV			II	III	IV			II	III	IV		
	I			V1.1	V1.2	V1.3			V2.1	V2.2	V2.3			V3.1	V3.2	V3.3
Actinomicete Seria Albus				1	1	1		1		1		1	1	1	1	1
Actinomicete Seria Coeruleo-Griseus						1		1					1			
Actinomicete Seria Griseus					1	1										1
Actinomicete Seria Fuscus		1	1	1	1	1	1	1				1	1	1		1
Actinomicete Seria Luteus		1						1								1
Actinomicete Seria Ruber																
Alcaligenes faecalis			2													
Arthrobacter citreus			1	1												
Arthrobacter globifomis		1	1			1		1				1				1
Arthrobacter oxydans							1									
Arthrobacter simplex			1				1	1						1	1	
Arthrobacter sp.													1			
Bacillus cereus	2			2			2		2			2			2	
Bacillus cereus var. Mycoides	2	2						2	2	2			2		2	
Bacillus circulans	1	1	1			1	1			1	1	1	1			1
Bacillus megaterium	1		1	1		1	1	1	1	1	1	1	1	1	1	1
Bacillus mesentericus						2										
Bacillus polymixa									2							
Bacillus sphaericus	2		2	2		2	2		2			2		2		
Bacillus subtilis	1	1	1	1				1			1	1	1			1
Bacillus sp.						1			1		1					
Chromobacterium violaceum														2	2	
Escherichia freundii																
Flavobacterium sp.			2					2			2					
Micrococcus sp.										2						
Mycobacterium roseum																
Paenibacillus sp.						1								1	1	
Pseudomonas acidophila	2			2				2		2		2	2			
Pseudomonas aeruginosa																
Pseudomonas aurantiaca												1				
Pseudomonas fluorescens	1	1	1	1	1	1		1	1	1	1	1		1	1	1
Pseudomonas lemonnieri																
Pseudomonas pseudogleyi				2		2								2	2	
Pseudomonas putida																
Pseudomonas sp.	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1
Pseudomonas striata			2										2			
Pseudomonas syringae																
Serratia marcescens								2								
Total	9	8	13	11	5	14	8	14	8	7	7	12	11	10	10	10

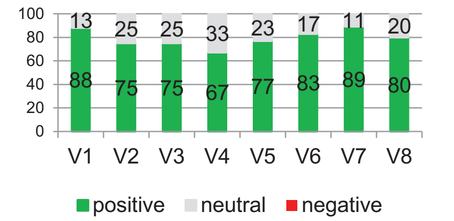
Bacteria	V4 (*Sinapis + Tagetes*)					V5 (*Sinapis+Tagetes+Phacelia*					V6 (*Tagetes + Phacelia*)					V7 (*Tagetes*)					V8 (control)				
	II	III	IV			II	III	IV			II	III	IV			II	III	IV			II	III	IV		
			V4.1	V4.2	V4.3			V5.1	V5.2	V5.3			V6.1	V6.2	V6.3			V7.1	V7.2	V7.3			V8.1	V8.2	V8.3
Actinomicete Seria Albus		1		1	1	1	1	1	1	1	1	1		1	1		1		1	1	1	1	1	1	1
Actinomicete Seria Coeruleo-Griseus						1							1								1		1		
Actinomicete Seria Griseus				1							1		1		1							1		1	1
Actinomicete Seria Fuscus	1	1			1	1	1	1					1	1	1	1	1	1		1		1	1	1	1
Actinomicete Seria Luteus		1				1												1			1	1	1		1
Actinomicete Seria Ruber		1															1								
Alcaligenes faecalis																									
Arthrobacter citreus																								1	1
Arthrobacter globifomis		1				1	1				1	1				1	1	1			1	1	1	1	1
Arthrobacter oxydans	1										1					1									
Arthrobacter simplex																	1						1		
Arthrobacter sp.											1														
Bacillus cereus	2	2	2			2		2				2	2							2		2	2		
Bacillus cereus var. Mycoides		2	2		2					2		2		2		2	2								
Bacillus circulans	1	1	1		1	1	1			1	1	1		1	1	1	1	1	1	1	1	1	1	1	1
Bacillus megaterium	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bacillus mesentericus								2	2						2										
Bacillus polymixa			2	2	2					2								2							
Bacillus sphaericus	2	2				2	2						2						2		2	2			
Bacillus subtilis			1			1		1			1		1			1		1				1		1	1
Bacillus sp.			1					1				1	1		1					1					
Chromobacterium violaceum	2	2				2				2							2								
Escherichia freundii																						2			
Flavobacterium sp.									2																
Micrococcus sp.									2			2		2			2		2					2	
Mycobacterium roseum																	2							2	2
Paenibacillus sp.			1	1				1		1			1												
Pseudomonas acidophila							2				2						2				2	2			
Pseudomonas aeruginosa				3						3			3		3										
Pseudomonas aurantiaca	1							1				1	1												
Pseudomonas fluorescens	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Pseudomonas lemonnieri													1												
Pseudomonas pseudogleyi		2									2		2		2				2				2	2	2
Pseudomonas putida																							1		
Pseudomonas sp.		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1
Pseudomonas striata		2										2											2		
Pseudomonas syringae																						3		3	
Serratia marcescens																									2
Total	9	14	10	8	8	13	9	10	7	10	12	11	15	8	11	9	14	9	8	8	10	15	14	14	14

1=positive, 2= neutral, 3=negative

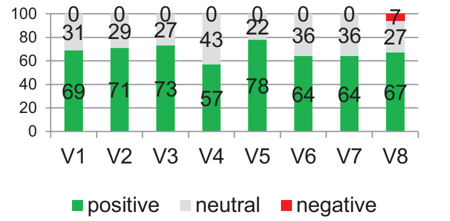
Figure 2. Influence of organic technology applied on soil bacteria diversity

Table 1

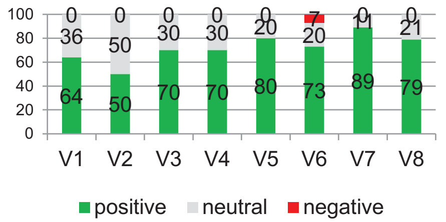
Evolution of percentage of bacterial type in the forth stages



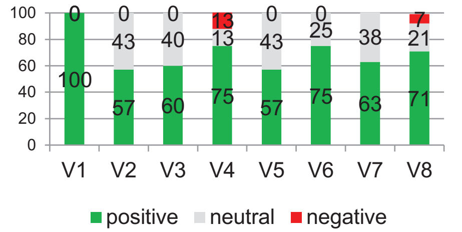
Percentage by type of bacteria in the 2nd stage



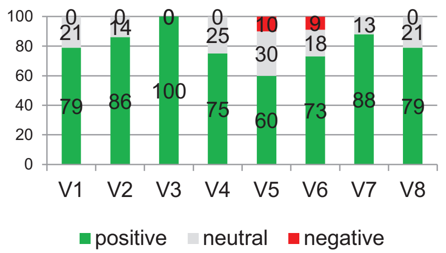
Percentage by type of bacteria in the 3rd stage



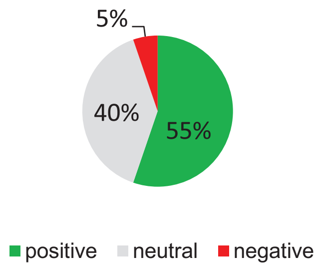
Percentage by type of bacteria in 4th stage-woodchips



Percentage by type of bacteria in 4th stage-wool



Percentage by type of bacteria in 4th stage-un-mulched



Percentage by type of bacteria in the forth stages

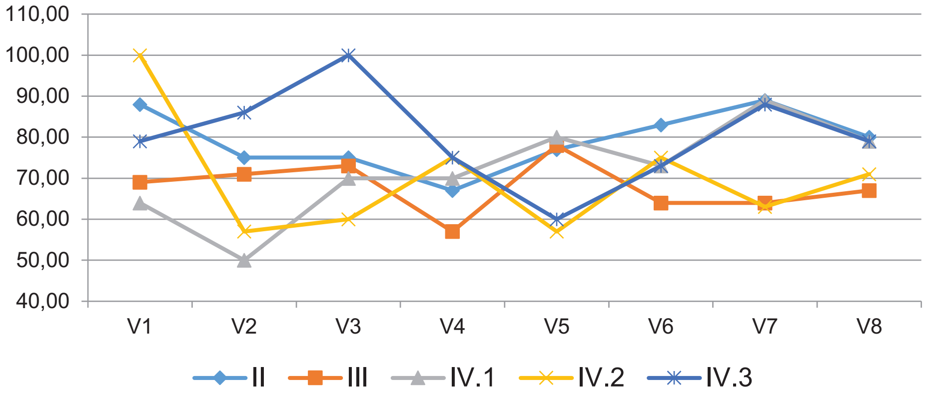


Figure 3. Positive bacteria rate variation between 2015 – 2016 period

CONCLUSIONS

Technologies in organic agriculture must include specific actions for increasing soil activity. The influence of ameliorative plans incorporated in soil (*Sinapis alba* L., *Phacelia tanacetifolia* L. and *Tagetes patula* L.) combined with organic mulches as wood chips and wool were beneficial for the soil. At the end of the study, 95% of the total bacteria identified were with positive or neutral influence both on soil and plant growth.

REFERENCES

Aghaalikhani M., Ehteshami S. M. R. 2008. Biological profitability of maize inoculation with selected rhizosphere micro organisms (*Pseudomonas fluorescens* and *Glomus intraradices*) under Water Deficit Stress, archived at http://orgprints.org/view/projects/conference.html

Bergey D.H., Holt, J. G. 1994. Bergey's Manual of Determinative Bacteriology, 9th edition. Williams and Wacket, Baltimore, Washington DC.

Bettiol W., Ghini R., Galvão J. A. H., Ligo M. A. V., de Carvalho Mineiro J. L. 2002. Soil organisms in organic and conventional cropping systems. Sci. Agric., 59 (3).

Butcaru A. C., Stănică F., Matei G. M., Matei S. 2019. Influences of soil ameliorative plant species on the organic edible rose culture. Acta Horticulturae, 1242, 107-114.

Butcaru A. C., Stănică F. 2018. Cultivation technology of organic roses for petal production, Scientifique Papers, Series Horticulture, LXII, 203-210.

Butcaru A. C., Stănică F., Matei G. M., Matei S. 2017. Soil microbial activity in an organic edible rose crop, Scientifique Papers, Series Horticulture, LXI, 107-112.

De Araújo A. S. F., De Melo W. J. 2010. Soil microbial biomass in organic farming system. Ciência Rural, 40(11), 2419-2426.

Grebenişan I. 2007, Microbiologie - note de curs. Cartea Universitară Publishing House, Bucharest.

Lipşa F. D., Ulea E., Irimia N., Talpan I-V. 2008. Cercetări privind influenţa fertilizării şi al amestecurilor complexe din structura covorului vegetal al unor pajişti temporare asupra microflorei solului. Scientific Papers Agronomy, 51: 140-147.

Neață G. 2002. Agrochimia și biologia solului. Printech Publishing House, Bucharest.

Norvell A. W. A., Bjorkman T., Harman G. E. 1999. Solubilization of Phosphates and Micronutrients by the Plant-Growth-Promoting and Biocontrol Fungus Trichoderma harzianum Rifai 1295-22, applied and environmental microbiology, 65(7): 2926–2933.

Matei G. M., Dumitru S., Matei S., Butcaru A. C., Stănică F. 2017. Microbiological aspects in soil microbiome composition and activity under the influence of organic mulches. Conference Proceedings Vol. 17, Nano, Bio, Green and Space-Technologies for a Sustainable Future Issue 61, Micro and Nano Technologies, Advances in Biotechnology, 813-820.

Pacwa-Płociniczak M., Płaza G. A., Poliwoda A., Piotrowska-Seget Z. 2014. Characterization of hydrocarbon-degrading and biosurfactant-producing *Pseudomonas sp*. P-1 strain as a potential tool for bioremediation of petroleum-contaminated soil. Environ Sci. Pollut. Res., 21:, 9385–9395.

Velivelli S. L. S., Sessitsch A., Prestwich B. D. 2015. The Role of Microbial Inoculants in Integrated Crop Management Systems. Potato Research, 57: 291–309.

Wang D., Rosen C., Kinkel L., Cao A., Tharayil N., Gerik J. 2009. Production of methyl sulfide and dimethyl disulfide from soil-incorporated plant materials and implications for controlling soilborne pathogens. Plant Soil, 324,185–197.

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LUNCA MURESULUI NATIONAL PARK'S MIXED HARDWOOD STANDS WITH PEDUNCULATE OAK AFFECTED BY EXTREME DESTABILIZING PHENOMENA

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Keywords*: windstorm, uproots, pedunculate oak*

ABSTRACT

In the last few decades, due to climatic warming, we can observe an intensification in general atmospheric movement and a slight displacement of the climatic regions from south to north, thus generating a large spectrum of extreme climatic phenomena.

The violent windstorm that took place in the western counties of Timis, Arad and Alba on the 23rd of June 2017 had catastrophic effects on the ecosystems of mixed hardwood stands with pedunculate oak and ash stands from the Lunca Muresului National Park.

This study is meant to present the state of the windfalls, breaks and uproots caused by wind in the mixed hardwood stands with pedunculate oak that belong to the National Park of Lunca Muresului.

INTRODUCTION

The study of windfalls, breaks and uproots caused by wind, as a result of negative economic and ecological effects produced by forestry ecosystems, represents a severe problem of the silvicultural research, its importance imposing it self due to the need to elaborate ecological systems of reconstruction and sustainable management of affected stands.

In the county of Arad, the total volume of cubic meters of wood affected by the windfall has exceeded 85 thousand cubic meters. Out of the area overseen by the Lunca Muresului National Park, the most affected by this phenomenon was the Ceala forest, production unit V – Ceala, that belongs to the Ocolul Silvic Iuliu Moldovan Arad, with a volume of 12.7 thousand cubic meters, 7.3 thousand of it over a surface of 39.6 hectares out of which the mass of timber resulted from the windfall will be integrally extracted and another 5.3 thousand of it over a surface of 157.1 hectares out of which the mass of timber resulted from wind caused breaks and uproots will be partially extracted.

MATERIAL AND METHODS

Knowing the primary limiting factors for the growth and development of the hardwood stands and extreme climatic phenomena which cause ecological unbalancing of the forest based ecosystem, requires knowing the causes of their occurance, characteristics, amplitude, localization and the way they act.

In the last few decades, due to climatic warming, we can observe an intensification in general atmospheric movement and a slight displacement of the climatic regions from south to north (Bogdan, O., Niculescu, E., 1999), thus generating a large spectrum of extreme climatic phenomena.

The climatic risks of the wind falls are described by temporary and unexpected occurrence of aeolian movement, with speeds over 50m/s and duration of the disrupting phenomenon ranging between a few hours up to 24 hours. By territorial expansion, their effect is moving from isolated trees to tens or hundreds of ha, having destroying economic, phyto-sanitary and landscape consequences.

Depending on the mechanical impact that is conditioning the level of damage on the forest based ecosystem, in correlation with the high speed of the wind, the intensity and the amplitude of the phenomenon, windfalls are classified as *endemic windfalls* and *catastrophical windfalls.*

Endemic windfalls are the consequence of winds with medium intensity and their economic effects are quantified by cumulation as they are caused.

This type of wind perturbation happens on smaller areas in all forest based ecosystems, sometimes only causing tree breaks and uproots.Their occurrence is the consequence of inadequate sivicultural interventions within mixed hardwood stands, resulting a regional modification of stationary factors, especially of meteorological factors.

The intensity and the effect of endemic windfalls can be influenced by equate silvicultural interventions designed to ensure both the phyto-sanitary state and the correction of structural paremeters,

Catastrophical windfalls are massive falls that occur due to a extreme aeolian conditions, the wind reaching very high speeds, their strength exceeding the 9th level corresponding to the Beaufort scale. These windfalls spread over areas of hundreds of hectares, differing from the endemic ones, by the volume of wood mass affected, around hundreds of thousands or even millions of cubic meters of wood, corresponding to the geographical scale used to analize the inflicted damage. There are some windfalls that occur rarely, once every 10 – 15 years and affect entire hardwood stands from a given area, regardless of their stability.

As natural phenomena with a complex micro – and macrozonal character, the occurrence of windfalls is not olny based on natural causes but also anthropic causes.

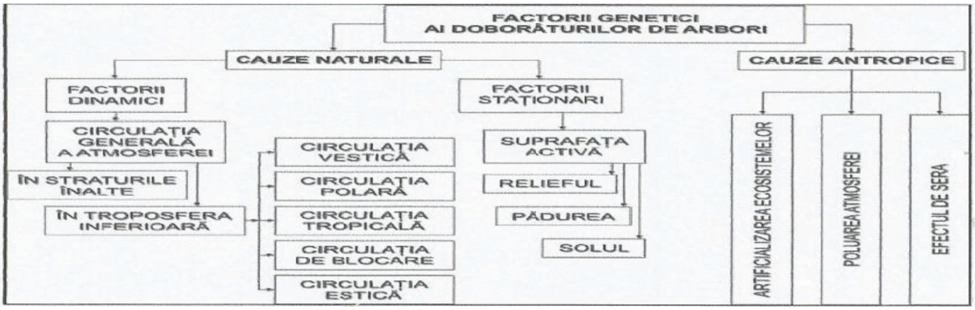

Fig. 1. The factors of windfalls genesis (Bogdan & Coșconea 2010)

Natural factors include:

- Dynamic factors are specific to the way air currents manifest, creating pressure on the components of the forest based ecosystem;

- *Stationary* factors represent the active area's characteristics, the basis for the windfalls occurrence.

The intensity and characteristics of the two categories of natural factors determine the intensity and the magnitude of the destabilizing phenomena.

Therefore, from the dynamic factors point of view, windfalls within the forest ecosystems occur in the conditions of a very high thermobaric gradient, oriented on an orographic barrage, in this case of the Carpathians Mountains, above which the air currents need to escalate. This contrast appears due to the presence of two opposite baric formations: one is the cyclone with a very low pressure in the middle and the second is the anticlyclone with a very high atmospherical pressure, with high pressure in the centre, which develops over the Europe and it is specific to different types of atmospherical movement (western, polare, and eastern)(Bogdan & Coșconea 2010).

Stationary factors constitute the active surface upon which the impact with the air movement is direct, the landscape, the forest and the soil with their characteristics have a deciding role in the occurance and intensity of windfalls.

The characteristics of the landscape - altitude, exposition, slope and the degree with vegetation coverage, all these are conditioning and favoring the occurance of windfalls.

The forest influences and is influenced by the climatic conditions. Its influence consists in its role of an obstacle in the way of the air masses in motion. Against forest ecosystem, the wind acts the same as against an orographic barrage, dividing itself in 2 ”branches”: one that escalades the forest which acts as an obstacle and reduces its speed, and another branch that penetrates it and gradualy fades away.

The soil, a stationary component of the forest based ecosystem, influences via its characteristics, reflecting over the composition and the nature of the ecosystem's biocenosis and implicitly by ensuring trees with proper rooting conditions and stability against the violent action of the wind.

The intervention of the anthropic factor on a global or regional scale is able to amplify the effect of windfalls. Regionwide, due to its actions in forest ecosystems, man can create hardwood stands of the monocultural type, and via exploitation projects can create new tree lines exposed to winds. At a global level, poluation has a negative effect over climatic change and it can determine an increase in frequency of occurrance of extreme meteroligical phenomena- storms, drought, floods, etc.

Knowing the causes that determinees them, the management of natural or cultivated forest based ecosystems is necessary to include unavoidable natural perturbations instead of ignoring or supperessing them (Cadar 2014).

Considering the information presented below, the windfalls from the summer of 2017 in the Ceala Forest, forest district Iuliu Moldovan, product unit V – Ceala from the protected area *Lunca Muresului National Park,* will be analyzed.

As for work methods, the surfaces affected by windfalls with total and partial extraction of the wood mass were identified. From the arrangement, the affected volumes, age, composition and consistency were analyzed.

RESULTS AND DISCUSSIONS

Among extreme climatic phenomena, that via the perturbation they generate have a strong negative impact upon the structure and functionality of the forest ecosystems, a significant place is held by the high intensity winds (squalls and storms), whose effect is represented in the hardwood stands not only by windfalls Fig. 2(b), but also by breaks and uproots Fig. 2(b).

Fig.2. Pedunculate oak trees break and uprooting Ceala forest – foto Nicolae Cadar

Table 1 presents the centralized case of windfalls, with integral extraction of forest mass and with partial extraction of the mass of broken and fallen trees within the production unit V – Ceala. (Arrangement O.S. I. Moldovan, 2012).

According to specialists within the Arad meteorological station, the cause of the violent storm, whose bursts of wind exceeded the speed of 100km/s classified in the strength 9 on the Beaufort Scale, (Climatological Atlas of Romania , 1996) was represented by the fact that a cold atmosherical front heading west came in contact with the very hot soil of the forest ecosystem.

From a climatic point of view, the temperatures in the afternoon of the previously mentioned day were around 30 - 32 °C, and due to this climatic regime, the short (cca 15 minutes) storm's intensification were placed around 25 – 30 m/s.

To substantiate the action of the wind, the stationary factors were favorable to this destabilizing phenomenon over the forest based ecosystem at the date it took place.

The devastating impact of the destabilizing climatic factor on the affected area from the protected region Lunca Muresului National Park had immediate consequences not only of economical nature, but also more importantly they affect the landscape by destructuring the compact wooded region.

The exploitation of the forest mass affected by the aeolian agent implies the change of the management plan of the production unit V – Ceala. Moreover, the volume of 12.7 thousand cubic meters, foreseen to be exploited and included in the economical network, can not be replaced. It represented extraordinary products, so the affected hardwood stands were included in the management subunit type ”M” – forests subjected to special conservation.

Tabel 1.

The situation of surfaces affected by windfalls, broken trees and windthrew trees from the Ceala woodland, production unit V – Ceala, Forest District Iuliu Moldovan from Arad

Nr. crt.	u.a.			Age (yrs)	Composition before the storm	Consistency	Surfaces affected by windfalls with integral extraction of wood mass		Surfaces affected by extraction of broken and downed trees by wind with partial extraction of wood mass	
	Nr.	Surf. (ha)	Vol. (mc)				Surf. (ha)	Volume (mc)	Surf. (ha)	Volume (mc)
0	1	2		3	4	5	6	7	8	9
1.	29A	51,81	3193	110	10 St	0,7	4,50	825	27,31	2368
2.	29B	5,05	671	110	8 Fr 2 St	0,7	2,74	618	2,31	53
3.	30A	9,82	1350	125	10 St	0,7	7,00	1282	2,82	68
4.	31A	18,81	1561	120	5 St 4 Fr 1 Dt	0,6	7,13	1231	11,68	330
5.	32A	52,92	2661	110	10 St	0,8	7,23	1505	45,69	1156
6.	33A	9,77	1334	125	7 St 3 Fr	0,6	3,82	1015	5,95	319
7.	33G	20,62	769	125	10 Fr	0,6	2,40	432	18,22	337
8.	34B	10,37	309	125	10 Fr	0,4	1,00	91	9,37	218
9.	34F	4,20	324	125	7 Fr 2 St 1 Dt	0,5	2,94	208	1,26	116
10.	34D	4,29	173	125	10 Fr	0,6	-	-	4,29	173
11.	35A	9,05	328	120	8 Fr 1 St 1 Dt	0,5	0,82	142	8,23	186
Total		**196,71**	**12673**	*	*	*	**39,58**	**7349**	**157,13**	**5324**

The visual impact over the landscape, consequence of the exploitation of the mass of wood, will be huge, for the microzone affected within the protected area, especially due to the fact that there will be whole zones fully affected by windfalls, over a surface of 39.58 hectares, from which will be harvested a volume of 7.4 thousand cubic meters, intertwined with forested areas,

The recovery of the state of biodiversity and restoring the ecological equilibrium of the forest based ecosystems affected by the destabilizing climatic aeolian factor, to ensure the protection functionality at ideal parameters of the forests from the region overseen by the Lunca Muresului National Park. The Ceala forest will undergo ecological reconstruction.

CONCLUSION

The data in this paper explains the way that a group of hardwood stands older than 110 years with reduced consistency (0.4 – 0.6), over a surface of 197.91 ha situated in neighbouring areas were strongly affected by a whirlwind conditions during a storm. The developed foliage of the main affected species (pedunculate oak and ash), correlated with the high slenderness indicators were favorable to the occurance of the disaster in the forest ecosystems.

Out of the area overseen by the Lunca Muresului National Park, the most affected by this phenomenon was the Ceala forest, production unit V – Ceala, that belongs to the Iuliu Moldovan Forest District Arad, with a volume of 12.7 thousand cubic meters, 7.3 thousand of it over a surface of 39.6 hectares out of which the mass of timber resulted from the windfall will be integrally extracted and another 5.3 thousand of it over a surface of 157.1 hectares out of which the mass of timber resulted from wind caused breaks and uproots will be partially extracted.

REFERENCES

Bogdan O., Niculescu E. 1999. Riscurile climatice din România, Editura Sega - Internațional, 245 p.

Bogdan O., Coșconea M. 2010. Riscul doborâturilor de arbori în România, Revista Riscuri și catastrofe, Anul IX, vol.8, nr.1, Universitatea Babeș Bolyai Cluj Napoca, pp. 89 - 102.

Cadar N. 2014. Conservarea durabilă a arboretelor de stejar pedunculat din ariile protejate Bazoș și Lunca Mureșului (referat teză doctorat), Universitatea de ştiinţe agricole şi medicină veterinară a Banatului „Regele Mihai I al României" Timişoara, Facultatea de agricultură, Specializarea: Protecția Naturii, 20 pag.

* * *, 1996, Atlasul Climatologic al României, Bucureşti

* * * 2012, Amenajamentul Ocolului Silvic Iuliu Moldovan (Studiul general, U.P. I Bezdin, UP II Ghedus şi UP V Ceala), ICAS Bucureşti

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MAINTAINING SOIL FERTILITY AND ENVIRONMENTAL PROTECTION BY APPLYING OPTIMUM MINERAL FERTILIZATION

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Keywords: *fertilization plan, agrochemical study, optimum economic dose*

ABSTRACT

This paper presents a fertilization plan carried out at farm level as an useful tool for efficient use of mineral fertilizers on agricultural lands in order to prevent or reduce water bodies pollution with nitrates. The case study is accomplished within a farm located in Mostistea watershed. The fertilization plan is obtained by using best practices for efficiently nitrogen use at farm level. Different indicators were needed: expected crop yield at farm level, soil indicators and coefficients of nitrogen use. As much the difference between applied nitrogen and exported nitrogen is lower within the farm, as much the nitrogen use efficiency is higher. For example, in case of wheat, the optimum economic nitrogen dose recommended for obtaining 7000 kg/ha is 118 kg/ha of nitrogen. This dose is correlated with the optimum soil nitrogen supply, plant nitrogen need and the lower risk of nitrogen losses in water bodies.

INTRODUCTION

The European Nitrates Directive transposed in Romanian legislation by the Government Decision no. 964/2000 with its subsequent amendments, approves the Action Plan for water protection against nitrates pollution from agricultural sources. Its aim is to reduce water pollution with nitrates from agricultural sources and to prevent this pollution type. It was decided to apply a single Action Program (Action Plan for water protection against nitrates pollution from agricultural sources, 2013) at country level and do not designate vulnerable zones to nitrate pollution from agricultural sources, because all national water resources drain into Black Sea. The Action Program follows the measures established in the Code of Agricultural Practices for water protection against nitrates pollution from agricultural sources (Dumitru et al., 2015). An important measure from this Code refers to the standards on maximum quantities of nitrogen fertilizers which may be applied on agricultural lands in order to prevent or reduce water pollution with nitrates. For this, fertilizer plans at farm level are reccomended to be carried out. A fertilization plan is based on a soil agrochemical study. Within the agrochemical study, the maximum nitrogen doses which might be applied in soil are calculated. For calculation of the maximum nitrogen doses, soil nitrogen content, soil physical and chemical properties as well as the expected crop yields are taken into account. If the maximum calculated nitrogen (mineral and organic) dose is lower than 170 kg nitrogen/ha/year, the maximum nitrogen dose from animal manure which might be applied on agricultural land should not exceed this value.

In order to obtain high yields and to increase the soil fertility, a proper fertilizer dose should be applied for increasing soil nutrients content as well as the soil fertility without lossing nitrates by surface runoff or by leaching and avoiding water bodies pollution.

The fertilization plan is accomplished for a period of 4-6 years for crops within a certain rotation at farm level and contains nutrients economic optimum doses (which ensure a certain level of crop yield at which the maximum benefit is achieved) and technical doses (which take into account the ecological potential and the amount of nutrients needed to maintain / increase the soil fertility and to achieve high crop yields without a certain benefit and possible losses) (Lacatusu 2016). All the fertilization doses are established in kg/ha.

Therefore, the paper presents a fertilization plan accomplished by using modern agricultural practices and technologies for efficiently nitrogen use at farm level in order to preserve soil fertility and environment and is located in Mostistea watershed.

MATERIAL AND METHODS

The fertilization plan was carried out going through three stages: field stage, laboratory stage and desk stage. The field stage included activities such as: obtaining information about the farm specific conditions (physical blocks, crop location on physical blocks, previous agrochemical treatments, soil types) and soil sampling according to the instructions of accomplishing of agrochemical studies. Two soil samples were collected from one physical block within the farm. The laboratory stage included the measurement of soil indicators used for nitrogen doses calculation: soil reaction (pH), organic carbon (Corg), available phosphorus (P_{AL}), available potassium (K_{AL}). The nitrogen index (IN) was calculated. During the desk stage cartograms related to soil reaction (pH) and availability of phosphorus (P_{AL}) and potassium (K_{AL}) were accomplished. The two soil samples were located by numbers and agrochemical values on cartograms. Then, a fertilization parcel (groups of agrochemical subparcels with agrochemical values included in the same variation interval) was established. For the fertilization parcel, a fertilization plan was accomplished. In this paper the results obtained for one physical block are presented. Both economic and technical optimum doses were calculated.

RESULTS AND DISCUSSIONS

The plant nutrients availability and soil fertility are strongly influenced by soil properties. Therefore, is very important to periodically evaluate the soil fertility and to correlate the applied fertilization doses with the plant requirements. Moreover, in the Action Plan for water protection against nitrates pollution from agricultural sources it is mentioned that for the farms which practice irrigated agriculture and for that’s where the planned crop yield requires higher amounts of nitrogen than those given by the maximum standards set out in the Code of Good Agricultural Practices for water protection against nitrate pollution from agricultural sources (Dumitru et al. 2015), it is mandatory to accomplish the fertilization plan based on agrochemical study.

The soil type in the studied area is a typical Cambic Chernozem having a natural high level of fertility. The geographical coordinates of the parcel are presented in Figure 1. The studied parcel is under the arable land use.

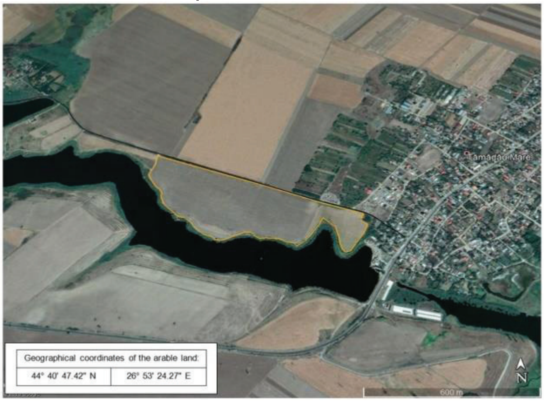

Figure 1. Geographical coordinates of the studied physical block

The cartograms related to soil reaction (pH) and fertilization parcel are presented in Figures 2 and 3. Each soil sample was located by numbers and agrochemical values on cartograms.

Figure 2. Cartogram of the soil reaction (pH)

Within the investigated physical block, one fertilization parcel (P 1-2) was established (Figure 3) by fitting the agrochemical subparcels with agrochemical values included in the same variation range. In Figure 3 the average values of soil reaction (pH), humus content, available phosphorus (P_{AL}), available potassium (K_{AL}), and nitrogen index (IN) for the established fertilization parcel are also presented.

The soil pH values within the studied physical block varied between 7.35 – 7.94, which highlighted a lightly alkaline soil (Figures 2 and 3). The lightly alkaline reaction of soil indicates a saturation of the soil in bases above 95-98%, which indicates a good soil fertility.

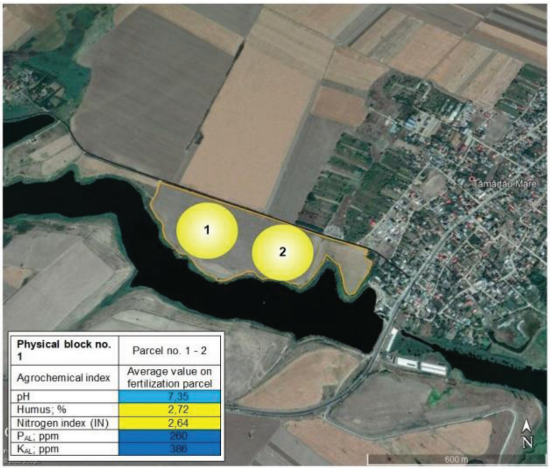

Figure 3. Fertilization parcel established within the physical block

Soil nitrogen content was evaluated by using the nitrogen index (IN) and it was moderate (the IN values were at the lower limit of the variation range) (Figure 3). The average value of nitrogen index (IN) was classified as medium nitrogen content (2.64). This indicates a good fertility level of the soil at that specific parcel of the farm.

Both the soil available phosphorus and available potassium contents were classified as very good, with average values of 260 mg/kg and 386 mg/kg respectively. On such soils with a good fertility, the fertilizers doses containing phosphorus and potassium should be applied according to the plant needs, soil phosphorus and potassium contents, expected yield.

The expected and achievable yields at the farm level are presented in Table 1. The achievable yields were established based on the land mark in the studied area. For example, in case of winter wheat the achievable yield is 4.0 t/ha. The expected yields are higher if new and modern agricultural techniques and practices are applied. In case of winter wheat the expected yield are 7.0 t/ha.

Table 1

Expected yields of the farmer in the studied area

Crop	Expected yields of the farmer (t/ha)	Achievable yields, (t/ha)
Wheat	7.0	4.0
Maize	9.0	7.0
Sunflower	4.0	2.7
Rape	4.0	2.9

In this context a fertilization plan for the established fertilization parcel was accomplished. This contains economic and technical optimum doses – DOE and DOT (which ensure a certain level of crop yield at which the maximum benefit is achieved) for a four years crop rotation, winter wheat – maize – sunflower – rape. In Table 2 the fertilization plan is presented for the physical block. For the calculation of the optimum economic doses (DOE) and technical economic doses (DOT) different aspects were taken into account: prices of mineral fertilizers, nutrients crop requirements, soil nutrients content and economic aspects. DOE and DOT are also calculated for achieving at farm level the expected yields.

Table 2

Fertilization plan

Crop	Physical block no. 1		
	Fertilization plan		
	Parcel no.	*1 - 2*	
	Doses of amendments, organic fertilizers		
	$CaCO_3$; t/ha	-	
	Partially decomposed animal manure; t/ha	-	
	Doses of nitrogen, phosphorus and potassium on parcels within the physical block		
	Dose type (kg/ha)	DOE	DOT
Wheat	Nitrogen (N)	118	190
	Phosphorus (P_2O_5)	0	69
	Potassium (K_2O);	0	65
Maize	Nitrogen (N)	133	213
	Phosphorus (P_2O_5)	0	61
	Potassium (K_2O);	0	60
Sun-flower	Nitrogen (N)	70	121
	Phosphorus (P_2O_5)	0	71
	Potassium (K_2O)	0	52
Rape	Nitrogen (N)	83	136
	Phosphorus (P_2O_5)	0	50
	Potassium (K_2O);	0	50

By using traditional agricultural practices within the farm it might be achieved a wheat yield of 4.0 t/ha. On the contrary, by using modern agricultural practices and technologies at farm level it might be achieved a wheat yield of 7.0 t/ha. The recommended optimum nitrogen dose for obtaining a wheat yield of 7.0 t/ha, for the established fertilization parcel, is around 118 kg of nitrogen per ha. As much the difference between applied nitrogen and exported nitrogen is lower within the farm, as much the nitrogen use efficiency is higher (Oenema et al., 2013). This dose is correlated with the optimum soil nitrogen supply, plant nitrogen need and the lower risk of nitrogen losses in water bodies.

CONCLUSIONS

A fertilization plan was established in a physical block located within a farm from Mostistea watershed. It contains both economic and technical optimum doses – DOE and DOT for a four years crop rotation, winter wheat – maize – sunflower – rape. The following conclusions may be drawn:

The soil reaction is lightly alkaline and no limestone amendments are necessary to be applyied. The soil nitrogen content is classified as moderate being affected by the high degree of base saturation. The soil available phosphorus and potassium contents are very good.

The achievable yields were established based on the land mark in the studied area and taking into account that a conventional agricultural technology is used. In case of winter wheat, for example, the achievable yield is 4.0 t/ha. The expected yields are higher if new and modern agricultural techniques and practices are applied. In case of wheat the expected yields are 7.0 t/ha. The recommended optimum nitrogen dose for obtaining the expected wheat yield of 7.0 t/ha, for the fertilization parcel analyzed, is around 118 kg of nitrogen per ha. As much the difference between applied applied nitrogen and exported nitrogen is lower within the farm, as much the nitrogen use efficiency is higher. This dose is correlated with the optimum soil nitrogen supply, plant nitrogen need and the lower risk of nitrogen losses in water bodies.

Therefore, the fertilization plan carried out at farm level is an useful tool for efficient use of mineral fertilizers on agricultural lands in order to prevent or reduce water bodies pollution with nitrates.

ACKNOWLEDGMENT

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REFERENCES

Dumitru M., Simota C., Cioroianu T., Lacatusu R., Dumitru E., Calciu I., Panoiu I., Roman G.V., Mihalache M., Creanga I., Darie C., Catana D., Dragoi D.G., Nedelea I. 2015. Codul de Bune Practici Agricole pentru Protectia Apelor impotriva poluarii cu nitrati din surse agricole. Ed. eKarioka, Bucuresti, ISBN 978-606-94088-0-3, 159 pp.

Lacatusu R. 2016. Agrochimie, Editura Terra Nostra, Iasi, 440 pp.

Oenema O, Brentrup F, Lammel J, Bascou P, Billen G, Dobermann A, Erisman JW, Garnett T, Genovese G, Haniotis T, Hillier J, Hoxha A, Lassaletta L, Jensen LS, Olazabal C, Oleszek W, Pallière C, Powlson D, Quemada M, Schulman M, Sutton MA, Van Grinsven HJM, Vis JK, Winiwarter W. 2013. Nitrogen Use Efficiency (NUE), Guidance Document for assessing NUE at farm level. Available on-line at: www.eunep.com.

*** 2000. Hotărârea Guvernului nr. 964/2000 cu modificările și completările ulterioare privind aprobarea Planului de acțiune pentru protecția apelor împotriva poluării cu nitrați proveniți din surse agricole.

*** 2013. Anexa la Decizia Ministerului Mediului si Schimbarilor Climatice nr. 221983/GC/12.06.2013 - Program de actiune pentru protectia apelor impotriva poluarii cu nitrati din surse agricole, 17 pp.

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CALAMAGROSTIS SAMPLES PRESENT IN ALEXANDRU BELDIE HERBARIUM

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Keywords: *Calamagrostis, herbarium, plants, collections, botanists*

ABSTRACT

Well represented within "Alexandru Beldie" Herbarium from „Marin Drăcea" National Institute for Research and Development in Forestry, Calamagrostis Genus distinguishes itself through 117 plates that contain 16 species and numerous subspecies. Together with the samples, the herbarium contains important information such as the plants' harvesting places, the harvesting dates and the specialists who have collected them. The present paper organizes and presents the samples of these genus present in the herbarium based on their different characteristics such as harvesting periods (together with their graphic representation), harvesting places (through harvesting maps) or the specialists who have collected them. The introduction is dedicated to a short description of the herbarium and of its most representative genres. This is followed by the work method used which allows the identification of herbarium maps by recording their number and drawer, the collection's name, the specialists name and the harvesting place and date. A final organizing criterion which has a special importance is represented by the conservation degree. This is marked on a scale from 1 to 4, where 1 means a very good conservation state while 4 represents a very week conservation state. The 1920-1960 period is the most important period for the development of Calamagrostis collections for the herbarium. On the other hand, the oldest plant from the herbarium dates back to 1849 and was collected from around Cluj. Calamagrostis samples were harvested from all around the country, with a focus on mountain areas. The article's conclusions reunite some unusual and interesting aspects regarding the Calamagrostis samples present in "Alexandru Beldie" herbarium.

INTRODUCTION

„Marin Drăcea" National Institute for Research and Development in Forestry from Bucharest hosts one of the most impressive plant collections from our country – "Alexandru Beldie" Herbarium. This collection was created in 1929 and is inscribed in Index Herbariorum (BUCF international code), containing a considerable number of approximately 40.000 vouchers (Vechiu et al., 2018; Dincă et al., 2018).

Alexandru Beldie was one of the greatest Romanian botanists who dedicated his career to studying the flora from Bucegi Mountains (Beldie 1967, Beldie 1972). Together with Alexandru Beldie, the herbarium was developed by numerous national and foreign specialists.

Besides the *Calamagrostis* genus, the herbarium contains numerous other genera such as: 42 *Agrostis* species (Cântar et al., 2019), 21 *Alnus* species (Dincă et al., 2019), 17 *Amaranthus* species (Dincă et al., 2018), 25 *Asperula* species (Plesca et al., 2020), 36 *Bronus* species (Tudor et al., 2019), 130 *Campanula* species (Dincă et al., 2020), 58 *Cornus* species (Vechiu et al., 2019), 7 *Lycopodium* species (Vechiu et al., 2018), and 80 *Trifolium* species (Cântar et al., 2018). The species present in the herbarium were collected from different parts of our country such as Bazoș Dendrology Park from Timiş County (Chisăliță *et al*., 2017), Moldavia (Vasile et al., 2019) or former Vlașca County (Ciontu et al., 2019).

MATERIAL AND METHODS

The purpose of this present paper is to present and organize the *Calamagrostis* samples present in the herbarium which amount to 16 species and 117 vouchers. The used method involved organizing the *Calamagrostis* herbarium's vouchers based on the following criteria:

- Criteria about the location within the herbarium: herbarium drawer number, drawer voucher number, botanic collection to which it belongs;
- Criteria regarding the sample: specie's name, plant's conservation degree (on a scale of 1 to 4, where 1 means a very good conservation state and 4 a poor conservation state);
- Criteria regarding the plant's harvesting: harvesting date, harvesting place, the specialist that has collected and/or determined it.

Table 1

Calamagrostis Genus inventory from Al. Beldie Herbarium, INCDS Bucharest (excerpt)

Drawer number	**Voucher number**	**Herbarium/ Botanic Collection/ Institution**	**Specie's name**	**Harvesting date**	**Harvesting place**	**Collected/ Determined by:**	**Conservation degree (1-4)**
64	7	Wiener Tausch-Herbarium	Calamagrostis halleriana	1853.01.01	Teplitz in Bohmen	M. Winkler	1
64	17	Societas Helvetica 1885	Calamagrostis stricta Spr.	1879.07.01	Tromsodal-Finmarkia-Norvegia	S. Sommier	1
64	38	Plantae Scandinavicae	Calamagrostis chalybaea (Laest.) Fr.	1887.08.01	don le ror Macesson	C. F. Sundberg	1
64	16	Herbier A. Pellat	Calamagrostis t enella	1893.07.11	Lautaret, H. Alpes	A. Pellat	1
64	107	N. Al. Iacobescu Herbarium	Calamagrostis arundinacea (L.) Roth	1907.08.09	Urlătoarea, Bucegi		1
64	25	Bucharest's Polytechnic School Botanic Lab.	Calamagrostis pseudophragmites (Haller f.)	1919.08.26	Bucegi, V. Ialomiței	M. Haret	1

RESULTS AND DISCUSSIONS

Calamagrostis is a genus from the Poaceae family that contains approximately 260 species present especially in temperate regions. Towards equatorial latitudes, Calamagrostis species appear at high altitudes. These perennial plants usually have narrow unpubescent leaves. The plant's inflorescence forms a panicle and some species can even resemble reeds.

The genus's name originates from the Greek words *kalamos* which means "read" and *agrostis* which means a type of grass. Many species are popular as decorative plants and are known as "ornamental grass" (https://www.missouri botanicalgarden.org/).

The species that were identified within the herbarium after the systematization were the following: *Calamagrostis halleriana* (Gaudin) P.Beauv., *Calamagrostis sylvatica* (Schrad.) DC., *Calamagrostis arenaria* (L.) Roth, *Calamagrostis arundinacea* (L.) Roth, *Calamagrostis chalybaea* (Laest.) Fr., *Calamagrostis epigeios* (Linnaeus) Roth, *Calamagrostis gracilescens* (Blytt), *Calamagrostis lanceolata* Roth, *Calamagrostis littorea* DC, *Calamagrostis phragmitoides* Hartm., *Calamagrostis pseudophragmites* (Haller f.), *Calamagrostis stricta* Spr., *Calamagrostis tenella* (Schrad.) Link, *Calamagrostis varia* L., *Calamagrostis villosa* (Chaix), and *Ammophila arenaria* × *Calamagrostis epigeios* (Syn. *Psamma baltica* (Flugge ex Schrad.) P. Beauv.).

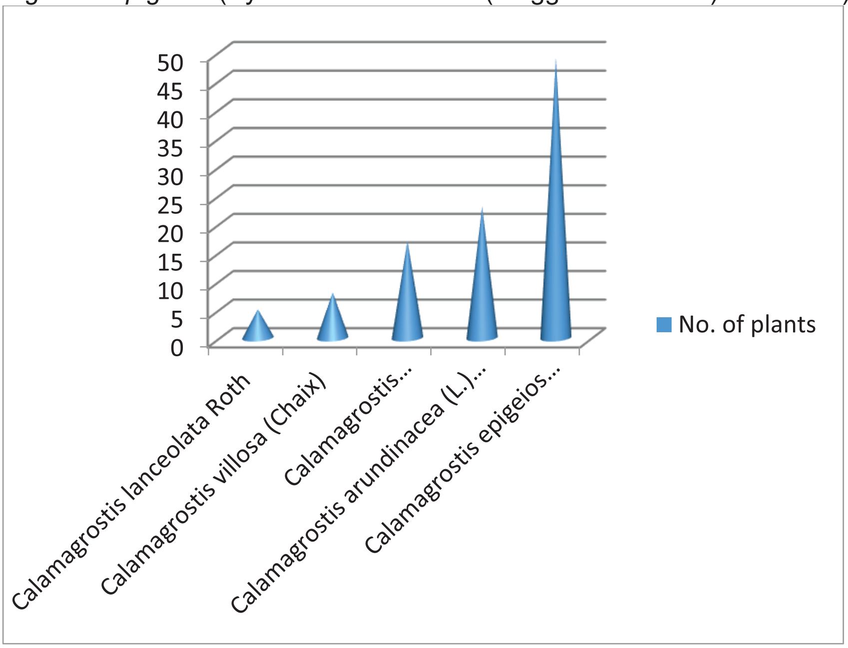

Figure 1. *Calamagrostis* Genus species present in the herbarium

The most numerous species present in "Alexandru Beldie" Herbarium are the following: *Calamagrostis epigeios* (Linnaeus) Roth (49 samples), *Calamagrostis arundinacea* (L.) Roth (23 samples), *Calamagrostis pseudophragmites* (Haller f.) (17 samples), *Calamagrostis villosa* (Chaix) (8 samples), and *Calamagrostis lanceolata* Roth (5 samples) (Fig. 1).

Calamagrostis epigeios is the most widespread species within the herbarium, being present in 49 vouchers. Commonly known as wood small-reed or bush grass, the species is native to Eurasia and Africa where it vegetates on average moisture places up to salt marshes and wet habitats. *Calamagrostis epigeios* has a broad distribution in temperate Eurasia, from France and Great Britain to Japan. A distinct variety is found in southern and eastern Africa (wikipedia.org).

The systematization method has allowed for the repartition of the number of collected samples on certain time periods as well as for their graphical representation (Fig. 2). In this way, the evolution in time of the collection's development was also analyzed. The *Calamagrostis* samples were collected on a period of 170 years, starting from the middle of the XIX century up to the end of the XX century.

As in the case of other collections present in "Alexandru Beldie" Herbarium, the "flowering" period of this herbarium has left its mark on the development of *Calamagrostis* collections. As such, the majority of samples were collected during 1920 and 1960 when most of the herbarium's plants were also collected.

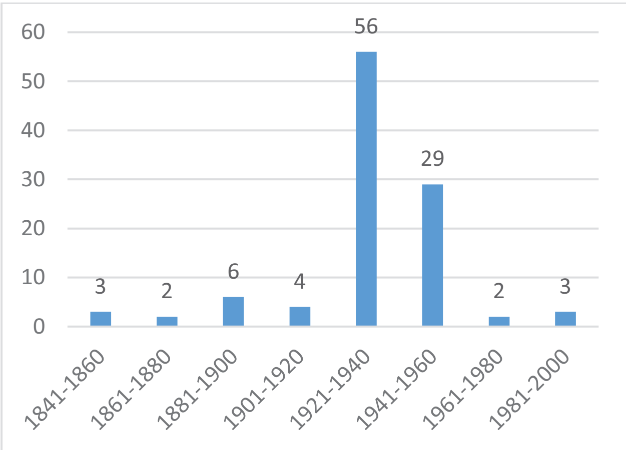

Figure 2. Harvesting period of *Calamagroistis* samples from „Alexandru Beldie" Herbarium

The oldest *Calamagrostis* sample present in the herbarium has 170 years and is represented by a *Calamagrostis epigeios*, harvested in 1849 near Cluj by Woeff.

The systematization has allowed for an analysis of the geographic area from which *Calamagrostis* species originate. Based on their harvesting place mentioned within the herbarium, a map of samples was obtained (Fig. 3).

Figure 3. Harvesting locations of *Calamagroistis* species from „Alexandru Beldie” herbarium

As can be seen in Figure number 3, the harvesting locations of *Calamagrostis* species present in the herbarium cover the majority of mountain areas from Romania, as well as low areas such as Danube's gorge, Danube's Delta, Ilfov County etc. The harvesting locations are strongly connected with the activity realized by different specialists who have contributed to the herbarium's development. As such, Alexandru Beldie dedicated his work to studying the flora from Bucegi Mountains from where numerous *Calamagrostis* species were collected. Paşcovschi focused his work in Banat and has contributed to the development of *Calamagrostis* collections with samples from this area.

Besides the specialists mentioned above, the *Calamagrostis* collections were enriched by other Romanian and foreign specialists such as: Chiriță, Cretzoiu, Georgescu, Petcuț, Haralamb, Coman, Badea, Neuwirth, Ghișa, Iacvob, Bunea, Morariu, Onică, Tătăreanu, Leandru, Todor, Prodan, Petrini, Sandberg, Zarneti, Grutter, Huter, Bornmuller, Iacobescu, Haret, Nyarady, Woeff, Winkler, Bergstedt, Sommier, Indebbetou, Sundberg, Pellat, Fries.

CONCLUSIONS

Calamagrostis Genus is well represented within Al. Beldie Herbarium from INCDS Bucharest, amounting to 117 vouchers that contain 16 species and numerous subspecies. The most numerous samples present in the herbarium belong to *Calamagrostis epigeios* (Linnaeus) Roth (49 samples).

The *Calamagrostis* species value is doubled by their immense historical value. For example, the oldest plant dates back to 1849 and the herbarium contain 11 other samples that existed during the XIX century.

The *Calamagrostis* samples from the herbarium were harvested from all around Romania, especially from mountain areas. Besides the national samples, the herbarium also contains 15 *Calamagrostis* samples from countries such as Switzerland, Germany, Austria, Hungary or Bulgaria (areas that belonged to Romania when they were harvested).

Regarding the development periods of the *Calamagrostis* collections, they covered a period of approximately 150 years, between 1849 and 1994, with a maximum development during 1920 and 1960.

REFERENCES

Beldie A. 1967. Flora și vegetația Munților Bucegi. Ed. Academiei R.S.R., București, 578 p., Romania.

Beldie A. 1972. Plantele din Munții Bucegi. Determinator. Ed. Academiei R.S.R., București. 409 p., Romania.

Cântar I.C., Dincă L., 2018. *Trifolium* genus species present in "Alexandru Beldie" Herbarium from "Marin Drăcea" National Institute for Reseach and Development in Forestry, Annals of West University of Timisora, ser. Biology, 21(2): 123-132.

Cântar I. C., Dincă L. 2019. *Agrostis* species present in the "Alexandru Beldie" Herbarium from "Marin Dracea" National Institute for Research and Development in Forestry. Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series, Vol. 48(2), 44-49.

Ciontu C.I., Dincă L. 2019. Plants from former Vlașca County that are present in "Alexandru Beldie" Herbarium. Research Journal of Agricultural Science, 51 (4): 254-261.

Chisăliţă I., Vasile D., Dincă L. 2017. Unele specii de plante culese din parcul Bazoș, județul Timiș, existente în colecția Herbarului Alexandru Beldie de la INCDS București. Revista de Silvicultură și Cinegetică, 40: 71-76.

Dincă L., Dincă M., Pantea S.D., Timiş-Gânsac V., Oneţ C. 2018. Amaranthus plant - between myth and usage. Natural Resources and Soustainable Development, 8(1): 9-16.

Dincă L., Peticilă A. 2019. How many alder species (Alnus sp.) exist? A statistic based on herbarium vouchers. Scientific papers, Series B, Horticulture, 63(1): 613-619.

Dincă L., Vechiu E. 2020. A statistic of Campanula species based on vouchers from different herbarium. Annals of West University of Timişoara, ser. Biology, 23 (1): 29-38.

Plesca I.M., Blaga T., Dincă L., 2020. Asperula L. species preserved in 'Alexandru Beldie' Herbarium. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture, 77(1): 92-97.

Tudor C., Dincă L., 2019. What can we learn about Bromus genus preserved in "Alexandru Beldie" herbarium? Research Journal of Agricultural Science, 51 (4): 218-225.

Vasile D., Dincă L., 2019. Specii de plante din Republica Moldova păstrate în colecția ierbarului "Alexandru Beldie". Buletin Ştiinţific. Revista de Etnografie, Ştiinţele Naturii şi Muzeologie (Serie Nouă), 43(30): 6-16.

Vechiu E., Dincă L., Cântar I.C., 2018. Describing the *Lycopodium* Genus based on the plants present in Al. Beldie Herbarium. Research Journal of Agricultural Science, 50(4): 385-390.

Vechiu E., Dincă L., 2019. Characterization of Cornus plant present in "Al. Beldie" herbarium. Research Journal of Agricultural Science, 51 (3): 169-175.

***https://www.missouribotanicalgarden.org/

***https://www.wikipedia.org

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IMPLEMENTING THE HIERARCHY-ANALYTIC PROCESS FOR FOREST FRUITS FROM DOLJ COUNTY, ROMANIA

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***Keywords**: alternatives, analytic hierarchy process (AHP), criteria, market, forest fruits*

ABSTRACT

The present article applies an analytical hierarchy process (AHP) in order to analyze the importance of forest fruits from Dolj County. The first part focuses on presenting the AHP notion and mentioning some areas from our countries where this method was applied in similar studies. This if followed by a short description of Dolj County, with an emphasis on the county's areas occupied by forests. The material and method chapter presents the types of forest fruits and the eight ones that were analyzed based on the 19 criteria that have resulted from the AHP analysis. Furthermore, the AHP analysis work method is detailed together with the predecessors of this method and the software we have used. The results start by presenting the alternative AHP ranking used later on for creating a Diagram of performance sensitivity in AHP ranking with the help of the Expert Choice Desktop software. All these are sustained by graphical representations and analysis of the importance intensity for each criterion distributed on species as well as of the average intensity importance. The conclusions reunite the article's most important results as well as solutions for practically applying AHP and improvement suggestions for further analyses.

INTRODUCTION

The analytical hierarchy process (AHP) represents an analysis and structure technique for complex decisions based on psychology and mathematics that was developed by (2008). This type of analytic hierarchy process can also be used for analyzing forest fruits from a certain area, as is the case of the present article which presents the implementation and results of this process for forest fruits located in Dolj County.

These types of studies based on an analytical hierarchy process (AHP) were also obtained by some researchers for different areas of our country such as Arad (Pleșca et al. 2019), Bistriţa (Tudor et al. 2020), Satu-Mare (Tudor et al. 2019), Sibiu (Vechiu & Dincă 2019), Gorj (Vechiu et al. 2018), Bacau (Blaga et al. 2019), and Dâmbovița (Cântar & Dincă 2020). However, the majority of these studies did not focus exclusively on forests fruits as the present article does, but on the entire non-wood products.

Besides its wood material, Romania owns considerable quantities of non-wood products that are mainly exported (Bragă & Dincă 2019). An important percentage is represented by forest fruits so that their harvesting can represent an economic alternative to the exploitation of wood masses especially in counties with reduced forest surfaces and a low wood volume that can be exploited, as is the case of Dolj County. Situated in the south-west part of Romania, the county has a total surface of 7.414 square kilometers. The county is bordered by Vâlcea and Gorj Counties in north, by Olt County in east, Mehedinţi County in west and the Danube in the south. Dolj County has a forest surface of 84.400 ha, which represents approximately 11% of the county's total surface. The majority of this surface is managed by Dolj Forest District from within ROMSILVA, the National Forest Management (Cântar et al. 2018).

Figure 1. The study area of Dolj County (source: https://discoverdolj.ro/)

MATERIAL AND METHODS

The present paper analyses the most important non-wood products of forests from Dolj County, namely forest fruits, based on their importance framed by 19 criteria. The analysis relied on an analytical hierarchy process (AHP) and on the Expert Desktop Choice Software. This method was developed based on previous researches (Saaty 2008; Tudor & Dincă 2019; Dincă & Timiș-Gânsac 2020) and was also applied within the COST 1203 action - European non-wood forest products network.

The eight most representative forest fruits for this area were chosen based on the specialty bibliography, on knowledge about the vegetation from Dolj County and on grades offered by the specialists involved in this study for all 19 criteria established. These eight forest fruits were: *Rosa canina, Fragaria vesca, Sambucus nigra, Crataegus monogyna, Prunus mahaleb, Pyrus piraster, Corylus avelana, Quercus sp.*

The importance of forest fruits from Dolj County was classified based on the grades given by three specialists for each of the 19 considered criteria, namely: 1-harvesting period, 2-harvested quantity / worker/8 hours, 3-harvesting cost, 4-knowledge for harvesting, 5-tools needed for harvesting, 6-complexity of the harvesting process, 7-development of the harvesting process, 8-knowledge for recognition, 9-distribution range, 10-biotic threats, 11-abiotic threats, 12-perishability, 13-market potential, 14-market demand, 15-"celebrity" of the product on market, 16-the price of the raw product, 17-the price of the derived product, 18-portfolio of derived products, 19-Transport (from harvesting place to storage center). The forest fruits were evaluated with grades from 1 to 8 for each criterion. These grades represented the importance of forest fruits in regard with the criterion's attribute.

RESULTS AND DISCUSSIONS

The analytic hierarchy process (AHP) used to determine the importance of forest fruits from Dolj County has allowed their classification as follows: hazelnuts (*Corylus avellana*), wild strawberries (*Fragaria vesca*), mahaleb cherry (*Prunus mahaleb*), rosehips (*Rosa canina*), European wild pear (*Pyrus piraster*), elder berries (*Sambucus nigra*), acorns (*Quercus sp.*), common hawthorn (*Crataegus monogyna).*

Table 1

AHP alternative ranking (Dolj County)

Criterion		Berries							
		Rosa canina	*Fragaria vesca*	*Sambucus nigra*	*Crataegus monogyna*	*Prunus mahaleb*	*Pyrus piraster*	*Corylus avelana*	*Quercus* sp.
		1	2	3	4	5	6	7	8
1	Harvesting period	8	1	3	6	2	4	5	7
2	Harvested quantity / worker / 8 hours	4	1	3	5	2	7	6	8
3	Harvesting cost	7	2	3	6	5	4	8	1
4	Knowledge for harvesting	3	1	7	6	8	2	4	5
5	Tools needed for harvesting	3	1	4	5	8	7	6	2
6	Complexity of harvesting process	3	1	2	4	8	6	7	5
7	Development of harvesting process	2	1	3	5	6	8	7	4
8	Knowledge for recognition	1	2	6	3	8	4	7	5
9	Distribution range	8	2	5	7	1	4	3	6
10	Biotic threats	1	7	5	2	8	4	3	6
11	Abiotic threats	2	8	5	1	4	3	6	7
12	Perishability	3	8	7	4	6	5	2	1
13	Market potential	7	6	2	5	3	4	8	1
14	Market demand	6	8	3	2	5	4	7	1
15	"Celebrity" of the product on market	7	8	4	5	2	3	6	1
16	The price of raw product	5	8	2	3	6	4	7	1
17	The price of the derived products	4	8	5	3	6	2	7	1
18	Portfolio of derived products	6	7	4	2	5	3	8	1
19	Transport (harvesting to storage)	3	8	6	4	7	5	2	1

In regard with the intensity of importance for each criterion distributed on species (fig. 2), hazelnuts *(Corylus avellana)* showcase a considerable importance for the majority of analyzed criteria.

Furthermore, wild strawberries (*Fragaria vesca*) have a higher importance of criteria connected to the market (criteria 13, 14 and 15) and to the price (criteria 16 and 17), while having fewer biotic and abiotic threats (criteria 10 and 11) and a lower perishability (criteria 12).

Hazelnuts *(Corylus avellana)* has also obtained the highest value – 6- for the calculated average for expressing the importance and potential of each species (fig. 3). These average reaches value 5 for mahaleb cherry (*Prunus mahaleb*) and wild strawberries *(Fragaria vesca)*. All other analyzed forest fruits have recorded the value 4 for this element, with the exception of acorns (*Quercus sp.*) that recorded 3 as a value.

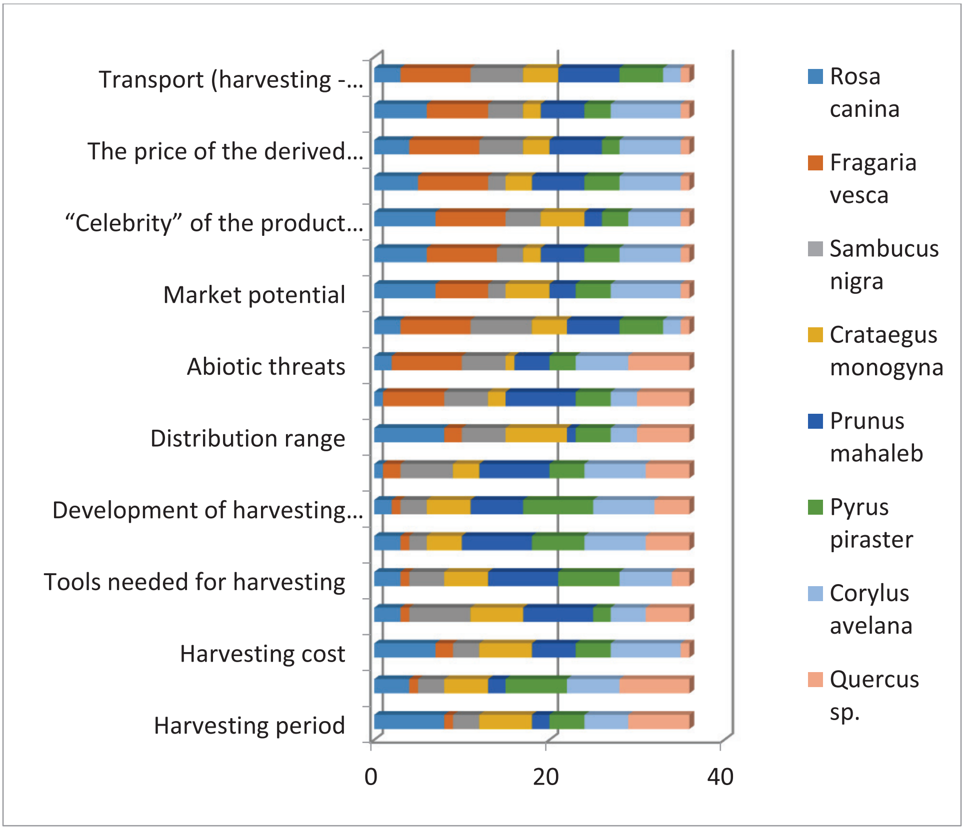

Figure 2. The intensity of importance for each criterion distributed on species

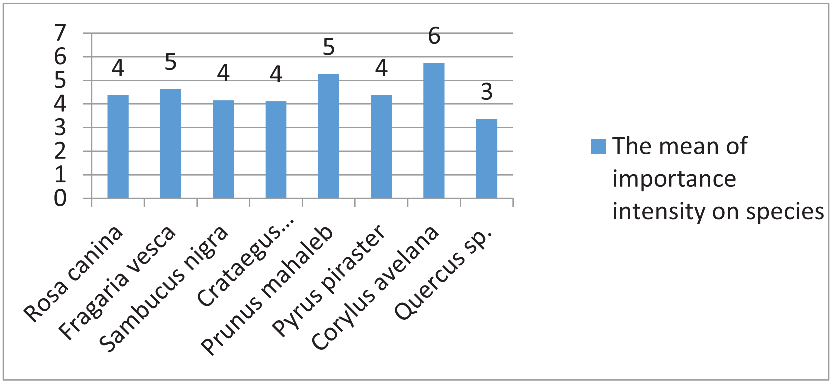

Figure 3. The calculated mean for expressing the importance and potential of every species

The sensitivity diagram (figure 4) realized for forest fruits from Dolj County based on the AHP method, situates hazelnuts *(Corylus avellana)* on the first place, with considerable values for each criterion, with the exception of perishability. The species is closely followed by wild strawberries (*Fragaria vesca*) and mahaleb cherry (*Prunus mahaleb*).

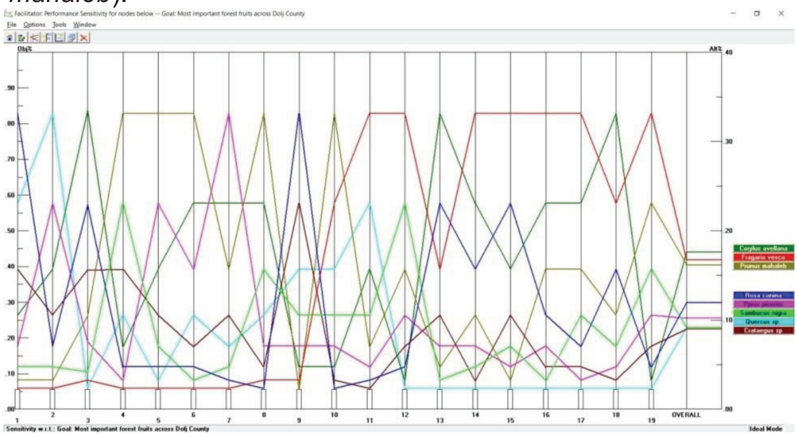

Figure 4. Diagram of performance sensitivity in AHP ranking

All the other analyzed forest fruits are situated on inferior positions in regard with their importance for Dolj County.

CONCLUSIONS

The results for applying an analytic hierarchy process for analyzing forest fruits as illustrated in the present article reveals the fact that the AHP method is precise and leads to palpable results that can be used by forest managers to improve their surfaces and productions.

The AHP analysis in the domain of forest fruits can also be used by different local stakeholders from the harvesting-commerce-consumption domains in order to choose the most profitable forest fruits that correspond to the criteria taken into account. As such, an AHP analysis can be personalized based on the stakeholders' requests and interests by choosing criteria that are specific to harvesting, trading and consuming forest fruits. As such, the importance of forest fruits can be changed on the different segments involved in this chain.

A performant, improved and efficient AHP analysis can be obtained by choosing a large number of specialists and stakeholders which will grade the importance of the forest fruits based on objective criteria and on their individual purpose and interest.

REFERENCES

Blaga T., Pleșca I.M., Dincă L. 2019. Selecting the most promising non-wood forests products for Bacau County using the analytic hierarchy process. Studii și Cercetări Științifice-Biologie, 28(1): 29-33.

Bragă C., Dincă L. 2019. Forest is not only wood: Evaluating non-timber products from Dambovita County. Current Trends in Natural Sciences, Vol. 8, Issue 15: 73-78.

Cântar I. C., Enescu C. M., Dincă L. 2018. Application of the analytic hierarchy process in selection of the most important non-wood forest products for Dolj County, Craiova. Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series, 48(2): 50-57.

Cântar I. C., Dincă L., 2020. The most important NWFPs from Dambovita County identified through the analytical hierarchy process. Annals of the University of Craiova – Agriculture, Montanology, Cadastre Series, Vol. 49, No. 2: 70-73.

Dincă L., Timiș-Gânsac V. 2020. The usage of non-wood forest products - Culinary and artisanal traditions in Romania. Sustainable Development Research; Vol. 2, No. 1: 50-57.

Pleșca I. M., Blaga T., Dincă L., Breabăn I. G. 2019. Prioritizing the potential of non-wood forest products from Arad county by using the analytical hierarchy process. Present Environment and Sustainable Development, Vol. 13, Nr. 2, pp. 225-233.

Saaty T.L. 2008. Decision making with the analytic hierarchy process. International Journal of Services Sciences, Vol. 1, Issue 1: 83-98.

Tudor C., Constandache C., Dincă L. 2019. Benefits brought by the abundance and importance of forest fruits from Satu Mare County, Romania. Book of Proceedings of the X International Scientific Agricultural Symposium "Agrosym 2019": 1920-1925.

Tudor C., Dincă L., Constandache C. 2020. Benefits brought by the abundance and importance of forest fruits from Bistrita-Nasaud County. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture, 77(1): 110-116.

Tudor C., Dincă L., 2019. The main categories of non-wood forest products from Vrancea County. Research Journal of Agricultural Science, Vol. 51, Issue 4: 211-217.

Vechiu E., Dincă L., Enescu C.M. 2018. Which are the most important forest fruits from Gorj county? Revista de Silvicultură și Cinegetică, Vol. 42: 89-93.

Vechiu E., Dincă L. 2019. Forest fruits from Sibiu County. Research Journal of Agricultural Science, 51 (3: 163-168.

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EVALUATING GAME AND FISH SPECIES FROM VÂLCEA COUNTY

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***Keywords**: Vâlcea, fallow deer, huchon, otter, badger*

ABSTRACT

The game fund surface of Vâlcea County is of 529.265ha, distributed in 47 funds with a climate that ranges from moderately continental in Sub-Carpathian hills up to a mountain climate in high areas. Eight species were selected from the county's main game and fish species, namely: fallow deer (Damadama L), bear (Ursusarctos L), fox (Vulpes vulpes L), badger (Meles meles L), marten (Martes martes L), otter (Lutra lutra L), huchon (Hucho hucho) and carp (Cyprinus carpio). These species were classified based on their ordering after 19 criteria (harvesting period, harvesting cost, harvesting knowledge, tools necessary for harvesting, the harvesting's process complexity, harvesting development, knowledge about the species, distribution domain, market potential, market request, market "celebrity", raw product's price, the price of the derived product, derived products portfolio). Grades from 1 to 8 were given for each analysed species, resulting that the most important species are fallow deer and huchon, while the least important ones are otter and badger. The county presents a high potential for harvesting and trading game species as the forest and fish areas are very well represented. As such, the game and fish species have the proper space and environment to reproduce and develop.

INTRODUCTION

In order to hunt, humans need certain tools and must apply specific hunting methods, based on the species and the distance involved. Primitive humans were forced to limit themselves to gathering fruits and meat remains from animals lacerated by predatory species or to capture small or baby animals (Cotta et al. 2001).

Only later did humans start to procure their food by hunting. Their weapons have constantly evolved from a rock to a broken branch from nearby forests up to today's evolved and sophisticated weapons. As long as their numbers were sufficiently low, exploiting Earth's natural resources had a small impact. However, the population's increase has led to unfavourable consequences that steadily resulted in the loss of wild flora and fauna (Crăciunescu et al. 2014).

At the present moment, the concept of hunting includes, besides the actual hunting actions, a large array of activities for conserving biodiversity, the management of wild fauna, educating and training specialists, research studies, awareness actions, sociological studies etc.

The management of game funds limits the number of hunted species and intends to maintain habitats and biodiversity (Molnár 2011; Momiret al. 2015).

The present study intends to emphasize the most important game and fish species from Vâlcea County as well as to evaluate them through an analytical hierarchy process (AHP). The Expert Choice Desktop Software was used for obtaining the analyses (Ciontu et al. 2018; Blaga et al. 2019; Dincă et al. 2018; Tudor et al. 2020).

The concept of non-wood forest products (NWFPs) was introduced four decades ago in the tropical silviculture for taking into consideration all the production generated by the forest sector (Ciontu et al. 2020; Pleșca et al. 2019; Enescu et al. 2020). In Romania, non-wood forest products are mainly represented by forest fruits, mushrooms, medicinal plants and game species, amounting to approximately 350 species (Cântar et al. 2018; Vechiu et al. 2018; Timiș-Gânsac et al. 2018; Dincă et al. 2020).

MATERIAL AND METHODS

The study was realized in Vâlcea County, which is located in South Romania. Covering a surface of 5.765 km², the county is flanked by Alba and Sibiu Counties to the North, Argeș County to the East, Olt County in South and South-East, Dolj County in South-West, Gorj County in West and Hunedoara County in North-West. The county's seat is Râmnicu Vâlcea municipality. From an administrative point of view, Vâlcea County is divided in 2 municipalities, 9 cities and 78 villages.

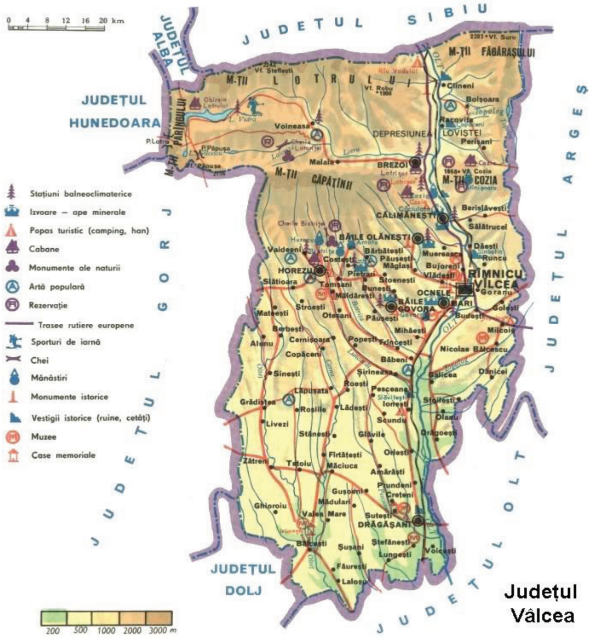

Fig. 1 Location of Vâlcea County (source www.pe-harta.ro)

Vâlcea Forest District manages a surface of 132.482 ha of forest fund from which 93.640 ha are public state forest property and 38.842 ha are private forests owned by physical or juridical entities.

Vâlcea Forest District is divided in 9 forest districts: Băbeni, Bălcești, Călimănești, Drăgășani, Horezu, Rm.Vâlcea, Romani, Stoiceni and Voineasa.

The complex activity of this forest district, as well as its geographic positioning, its forest's diversity and the protection it exercises on soils and waters represents an excellent business card for the silvicultural personnel involved directly or indirectly in attaining its objectives (www.rosilva.ro).

Vâlcea County has 47 game funds, covering 529.265 ha where the following game species live: bear, wolf, lynx, red deer, chamois, roe buck, fallow deer, boar, hare, wildcat, pheasant, partridge, badger, fox, marten, ferret and weasel. The fish fauna is also well represented. Eight species were taken into account for this study (fallow deer, bear, fox, badger, marten, otter, huchon, carp) and used in an analytical hierarchy process (AHP). The results were analysed with the Expert Choice Desktop software.

AHP is one of the most used worldwide models for decision making and for solving complex problems in numerous domains, including biological sciences (Aras et al. 2004, Wang et al. 2004, Park et al). The analytical hierarchy process uses pair comparisons of selected criteria in order to evaluate their importance (Huang et al. 2011). As such, the complex problem (namely the purpose of this study) is structured hierarchically with the objective at the hierarchy's top, while the criteria (and sub-criteria, if they exist) are on the hierarchy's levels, followed by the alternatives (namely the selected eight non-wood forest products) are located at its basis (San Cristóbal 2011).

RESULTS AND DISCUSSIONS

The following species were selected for this study: fallow deer (*Dama dama* L), bear (*Ursus arctos* L), fox (*Vulpes vulpes* L), badger (*Meles meles* L), marten (*Martes martes* L), otter (*Lutra lutra* L), huchon (*Hucho hucho*) and crap (*Cyprinus carpio*). The alternative AHP classification for the 19 criteria taking into account is presented in Table number 1.

Based on the AHP results, the most important game and fish species from Vâlcea County are fallow deer and huchon, while the least important ones are otter and badger (Figure 2).

Fallow deer is situated in the AHP's top results and even though it does not have a long harvesting period, it has a larger portfolio of derived products, a larger distribution network and a high marked demand. However, the costs are higher for its harvesting, its transportation from the harvesting point to the storage centre as well as for its derived products. The second product is huchon (*Hucho hucho*) which is a predatory fish from the Salmonidae Family present in running mountain waters with a rocky bottom. The species is endemic for Danube's basin. Due to excessive fishing, this species is endangered in Romania and is protected by law and hunted only with special authorisation. Its economic value is very high.

Huchon is the largest salmonid from Romania's waters and can reach 1-2 m in length and 10-52 kg in weight. However, most samples do not exceed 2-3 kg. The species is a predatory avid fish, causing a large damage amongst fishes. Its body is elongated, cylindrical and covered with relatively large scales. The head is large, with a conic muzzle, a large mouth with strong teeth, disposed terminally. The dorsal flipper is located before the ventral flippers, while the anal flipper is much behind the dorsal one.

Table 1

AHP alternative ranking

Criteria		Animal species							
		Fallow-deer	Bear	Fox	Badger	Marten	Otter	Huchon	Carp
		1	2	3	4	5	6	7	8
1	Harvesting period	5	1	8	6	4	2	3	7
2	Harvested quantity by one worker in 8 hours	3	1	6	4	5	2	7	8
3	Harvesting cost	7	8	1	2	6	3	5	4
4	Knowledge for harvesting	4	1	5	2	7	3	8	6
5	Tools needed for harvesting	8	1	3	2	4	5	7	6
6	Complexity of harvesting process	4	1	3	2	5	6	8	7
7	Development of the process of harvesting	7	4	8	1	3	2	5	6
8	Knowledge for recognition	6	2	1	3	7	4	8	5
9	Distribution range	8	5	6	3	4	2	1	7
10	Biotic threats	8	1	2	3	7	4	6	5
11	Abiotic threats	7	1	2	3	4	6	8	5
12	Perishability	6	5	1	2	3	4	8	7
13	Market potential	8	1	3	2	4	6	5	7
14	Market demand	7	5	2	1	3	4	6	8
15	Celebrity" of the product on the market	8	6	4	1	3	2	5	7
16	The price of raw product	7	8	4	1	3	2	6	5
17	The price of the derived product	7	1	2	4	8	3	6	5
18	Portfolio of derived products	6	5	2	1	4	3	7	8
19	Transport from the harvesting point to the storage centre	7	8	6	4	5	3	1	2

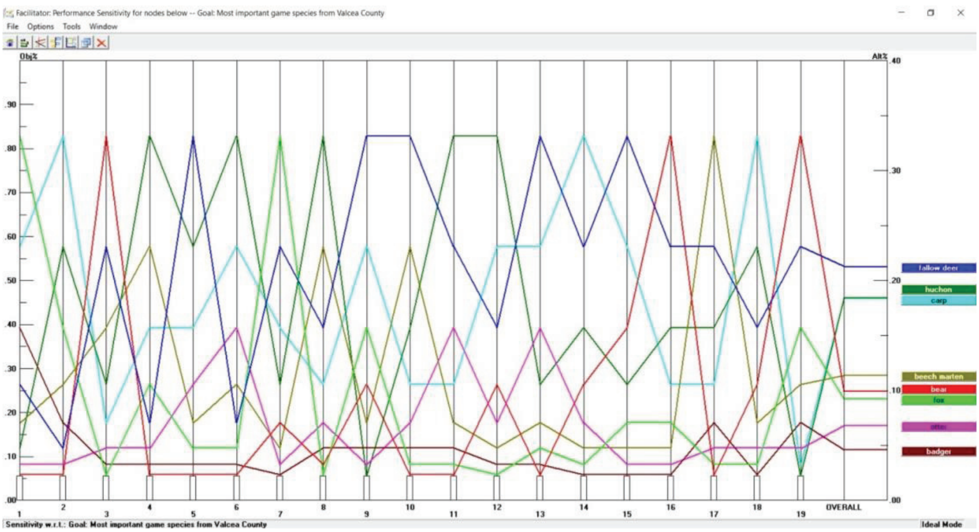

Fig. 2. The hierarchy process's results for Vâlcea County

These are completed by an adipose flipper. The body's colour is grey-brown on the back and slivery on the sides and abdomen. Huchon lays its spawns on stony bottoms, during March-April. In addition, it can also reproduce artificially. Until 2014, Vâlcea Forest District had the largest fishing complex from the country, Brădișor trout farm, the largest trout producer from the country with a capacity of 140 tons per year and the only national trout farm with a floating platform used for raising and reproducing trout as well as huchon. Closed down in 2016 due to floods and the death of tens of tons of trout, the huchon were transferred to Mureș Forest District. At the present, Brădișor complex functions in basins at the surface and has a profitable activity but does not have reproducing huchon and no longer produces progenies for the repopulation of national mountain rivers.

On the other hand, the least important game species resulted from the analytic hierarchy process are otter and badger. Otter is hunted only if it appears in fishing complexes as it causes significant damages. The badger has the largest hunting period but has scored low grades for all other criteria. As such, it is of interest for hunters only as a prevention method or for procuring badger lard, renowned for its universal use.

Table 2. Harvesting quota for mammals located in Vâlcea County during the 2020-2021 season(OMAP 1400/2020)

Species	Red deer	Fallow deer	Chamois	Roe buck	Wild boar	Hare	Fox	Jackal	Badger	European pine marten	Ferret	Weasel
Harvesting quota	113	3	118	568	1.920	684	1.301	420	83	21	22	5

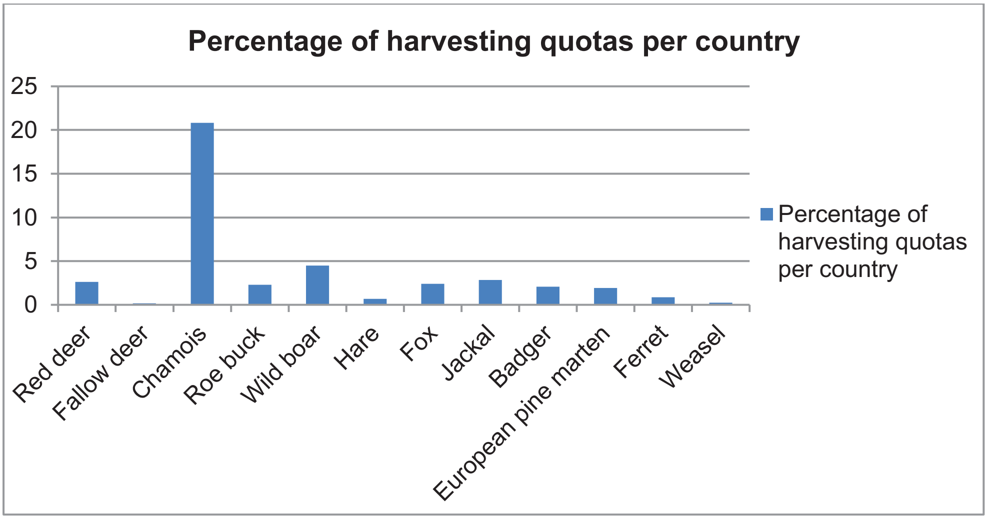

Fig. 3. Percentages for mammal harvesting quota during 2020-2021 for Vâlcea County, compared with national quotas

Table 3. Bird harvesting quota for Valcea County during the 2020-2021season(OMAP 1400/2020)

Species	Greylag goose	White fronted goose	Mallard	Eurasian Teal	Coot	Woodcock	Hooded crow	Rook	Magpie	Jaybird	Snipe
Harvesting quota	170	223	1.500	575	315	170	756	86	1.132	593	36

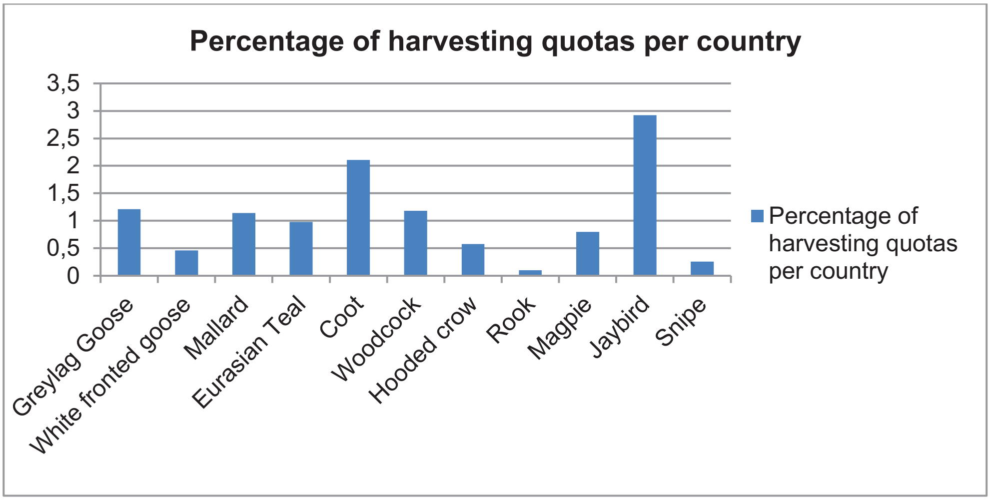

Fig. 4. Percentages for bird harvesting quota during 2020-2021 for VâlceaCounty, compared with national quotas.

CONCLUSIONS

Vâlcea County presents a high harvesting diversity, potential and distribution for species of game interest. This aspect is determined by the well representation of forest areas so that game species have the space and environment in which to develop. Their hunting and distribution represents an important income for game fund owners.

The game management must be based on solid scientific and organizational basis from which we mention the main ones:

- knowing the game species' biology under morph-anatomic, ecological and ecologic aspects;
- respecting the principles of game culture;
- protecting game by improving life conditions, strictly and numerically controlling pests and fighting against illegal hunting (poaching);
- the rational exploitation of game populations and the efficient capitalization of the resulted products.

By analysing 8 species through an analytical hierarchy process, the most important game species (that can be hunted on 47 game funds with a surface of 529.265 ha) are fallow deer and huchon. Even though the fallow deer does not have a long harvesting period, its portfolio of derived products and its distribution array are larger, having a high market demand and higher harvesting and transportation costs. Huchon is the largest salmonid from Romania's waters but is hardly encountered anymore. On the other hand, the least important game species are otter and badger. Otter is hunted only if it appears in fishing complexes as it causes significant damages. Badger has a longer hunting period but scored low grades for all the other criteria and is hunted only as prevention or for its lard, a good-to-everything product.

The results of this study represent an important contribution to the evaluation of the potential of NWFPs, with a focus on harvesting, marketing and other connected activities.

The combination between the analytical hierarchy process and Expert Choice Desktop proved to be an easy to use tool for solving a complex decision-making problem. In order to obtain more representative results, future research studies should take into account additional criteria and should involve specialists and entities from other domains.

REFERENCES

Aras H, Erdogmus S, Koc E. 2004. Multi-criteria selection for a wind observation station location using analytic hierarchy process. Renewable Energy 29: 1383-1392.

Blaga T., Pleșca I.M., Dincă L. 2019: Selecting the most promising non-wood forests products for Bacau County using the analytic hierarchy process. StudiișiCercetăriȘtiințifice-Biologie, 28(1): 29-33.

Cântar I.C., Enescu C.M., Dincă L. 2018. Application of the analytic hierarchy process in selection of the most important non-wood forest products for Dolj County. Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series, 48(2): 50-57.

Ciontu C.I., Dincă L., Enescu C.M., Oneț A., Oneț C. 2018. Analyzing the importance of game species from Argeș County. Natural Resources and Sustainable Development, 8(2): 138-147.

Ciontu C.I., Dincă L., Bratu I., 2018. Analizaunorspecii de interescinegetic din judetul Calarasi. Revista de Silvicultură și Cinegetică, 43, 91-95.

Ciontu C. I., Chisăliță I., Dincă L. 2020. Study concerning the evaluation of game and fish species from Caraș-Severin County.Annals of West University of Timişoara, ser. Biology, 23 (1): 21-28.

Cotta V, Bodea M, Micu I, 2001.Vânatu Ișì vânătoarea în România, Ed. Ceres, 17.

Crăciunescu A, Gărgărea P. 2014. Cinegetică-Salmonicultură – Îndrumar de lucrări practice.Ed. Ceres, 17-18.

Dincă L., Enescu C.M., Timiș-Gânsac V. 2018. Game species from Tulceacounty and their management. Scientific papers series Management, Economic Engineering in Agriculture and Rural Development, 18(3): 101-106.

Dincă L., Timiș-Gânsac V. 2020.The usage of non-wood forest products - Culinary and artisanal traditions in Romania. Sustainable Development Research; 2(1): 50-57.

Enescu R., Dincă L. 2020: An assessment of forest fruits from Arad County. Annals of the University of Craiova – Agriculture, Montanology, Cadastre Series, 49(2): 107-112.

Huang IB, Keisler J, Linkov I. 2011. Multi-criteria decision analysis in environmental sciences: Ten years of applications and trends. Science of the Total Environment, 409: 3578-3594.

Molnár, L. M., 2011.Vânătoare şi pescuit în epoca romană. Analele Universităţii Creştine „Dimitrie Cantemir”, Bucureşti, Seria Istorie –Serie nouă, Anul 2, Nr.1-2: 101-124.

Momir B., Petroman I. , Petroman C., Stefanovic M. , Gavruta A. , Firu A. , Marin D. 2015. Management of hunting and hunting fund (a case study).Lucrări Științifice Management Agricol, Vol. 17, No. 14: 44-50.

Park S, Choi C, Kim B, Kim J. 2013. Landslide susceptibility mapping using frequency ratio, analytic hierarchy process, logistic repression, and artificial neural network methods at the Inje area, Korea. Environmental Earth Sciences 68: 1443-1464.

Pleșca I. M., Blaga T., Dincă L., Breabăn I. G. 2019. Prioritizing the potential of non-wood forest products from Arad county by using the analytical hierarchy process. Present Environment and Sustainable Development, 13(2): 225-233.

San Cristóbal JR, 2011. Multi-criteria decision-making in the selection of a renewable energy project in Spain: The Vikor method. Renewable Energy 36: 498-502.

Timiș-Gânsac V., Dincă L., Enescu C.M., 2018. The most important animal species from Bihor County. Annals of the University of Oradea, Fascicle: Environmental Protection 30: 165-170.

Tudor C., Dincă L., Constandache C., 2020. Benefits brought by the abundance and importance of forest fruits from Bistrita-Nasaud County. BulletinUASVM Horticulture 77(1): 110-116.

Vechiu E., Dincă L., Enescu C.M., 2018. Which are the most important forest fruits in GorjCounty ?Revista de SilviculturășiCinegetică, 23(42): 89-93.

Wang G, Huang SH, Dismukes JP, 2004. Product-driven supply chain selection using integrated multi-criteria decision-making methodology. International Journal of Production Economics 91: 1-15.

*** OMAP 1400/2020. Ordinul ministrului apelor și pădurilor nr.1400/13.07.2019, privind aprobarea cotelor de recoltă pentru unele specii de faună de interes cinegetic, la care vânătoarea este permisă, pentru perioada de vânătoare 2020-14 mai 2021anexele 1-6.https://pe-harta.ro/timis

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CARLINA GENUS IN "ALEXANDRU BELDIE" HERBARIUM

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Keywords*: Carlina genus, herbarium, plants, botanists.*

ABSTRACT

Carlina Genus is well represented within Alexandru Beldie Herbarium from „Marin Drăcea" National Institute for Research and Development in Forestry. This genus stands apart through an important number, amounting to 44 vouchers, as well as through the information they contain. This information refers to the plant's harvesting locations, which cover the entire country and areas from Europe,and to renowned specialists who have contributed to the collection's development by harvesting or identifying Carlina plants. The article starts by describing the herbarium and continues with presenting the studied material. This section details the materials and methods used for elaborating the article and then orders and presents the most important plants. Furthermore, the paper renders graphically the plants' harvesting periods as well as a map that highlights the harvesting locations from Romania. The conclusions present some remarkable aspects regarding the Carlina species and samples present in the herbarium.

INTRODUCTION

„Marin Drăcea" National Institute for Research and Development in Forestry from Bucharest keeps in appropriate conditions a herbarium created in 1929 – "Alexandru Beldie" Herbarium. This collection is inscribed in Index Herbariorum, has the international BUCF code and contains approximately 40.000 vouchers (Vechiu et al. 2019; Dincă et al. 2018).

Significant contributions from important personalities from the systematic domains have led to the herbarium's collections and development. The herbarium is named after Alexandru Beldie, one of the most important Romanian botanists who have dedicated his work to studying the flora from Bucegi Mountains (Beldie 1967, Beldie 1972).

Besides the Carlina genus taken into account for this study, the herbarium contains numerous species such as: 42Asperula species (Plesca et al. 2020), 21Agrostis species (Cântar et al. 2019), 36Bromus species (Tudor et al. 2019), 6Vacciniumspecies (Scărlătescu et al. 2017) and130 Campanula species (Dincă et al. 2020).

The herbarium contains species harvested from different parts of our country such as Bucegi (Crisan et al. 2020), or the previous Vlașca County (Ciontu et al. 2019), as well as from abroad (Vasile et al. 2019).

MATERIAL AND METHODS

The present paper systematizes and presents the Carlina species present in the herbarium, amounting to a total number of 15 species and 44 samples, systematized in 44 vouchers.

Systematization was the main method used, with each plant belonging to this genus being organized based on a number of criteria such as: herbarium drawer number, drawer voucher number, botanic collection to which it belongs, species name, harvesting date, harvesting place, the specialist that has collected and/or determined it, as well as the plant's conservation degree. This last aspect was graded on a scale of 1 to 4, where 1 means a very good conservation state and 4 a poor conservation state.

Table 1

Carlina Genus inventory from Al. Beldie Herbarium, INCDS Bucharest (excerpt)

Drawer number	Voucher number	Herbarium/ Botanic Collection/ Institution	Specie's name	Harvesting date	Harvesting place	Collected/ Determined by:	Conserv ation degree (1..4)
78	29	Flora RomaniaeExsiccata A MuseoBotanicoUniv ersitatisClusiensis (in Timisoara)	Carlina acanthifo lia All.	1942.09.1 1.	distr. Severin, Caransebe ș 350-400 m	78	29
78	2	Bucharest's Polytechnic School, Botanic Laboratory	Carlina acaulis L.	1920.09.0 1.	Bucegi, Furnica	78	2
78	3	ICEF, The Institute of Forestry Research and Experimentation	Carlina acaulis L.	1934.09.0 2.	Rezervatia Bratocea	78	3
78	4	Al. Beldie Herbarium, Bucharest	Carlina acaulis L.	1945.08.1 6.	Bucegi, PiciorulBa belor	78	4
78	6	Stephen Sommier- Plantae in Etruria lectae	Carlina acaulis L.	1872.08.0 6.	?	78	6
78	7	Botanic Laboratory Herbarium/ Bucharest Polytechnic School	Carlina acaulis L.	1931.08.1 9.	judMuscel, Mt Mușuroael e	78	7
78	8	Botanic Laboratory Herbarium/ Bucharest Polytechnic School	Carlina acaulis L.	1939.09.0 4.	distr. Prahova, Bucegi, V. Cerbului 1900m	78	8
78	9	Bucharest's Polytechnic Herbarium, Silviculture Faculty, Botanic Laboratory	Carlina acaulis L.	1936.08.2 0.	Mt. Apuseni, j Alba, Almașul Mic de Munte	78	9
78	10	Bucharest's Polytechnic School, Botanic Laboratory	Carlina acaulis L.	1918.09.0 7.	Bucegi, Vf. Cu Dor	78	10
78	12	Forestry Research Institute's Herbarium / Agriculture and Silviculture Ministry	Carlina acaulis L.	1941.08.0 1.	Almașul Mic de Munte	78	12
78	15	Hortus Botanicus Instituti Agromonici T. Vladimirescu Flora OlteniaeExsiccatam	Carlina acaulis L.	1964.09.0 8.	Oltenia, distr. Gilort, Novaci 850 m alt	78	15

78	5	Bucharest's Polytechnic Herbarium, Silviculture Faculty, Botanic Laboratory	Carlina acaulis L. var alpina	1942.08.01.	Bucegi, Caraiman, V. Seacă	78	5
78	14	Bucharest's Polytechnic Herbarium, Silviculture Faculty, Botanic Laboratory	Carlina acaulis L. var typica Beck	1946.07.26.	Țibleș, PiciorulCuților	78	14
78	1	Flora Bosniaca	Carlina aggregata W.C.	1892.09.01.	Transnik 700-1700 m alt	78	1
78	25	Flora Sicula	Carlina gammifera Lef.	1890.09.01.	Caccamo :?	78	25

RESULTS AND DISCUSSIONS

Carlina is a genus that contains approximately 34 thistle species from the Asteraceae Family.

The species found in the Herbarium were the following: *Carlina acanthifolia, Carlina acaulis, Carlina aggregata, Carlina gammifera, Carlina intermedia, Carlina macrocephala, Carlina vulgaris, Carlina bibracteata, Carlina brevibracteata, Carlina corymbosa, Carlina cynara, Carlina fiumensis, Carlina longifolia, Carlina oligocephala, Carlina simplex*.

The most numerous Carlina species present in the Herbarium are: Carlina vulgaris (15 vouchers), *Carlina acaulis* L. (13 vouchers),*Carlina brevibracteata* (3 vouchers), *Carlina longifolia* (2 vouchers), *Carlina acanthifolia* (1 voucher) (Fig. 1).

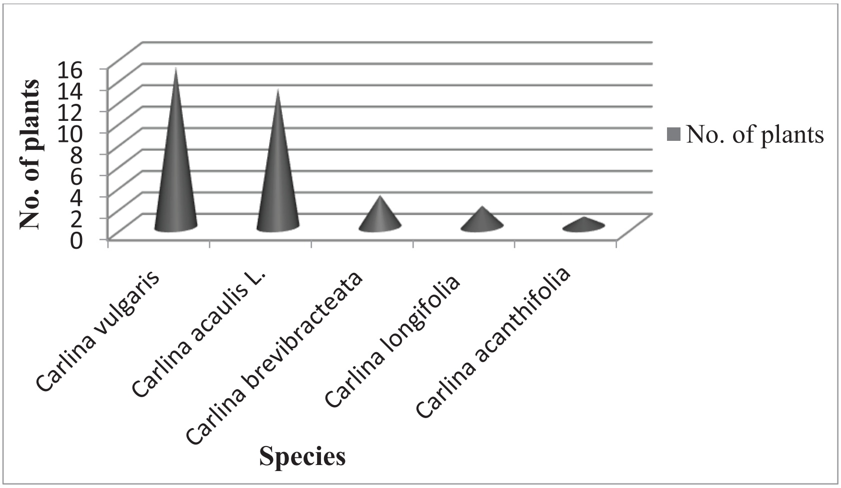

Figure 1. The most numerous Carlina species present in the Herbarium

Carlina is a genus of flowering plants in the Asteraceae family. It is distributed from Madeira and the Canary Islands in Europe and North Africa to Siberia and north-western China.

The name of the Carlina Genus honours the emperor St. Roman Charles V (1500–1558). Plants of the genus are commonly known as carline thistles.

Carlina species are very similar in morphology to the true thistles (Cirsium genus) and are part of the thistle tribe Cynareae. Most are biennial herbs, but the genus includes annuals, perennials, shrubs and dwarf trees. The largest reach about 80 centimetres in height. The stems are vertical and branched or unbranched. The whole plant is thorny. The leaves have serrated or lobed blades with thorny edges and sometimes woolly hairs. The heads of the flowers are solitary or carried in inflorescences. The head is hemispherical to the bell and lined with several layers of spinous spinning. The outer rows can be very long and leaf-like. The species has tubular or funnel-shaped disc flowers in yellow or red shades. The fruit is a hairy cypress, with a skin-like puppet, made up of tufts of hairs (wikipedia.org).

Carlina species have been used as herbal remedies in European systems of traditional medicine. *C. acaulis* root is known as Carlinae radix and is still used medicinally as a diuretic and as a treatment for conditions such as skin lesions and rashes, mumps and toothache. Most commercial preparations of Carlinae radix are not C. acaulis, but are actually adulterated with *C. acanthifolia* (fig.2), a related species. The essential oil of both species is composed mainly of carline oxide, a derivative of acetylene. The compound has antimicrobial activity.

Fig. 2.*Carlina acanthifolia*

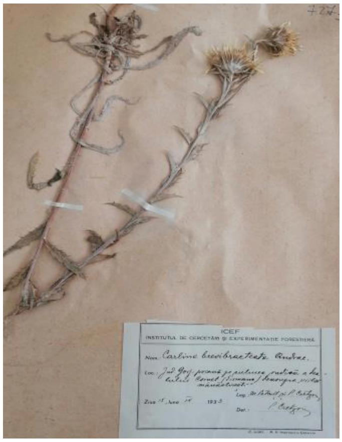

Fig. 3.*Carlina brevibracteata*

Carlina vulgaris (fig.5) is a biennal plant that grows to 0.5 m and is resistant to its local area (UK). It is in bloom from July to October. The species is hermaphroditic (has both male and female organs) and is pollinated by bees, and Lepidoptera (moths and butterflies). The plant is self-fertile and suitable for light (sandy), medium (clayey) and heavy (clayey) soils. It prefers well-drained soils and can also grow on nutritionally poor soils. The suitable pH is acidic, neutral and basic (alkaline) soils and can grow in very alkaline soils. However, it can't grow in the shade and it prefers dry or moist soils.

Fig. 4.*Carlina macrocephala* Fig. 5.*Carlina vulgaris*

As can be seen in fig. 6, the number of plants collected increased over time until 1890-1934, which became the peak of their harvest. The oldest plant belonging to this genus is represented by a *Carlina corymbosa* L. collected in 1855 by the botanist Elise Braig. In addition, the herbarium hosts a sample of species that belongs to the Red list of higher plants from Romanian (*Carlina acanthifolia* All.) (Oltean et al. 1994), Collected in 1942 from Caransebeș – Caraș Severin County, by N. Boșcaiu, fig. 2.

Figure number 5 presents the distribution of Carlines species on the Romanian territory and emphasizes its presence in all the Romanian Carpathians.

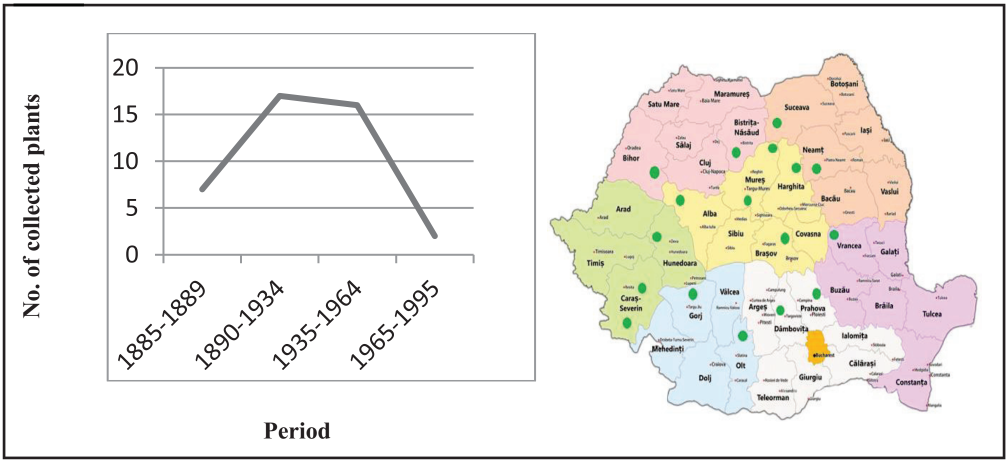

Fig. 6. Time (left) and place (right) of Carlina collections

The Romanian specialists who enriched the “Alexandru Beldie” herbarium with species from the Carlina genus are: Al. Beldie, A. Haralamb, C.C. Georgescu, G. P. Grintescu, D. Cîrțu,M. Leoveanu, S P. Cretzoiu, I. Morariu, S. Pașcovschi, M. Onică, T. Bunea, N. Boșcaiu, and M. Petcuț.

Among the foreign botanists we mention: D. Wolff, Bogsch, E. Brandis, E. Reverchon, Elis Busch, N. Busch, Elise Braig, M. Haret, N. Guzzino, andSteinitz.

CONCLUSIONS

Carlina genus occupies an important place in Al. Beldie Herbarium from INCDS Bucharest through a total number of 15 species present in 44 vouchers. The best represented species of this genus present in the herbarium belong to Carlina vulgaris and Carlinaacaulis L. and can be found in 15 and 13 vouchers.

Within the herbarium, the genus is also represented by a rare species present in the Book of Superior Romanian Plants (rare, endangered or endemic species), namely Carlinaacanthifolia All., harvested in 1942 from the Caransebeș area, CarașSeverin county, by the botanist N. Boșcaiu.

In addition, the Carlina species present in the herbarium have an important historical value, the oldest specimen dating back to 1855 (a sample of *Carlina corymbosa* L. collected by Elise Braig).

The Carlina species from the herbarium were collected from all Romanian regions, covering both the mountainous areas (Bucegi, Apuseni, Mureș), as well as the hill and plain areas (Gorj, Olt, Caraș-Severin). The samples were also collected from Europe, namely from the Pyrenees mountains, Hungary or Czechoslovakia. Regarding the harvesting period, the Carlina collection was created over a period of 150 years, starting with *Carlina corymbosa* L. (harvested in 1855) and ending with Carlina vulgaris (harvested in 1992). The maximum development period of the collection was recorded between 1890 and 1934, when 17 samples were added.

Even if the period coincides with the two world wars, this fact did not stop our predecessors from their task of leaving us an exceptional heritage: the Alexandru Beldie Herbarium.

REFERENCES

Beldie A. 1967. Flora și vegetația Munților Bucegi. Ed. Academiei R.S.R., București, 578 p., Romania.

Beldie A. 1972. Plantele din MunțiiBucegi. Determinator. Ed. Academiei R.S.R., București. 409 p., Romania.

Cântar I.C., Dincă L. 2019. Agrostis species present in the "Alexandru Beldie" Herbarium from "Marin Dracea" National Institute for Research and Development in Forestry. Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series, 48(2): 44-49, România.

Ciontu C.I, Dincă L. 2019. Plants from former Vlașca County that are present in "Alexandru Beldie" herbariun. Research Journal of Agricultural Science, 51 (4): 254-261.

Crisan V., Dincă L., Deca S. 2020. Plants from Jepi Mountains, Bucegi, present in "Alexandru Beldie" Herbarium. Current Trends in Natural Sciences, 9(17): 160-167, România.

Dincă L, Dincă M., Pantea S.D., Timiș-Gânsac V., Oneț C. 2018. Amaranthus plant - between myth and usage. Natural Resources and Soustainable Development, 8(1): 9-16, România.

Dincă L., Peticilă A. 2019. How many alder species (Alnus sp.) exist? A statistic based on herbarium vouchers. Scientific papers, Series B, Horticulture, 63(1): 613-619, România.

Dincă L., Vechiu E. 2020. A statistic of Campanula species based on vouchers from different herbarium. Annals of West University of Timişoara, ser. Biology, 23 (1): 29-38, România.

Oltean M., Negrean G., Popescu A., Roman N., Dihoru G., Sanda V., Mihăilescu S. 1994. Listaroşie a plantelor din România, Institutul de Biologie, Bucureşti

Plesca I. M., Blaga T., Dincă L. 2020. Asperula L. species preserved in ‘Alexandru Beldie’ Herbarium. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca.Horticulture 77(1): 92-97, România.

Scărlătescu V., Vasile D., Dincă L. 2017. The importance of *Vaccinium* species collection. Research Journal of Agricultural Science, 50 (1): 194-201, România.

Tudor C., Dincă L. 2019. What can we learn about Bromus genus preserved in "Alexandru Beldie" herbarium? Research Journal of Agricultural Science, 51 (4): 218-225, România.

Vasile D., Dincă L. 2019. Specii de plante din Republica Moldova păstrate în colecția ierbarului ”Alexandru Beldie”. Buletin Ştiinţific Revista de Etnografie, Ştiinţele Naturii şi Muzeologie (Serie Nouă), 43(30): 6 -16, România.

Vechiu E., Dincă L. 2019. Characterization of Cornus plant present in "Al. Beldie" herbarium. Research Journal of Agricultural Science, 51 (3): 169-175, România.

*** https://wikipedia.org/wiki/Carlina

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STUDIES REGARDING THE ABUNDANCE OF SOME FISH SPECIES OF COMUNITY IMPORTANCE FROM THE NORDUL GORJULUI DE VEST SITE

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Keywords: *Gobio uranoscopus, Barbus meridionalis, Cottus gobio, abundance*

ABSTRACT

The studies were carried out during spring-late summer (May-August) and autumn (September-October). Following our studies regarding the fish species of community importance we have determined the abundance of the collected species. In the North West Gorj site, the abundance of protected fish species differs from one stream to another but it is clear that Barbus meridionalis was the most abundant species, compared to the other species studied.

INTRODUCTION

Over the last century, riverine ecosystems have suffered from intense human intervention resulting in habitat loss and degradation and as a consequence, many fish species have become highly endangered, particular in rivers where heavy demand is placed on freshwaters. The main causes are habitat destruction and defragmentation (Fu et al. 2003), water abstraction, industries and private use (Szollosi-Nagy 2004; Gibbs 2000; Dawson and others 2003) exotic species introduction (Copp et al. 2005), pollution (Lima-Junior et al. 2006) and global climate change impacts (Leveque et al. 2005; Mas-Marti et al. 2010).

Freshwater fish are one of the most threatened taxonomic groups (Darwall & Vie 2005) because of their high sensitivity to the quantitative and qualitative alteration of aquatic habits (Kang et al. 2009. As a consequence, they are often used as bioindicator for the assessment of water quality, river network connectivity or flow regime (Chovance et al. 2003). Conservation measures to mitigate the impact of the pressures have largely been slow and inadequate and as a result many of the species are declining rapidly.

MATERIAL AND METHODS

The sampling of ichthyofauna from the protected area under study was carried out in compliance with the legislation in force at those times and with Ordinance 1133/2005 regarding the obtaining of the fishing authorization for scientific purposes, and the quantities of products obtained from scientific fishing have not been marketed.

The equipments that were used to fulfill the proposed objective were: jeweler, camera, portable magnifying glass, determination key. The equipment has of course been disinfected both before and after use to prevent the spread of diseases and parasites. The biological material extracted for the investigation was released after the completion of the investigation phases. The sampling period in rheophilic and limnic resorts was late spring-late summer (May-August) and autumn (September-October).

The sampling by which the ichthyofauna study was carried out where there were shallow water areas was done using fishing nets, used mainly by placing them at both ends of the segments chosen for sampling (the ends of a 75-meter segment were blocked), in 5 representative stations within the perimeter of the area. All fish caught were kept in buckets of water. To minimize the stress caused to them, the period in which they were captive was as short as possible and the count was performed after each segment and the fish were released immediately after, in the area where they were caught. The fish were manipulated to avoid losses and injuries.

RESULTS AND DISCUSSIONS

The studies were carried out during 2015, spring-late summer (May-August) and autumn (September-October).

Fish abundance is a measure of the number or amount of a fish in a given area.

Gobio uranoscopus

Class Actinopterygii, order Cypriniformes, family Cyprinidae, genus Gobio

It has an elongated, thick, cylindrical body, uncompressed laterally, with a thickness slightly less than the height. The dorsal profile is slightly convex and the ventral one is horizontal. The snout is sharp, the eyes look upwards. The mustaches are long, and at the junction of the lips there is a rather strong extension that resembles a second pair of mustaches.

It reaches a length of 7-8 cm (rarely around 12.3 cm). Reproduction takes place in May-June, the eggs being deposited on rocks, in shallower areas, but with a current speed of 1 m / s. Although several individuals are found in certain rapids, they never form true flocks. The food consists of bioderm and small rheophilic invertebrates.

Gobio uranoscopus is a species with a relatively low prevalence in Romania. On the territory of the Nordul Gorjului de Vest Site, the species was identified along the rivers: Șușita Verde, Șușita Seaca, Bistrița, Bistricioara, Tismana, Jales, as well as in Lake Vaja-Clocotis.

Barbus meridionalis

Class Actinopterygii, order Cypriniformes, family Cyprinidae

Its body is elongated and dense, with small scales, lacking the last serrated radius of the dorsal fin. The back is gray-brown, the sides and belly silver. It is dotted with black spots and lives exclusively in the rivers and streams of the mountain region and the upper part of the hilly region. It does not weigh more than 300-400g but can reach up to 1.5 kg.

It lives in stony, fast and cold rivers, as well as in some muddy streams. It shows preference especially for the portions with strong current and stony bottom, especially in the downstream area of its area.

The food consists mainly of larvae of aquatic insects, worms, small crustaceans and plant debris.

Cottus gobio

Class Actinopterygii, order Scorpaeniformes, family Cottidae, genus Cottus.

It has an elongated and thick body, a slightly convex profile between the tip of the snout and the eyes, then almost horizontal. The eyes in the front half of the head, bulging, look up. The upper half of the eye is often covered with a pigmented eyelid, easily confused with the skin. The dorsal part of the body is brownish-brown, with marbled spots sometimes beating reddish. It is rarely dark gray. The ventral face is light yellow or white. In the posterior half of the body there are 3-4 dark transverse stripes, sometimes almost black. The food consists of insect larvae, amphipods, eggs and chickens, occasionally frog eggs.

It lives exclusively in cold, mountain fresh water, generally in rivers and streams, rarely in mountain lakes. It sits under rocks in places with slightly deeper and relatively slower water, often towards the shore or in the side arms. It is not very mobile, but if it is disturbed it moves a short distance. It is strictly sedentary and does not migrate.

Table nr.1

Abundance of the fish species of community importance from the Nordul Gorjului de Vest Site during 2015

Spring	***Barbus meridionalis* %**	***Gobio uranoscopus* %**	***Cottus gobio* %**
Porcu	55.5	38.2	6.3
Susita Verde	57.2	39.5	3.3
Susita Seaca	59.8	38.7	1.5
Harabor	61.2	37.6	1.2
Sambotin	75.8	23.7	0.5
Cartiu	80.5	19.2	0.3
Tismana	55.9	37.7	6.4
Jales	57.6	35.2	7.2
Bistrita	54.6	36.5	8,9
Plescioara	58.7	37.9	3,4
Motru Sec	48.5	46.8	4,7
Paraul Racilor	48.7	45.6	5,7

From the analysis of the data on the abundance of the fish species of community importance it come out that the highest values has been recorded for the Barbus meridionalis species, with a maximum of 80.5 in the Cartiu spring, followed by *Gobio uranoscopus* 46.8 in the Motru sec spring, the highest value for the Cottus gobio species has been 8,9.

CONCLUSIONS

In the North West Gorj site, the abundance of protected fish species differs from one stream to another but it is clear that Barbus meridionalis was the most abundant species, compared to the other species studied.

The low values recorded for the Cottus gobio species, can be explained by the fact that this species is not very mobile, but if it is disturbed it moves a short distance. It is strictly sedentary and does not migrate.

From the point of view of the spring biodiversity, we can conclude that: Susita verde, Susita seaca, Sambotin, Cartiu and Porcu provides ecological conditions for these fish species as well food and shelter.

REFERENCES

Copp GH., Bianci Bogutskaya NG., Eros T., Falka I., Ferreira MT., Fox MG., Freyhof J., Gozlan RE., Grabowska J., Kovac V., Moreno-Amich R., Naseka AM., Wiesner C. 2005. To be, or not to be, a non-native freshwater fish? Appl Ichthyol 21: 242–262.

Chovance A., Hoffer R., Schiemer F. 2003. Fish as bioindicators. In: Market BA, Breure AM, Zechmeiser HG (eds) Bioindicatos and biomonitors: 639–675.

Darwall WRT., Vie JC. 2005. Identifying important sites for conservation of freshwater biodiversity: extending the species-based approach. Fish Manag Ecol 12: 287–293.

Dawson TP., Berry PM., Kampa E. 2003. Climate change impacts on freshwater wetland habitat. J Nat Conserv 11: 25–30.

Fu C., Wu J., Chen J., Wu Q., Lei G., 2003. Fresh water fish biodiversity in the Yangtze River basin of China: patterns, threats and conservation. Biodivers Conserv 12: 1649–1685.

Gibbs JP., 2000, Wetland loss and biodiversity conservation. Conserv Biol 14(1): 314–317.

Kang B., He D., Perrett L., Wang H., Hu W., Deng W., Wu Y., 2009. Fish and fisheries in the Upper Mekong: current assessment of the fish community, threats and conservation. Rev Fish Biol Fish 19: 465–480.

Leveque C., Balian EV., Martens K., 2005. An assessment of animal species diversity in continental waters. Hydrobiologia 542: 32–67.

Lima-Junior SE., Cardone IB., Goitein R. 2006. Fish assemblage structure and aquatic pollution in a Brazilian stream: some limitations of diversity indices and models for environmental impact studies. Ecol Freshw Fish 15(3): 284–290.

Mas-Marti E., Garcia-Berthou E., Sabater S., Tomanova S., Monoz I., 2010. Comparing fish assemblages and trophic ecology of permanent and intermittent researches in a Mediterranean stream. Hydrobiologia. doi:10.1007/s10750-010-0292-x.

Szollosi-Nagy. 2004. In: Proceedings of the United Nations seminar, 25–26 November 2004, Delft, Netherlands.

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THE DIFFERENCES BETWEEN HALOPHYTE SPECIES GROWN IN DIFFERENT SOILS USING IMAGING SOFTWARE TOOLS

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Keywords*: climate changes, WinFolia, salinity, leaf area*

ABSTRACT

Today, the entire world is facing with the response of the nature to anthropic factors, also called climate change. Thereby, the impact of climate change is manifested globally, in all areas and sectors, including agriculture. This, as the main food supplier, is strictly dependent on the quality of the soil resources, which is in a continuous depreciation. The aim of this paper is to present some data related to Amaranthus sp., Limonium sp., Portulaca sp., and Festuca sp. grown in greenhouse conditions, on different types of soil, with pH and conductivity known in order to establish plant adaptability for soil remediation, using image analysis.

INTRODUCTION

Plants have adapted different physiological and morphological characteristics in response to environmental stress factors. Stomatal limitation and photosynthesis are the primary responses of plants under stress conditions (Cakalogullari & Tatar, 2020). Several parameters at the morpho-anatomical level as leaf area, size and shape, leaf thickness, stomatal size and density and at the physiological level (photosynthetic rates and intrinsic water-use efficiency) can be used as representative indices to evaluate plant adaptation to different climate and resources. (Nakanwagi et al. 2018, Kurt & Odabas 2020).

Halophytes are salt-tolerant plants able to grow and develop under abiotic stressors like high salinity, high UV radiation, and drought due to different physiological and biochemical adaptations. Other than physiological variation, halophytes likewise adjust some anatomical changes to adapt up to soil salinity. These plant adaptations include the epidermal thickness and spongy tissue of the leaves.

The ability of halophytic species to remove salt from saline land makes it a promising soil remediation tool (Komaresofla et al. 2019, Rodrigues et al. 2020). Leaves are very important parts of the plants; they represent the largest proportion of the total canopy surface in most of them. In the leaves are found important physiological processes like photosynthesis and transpiration, gas exchange and hosting various metabolic processes, being very important for cultural practices (Nakanwagi et al. 2018, Kurt & Odabas 2020).

Leaves can also have the role to regulate weed abundance through a crop–weed competition tendency, efficiency of water use by plant, drought tolerance, and soil erosion control by regulating rainfall drop impact, which influence crop growth and yield. Leaf area determines the light interception capacity and besides light use efficiency are useful parameters for characterizing the plant productivity and efficiency of cropping system (Li et al. 2013).

The relationship between leaf area and plant growth in terms of mass it is influenced by the quantity of carbon partitioned among new leaf area, leaf mass, root mass, reproduction, and respiration. Leaf area also it is correlated with leaf chemical composition, photosynthetic rate, leaf longevity, and carbon investment (Nakanwagi et al. 2018).

The estimation of leaf area, perimeter, form coefficient, aspect ratio can be useful leaf parameters with many advantages in agricultural experiments (Shi et al. 2019, Schrader et al. 2017).

The objective of the research was to observe which of the facultative or obligate halophyte plant species can grow on different saline cultivation substrates, in order to improve their physical properties.

MATERIAL AND METHODS

The seeds were sowed in January in pots, and after five months leaves of the plant species were analysed. *Amaranthus cruentus*, *Limonium sinuatum*, *Portulaca sativa* and *Festuca arundinacea* were sowed in following soils: soil from Dâmbovița County (S1), soil from Ialomița County (S3), and soil from Lacul Sarat (S2), Brăila County. The plants cultivated in peat and perlite are the control ones.

For morphological analysis of leaves, WinFOLIA equipment was used. WinFOLIA is a computer image analysis system that accurately do morphological measurements on broad leaves. It comprises hardware for image acquisition (scanner or digital camera and accessories) and a computer program, WinFolia, specifically designed for leaf area, morphology and disease analysis. Different configurations are offered in function of measurements, speed, accuracy and portability. The software was used for the analysis of apricot (Florea et al. 2019), and fig biotypes leaves (Ahmad et al. 2017; Stănică 2017).

Differences in morphological and anatomical leaf traits were analysed per species by one-way analysis of variance (ANOVA) at $p \leq 0.05$; 0.01 and 0.001. Results are presented as means ± standard error.

RESULTS AND DISCUSSIONS

According to the analyses carried out, it was found that on the soil S1 *P. sativa* developed better than on the soil S3. As for the *F. arundinacea* species, both the roots and the leaves were larger on soil S3 than on soil S1. In the same way as *F. arundinacea*, the *A.cruentus* species was highlighted, on S3 both the roots and the aerial part were more developed. There were no significant differences in the case of *L. sinuatum*. The results were related to those obtained from scanning the of plants grown on peat and perlite substrate.

Table 1

Morphological and anatomical leaf characteristics of *P sativa*, *A cruentus*, and *L sinuatum* cultivated on three different soil type

Plant	Leaf Area	Perimeter	Vert Length	Horiz Width	Avg Horiz Width	Aspect Ratio (W/L)	Form Coeff.
***P.sativa* peat (control)**	3.85±0.07	7.95±0.19	3.23±0.04	1.85±0.06	1.19±0.01	0.57±0.01	0.77±0.02
***P.sativa* S1**	1.76± 0.01 ***	5.82±0.01 **	2.37±0.04 **	1.07±0.01 **	0.74±0.01 ***	0.45±0.01 **	0.65±0.00 ns
***P.sativa* S3**	1.99±0.27 ***	6.63±0.59 *	2.59±0.17 **	1.22±0.06 ***	0.77±0.06 ***	0.47±0.02 **	0.57±0.02 ns
***A.cruentus* peat (control)**	29.65±0.60	26.75±0.29	9.50±0.75	5.13±0.06	3.13±0.35	0.54±0.06	0.52±0.00
***A.cruentus* S1**	11.10±0.05 ***	19.21±1.23 *	8.11±0.65 ns	2.85±0.17 ***	1.37±0.09 **	0.35±0.03 *	0.38±0.04 *
***A.cruentus* S3**	16.66±0.24 ***	22.33±1.89 ns	9.19±0.83 ns	3.74±0.01 **	1.81±0.12 **	0.41±0.05 *	0.42±0.06 *
***L. sinuatum* peat (control)**	20.83±3.13	34.33±3.02	13.68±1.23	3.57±0.19	1.52±0.10	0.26±0.01	0.22±0.00
***L. sinuatum* S1**	10.30±3.34 ns	25.89±1.44 ns	8.81±1.17 ns	2.57±0.34 *	1.17±0.20 ns	0.29±0.06 ns	0.19±0.03 **
***L. sinuatum* S3**	11.23±0.71 ns	29.74±0.08 ns	10.87±0.35 ns	2.79±0.19 *	1.04±0.09 ns	0.26±0.02 ns	0.16±0.01 **

Mean values ± standard error are shown; Different asterisks indicate significant differences among soil type within each species (* = Significant difference from all ($p < 0.05$); ** = Significant difference from all ($p < 0.01$); *** = Significant difference from all ($p < 0.001$); ns=not statistically significant

Portulaca sativa cultivated on S1 and S3 soil had significant differences to control, regarding leaf area, perimeter, vert length, horiz width, avg horiz width, aspect ratio(W/L). Leaf area values of the plants cultivated on S3 are higher than those cultivated on S1. Regarding form coefficient was not found any statistically differences between plants grown on S1 and S3 and peat (Table1).

Amarantus cruentus cultivated on S3 had no significant differences reagarding perimeter and vert length. *A. cruentus* cultivated on S3 and S1 had significant differences to control, between morphological and anatomical leaf characteristics. Like *P. sativa*, *A. cruentus* cultivated on S3 had higher values then *A. cruentus* cultivated on S1.

Limonium sinuatum cultivated on S1 and S3 had significant differences in mean only for horiz width and form coefficient, than control. According to Acosta-Motos, 2017, halophytes have a series of adaptations to salinity including different changes. These changes are referring to root/canopy ratio, chlorophyll content, leaf anatomy, and others. In the rest parameters anayzed there were not any statisticaly differences between soil types.

Regarding aspect Ratio(W/L) we found significant differences between *L. sinuatum* grown on S3 and S1.

With regard to plant growth and development on S2 substrate, do not fully express their genetic potential, and yield under salt stress. WinFolia images are presented in images A (*Festuca* sp.), B (*Amaranthus* sp.), C (*Portulaca* sp.) and D (*Limonium* sp.)

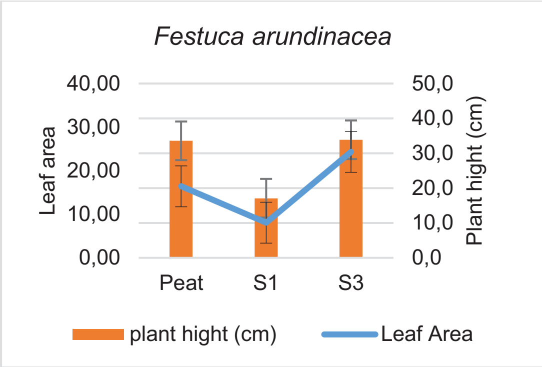


Figure 1. Inflence of soil type on leaf area and plant hight of *Festuca arundinacea*

A. WinFolia measurements for *Festuca arundinacea*

Very high positive correlation r=0.881 it was found between leaf area and plant hight regarding *Festuca arundinacea* grown on peat, S1 and S3. It can be also noted that there is no statistical difference between results found on peat and S3 (Figure 1).

The same trend in plant hight and leaf area like *F.arundinacea* it is found in *Amaranthus cruentus*. It was found a very high positive correlation r=0.837 between leaf area and plant hight, and also between peat and S3 were no statistically differences (Figure 2).

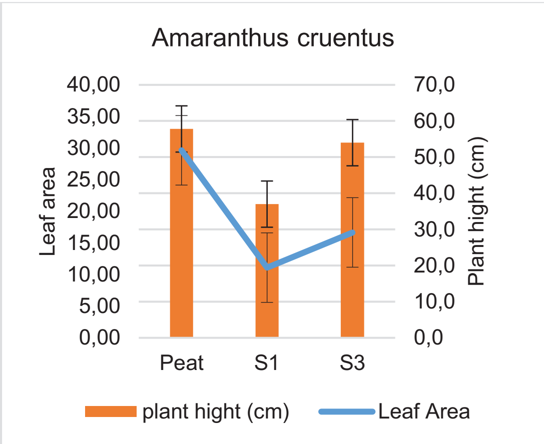
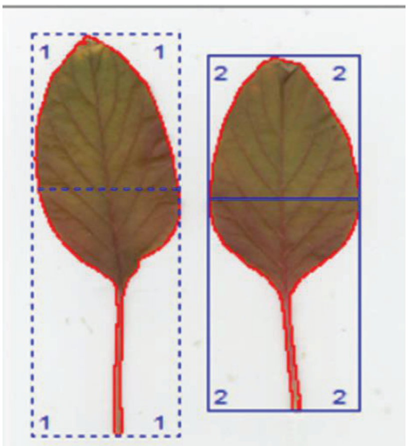
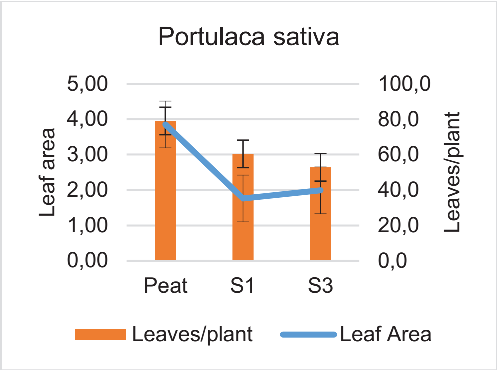


Figure 2. Inflence of soil type on leaf area and plant hight of *Amaranthus cruentus*



B. WinFolia measurements for *Amaranthus cruentus*



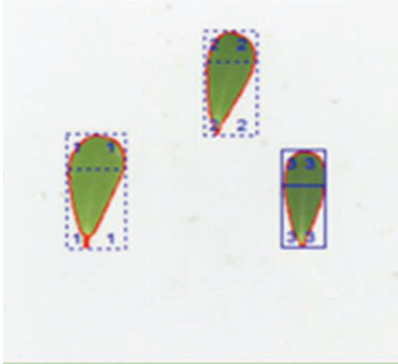
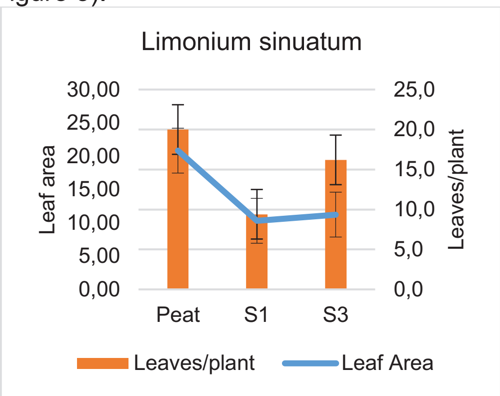


Figure 3. Inflence of soil type on leaf area and number of leaves of *Portulaca sativa*

C. WinFolia measurements for *Portulaca sativa*

Very high positive correlation r=0.926 it was found between between leaf area and number of leaves/plant regarding *Portulaca sativa* grown on peat, S1 and S3. On S1 soil *P. sativa* plants had a better grow and developement than on S3 soil (Figure 3).



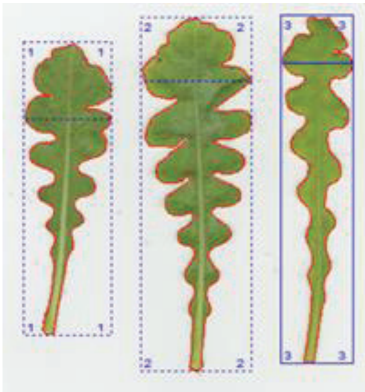


Figure 4. Inflence of soil type on leaf area and number of leaves of *Limonium sinuatum*

D. WinFolia measurements for *Limonium sinuatum*

Very high positive correlation r=0.822 it was found between leaf area and number of leaves/plant regarding *Limonium sinuatum* grown on peat, S1 and S3. It can be noted that leaf area and number of leaves/plant in *L. sinuatum* folow the same trend like *F.arundinacea* and *A. cruentus* for plant hight and leaf area (Figure 4).

CONCLUSIONS

The substrate influenced the growth and development of the halophytes. Between species, *Limonium sp*. and *Portulaca sp*. showed good adaptability on salinity. None of the plant species developed on soil S2, this being with the highest salinity. *Portulaca sativa* had a better grown on S1 soil then *L. sinuatum*, *A. cruentues* and *F.arundinacea*.

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REFERENCES

Acosta-Motos J., R., Ortuño M. F., Bernal-Vicente A., Diaz-Vivancos P., Sanchez-Blanco M. J., Hernandez J. A., 2017. Review Plant Responses to Salt Stress: Adaptive Mechanisms, Agronomy. 7, 18.

Ahmad H., Stănică F., Al Masoody M. M., Butcaru A. C. 2017. Preliminary Characterization of some Fig Biotypes in Romania, Bulletin UASVM Horticulture, 74: 117-122.

Cakalogullari U., Tatar M.O. 2020. Adaptation of cotton (Gossypium hirsutum L.) to limited water conditions: reversible change in canopy temperature. AgroLife Scientific Journal, 9: 64-72.

Florea I. M., Stănică F., Butcaru A. C., Mihai C. A., Mardare E. 2019. Incidence of bacterial disease on some apricot varieties cultivated in Bucharest area, Scientific Papers. Series B, Horticulture., LXIII: 35 – 46.

Kurt D., Odabas M. S. 2020. Modeling of the effects of nitrogen doses on agronomic characteristics and leaf area of Hypericum pruinatum L., Int J Agric Life Sci, 6: 288-292.

Komaresofla B. R., Alikhani H., A., Etesami E., Khoshkholgh-Sima N., A., 2019. Improved growth and salinity tolerance of the halophyte Salicornia sp. by co–inoculation with endophytic and rhizosphere bacteria, Applied Soil Ecology, 138: 160-170.

Li L., Zhang L., Zhang F. 2013. Crop mixtures and the mechanisms of overyielding, Encyclopedia of Biodiversity (Second Edition), Academic Press, pp. 382-395.

Nakanwagi M. J., Sseremba G., Kabod N., P., Masanza M., Balyejusa Kizito E. 2018. Accuracy of using leaf blade length and leaf blade width measurements to calculate the leaf area of Solanum aethiopicum shum group, Heliyon, 4, e01093.

Rodrigues M. J., Monteiro I., Castañeda-Loaiza V., Placines C., Conceição Oliveira M., Reis C., et al. 2020. Growth performance, in vitro antioxidant properties and chemical composition of the halophyte Limonium algarvense Erben are strongly influenced by the irrigation salinity, Industrial Crops and Products, 143, 111930.

Schrader J., Pillar G., Kreft H. 2017. Leaf-IT: An Android application for measuring leaf area., Ecol Evol, 7: 9731–9738.

Shi P., Mengdi L., Xiaojing Y., Gielis J., Ratkowsky D.A. 2019. Proportional relationship between leaf area and theproduct of leaf length and width of four types of special leaf shapes, Forests,10, 178;

Stănică F. 2017. Preliminary results on Romanian fig population assessment, Acta Horticulturae, 1173, 17 – 22.

Weraduwage S. M., Chen J., Anozie F. C., Morales A., Weise S. E. Sharkey T. D. 2015. The relationship between leaf area growth and biomass accumulation in Arabidopsis thaliana. Front. Plant Sci. 6: 167.

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RESEARCH ON CONTROL OF WEEDS IN PEANUTS GROWN ON IRRIGATED SANDY SOILS

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Keywords: *peanuts, herbicid, weeds.*

ABSTRACT

On psamosoils in southern Oltenia use of fertilizers and irrigation water provides favorable conditions for crop growth and development but equally for weeds.

Due to the high degree of weeding of sandy soils chemical weed control is a technological measure that leads to increased production.

In order to establish a broad-spectrum strategy to control monocotyledonous and dicotyledonous weeds 5 herbicides in different doses and combinations were studied.

In the control of monocotyledonous weeds the best results were obtained by using the combination of Stomp Aqua 4l / ha + Fusilade Forte 150EC 1.5 l / ha + Corum + Dash HC adjuvant 1.25 l / ha.

The best option to control annual dicotyledonous weeds was achieved when the combination of herbicides Dual Gold 960EC 1.5l / ha + Fusilade Forte 150EC 1.5l / ha + Corum + Dash HC adjuvant 1.25l / ha was applied.

INTRODUCTION

One of the keys to success in peanut production is the effective control of weeds at the beginning of the growing season. Research conducted at the University of Georgia Tifton Campus has shown the importance of weed control in the early stages (Johnson & Davis 2015; Johnson et al. 2012a. 2012b). Successful weed control should begin when peanuts are in the cotyledon stage through work called “blind weeding” and then repeated at weekly intervals for six to eight weeks (Wann et al. 2011). On psamosoils in southern Oltenia use of fertilizers and irrigation water provides favorable conditions for crop growth and development but equally for weeds. The chemical control of weeds creates favorable premises for the complete mechanization of agricultural crops while facilitating the increase of the efficiency of some agrophytotechnical measures and the cultivation parameters for them (Şarpe et al. 1981).

Peanut cultivation is very sensitive to weeding it must be kept clean for the first 4 to 6 weeks to obtain maximum yields. Therefore, weed control is a very important link in peanut growing technology.

Weed species that invade crops can be destroyed by both manual and mechanical plows and chemically by using herbicides.

Research conducted by Șarpe et al.1987, Milica Dima 2006 highlighted the possibility of weed control in peanuts with herbicides.

Herbicides are important because of the possibilities they offer to remove the damage caused by weeds and thus to obtain high yields.

On psamosoils the common weeds that cause problems are Cynodon dactylon, Sorghum halepense, Ambrosia artemisiifolia. Due to the high degree of weeding of sandy soils chemical weed control is a technological measure that leads to increased production.

MATERIAL AND METHODS

The research was conducted at Research-Development Station for Plant Culture on Sands Dabuleni in the period 2001-2003.

In order to establish a strategy with broad spectrum monocotyledonous and dicotyledonous weed in peanut culture were studied 5 herbicides in different combinations and doses.

The experiment included 10 experimental variants placed in the field after randomized blocks method: **V1**- Control 1(cultivated); **V2**- Control 2(uncultivated); **V3**- Dual Gold 960 EC;**V4**-Stomp Aqua; **V5**- Dual Gold 960 EC + Fusilade Forte 150 EC; **V6**- Stomp Aqua+ Fusilade Forte 150 EC; **V7**- Dual Gold 960 EC + Fusilade Forte 150 EC+ Corum+adjuvant Dash HC; **V8**- Stomp Aqua+ Fusilade Forte 150 EC+ Corum+adjuvant Dash HC; **V9**- Dual Gold 960 EC + Fusilade Forte 150 EC+ Benta 480 SL; **V10**- Stomp Aqua+ Fusilade Forte 150 EC+Benta 480 SL.

In the experiment the technology of cultivating peanuts was applied on sandy soils.

Observations and determinations were made on:

- herbicide selectivity by EWRS scale notes (Note 1-selective note 9-unselective);

-herbicide efficacy by EWRS scale notes (note 1-very good efficacy. note 9-very poor efficacy);

- degree of weeding at harvest: by EWRS notes (1-9) and gravimetric by groups of weeds;

- some elements of productivity: no. of pods per plant. production of pods per ha.

Pod production was calculated at STAS humidity of 9%. The interpretation of the research results made by the variance analysis method (Săulescu, N.A. & Săulescu, N.N.1967).

RESULTS AND DISCUSSIONS

The selectivity of the herbicides is generated by the location of the treatment the properties of the herbicide and the climatic and soil conditions. The results obtained on the selectivity of herbicides indicate that all tested products which are applied to the soil surface as pellicular and generally have a low solubility are selective for plant (note 1) (table 1).

These herbicides migrate into the soil a few centimeters and become toxic to weeds that germinate in this layer, while they are selective for cultivation.

The selectivity of herbicides applied in vegetation is based either on a specific enzymatic or hormonal system, either on their own metabolites, capable of participating in the rapid degradation of the herbicide or its binding and immobilization (Berca 1996) .

Observations and measurements made in version uncultivated revealed the presence of the following species of weeds before treatment postemergent 1: *Cynodon dactylon* 20%. *Sorghum halepense* 5%. *Ambrosia artemisiifolia* 70%. *Digitaria sanguinalis* 5%.

Table 1

Results of selective herbicides applied to peanut crop

No. crt.	Tested herbicides	Dose (l/ha)	Epoch of application	EWRS note (1-9)
1	Control 1(Cultivated)			
2	Control 2(Uncultivated)			
3	Dual Gold 960EC	1.5	preemergence	1
4	Stomp aqua	4	preemergence	1
5	Dual Gold960EC	1.5	preemergence	
	Fusilade	1.5	postemergence1	1
6	Stomp aqua	4	preemergence	
	Fusilade Forte 150EC	1.5	postemergence 1	1
7	Dual Gold 960EC	1.5	preemergence	
	Fusilade Forte 150EC	1.5	postemergence1	
	Corum+adjuvant Dash HC	1.25	postemergence 1	1
8	Stomp Aqua	4	preemergence	
	Fusilade Forte 150EC	1.5	postemergence 1	1
	Corum+adjuvant Dash HC	1.25	postemergence 1	
9	Dual Gold 960EC	1.5	preemergence	
	Fusilade Forte 150EC	1.5	postemergence 1	1
	Benta 480 SL	1.25	postemergence 1	
10	Stomp Aqua	4	preemergence	
	Fusilade Forte 150EC	1.5	postemergence 1	1
	Benta 480 SL	1.25	postemergence 1	

In the control of monocotyledonous weeds the best results were obtained by using the combination of Stomp Aqua 4l / ha + Fusilade Forte 150EC 1.5 l / ha + Corum + adjuvant Dash HC 1.25 l / ha.

In terms of the weight of weeds in groups, an amount of 7642 kg / ha of annual dicotyledons (78.8%) is observed in the uncultivated variant. Compared to that, the best option to control annual dicotyledonous weeds was achieved when the combination of Dual Gold 960EC 1.5 l / ha + Fusilade Forte 150EC 1.5 l / ha + Corum + Dash HC adjuvant 1.25 l / ha herbicides was applied (Table 2).The number of pods per plant differs depending on the herbicide variants, correlating indirectly with the degree of weeding.Compared to the control 1(uncultivated), which were recorded in 16.7 mature pods per plant is distinguished herbicidal effectiveness of all variants of the number of pods per plant was between 20.6-33.5 pods per plant.The best results regarding the number of pods per plant were obtained by herbiciding the crop with Dual Gold 960EC + Fusilade Forte 150EC + Corum + Dash HC adjuvant herbicides, followed by the herbicide version with Stomp aqua + Fusilade Forte 150EC (table 3).

Table 2

Results regarding the efficacy of the herbicide for the control of weeds in peanut cultivation
(gravimetric determinations at harvest 2019-2020)

No. Crt.	Tested herbicides	Dose (l/ha)	Epoch of application	Weight of weeds: Annual mono-cotyledons (kg/ha)	Weight of weeds: Perennial monocotyledons (kg/ha)	Weight of weeds: Anuale dicotyledons. (kg/ha)	Total weight (kg/ha)	Total weight (%)
1	Control 1(Cultivated)			-	-	7642	7642	78.8
2	Control 2(Uncultivated)			-	1309	8380	9689	100
3	Dual Gold 960EC	1.5	preemergence	-	-	19630	19630	202.6
4	Stomp aqua	4	preemergence	-	-	16428	16428	169.5
5	Dual Gold960EC	1.5	preemergence	-	-			
	Fusilade	1.5	postemergence1	-	-	20714	20714	213.7
	Stomp aqua	4	preemergence	-	-			
6	Fusilade Forte 150EC	1.5	postemergence 1	-	-	11594	11594	120
	Dual Gold 960EC	1.5	preemergence				4701	48.5
7	Fusilade Forte 150EC	1.5	postemergence1	250	2499	1952		
	Corum+adjuvant Dash HC	1.25	postemergence 1					
8	Stomp Aqua	4	preemergence	36	60	3428	2524	36.3
	Fusilade Forte 150EC	1.5	postemergence 1					
	Corum+adjuvant Dash HC	1.25	postemergence 1	-	-			
	Dual Gold 960EC	1.5	preemergence	-				
9	Fusilade Forte 150EC	1.5	postemergence 1	-	215	14024	14239	147
	Benta 480 SL	1.25	postemergence 1	-				
	Stomp Aqua	4	preemergence	-				
10	Fusilade Forte 150EC	1.5	postemergence 1	-	464	14880	15344	158.3
	Benta 480 SL	1.25	postemergence 1	-				

Table 3

The influence of herbicidation on some elements of productivity and on the production of peanut pods(2019-2020)

No. crt.	Tested herbicides	Dose (l/ha	Epoch of aplication	Number of mature pods/ plant	Production			
					Average production (kg/ha)	Relativ production (%)	The difference compared to control(kg/ha)	Semnification
1	Control 1(Cultivated)			16.7	910	37.4	-1519	
2	Control 2(Uncultivated)			20.6	2429	100	Mt.	Mt.
3	Dual Gold 960EC	1.5	preemergence	26.5	1751	72.1	-678	
4	Stomp aqua	4	preemergence	31.8	3378	139	+949	*
5	Dual Gold960EC	1.5	preemergence	28.1	3574	147.1	+1145	**
	Fusilade	1.5	postemergence1					
6	Stomp aqua	4	preemergence	26	3859		+1430	**
	Fusilade Forte 150EC	1.5	postemergence 1					
7	Dual Gold 960EC	1.5	preemergence	33.5	3178	130.8	+749	
	Fusilade Forte 150EC	1.5	postemergence1					
	Corum+adjuvant Dash HC	1.25	postemergence 1					
8	Stomp Aqua	4	preemergence	31.9	3940		+1511	**
	Fusilade Forte 150EC	1.5	postemergence 1					
	Corum+adjuvant Dash HC	1.25	postemergence 1					
9	Dual Gold 960EC	1.5	preemergence	27	3318	136.6	+889	*
	Fusilade Forte 150EC	1.5	postemergence 1					
	Benta 480 SL	1.25	postemergence 1					
10	Stomp Aqua	4	preemergence	23.7	3297	135.7	+868	*
	Fusilade Forte 150EC	1.5	postemergence 1					
	Benta 480 SL	1.25	postemergence 1					
	LSD 5%=			16.6	832 kg/ha			
	LSD 1%=			22.7	1141 kg/ha			
	LSD 0.1%=			31.0	1553 kg/			

Analyzing the production results obtained under the influence of herbicide, there is a close correlation between them and the value of the productivity elements.

The variants with the best results regarding weed control presented maximum values in terms of production level.

Compared to control 1 (uncultivated), in which a yield of 910 kg / ha was obtained, almost all herbicide variants achieved significant and distinctly significant increases between 749-1511 kg / ha.

CONCLUSIONS

The results on the selectivity of the herbicides applied to the peanut crop showed that all the herbicides applied were selective for the peanut plants.

In the control of monocotyledonous weeds the best results were obtained by using the combination of Stomp Aqua 4l / ha + Fusilade Forte 150EC 1.5 l / ha + Corum + adjuvant Dash HC 1.25 l / ha herbicides.

In terms of the weight of weeds in groups, an amount of 7642 kg / ha of annual dicotyledons (78.8%) is observed in the uncultivated variant. Compared to that, the best option to control annual dicotyledonous weeds was achieved when the combination of Dual Gold 960EC 1.5 l / ha + Fusilade Forte 150EC 1.5 l / ha + Corum + Dash HC adjuvant 1.25 l / ha herbicides was applied.

The results obtained in the uncultivated variant with a yield of 910 kg / ha, highlights the importance of herbicides and maintenance applied to peanut cultivation on irrigated psamosoils.

REFERENCES

Berca M.1996. Combaterea buruienilor din culturile agricole, Editura Fermierul.

Dima Milica 2006. Comportarea unor soiuri şi linii de arahide, în condiţii diferite tehnologice, pe psamosolurile irrigate din sudul Olteniei. Teza de doctorat. Universitatea din Craiova.

Johnson, W. C., III, Boudreau M. A., Davis J. W. 2012a. Cultural practices to improve in-row weed control with cultivation in organic peanut production. Weed Technol. 26: 718–723.

Johnson, W. C., III, Boudreau M. A., Davis J. W.. 2012b. Implements and cultivation frequency to improve in-row weed control in organic peanut production. Weed Technol. 26: 334–340.

Johnson, W.C., IIIand Davis J. W. 2015. Perpendicular cultivation for improved in-row weed control in organic peanut production. Weed Technol. 29:128–134.

Wann, D. Q., Tubbs R. S., Johnson W. C., III, Smith A. R., Smith N. B., Culbreath A. K., Davis J. W. 2011. Tine cultivation effects on weed control, productivity, and economics of peanut under organic management. Peanut Sci. 38: 101–110.

Săulescu A.N. & Săulescu N.N. 1967. Câmpul de experienţă, Editura Agrosilvică, Bucureşti.

Şarpe N., Chicea I., Pop L. 1981. Folosirea raţională a erbicidelor, Simpozion Constanţa.

Şarpe N., Ciorlăuşi M., Ghinea L., Vlăduţu I. 1987. Combaterea integrată a buruienilor. Erbicidele, Editura Ceres, Bucureşti.

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STUDIES ON THE IMPLICATIONS OF FERTILIZATION AND PLANT NUTRITION SPACE ON GRAIN SORGHUM PRODUCTION COMPONENTS IN SANDY SOIL CONDITIONS

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Keywords: *plant, development, leaf index, production, quality*

ABSTRACT

*The research was carried out during 2018-2020, at R & DSPCS Dăbuleni and focused on the reaction of the sorghum plant for grains to the fertilization regime, depending on the size of the nutrition space. The obtained results highlighted the fact that the sorghum for grains capitalized with good results the pedoclimatic conditions in the area of sandy soils. There was a positive correlation between fertilization and biometric parameters of the sorghum plant. Fertilization with N150P80K80 + ALBIT, applied foliar at a dose of 40 ml / ha, in the phase of 6-8 leaves of the plant, determined, compared to unfertilized, the growth by 19.1-20.6 cm, at the height of the plant, by 5 , 7-7 mm, at the diameter of the stem, by 2.36-3.5 cm, at the length of the panicle and by 0.97-1.66, at the leaf area index, depending on the number of plants per unit area. Between the production obtained from grain sorghum and the plant nutrition regime there is a positive correlation, distinctly significant (r = 0.991 **), which highlights production increases, which exceed the limit difference of 5%, compared to unfertilized.*

INTRODUCTIONS

The importance of sorghum cultivation is given by its role as an alternative to maize cultivation, amid multiple uses: in animal feed (USA and Australia), in food (India, China, Central America), in the food and light industry (starch production, of ethyl alcohol, beer). Sorghum has poor nutrient requirements because it has a well-developed root system, which allows it to extract all the nutrients it needs from the soil (Harlan & De Wet 1972, Narges Zand & Mohammad Reza Shakiba 2013). For a normal development of the plant, sorghum needs small amounts of phosphorus and potassium, the need being: 20-60 kg / ha s.a. Nitrogen requirements are slightly higher, but lower than maize, namely 50-80 kg s.a./ha (Isticioaia 2017). The literature mentions that grain sorghum has a good ability to efficiently capitalize on natural resources, achieving high yields in ecological conditions unfavorable to other cereals (Antohe I. et al. 2002). International studies have shown that elements of technology, such as crop rotation, fertilization and density, have significantly influenced the production potential of grain sorghum (Kaufman 2013, Narges Zand & Mohammad Reza Shakiba 2013). The requirements of the plant to the soil are minimal, so it can be grown on soils with soils whose pH has very wide values, between 4.5-8.5. Compared to other agricultural species, sorghum makes much better use of sandy and saline soils. In Ontario, the recommended nitrogen rate is 100 kg / ha for S. bicolor used as fodder and 50-100 kg / ha for sorghum-Sudan grass hybrids (OMAFRA 2009, Cothren et al. 2000). It is recommended, a fractional application of nitrogen, half at sowing and half in vegetation, to optimize yield and quality. For grain sorghum, AERC recommends applying 40 kg / ha nitrogen, 30 kg / ha phosphorus and 30 kg / ha potassium to sowing, followed by fertilization with 40 kg / ha nitrogen, four to five weeks after sowing (AERC 2015)

MATERIALS AND METHODS

The researches were carried out in the period 2018-2020, at R & DSPCS Dăbuleni and focused on the reaction of the sorghum plant to the fertilization regime, depending on the size of the nutrition space. The experiment was located according to the method of plots subdivided with two factors, taking into account 3 sowing densities (Factor A: 20, 25, 30 germinating seeds / m^2) and 5 root and foliar fertilization (Factor B: Unfertilized, $N_{80}P_{80}K_{80}$, $N_{80}P_{80}K_{80}$ + ALBIT biostimulator, at a dose of 40 ml / ha, $N_{150}P_{80}K_{80}$, $N_{150}P_{80}K_{80}$ + ALBIT biostimulator, at a dose of 40 ml / ha). Fertilization with $N_{80}P_{80}K_{80}$ was performed in the preparation of the germination bed, and the difference between nitrogen and foliar fertilization was performed in the phase of 6 - 8 leaves of the sorghum plant. The experiment was placed in irrigated conditions, on a sandy soil with a low natural fertility, characterized by a total nitrogen content between 0.05-0.07%. The extractable phosphorus content showed values in the range of 25-41 ppm, which indicates a medium to well-supplied supply state. In terms of content in exchangeable potassium and organic carbon, the soil was characterized as poorly supplied (22-39 ppm K exchangeable; 0.27-0.50%), organic carbon). The pH of the soil showed values in the range of 5.97-6.39, values that showed a weakly acid to moderately acidic reaction. During the growing season, determinations of plant biometrics were performed, and at harvest the productivity and quality of production was determined. The results were calculated and analyzed by the method of analysis of variance (ANOVA) and using mathematical functions.

RESULTS AND DISCUSSIONS

Analyzing the climatic conditions recorded during the vegetation period of sorghum (May-August 2018-2020), the drought phenomenon is accentuated, as a result of the increase of the average temperature by 1.7 (^{0}C) and the registration of a lower amount of precipitation by 19.6 mm compared to the multiannual average (Table 1). Due to the high resistance to drought, sorghum is called “plant camel”, having a need for the entire vegetation period is 2500-3500 ^{0}C, an amount that accumulated during the study period. Thus, during the vegetation phenophases, May 1-August 31, there were about 2773 ^{0}C, optimal temperatures for the normal development of plant metabolism and an insufficient amount of precipitation, being necessary the work of crop irrigation.

Table 1

Climatic conditions recorded at the weather station of R & DSPCS Dăbuleni

Monthly climatic elements / period		IV	V	VI	VII	VIII	Average / Amount Mai-August
Average monthly temperature (^{0}C)	2018-2020 Period	14.5	18.4	22.6	24.0	25.1	20.9
	Multiannual period (1956-2020)	11.9	17.1	21.6	23.0	22.6	19.3
	Deviation from the multiannual	2.6	1.3	1.0	0.9	2.5	+1.7
Rainfall (mm)	2018-2020 Period	37.5	59.0	70.2	50.7	32.1	249.4
	Multiannual period (1956-2020)	46.6	62.8	70.5	56.1	33.1	269.0
	Deviation from the multiannual	-9.1	-3.8	-0.3	-5.4	-1.0	-19.6

The growth and development of the plant in grain sorghum was influenced by the factors studied (Table 2). The obtained results showed a positive correlation between fertilization and determined morphological parameters, with maximum values for plants fertilized with $N_{150}P_{80}K_{80}$ + Albit at a dose of 40 ml/ha. This fertilization formula caused increases, compared to unfertilized, of 19.1-20.6 cm, at the height of the plant, of 5.7-7 mm, at the diameter of the stem, of 2.36-3.5 cm, at panicle length and 0.97-1.66, at the leaf area index (LAI), depending on the number of plants per unit area. Plant density correlated positively with plant size and leaf area index and negatively with stem diameter and panicle length. The leaf area index is an indicator of utmost importance with a role in the accumulation of production. The literature has pointed out that plant cultivation densities that are too small or too high also change the ratio between total phytomas and useful phytomas, the productivity of basal leaves decreases below the level of respiration losses, so that the yield of the leaf index decreases by more than 4-7 (depending on the species, cultivation, etc.), (Bălteanu Gh. & Barnaure V. 1989). The results obtained in sorghum highlighted values of the leaf index between 3.44-5.77, the maximum values being recorded by insuring at seeding 30 germinating seeds / m^2 (Table 2).

Under sandy soil conditions, sorghum grain production ranged from 3188.5-6300.4 kg / ha, depending on fertilization and plant density (Table 3). Compared to the control, unfertilized, which recorded yields between 3188.5 -3752 kg / ha, the application of a root fertilization with a complex fertilizer based on nitrogen, phosphorus and potassium, associated with a foliar fertilization with a biostimulator determined the increase significant and distinctly significant production, depending on plant density. If we analyze the influence of the number of plants / unit of surface, we observe distinctly significant differentiations of the production achieved in the sown variants with 25-30 s.g./m^2, compared to the sowing insurance of 20 s.g./m^2. The interaction of the two technological factors studied, led to the registration of a maximum production in the version sown at 30 s.g./m2, and fertilized with $N_{150}P_{80}K_{80}$ + *ALBIT*, applied in a dose of 40 ml / ha in the phase of 6-8 leaves.

Table 2

The influence of fertilization and sowing density on the development of the sorghum plant for grains

The experimental variant		Plant height (cm)	Stem diameter (mm)	Panic length (cm)	LAI
Plant density	Fertilization				
20 s.g./m^2	Unfertilized	91.4	11.3	20.4	3.44
	$N_{80}P_{80}K_{80}$	99.0	13.2	22.2	3.61
	$N_{80}P_{80}K_{80}$ + ALBIT	100.9	15.0	22.4	3.79
	$N_{150}P_{80}K_{80}$	110.8	17.0	24.1	3.85
	$N_{150}P_{80}K_{80}$ + ALBIT	111.4	18.2	24.7	4.41
Average at 20 s.g./m^2		102.7	14.94	22.76	3.82
25 s.g./m^2	Unfertilized	94.0	10.2	20.3	4.01
	$N_{80}P_{80}K_{80}$	97.6	12.9	21.7	4.44
	$N_{80}P_{80}K_{80}$ + ALBIT	102.3	14.3	22.0	4.42
	$N_{150}P_{80}K_{80}$	112.1	16.0	23.5	4.72
	$N_{150}P_{80}K_{80}$ + ALBIT	113.1	17.2	23.8	5.38
Average at 25 s.g./m^2		103.82	14.12	22.26	4.594
30 s.g./m^2	Unfertilized	96.8	9.7	20.2	4.11
	$N_{80}P_{80}K_{80}$	100.9	12.7	21.1	4.93
	$N_{80}P_{80}K_{80}$ + ALBIT	104.6	13.0	21.6	5.01
	$N_{150}P_{80}K_{80}$	113.0	14.6	22.7	5.43
	$N_{150}P_{80}K_{80}$ + ALBIT	117.4	15.4	23.7	5.77
Average at 30 s.g./m^2		106.54	13.08	21.86	5.05

Table 3

Production results obtained for grain sorghum, depending on fertilization and sowing density

The experimental variant	Grain yield (kg/ha)					
	20 s.g./m^2		25 s.g./m^2		30 s.g./m^2	
Unfertilized	3188.5	Control	3752.0	Control	3424.5	Control
$N_{80}P_{80}K_{80}$	4030.8	842.3	4370.0	618.0	4150.0	725.5
$N_{80}P_{80}K_{80}$ + ALBIT	4515.6	1327.1*	4861.6	1109.6*	4903.2	1478.7**
$N_{150}P_{80}K_{80}$	5125.6	1937.1***	5543.8	1791.8**	5797.6	2373.1***
$N_{150}P_{80}K_{80}$ + ALBIT	5648.4	2459.9***	6021.8	2269.8***	6300.4	2875.9***
Grain yield/ plant density	4501.8	Control	4909.8	408**	4915.1	413.3**
a1b2-a1b1	LSD 5%= 967.3 kg/ha;		LSD 1%=1348.9 kg/ha;		LSD 0.1%=1900 kg	
a2-a1	LSD 5%= 275 kg/ha;		LSD 1% = 386.9 kg/ha;		LSD 0.1%= 562 kg	

Between the production obtained from grain sorghum and the plant nutrition regime there is a positive correlation, distinctly significant (r = 0.991 **), which highlights production increases, exceeding the limit difference of 5%, compared to unfertilized (Figure 1).

The grain production obtained in the 15 combinations of the two factors studied was significantly distinctly correlated with the leaf area and the protein content (Figure 2).

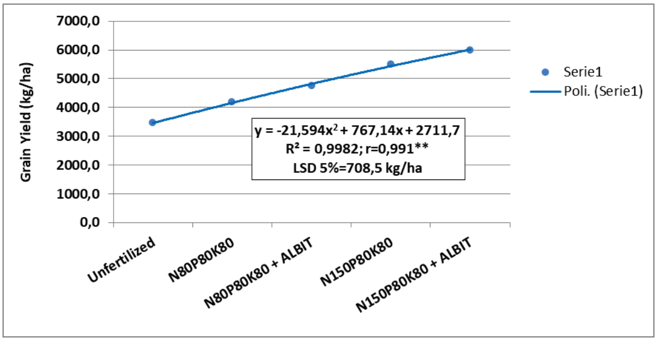

Figure 1. Correlation between fertilization and the yield obtained from grain sorghum

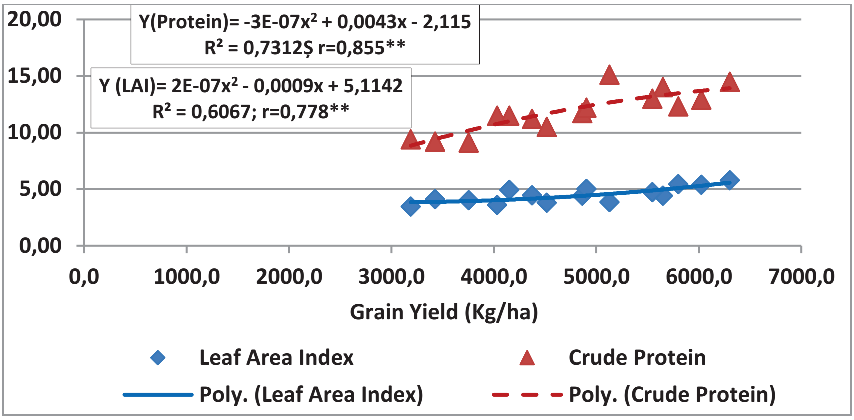

Figure 2. Correlation of yields obtained for grain sorghum with leaf surface index and grain protein content

CONCLUSIONS

Sorghum has successfully capitalized on the pedoclimatic conditions in the area of sandy soils

There was a positive correlation between fertilization and biometric parameters of the sorghum plant, with maximum values for plants fertilized with $N_{150}P_{80}K_{80}$ + ALBIT at a dose of 40 ml / ha.

Fertilization with $N_{150}P_{80}K_{80}$ + ALBIT in a dose of 40 ml / ha, in the phase of 6-8 leaves of the plant, determined, compared to unfertilized, the growth by 19.1-20.6 cm, at the height of the plant, by 5 , 7-7 mm, at the diameter of the stem, by 2.36-3.5 cm, at the length of the panicle and by 0.97-1.66, at the leaf area index, depending on the number of plants per unit area.

The production obtained from sorghum for grains was positively correlated with the nutrition regime of the plant, the correlation being distinctly significant (r = 0.991**), and the production increases exceed LSD 5% of 708,5 kg/ha, compared to unfertilized.

The grain production from sorghum was significantly distinctly correlated with the leaf area (r=0,778**) and the protein content (r=0,855**).

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REFERENCES

Antohe I., Drăghici I., Naidin C. 2002. Sorghum an alternative crop for south of Romania.In: Drought mitigation and prevention of land desertification, 22-24 April, 2002, Bled, Slovenia: 112.

Bălteanu Gh. & Barnaure V. 1989. Fitotehnie, Editura Ceres București 1989 412 pag.

Cothren J. T., Matocha J. E., Clark L. E. 2000. Integrated crop management for sorghum. Pages 409-441 in C. W. Smith, R. A. Frederiksen, eds. Sorghum: Origin, history, technology, and production. John Wiley & Sons, Inc., New York.

Harlan J. & De Wet J. 1972. A simplified classification of cultivated sorghum. Crop Science 12(2): 172-176.

Isticioaia Simona - Florina, Alexandra Leonte, Monica Herea. 2017. Research regarding the influence of sowing density on the dry substance and biomass production at sorghum, under the Center of Moldova pedoclimatic conditions. Volum omagial - 55 de ani de Cercetare – Dezvoltare la S.C.D.A. Secuieni. Ed. Ion Ionescu de la Brad - Iaşi, pg. 146 - 152, ISBN 978-973-147-253-9.

Kaufman RC, Wilson JD, Bean SR, Presley DR, Blanco-Canqui H, Mikha M., 2013. Effect of nitrogen fertilization and cover cropping systems on sorghum grain characteristics, J Agric Food Chem. 2013 Jun 19;61(24): 5715-9. doi: 10.1021/jf401179n. Epub 2013 Jun 5.

Narges Zand, Mohammad Reza Shakiba. 2013. Effect of plant density and nitrogen fertilizer on some attribute of grain sorghum (sorghum bicolor (l.) moench), International journal of Advanced Biological and Biomedical Research. 1(12): 1577-1582.

*** AERC, 2015. Agriculture Environmental Renewal Canada Inc. 2008. Canadian grain sorghum hybrid. [Online] Available: http://www.aerc.ca/grain sorghum. html [28 Feb. 2015].

*** OMAFRA, 2009. Ontario Ministry of Agriculture, F. a. R. A. 2009. Agronomy Guide for Field Crops: Publication 811. Queen's Printer for Ontario, Toronto.

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RESEARCH REGARDING THE BEHAVIOR OF SOME GENOTYPES OF RYE IN THE CONDITIONS OF SANDY SOILS FROM SOUTHERN OLTENIA

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Keywords: *biometrics, physiology, quality, yield*

ABSTRACT

Rye (Secale cereale) is a cereal that capitalizes drier areas with poorly productive soils, obtaining good results, where wheat does not generate economic production.. Having a well-developed root system, with a high absorption capacity, rye is an unpretentious plant to the natural fertility of the soil, being included in the composition of crop rotations in dry areas in the south and northwest of the country, in main crop or as backstage for crops that require deflationary protection. The yield results obtained for the 4 rye genotypes, cultivated in the conditions of sandy soils, showed productions between 2961-4785 kg/ha, the Serafino variety was distinguished with the maximum production. Compared to the control variety, Suceveana, all rye genotypes cultivated this year achieved production increases between 30.4-67.3%, statistically assured as distinct and very significant.

INTRODUCTIONS

Rye (*Secale cereale*) is an cereal extremely adapted to the conditions in Romania, using more harsh soil and climate conditions compared to wheat, with which it is related at least as a phenotypic aspect. Rye makes good use of poor soils, being less pretentious to the soil, due to the deep root system and high absorption capacity. It succeeds on soils where wheat does not give results, such as sandy soils (Matei Gh. et al. 2009). It is part of the crop rotations in the dry areas in the south and northwest of the country, used as the main crop or as backstage for the crops that require protection against deflation (Marinică Gh. et al. 2003). From a qualitative point of view, it was found that balanced fertilization of rye with NPK led to significant increases in grain protein content (Gh. Matei et al. 2009). Compared to wheat, the percentage of protein is lower, but rye protein is richer in lysine (Nicolescu M. et al. 2008). Recent studies have highlighted the possibilities of replacing corn in the feed of chickens with barley and rye. However, the limitation of their inclusion rate compared to maize was due to the presence of non-starch polysaccharides (NSP), such as beta-glucans (in the endosperm cell wall of barley) and arabinoxylans (rye), which creates viscous water solutions (Bederska-Łojewska et al. 2017, Bedford &

Classen 1992, Van Krimpen et al. 2017). Due to these chemical properties, it can be used in the livestock sector as grains, or as green mass fourage. Research by H. R. Sharma et al. (1981), on the introduction of rye into the diet of Holstein cows, pointed out that it can participate in other fourage up to 60%. The increase in the percentage of rye participation in fourage has led to a decrease in the degree of digestibility. To improve the digestibility of the authors highlight using of roasted rye beans.

MATERIALS AND METHODS

The researches were carried out in the conditions of the agricultural year 2019/2020, at R&DSPCS Dăbuleni and regarded the behavior of three foreign rye genotypes (Binnto, Serafino, Inspector), compared to a local genotype (Suceveana), in sandy soils conditions of Southern Oltenia. The experiment was designed by the method of randomized blocks in three repetitions, in the conditions of a sandy soil with a low natural fertility, poorly supplied with total nitrogen (0.05-0.07%), medium to normal supplied with extractable phosphorus (33- 65 ppm), and low to medium supplied in exchangeable potassium (50-121 ppm) and with a strong acid soil reaction (pH_{H2O} = 4.66-4.79). Determinations were made regarding the resistance of the plant to stress, the yield of the plant (number of ears/square meter, length of ear, number of grains in ear), quantity and quality of yield obtained. Plant physiology analyzes (photosynthesis and transpiration) were determined directly in the experimental field, using the portable apparatus for photosynthesis LC Pro SD. Grain quality analyzes (Protein, Wet Gluten, Zeleny Sedimentation Index, Hardness Index) were performed in the laboratory by the Perten method.
The obtained results were calculated and interpreted from a statistical point of view using mathematical functions and variable analyze (ANOVA).

RESULTS AND DISCUSSIONS

Analyzing the climatic conditions recorded at the weather station of R&DSPCS Dăbuleni (Table 1), it can be observed that were favorable for the growth and development of rye plants, within the limits of biological requirements of the plant (minimum seed germination temperature of 1-2 ^{o}C, the amount temperatures during the vegetation of 1,800-2,000 ^{o}C, in winter, young plants withstand temperatures up to -20 ^{o}C, without being covered by snow). During the vegetation period of rye culture (October 2019-July 2020) there was recorded an average air temperature of 11.74^{o}C, with 2.04^{o}C higher compared to the multiannual average, thus noticing the accentuation of the arid climate in the area of sandy soils. Although the recorded precipitations exceeded the multiannual average by 25.9 mm, they were unevenly distributed over the vegetation period of the rye, requiring supplementation of the water deficit from the soil at the emergence of the plant by a watering with a norm of 250 m^3 water/ha. Also, the registration of an extremely dry period, when for 25 days only 19.8 mm of precipitation was recorded, required the application of a watering during the heading stage of the plant (May 14). The length of the day influences the resistance of the rye plant to frost (Marilyn Griffith et al. 1993). The results obtained in this sense showed that the rye plant grows well in short day conditions, conditions that characterize the climate in Romania, being more tolerant of frost, than plants grown in long day conditions. Unfavorable weather conditions (especially drought) in recent years, which often last a long part of the growing season, have a negative effect on the yield of plants, not only of sensitive but also resistant species such as rye (Ilona Czyczyło-Mysza and Beata Myśków 2017).

Table 1

Climatic conditions registered at the weather station of R&DSPCS Dăbuleni in the agricultural year 2019/2020

Climatic elements / year / month	2019			2020							X 2019-VII 2020
	X	XI	XII	I	II	III	IV	V	VI	VII	
Average air temperature (^{0}C) 2019/2020	13.5	9.7	2.8	0.8	6.1	7.9	12.9	17.2	22.0	24.5	11.74
Rainfall (mm) 2019/2020	16.2	133	29.9	6.3	64.3	62.8	11.6	59.2	55.8	73.0	512.1
Relative humidity (%) 2019/2020	80.0	94.0	93.0	84.3	77.7	75.0	74.7	79.3	78.2	81.7	81.8
Multiannual average temperature (^{0}C) (1956-2019)	11.4	5.6	0.6	-1.4	1.0	6.0	11.9	17.1	21.6	23.0	9.68
The amount of multiannual rainfall (mm) (1956-2019)	42.1	49.7	50.7	34.3	33.7	39.8	46.6	62.8	70.5	56.1	486.2

The determinations regarding the growth and development of the plants to the 4 rye genotypes studied showed a plant height between 118.6-161.6 cm, an element that was negatively correlated with the fall resistance (Table 2). The analysis of the productivity elements of the plant, highlighted the Serafino genotype, which registered 515 ears/ m², 11.4 cm ear length and 58 grains/ear.

Table 2

Biometric determinations on morphological characteristics of rye genotypes cultivated in sandy soil conditions

Genotype	Plant height (cm)	No. ears / m²	Ear length (cm)	No. grains / ear	Fall resistance
Binnto	118.6	504	10.4	61	1
Serafino	135.6	515	11.4	58	1
Inspector	129	495	12.8	60	1
Suceveana	161.6	501	11.4	54	3

The results regarding the diurnal variation of photosynthesis in rye (Figure 1), in the flowering phenophase, showed maximums in the morning, except for the Binnto hybrid, at which the photosynthetic maximum was recorded at 3 pm (5.06 µmol $CO_2/m^2/s$). If we analyze the functional link between the accumulation of CO_2 and the climatic conditions recorded at the time of the determinations, it is observed that most rye genotypes make better use of the microclimate created by active photosynthetic radiation of 242.5 µmol/m^2/s and a temperature of about 28.63 ^{o}C (Table 3, Figure 1). The transpiration process of the plant is directly influenced by the temperature recorded in the air (Figure 2), the values being differentiated according to genotype, the maximum value being recorded at 15, in the Serafino genotype (3.21 mmol $H_2O/m^2/s$). At this variety, the largest amount of water was lost through transpiration, consumption was productive, as it recorded the highest accumulation of substance came out through the process of photography. Through foliar perspiration, the plants avoided overheating, the evaporated water being used efficiently, as the genotypes with the highest water losses also had the highest photosynthetic yield.

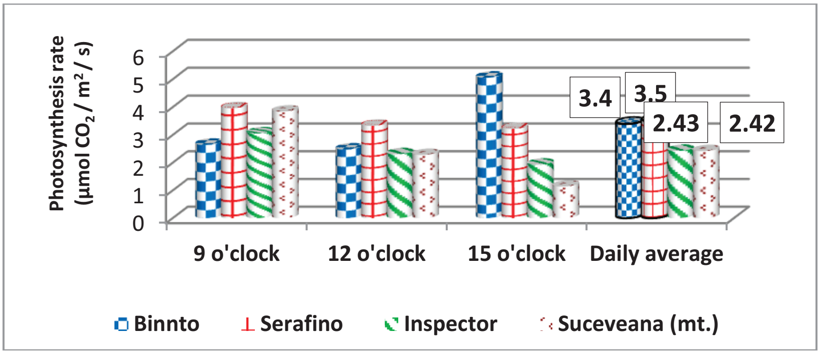

Figure 1. Diurnal variation of the photosynthesis process in some rye genotypes

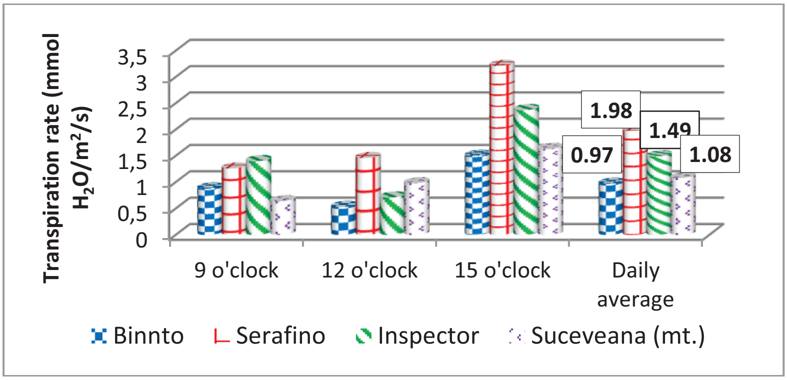

Figure 2. Diurnal variation of the transpiration process in some rye genotypes

Table 3

Climatic conditions recorded at the time of physiological determinations

Climatic conditions	9 o'clock	12 o'clock	15 o'clock
Active solar radiation in photosynthesis (µmol / m^2 / s	242.5	651	538.5
Temperature (°C)	28.63	34.4	39.85
Atmospheric pressure (hPa)	1003	1003	1003

The analysis of the yield results highlighted the Serafino variety with the highest grain yield (4785 kg/ha), registering a very significant production difference from a statistical point of view, compared to the Suceveana variety, taken as a control (Table 4). The weight of a thousand grains (TWG) recorded values between 24 g (Binnto) and 30 g (Suceveana), and the hectolitre weight (WH) varied between 68 kg (Binnto) and 75 kg (Serafino).

Table 4.

Production results obtained for some rye genotypes, in sandy soil conditions

Genotypes	Grain yield kg/ha	The difference compared to the control kg/ha	WH (Kg/hl)	TWG (g)
Binnto	3887	926**	68	24
Serafino	4785	1824***	75	29
Inspector	3730	769**	74	29
Suceveana	2961	Control	71	30

LSD 5%=460.5 kg/ha; LSD 1%=697.3 kg/ha; LSD 0,1%=1120.2 kg/ha

Analysis of grain quality in the rye genotypes studied revealed differences in protein, gluten, Zelenny index and hardness index (Table 5). The chemical composition of the rye grain shows values of crude protein in the range of 9-12.17%, with maximum values for the Suceveana variety, a variety that also showed increased values of gluten content, grain hardness and Zeleny index.

Table 5.

Grain quality in some rye genotypes grown on sandy soils

Genotype	Protein (%)	Hardness (%)	Gluten (%)	Zeleny Index (%)
BINNTO	11.13	46.9	21.4	32
SERAFINO	9	51.5	15.5	17
INSPECTOR	11.77	47	23.13	36
SUCEVEANA	12.17	46.2	25.03	38

CONCLUSIONS

The analysis of the productivity elements of the plant, highlighted the Serafino genotype, in which were registered 515 ears/m^2, 12.2 cm length of the ear and 51 grains/ear.

The average daily values of the physiological processes in the plant showed that the Serafino genotype, even if it lost the largest amount of water through transpiration (1.98 mmol $H_2O/m^2/s$), the consumption was productive, as it recorded the highest high accumulation of dry matter through the process of photosynthesis (3.5 µmol $CO_2/m^2/s$).

The analysis of the production results highlighted the Serafino variety with the highest grain yield (4785 kg/ha), registering a very significant production difference from a statistical point of view, compared to the Suceveana variety.

The chemical composition of the rye grain showed values of crude protein in the range of 9-12.17%, with a maximum in the Suceveana variety.

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REFERENCES

Bederska-Łojewska D., Swiatkiewicz S., Arczewska-Włosek A., Schwarz T., 2017. Rye non-starch polysaccharides: Their impact on poultry intestinal physiology, nutrients digestibility and performance indices. A review. Ann. Anim. Sci. 17: 351–369.

Bedford M.R., Classen H. 1992. Reduction of intestinal viscosity through manipulation of dietary rye and pentosanase concentration is effected through changes in the carbohydrate composition of the intestinal aqueous phase and results in improved growth rate and food conversion efficiency of broiler chicks. J. Nutr., 122: 560–569.

Ilona Czyczyło-Mysza & Beata Myśków. 2017. Analysis of the impact of drought on selected morphological, biochemical and physiological traits of rye inbred lines. Acta Physiologiae Plantarum, 39, Article number: 87, Electronic ISSN 1861-1664, DOI 10.1007/s11738-017-2385-x.

Matei Gheorghe, Dumitru Gheorghe, Diaconescu Adilen, Cojocaru Ileana, 2009. Study on the influence of rotation and fertilization on production from rye grown on sandy soil in southern Oltenia. Analele Universităţii din Craiova, seria Agricultură – Montanologie – Cadastru Vol. XXXIX: 184-192.

Marinică Gh., Gheorghe D., Ploae P., Baron Milica, Ciolacu Floarea, Ciuciuc Elena, Croitoru Mihaela, Diaconescu A., Drăghici Reta, Drăghici I., Durău Anica, Ifrim Aurelia, Marcu Florentina, Marinică Alisa, Nanu Șt., Ploae Marieta, Rățoi I., Șearpe Doina, Șoimu T., Toma V., Vladu Florentina. 2003. Cercetări privind sistemul de agricultură pentru nisipuri și soluri nisipoase. Lucrări științifice SCDCPN Dăbuleni, vol. XV, Editura SITECH Craiova, ISBN 973-657-514-4, pag. 17-27.

Marilyn Griffith, Heather C. H. McIntyre, 1993. The interrelationship of growth and frost tolerance in winter rye. Physiologia Plantarum, Online ISSN:1399-3054, https://doi.org/10.1111/j.1399-3054.1993.tb01739.x,Volume87, Issue3, Pages 335-344.

Nicolescu M., et al. 2008. ,,Particularităţi ale sistemului de agricultură durabilă din Oltenia”. Ed. Sitech, Craiova.

Sharma H.R., Ingalls J.R., McKirdy J.A., Sanford L.M., 1981. Evaluation of Rye Grain in the Diets of Young Holstein Calves and Lactating Dairy Cows. Journal of Dairy Science, ISSN: 0022-0302, https://doi.org/10.1002/agj2.20349, p. 441-448

Van Krimpen M.M., Torki M., Schokker D. 2017. Effects of rye inclusion in grower diets on immune competence-related parameters and performance in broilers. Poult. Sci., 96, 3324–3337. Volume 64, Issue 3, March 1981, https://doi.org/10.3168/jds.S0022-0302(81)82591-X, Pages 441-448.

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AGRICULTURE WITH HIGH NATURAL VALUE IN ROMANIA; SOIL QUALITY AND SOCIO-ECONOMIC IMPACT IN THE CONTEXT OF CRISIS

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Keywords*: HNV agriculture, soil quality, socio-economic impact, crisis situations*

ABSTRACT

This paper presents the situation of soil quality in Romania, in areas where Agriculture with High Natural Value (HNV farming) is practiced and the opportunity to capitalize on these soils, in the context of crisis situations. HNV farming is a new concept, developed very recently (in the last two decades), to describe those agricultural systems in Europe that have the widest biodiversity. This concept brought an alternative and complementary approach to the typology that has become conventional regarding nature conservation. The new concept recognizes that the preservation of biodiversity in Europe depends to a large extent on the continuation of traditional agricultural practices in much larger areas of Europe's rural area. The diversity offered ensures ecological balance, resilience to climate change and nutritious food, but also ensures the livelihood of many farming communities through their economic productivity.

INTRODUCTION

The concept of High Natural Value Agriculture is somewhat difficult to define. After all, the terminology itself can be exposed to subjective judgments and interpretations (Strohbach et al. 2015). While the word "nature" most often describes the surrounding physical world in relation to human beings, the term "value" complicates matters due to the extremely diverse perspectives on that notion between different cultural, social, political, gender, etc. groups. The combination of "nature" and "value" leaves place for a multitude of interpretations. This initially vague tinge of the concept seems to be the reason why there are currently difficulties in locating and characterizing HNV agriculture. However, a certain consensus has been created between researchers and policymakers on what HNV agriculture really is and, to a lesser extent, where it can be located. An only partially solved problem remains the identification of HNV indicators, given the already chronic lack of data in some Member States (for example, on the application of fertilization) or simply limiting access to data for protective reasons against EU subsidies (such as data related to the Integrated Administration and Control System-IACS). Another is related to the existing diversity of HNV agriculture and agricultural land typologies in very different soil conditions, climate or economic and social context.

Although some HNV farming systems are associated with the continuation of traditional farming practices in Southern Europe, the vast majority of other

European HNV systems are significantly connected to grazing systems on semi-natural habitats in mountainous or other inaccessible areas (Bignal & McCracken, 2000).

HNV farming systems were first described as predominantly low-intensity agricultural systems which involve a relatively complex relationship with the environment (Baldock et al. 1993). They preserve important habitats on both cultivated and grazed land and contain various landscape elements such as hedges, fruit trees or lakes/ponds. HNV agriculture was later defined as a practice located in areas where: (i) agriculture is the mainland use; (ii) agriculture maintains (or is associated with) a wide variety of wild species or habitats or the presence of species of European / national/regional interest, and (iii) the conservation of these species and habitats is dependent on the continuation of agricultural specific practice (Andersen et al., 2003).

With 87% of the territory of the rural area populated by 47% of the inhabitants, Romania is on the second place in the EU as agricultural potential, after France (Dinu 2012). Only 20% of the national agricultural land is considered HNV (EEA, 2010). Romania has a privileged position in terms of the potential for preserving traditional agricultural practices in areas designated HNV, with small farms in a mosaic landscape of agricultural uses, this situation leading a number of local researchers and especially from other Member States, to initiate in-depth studies in the field.

While the pandemic poses some serious challenges for the food system in the short term, it is also an opportunity to accelerate transformations in the food and agriculture sector to build its resilience in the face of a range of challenges, including crisis situations.

MATERIAL AND METHODS

In order to determine the quality of the soils, areas from Mures and Caras-Severin counties, eligible for HNV, were identified (Figure 1 and 2). In a first stage, the field research was carried out in the HNV eligible area in south-eastern Transylvania, in the Natura 2000 site Târnava Mare. Selected area presents a functional historical landscape, with fauna, flora and complementary microorganisms belonging to an ancient ecosystem, in which meadows with wildflowers and traditional pastures maintain their role in agriculture. Such areas are rare in the plain areas of Europe and extremely valuable for conservation research and interpretation. Agriculture is predominantly in small, semi-subsistence farms (ADEPT, 2010).

In the south-western part of Romania, the HNV soil investigation area was selected in the northern half of the county, in two areas corresponding to the two sides of the Semenic-Cheile Carașului National Park, on the Dognecea corridor bordered on the west by the Dognecea Mountains and on the east by the Anina Mountains, respectively the Timiș-Cerna corridor, bordered on the west by the Semenic Mountains and on the east by the southern hilly area of the Godeanu Mountains and the Țarc Mountains.

The samples were collected from soil profiles, in natural arrangement and disturbed, on the identified genetic horizons.

Figure 1: Saschiz P5 profile

Figure 2: Sub Margine, HNV agriculture

Disturbed samples were used for laboratory measurements, according to the established methodology and standards in force: texture, organic carbon content, pH, accessible phosphorus and potassium contents, total nitrogen. Samples in natural (undisturbed) location were used to measure bulk density (DA), penetration resistance (RP), total porosity (PT), soil moisture (wi), compaction index (IC), saturated hydraulic conductivity (kat) and degree of compaction (GT). The cation exchange properties were determined in samples with a pH of less than 7.00. The intensity of salinization was assessed by the total content of soluble salts in 1: 5 aqueous extract. The microbiological analyzes performed (Matei, 2011) aimed at: the number of heterotrophic bacteria; the number of microscopic fungus and the potential level of soil respiration.

Taxonomic identifications were made based on cultural, morphological, and / or physiological characteristics, according to specific determinants for bacteria (Bergey 1994) and fungus (Domsch & Gams, 1970; Watanabe 2002; Samson & van Reenen-Hoestra, 1988). Chromatograms make it possible to obtain information on the biological quality of the soil through analytical separations and the formation of images whose uniformity, shape, size, colour, texture indicate the degree of soil health, vitality, fertility, intensity of biotic activity, soil conditions, the degree of complexity of the organic matter and the presence of stable humus.

RESULTS AND DISCUSSIONS

Physical, chemical and microbiological analyzes of soil samples collected from six profiles in a mountainous area of Caraş-Severin County eligible for HNV payments showed that the studied soils have a good fertility because the analytical values are mainly in intervals favorable to plant growth and nutrition.

The soils in the selected area are from a textural point of view, light and medium soils, with a texture that varies from coarse clayey sand to dusty clay, with an almost absent carbonate content (up to 1% carbonate total calcium). The soil reaction is moderately-weakly acidic, with pH values from 4.83 to 5.94 (Florea et al. 1987) in the first horizon. Values are generally favorable for plant growth. The range of characteristic values for permanent meadow soils is 4.40-6.00 (Vasu 1986). The contents of organic matter, evaluated according to texture (medium) (Florea et al. 1987), vary from small to large. The C/N ratios, with values of 7.2-22.5, describe a content of variously humified organic matter, a natural situation for grassland and meadow soils. Total nitrogen content balances organic matter content well, as suggested by C/N ratios. From the point of view of the total content of soluble salts, the soil is unsalinated, with values well below the limit of poor salinization. Data processing indicates an effective cation exchange capacity generally low. After the level of saturation in the bases the soil is oligobasic - moderate mesobasic (Florea et al. 1987).

From a microbiological point of view, the analyzed soils include bacterial and fungal communities, generally low and moderate level, medium and low level global physiological activities and microbial cenoses consisting of 3 to 10 taxons, with species related to the recycling processes of the matter, organic matter of plant origin in the soil, decomposition of animal manure, species with antagonistic capabilities and the role of biological control agents of phytopathogens in the rhizosphere and soil. The chromatograms of the analyzed soils reflect problems of integration of the mineral component, reduced mineral diversification, predominant abiotic conditions, poor conditions of organic aggregation and flocculation. The inaccessible mineral content is increased in all samples analyzed.

In general, the humification processes are of low to medium intensity and there is a low diversity of biosynthesis sources. Also, stability over time and mineral diversity are reduced.

In Mures County, most of the investigated soils have a medium clayey clay texture with a clay content (< 0.002 mm) from 30 to 40%, with slight increases of the clay content in some layers of the profiles and slightly low clay contents (texture clayey) in some layers of soils in the north-east of the investigated area.

The average values of resistance to penetration are close to the average levels (52 kgf / cm^2 in the soil surface layer, while the average values of the shrinkage index (0.0074) indicate the lack of susceptibility to cracks.

The average values of saturated hydraulic conductivity (12.5 mm / h show relatively high soil permeability and a good level of internal soil drainage. In correlation with the determined soil texture, as the values of bulk density and total porosity have an average level and the calculated average of the degree of soil compaction shows low values (-0.60519% v / v in the upper layer and 7.3469% v / v in the next) the absence or presence of at most slight compaction in the tested soils signals an HNV conservation management of soil generally acceptable in this area.

The soil reaction varies in a wide range of pH values, from 5.78 to 8.24 covering moderately acidic - weakly alkaline ranges (Florea et al., 1987). Values are generally favorable for plant growth. The higher values are consistent with the presence of carbonates in the soil profile. Organic matter content is high and very high. The reports C/N, with values of 4.5-31.4, describe generally well-humified organic matter content. The contents of nitrogen are also normal grassland and meadow soil and organic matter contents balances well as suggests the reports C/N. Mobile phosphorus contents are small and very small (Florea et al. 1987), a situation often encountered in Romanian soils. On the contrary, mobile potassium contents are medium, large and very high (Florea et al. 1987). According to the degree of saturation in the bases, the soil is sub-mesobasic (Florea et al. 1987). The soil analyzed are unsalinated.

Analysis of soil samples chromatograms reveals increased enzymatic activity. In general, the nutrient reserve is increased and environmentally diversified, the humification processes are intense, colloidal substances are present, the mineral component is very well integrated in the organic material, the protein content being well structured and complex in most samples. Bacterial and fungal activity is well evidenced in most of the soils invested in Mures County.

As an essential ecological factor, soil is one of the most important natural resources, being the central foundation of agricultural activity. Soil protection measures maintain its productive capacity and the environmental effects of various uses or technologies applied can have special implications on the degree of sustainability of the agro-ecosystem, whether it is semi-natural or cultivated. Often ignored, the role of soil is complex, and of the six major characteristic functions, three have ecological determination and the others are related to cultural, social, economic and technical aspects.

HNV agricultural systems are found in the most varied situations and agronomic, economic, social and environmental contexts but are usually identifiable in the most marginal areas of Europe where productivity is conditioned by limiting factors such as poor soils, steep slopes, high altitudes, heavy rainfall, etc. and where there is very little potential for intensifying practices and increasing incomes. In addition to natural factors, a number of other factors have been identified and discussed, called “failure factors” that limit the possibilities for initiating innovative actions and therefore must be overcome (Jones and Poux 2012; Redma, 2014).

An essential feature of all HNV farming systems is that they simultaneously produce two types of "goods" that are completely different in terms of their basic nature. On the one hand, they produce classic agricultural products, which are "market goods" (feed, food and fiber) on the other hand; they contribute significantly to the creation and maintenance of landscapes and habitats.

CONCLUSIONS

The food sector will be vulnerable to the negative impacts on the workforce from the spread of pandemics and other crisis situations (workers being sick or in isolation), and will face additional production and distribution costs as a result of health and safety measures introduced to reduce the exposure of their workforce.

HNV areas deserve support, not only for the conservation of the natural diversity they maintain, diversity that ensures ecological balance, resilience to climate change and nutritious food, but also for their economic and agricultural productivity that ensures the livelihood of many farming communities. The support provided to these areas contributes to the prosperity of local communities, by opening up opportunities for the diversification of economic activity, such as the development of rural tourism offers and businesses based on quality and healthy products.

Looking ahead, pandemic situations offer an opportunity to enhance the resilience, sustainability, and productivity of the agriculture and food sector.

ACKNOWLEDGMENT

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REFERENCES

ADEPT Foundation 2010. High Nature Value grasslands. Securing the ecosystem services of European farming post 2013, Conferință internațională, 7-9 septembrie 2010, Sibiu, Romania.

Andersen E., Baldock D., Bennett H., Beaufoy G., Bignal E., Brouwer F., Elbersen B., Eiden G., Godeschalk F., Jones G., McCracken D., Nieuwenhuizen W., Van Eupen M., Hennekens S. Zervas G. 2003. Developing a High Nature Value Farming Area Indicator. Consultancy report to the European Environment Agency, IEEP, Copenhagen.

Baldock D., Beaufoy G., Bennet G., Clark J. 1993. Nature Conservation and New Directions in the Common Agricultural Policy. Institute for European Environmental Policy, London.

Bergey D. H., Holt J. G. 1994. Bergey's Manual of Systematic Bacteriology 9th ed., Wiliams and Wiliams Eds., Baltimore, USA.

Bignal E. M., McCracken D. I. 2000. The nature conservation value of European traditional farming systems. Environ. Rev. 8: 149–171.

Dinu C. 2012. Helping to Adapt: NGOs Influence on the Resilience of a Cultural Landscape from Transylvania, Romania, MSc Thesis in Sustainable Development Environmental Policy and Management, Universiteit Utrecht, NL.

Domsch K. H., Gams W. 1970. Fungi in agricultural soils, T&A Constable Ltd., Edinburg, London.

EEA-European Environment Agency 2010. Approximate Distribution of HNV Farmland in EU-27. European Environment Agency, Copenhagen, Denmark.

Florea N., Bălăceanu V., Răuță C., Canarache A. (red. coord.). 1987. Metodologia elaborării studiilor pedologice. Partea a III-a–Indicatori ecopedologici, MA, ASAS, ICPA București.

Jones, G., Poux, X. 2012. Chapter 5.2-Socio-economic perspectives on HNV farming. In: Oppermann, R., Beaufoy, G. and Jones, G. (Eds.), High Nature Value Farming in Europe: 451-458.

Matei S. 2011. Determinarea respiratiei solului si a biomasei microbiene, în: Dumitru M., Manea A.(coord.), 2011, Metode de analiză chimică și microbiologică (utilizate în sistemul de monitorizare a solurilor), Ed. SITECH, Craiova: 283-288.

Redman M. 2014. High Nature Value (HNV) farming profitability. Starting paper prepared for the first Focus Group meeting in Madrid, Spain (12-13 June 2014), EIP-AGRI Focus Group, EC.

Samson A. R., Hoekstra R. S. E. 1988. Introduction to food borne fungi, Ed.CBS Netherland.

Strohbach M. W., Kohler M. L., Dauber J., Sebastian Klimek S. 2015. High Nature Value farming: From indication to conservation, Ecological Indicators 57: 557–563.

Vasu Alexandra, Neacşu Marcela, Daniliuc D. 1986. Caracterizarea ecopedologică a unităţilor reprezentative de pajişti din regiunea de munte în vederea stabilirii necesarului de măsuri de tehnologii de îmbunătăţire, Lucr. Şt. ale ICPCP Măgurele Braşov, Vol.IX, Bucureşti.

Watanabe T. 2002. Pictorial Atlas of Soil and Seed Fungi: Morphologies of Cultured Fungi and Key to Species 2nd ed., CRC PRESS, Boca Raton London, New York, Washington D.C., USA.

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LIGHT MICROSCOPY IMAGES OF POLLEN OF 3 GERANIACEE SPECIES

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Keywords*: Geranium macrorrhizum, Geranium sanguineum „Max Frei”, light microscopy, Pelargonium hybridum (P. zonale), pollen morphology*

ABSTRACT

The pollen of the plant species included in the Geraniaceae family found in different geographical regions was analysed in several studies, using light microscopy (LM) and scanning electron microscopy (SEM), sometimes transmission electron microscopy (TEM) was also used. The pollen of geraniacee found in Romania was described by Tarnavschi et al. (1987) based on LM. In the present study, light microscopy images of pollen grains of Geranium macrorrhizum, Geranium sanguineum „Max Frei” and Pelargonium zonale were analised and results were compared with those found in the scientific literature.

INTRODUCTION

The fact that geraniums are some of the best known flowers in Romania is shown by the annual Geranium festival in Bran that celebrates the cultivated ornamental *Pelargonium* species that were widespread in traditional rural households, but the spontaneous *Geranium* species (*G. macrorrhizum* – perrenial found in wet shady places in the mountainous and subalpine region, *G. pratense* – perrenial with blue flowers growing in wet meadows, *G. robertianum* – annual with pink flowers, growing in lowland and mountain forests) and *Erodium cicutarium* (widespread on meadows or ruderal areas) are also very well known. Some geraniacee species were used empirically in folk medicine, some are aromatic, also some species of the *Geranium* genera are melliferous, attracting bees and bumble bees, for example *Geranium sanguineum* is one of the predominant species in bee pollen samples from Transylvania (Romania) (Stanciu et al. 2016).

Pollen of geraniacee species from different regions was analysed in several studies, using both light microscopy (LM) and scanning electron microscopy (SEM), sometimes transmission electron microscopy (TEM) was also used. The pollen of geraniacee found in Romania was described by Tarnavschi et al. 1987 based on LM. In the present study, light microscopy images of pollen grains of *Geranium macrorrhizum, Geranium sanguineum* „Max Frei” and *Pelargonium zonale* were analised and results were compared with those found in the scientific literature.

MATERIALS AND METHODS

Pollen was analysed fresh, from *Geranium macrorrhizum* and *Geranium sanguineum* "Max Frei" plants bought from Garden Services S.C. situated within the Agronomie Herăstrău University Campus and from perennial *Pelargonium zonale* (*P.* identification - dr. Vâşcă Diana, Faculty of Horticulture USAMVB) cultivated in Bucharest (May 2019, Figure 1). The analysis was carried out at the Laboratory of Biology of the Faculty of Biotechnologies, University of Agronomic Sciences and Veterinary Medicine of Bucharest using wet mounts (sometimes toluidine blue (TB) was added for better contrast) and a Micros Austria optical microscope with ocular micrometer (calibration ratio was 1 μm for objective 100× and 2.5 μm for objective 40×). Microscopic images have been photographed with a Sony Cyber-shot® digital camera (Carl Zeiss Vario-Tessar 5× zoom lens). The classification of pollen according to size is from Stebler 2019.

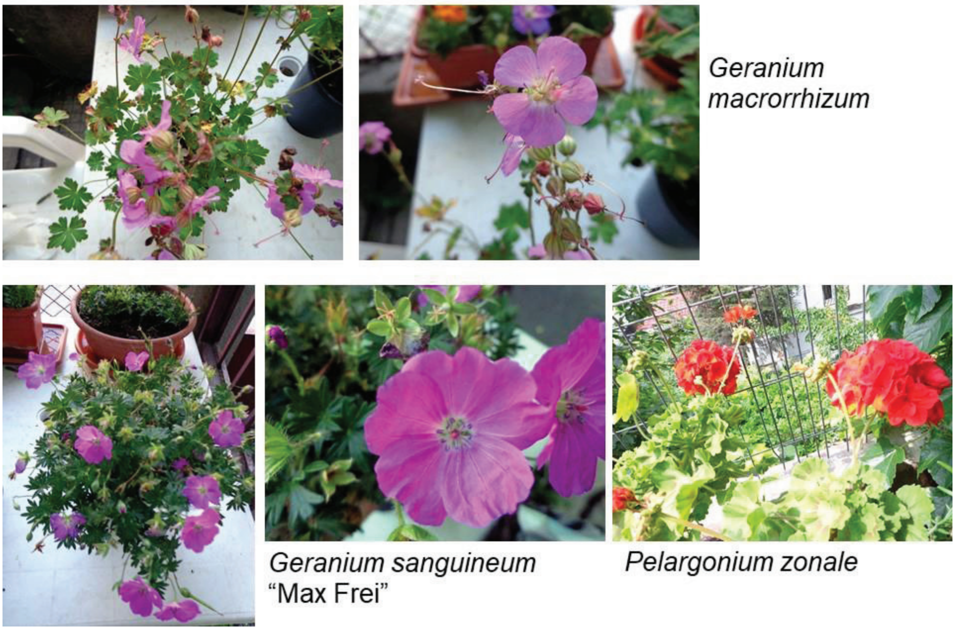
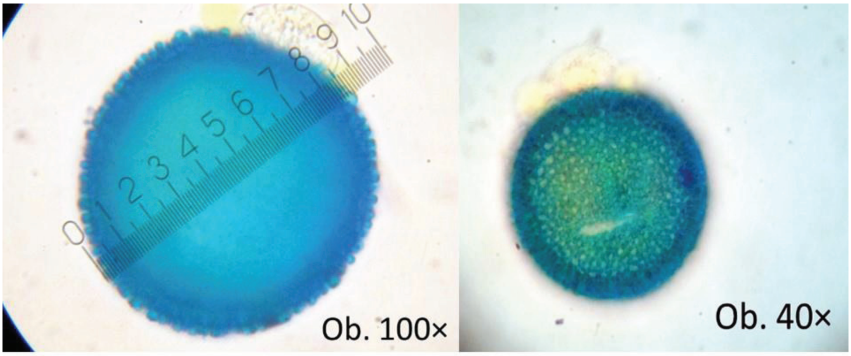


Figure 1. Fresh plants used as biological material in the present study

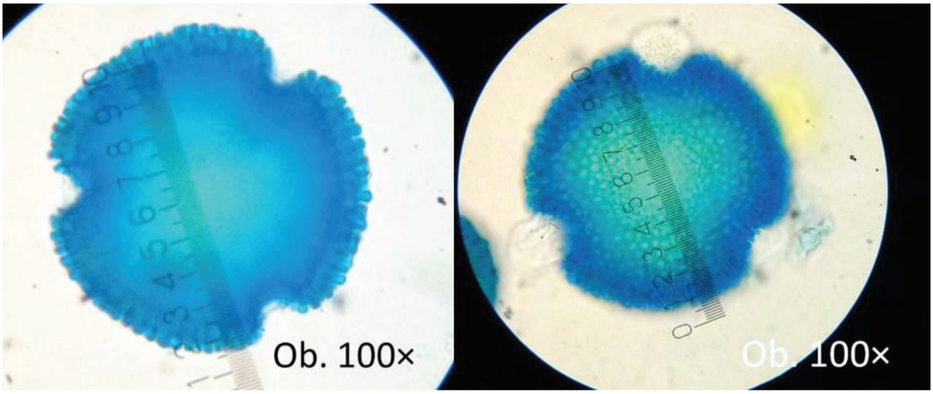
RESULTS AND DISCUSSIONS

Microscopic images of *Geranium macrorrhizum* pollen showed large, isopolar, spheroidal, tricolpate pollen grains with short colpi (<1/3). Exine ornamentation: reticulate, clavate, heterobrochate (Figures 2-3).



Optical section Upper focus

Figure 2. *Geranium macrorrhizum* pollen grain in slightly oblique equatorial view (TB)



Optical section Upper focus

Figure 3. *Geranium macrorrhizum* pollen grain in polar view (TB)

In the present study in light microscopy *Geranium sanguineum* pollen appears to be very large, isopolar, spheroidal, triporate with elliptical shaped pores and reticulate, clavate ornamentation, heterobrochate (Figures 4-7).

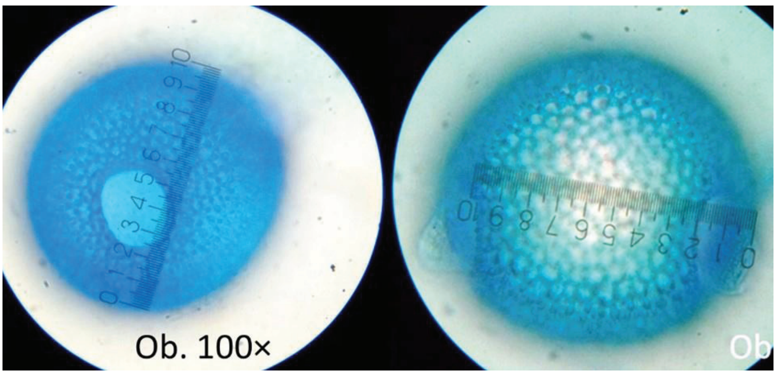


Figure 4. *Geranium sanguineum* pollen grain – lateral view of apertures (TB)

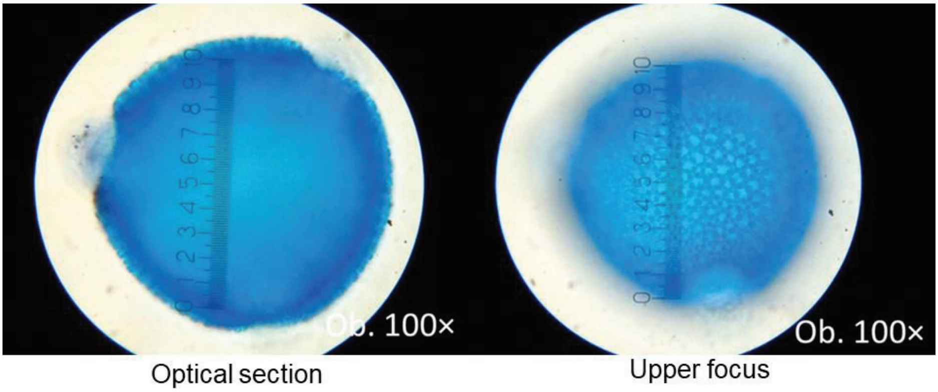


Figure 5. *Geranium sanguineum* pollen grain in polar view (TB)

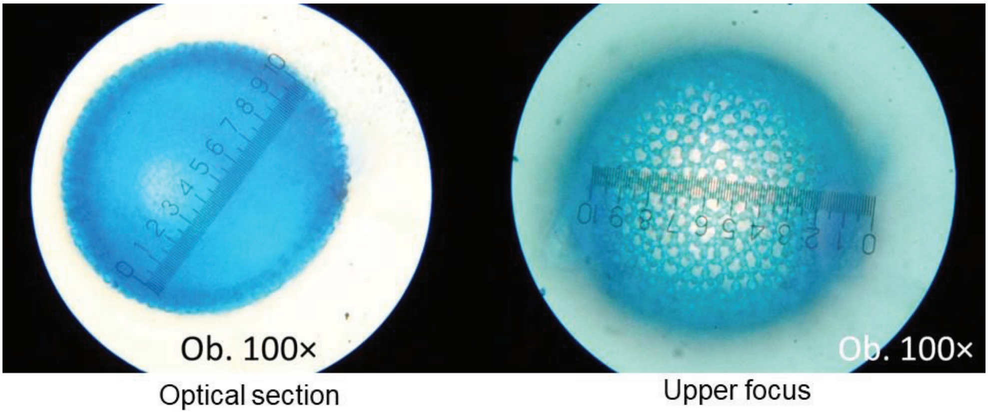


Figure 6. *Geranium sanguineum* pollen grain in equatorial view (TB)

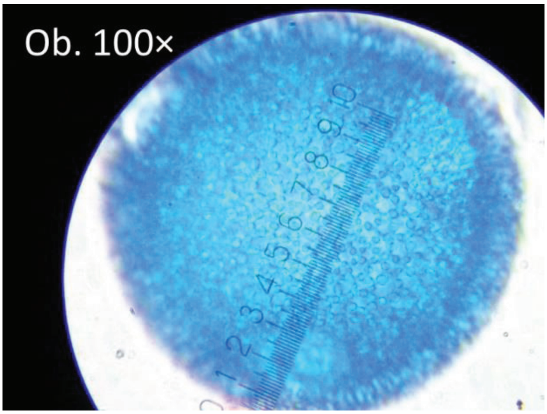


Figure 7. *Geranium sanguineum* exine surface (TB)

Similarly to the description of Stebler 2020, *Pelargonium zonale* pollen showed large, tricolporate, isopolar, spheroidal grains with reticulate, heterobrochate exine (~ 5 μm) (Figures 8-11). In the present study pollenkitt was also seen.

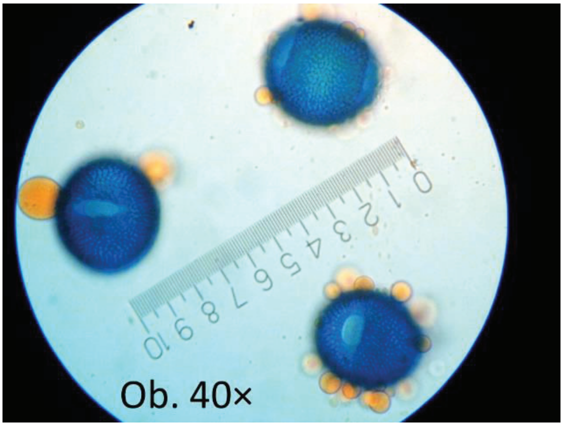


Figure 8. *Pelargonium zonale* tricolporate pollen grains (TB)

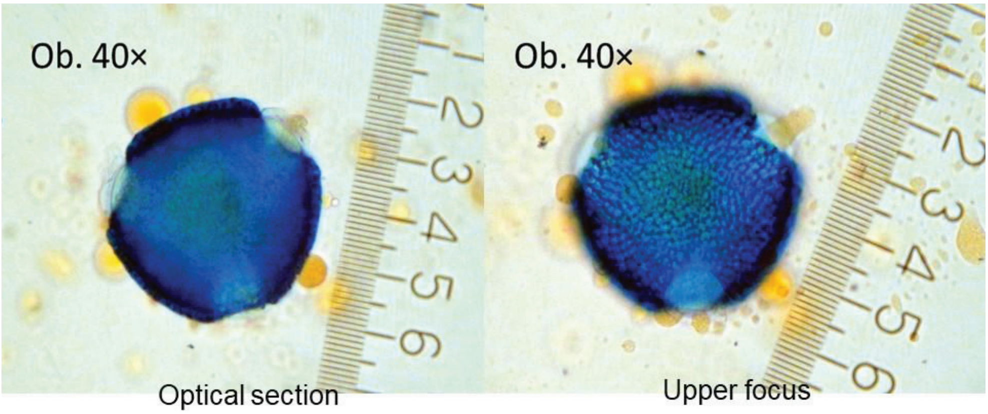


Figure 9. *Pelargonium zonale* pollen grain in polar view (TB)

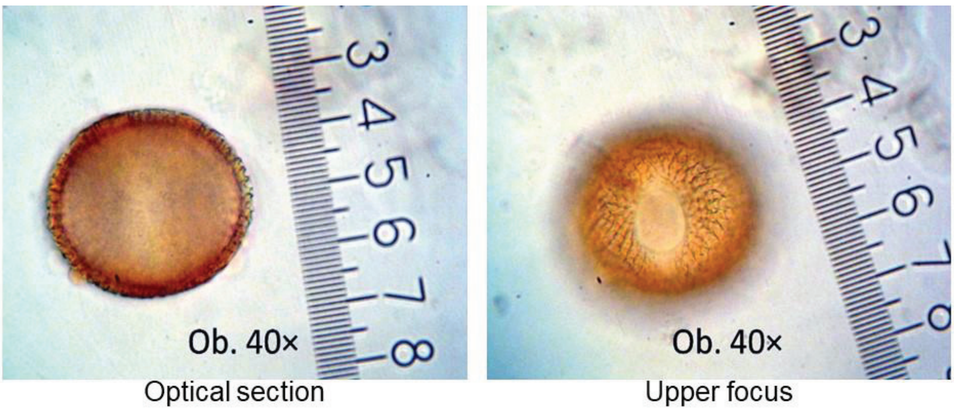


Figure 10. *Pelargonium zonale* pollen grain in lateral view

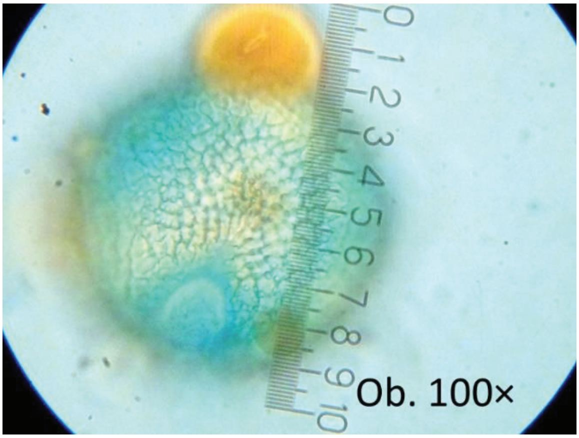


Figure 11. *Pelargonium zonale* exine surface (TB)

CONCLUSIONS

For all 3 species the description from Tarnavschi et al. 1987 is useful in LM studies, however, SEM techniques showed *Geranium macrorrhizum* pollen grains to be tricolpate with very short, almost porate apertures (Kremer et al. 2013) while *Geranium sanguineum* had tricolporate apertures (Deniz et al. 2013). However, tricolporate *Geranium phaeum* pollen grains seem to be porate in hydrated condition (Halbritter 2017). For mellisopalynological studies, the LM analysis can only be used to the genus level.

REFERENCES

Deniz İ., Çırpıcı A., Yildiz K. 2013. Palynological study of the *Geranium* (*Geraniaceae*) species from the Thrace region (Turkey-in-Europe). *Phytologia Balcanica* 19 (3): 347 – 355.

Halbritter H. 2017. *Geranium phaeum*. In: PalDat - A palynological database. https://www.paldat.org/pub/Geranium_phaeum/302947; accessed 2020-08-24

Kremer D., Čepo D. V., Dunkić V., Müller I. D., Kosalec I., Bezić N., Stabentheiner E. 2013. Phytochemical and Micromorphological Traits of *Geranium dalmaticum* and *G. macrorrhizum* (*Geraniaceae*). *Natural Product Communications*. https://doi.org/10.1177/1934578X1300800526

Stanciu O. G., Dezmirean D. S., Campos M. G. 2016. Bee pollen in Transylvania (Romania): Palynological characterization and ORACFL values of lipophilic and hydrophilic extracts of monofloral pollen pellets. *Journal of Agricultural Science and Technology* A 6: 18–37.

Stebler, T. 2019. Kategorien, Pollen-Wiki – Der digitale Pollenatlas, https://pollen.tstebler.ch/MediaWiki/index.php?title=Kategorien (12 Mai 2019).

Stebler T. 2020. "*Pelargonium zonale hybridus*", Pollen-Wiki, https://pollen.tstebler.ch/MediaWiki/index.php?title=Pelargonium_zonale_hybridus (25. Aug. 2020).

Tarnavschi I. T., Şerbănescu-Jitariu G., Mitroiu-Rădulescu N., Rădulescu D. 1987. *Monografia polenului florei din România*. Vol. II. Editura Academiei Republicii Socialiste România, Bucureşti: 80-91.

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THE INFLUENCE OF IRRIGATION REGIME ON TOMATO CROP PRODUCTION

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Keywords: *irrigation, tomato, production.*

ABSTRACT

The management of the soil-water-plant-atmosphere system offers the possibility to monitor the influence of irrigation methods on the environment and leads to the development of agricultural technologies that allow a rational use of water.

By applying irrigation water, the soil is supplied with additional amounts of water, compared to those received naturally by precipitation, depending on the soil and climate conditions and the plant requirements.

Under different water and nutrient supply conditions, it is found that tomatoes change their growth and development during the vegetation period.

Analyzing the production capacity of irrigated tomatoes, it is observed that the least productive is the irrigation on the alternative furrow, and the most productive is the drip irrigation variant. The drip irrigation technique helps to improve the efficiency of irrigation water use in tomato culture.

INTRODUCTION

Being renewable, the water resources depend on the various configurations of climatic factors and the human influence on the environment (Dumitru et al. 2003).

Due to the temperate-continental climate of our country, characterized by high temperatures and low rainfall, especially in the plain area, there is a poor hydrological balance (Grumeza et al. 1988; Grumeza et al. 2005).

Dobrogea is one of the most arid areas in the country, and the extension of the areas arranged for irrigation is justified by the lack of humidity, especially in the warm period of the year. The research conducted by Ștefan Renea showed that the water deficit in the warm period exceeds 350 mm, for the S.C.C.I. ”DOBROGEA ” - Valu lui Traian (Păltineanu et al. 2000).

The application of irrigation water is both an important technological link in agricultural technology and the most important technical means of eliminating the water deficit from the soil (Biolan et al. 2015).

The need for irrigation is highlighted by the decrease of the water supply in the soil, below the lower limit of the active humidity range. The knowledge of soil-water-plant relationships is of particular importance in the process of optimal management of soil water regime through irrigation.

MATERIAL AND METHODS

The experiments took place in the conditions of the dry area in Dobrogea, with an average annual rainfall of 400 mm, on a chernozem type of soil, from 2015 to 2017.

In order to research the influence of water and different watering methods on tomato cultures, we set up a field experience at the Didactic Farm of the Faculty of Natural Sciences and Agricultural Sciences, "Ovidius" University of Constanța.

This paper presents the influence of deficit irrigation techniques (reduced drip irrigation rate) and two irrigation methods (drip and furrows) on the production obtained from tomato cultivation.

To examine the productivity elements of tomato cultivation, observations, measurements and determinations were made according to the analyzed factor (low-furrow irrigation, drip irrigation and full-time furrow irrigation).

In order to carry out the studies, periodic observations were made in the field, regarding the growth and the development of the vegetative organs and fruits on the three batches of tomatoes. At harvest, the amount of tomato production was determined according to the watering method used.

From a technological point of view, tomato crops were made on the basis of the general technology of growing vegetables in the open field.

During the vegetation period, all the necessary works for the establishment and maintenance of the tomato culture were carried out, ensuring optimal conditions for the growth and development of the plants on the three studied alternatives.

RESULTS AND DISCUSSIONS

The production results obtained for tomatoes, Campbell 33 variety, highlight the importance of choosing the watering method depending on the conditions of the crop year.

The growth of tomato plants, in irrigated system, was faster at drip watering compared to watering on furrows. Irrigation water management influenced the growth of tomatoes, without major differences.

For the conditions in which it was experimented, it is observed that the fruiting of the tomatoes was influenced by the application of water, but also by the climatic factors.

Within the experimental plots located in Constanța, the production obtained was assessed by its main components: number of plants / unit area, number of fruits / plant, fruit weight itself and fruit weight / plant.

Table 1

The influence of the irrigation regime on the elements of productivity in tomatoes, Constanța 2015 – 2017

Alternative	Average fruit weight (g)	Average fruit / plant weight (kg)
Drip irrigation	143,5	1,29
Irrigation on furrows	103,2	0,92
Irrigation with low drip irrigation	91,7	0,82

From the data presented in Table 1 it is found that by applying relatively evenly the maintenance works on the whole surface, the average weight of the fruit registered higher values at full-time drip irrigation. The Campbell 33 variety recorded a decrease in fruit weight by 51.8 grams compared to the drip irrigated variant.

As it results from the data obtained in this period of 3 years, the average weight of the fruits per plant showed large variations, with limits between 0.82 kg / plant (the irrigated variant with reduced norm) and 1.29 kg / plant (the variant irrigated full time) and this primarily due to irrigation, thus demonstrating the decisive role of this technological factor for tomato culture, under irrigation conditions.

Tomato production totaled, on average, 2.29 kg / m^2 for the drip irrigated version, 2.57 kg / m^2 for the furrow irrigated version and 3.61 kg / m^2 for full-time drip irrigation.

Harvesting was done manually, in stages of 4-5 days, on each experimental plot, the production being expressed in tons / hectare.

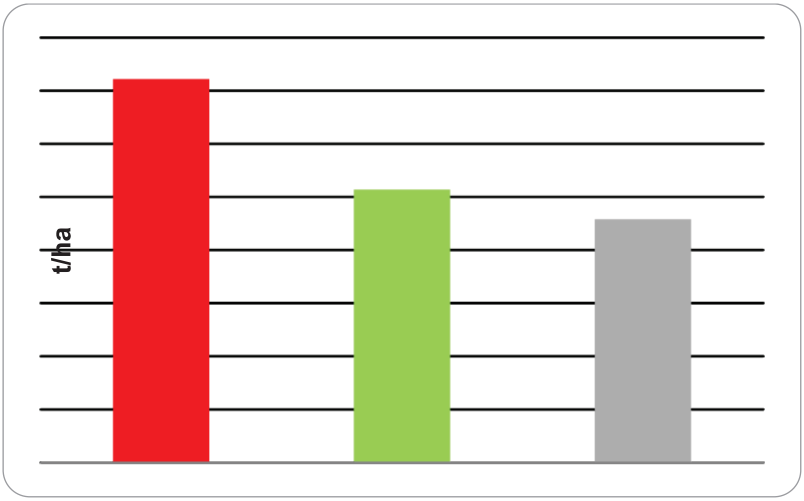

Figure 1 The influence of irrigation on tomato production

The production of tomatoes grown in the open field and irrigated by drip was 36.1 t / ha, compared to those irrigated by furrows where a production of 25.7 t / ha was obtained. The production difference between the two variants was distinctly significant of 10.4 t / ha.

CONCLUSIONS

Analyzing the interaction of the experimental factors, the method of watering and the years on the production of tomatoes, it is found that higher yields are obtained in the full-drip irrigated version compared to the furrowed irrigated version. The lowest experimental yields were obtained under low-irrigation conditions.

REFERENCES

Biolan C., Biolan I., Mardare F., Șerbu I. 2015. Tehnici moderne de irigare a culturilor agricole. Editura AGIR, București.

Dumitru M. și colab. 2003. Cod de bune practici agricole Vol. 1. Editura Expert, Bucureşti.

Grumeza N., Klepș C. 2005. Amenajări de irigații din România. Editura Ceres, București.

Grumeza N., Merculiev O., Tușa C. 1988. Consumul de apă al plantelor cu aplicații în proiectarea și exploatarea amenajărilor de irigații. Întreprinderea poligrafică „Oltenia” Craiova.

Păltineanu Cr., Mihăilescu I. Fl., Seceleanu I. 2000. Dobrogea condiții pedoclimatice, consumul și necesarul apei de irigație pentru principalele culturi agricole. Editura Ex Ponto, Constanța.

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SOIL'S PLANT AVAILABLE WATER AND NITROGEN INORGANIC MODELING AND DIGITAL GIS MAPPING OF WINTER WHEAT, UTILIZING PRECISION AGRICULTURE, GEOSTATISTICAL MODELS, SOIL'S pH, WATER HOLDING CAPACITY, SAND, CLAY AND SILT

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Keywords*: Soil's plant available water, nitrogen inorganic, soil and hydraulic laboratory analyses, GIS and Spatial analysis, geostatistical models.*

ABSTRACT

The paper presents a spatial modeling-mapping approach of soil's plant available water (PAW) and soil's Nitrogen inorganic (N-in) correlation with soil's pH, water holding capacity (WHC) and texture (Sand, Clay, Silt) of a winter wheat (Triticum turgidum) crop using field measurements, soil and hydraulic laboratory analyses, Precision Agriculture, geostatistical models and GIS. Geostatistical models of CoKriging were used as the base for PAW and N-in modeling-mapping at field level with 5 treatments-different auxiliary variables: Soil's pH, WHC, Sand, Clay and Silt contents. Results revealed that the best models and GIS maps were the outputs of PAW-WHC and N-in-Sand (Modeling Prediction Errors were $MPE_{PAW}= 0.0054$, $MSPE_{PAW}=0.0066$, $RMSSE_{PAW}=0.9965$, $MPE_{N\text{-}in}=-0.0655$, $MSPE_{N\text{-}in}=-0.0085$ *and* $RMSSE_{N\text{-}in}=1.024$*). These CoKriging models can be used for digital modeling-mapping with high accuracy for precision agriculture applications and improved irrigation and fertility decisions for site-specific management with variable rate technology.*

INTRODUCTION

Planet's Earth population nowdays is facing tremendous challenges including food security, climate change, land degradation, biodiversity and soil loss, water resources shortage and ecosystem sustainability (Filintas 2011, FAO & ITPS 2015). The above global and also regional issues are closely related to soil-water functions that linking with biomass production, environmental buffering, water purification and climate mitigation (Filintas et al. 2010, Koutseris et al. 2010, Stamatis et al. 2011, McBratney et al. 2014). In order to address the above-mentioned issues, it is needed spatially accurate soil information and precise digital GIS (Geographical Information System) mapping. However, the existing soil and water maps which are produced by conventional soil and hydraulic surveys and mapping techniques, are often coarse in scale, lack important details, have inaccurate spatial boundaries and attribute data (McBratney et al. 2003, Dioudis et al. 2009, Filintas et al. 2010, Arrouays et al. 2014). The evolution of computation power and geo-information new technology has created a great potential for improvement in soil and water mapping (SWM). In this scientific field, the digital soil and water mapping or predictive SWM, had emerged (Scull et al. 2003, Dioudis et al. 2009, Filintas et al. 2010, Stamatis et al. 2011, Minasny & McBratney 2016, Pásztor et al. 2016, Filintas et al. 2019). In the last decade, major progresses have been made in different aspects of digital soil and water mapping which is becoming more mature than ever before. Therefore, the objective of this paper is to present and evaluate a spatial modeling-mapping approach of soil's plant available water (PAW) and soil's Nitrogen inorganic (N-in) concentrations in correlation with soil's pH, water holding capacity (WHC) and texture (sand, clay and silt) of a winter wheat (*Triticum turgidum)* crop using field measurements, soil and hydraulic laboratory analyses, precision agriculture, geostatistical models and GIS.

MATERIAL AND METHODS

Study area: The experiment was conducted at the farmland of Gaiopolis campus-University of Thessaly at Larisa city in Central Greece. The study area has a temperate Mediterranean climate with warm dry summer and a mild winter, and is designated as Csa according to the Koeppen climatic classification (Filintas 2005), and also it is characterized as XERIC MOISTURE REGIME according to Soil Survey Staff (1975), with mean annual temperature and rainfall of 18.8 °C and 513.68 mm, respectively.

Experimental Site and Treatments description: The experimental field was 15.64m width x 64m length, giving a total field area of 1000.96m^2 (0.10 ha). Precision agriculture methods and geostatistical models of CoKriging Interpolation were used as the base for PAW and N-inorganic modeling-mapping at field level with 5 (treatments) different auxiliary variables: Soil's pH, Water Holding Capacity, Sand, Clay and Silt contents. Treatment A was modeling-mapping of PAW (% volumetric) and N-inorganic (ppm) with auxiliary variable soil's pH, Treatment B was modeling-mapping of PAW and N-in with auxiliary variable soil's Water Holding Capacity, Treatment C was modeling-mapping of PAW and N-in with auxiliary variable soil's Sand content (%), Treatment D was modeling-mapping of PAW and N-in with auxiliary variable soil's Clay content (%), and Treatment E was modeling-mapping of PAW and N-in with auxiliary variable soil's Silt content (%).

Soil sample collection, Satellite GPS registration and soil's characteristics laboratory determination: At the experimental cropfield, soil samples (0–30 cm) were collected in an grid pattern to determine texture [(clay content (Cl), silt (Si) content, sand (Sa) content and gravel (Gr) content)], soil's Nitrogen inorganic (N-in) and pH, soil's structure and texture classes, and plant available water (PAW) (% vol.) that was determined by Field Capacity water content (or Water Holding Capacity) (% vol.) and wilting point water content (% vol.) measurements. A Satellite Global Positioning System (GPS) receiver was used to identify and register the sampling locations. A total of 51 soil samples were air-dried and passed through a 2 mm mesh to determine soil texture by the Bouyoucos method (Bouyoucos 1962, Page et al. 1982).

Soil's pH was determined in a 1:5 soil/water extract, while pH value was measured by using glass electrode and a pH meter. Soil's Nitrogen inorganic forms were extracted with 0.5 mol L^{-1} $CaCl_2$ and estimated by distillation in the presence of MgO and Devarda's alloy, respectively (Page et al. 1982).

The water available (PAW) for plant growth is the difference between soil's Field Capacity (FC) and wilting point (WP) water contents. The FC and WP water contents were measured with the porous ceramic plate method placed into a container that is pressurized with 1/3 atmospheres (about 5 psi) for FC and with 15 atmospheres (about 225 psi) for WP (Dioudis et al. 2009, Filintas et al. 2010, Filintas et al. 2019). Soil classification [Fig.1.(f)] with USDA Soil Classification Triangle was performed according to USDA classification (Soil Survey Staff 1975).

Statistical Data Analysis: Data analysis was performed using the IBM SPSS (Norusis 2008) statistical software package. The results are means of the samples and measurements of PAW, Nitrogen inorganic, pH, WHC, Sand, Clay and Silt data groups. Mean separation was made using $LSD_{0.05}$ statistical test as the test criterion when significant differences (P=0.05) between treatments were found (Steel & Torrie 1982). Moreover, the Nitrogen inorganic and PAW results that obtained, were associated with soil's chemical, physical and hydraulic properties (pH, N-in, texture, PAW and Water Holding Capacity) using Pearson correlation statistical test. The significant correlations at a 95% confidence interval were considered to evaluate Nitrogen inorganic and PAW prediction models for the studied experimental field.

Geostatistical modeling and spatial interpolation methodology: For the experimental farm field, spatial interpolation was used with the geostatistical models of CoKriging, which are used to estimate an unknown value, given the observed values at sampled plots (Lu & Wong 2008, Dioudis et al. 2009, Filintas et al. 2010, Filintas 2011, Stamatis et al. 2011, Filintas et al. 2019). The method is based on the assumptions that the attribution values (of PAW, Nitrogen inorganic, pH, WHC and soil texture) at the unsampled soil sites are a weighted average of values at sampled soil sites of the experimental farm field. Using the parameters found from measurements and laboratory analyses (which were digitally mapped in a GIS geodatabase environment) as input auxiliary variables, we delineated PAW and Nitrogen inorganic field maps with the help of spatial analysis and the use of a GIS software (ArcGIS©).

In addition, the evaluation of PAW and N-inorganic require statistical analysis of residual errors, the difference between predicted and observed values and prediction characterization between over- and underestimates. To that end, we used the statistical parameters described by Loague & Green (1991), Filintas (2011), Filintas et al. (2019), such as the equations for the Mean Prediction Error (MPE), Mean Standardized Prediction Error (MSPE) and the Root Mean Square Standardized Error (RMSSE). The MPE and MSPE values should approach zero for an optimal prediction and the RMSSE should approach one.

RESULTS AND DISCUSSIONS

Laboratory texture and classification results showed that the field has a sandy clay loam (SCL) soil (Bouyoucos 1962, Page et al. 1982). The results and statistical analysis showed that Nitrogen inorganic during the measurement period is oscillating from a minimum 50.00 ppm to a maximum 98.00 ppm (mean N-in=68.57 ppm, standard deviation StdD=11.53) as illustrated in Table 1. The plant available water % volumetric water content ranges from a minimum 8.52% vol. to a maximum 12.45% vol. (mean PAW=11.01% vol., StdD=0.92). Sand contents were generally between 52.04% and 57.67%. Most soil samples contained between 13.61% and 22.31% silt and from 22.18% to 28.72% clay (Table 1).

Digital soil and water mapping are the generation of geographically referenced soil-water databases based on quantitative relationships between spatially explicit environmental data and measurements made in the field and in laboratory (McBratney et al. 2003). Regarding quantitative relationships the Pearson correlation statistical test results signifying a positive correlation between Nitrogen inorganic and PAW and the correlation coefficient of r=0.031* indicate the tendency of Nitrogen inorganic and PAW to increase together. Also, a positive correlation exists between Nitrogen inorganic and pH (r=0.583**), PAW (r=0.031*), WHC (r=0.513**), Clay (r=0.596**) and Silt (r=0.274*). On the contrary, between Nitrogen

inorganic and Sand (r=-0.761**) and between PAW and Sand (r=-0.381**) were found negative correlations, which arise when Nitrogen inorganic and PAW increase as Sand content decreases.
Correlation is significant at the: (**) 0.01 level (2-tailed) and (*) 0.05 level (2-tailed).

Table 1

Statistical results of soil's chemical, hydraulic and physical characteristics

Soil Parameter	Min	Max	Mean	Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic
Nitrogen inorganic	50.00	98.00	68.57	11.53	132.94
pH extract (1:5)	7.50	8.10	7.81	0.11	0.01
Plant Availiable Water	8.52	12.45	11.01	0.92	0.85
Water Holding Capacity	26.12	29.73	27.68	1.08	1.16
Sand	52.04	57.67	55.35	1.77	3.12
Clay	22.18	28.72	25.00	1.36	1.86
Silt	13.61	22.31	19.64	1.94	3.76

Sand, Clay and Silt units are in percentage (%), PAW and WHC in % vol. and N-in in ppm.

The soil and water characteristics of the experimental cropfield that were measured and analyzed, were digitized according to their GPS locations in WGS 1984 Geographic Coordinate System and stored in a digital geodatabase in a GIS environment. Then treatments' data were projected to the WGS 1984 UTM Zone 34N Coordinate System for better use in Greece's Coordinates. Finally, spatial interpolation was performed with the geostatistical models of CoKriging, which are used to estimate an unknown value, given the observed values at sampled plots (Filintas et al. 2007, Filintas 2008, Lu & Wong 2008, Filintas 2011, Stamatis et al. 2011, Filintas 2011b, Filintas et al. 2019).

The spatial GIS modeling results are depicted on various digital GIS soil variables maps of the *Triticum turgidum* cropfield. In Fig.1.(a) are depicted the modeling results on a Sand (%) GIS map, in (b) a Clay (%) GIS map, in (c) a Silt (%) GIS map, in (d) soil's pH GIS map and in (e) soil's Water Holding Capacity (% vol.) GIS map. Next step was the calculation and comparison of the semi-variograms [example presented in Fig.1.(g)] and the diagrams of predicted vs measured data [Fig.1.(h) and (i)] of the various CoKriging modeling approaches.

Using the functions of GIS software, the modeling Prediction Errors (MPE, MSPE and RMSSE) were calculated. Results revealed that the best models and GIS maps were the outputs of PAW-WHC and N-in-Sand that outperformed as the top ranked of the best models (Modeling Prediction Errors were MPE_{PAW}= 0.0054, $MSPE_{PAW}$=0.0066, $RMSSE_{PAW}$=0.9965, $MPE_{N\text{-}in}$=-0.0655, $MSPE_{N\text{-}in}$=-0.0085 and $RMSSE_{N\text{-}in}$=1.024).

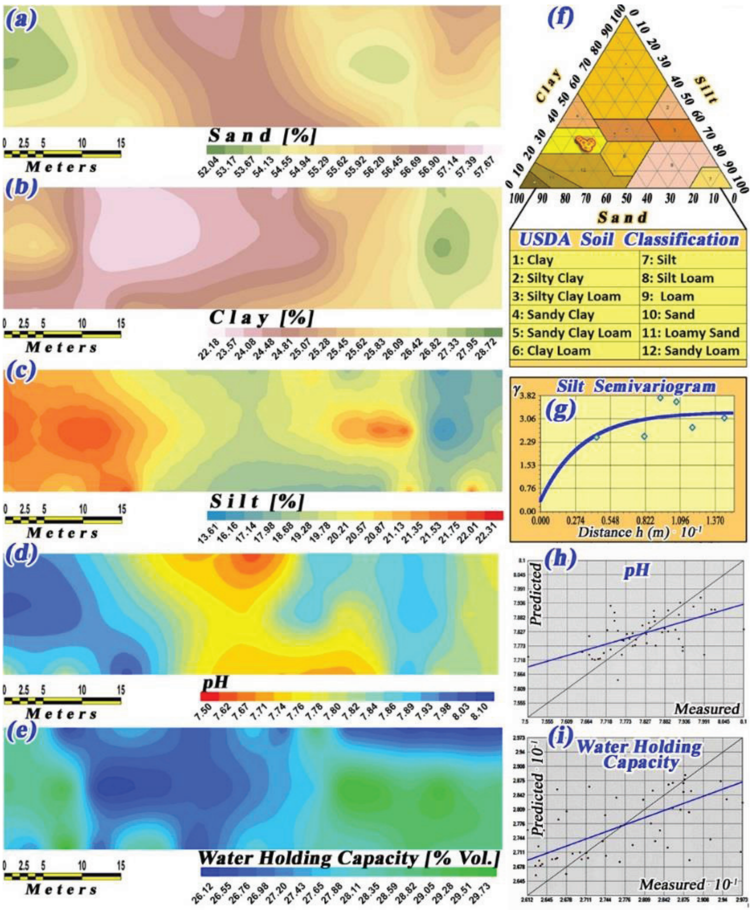

Figure 1. Farmfield's modeling and mapping results on a digital GIS soil : (a) Sand map (%), (b) Clay map (%), (c) Silt map (%), (d) pH map, (e) Water Holding Capacity map (% Vol.), and in (f) the USDA Soil Classification Triangle, (g) Silt Semivariogram, (h) pH diagram, (i) WHC diagram.

The semivariograms of the various models presented in Fig. 2. (e, f, g and h) showed that the best modeling results from best to worse rank was found to be the spatial correlation between: Fig. 2. (a) N-in - Sand (Results rank 1st place (best treatment for N-in) treatment C), Fig. 2. (b) N-in - Clay (treatment D) ranked 2nd place, Fig. 2. (c) PAW - Water Holding Capacity (Results rank 1st place (best treatment for PAW) treatment B) and Fig. 2. (d) PAW - Clay (treatment D) ranked 2nd place.

The prediction error results are well accepted since the MPE and MSPE values should approach zero for an optimal prediction and the RMSSE should approach one. Moreover, geostatistical results confirm the validity and precision of the produced digital soil-water PAW and Nitrogen-inorganic GIS maps with WHC and Sand as auxiliary variables and the other GIS maps at field level.

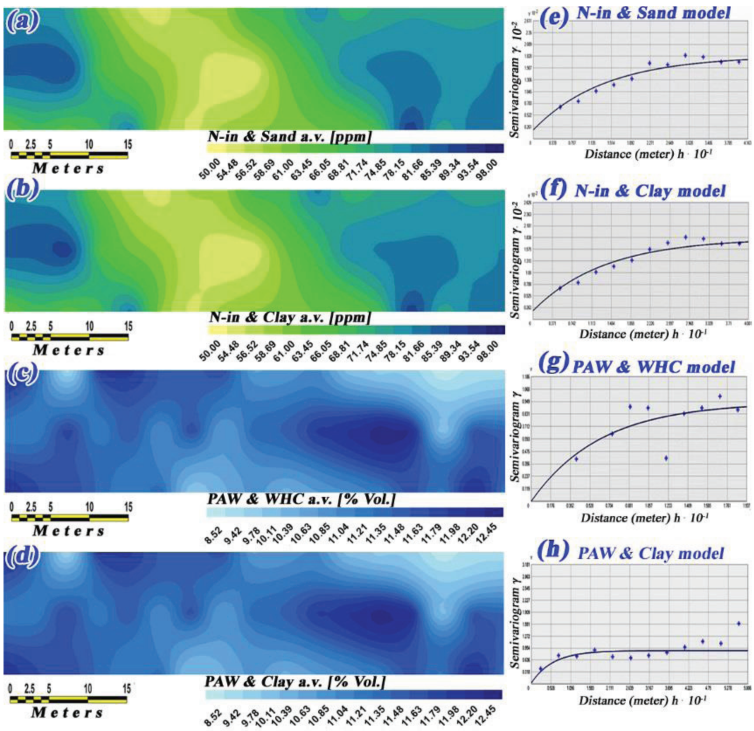

Figure 2. GIS modeling-mapping results of soil's Nitrogen-inorganic and Plant Available Water digital GIS maps produced with various auxiliary variables (a.v.): (a) N-in - Sand (ranked 1st place for N-in), (b) N-in – Clay (2nd place), (c) PAW - Water Holding Capacity (ranked 1st place for PAW) and (d) PAW – Clay (2nd place).

Knowing the spatial patterns and variability of soil's Plant Available Water and Nitrogen-inorganic could be beneficial for the farmers. The presented digital GIS maps revealed an obvious soil-water spatial variability and shed light to soil's studied specific variables spatial patterns. The soil and water digital GIS maps at field level could possibly act as assisting decision tools for site-specific management with variable rate technology (VRT) irrigation and VRT fertilizing precision applications.

CONCLUSIONS

The prediction errors results (MPE_{PAW}=0.0054, $MSPE_{PAW}$=0.0066, $RMSSE_{PAW}$=0.9965, $MPE_{N\text{-}in}$=-0.0655, $MSPE_{N\text{-}in}$=-0.0085 and $RMSSE_{N\text{-}in}$=1.024) of modeling validation and precision for soil's Plant Available Water and Nitrogen-inorganic GIS mapping confirmed the validity, precision and high accuracy of the produced PAW-WHC and N-in-Sand digital GIS maps of the *Triticum Turgidum* experimental Cropfield. The results proved that the CoKriging geostatistical models performed excellently well and are considered very suitable for soil's N-in, pH, Plant Available Water, Water Holding Capacity and other soil parameters (clay, silt, sand, etc.) modeling and geospatial GIS mapping. These models of CoKriging Interpolation can be used for digital modeling-mapping with high accuracy for precision agriculture and site specific management applications with variable rate technology (VRT) for improved irrigation and fertility decisions for the farmers benefit and welfare, as well as for environmental purposes (reducing fertilizers quantities and cost, reducing valuable irrigation water amount and cost, preserve and protect soil's biodiversity, the soil environment and its valuable nutrients).

REFERENCES

Arrouays D., Grundy M. G., Hartemink A. E., Hempel J. W., Heuvelink G. B. M., Hong S. Y., Lagacherie P., Lelyk G., McBratney A. B., McKenzie N. J., Mendonca-Santos M. L., Minasny B., Montanarella L., Odeh I. O. A., Sanchez P. A., Thompson J. A., Zhang G. L.. 2014. Chapter three-GlobalSoilMap: Toward a fine-resolution global grid of soil properties. In: Advances in Agronomy. Elsevier Science & Technology, Netherlands.

Bouyoucos J. G. 1962. Hydrometer method improved for making particle size analysis of soils. Agron J., 54, 464-465.

Dioudis P., Filintas A., Koutseris E. 2009. GPS and GIS based n-mapping of agricultural fields' spatial variability as a tool for non-polluting fertilization by drip irrigation. Int. J. Sus. Dev. Plann. Vol. 4, No. 3, 210–225.

FAO and ITPS 2015. Status of the World's Soil Resources-Main Report. Food and Agriculture Organization (FAO) of the United Nations and Intergovernmental Technical Panel on Soils (ITPS), Rome, Italy.

Filintas A. 2005. Land use systems with emphasis on agricultural machinery, irrigation and nitrates pollution, with the use of satellite remote sensing, geographic information systems and models, in watershed level in Central Greece. MSc thesis, Department of Environment, University of Aegean, Mitilini, Greece.

Filintas Ag., Dioudis P., Koutseris E., Papadopoulos A. 2007. Soils Nitrates GIS mapping, Irrigation water and applied N-fertilizer effects in soils nitrogen depletion in a drip irrigated experimental field in Thessaly basin, in: Proceedings of 3rd IASME/WSEAS International Conference on: Energy, Environment, Ecosystems and Sustainable Development (EEESD'07), Agios Nikolaos, Crete Island, Greece, July 24–26, 486-492.

Filintas A. 2008. Study and mapping of biomass yield with the use of spatial statistics and geoinformation. M.Sc. thesis, Dept. Of Natural Resources and Agriculture Engineering, Agricultural University of Athens, Athens, Greece.

Filintas A., Dioudis P., Prochaska C. 2010. GIS modeling of the impact of drip irrigation, of water quality and of soil's available water capacity on Zea mays L, biomass yield and its biofuel potential. Desalination Water Treat 13(1–3):303–319.

Filintas A. 2011. Land use evaluation and environmental management of biowastes, for irrigation with processed wastewaters and application of bio-sludge with agricultural machinery, for improvement-fertilization of soils and cultures, with the use of GIS-Remote Sensing, Precision Agriculture and Multicriteria Analysis. PhD Thesis, Dept. of Environment, University of the Aegean, Mitilini, Greece.

Filintas A. 2011b. Environmental study of pollution and quality of water resources, hydrogeology and hydrochemistry of the Pinios riverine hydrosystem of Thessaly by the use of field research, laboratory analysis, Data Bases, GPS, GIS, Remote Sensing and statistical analysis. Project FreeMed: Fleuves et Rivieres Edpaces D'Equilibre pour la Mediterranee (Rivers Spaces of Balance for the Mediterranean), EVS, Region of Thessaly, Larissa, Greece, (with extended abstracts in Greek and French).

Filintas A., Gougoulias N., Papachatzis A. 2019. Soil organic matter modeling and digital mapping of a Triticum turgidum cropfield using as auxiliary variables the plant available water, texture, field measurements, soil laboratory analyses, GIS and geostatistical models. Annals of the University of Craiova, seria Biologie, Horticultură, Tehnologia Prelucrării Produselor Agricole, Ingineria Mediului, Vol. XXIV(LX):537-544.

Koutseris E., Filintas A., Dioudis P. 2010. Antiflooding prevention protection, strategic environmental planning of aquatic resources and water purification: the case of Thessalian basin, in Greece. Desalination 250(1):318–322.

Loague K., Green R. E. 1991. Statistical and graphical methods for evaluating solute transport models: overview and application. Journal of Contaminant Hydrology, vol. 7, 51-73.

Lu G. Y., Wong D. W. 2008. An adaptive inverse-distance weighting spatial interpolation technique. Comput. Geosci. 34 (9), 1044-1055.

McBratney A. B., Mendonca-Santos M. L., Minasny B. 2003. On digital soil mapping. Geoderma 117: 3-52.

McBratney A. B., Field D. J., Koch A. 2014. The dimensions of soil security. Geoderma, 213, 203–213.

Minasny B, McBratney A. 2016. Digital soil mapping: A brief history and some lessons. Geoderma, 264, 301–311.

Norusis M. J. 2008. SPSS 17.0 Guide to Data Analysis. Englewood Cliffs:Prentice Hall, USA.

Page A. L., Miller R. H., Keeney D. R. (1982). Methods of Soil Analysis Part 2: Chemical and Microbiological Properties. Agronomy, ASA and SSSA, Madison, Wisconsin, USA.

Pásztor L., Laborczi A., Takács K., Szatmári G., Bakacsi Z., Szabó J. 2016. Variations for the implementation of SCORPAN's "S", In: Digital Soil Mapping Across Paradigms, Scales and Boundaries. Springer, Singapore. pp. 331–342.

Scull P., Franklin J., Chadwick O. A., McArthur D. 2003. Predictive soil mapping: A review. Progress in Physical Geography, 27, 171–197.

Stamatis G., Parpodis K., Filintas A., Zagana E. 2011. Groundwater quality, nitrate pollution and irrigation environmental management in the Neogene sediments of an agricultural region in central Thessaly (Greece). Environ. Earth Sci. 64, 1081–1105.

Steel R. G. D., Torrie J. H. 1982. Principles and Procedures of Statistics. A Biometrical Approach. 2nd ed., McGraw-Hill, Inc., pp. 633.

Soil Survey Staff 1975. Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys. USDA Natural Resources Conservation Service, USA.

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THE EFFECTS OF *CRITHMUM MARITIMUM* L. FOLIAR TISSUES ON SOIL ORGANIC MATTER BIODEGRADATION AND OTHER SOIL CHEMICAL PROPERTIES

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Keywords: *Sea fennel; soil chemical properties; soil organic matter biodegradation*

ABSTRACT

The effects of sea fennel dry leaves on soil organic matter biodegradation and on soil chemical properties in an incubation experiment were studied. The air dried foliar tissues, incorporated at four different rates (0, 0.2, 0.4 and 0.8 g per 50 g of soil mixture with 6.02 g of manure) resulted in an increase in the mineralization of organic carbon, and nitrate nitrogen content. Also, electrical conductivity and exchangeable Na content increased, without any risk of soil salinity.The levels of available forms of Cu and Mn were increased at the two highest rates of added leaves, while the levels of available forms of P, Zn, Fe and exchangeable forms of K, Mg and Ca did not show statistically significant differences compared with control. This study indicated that the sea fennel dry leaves could be applied to the soil to improving the chemical and biological properties of the soil.

INTRODUCTION

Crithmum maritimum L. (sea fennel) is an edible halophyte plant, growing on maritime rocks along the Mediterranean, Black Sea, Pacific, and Atlantic coasts (Siracusa et al. 2011). The leaves of sea fennel are used as a condiment, as pickled and as season salad (Malesˇ et al. 2003). This plant has pharmacological properties indicating its utilization in in traditional medicine as antiscorbutic and diuretic, while in agriculture can be used as insecticide (Amor et al. 2005). Sea fennel are very good source of phenolic compounds, ascorbic acid, carotenoids, and generally bioactive compounds with antioxidant, anticarcinogenic and antimicrobial properties (Suhaj 2006, Meot-Duros and Magne 2009). In addition, sea fennel essential oil showed that has very high antioxidant and antibacterial activity (Senatore et al. 2000, Jallali et al. 2014).

The addition of organic materials in the soil, affects soil structure and the biological activity of soil microflora, which determines the biochemical status of soil fertility (Riber et al. 2014). In addition, it has been proven that organic materials and composts that are rich in available elements reducing the negative impact of soil pathogens (Bailey and Lazarovits 2003). In modern alternative forms of agriculture is mandatory to replace chemicals with natural additives. Between them, the plant debris for their role in the soil fertility, the plant essential oils for their role as pesticides against of soil pathogens (Gravanis et al. 2005). Laboratory studies have shown, the effect of oregano on degradation of organic fertilizers, and it was found that the presence of foliar tissues of oregano, act a slowing effect on degradation of organic fertilizer (Gougoulias et al. 2010).

The aim of work is to examine in vitro the effect of air-dried sea fennel leaf tissues on soil organic matter biodegradation and other soil chemical properties.

MATERIAL AND METHODS

The leaves collections of sea fennel took place during the maturation stage from the maritime rocks along of Central Greece.

Incubation experiment: In this study, 6.02 g of manure containing 2.50 g of organic matter, obtained from the farming establishments of University of Thessaly, was added to 50 g of air-dried soil that was poor in organic matter, derived from the same region (Table 1). Into 50 g of this soil plus 6.02 g of manure, 0, 0.2, 0.4 and 0.8 g of air-dried and well milled of sea fennel leaf tissues were added. In the incubator, the treatments kept at 28 ^{0}C for a period of 15 weeks and were prepared in four replicates. During the first three weeks of the incubation period, the moisture was maintained at two-thirds of field capacity, but for the next three weeks the soils were left to dry. This process was repeated until the end of the incubation period, according to (Wu and Brookes 2005) the alternation of drying and rewetting soil samples enhances mineralization of both soil biomass organic matter and non-biomass organic matter. At the end of the incubation period, soil samples were analyzed.

Methods of analyses: Samples were analyzed using the following methods which are referred by (Page et al. 1982).

Organic matter was analyzed by chemical oxidation with 1 mol/l $K_2Cr_2O_7$ and titration of the remaining reagent with 0.5 mol/l $FeSO_4$. The electrical conductivity and pH were measured in the extract (1part soil : 5 parts H_2O). Both ammonium and nitrate nitrogen were extracted with 0.5 mol/l $CaCl_2$ and estimated by distillation in the presence of MgO and Devarda's alloy, respectively. Available P forms (Olsen P) was extracted with 0.5 mol/l $NaHCO_3$ and measured by spectroscopy. Exchangeable forms of potassium and sodium ware extracted with 1 mol/l CH_3COONH_4 and measured by flame Photometer. Available forms of Mn, Zn, Fe and Cu were extracted with DTPA (diethylene triamine pentaacetic acid 0.005 mol/l + $CaCl_2$ 0.01 mol/l + triethanolamine 0.1 mol/l) and measured by atomic absorption (Spectroscopy Varian Spectra AA 10 plus), with the use of flame and air-acetylene mixture. Also, exchangeable forms of calcium and magnesium ware extracted with 1 mol/l CH_3COONH_4 and measured by atomic absorption. Soil exchangeable sodium percent (ESP) was determined according to equation:

$ESP = (Na^+ \; CEC^{-1}) \times 100$ (1)

Where:

ESP = Exchangeable sodium percentage (%)

Na^+ = Measured exchangeable Na (cmol kg^{-1})

CEC = Cation exchange capacity (cmol kg^{-1})

Element analysis of leaves: Dried samples of leaves were analyzed using the following methods:

Total nitrogen content in leaves was measured using the Kjeldhal method described by (Jones Jr 1997). Total phosphorus, sodium and potassium contents were determined by dry combustion according to the methods described by (Jones jr and Case 1990).

Statistical analysis: Data analysis was made using the MINITAB (Ryan et al. 2005) statistical package. Analysis of variance was used to assess treatments effect. Mean separation was made using Tukey's test when significant differences (P = 0.05) between treatments were found.

Table 1

Chemical properties of soil samples, manure and sea fennel leaf used in the experiment

Property	Soil	*Manure	Sea fennel (air dried material)
Texture	Sandy Loam	-	-
pH	7.86 ± 0.46	8.94 ± 0.49	-
EC, dS/m	0.38 ± 0.03	2.49 ± 0.23	-
Organic matter (%)	0.81 ± 0.04	41.5 ± 2.39	-
N -Total (g/kg)	1.16 ± 0.14	9.72 ± 0.09	12.50 ± 0.65
N-NO_3^- (mg/kg)	129.2 ± 12.17	-	-
N-NH_4^+ (mg/kg)	43.3 ± 4.12	-	-
Na-exchangeable (mg/kg)	109.6 ± 7.2	-	-
K-exchangeable (mg/kg)	223.7 ± 11.9	-	-
CEC (cmol/kg)	12.8 ± 0.9	-	-
P -Olsen (mg/kg)	10.1 ± 2.1	-	-
Cu –DTPA (mg/kg)	0.77 ± 0.06	-	-
Zn -DTPA (mg/kg)	1.11 ± 0.08	-	-
Mn -DTPA (mg/kg)	1.13 ± 0.31	-	-
Fe -DTPA (mg/kg)	1.01 ± 0.08	-	-
K-Total (g/kg)	4.71 ± 0.34	15.52 ± 0.93	16.75 ± 0.91
Na-Total (g/kg)	0.29 ± 0.03	6.42 ± 0.33	14.50 ± 0.76
P -Total (g/kg)	0.32 ± 0.04	5.16 ± 0.32	7.12 ± 0.38

*Digested sheep manure five months; Electrical conductivity, (EC) and soil pH is determined in (1:5) soil / water extract; Data represent average means and SE deviation. (n) = 4.

RESULTS AND DISCUSSIONS

The results of the laboratory experiment at the end of the incubation period, they showed that decomposition of soil organic matter added as manure or preexisted organic matter in the soil, was increased from the application of sea fennel leaf in the soil mixtures, compared with control (soil plus manure). In particular, the decomposition of organic matter in soil where the sea fennel leaf were incorporated, were higher from 2.63 to 15.33 %, compared with control (Figure 1). Similar laboratory studies have shown, the effect of basil on degradation of organic fertilizers, and it was found that the presence of foliar tissues of basil, has an accelerating effect on biodegradation of organic fertilizer (Chouliaras et al. 2007).

Nitrate-nitrogen content in the soil mixtures (soil plus manure) increased by the addition of sea fennel dry leaf at the end of the incubation period compared with control, at all treatments. This means that sea fennel biomass promotes the nitrification process in the soil. Contrast, ammonium-nitrogen was decreased by the addition of dry plant tissues of sea fennel, while stronger decrease was observed with the addition of the highest rate (figure 2).

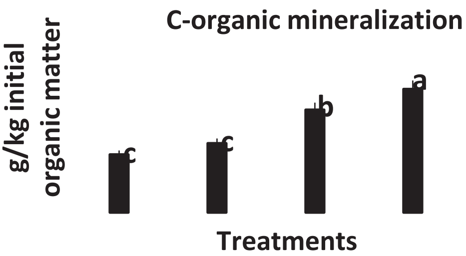

Figure 1. Effect of sea fennel dry leaf added rates on soil organic carbon mineralization; C, control (soil plus manure); CS1, CS2 or CS3, control and foliar tissues 0.2, 0.4 or 0.8 g, respectively; Bar values with the same letter on the top are not significantly different according to Tukey's test (P > 0.05).

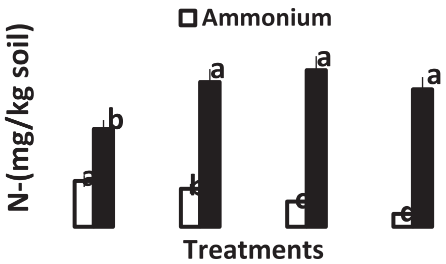

Figure 2. Effect of sea fennel dry leaf added rates on soil ammonium and nitrate content; C, control (soil plus manure); CS1, CS2 or CS3, control and foliar tissues 0.2, 0.4 or 0.8 g, respectively; For each chemical property of samples, bar values with the same letter on the top are not significantly different according to Tukey test (P > 0.05).

Available phosphorus did not show statistically significant differences at the end of the incubation period, at the all added rates of sea fennel dry leaf, compared with control (Table 2). Electrical conductivity increased at the end of the incubation period at the all added rates of sea fennel dry leaf. In particular, the highest increase (61.0 %) was caused by the highest added rate sea fennel, compared with control, without any risk of soil salinity (Table 2). This increase is due in conditions highest intensity biodegradation of soil organic matter. Contrary, the highest added rate of sea fennel leaf decreased the soil pH compared with control at the end of the incubation period. The decrease of soil pH at the highest dose at the end of the incubation period, probably is due to the stronger decomposition of soil organic matter, and in the increased oxidation of N-NH_4^+ to N-NO_3^-. The available forms of Cu and Mn were increased at the end of the incubation period, with the application of the two highest rates dry leaves in the soil mixtures, compared with control. Furthermore, available forms of Zn and Fe by the addition of dry leaves in the mixtures (soil plus manure), did not show statistically significant differences at the end of the incubation period compared with control, at all treatments(Table 2).

Table 2

Chemical properties of soil mixtures at the end of the incubation period

Treatments	P-Olsen	EC	pH	DTPA			
		Extract (1: 5) soil / water		Cu	Zn	Mn	Fe
	mg / kg soil	dS / m		mg / kg soil			
C	155.2[a]	0.77[b]	7.86[a]	0.79[c]	3.26[a]	2.03[c]	1.43[a]
CS1	153.7[a]	0.95[c]	7.76[a]	0.84[bc]	3.34[a]	2.26[c]	1.47[a]
CS2	150.6[a]	1.23[b]	7.70[a]	0.99[b]	3.39[a]	2.79[b]	1.52[a]
CS3	157.8[a]	1.24[a]	7.47[b]	1.37[a]	3.50[a]	3.26[a]	1.62[a]

For each chemical property of soil mixtures, columns of table with the same letter do not differ significantly according to Tukey's test (P = 0.05); C, control (soil plus manure); CS1,CS2 or CS3, control and sea fennel dry leaf 0.2, 0.4 or 0.8 g, respectively.

The exchangeable forms of K, Mg and Ca of the soil mixtures did not show statistically significant differences at the end of the incubation period, at the all added rates of sea fennel dry leaf, compared with control (Table 3). Exchangeable Na content increased at the end of the incubation period at the all added rates of sea fennel dry leaf, compared with control. However, the ESP (%) was low and there is no risk sodic soil. Furthermore, the two highest added rates of sea fennel dry leaf, increased the cation-exchange capacity (CEC) of soil mixtures at the end of the incubation period compared with control (Table 3).

Table 3

Chemical properties of soil mixtures at the end of the incubation period

Treatments	Exchangeable forms				
	Na	K	Mg	Ca	CEC
	mg / kg soil				cmol / kg soil
C	151.8[d]	643.5[a]	2340[a]	2224[a]	35.24[b]
CR1	345.0[c]	604.5[a]	2436[a]	2300[a]	34.85[b]
CR2	844.1[b]	596.7[a]	2520[a]	2450[a]	38.45[a]
CR3	936.1[a]	643.5[a]	2556[a]	2500[a]	39.52[a]

For each chemical property of soil mixtures, columns of table with the same letter do not differ significantly according to Tukey's test (P = 0.05); C, control (soil plus manure); CS1, CS2 or CS3, control and sea fennel dry leaf 0.2, 0.4 or 0.8 g, respectively.

CONCLUSIONS

Three different rates of sea fennel dry leaf were applied into a soil amended with manure, and after an incubation experiment 15 weeks the effects on the soil chemical properties were attested. These results confirm that, dry foliar tissues of sea fennel it is a valuable material for soil amendment, could be applied to the soil as an acceleration agent for soil organic matter biodegradation, improving soil chemical and biological properties, without any risk of soil salinity.

REFERENCES

Amor N. B., Hamed K. B., Debez A., Grignon C., Abdelly C. 2005. Physiological and antioxidant responses of the perennial halophyte Crithmum maritimum to salinity. Plant Science, 168(4): 889-899.

Bailey K. L., Lazarovits G. 2003. Suppressing soil-borne diseases with residue management and organic amendments. Soil and tillage research, 72(2): 169-180.

Chouliaras N., Gravanis F., Vasilakoglou I., Gougoulias N., Vagelas I., Kapotis T., Wogiatzi E. 2007. The effect of basil (*Ocimum basilicum* L.) on soil organic matter biodegradation and other soil chemical properties. Journal of the Science of Food and Agriculture, 87(13): 2416-2419.

Gougoulias N., Vagelas I., Vasilakoglou I., Gravanis F., Louka A., Wogiatzi E., Chouliaras N. 2010. Comparison of neem or oregano with thiram on organic matter decomposition of a sand loam soil amended with compost, and on soil biological activity. Journal of the Science of Food and Agriculture, 90(2): 286-290.

Gravanis F.T., Chouliaras N., Vagelas I., Gougoulias N., Sabani P., Wogiatzi E. 2005. The effect of Oregano (*Origanum vulgare*) as an alternative soil-borne pathogen control agent, on soil organic matter biodegradation and other soil chemical properties, Crop Science & Technology Congress Proceedings 1, Glasgow, Scotland, UK, 31 Oct - 2 Nov, pp. 2A-11:105-108.

Jallali I., Zaouali Y., Missaoui I., Smeoui A., Abdelly C., Ksouri R. 2014. Variability of antioxidant and antibacterial effects of essential oils and acetonic extracts of two edible halophytes: Crithmum maritimum L. and Inula crithmoïdes L. Food chemistry, 145: 1031-1038.

Jones Jr J.B. 1997. Plant nutritional manual CRC Press. New York.

Jones Jr J.B., Case V.W. 1990. Sampling, handling, and analyzing plant tissue samples. Soil testing and plant analysis, 3: 389-427.

Malesˇ Zˇ., Zˇuntar I., Nigovic´ B., Plazibat M., Vundac´ V.B. 2003. Quantitative analysis of the polyphenols of the aerial parts of rock samphire Crithmum maritimum L. Acta Pharm 53:139–144.

Meot-Duros L., Magne C. 2009. Antioxidant activity and phenol content of Crithmum maritimum L. leaves. Plant Physiology and Biochemistry, *47*(1), 37-41.

Page A.L, Miller R.H., Keeney D.R.1982. Methods of Soil Analysis. Part 2, Chemical and Microbiological properties. Agronomy (9), ASSSA, Mad. Wisc. USA.

Riber L., Poulsen P.H., Al-Soud W.A., Hansen L.B.S., Bergmark L., Brejnrod A., Sørensen S.J. 2014. Exploring the immediate and long-term impact on bacterial communities in soil amended with animal and urban organic waste fertilizers using pyrosequencing and screening for horizontal transfer of antibiotic resistance. FEMS microbiology ecology, 90(1): 206-224.

Ryan B.F., Joiner B.L., Cryer J.D. 2005. MINITAB Handbook: Updated for release 14, 5th edition. Brooks/Cole-Thomson Learning Inc., Kentaky, KY.

Senatore F., Napolitano F., Ozcan M. 2000. Composition and antibacterial activity of the essential oil from Crithmum maritimum L.(Apiaceae) growing wild in Turkey. Flavour and fragrance journal, 15(3): 186-189.

Siracusa L., Kulisic-Bilusic T., Politeo O., Krause I., Dejanovic B., Ruberto G. 2011. Phenolic composition and antioxidant activity of aqueous infusions from Capparis spinosa L. and Crithmum maritimum L. before and after submission to a two-step in vitro digestion model. Journal of agricultural and food chemistry, *59*(23): 12453-12459.

Suhaj M. 2006. Spice antioxidants isolation and their antiradical activity: a review. J Food Compos Anal 19: 531–537.

Wu J., Brookes P.C. 2005. The proportional Mineralisation of Microbial Biomass and Organic Matter caused by air-drying and rewetting of a grassland soil. Soil Biology & Biochemistry, 37: 507-515.

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ERVANT VARIETY – NEW RESULT OF POTATO BREEDING RESEARCH AT NIRDPSB BRASOV

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Keywords: *potato variety, breeding, cultivar description, technology, culinary quality*

ABSTRACT

Among the achievements of National Institute of Research and Development for Potato and Sugar Beet in 2019 was the registration of the potato variety Ervant. The variety was obtained through sexuat hybridization between Bellarosa and Laura varieties followed by individual clonal selection. As vegetation period enroll in the group of middle varieties. Ervant variety has a high yield capacity (79 t/ha in network ISTIS, Targu Secuiesc location), is resistant to black wart biotype 1 (Synchitrium endobioticum) and to different viruses (PVY and PLRV) and middle sensitive to late blight (Phytophthora infestans) on foliage and relative resistant to late blight on tubers. The tubers have a short oval shape, with shallow eyes, the color of the skin is yellow and the pulp is cream. The variety is conceived for autumn-winter consumption, being suitable for most culinary preparations, from salad to french fries and mash potatoes. The variety is currently patented and registred in the Official Catalogue of new varieties of plants for culture in Romania.

INTRODUCTION

The cultivated potato (*Solanum tuberosum* L.) is the most important non-cereal crop in the world and a key component of global food security (Devaux et al. 2014). More than 4,000 different potato varieties are grown worldwide (Zaheer and Akhtar 2016, Tillault & Yevtushenko, 2019). The increase in global potato production requires the constant development of new varieties to satisfy the demands of the consumer (e.g., improved taste and nutritional value), the grower (e.g., higher yield and enhanced disease resistance) and the processor (e.g., low reducing sugars) (Govindaraj et al. 2015).

Potatoes are an excellent source of many bioactive components in the human diet. In our diet, a typical meal of 200 g of boiled potatoes (at least three medium sized tubers) will contribute 9% of the Guideline Daily Amount (GDA) of protein, 11% of carbohydrates, 11% of dietary fibres, up to 28% of potassium, 18% of phosphorus and 15% of magnesium as well as 47% of the Recommended Dietary Allowance (RDA) of vitamin C (Visvanathan et al. 2016, Wadas & Rymuza 2019).

Potato is used mainly for three purposes, as table purpose (vegetable and number of recipes), as a seed tuber and as a processed food like chips, wafers, flakes, starch, granules, flour, potato biscuits, potato patties, puffs, wedges, pancakes, dehydrated mashed potatoes, canned potatoes (Banjade et al. 2019).

Desirable attributes for potato tubers are high storage capacity, good shape, adequate color, smooth skin and smooth eyes, no scars or cracking (Fallahi 1997, Hassanpanah et al. 2011).

Potato is financially more remunerative than cereals from food security and can be recommended as a partial replacement of cereals (Anwar et al. 2015).

As a result of the pressures exerted by climate change, the breeding programs are working to create drought-resistant varieties, varieties with a shorter germination period and/or vegetation. The principle pursued in selecting the suitable varieties is, on the one hand, to increase the efficiency of the use of natural and climatic resources, and, on the other hand, to minimize the impact of agricultural practices on the environment.

For that, the choice of varieties should take into account the adaptability to local climatic conditions (resistance to water stress in drought vulnerable areas) and the natural potential for quality and quantity.

MATERIAL AND METHODS

The new medium early potato variety Ervant was developed at the NIRDPSB Brasov. Ervant was selected from the cross between varieties Bellarosa and Laura.

Conventional breeding methods, crossing with different hybrid varieties or hybrids and repeated selection of hybrid tuber generations were used in breeding. The crossing and growing of seedling were carried out in the greenhouse and the next generations were tested in the field.

After was done a comparative crop, 2 years in the network of National Institute for Testing and Registration of Varieties and finally was obtained the patent and the registration in the National List of Cultivated Varieties.

The resistance to black wart (*Synchitrium endobioticum*) was determinated at Pojorata Station, Suceava country.

Diseases (late blight and viruses) attacks on the behavior of the variety were determinated in the fields of NIRDPSB Brasov. The culinary quality and the starch content were determinated in the Technology lab of NIRDPSB Brasov.

RESULTS AND DISCUSSIONS

The morphological description of Ervant variety is given in accordance with UPOV characteristics (Figure 1).

The plant is tall, with erect habit and a high number of steams. The leaf is small like size, green color and has an average number of leaflets. The flowers have a large corolla opening, are light pink and the flowering is poor.

The tubers have a short oval shape, with shallow eyes, the color of the skin is yellow and the color of the pulp is cream.

Figure 1. Morphological description of Ervant variety

Resistance to pests and diseases according to the test performed in NIRDPSB Brasov fields, Ervant variety is resistant to PVY and leaf roll viruses (PLRV) and middle sensitive to late blight (*Phytophthora infestans*) on foliage and relative resistant to late blight on tubers (Table 1).

The breeding program developed at the NIRDPSB Brasov imposed the restrictive condition that all clones proposed to became varieties to be resistant to potato wart (*Synchitrium endobioticum*), biotype 1. According to the test performed to Pojorâta station (Suceava country), Ervant variety is resistant to this quarantine disease.

Table 1

Ervant variety diseases resistance compared with standard varieties

Variety	PVY	Leaf roll virus (PLRV)	Late blight	
			to foliage	to tuber
Ervant	8	8	5	8
Rustic (control)	7	7	9	8
Roclas (control)	8	7	6	7

1 – sensitive
9 – very resistant

Growing recommandations

Site requirements. Low to medium demands to the soil conditions and water supply. Futher this variety has a good tolerance to drought as well as a good resistance to secondary growth (in the climatic conditions of RDSPCS Dabuleni, Dolj country, in 2018, the variety obtained a production of 41 t/ha).

Planting. Density between 44.400- 53.300 plants (seed size 35/55 mm). Planting depth 5 cm. The size of the ridge at planting is from small to medium-sized, having a height of 12-15 cm.

Fertilization. To achieve an average yield of 35-40 t/ha is necessary a fertilizer complex administration (N:P:K) at least 800 kg/ha. During the potato vegetation, 3-4 treatments can be made with foliar fertilizers, which contain macro and microelements and stimulants.

Herbicides. 2-5 days before crop emergence it must be applied an pre-emergent herbicide (metribuzin, metabromuron, aclonifen, prosulfocarb etc.). Due to the filmic effect of a good part of the herbicides that control the annual weeds, we recommend that, after application, no intervention in the crop (plowing or ridging) for 4-6 weeks, until the end of the herbicide effect, in order not to destroy the formed film. Post-emergence can be applied a selective herbicide, with graminicidal action (based on propaquizalop, haloxifop-R-methyl, fluazifop-P-butyl, quizalofop).

To Ervant variety were not observed problems regarding chlorosis, necrosis or some deformation due to the use of this kind of herbicides.

Pests and diseases. Foliage protection against late blight (*Phytophthora infestans*): strongly recommanded the first treatment to be applied using forecast and warning (AGROEXPERT SYSTEM). In the lack of DSS system, the first treatment must be applied when the plants are 10-20 cm high and the conditions are favourable for the disease. Treatments applied regularly and sustained according to the specific climatic conditions, with the alternation of systemic and contact products. The effectiveness of a treatment is obvious when certain rules are followed, when the spray is not done on dew or humidity, when there is no wind, when the nozzles are calibrated and ensure uniformity, when the product is valid and the doses are strictly observed (Hermeziu and Hermeziu 2012).

Harvest. 15-20 days before harvest the field must be prepared by killing the stems mechanically or chemically, depends on the destination (seed or consumption).

Cooking quality. In the breeding programme the taste of potato is not a very important trait, but for consumers is important to know how to use a variety (french fries, mashed potato, chips etc.).

The content of dry matter, including starch content is influenced by the physiological age of tuber at harvesting, the intensity of light, the water supply in the soil, soil conditions, etc. (Tsahkna & Tähtjärv 2007, Tsahkna & Tähtjärv 2008). Assessments on the culinary quality of potato varieties are made for boiled potato samples using a method developed by Goodijk & Lugt (1959) and an assessment key of potato culinary qualities (Mureșan 1999) (Table 2). Features like general appearance, taste, disintegration, consistency, mealiness, moistness, granulation are marked according to the rating steps with grades from 1 to 4, except color, which is noted with grades from 1 to 6. The sum of the grades obtained for boiling disintegration, consistency, mealiness, moistness and starch structure include a variety in one of the types of use (A, B, C or D), where A means suitable for salads, B – all type of culinary preparations, C- industrial processing (chips, pommes frites) and D – industry of starch and alcohol.

Table 2

Culinary quality of Ervant variety compared with standard varieties Rustic and Roclas (2017)

Character	Ervant	Rustic	Roclas	Observations
Aspect	1.50	2.38	2.13	1-very showy 4-unshowy
Taste	1.75	2.13	1.88	1-excelent 4-less good
Color	3.25	4.25	4.25	1-white 6-intense yellow
Disintegration	1.13	2.13	2.0	1-remain whole 4 hard crush
Consistency	1.75	2.13	2.5	1-firm hearty 4-unhearty
Mealiness	1.88	3.13	2.13	1-unmealy 4-very mealy
Moistness	1.63	3.13	2.13	1-moist 4-dry
Granulation	1.75	2.88	2.13	1-fine 4-very coarse
Cooking type	A/B	B/C	B	
Starch content	13.0	17.5	15.58	

Yield and adaptation determine the possible acceptability of the future variety. Ervant variety exceeded the control varieties, Roclas, Rustic and Christian, the yielding capacity in different enviromental conditions and also the ecological plasticity of the variety proving significant. The control varieties were excedeed with value between 13,2-23,5% in 2016 and 18,3-21,8% in 2017 (Table 3). Like all other varieties, Ervant variety was prior approval tested by State National Institute for Testing and Registration of Varieties (ISTIS) network, evaluations being made in seven reference centers: Targu Secuiesc, Sibiu, Satu Mare, Radauţi, Ludus, Harman (Braşov country), Bacau.

Table 3

Yielding capacity in State Institute for Testing and Registration of Varieties network

ISTIS station	Year 2016			Year 2017		
	Ervant (t/ha)	Roclas (t/ha)	Rustic (t/ha)	Ervant (t/ha)	Roclas (t/ha)	Christian (t/ha)
Targu Secuiesc	64.60	56.19	49.65	79.07	56.17	63.09
Sibiu	53.93	46.43	41.99	44.84	38.52	38.12
Satu Mare	37.05	35.16	28.32	36.08	32.46	32.01
Radauţi	39.74	33.44	36.57	41.86	37.21	37.76
Ludus	42.83	33.82	32.93	21.83	18.76	22.49
Harman	48.98	43.91	41.91	65.29	47.92	45.85
Bacau	42.91	43.62	36.75	23.72	25.72	23.62
Average	47.29	41.79	38.30	44.67	36.68	37.56

CONCLUSIONS

The potato variety Ervant was breed at the National Institute of Research and Development for Potato and Sugar Beet Brasov. The patent was obtained in 28.02.2019 and the variety is currently registred in the Official Catalogue of new varieties of plants for culture in Romania.

Ervant variety have a very good capacity of yield, is very well adapted to soil and climate condition of Romania on the base of testing activity on the network of the State National Institute for Testing and Registration of Varieties (ISTIS).

The introduction in production of a large number of Romanian potato varieties represent an increased genetic diversity and the possibility for farmers to choose varieties well adapted to local climatic conditions, to avoid thermo-hydric stress and to reach good yield every year.

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REFERENCES

Anwar M., Shabbir G., Shahid M. H., Samreen W. 2015. Determinants of potato prices and its forecasting: A case study of Punjab, Pakistan. Punjab, Pakistan: Punjab Economic Research Institute

Banjade Sarita, Shrestha S.M., Pokharel N., Pandey D., Rana M. 2019. Evaluation of growth and yield attributes of commonly grown potato (*Solanum tuberosum*) varieties at Kavre, Nepal. International Journal of Scientific and Research Publications, Vol. 9, issue 11: 134-141

Devaux A., Kromann P., Ortiz O. 2014. Potatoes for sustainable global food security. Potato Research, 57: 185– 199. https://doi.org/10.1007/s11540-014-9265-1

Govindaraj M., Vetriventhan M., Srinivasan M., 2015. Importance of genetic diversity assessment in crop plants and its recent advances: An overview of its analytical perspectives. Genetics Research International, 1–14. https://doi.org/10.1155/2015/431487

Fallahi M. 1997. Potato Knowlegde and Technology. Barsava Publishing Co., Mashhad, Iran Hassanpanah D., Hassanabadi H., Azizi Chakherchaman 2011. Evaluation of cooking quality characteristics of advanced clones and potato cultivars. American Journal of Food Technology 6 (1): 72-79

Hermeziu Manuela and Hermeziu R. 2012. Strategia corectă aplicată în controlul manei cartofului. Cartoful în România vol. 21, nr. 1: 65-68

Lugt G. and Goodijk G. 1959. Raport on the third Meeting of the working grup “Potato quality. Research” of the European Association for Potato Research. Schwitzerland. nr. 15.

Mureşan S. 1999. Calitatea cartofului pentru consum. Calitatea culinară a tuberculilor de cartof, Cartoful în România, vol. 9, nr. 2: 18-21

Tsahkna A., Tähtjärv T. 2007. Cultivation of potato varieties in different locations in Estonia, Journal of Agricultural Science, XVIII (1): 72-77

Tsahkna A., Tähtjärv T. 2008. The new potato variety ‘Reet’. Agronomijas Vēstis (Latvian Journal of Agronomy), No.11: 159-164

Tillault A. S. and Yevtushenko D.P. 2019. Simple sequence repeat analysis of new potato varieties developed in Alberta, Canada. Plant Direct. 2019; 3: 1–10. https://doi.org/10.1002/pld3.140

Zaheer K., Akhtar M. H. 2016. Potato production, usage, and nutrition. A review. Critical Reviews in Food Science and Nutrition 56: 711-721. https://doi.org/10.1080/10408398.2012.724479

Visvanathan R., Jayathilake C., Jayawardana B.C., Liyanage R. 2016. Health-beneficial properties of potato and compounds of interest. Journal of the Science of Food and Agriculture, 96 (15): 4850- 4860. DOI: https://doi.org/10.1002/jsfa.7848 39

Wadas Wanda and Rymuza Katarzyna 2019. Comparative Study of the Quality of New Potatoes Imported from the Mediterranean Area. Journal of Ecological Engineering, vol. 20, Issue 5: 59–68.

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STUDIES OF EFFICACY OF DIFFERENT HERBICIDES AGAINST WEEDS IN POTATO CROP IN CENTRAL PART OF ROMANIA

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Keywords*: potato, herbicide, efficacy, crop tolerance, weed control*

ABSTRACT

The present study was conducted to determine the response of new cultivars to diferent herbicides, applied either pre-emergence or post-emergence and to determine any effect on tuber yield. Test results come from a field experiment conducted between 2018–2019 to the National Institute of Research and Development for Potato and Sugar Beet Brasov. Two factors were tested: factor I - potato varieties: Cezarina, Asinaria, Castrum, Sevastia, Marvis, Sarmis, Christian, Brasovia, Ervant, Cosiana, Azaria and Darilena; factor II – five herbicides to control weeds (V1: Control; V2: Sencor 70 WG; V3: Arcade; V4: Proman; V5: Sencor 70 WG + Sencor 70 WG). In the period of examination were registered a predominant number of 6 weeds species (Green foxtail, Lamb's quarters, Redroot pigweed, Field bindweed, Birdeye speedwell, Cleavers).

INTRODUCTION

Weeds are growing in places where they are not wanted, they are competitive and repress other plants, are resistant to some control measures, forms abundant populations, are not useful but on the contrary hurtful for people and animals (Donescu & Hermeziu 2014). A combination of cultural practices and appropriate herbicides usually gives the most effective weed control. Herbicide rates must be adjusted for soil texture, percentage of organic matter, soil pH, weed species, potential for soil residue and other used herbicides (Frâncu 1988, Hermeziu et al. 2018). Competition between potatoes and weeds should be minimized from planting to the time of canopy closure, 6 to 7 weeks later. Weeds that emerge after row closure usually will not compete with the potato crop so long as the canopy is uniform and dense. Crop uniformity and density is determined by the stature of the variety and the uniformity of plant spacing.

Weeds reduce the efficiency of some agricultural works, such as the application of fertilizers, irrigation etc. Weeds also present a problem at harvest by increasing mechanical damage to tubers, reducing harvesting efficiency, and slowing down harvesting operations (Siblani & Haidar 2017). High yielding capacity and better quality are considered the two main objectives in potato production. Weed invasion reduces both quality and quantity of potato tubers through decreasing size, weight and number of tubers (Arnold et al. 1997, Karimmojeni et al. 2014). Eliminating weeds early is the primary objective in potato production (Felix et al. 2008) because weeds emerging with potato crop or a week later can cause higher crop loss than weeds emerging 3 or more weeks later (Nelson & Thoreson 1981, Uremis et. al. 2009). The efficiency of a given chemical is limited only to controlling certain weed species and it can vary with the weed density, time of weed emergence, crop management practices, cropping system and the environmental conditions under which the crop is grown. Thus, it is important to conduct location specific experiments on weed management (Kebede et al. 2016). Continued development of herbicides with different modes of action is important in order to provide potato producers with tools to manage difficult-to-control weeds and delay development of herbicide-resistant weeds (Boydston et al. 2012). Characteristic for the weed population of potato fields in central part of Romania are annual weeds like *Amaranthus spp*., *Chenopodium spp*., *Echinochloa crus-galli* L. and *Setaria spp*.. From among perennial plants *Cirsium arvense* L. and *Convulvulus arvensis* L. can cause high problems.

MATERIAL AND METHODS

Experiments were carried out at the National Institue of Research and Development for Potato and Sugar Beet Brasov, Romania, in 2018-2019. The soil was cambic chernozeum with 6.7 pH, humus 4.68% and clay 27%. The pre-crop in 2018 was wheat and in 2019 mustard.

The field experiments each year were set up in random block, 3 replicate plots with 4 rows each with 11 plants. The size of elementary plot was 9 m^2, with the distance 75/30 cm. Fertilizer, NPK 16-16-16, was applied at 800 kg/ ha rate in 2018 and at 1000 kg/ha rate in 2019, before potato planting.

Six Romanian potato varieties, Cezarina, Asinaria, Castrum, Sevastia, Marvis, Sarmis, were planted in 2018 April, 19, and other 6 varieties, Christian, Brasovia, Ervant, Cosiana, Azaria and Darilena, in 2019 April, 4.

Herbicide use: V1: Control (untreated); V2: Sencor 70 WG (metribuzin 70%) - 1.2 kg/ha; V3: Arcade (800 g/l prosulfocarb+ 80 g/l metribuzin) - 4.0 l/ha; V4: Proman (500 g/l metobromuron) - 4.0 l/ha; V5: Sencor 70 WG + Sencor 70 WG (metribuzin 70%) - 0.6 + 0.4 kg/ha.

The measurement of weeds was made by using a metric frame (4 x 0.25 m2 quadrats), recording the number of weeds per square meter. The result from the control variant (V1) represents the first level of infestation, while the results from the variants V2-V5 represent the effects of the used herbicides.

In order to evaluate the degree of weed infestation and effectiveness of control methods, the following evaluation methods were used:

- covering degree (G. a. %) = (no. of weeds per variant / no. of weeds for control) x 100.
- participation degree (G. p. %) = (no. of weeds per species / total no. of weeds per variant) x 100.

RESULTS AND DISCUSSIONS

2018. During the vegetation period (April - August) the air temperature was higher on average by 2.7oC, compared to MAA. Between April 1 and August 31, the total rainfall exceeded the value of MAA by only 16.6 mm. It should be noted, however, that the distribution of precipitation was very uneven. In May, rainfall was 42.4% less than MMA. In June and July, the water needed for plant development and for the accumulation of production was provided by the abundant rainfall of 204.8 mm in June (211.8% compared to MAA) and 133.6 mm in July (133.9% compared to MAA). In August, the air temperature higher with 2.7oC than MAA and less precipitation (only 61.0% compared to MMA) accelerated the drying of the foliage and the maturation of tubers. Slightly higher temperatures by 1.1oC and lower rainfall (82.7% compared to MAA) in September allowed the potato to be harvested in good conditions

2019. From planting to potato flowering, between April and May, the average monthly temperatures were close to normal. May, rich in rainfall (98.6 l / sqm) and with temperatures close to MAA characteristic to the area contributed to a good start of crops by uniform emergence of plants. In June, however, the recorded monthly average exceeded MMA values by 3.1oC. In the second part of the growing season, in July (+ 0.9°C), August (-2.0°C) and September (+ 1.2°C) the average monthly temperatures fluctuated generally around MAA (Table 1).

Table 1

Air temperature and rainfalls during the experiment

Year	Month					
	May	June	July	August	September	
	Air temperature (°C)					Average
2018	16.3	18.1	18.8	20.2	14.7	17.6
2019	13.4	19.6	19.0	15.5	14.8	16.5
MMA	13.6	16.5	18.1	17.5	13.6	15.9
	Amount of rainfall (mm)					Total
2018	34.8	204.8	133.6	46.6	43.4	463.2
2019	98.6	110.0	68.6	86.2	8.9	372.3
MMA	82.0	96.7	99.8	76.4	52.5	407.4

In two-year period of examination were registered a predominant number of 6 species (Green foxtail, Lamb's quarters, Redroot pigweed, Field bindweed, Birdeye speedwell, Cleavers).

Table 2

Weeds covering degree 2018

	Cezarina	Asinaria	Sevastia	Castrum	Marvis	Sarmis
G. a %						
V1 (control)	162	152	189	154	138	134
V2	8.62	0.12	1.10	2.10	1.70	2.20
V3	9.25	2.70	5.68	6.45	3.25	2.80
V4	6.58	5.48	8.54	10.00	6.15	6.00
V5	0.02	0.05	0.10	1.15	0.70	0.55

In 2018 the best results (with a cover degree of 0,02%, 0,05% and respectively 0,10%) was obtained to the V5 (Sencor 0.6 kg/ha + 0.4 kg/ha) to the varieties Cezarina, Asinaria and Sevastia. Also very good results was obtained in V2 (metribuzin 1.2 kg/ha), with a cover degree of 0,12%, 1,10% and 1.70% to the varieties Asinaria, Sevastia and Marvis.

Table 3

Weeds covering degree 2019

	Azaria	Ervant	Christian	Darilena	Cosiana	Brasovia
G. a %						
V1	516	591	532	649	739	659
V2	16.86	27.41	42.48	0.22	18.00	16.24
V3	8.14	12.52	37.78	0.12	8.93	5.77
V4	21.32	36.55	30.26	0.14	21.52	24.00
V5	10.27	4.74	11.28	0.07	6.36	4.70

In 2019 the potato variety Azaria V3 (Arcade 4.0 l/ha) with a cover degree 8.14% presented the best result. To the other varieties, Ervant, Cosiana and Brasovia the best results (with a cover degree 4,74%, 6,36% and respectively 4.70%) was obtained to the V5 (Sencor 0.6 kg/ha+0.4 kg/ha). Regarding the variety response, significant impact of potato cultivars on the number and weed species composition were obtained in Darilena variety in all treated variants, the degree of weed coverage being minimal (Table 3).

It was observed that weeds population varied significantly in the two analysed years. Minimum population was observed in 2018.

Table 4

Structure and number of weeds recorded in control variants (ind./m^2) 2018

Weed species	**2018**					
	Cezarina	**Asinaria**	**Sevastia**	**Castrum**	**Marvis**	**Sarmis**
Setaria viridis	11.8	14.0	16.7	18.0	16.0	10.0
Chenopodium album	2.2	1.33	2.0	2.7	2.3	6.0
Amaranthus retroflexus	3.0	5.0	4.3	2.7	1.0	2.7
Convolvulus arvensis	1.0	1.67	1.0	2.7	1.0	2.0
Veronica persica	0	0	1.0	0	0	0.3
Galium aparine	0	0	0	0	0	0.7
Total	18.0	22.0	25.0	26.1	20.3	21.7

In the total weediness of control variant in 2018 the weed species above mentioned were presented with the highest number 26.1 individuals/sqm to Castrum variety and the lowest number 18.0 individuals/sqm to Cezarina variety (Table 4).

Table 5

Structure and number of weeds recorded in control variants (ind./m^2) 2019

Weed species	**2019**					
	Brasovia	**Christian**	**Darilena**	**Azaria**	**Cosiana**	**Ervant**
Setaria viridis	194.3	148.3	204.3	158.3	220.3	172.3
Chenopodium album	4.7	3.1	2.7	3.0	6.3	8.3
Amaranthus retroflexus	10.7	9.7	8.3	1.7	10.3	6.0
Convolvulus arvensis	6.0	0.0	0.7	0.3	5.7	1.3
Veronica persica	4.0	7.7	5.3	6.3	3.3	6.7
Galium aparine	0.0	0.0	0.0	2.3	0.3	2.3
Total	219.7	168.8	221.3	171.9	246.2	196.9

In the total weediness of control variant in 2019 the weed species above mentioned were presented with the highest number 246.2 individuals /sqm to Cosiana variety and the lowest number 168.8 individuals/sqm to Christian variety in 2019 (Table 5). The major problem was *Setaria viridis* that was no controlled by applied herbicides. *Setaria viridis* being a grass need a postemergence herbicide too.

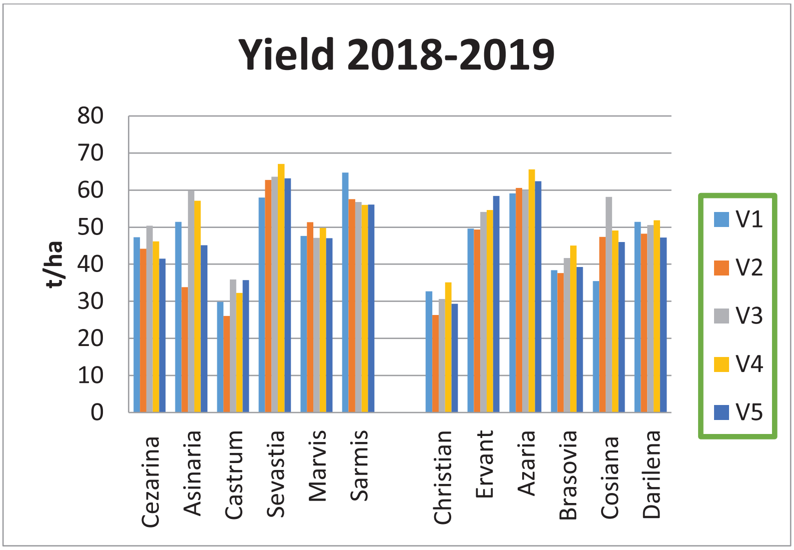

Figure 1. Total yield in 2018 and 2019 (Brasov)

Regarding the production, in 2018 highest value were obtained to Sarmis (64,75 t/ha) and Sevastia (67.07 t/ha) varieties, regardless of the herbicide used. In 2019 Azaria (65.59 t/ha) variety achieved the largest productions. Among the herbicide variants used two consecutive years in NIRDPSB Brasov, the highest efficacy present V4 (metobromuron product) followed by V3 (prosulfocarb + metribuzin product) irrespective of studied potato varieties.

CONCLUSIONS

A warmer months and an uneven distribution of precipitation influence weeds distribution and their impact on crop production. Field trials conducted to INCDCSZ Braşov during 2018-2019 studied the effect of some preemergent and postemergent herbicides on weed control.

It's important to take account of the potential weed reserve in soil and to see the correlation between meteorological data and the intensity of weed infestation.

Weed infestation determined in potato field showed a total of 6 species, relatively poor community, but with a large number of individuals. Growth of weeds in the treated plots resulted in low weed density and total marketable yield was noticeably higher. Applied herbicides showed very high level of efficiency in reducing the weeds number. We also considered that is important to apply a graminicide when grasses have 10-15 cm.

REFERENCES

Arnold RN., Murray MN., Gregory EJ., Smeal D., 1997. Weed control in field potatoes. Agricultural Experiment Station Research Report No. 723. Farmington, College of Agriculture, New Mexico State University

Boydston, R.A., Felix, J., Al-Khatib, K. 2012. Preemergence herbicides for potential use in potato production. Weed Technology 26:731–739

Donescu Daniela, Hermeziu Manuela. 2014. Program guide for the prevention and integrated control of weeds, diseases and pests in potato. Protecţia Plantelor vol. XXIV, nr. 93. Soc. Prot. Pl. Transilvania, 5-12

Felix J., Ivany J., Kegode G. O., Doohan D. 2008. Timing potato cultivation using weedcast model. Weed Sci., DOI: 10.1614/WS-08-019.1

Frâncu Georgeta. 1988. Aplicarea preemergentă a erbicidelor la cultura cartofului. Cartofulul în România nr. 2 vol. 8, 15-17

Hermeziu Manuela, Moldovan Cristina, Hermeziu R., Niţu Sorina. 2018. Weeds control in potato crop using different metribuzin doses. Agricultura, agricultural practice and science journal, vol. 105, no. 1-2,11-16

Karimmojeni H., Barjasteh A., Mousavi R.S., Bazrafshan A.H. 2014. Determination of the critical period of weed control in potato (*Solanum tuberosum* L.), New Zealand Journal of Crop and Horticultural Science, 42:3, 151-160, DOI: 10.1080/01140671.2013.875926

Kebede G., Sharma J.J., Dechassa N. 2016. Evaluation of chemical and cultural methods of weed management in potato (*Solanum tuberosum* L.) in Gishe District, North Shewa, Ethiopia

Nelson D. C., Thoreson M. C., 1981. Competition between Potatoes (*Solanum tuberosum*) and Weeds. Weed Sci., 29: 672-677.

Siblani W., Haidar, M. 2017. Reduced Rates of Metribuzin and Time of Hilling Controlled Weeds in Potato. Am. J. of Plant Sciences, 8: 3207-3217.

Uremis I., M. E. Caliskan A. Uludag, Caliskan S. 2009. Weed management in early-season potato production in the Mediterranean conditions of Turkey. Bulg. J. Agric. Sci. 15: 423-434

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FRUITS VARIABILITY OF *Datura stramonium* L. WEED

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Keywords: *capsule, Datura stramonium, morphological characters, variability*

ABSTRACT

*The species represents an annual dicotyledonous (Oudhia & Tripathi, 1998) to which increasing attention is given. On the one hand, there has been a clear spread in agricultural areas, and on the other hand the interest from a medicinal point of view has increased (Cortinovis & Caloni 2015). Its spread occurs through the relatively high number of seeds it produces and by their high persistence in the soil. The morphological characters of the plant and especially the reproductive ones have shown a continuous evolution, depending on the ecotype existing at one point. The capsule was 3.6 cm high, 7.4 cm thick and 4.6 g weight. On the capsule the big thorns were 7.3 mm long and the small spines 3.1 mm long. The capsule formed an average of 397 seeds weighing 2.9 g. the seeds had a length of 2.8 mm and a width of 2.9 mm. positive correlations were obtained between the height of the capsules with the number of seeds/capsule (r = .826***) and between the length of the large thorns and the weight of the seeds/ capsule (r = .0451***). The negative correlations were between the mass of one thousand seeds and the other characters. The plant formed seeds with the highest absolute weight when the number in a capsule was smaller, like an adaptation sense.*

INTRODUCTION

Adaptation of the weed to the new current conditions (Henry & Bauman, 1991; Oliver et al. 1991) can also be demonstrated by observing the tendency of variability of as many morphological characters as possible. It was found that a weed with the greatest variability of reproductive characters, was able to adapt much better to the ecology of one crop or another area. A known weed in agricultural fields is *Datura stramonium* L. (pro syn *D. inoxia* Mill, *Stramonium spinosum* Lam, thornapple, moon flower, Jamestown weed, DATST in Bayer code). The name Datura comes from Sanskrit धतूरा *dhatūra* 'thorn-apple', a Hindu name, but also from *toloache* and *tolguacha* which derive from *tolohuaxihuiti* = nodding head, of Mexican origin (Geeta & Gharaibeh, 2007). The name of the *stramonia* was used in 17 century for different species of *Datura*. *Stramonium* originates from Greek στρύχνος "nightshade" and μανιακός "mad". The fruit is ovoid in shape, being an erect capsule, 3.5-6.5 cm long, 2-5 cm wide, opening through four valves, being densely covered with longer and shorter spines, rarely with brushes.

The seeds are numerous, dark brown to black, flattened, kidney-shaped, with irregularly covered surface with pits. The seeds are 3-4 mm long/high and 2-3 mm wide. The plant vegetates under different environmental conditions and blooms in summer- early autumn. The plant is not consumed by animals because of the smell af the active principles that it secretes and which are toxic (Bruneton 2005; Boumba et al. 2004). From a medicinal point of view, the plant contains a number of valuable compounds (Jiao et al. 2002). Thus, all parts of the plant contain dangerous levels of tropic alkaloids: *atropine, hioscyanine* and *scopolamine*, classified as delusional. The plant also had the *daturine* alkaloid. The weed is native to Central America and has spread all over the world, preferring the hot-temperate climate. By making measurements under different vegetation conditions, some new elements could be brought into the description of this weed species, with special requirements for medicine. Mature capsules were analyzed in this study. Thus, their height and width, weight, length of large and small spines, the number of seeds in a capsule, their weight, the height and width of the seeds, as well as their absolute mass (as the mass of a thousand seeds- TSW).

MATERIAL AND METHODS

Determinations were made during August and September on mature plants of *Datura stramonium,* during the last two years. Plants were chosen from the ruderal area of agricultural land in the resort area. One capsule was cut into 100 plants of *Datura stramonium*. The capsule was measured: the height, the width, the total weight, the length of the big thorns, the length of the small spines. The seeds were taken out of the capsule and counted, weighet and their absolute height, width and weight determined. The morphological characters obtained were analyzed by the histogram method (frequency polygon, FP,%). Within the method, the class intervals were used. The study carried out several aspects, namely: i) the modal values, the ones with the highest frequencies, ii) the limits of the variability ranges of the studied characters and iii) the specificity of each character of the weed ecotype in the analyzed area. Between the analyzed characters, simple correlations and regressions were established. These correlations could express some tendencies within the studied eco-type. In expressing the values, the Excel program was used. In the calculation of all the determined characters, the analysis of variance anova test) was used, namely on the variation strings. Statistical parameters were calculated using he formulas: $\bar{u} = \Sigma x/n$, where $\bar{u}$ = average of the determinations, and x = the determined values, s^2 (variance) = $1/(n-1).[\Sigma x^2-(\Sigma x)^2/n]$, s (standard error) = $\sqrt{s^2}$, s% (variation coefficient) = $s/\bar{u}.100$.

RESULTS AND DISCUSSIONS

Capsule and seed variability. After flowering, capsules are formed in a relatively short time. The data from the literature show values of the capsule sizes between 3.5 and 6.5 cm in height (their position being erect) and 2-5 cm in width. By measuring the height of the capsule from the base to the top, some differences were found (Figure 1). The limit of values was between 2 and 4.9 cm. The modal value was at heights of 3.8-4 cm (30%), followed by those with 3.5-3.7 cm (18%). The shorter capsules, 2-2.8 mm and the tallest (4.9 cm) had a frequency of 102%. The thickness of the capsules showed values between 1.6 and 3.4 cm. the modal value was 2.6-2.7 cm (40%), followed by those with 2.8-2.9 cm (17%). Capsules with larger thicknesses constituted 5% of the total (Figure 2). The weight of the capsule had specific values (Figure 3). Thus, the capsule weight limits were between 1 and 8 g. They dominated the capsules whose weight was 5-6 g (22%), followed by those with 4-5 g (20%). The weed capsule looks characteristic (Figure 4).

The fruit is covered with a multitude of thorns. Some of them are longer and are positioned towards the top, and the vast majority are the short ones. The two categories were measured in length, separated. Thus, the large thorns had lengths between 4 and 12 mm. Those with lengths of 7-8 mm (24%) dominated, followed by those with 6-7 mm (21%) and 6-9 mm (19%) (Figure 5).

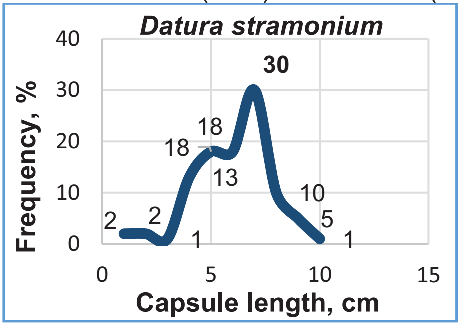

Figure 1. Frequencies of capsule length::
2-2.2 -2.5 -2.8 -3,1 -3.4 -3.7 **-4** -4.3 -4.6 4.9

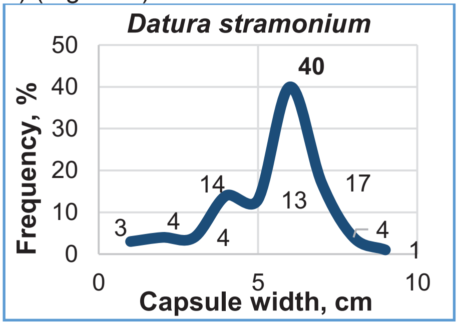

Figure 2. Frequencies of capsule width:
1.6-1.7 -1.9 -2.1 -2.3 -2.5 **-2.7** -2.9 -3.1 -3.3 3.4

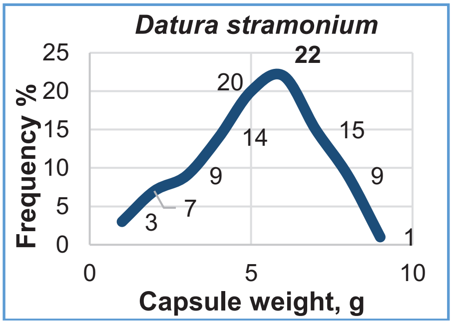

Figure 3. Frequencies of capsule weight:
<1 1.1-2 -3 -4 -5 **-6** -7 -8

Figure 4. Plant capsule aspect

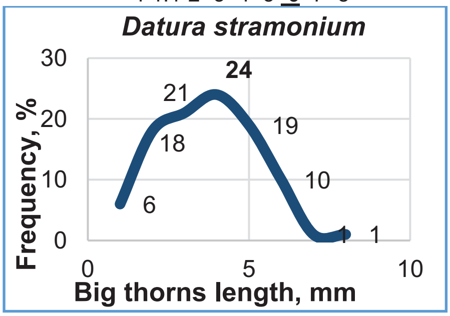

Figure 5. Frequencies of big thorn length:
4.1-5 -6 -7 **-8** -9 -10, -11 -12

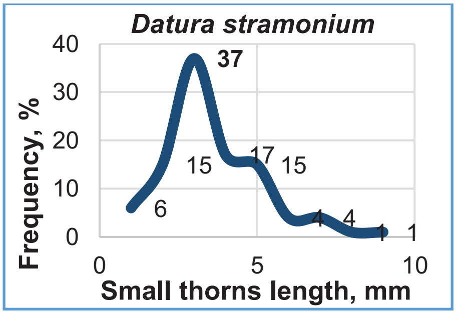

Figure 6. Frequencies of small thorn length:
1.5-2 -2.4 **-3** -3.4 -4 -4.4 -5 -5.4 -6

Short thorns had values between 1.5 and 6 mm. The modal value was between 2.5 and 3 mm (37%). Thorns with close lengths constituted 15-17% of the total (Figure 6).

The capsule of *D. stramonium* forms seeds in a variable number, i.e. in a relatively large amount. And in the case of the analyzed capsules, between 100 and 740 seeds/ capsule were found. The highest frequency had the capsules with 460-539 seeds (22%), followed by those with 390-460 seeds (14%). Capsules with seeds below 200 and over 700 made up about 10% of the total (Figure 7). The weight of these seeds in a capsule was recorded with values below 0.5 g and 5.60 g (Figure 8). They dominated the capsules whose seeds had a mass between 3.05 and 3.56 g (17%). They followed those with weights between 3.56 and 4.97 g (16%). Seed dimensions had specific variability. Thus, the height measured from point of attachment to the top had values between 2 and 4 mm. The determinations made showed dominant lengths of seeds of *D. stramonium* in the range 2.5-2.7 mm (24%). These were followed by those with 2.7-3.1 mm (17-22%) (Figure 9). The width/ thickness of the seed drill was between 2 and 4 mm. The highest frequency was those with 3-3.2 mm (33%), followed by 14% of those with 2.9-3 mm (Figure 10).

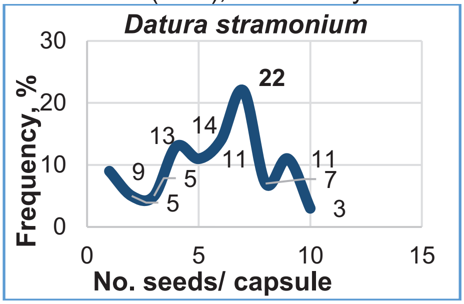

Figure 7. Frequencies of no. seeds/capsule: -110 -180 -250 -320 -390 -460 **-530** -600 -670 -740

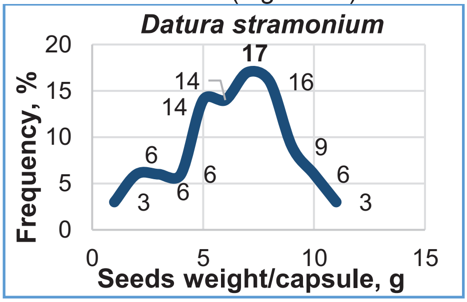

Figure 8. Frequencies of weight <0.5 -1,01 -1.52 -2.03 -2.54 -3.05 **-3.56** -4.97 -4.58 -5.09 -5.60

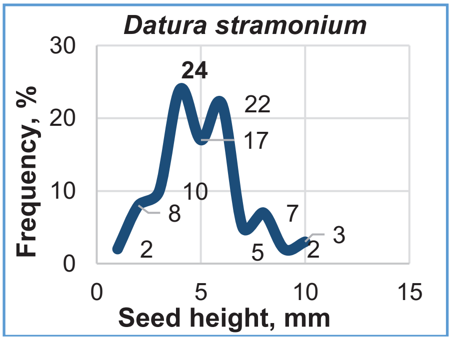

Figure 9. Frequency of seed height: -2.1 -2.3 -2.5 **-2.7** -2.9 -3.1 -3.3 -3.5 -3.7 -3.9

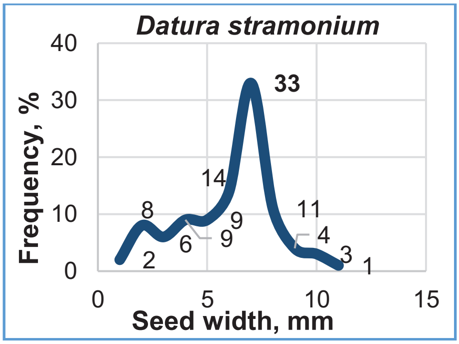

Figure 10. Frequency of seed width: -2 -2.2 -2.4 -2.6 -2.8 -3 **-3.2** -3.4 -3.6 -3.8 -4

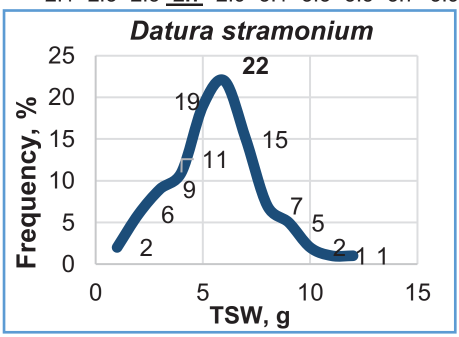

Figure 11. Frequencies of TSW: -5.5 -6 -6.5 -7 -7.5 **-8** -8.5 -9 -9.5 -10 -10.5 -11

Figure 12. Capsule with mature seeds

The absolute weight of the seeds, or thousand seeds weight (TSW), fell in value between 5 and 11 g. Dominant was the class range 7.6-8 g (22%), followed by the one with 7.1-7.5 g (19%). The grains with the absolute mass in the intervals with lower values, as well as those in the intervals with higher values, constituted 1-2% of the total (Figure 11). The appearance and color of the weed seeds are specific (Figure 12).

Correlations between the main characters. The correlation between the number of seeds in a capsule and the height of the capsule was positive and very significant: r = .826***. In these conditions it can be stated that under conditions in which the plant formed higher capsules, more seeds were formed inside them (Figure 13). In another correlation, between the number of seeds in a capsule and their absolute mass, the negative tendency was found. The link was very well ensured statistically (r = -.359^{000}). the explanation is that the heavier grains of *D. stramonium* formed when their number was slightly lower (Figure 14):

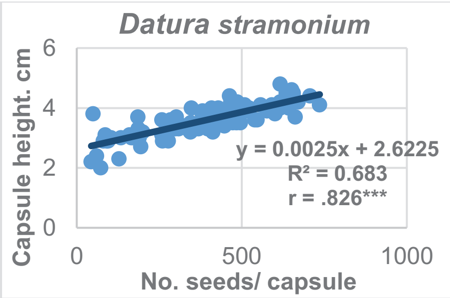

Figure 13. Correlation of no. seeds/ capsule and capsule height

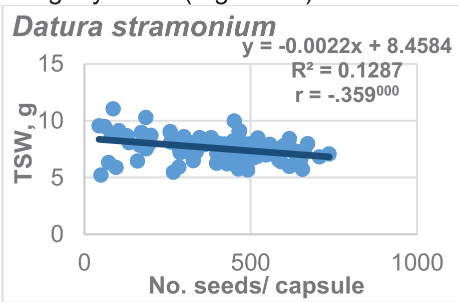

Figure 14. Correlation of no. seeds/ capsule and TSW MMS

From a synthetic table of the correlations between the different characters, there were positive links between the capsule characters except the seed size and their absolute mass (Table 1). Particular positive correlations were obtained between the height x thickness of the capsule with the number and weight of seeds in a capsule.

Table 1

Correlations between the main characters of *D. stramonium* fruit

Character	Capsule		Capsule thorns		Seeds				
	Width, cm	Weight, g	Big, mm	Small, mm	No./ Caps.	Weight, g	Height, mm	Width, mm	TSW, g
Capsule height,cm	.779***	.833***	.375***	.226*	.826***	.796***	.055	-.234^{0}	-.314^{00}
Capsule width, cm	1	.768***	.397***	.173	.719***	.740***	-.022	-.049	-.170
Capsule weight, g		1	.412***	.227*	.885***	.898***	.022	.144	-.144
Big thorns length,mm			1	.451***	.465***	.451***	.223*	-.347^{000}	-.145
Small thorns length, mm				1	.192*	.248*	.423***	.384***	.024
No. seeds/ capsule					1	.956***	-.060	-.202^{0}	-.359^{000}
Seeds weight.g						1	-.032	-.152	-.118
Seed height, mm							1	-.545^{000}	.024
Seed width, mm								1	.296**
TSW, g									1
DL 5 % = .190 DL 1 % = .250 DL 0.1 % = .230									

Statistical analysis of the variability of the capsules and grains. For each analyzed character were calculated: mean (ā), variance (s^2), standard error of mean (s) and variation coefficient (VC,%). Statistical estimates made have revealed characteristic values of the *D. stramonium* ecotype. The values obtained were characteristic. Thus, the capsule averaged 3.6 cm in height, 2.7 cm in thickness and weighted 4.6 g. the large thorns measured 7.3 mm, and the small thorns 3.1 mm (Table 2). The number of seeds in a capsule averaged 397 pieces, weighted 2.9 g, had an average height of 2.8 mm, a thickness of 2.9 mm and an TSW of 7.6 g (Table 3). High variation coefficient was for capsule weight (47%) and for number os seeds /capsule 45%).

Table 2

Statistical indices of *D. stramonium* capsule variability

Indices	Capsule			Ţhorns	
	Height, cm	Width, cm	Weight, g	Big, mm	Small, mm
Media, ā	**3.61**	**2.74**	**4.60**	**7.3**	**3.1**
Variance, s^2	0.270	0.116	4.587	2.242	0.585
Std. error, s	0.520	0.340	2.142	1.497	0.765
Var. coef., %	**14.40**	**12.41**	**46.56**	**20.51**	**24.68**

Table 3

Statistical indices of *D. stramonium* seeds variability

Indices	Seeds				
	No./ capsule	Weight, g	Height, mm	Width, mm	TSW, g
Media, ā	**397.45**	**2.94**	**2.83**	**2.94**	**7.58**
Variance, s^2	32.442	1.465	0.263	0.186	1.031
Std. error, s	180.12	1.210	0.513	0.432	1.015
Var. coef., %	**45.32**	**41.17**	**18.13**	**14.68**	**13.39**

CONCLUSIONS

A common species important for agriculture and medicine is *Datura stramonium* L. In order to use it, it was considered best to know as much of the specific morphological characters as possible. Therefore, the morphological variability, especially the reproductive one, being less known, could express the eco-type existing under these conditions.

The capsules formed had an average length of 3.61 cm, a thickness of 2.74 cm and a weight of 4.60 g. On a capsule large long thorns of 7.3 mm were formed, and small horns of 3.1 mm. In an average capsule 397.45 seeds were formed, which weighted 2.94 g. An average seed had an average height of 2.83 mm, a thickness of 2.94 mm, and an absolute weight of 7.58 g.

The correlations obtained between the determined morphological characters, have shown positive connections at the level of the capsules between length, thickness, weight and length of thorns. Negative links were observed between the capsule characters and the seed details. The plant protect its reproductive system by forming larger seeds number under the relative lower conditions of the capsules.

REFERENCES

Boumba V. A., Mitselou A., Vougiouklakis T. 2004. Fatal poisoning from ingestion of Datura stramonium seeds. Veterinary and Human Toxicology, 46 (2), 81–82.

Bruneton J. 2005. Plantes toxiques. Végétaux dangereux pour l'Homme et les animaux*,* Éditions TEC & DOC, 1- 618.

Cortinovis C., Caloni F. 2015. Alkaloid-containing plants poisonous to cattle and horses in Europe. Toxins, 7(12): 5301–5307.

Geeta R., Gharaibeh W. 2007. Historical evidence for a pre-Columbian presence of *Datura* in the Old World and implications for a first millennium transfer from the New World, Journal of Bioscience, 32(7): 1227-1244.

Henry W.T., Bauman T.T. 1991. Interference between soybean (*Glycine max*) and jimsonweed (*Datura stramonium*) in Indiana. *Weed Technology*, 5(4): 759-764.

Jiao M., Luna-Cavazos M. & Bye R. 2002. Allozyme variation in Mexican species and classification of *Datura* (*Solanaceae*), Plant Systematic Evolution, 232(3-4): 128- 225.

Oudhia P., Tripathi R.S. 1998. Allelopathic potential of *Datura stramonium* L., Crop Research 16(1), 37-40.

Oliver L.R., Chandler J.M., Buchanan G.A. 1991. Influence of geographic region on jimsonweed (*Datura stramonium*) interference in soybeans (*Glycine max*) and cotton (*Gossypium hirsutum*). Weed Science, 39(4): 585-589.

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MORPHOLOGICAL CHARACTERS OF NEW WHEAT AND TRITICALE VARIETIES

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Keywords*: grains, ears, spikelets, variability*

ABSTRACT

*The new wheat and triticale varieties, winter forms, describe improved morphological characters (Ammar et al., 2004). The new directions mainly focus on the straw height and the components of the ear/spike (Becker et al., 2001; Cavaleri, 2002). From practice it has been shown that new varieties that form crops with relatively lower heights could register for different levels of intensification. On the other hand, the current studies on the morphological characters could be used in the improvement of varieties, adapted to the current requirements. The wide genetic endowment and the growing conditions of wheat and triticale usually lead to the characteristic expression of plant morphology (Ma et al., 2004; Kalih et al., 2014.). In the winter wheat, in case of the Mulan variety, as well as the Agentus variety, there were some new directions, which were recently improved (Chelkowski & Tyrka, 2003; Kuleung et al., 2006). Thus, in comparison with the two varieties, the straw was shorter in triticale by 10 cm. The thickness of the base straw was smaller in triticale by 1 mm. the ear had a greater length in wheat by 1 cm, instead the weight of the ears/spikes was higher in triticale by 0.5 g. the triticale contained 6 more spikelet in a spike. The spikelet had the glume and palea/lemma shorter in wheat. The average grain contained the same number of grains in both plants, and the total mass of grains in one ear weighed more than 0.5 g in triticale. The grains were longer by about 3.0 mm and thicker by 0.2 mm in the variety of triticale. The mass of one thousand grains was greater by 20 g in triticale. Specific correlations were obtained between the morphological characters of the plants. Thus, in wheat the correlation between the grain length and the other character showed insignificant links. The mass of one thousand grains correlated very positively with the weight of the grain (r = .463***) and with the thickness of the grains (r = .332***). In triticale, in all cases positive correlations were obtained. Both varieties of winter wheat and winter triticale demonstrates by their morphological characteristics, a good zonal adaptability.*

INTRODUCTION

Winter wheat [*Triticum aestivum* (L.) Thell. ssp. *vulgare* (Will.) MK] (pro syn. *Triticum hybernum* L., *T. macha* Dekap. & Menab., *T. sativum* Lam., *T. sphaerococcum* Percival, *T. vulgare* Will, commom wheat, bread wheat) is one of the most important crop plants (Bettge & Morris, 2000). *Triticum* derives from *threshing* (*bruising*), sorting, and *aestivum* from summer. Threshing wheat is called *spelta*. This with the genes from *Aegilops tauschii* gives the bread wheat the resistance to cold, required in temperate climatic conditions (Erekul & Köhn, 2006).

Triticale (*x Triticosecale* Wittm. ex A. Camus), (pro syn. *x Triticale* Erich von Tschemak ex. Müntzing) being a new species and although recently obtained, it is becoming more and more widespread due to various uses. The species is actually a hybrid between wheat (*Triticum*) and rye (*Secale*). From both species the plant has a certain quality (from wheat), as well as resistance to climatic extremes (from rye). Due to their high adaptability, the two plants meet in a variety of growing conditions, practically on all continents. The purpose of their cultivation is grain production and the total plant material. Winter wheat with hexaploid genome 2n = 6x (6x7) = 42, has six sets of A^uA^uBBDD chomosomes. Winter triticale with the hexaploid genome (most productive) 2n = 42, has the content of AABBRR, namely 28 chromosomes from wheat (AABB) and 14 chromosomes from rye (RR). Both cultivars also contain the modern *RHt* gene, which determines the stem/straw short, suitable for rich fertilization and mechanized harvesting. The consequence is the possibility of these new varieties being more productive. From the botanical point of view the inflorescence of the two plants is a terminal spike, distich, 4-18 cm long, with sessile spikelet, trapped solitary on the rachis zigzag. The spikelet is 10-25 mm long, being compressed laterally with two glume and several flowers. The glume have the tip as a short, sharp tooth, but also and awn of 3-5-10 cm. each flower has a palea and lemma. Depending on the variety the lemma extends as an awn, or as a hood. When the glume and lemma adhere to the grain, it thus becomes clothed. The grain (kernel) is ellipsoidal in shape, with a central channel on one side. The grain is 4-12-14 mm long and 1.5-4.5 mm thick. The mass of one thousand grains (MTG) is 15-60-70 g. The plant generally forms stems with heights between 50 (^)) and 140 (150) cm. The researches performed to observe the variation of some characters of the wheat and triticale plants included: i) the strain through the total length of the straw and the thickness of the basal internode, ii) the length and weight of the ear, iii) the number of spikelets/ear, the length of the glume and palea (lemma) and the length of the awns, iv) the number of the grains/ear, the weight, mass of a thousand grains and the size of grains (length and thickness).

MATERIAL AND METHODS

The variants have been cultivated in the last two years with the winter wheat variety *Mulan* and the *Agentus* winter triticale variety, with relatively close morphological characteristics. The experience was established according to the block method, with 25 m^2 each variants, in 4 replications. The technology used was that recommended by the resort. At full maturity, 25 plants/strains from each repetition (100 in total) were randomly selected, cut and brought to the laboratory. The 100 strains were measured and determined: the total length of the straw, the thickness of the basal internode, the length and weight of the spike, the number of grains in the spike, the length of the glume, the palea and awn, the number of grains in a spike and their weight, mass of a thousand grains (MTG), as well as grain size: length and thickness.

The morphological characters obtained were analyzed by the histograms method (frequency polygons, FP%). In their expression were used both absolute values as such as class intervals, determined according to the specific string of values obtained. The study carried out highlighted several aspects, namely: i) the modal values (with the highest frequencies), ii) the limits of the intervals of variability of the studied characters and iii) the specificity of each character of the wheat and triticale eco-types in the analyzed area. Between the analyzed characters, the correlations were established, with the help of which we could observe their tendencies within the studied ecotypes. The Excel program was used to express the values. The significance of the correlation coefficients was obtained by comparing with the r_{max} values for the 5%, 1% and 0.1% levels of the transgression probabilities.

In the statistical calculation of all the obtained values the analysis of variance (Anova test) was used, on the ranges of variation. Statistical parameters were calculated using the formulas: $\bar{u} = \Sigma x/n$, where $\bar{u}$ = average of the determinations, and x = the determined values, s^2 (variance) = $1/(n-1).[\Sigma x^2-(\Sigma x)^2/n]$, s (standard error) = $\sqrt{s^2}$, s% (variation coefficient) = $s/\bar{u}.100$.

RESULTS AND DISCUSSIONS

Variability of wheat and triticale straw dimensions. The stalk of wheat/ triticale consists of several internodes (usually 5-7) with increasing lengths toward the ear. Generally the straw has lengths between 50 (60) cm and 150 cm. At harvesting maturity, the stems are upright, with a relatively small waist. From measurements it turned out that the wheat straw was between 55 and 79 cm. the high frequency had straws of 70-74 cm (40%), followed by those with 65-69 cm (38%). The triticale straws had lengths of 45-84 cm, of which 60-64 cm (39%) dominated. Close to them were those of 65-69 cm (31%) (Figure 1). The diameter/ thickness of the straw at the base was between 3.0 and 5.4 mm in wheat and 2.0-4.9 mm in triticale (Figure 2). They dominated the segments with 4.0-4.4 mm in wheat (52%) and those with 3.0-3.4 mm respectively in triticale (45%).

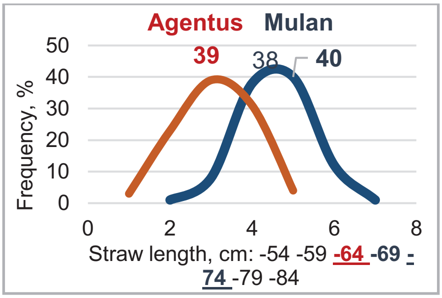

Figure 1. Frequencies of straw length

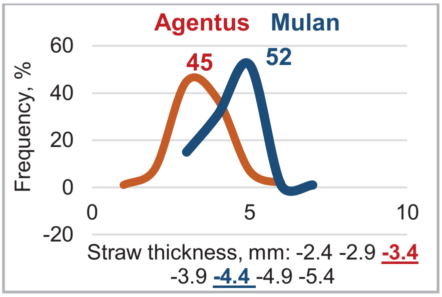

Figure 2. Frequencies of straw thickness

Variability of wheat and triticale ear/ spike. The appearance and dimensions of the two plant's ears had different characteristics. Thus, the length of the ear ranged between 7 and 12 cm in the Mulan wheat variety and between 6 and 12.4 cm in the Agentus triticale variety. They dominated the lengths of 9-10 cm (25-26%) in wheat and those of 8-8.4 cm (21%) in triticale (Figure 3). The weight of the ears was between 1.0 and 3.9 g for wheat and between 1.5 and 6.4 g for triticale (Figure 4).

They dominated the ears whose weights were between 2.0-2.4 g on wheat (40%) and between 2.5-2.9 g in triticale (35%). The number of spikelets in a spike ranged from 14 to 33 in both plants (Figure 5). They dominated the spikes with 18-19 spikelets (40%) in wheat and those with 22-25 spikelets in triticale (20-23%). The appearance of the Mulan variety was characteristic (Figure 6).

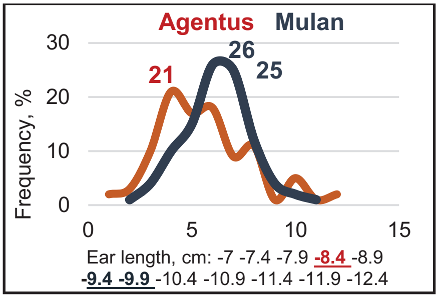

Figure 3. Frequencies of ear length

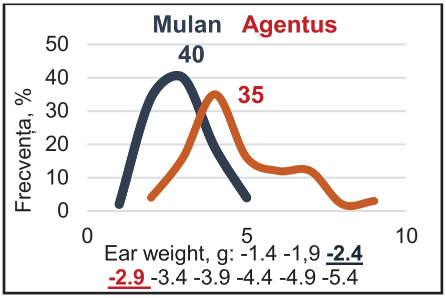

Figure 4. Frequencies of ear weight

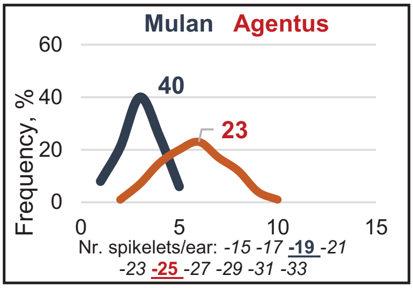

Figure 5. Frequencies of no. de spikelets/ear

Figure 6. Mulan winter wheat variety

The glume of the spikelets had different lengths. They were between 8 and 13 mm (Figure 7). In case of Mulan wheat, 10 mm long glume (53%) dominated. And Agentus triticale dominated 11 mm (52%) glume. The lower palea (lemma) had lengths between 8.6 and 11.0 mm in wheat and between 8.6 and over 14.5 mm in triticale (Figure 8). They dominated the paleas with 9.6-10 mm (45%) in wheat and between 11.6 and 13 mm (23%) in triticale.

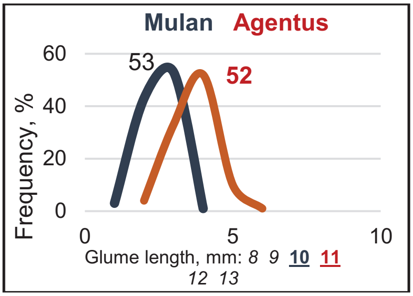

Figure 7. Frequencies of glume length

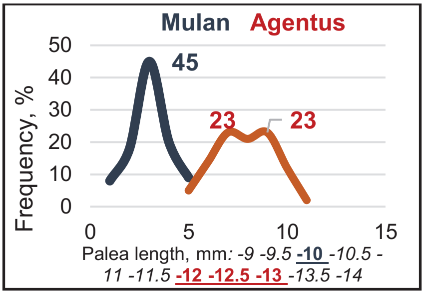

Figure 8. Frequencies of palea length

Variability of wheat and triticale grains. Research has shown that each species and variety has characteristic grain-related aspects (Kuleung et al., 2006). In the case of wheat, the number of grains in a wheat ear was between 31 and 90. The highest frequency was wheat with 41-50 grains (42%). The number of grains in triticale was between 21 and over 90. The highest frequency was obtained in the range 41-50 (29%) (Figure 9). The weight of the grains formed in a wheat had corresponding values between 1.0 g and 3.5 g and between 1.0 and 5.0 g in triticale.

The highest frequency was obtained by weights of 1.5-2.0 g (50%) in Mulan wheat and 2-2.5 g (37%) in triticale Agentus variety (Figure 10).

The grain size also had some characteristics. Thus, the grain length was in the range 5-7.4 mm, with a maximum at 6-6.4 mm (57%) in wheat and the interval between 7.5-10.4 mm, with a maximum in 9-9.4 mm (49%) in triticale (Figure 11). The grain thickness was between 2.6 and 3.8 mm, with the modal value at 3 mm (33%) in the case of Mulan wheat variety and between 2.5-3.9 mm with the dominant range of 3.2 mm (20%) in the case of Agentus triticale variety (Figure 12).

The mass of a thousand grains (MTG) has shown several differentiations. The extremes of this character were between 20 and 39 g in wheat and between 25 and 59 g in triticale. The modal/ dominant values were also different. Thus, in the case of Mulan wheat they dominated the values of 30-34 g (49%), while in the Agentus triticale the grains with the mass of 50-54 g (36%) dominated (Figure 13). In the grains of the Agentus variety, grains with an absolute mass much larger than yhat of wheat were formed (Figure 14).

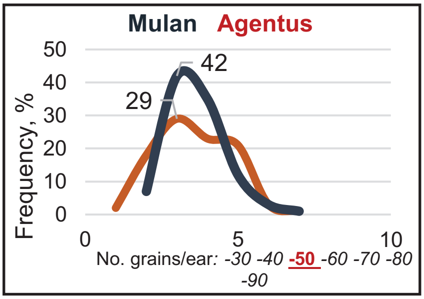

Figure 9. Frequencies of no. grains/ear

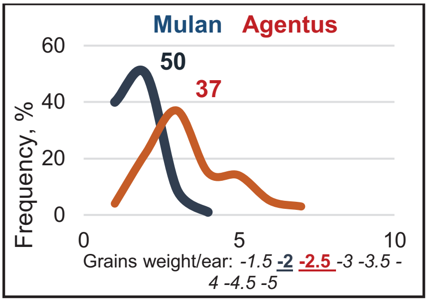

Figure 10. Frequencies of grains weight/ear

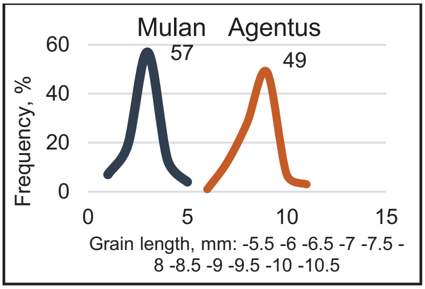

Figure 11. Frequencies of grain length

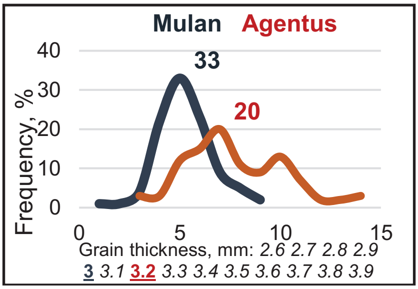

Figure 12. Frequencies of grain thickness

<u>Correlations between the main morphological characters of wheat and triticale plants.</u> If we analyze the whole set of correlations between all the characters analyzed in wheat and triticale, we find specific situations. Thus, in the wheat Mulan variety, statistical correlations were obtained in most cases.

Of these, we noticed the positive correlations between the weight of the grain with other characters, less evident with the glume and palea and with the length of the grain. The length of the grain correlated insignificantly with the other characters. The mass of a thousand grains correlated very significantly with the thickness of the grains. Negative correlations were found between the number of grains/ear with the length of the grain and between the number of spikelets/ear with MTG (Table 1).

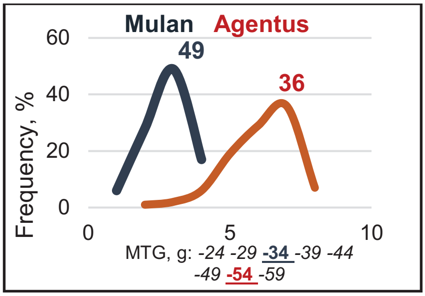

Figure 13. Frequencies of mass of thousand

Figure 14. Agentus triticale variety grains weight

Table 1

Correlations between the main characters of wheat and triticale varieties

Winter wheat, Mulan variety												
Indices	**Ø straw mm**	**Ear length. cm**	**Ear weight g**	**No. spikelets**	**Glume mm**	**Palea mm**	**Awn cm**	**No. grains**	**Grain weight, g**	**Grain length, mm**	**Grain thickness, mm**	**MTG, g**
Straw, cm	.158	.041	.071	.067	.083	.058	-.066	.169	.049	-.166	.017	-.114
Ø straw	1	.377***	.318**	.402***	.044	-.122	.001	.273**	.338***	.022	.179	.201*
Ear, cm		1	.693***	.777***	.111	.026	.063	.706***	.652***	.061	.071	.109
Ear,g			1	.506***	.281**	.046	.069	.839***	.979***	.024	.304**	.463***
No. spkelet				1	.028	-.133	.074	.602***	.468***	.020	.006	-.057
Glume,mm					1	.450***	-.166	.160	.241*	.092	.039	.182
Palea, mm						1	-.134	.035	-.004	.111	-.163	.042
Awn, cm							1	.039	.073	.188	-.157	.051
No. grains								1	.794***	-.081	.137	-.048
Gr weight,									1	.056	.327***	.559***
Gr.len,mm										1	$-.233^{0}$	.198*
Thick, mm											1	.332***
Winter triticale, Agentus variety												
Straw, cm	.277**	.177	.209*	.158	.066	.075	.185	.143	.185	.153	.014	.155
Ø straw	1	.543***	.567***	.369***	.399***	.348***	.173	.447***	.553***	.266**	.172	.328***
Ear, cm		1	.840***	.809***	.427***	.351***	.179	.815***	.811***	.268**	.135	.134
Ear,g			1	.403***	.543***	.497***	.268**	.901***	.972***	.260**	.213*	.333***
No. spkelet				1	.265**	.189*	.144	.723***	.669***	.221*	.048	-.001
Glume,mm					1	.760***	.188	.516***	.502***	.245*	-.069	.089
Palea, mm						1	.177	.428***	.475***	.211*	-.026	.206*
Awn, cm							1	.267**	.249**	.049	.117	.036
No. grains								1	.908***	.243*	.100	-.022
Gr weight,									1	.262	.247*	.392***
Gr.len,mm										1	.171	.087
Thick, mm											1	.361***
DL 5 % = 0.19 DL 1 % + 0.25 DL 0.1 % = 0.32												

In the Agentus triticale variety, most correlations were positive and statistically assured. One explanation is that triticale may be better suited to the conditions of the resort.

Statistical analysis of the variability of wheat and triticale morphological characters. The results obtained in the morphological analysis of some characters in autumn wheat and triticale, showed specific aspects. Thus, by comparing the Mulan wheat variety with Agentus triticale variety, the straw length measured on average 70 cm compared to 62 cm. The diameter of the straw at the base was approximately equal, with a few millimeters extra to the wheat. The length of the spikes was 9.30 cm compared to 9.00 cm. The weight of the ears was 2.15 g compared to 3.11 g. The number of spikelets/ear was on the hand 18.2 in wheat compared to 24.1 in triticale (Table 2). Higher variability was due to the weight of the ear from the Agentus variety and the number of spikelets from the wheat ear/spike.

Between the two wheat- triticale varieties, the length of the glume was 9.54 mm compared to 10.7 mm, that of the palea with 9.88 mm as compared to 12.3 mm. in the same order, the number of grains formed in a spike was 52.1 to 52.3. The grain weight from an ear was 1.59 g to 2.48 g. The grains had an average size of 6.13/ 3.03 mm compared to 8.98/ 3.27 mm. The mass of one thousand grains was 30.6 g in wheat compared to 47.5 g in triticale (Table 3). Greater variability was found in the number of grains in a spike and in the weight of the grains in the Agentus triticale variety.

Table 2

Statistical indices of straw and ear/spike

Indices	Straw		Ear/spike		
	Length, cm	Basis diameter, mm	Length, cm	Weight, g	Noș of spikelets
	Winter wheat, Mulan variety				
Media,ā	**69.9**	**3.90**	**9.30**	**2.15**	**18.2**
Variance, s^2	17.2	0.12	2.11	0.14	15.5
Std. error, s	4.15	0.34	1.45	0.37	3.94
Var. coeff,%	**5.9**	**8.7**	**15.6**	**17.1**	**21.7**
	Winter triticale, Agentus variety				
Media,ā	**62.4**	**3.41**	**9.00**	**3.11**	**24.1**
Variance, s^2	27.6	0.04	1.01	0.74	10.09
Std. error, s	5.25	0.20	1.00	0.86	3.18
Var. coeff,%	**8.4**	**6.0**	**11.2**	**27.6**	**13.2**

Table 3

Statistical indices of spikelets and grains

Indices	Spikelet			Grains				
	Glume, mm	Palea, mm	Awn, cm	No. grains /ear	Grain weight, g	Grain length, mm	Grain thickness, mm	MTG, g
	Winter wheat, Mulan variety							
Media,ā	**9.54**	**9.88**	**3.1**	**52.1**	**1.59**	**6.13**	**3.04**	**30.6**
Variance, s^2	0.28	0.27	0.02	77.6	0.11	0.04	0.03	12.1
Std. error, s	0.53	0.52	0.15	8.81	0.33	0.21	0.18	3.48
Var. coeff,%	**5.5**	**5.3**	**4.7**	**16.9**	**20.9**	**3.4**	**6.0**	**11.4**
	Winter triticale, Agentus variety							
Media,ā	**10.7**	**12.3**	**6.4**	**52.3**	**2.48**	**8.98**	3.27	47.5
Variance, s^2	0.66	0.65	0.45	179.9	0.52	1.78	0.22	81.0
Std. error, s	0.81	0.80	0.67	13.4	0.72	1.33	0.47	0.00
Var. coeff,%	**7.6**	**6.5**	**10.6**	**25.6**	**29.1**	**14.9**	**14.3**	**19.0**

The number of grains in a spike was 52 in both plants, weighing from 1.6 to 2.5 g, the mass of thousand grains ranged from 31 to 48 g. The grains had dimensions of 6.1 to 9 mm in length and 3.0 to 3.3 mm in thickness. The morphological characteristics of the wheat kernels show that, in the same number of grains, they had a lower absolute mass in wheat, while in the triticale, grains in greater weight were formed and of course with the absolute mass much more high.

Simple correlations were established between all the studied characters, with some differentiations. Both positive and significant correlations were obtained between the characters of the straw and those of the productivity elements. Between the components of the wheat have established very close positive connections, which shows the great productive possibilities that the two varieties have, of wheat and of triticale.

CONCLUSIONS

The morphological characters of the autumn wheat studied in comparison with those of the triticale, had specific aspects. The choice of the two varieties to wheat and triticale was made due to the relatively close morphological similarity and because they have recent genetic improvements, especially for the high productive potential.

By comparison between the two wheat-triticale varieties, the stalk/straw had average lengths of 70 to 62 cm. From the obtained values we can see the existence of the low high on both plants, a condition induced more and more in the improvement of wheat and autumn triticale in order to maximize the crops production.

The spike of about 9 cm in length on both plants, had a weight of 2.2 to 3.1 g. The number of spikelets stood at 18 compared to 24. The pieces of the spikelets were: glume with lengths from 9.5 to 10.7 mm, lemma from 9 to 12 mm. All this data obtained describes specific characters relatively close between a variety of winter wheat and a variety of winter triticale.

REFERENCES

Ammar K., Mergoum M., Rajaram S. 2004. The history and evolution of triticale. Triticale improvement and production, in Mergoum M., Macpherson HG (eds.), FAO plant production and protection paper, pp.179.

Becker H.C., Oettler G., Hoppe G. 2001. Heterosis for field and other agronomic traits of winter triticale F_1 and F_2 hybrids. Plant Breeding, 120(4): 351- 353.

Bettge A.D., Morris C.F. 2000. Relationships among grain hardness, pentosane fractions, and and-use quality of wheat. Cereal Chemistry, 77: 241- 247.

Cavaleri P. 2002. Selection responses for some agronomic traits in hexaploid triticale. Agriscientia, 19: 45- 50.

Chelkowski J., Tyrka M. 2003. Enhancing the resistance of triticale by using genes from wheat and rye. Journal of Applied Genetics, 45: 283- 295.

Erekul O., Köhn W. 2006. Effect of weather and soil conditions on yield components and bread-making quality of winter wheat (*Triticum aestivum* L.) and winter triticale (*Triticosecale* Wittm.) varieties in north-east Germany. Journal of Agronomic Crop Science, 192: 452- 464.

Kalih R., Maurer H.P., Hackauf B., Miedaner T. 2014. Effect of a rye dwarfing gene on plant height, heading stage, and *Fusarium* head blight in triticale (*Triticosecale* Wittmack). Theoretical and Applied Genetic, 27: 1527- 1536.

Kuleung C., Baenziger P.S., Kachman S.D., Dweikat I. 2006. Evaluating the genetic diversity of triticale with wheat and rye SSR markers. Crop Science, 46: 1692-1700.

Ma X.F., Fang P., Gustafson j.p. 2004. Polyploidization-induced genome variation in triticale. Genome, 47: 839- 848.

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RESEARCH ON THE PECULIARITIES OF DIGESTION IN RUMINANTS

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Keywords: *biochemical parameters, feces, rumen pH*

ABSTRACT

The aim of the research was to highlight certain peculiarities of digestion in ruminants, cattle that were exploited in the specific conditions of milk production, following: rumen pH, some biochemical parameters in the blood, assessment of fecal matter score. Total mixed ration administered to dairy cows during the test period contained: 36.7% DM, 15.4% CP, 5.8% fat, 43.2% NDF, 27% ADF and 8.4% ash. Values obtained from the analysis of biochemical parameters suggest that the animals are in full health with low predispositions to hypoalbuminemia, hypoazotemia and hypoglycaemia. The values regarding the rumen pH varying between 5.91 and 6.76, being optimal. The fecal score, it was 4, the cows benefiting from a rational diet.

INTRODUCTION

The types of digestives found in animals are classified into herbivores (ruminants and non-ruminants), carnivores and omnivores. Many studies have focused on cattle because of their importance in the beef and dairy industry. For animals that normally consume rations based on fibrous feeds, such as ruminants (eg cattle), it is important to understand the physiology of the animal's digestion, as well as the nature of the microbial fermentation process in the digestive tract compartments (Boișteanu & Iolanda 2002). Analyzes performed on blood plasma represent, in the case of cattle, an effective tool for assessing the metabolic profile. They provide quick information on ensuring animal welfare. The notion of metabolic profile refers to the evaluation of the metabolic nutritional status of a group of animals, following laboratory analyzes. Metabolic disorders are real problems in the breeding of dairy cows, because zootechnical engineers tend to reach the maximum genetic potential of that species, which can lead to disorders of the systems that ensure the proper functioning of the body.

MATERIAL AND METHODS

The biological material was represented by Romanian Black Spotted dairy cows. The rumen fluid was collected from a number of 9 animals (reformed cows) after their slaughter. The pH was analyzed with the help of the InoLab 7110 laboratory pH meter, the method being an efficient one, the results being obtained in a few minutes.

To determine the biochemical parameters, blood samples were collected from 10 lactating cows, from the jugular vein, by venopuncture directly into vacutainers with red cap (without anticoagulant) and the samples were subjected to processing shortly after collection, being subjected to centrifugation at 3000 rpm for 10 minutes in the Rotofix 32 A Centrifuge. After obtaining blood plasma, we used the Cormay Accent 200 automatic biochemical analyzer to determine the biochemical parameters studied.

The fecal consistency score was established according to the method developed by Zaaijer and Noordhuizen in 2003, applying the boot test.

RESULTS AND DISCUSSIONS

Maximum growth rates for different species of rumen symbionts were obtained at different pH levels.

Table 1.

Rumen pH values for each animal

Cow registration number	pH
4889	6,34
0856	5,91
4876	**6,76**
8788	6,62
4899	6,64
0012	6,49
3224	6,33
1212	6,50
4266	6,61

The lowest value, recorded in the case of a cow was 5.91, a value that indicates the predisposition of the animal to disorders of rumen metabolism, and rumen acidosis may occur. This value of 5.91 can be attributed to a higher consumption of concentrates, before slaughtering the animal. Other studies, in vitro and in vivo (Mold et al. 1983), have shown that the optimal pH for microbial digestion of cellulose is in the range of 6.6 to 7.0. De Veth & Kolver in 2001 state that the optimum is registered at a pH of 6.3.

Table 2.

Values obtained for ammonia

Cow registration number	Ammonia (mg / dl)
4447	0,114
6766	0,112
6768	**0,119**
6455	0,070
0043	0,098
4699	0,108
4008	0,112
4999	0,106
6787	0,097
4100	0,110

It is observed that the number of cows studied has consistent ammonia values, but slightly lower, with a lower value (0.070) in the case of an animal than the minimum threshold reported by some researchers (0.077). Thus, the values obtained do not present concerns about the proper functioning of the metabolism, the observed ammonia concentrations being correlated with the quantity and quality of ingested nitrogenous substances.

Table 3.

Values obtained for total proteins

Cow registration number	Total protein (mg/dl)
4447	7104
6766	6887
6768	7245
6455	7240
0043	7160
4699	**7301**
4008	7000
4999	7208
6787	6988
4100	7290

Hypoproteinemia may occur when quantitative changes in body proteins fall below the 6800 mg / dl limit in lactating cows (Frank & Swensson. 2002).

Following this research, no cases of hypoproteinemia were observed, all values being above the minimum value reported in various studies. The lowest value recorded was 6887 mg/dl, and the highest value was 7301 mg/dl. The values obtained indicate that the dairy cows studied benefited from a nutritionally balanced ration.

Table 4.

The values obtained for albumin

Cow registration number	Albumin (mg/dl)
4447	2879
6766	2887
6768	**3246**
6455	3220
0043	3152
4699	3001
4008	2810
4999	2908
6787	2987
4100	2725

The level of albumin in the blood plasma falls within normal limits (2800-3400 mg/dl) only in the case of an animal with a lower value of 2725 mg/dl, which is considered to be hypoalbuminemia. Authors such as Rowlands et al. in 1975, they claimed that some low levels of albumin could be induced by fasciolosis or other parasites that lead to decreased ability of liver tissue to synthesize albumin.

Table 5.

Values optained for glucose

Cow registration number	Glucose (mg/dl)
4447	48,23
6766	50,51
6768	45,67
6455	41,43
0043	45,89
4699	51,32
4008	42,77
4999	46,90
6787	**51,45**
4100	**40,23**

In the present study, mild hypoglycaemia is observed in three animals (41.43 mg/dl, 42.77 mg/dl and 40.23 mg/dl, respectively), which can usually be caused by insufficient intake. Energetically, from the feed ration or may be caused by the existence of a small amount of glycogenetic precursors. In the specialized literature the average blood glucose values in lactating cows vary between 45 mg/dl and 77 mg/dl.

Table 6.

Values obteined for triglycerides

Cow registration number	Triglycerides (mg/dl)
4447	**130,62**
6766	214,35
6768	141,78
6455	189,45
0043	**290,76**
4699	158,55
4008	126,80
4999	277,81
6787	159,40
4100	140,20

According to the specialized literature, the concentration of triglycerides in cattle is between 150-450 mg/dl, with an average of 300 mg/dl. In the case of the concentration of triglycerides in dairy cows, low values are observed, in four animals there are even values below the minimum threshold reported in the literature (150 mg/dl).

Table 7.

The values obteined for total lipids

Cow registration number	Total lipids (mg/dl)
4447	160,25
6766	140,58
6768	152,10
6455	**202,58**
0043	**128,80**
4699	168,48
4008	145,20
4999	178,55
6787	138,89
4100	151,69

The values obtained in the case of the concentration of total serum lipids are between 138.89 - 202.58 mg/dl, relatively low values compared to the minimum value of 150 mg/dl specified by some authors. In a recent study, total lipid values in dairy cows were 240.7 mg/dl in the antepartum period, 295.7 mg/dl postpartum and 282.8 mg/dl at 2-3 months of lactation. The present study presents a low concentration of total serum lipids compared to other research but there are no concerns about animal health because the four animals exceeding the lower limit of 150 mg/dl, do not deviate much from this value (Coroian 2017).

The faeces observed in the farm under study are of relatively soft consistency and a specific noise is heard at the contact of the feces with the soil. The content of feces, however, are clearly circumscribed, remaining compact on the floor (Bjerre-Harpøth et al. 2012).

Figure 1. Applying the boot test in order to assess the fecal matter score

When applying the boot test, according to research conducted by Zaaijer & Noordhuizen in 2003, the profile of the sole of the boot will remain imprinted taking place the suction phenomenon after the boot is withdrawn when the fecal score is 4. Score 4 is considered normal in cows of milk.

CONCLUSIONS

Regarding the level of rumen pH, we obtained results with relatively small oscillations, ranging between 5.91 and 6.76. These values are considered normal, in correlation with: the physiological state of the animals studied, the ration administered.The values of the biochemical constants suggest that the studied dairy cows are in full health, with low predispositions to hypoalbuminemia, hypoazotemia and hypoglycemia. In the case of assessing the fecal matter score, a relatively soft consistency was observed, and when applying the boot test, the sole profile will remain printed after the boot is withdrawn, the fecal matter score being estimated to be 4.

REFERENCES

Bjerre-Harpøth , Friggens NC, Thorup VM, Larsen T, Damgaard BM, Ingvartsen KL, et al. 2012. Metabolic and production profiles of dairy cows in response to decreased nutrient density to increase physiological imbalance at different stages of lactation. J Dairy Sci. 95:2362–2380.

Boișteanu P. C., Iolanda M. 2002. Fiziologie animală, Editura Ion Ionescu de la Brad, Iaşi.

Coroian C.O. 2017. Biochemical and Haematological Blood Parameters at Different Stages of Lactation in Cows. Bulletin UASVM Animal Science and Biotechnologies 74(1).

De Veth M.J. & Kolver E.S. 2001. Diurnal variation in pH reduces digestion and synthesis of microbial protein when pasture is fermented in continuous culture. J. Dairy Sci. 84: 2066 - 2072.

Frank B., Swensson C. 2002. Relationship between content of crude protein in rations for dairy cows and milk yield, concentration of urea in milk, and ammonia emissions. J. Dairy Sci. 85: 1829–1838.

Mould F.L., Ørskov E.R. & Mann S.O. 1983. Associative effects of mixed feeds. Effects of type and level of supplementation and the influence of the rumen fluid pH on cellulolysis in vivo and dry matter digestion of various roughages. Anim. Fd Sci. Technol. 10: 15 – 30.

Rowlands GJ., Manston R., Pocock RM. Dew SM. 1975. Relationship between stage of lactation and pregnancy and blood composition in a herd of dairy cow and the influences of seasonal changes in management of these relationships. Journal of Dairy Research 42: 349–362.

Zaaijer D. and Noorduizen J.P.T.M. 2003. A novel scoring system for monitoring the relationship between efficiency and fertility in dairy cows. Irish Vet. Journal 56 (3): 145-151.

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CHARACTERISTICS REGARDING DOBROGEA'S PLATEAU GEOMORPHOLOGY BASED ON DATA FROM FOREST MANAGEMENT PLANSTHE TITLE OF THE PAPER

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Keywords*: Keywords plans, exposition, altitude, field configuration.*

ABSTRACT

The geomorphology of a vast terrain can be analyzed based on data from forest management plans as they characterize the field's part occupied by forests. In addition, these plans are extremely detailed for small surfaces of only some hectares. Based on these facts, the present article has studied Dobrogea's Plateau geomorphology by taking into account a large number of data from the forest management plans of all national forests situated in this area. These data focused on the relief, field configuration, exposition, slope and altitude. As such, the field's configuration is almost equally undulated and plane with no clear distinctions based on the exposition while the average altitude is of 125 m. Slopes under 20 ^{0} represent 40% of the studied territory in Ciucurova (13 447 ha), Babadag (12 8873 ha), Cerna (11 265 ha), Forest Districts, while slopes >40 ^{0} are found in Macin (261,6 ha) and Cerna (10,9 ha) Forest Districts.

INTRODUCTION

Dobrogea's Plateau is a geographic unit with varied structural characteristics that occupies 4.3% from our country's surface. Situated in the South-East part of Romania, the plateau is bordered by Danube's Meadow and Delta in North and West and by the Black Sea in East. In the South, it appears as an extension of the Pre-Balkan Plateau, crossing the border with Bulgaria (Fig. 1). Dobrogea's Plateau is the only morpho structural platform unit with the oldest structures and reliefs from our country (Grecu et al. 2019). The relief is hilly in the North, while plateaus predominate in the center and South. Altitudes between 300-400m (with Țuțuiat Peak reaching 467m) are located in the North-West part and they decrease up to 150-200m towards South and can reach even 10-40m towards the Danube and Black Sea side.

Dobrogea's Plateau structure genesis starts from the Proterozoic when Dobrogea's socket was crystallized and ended after the chimeric movements. In this time interval, due tot fragmentation and vertical tectonic movements, Dobrogea's Plateau territory was covered partially or totally by sea waters in more stages which led to the accumulation of sedimentary formations with different facies that are more or less faulted, dislocated or sinuous. The relief processes of external factors developed on both the petrographic and structural grounds but acted differently based on the temporal basis level and the growth or decrease movements caused unevenly all around the Plateau. In its North and Central part (Casimcea Plateau), Dobrogea's Plateau presents the remains of old chalcedonic and hercinic mountains that underwent a long subaerial molding. On the other hand, in its South part, Dobrogea's Plateau is a structural plateau with almost horizontal layers laid-down on the Moesic Platform's east extension during more sedimentary cycles

The climatic characteristics of Dobrogea's are determined by a number of factors: the high quantity of solar radiation; large opening towards North, South and East which causes a higher frequency of air masses on these directions; the Black Sea's basin that concentrates the cyclonal activity, especially from the Mediterranean Sea; Danube's Delta and Puddles; the intensification of continental climates favorized by a faded relief with a lack of vegetation and by large plain areas. The temperature records average annual values of 10 -110C, with -200C in January and 21-240C in July (Văduva 2003). There are approximately 220 days without frost and over 40 tropical days. The humidity deficit is very high due to strong evapotranspiration (700mm) and reduced precipitations that range between 400-550 mm (Prăvălie & Bandoc 2015).

Petrographically, Dobrogea's Plateau is situated in the East-European region, the Danubio-Pontic Province. The excessively continental climate had a distinct role in the development of these soils. Molisols have the most widespread areal and are represented by different chernozems. Cambic chernozems are found at altitudes of over 150 m and have a good fertility in silvosteppe conditions, being used for cereal cultures. Carbonate chernozems are located at 80-120 m altitude, in steppe conditions and require considerable quantities of water. Kastanozem can be found on the East side (in Nălbant depression and around Razelm-Sinoe Lakes, toward Tășanul) as well as on the West side (from Măcin to Oltina). Unlike chernozems, these soils are less rich in humus and have a good fertility, but require water as well. Rendzina can be found in Casimcea and North Dobrogea. Argiluvisols are present at altitudes higher than 250 m, under oak forests and are renowned for their forest.

Intrazonal soils cover few regions and are hydromorphic, salinized and alkaline soils, being present in the sea and meadow areas and on peaks intensely affected by trickles (erodisol, litosol). Dobrogea's Plateau forest soils are specific to plain areas and have a low acidity for luvisols and cambisols. Chernozems present a low alkalinity, with a high towards very high cationic exchange capacity, very high humidity and a considerable nitrogen level (Crișan & Dinca 2020).

Forest vegetation is mainly comprised of oak forests (Hinkov et al. 2019), or forests adapted to the area's drier climatic conditions (Ioana-Toroimac et al. 2006) such as manna ash (Dincă et al. 2020), or to soil erosion (Pedrotti 2020; Dincă & Achim 2019). However, alder forests exist also in humid areas (Blaga et al. 2019). Numerous old forests exist in Dobrogea's Plateau (Timiș-Gânsac & Dincă 2020), but not as many as those from the Southern Carpathians (Cântar et al. 2019). However, stands from this area are more homogenous than the ones from the Carpathian area (Dincă et al. 2020). These forest ecosystems offer a richer range of ecosystem services such as game (Dincă et al. 2018), non-wood forest products (Dincă & Timiș-Gânsac 2020) or forest fruits (Vechiu et al. 2018).

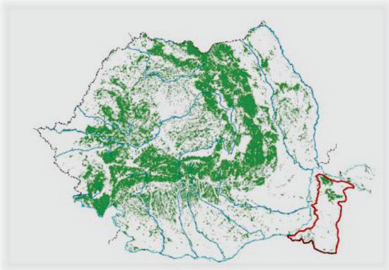

Figure 1. Romania – Dobrogea's Plateau

MATERIAL AND METHODS

This article is based on data collected from forest management plans of national forests located in Dobrogea's Plateau (managed by RNP Romsilva). As such, data from 10 forests districts were used, leading to an extremely vast database that ensures a better statistical representativity of the results obtained. The total surface of the analyzed stands from this area is of 103491 ha, while the following elements were analyzed: relief category, configuration, exposition, field slope, and altitude. All calculations and graphics were realized with Excel, while the map was created with ArcGIS.

RESULTS AND DISCUSSIONS

According to data from management plans, 43% (43 156 ha) of Dobrogea's Plateau is occupied by slope-superior slope, while 32% (32 559 ha) is represented by average and inferior slopes and 35% (25 880 ha) by plain surfaces (tab. 1).

Table 1

Relief categories from Dobrogea's Plateau

Relief Category	Surface (ha)	Surface (%)
Slope	36043	35%
Superior slope	7813	8%
Average slope	24485	24%
Inferior slope	8074	8%
Plateau	14026	14%
High meadow	1270	1%
Low meadow	7346	7%
Average plain	1909	2%
Islet	1330	1%

The field's configuration in Dobrogea's Plateau forest area is half plain (51%), with sinuous fields occupying 47% of this area and fragmented fields for the remaining 2% (fig. 2).

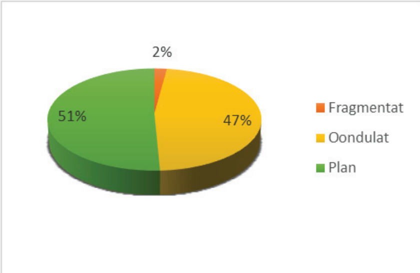

Figure 2. Field configuration in Dobrogea's Plateau

The slope's exposition is more diverse in the North area, in comparison with the South one. The Quaternary Neotectonics is characterized by weak droppings towards East and North and a slight increase in the South-West during the Holocene. In the central part, green schists are caught in a system of anticlionos and sinclinors, symmetrical folds orientated towards West-East. This orientation becomes NW-SE towards Babadagului Plateau. On its south side, Dobrogea's Plateau has altitudes fewer than 200 m and is strongly fragmented, with the surfaces adapted to the large corrugation of Neozoic formations (fig. 3).

Figure 3. Field expositions in Dobrogea's Plateau

The field's inclination for forests located in Dobrogea's Plateau is rendered in Figure number 4. The forests are distributed only on high hills, forming compact stands (for example Slava Cercheza, Ciucurova, Topolog, Hamcearca and Luncavița). Approximately 40% of these forests are distributed on fields with slopes under 20 0 (fig. 4).

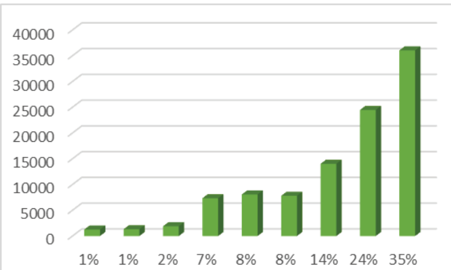

Figure 4. Field slopes for Dobrogea's Plateau

Slope categories are presented as follows (tab. 2):

Table 2

Slope categories from Dobrogea's Plateau

Surface (ha)	Slope (0)				
	0-10	11-20	21-30	31-40	>40
	50337.4	39824.1	9800.0	3054.8	474.9

Large surfaces occupied by forests are located in the following forest districts: Ciucurova (15 619 ha), Babadag (13 902 ha), Niculițel (12 548 ha), Cerna (12 297 ha), Măcin (11 430 ha) and Băneasa (10 815 ha).

Măcin and Cerna forest districts are areas with 260 and 10.9 ha of slopes whose inclination is larger than 400.

Dobrogea's Plateau has an average altitude of 125 meters and constitutes a low unit. The largest part of this area, namely 88% has altitudes fewer than 200m. The most representative altitudes are rendered in Figure number 5.

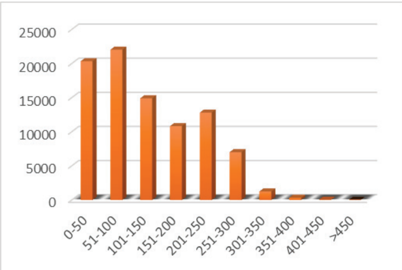

Fig. 5. Altitudes in Dobrogea's Plateau

CONCLUSIONS

A field's geomorphology can be appreciated and analyzed based on parceling descriptions present in forest management plans. These documents are essential as they contain a characterization of a field's geomorphology on small surfaces (approximately a few hectares).

The main exposition for the analyzed area is from East towards North, while the South part is mainly plain. Three of the ten forest districts present in Dobrogea's Plateau are small surfaces with slopes that have an inclination >40°, while a considerable percentage of forest is situated on plain areas or with an inclination < 20°. The majority of soils from this area can also be found in other geographic areas from Romania and have different chemical properties caused by geologic, geomorphologic and altitude differences.

REFERENCES

Blaga T., Dincă L., Pleșca I. M. 2019. How can smart alder forests (Alnus glutinosa (L.) Gaertn.) from the Southern Carpathians be indentified and managed. Scientific papers series „Management, Economic Engineering in Agriculture and Rural Development", 19(4): 29-35.

Cântar I.C., Dincă L., Chisăliță I., Crișan V., Kachova V. 2019. Identifying the oldest stands from the Southern Carpathians together with their main characteristics.

Proceedings of the Multidisciplinary Conference on Sustainable development, Filodiritto International Proceedings: 186-193.

Crișan V. E., Dincă L. C. 2020. Analysis of chemical properties of forest soils in Dobrogea Plateau. Revista de Chimie, 71(2): 267-272

Dincă L., Enescu C.M., Timiș-Gânsac V. 2018. Game species from Tulcea county and their management. Scientific papers series Management, Economic Engineering in Agriculture and Rural Development,18(3): 101-106.

Dincă L., Badea O., Guiman G., Bragă C., Crișan V., Greavu V, Murariu G., Georgescu L. 2018. Monitoring of soil moisture in Long-Term Ecological Research (LTER) sites of Romanian Carpathians. Annals of Forest Research, 61(2): 171-188.

Dincă L., Achim F. 2019. The management of forests situated on fields susceptible to landslides and erosion from the Southern Carpathians. Scientific papers series Management, Economic Engineering in Agriculture and Rural Development, 19(3), pag. 183-188.

Dincă L., Vechiu E., Oneț A. 2020. Can we identify manna ash (Fraxinus ornus L.) “smart forests” in Banatului Mountains? Natural Resources and Sustainable Development, 10(1): 91-100.

Dincă L., Murariu G., Enescu C. M., Achim F., Georgescu L., Murariu A, Timiș-Gănsac V., Holonec L. 2020. Productivity differences between southern and northern slopes of Southern Carpathians (Romania) for Norway spruce, silver fir, birch and black alder. Notulae Botanicae Horti Agrobotanici Cluj-Napoca 48(2): 1070-1084.

Dincă L., Timiș-Gânsac V. 2020. The usage of non-wood forest products - Culinary and artisanal traditions in Romania. Sustainable Development Research; 2(1): 50-57.

Grecu F., Rădulescu C. C., Comănescu L. 2019. Relief, paysage, geomorphosite dans le Plateau de Dobroudja du Sud (Roumanie). Analale Universitatii Bucuresti. Seria Geografie.

Hinkov G., Kachova V, Velichkov I, Dincă L. 2019. The Effect of Grazing on Old Oak Forests from Eastern Rhodopes Mountains. Ecologia Balkanica, 11(1): 215-223.

Ioana-Toroimac G., Zaharia L., Bigot S., Beltrando, G., 2006. Activité végétale et caractéristiques hydroclimatiques en Dobroudja (Roumanie): l'apport des données... Télédétection, 6(3): 195-204.

Pedrotti F. 2020. Overview of the Environment and Vegetation of the Danube Basin. In Human Impact on Danube Watershed Biodiversity in the XXI Century (pp. 7-26). Springer, Cham.

Prăvălie R., Bandoc G. 2015. Aridity variability in the last five decades in the Dobrogea region, Romania. Arid Land Research and Management, 29(3): 265-287.

Timiș-Gânsac V., Dincă L., Ceregi G. 2020. Considerations concerning the oldest stands from Banatului Mountains, Romania. Sustainable Development Research, 2(1): 64-71.

Văduva I. 2003. Air temperature in January within the South Dobroudja plateau.cIn Forum Geografic (No. 2: 34). University of Craiova, Department of Geography.

Vechiu E., Dincă L., Enescu C.M. 2018. Which are the most important forest fruits in Gorj County ? Revista de Silvicultură și Cinegetică nr. 42: 89-93.

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PRIORITIZING THE POTENTIAL OF NON-WOOD FOREST PRODUCTS (NWFP) FROM GALAȚI COUNTY BY USING THE ANALYTIC HIERARCHY PROCESS

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Keywords: *Lactarius piperatus, Anser anser, Măceș.*

ABSTRACT

Non-wood forest products represent a valuable tool for all industries, as well as for the culinary and handmade domains. Romania is known for its good representation and diversity of non-wood products. The present article presents the importance of using and capitalizing non-wood forest products, emphasizing the need to develop this sector. The article focuses then on analyzing three such products commonly found in Galați Forest District: summer goose present all year long as well as in Danube's Delta and in certain swamps, lakes and ponds; brier which records considerable annual quantities, especially in O.S. Tecuci (22-23 t) and O.S. Grivița (12-15 t); peppery milk cap a species that is not well-known but which has a high selling potential and a large market request. These three non-wood products were analyzed through the AHP method which established their value based on 19 criteria.

INTRODUCTION

Non-wood forest products (NWFP) represent an important part of the forest sector. Their value was reconsidered during the last years and their importance was recognized for the development of the socio-economic sector (Marshall & Cherukat 2009). Even though their importance is recognized worldwide, the policy and plans of forest management plans usually concentrate on wood production (Sainz et al. 2010). However, a report published by FAO (2009) shows that Western Europe foresees an increase in the competitivity for the forest's non-wood products and services with the intention to develop the market and to sustain producers and distributers as well as to offer more options to buyers. The percentage of non-wood forest products in Romania differs from one county to another, depending on the surface occupied by forests and on local traditions. In recent studies (Cântar et al. 2018; Enescu et al. 2018; Bragă et al. 2019; Tudor et al. 2019) these products were analyzed based on their spreading areal. From Romania's 41 counties, 29 have a forest deficit, including Galați, which has an afforestation percentage of 8% (MAP, 2017).

Numerous areas from Romania are renowned for their traditional products and some of them are obtained by manufacturing non-wood forest products. Their majority are used in the culinary industry. As such, knowing, understanding and perpetuating these traditions is extremely important for maintaining the cultural, ethnic, culinary and artisanal Romanian culture (Dincă et al. 2020).

MATERIAL AND METHODS

Galați County is located in Romania's south-east part (Figure 1), occupying 1.9% of our country's surface. The relief is tabular, strongly fragmented in north and less accentuated in south. From the point of view of altitude and relief particularities, the county is divided in five geomorphologic units: Lower Prut's Meadow, Inferior Siret's Meadow, Covurluiului Plain, Tecuciului Plain and Covurluiului Plateau.

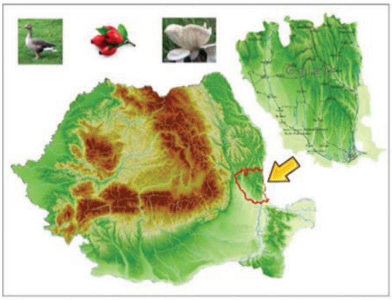

Figure 1. Location of Galați County (Source: the Shuttle Radar Topography Mission (SRTM) 30m)

The total surface of the public state forest fund managed by Galați Forest District through its 4 forest districts is of 20.741 ha. The forest fund's surface is of 19.515 ha. One of the traditional activities of RNP-Romsilva is to capitalize the forest's non-wood products. Annually, over 3000 tons of forest fruits originating from Romania's spontaneous flora are processed and certified as ecological agro-alimentary products. Amongst them we mention: blueberries, raspberry, sea buckthorn, brier, etc. Forest fruits can be capitalized both on the external and internal market, in high quantities, in a frozen or refrigerated state and in various packages (www.rosilva.ro.).

The analytical hierarchy process (AHP) was also used in the silvicultural domain and consists in decomposing a complex decision into a hierarchy with the purpose of establishing the best option (Saaty, 2008). Non-wood forest products were grouped in four categories as conceived in the European Project COST FP1203 European Non-Wood Forest Products (NWFPS) Network: mushrooms and truffles, tree products, subterranean plants and animal products. These four categories were also used in recent studies from Bacău (Blaga et al. 2019), Dambovița (Cântar et al. 2020), Satu Mare (Tudor et al. 2019) and Gorj (Vechiu et al. 2018).

The purpose of this study was to emphasize the most important non-wood forest products from Galați County.

RESULTS AND DISCUSSIONS

The three products that were selected for Galați County were: brier (*Rosa canina*), peppery milk cap (*Lactarius piperatus*), and summer goose (*Anser anser*).

Based on the opinions expressed by experts, the products were prioritized based on the 19 chosen criteria (Tab. 1).

Table 1

AHP alternative ranking

		Criterion	Mushrooms		Tree products	Understory plants			Animal origin	
			Boletus sp.	*Lactarius pipperatus*	*Acorn*	*Rosa canina*	*Allium ursinum*	*Hypericum perforatum*	*Anser anser*	*Abramis brama*
1	Harvesting period	1	5	4	7	8	1	3	2	6
2	Harvested quantity / worker / 8 hours	2	7	5	1	4	3	2	8	6
3	Harvesting cost	3	3	4	5	8	6	7	1	2
4	Knowledge for harvesting	4	5	3	4	7	1	2	8	6
5	Tools needed for harvesting	5	8	7	3	2	1	4	6	5
6	Complexity of harvesting process	6	6	7	3	4	1	2	8	5
7	Development of harvesting process	7	5	4	3	6	1	2	8	7
8	Knowledge for recognition	8	5	4	2	7	1	3	8	6
9	Distribution range	9	7	5	6	8	3	4	1	2
10	Biotic threats	10	8	7	1	6	3	4	5	2
11	Abiotic threats	11	7	5	2	6	1	3	8	4
12	Perishability	12	7	5	1	4	2	3	8	6
13	Market potential	13	8	6	3	4	1	2	7	5
14	Market demand	14	8	7	1	2	4	3	5	6
15	"Celebrity" of the product on market	15	8	4	1	5	6	3	7	2
16	The price of raw product	16	8	2	1	7	5	6	4	3
17	The price of the derived product	17	6	5	4	2	3	1	8	7
18	Portfolio of derived products	18	8	7	6	4	1	2	5	3
19	Transport (harvesting - storage center)	19	6	5	4	3	1	2	8	7

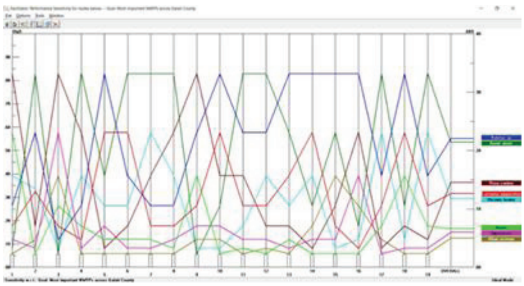

Figure. 2. The ranking of the eight NWFPs

Summer goose (*Anser anser*) (Fig. 3) is one of the largest anser gooses. The plumage is mainly gray with brown, while the superior parts are defined by the white margins of the flight feathers. The body's length is of 74-84 cm while the average weight can reach 2-4,5 kg. The feathers' magnitude ranges between 149 - 168 cm. The species is present in our country all year long but differs in distribution during the nesting season when it is more dispersed and when it prefers vast humid areas, associated to river bends from the plain areas. The largest density is found in Danube's Delta and in the lagoon system. During winter, the species prefers low plain areas, rich in autumn agricultural cultures or areas with natural grassy vegetation. The summer goose is threatened by hunting and the land's degradation in humid areas, a result of agriculture and industrial development (http://pasaridinromania.sor.ro).

The AHP analysis has shown that the summer goose offers a high quantity of harvest for a worker in 8 hours, lacks threats from abiotic factors and the market recognition and selling potential are very high. The harvesting cost is high, while the harvesting period is short and the spreading areal is limited. Despite those aspects, the summer goose occupies the first place among animal products from Galați County (Fig. 2).

Figure 3. Summer goose (Anser anser)
(https://pasarisiouaderasa.sunphoto.ro)

Peppery milk cap (*Lactarius piperatus*) (Fig. 4) is a species of edible mushrooms from the Russulaceae Family, Lactarius Genus that grows in both plain, hill and mountain areas. The species is not pretentious and can also grow in broad-leaved and resinous forests, both isolated or in large groups starting from June up to the end of autumn or the beginning of winter.

Peppery milk cap is white-yellow and has a convex hat, between 5 and 10 cm, with margins reverberating towards the foot; they flatten as the mushroom ages. The cuticle is smooth but chapped during dry periods. The leaves are hard, thick and narrow, while the spores are oval and verrucose. The foot is stable, upstanding and slightly curbed, with a height of 5-8cm, slender towards the basis and with a thickness between 2 and 4 cm.

Lactarius piperatus is rich in vitamins C and B, in magnesium, potassium and iron and has a low content of calories. It also contains lecithin and helps reduce cholesterol. As such, it is recommended for people that suffer from gastro-intestinal diseases, liver or kidney affections. The mushrooms can be fried on the grill or in pan, can be dried, used as condiment or conserved in saline water or vinegar.

For the peppery milk cap, the AHP analysis has shown a high selling potential and a high market request. Furthermore, the tools necessary and the process's complexity suggest a low difficulty in harvesting them. On the other hand, the harvesting's cost as well as the raw product's costs are high as the species is not very well known on the market. The same method has shown a stability for this species, regardless of its area. For example, the study realized in Arad County did not shown significant differences in the obtained AHP values (Pleșca et al. 2019).

Figure 4. Peppery milk cap (*Lactarius piperatus*)
(https://mapio.net https://www.flickr.com)

Brier (*Rosa canina*) (Fig. 5) belongs to Rosaceae Family and is present in Europe, Occidental Asa and North Africa. The species is a shrub with pennate leaves, while the stem is covered by small and sharp spikes. The height varies between 1 and 5 meters. The flowers are pink or white, have a diameter of 4-6 cm and are formed of five petals. The fruit is red or orange and spheroid.

The brier is found in plain areas, fields and hills, up to sub-mountains areas, or at the margin of forests and roads.

Both fruits and flowers are edible, either raw or in salads, decorating deserts or prepared in different ways: comfiture, syrup, tea, paste, vinegar etc. In addition, Brier is rich in vitamins A, B, C, K and E, is efficient in treating colds and flows, respiratory infections, biliary affections or in improving immunity and stimulating digestion.

The AHP analysis has revealed that brier has a long harvesting period and low costs even though the harvesting process is relatively complex. The spreading areal is very large, while biotic and abiotic factors do not present a high threat. However, the market request is low, while the derived product's price is very high.

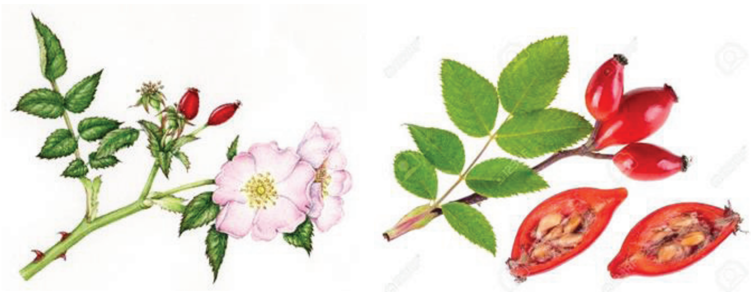

Figure 5. Brier (Rosa canina)
(https://www.123rf.com/ https://lizzieharper.co.uk)

CONCLUSIONS

Galați County is situated in a unique area for our country, being located between Danube's Delta and the exterior of the Carpathian ark. The geographical and climatic conditions have significantly influenced the fauna and geologic structure.

The present study has analyzed three species present in this country by using an AHP method. Based on the results, Brier presents a high potential as significant quantities are obtained after harvesting and can be traded and capitalized both locally and abroad.

The second place in the county and the first place in the hierarchy are occupied by an animal product, namely the summer goose. Even though implies higher production costs and a shorter harvesting period, the species presents a high market interest and a significant quantity harvested by a worker in 8 hours.

The obtained results sustain the idea that non-wood forest products can bring numerous economic benefits and can help determine a direction that can be acted upon in order to socially-economically develop this county.

REFERENCES

Blaga T., Pleșca I.M., Dincă L. 2019. Selecting the most promising non-wood forests products for Bacau County using the analytic hierarchy process. Studii și Cercetări Științifice-Biologie, 28(1): 29-33.

Bragă C., Dincă L. 2019. Forest is not only wood: Evaluating non-timber products from Dambovita County. Current Trends in Natural Sciences, 8(15): 73-78.

Cântar I. C., Enescu C. M., Dincă L., 2018. Application of the analytic hierarchy process in selection of the most important non-wood forest products for Dolj County, Craiova. Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series, 48(2): 50-57.

Cântar I. C., Dincă L. 2020. The most important NWFPs from Dâmbovița County identified through the analytical hierarchy process. Annals of the University of Craiova – Agriculture, Montanology, Cadastre Series, 49(2): 70-73.

Dincă L., Timiș-Gânsac V. 2020. The usage of non-wood forest products - Culinary and artisanal traditions in Romania. Sustainable Development Research; 2(1): 50-57.

Enescu C.M., Dincă L., Cântar I. 2018. Which are the most common non-wood forest products in Timis County? Research Journal of Agricutural Science, 50(1): 51-56.

Marshall E., & Cherukat C. 2009. Non-farm income from non-wood forest products. Food and Agriculture Organization of the United Nations (FAO).

Pleșca I. M., Blaga T., Dincă L., Breabăn I.G. 2019. Prioritizing the potential of non-wood forest products from Arad county by using the analytical hierarchy process. Present Environment and Sustainable Development, 13(2): 225-233.

Saaty T.L. 2008. Decision making with the analytic hierarchy process. International Journal of Services Sciences 1(1): 83-98.

Sainz R. C., Tome, M., Sánchez-González M., Miina, J., Spanos K., & Palahi M. 2010. Modelling non-wood forest products in Europe: a review. Forest systems, 19: 69-85.

Tudor C., Constandache C., Dincă L. 2019. Benefits brought by the abundance and importance of forest fruits from Satu Mare county, Romania. Book of Proceedings of the X International Scientific Agricultural Symposium "Agrosym 2019": 1920-1925.

Tudor C., Dincă L. 2019. The main categories of non-wood forest products from Vrancea County. Research Journal of Agricultural Science, 51(4): 211-217.

Vechiu E., Dincă L., Enescu C.M. 2018. Which are the most important forest fruits in Gorj County ? Revista de Silvicultură și Cinegetică nr. 42: 89-93.

***FAO: (2009) State of the world's forests 2009

***MAP,(2017) Raport privind starea pădurilor României în anul 2017

***www.rosilva.ro

***http://pasaridinromania.sor.ro

***https://mapio.net

***https://www.flickr.com

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***https://lizzieharper.co.uk

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HABITAT TREES WITHIN THE "RUNCU-GROȘI" NATURE RESERVE

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***Keywords**: ,,Runcu – Groşi" Nature Reserve, thick trees, habitat tree, beech, sessile oak*

ABSTRACT

Within the ,,Runcu – Groşi" Nature Reserve they were found a large number of thick trees, also called habitat trees (44 thick trees/ha, from which 1 thick tree/ha with the diameter larger or equal with 100 cm, 7 thick trees/ha having the diameters between 80 – 100 cm, and 36 thick trees/ha having the diameters between 60 – 80 cm). Within the habitat 9130, the large trees are beech and sessile oak trees. Together with these two species, within the 91Y0 habitat they are also Turkey oak and lime trees. The number of habitat trees within this Nature Reserve is quite similar compared to the numbers found in the beech dominated old forests of Central Europe.

INTRODUCTION

Within the modern epoch, the role of a forest goes beyond its traditional status which is a simple wood producer. These true "biodiversity depots" have a multiple role: *in situ* biodiversity conservation under all of its forms, carbon storage, but also could serve at the same time as model of management for the forests included in the economic circuit or for the forest protected areas having a structure different from the natural one. Therefore, the study of the forest having a high degree of naturality has become a preoccupation both for foresters and biologists, or for researchers from other activity domains.

The trees with large diameters (defined in this case as trees with diameter higher than 60 cm) contribute to a good functionality of the forest ecosystems, being essential components regarding the maintaining the accumulation of biomass, carbon storage, structural heterogenity, biodiversity and forest integrity. Also, they regulate the biotic filtration processes, dominating the structure, dinamics and functions of many forests from the temperate zone (Lutz et al., 2013 Fichtner et al. 2015].

This kind of trees are also called "habitat trees" and they provide, or could provide, due to their dimensions, ecological niches. The abundance and diversity of microhabitats provided by these trees are strongly related to their diameter (the larger the tree diameter, the more microhabitats it provides). In these trees there are 4 types of microhabitats:

- Cavities – four types can be distinguished by their origin and morphology:
  - Cavities generated by woodpeckers;
  - Cavities generated by the decomposition process;
  - Cavities temporarely or permanently filled with water;
  - Large cavities which start at the tree base and advance in the stem;

- Tree bark – partially or completely detached;
- Fructification bodies of saprophytic fungi;
- Other microhabitats [Bütler *et al.*, 2013].

MATERIAL AND METHODS

The researches are located within the Natural Reserve "Runcu - Groşi", which is part of the IV Groşi Production Unit (U.P.) of the Bârzava Forest District, Arad County Forestry Directorate, being situated on the Eastern part of the Forest District, occupying the basin of the Groşi Valley (fig. 1). The limits of the Runcu – Groşi Reserve are natural. It covers a surface of 260.9 ha, the geographical location by coordinates being $46^{0}11’$ Northern latitude and $22^{0}07’$ Eastern longitude (Giurgiu V. et al. 2001).

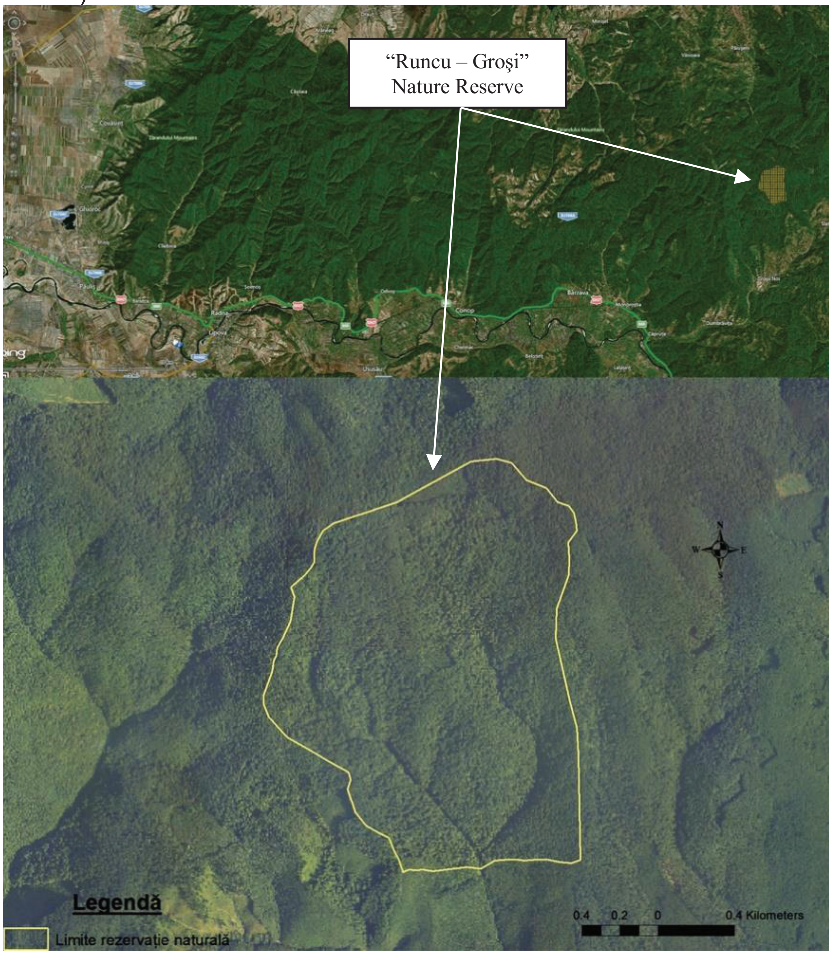

Figure 1. The positioning of ,,Runcu – Groşi” Nature Reserve [source: http://natura2000.eea.europa.eu]

Within the Reserve, a network of 134 circular sample plots of 1000 m^2 each was materialized. They were inventoried, after a selection process, 41 sample plots (4.1 ha). For the selection of the 41 sample plots it was intended that they show a minimal visible human influence and at the same time they capture in the most representative way all the structural characteristics of the forest stands from the Reserve.

The following information was recorded: the exact spatial position of the trees (alive and dead) inside the circular sample plot – measured using the FieldMap equipment, the tree species, the diameter – by measuring with a calliper respectively two perpendicular diameters and recording the average (only the trees with the diameter equal or larger than 60 cm were measured).

Also, the distribution of thick trees on types of forest habitats Natura 2000 was carried out. The mapping of these habitats was done based on field observations, being also used a series of scientific works.

RESULTS AND DISCUSSIONS

After inventoring the 41 sample plots it resulted a number of 182 thick trees (44 thick trees/ha) (figure 5). From them, 172 are living and the rest of 8 are dead on feet. Regarding the repartition by species, beech is the most frequent with a number of 113 trees (27 thick trees/ha), from which 108 are living and 5 are standing dead. The next species is the sessile oak with 58 trees (14 thick trees/ha), 54 being living trees and the rest of 4 being standing dead. With a small number of trees it can be mentioned the Turkey oak (9 living large trees) and the lime tree with two exemplars – one living and one dead large trees (figure 2). After analyzing the data it can be found that only 3 trees (2 living and one dead) have the diameter larger than 100 cm, 28 living trees and 2 dead trees have the diameters between 80 and 100 cm, and the rest of 142 living trees and 7 dead trees have the diameter between 60 and 80 cm.

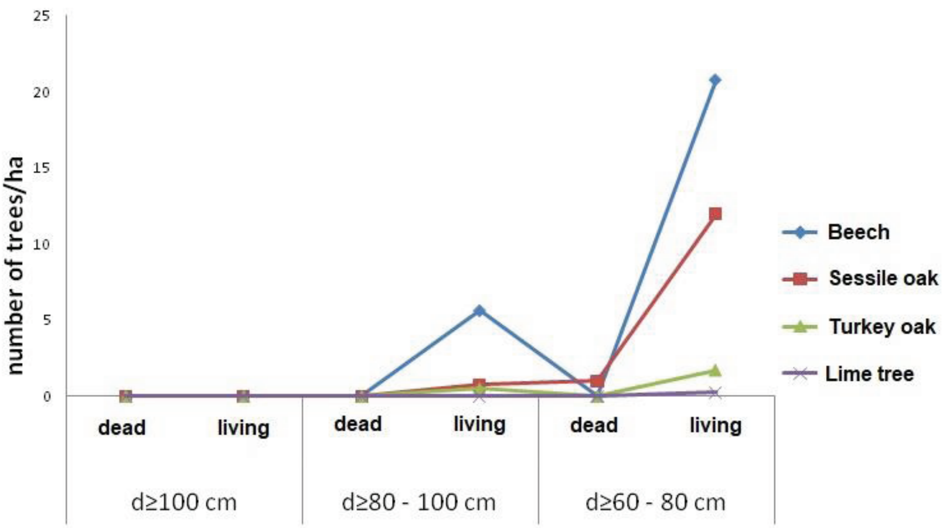

Figure 2. Distribution of total number of large trees/ha (living and standing dead), by species and by diameter categories

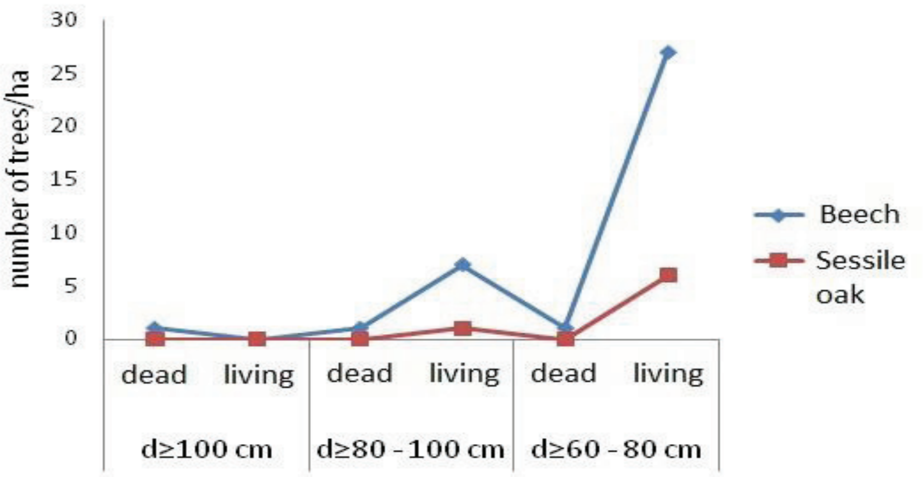

Figure 3. Distribution of total number of large trees/ha (living and standing dead) by species and by diameter categories– habitat 9130

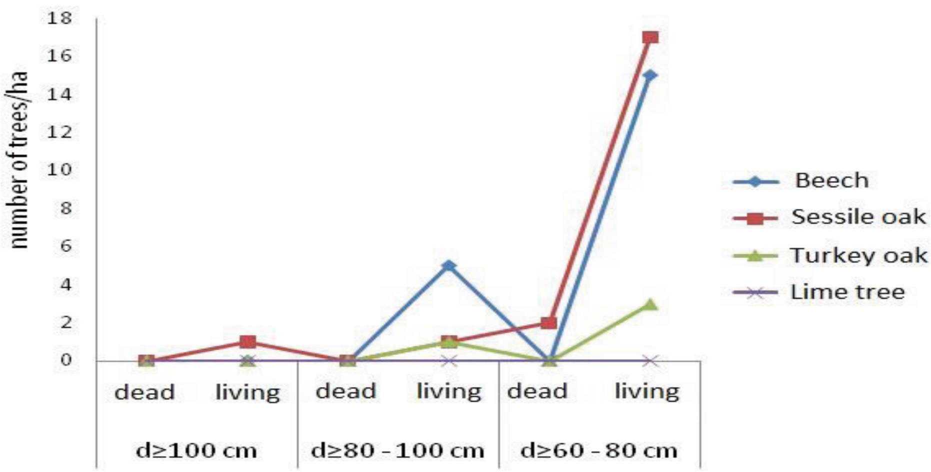

Figure 4. Distribution of total number of large trees/ha (living and standing dead) by species and by diameter categories– habitat 91Y0

Regarding the distribution of thick trees by Natura 2000 habitat types, within the very large diameter categories (d ≥ 100 cm) only a small number of trees/ha were recorded (1 living tree/ha for the habitat 91Y0 and 1 dead tree/ha for the habitat 9130). For the dimeters' interval d = 80 - 100 cm, within the habitat 9130 it was recorded 1 dead tree/ha and 8 living trees/ha, while in the habitat 91Y0 they were recorded 7 living trees/ha. For the diameters' interval d = 60 - 80 cm the number of thick trees is almost equal for the habitat 9130 (1 dead tree/ha and 33 living trees/ha, the beech being much well represented) and the habitat 91Y0 (2 dead trees/ha and

35 living treesi/ha, in this case the number of sessil oak exemplars being superior to the number of beech exemplars) (figure 3, figure 4).

The distribution of the number of living large trees by species respects the stand's composition within the "Runcu Groși" Nature Reserve, the beech being the species with the highest spatial constancy, followed by the sessile oak. The situation is similar in the case of the two types of Natura 2000 forest habitats.

In the old forests of the Central Europe, dominated by beech, a number of approximately 30 thick trees/ha was recorded with a diameter larger than 70 cm. Also in these forests, the density of living trees with a diameter larger than 80 cm varies between 10 – 17 trees/ha. The standing dead trees with large dimensions are found in smaller numbers compared to the living trees. In the European old forests the number of trees with the diameter larger than 70 cm varies between 1 – 8 trees/ha (Nilsson et al. 2003).

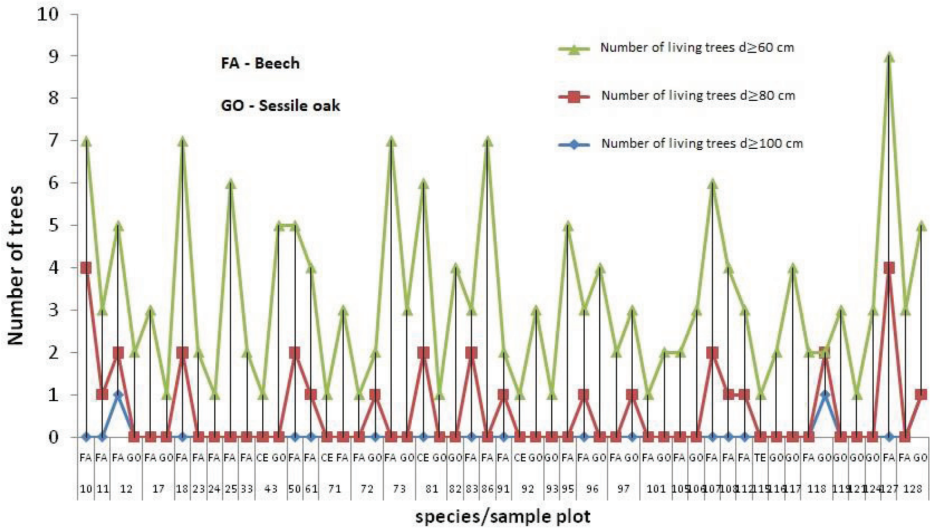

Figure 5 - Distribution of total number of (living) large trees by diameter categories, by species and by sample plot

CONCLUSIONS

After the analysis of the field data it can be observed the existence of a large number of thick trees (44 thick trees/ha from which 1 thich tree/ha with the diameter over or equal to 100 cm, 7 thick trees/ha with the diameters between 80 - 100 cm and 36 thick trees/ha with diameters between 60 – 80 cm). Within the habitat 9130, the thick trees are represented by the species beech and sessile oak. Together with these two species, within the 91Y0 habitat there can be found the Turkey oak and the lime tree.

REFERENCES

Bütler R., Lachat T., Larrieu L., Paillet Y. 2013. Habitat trees: key elements for forest biodiversity - capitol din Integrative approaches as an opportunity for the conservation of forest biodiversity, EFI report;

Fichtner A., Forrester D., I., Härdtle W., Sturm K., von Oheimb, G., 2015. Facilitative-Competitive Interactions in an Old-Growth Forest: The Importance of Large-Diameter Trees as Benefactors and Stimulators for Forest Community Assembly, Plos One;

Giurgiu V., Doniţă N., Bândiu C., Radu S., Cenuşă R., Dissescu R., Stoiculescu C., Biriş I. A. 2001. Les forets vierges de Roumanie / Pădurile virgine din România. Edite par l'ASBL Foret Wallone, 206 pag.

Lutz J., A., Larson A. J, Freund J. A., Swanson, M. E., Bible, K. J. 2013. The Importance of Large-Diameter Trees to Forest Structural Heterogeneity, Plos One, vol. 8, Issue 12;

Nilsson S., G., Niklasson M., Hedin J., Aronsson G., Gutowski J. M., Linder P., Ljungberg, H., Mikusinski G., Ranius T. 2003. Erratum to ''Densities of large living and dead trees in old-growth temperate and boreal forests'', Forest Ecology and Management 178: 355–370.

http://natura2000.eea.europa.eu)

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MAIN PRESSURES AND THREATS AFFECTING THE FOREST HABITATS FROM THE NATURA 2000 SITE ROSCI0246 TINOVUL LUCI

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Keywords: *ROSCI0246, Natura 2000, 91D0*, threats, pressures*

ABSTRACT

Within the Tinovul Luci Site, located in the southern part of the Harghita County on the territory of the Miercurea Ciuc Municipality and the Sâncrăieni Commune, the only Natura 2000 forest habitat found is 91D0 - Bog woodland. Some of the pressures and threats affecting this habitat have a direct action and a medium intensity. For example: Storms, cyclones (the cause of tree windthrows) and Problematic native (indigenous) species (Ipidae insects attacking the spuce), these pressures/threaths significantly affecting the structure and viability of the habitat. Other impacts have an indirect action, such as The forest harvesting operations (forestry activities), threat that is manifested in the vicinity od the Site.*

INTRODUCTION

In Romania, the habitat 91D0* - Bog woodlands is present especially on level ground or hollow terrain from the mountain areas, in specific sites and on small surfaces. Its existence is strictly tied to three principal elements: execessive humidity, acidic rocks and cold climate (Stăncioiu et al. 2008).

Over time, this type of habitat was affected by a series of pressures and threats which had as effcets the degradation of the ecosystems, such as: drainage of the land and draionage followed by plantatios, peat harvesting, grazing and tresspassing of the domestic animals through the habitat, the presence of roads inside and in the vicinity of the habitat. To all of the above, it can be added the small magnitude of populations, especially for the trees' species present within the bog, which cannot be found in the forest stands from the vicinity (Stăncioiu et al. 2008).

Nowadays, the bogs with forest vegetation have a protection status, being included in various types of protected areas, and the ones which are included in the forest fund are categorized by the functional zoning as protection forests.

MATERIAL AND METHODS

The research is located within the Natura 2000 Site ROSCI 0246 Tinovul Luci, located at the coodinates $46^{0}18'4''$ Northern latitude and $25^{0}43'13''$ Eastern longitude. The protected area is located in the Southern part of the Harghita County, on the administrative territory of the Miercurea Ciuc Municipality and the Sâncrăieni Commune, having a total surface of 271 ha.

[http://biodiversitate.mmediu.ro/rio/natura2000/static/pdf/rosci0246.pdf]. (figure 1)

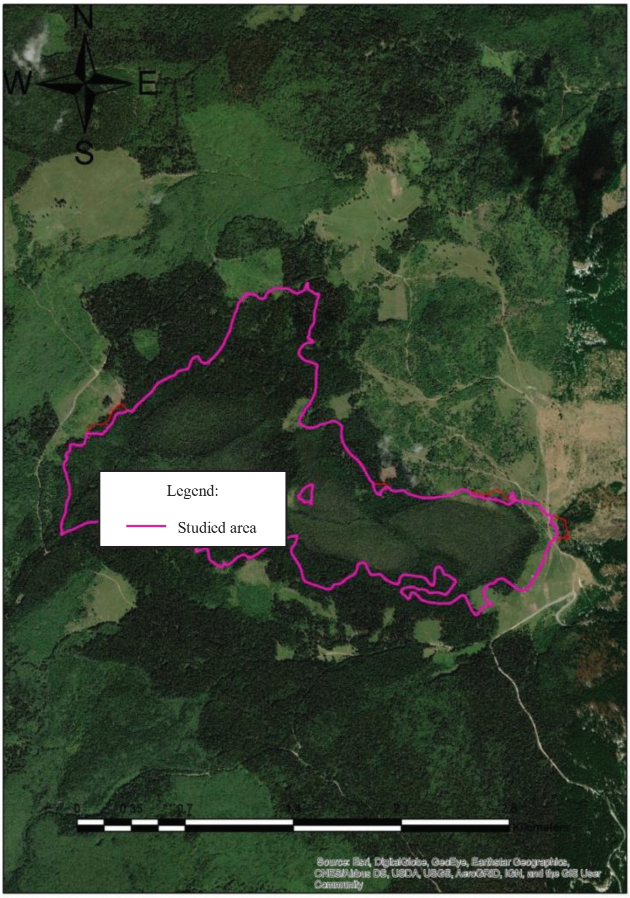

Figure 1 – Research location

The research material consists of forest stands found within the studied area. In order to determine the types of Natura 2000 forest habitats, an equivalence has been made between the forest habitats of Community interest with the Romanian habitats and the forest types used in the Romanian typology. In this respect, the equivalence from the research report "Establishment of management measures for forest habitats of community interest included in the Natura 2000 sites" - authors Iovu Biriş and Oliver Merce was used. This equivalence is based on a series of scientific papers: "Interpretation Manual of European Habitats", "Handbook for the Interpretation of Natura 2000 Habitats in Romania" - coordinators: Gafta D. and Mountford O., "Habitats of Romania "- authors: Doniță et al., "Types of forest ecosystems in Romania" - coordinators: Doniță N., Chiriţă C., Stănescu V., "Types of forest in Romania" - authors Paşcovchi S. and Leandru V. and "The list of habitats and species of Community interest for which sites of Community importance have been declared" (http://www-old.anpm.ro/files2/ Anexa4%20-%20SCI%20-%20 Lista%20tipurilor%20de% 20habitate% 20%C5%9Fi %20a%20s.pdf).

Subsequent to this equivalence, the correspondence forest type - Natura 2000 forest habitat was checked in the field. During this check, a complex data sheet was completed, in which the characteristics of the forest stand, shrub layer, seedlings layer and herbaceous flora were recorded (based on these determinations being the book "Flowers in Romania's forests" - authors: Candrea-Bozga et al. 2013). The implementation of the Natura 2000 forest habitats distribution maps was done through the ArcGIS 10 software.

Pressures and threats, as well as their codes, have been assimilated to those outlined in the "Pressures and Threats Nomenclature" in the "Guide to Managing Natural Areas Management Plans".

For each stress factor / limiting situation encountered the following aspects were observed: the incidence level, the affected habitat area and the intensity of the negative influence (Table 1).

Table 1

The scale of incidence level, the affected habitat area and the intensity of the negative influence [Stăncioiu et al. 2008]

No.	Name of the characteristic of threat evaluation	Scale of classification
1	Incidence level	Potential
		Small
		Average
		High
2	Affected habitat area	Small
		Average
		High
3	Intensity of the negative influence	Small
		Average
		High

The mapping of the pressures / threats was based on the forest management planning maps of the five Production Units mentioned above, using the ArcGIS 10 software.

RESULTS AND DISCUSSIONS

Following the field observation, only one forest habitat of Community interest was identified: 91D0* - Bog woodlands. This habitat is covering the whole surface of the protected area. The conservation status of this habitat type (estimated based on complete observations taken on a minimum area of 70% of the surface covered by the habitat) is favourable. The structure and functions of the habitat type, including its typical species, are in good condition, without significant deterioration, the viabiloity on long term of the habitat type being assured.

The main pressures and threats identified in the studies area are: B08 – The forest harvesting opperations (forestry activities), I02 – Problematic native (indigenous) species (Ipidae insects attacking the spuce) and L07 – Storms, cyclones (the cause of tree windthrows).

The forest harvesting opperations (forestry activities)

This pressure is manifested in the vicinity of the Site, respectively of the Reserve, indirectly affecting the entire surface of the protected areas. The forestry interventions (forest harvesting operations) affect the struture of the phytocoenosis edified by conifers (spruce, pine) by vulnerabilisation towards abiotic disturbance factors (wind), also acting towards the modification of the hydric regime of the area. The intensity of the pressure is low, therefore the viability on the long term of the habitat type, in the area, is not significantly affected.

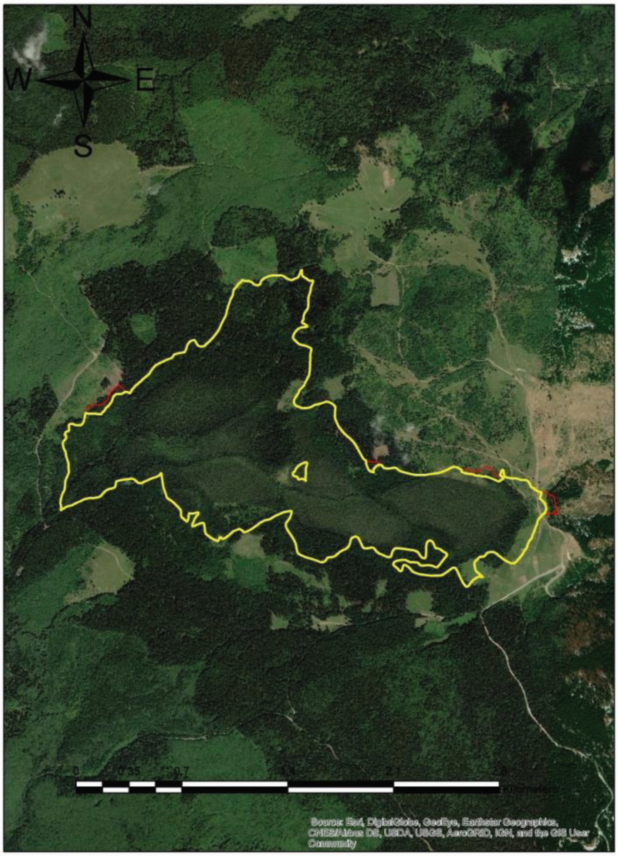

Figure 2 – Location of pressure B08

Problematic native (indigenous) species (Ipidae insects attacking the spuce)

This pressure is manifested in some point-locations distributed all over the area of the site, with a higher frequency on the Eastern part of the site. The development of the bark beetle species, generally from the *Ipidae* Family, is favored by the existence of broken, fallen, uprooted, etc. coniferous trees. Conditioned by the maintaining of the forest in a natural status at the site level, respectively at the Reserve level, the extraction of these trees being forbidden by law, a type of management should be implemented in order to assure the control of the populations of these insects, respectively not harming the healthy trees within the site/Reserve by them. The intensity of the pressure is average, the viability on the long term of the habitat type, in the area, is significantly affceted.

Storms, cyclones (the cause of tree windthrows)

This pressure is manifested on large areas. Because of the very wet ground, correlated with a superficial root system, the snow accumulate din the crown layer of the trees or heavy winds can cause massive windthrows. In this case, these phaenomena cover all the surface of the site. These disturbances belong to the category of abiotic disturbance factors. The intensity of the pressure is average, the viability on the long term of the habitat type, in the area, is significantly affected.

CONCLUSIONS

In the case of the Site Tinovul Luci, the tree layer is represented by the Scots pine (*Pinus sylvestris*) and spruce (*Picea abies*), also being found exemplars of birch, dwarf birch, black alder, goat willow and qaucking aspen.

Being a small-dimension Natura 2000 site, within the Tinovul Luci area only one (priority) forest habitat type was identified: 91D0* - Bog woodland. The main impacts (pressures and threats), by their intensity, are represented by: Storms, cyclones (the cause of tree windthrows), Problematic native (indigenous) species (Ipidae insects attacking the spuce) and The forest harvesting opperations (forestry activities). For the first two pressures/threats their intensity is average, the viability on the long term of the forest habitat type, in the area, being significantly affected. For the last pressure/threat, its intensity is low, the viability on the long term of the forest habitat type, in the area, not being significantly affected.

REFERENCES

Candrea-Bozga B. Ș., Indreica I. V., Lazăr G. 2013. Flori din pădurile României. Editura Green Steps, Brașov.

Doniţă et al. 2005, Habitatele din Romania, Editura Tehnică Silvică, București.

Gafta D,. Mountford O. 2008. Manual de interpretare a habitatelor Natura 2000 din România, Editura Risoprint, Cluj Napoca.

Merce O. 2012. Natura 2000 and the forests in Romania – management principles, problems and threats. JOURNAL of Horticulture, Forestry and Biotechnology, Volume 16(2).

Stăncioiu P. T. et al. 2008. Habitate prioritare alpine, subalpine şi forestiere din România – Măsuri de gospodărire, Editura Universităţii Transilvania din Brașov.

***http://biodiversitate.mmediu.ro/rio/natura2000/static/pdf/rosci0246.pdf

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HETEROTROPHIC CULTIVATION OF CHLAMYDOMONAS REINHARDTII USING GLYCERINE AS THE SOLE CARBON SOURCE

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Keywords: *Heterotrophic, Chlamydomonas reinhardtii, glycerine*

ABSTRACT

The heterotrophic growth of the microalgae species Chlamydomonas reinhardtii was examined at five different initial carbon concentrations of 0.41, 0.73, 1.17, 3.11 and 5.73 g L-1 while keeping the initial nitrogen concentration constant and equal to 45.4 mg L-1 in order to examine the effect of initial carbon concentration and initial ratio of carbon to nitrogen concentrations Co/No on the biomass productivity as well as the protein and lipid content on a dry mass basis. Co/No ratios were equal to 9, 16.1, 25.8, 68.5 and 126.2. The cultivations were carried out simultaneously in five 5L cylindrical glass bioreactors. The organic carbon was measured as a function of cultivation time. It was found that as the initial ratio of Co/No increases the carbon uptake rate (g C/(L-d)) initially increases sharply but above about a ratio Co/No of 25 it becomes nearly independent of the Co/No ratio. The protein content decreases, while the lipid content increases as the Co/No ratio is increased. Lipid content up to 32.6% was obtained and the biomass and lipid productivities are 0.09 g/(L-d) and 0.029 g/(L-d)) respectively at Co/No=126.2. When compared to the autotrophic growth of the same species and strain, the heterotrophic growth leads both to a shorter induction time as well as a shorter exponential time growth period. Also, both biomass and lipid productivities for heterotrophic growth are higher than the corresponding ones for the autotrophic growth.

INTRODUCTION

Microalgae are unicellular photosynthetic organisms that use light and carbon dioxide, with higher photosynthetic efficiency than plants, for the production of biomass. Some microalgae species can also grow and multiply heterotrophically in the absence of light if an organic carbon source becomes available (Mata et al. 2010). Heterotrophic growth presents several advantages compared to the autotrophic growth the most important being: a) the growth is not limited by light penetration, which is a problem with the autotrophic growth, b) higher growth rates and c) higher lipid content are obtained.

Among disadvantages are the potential of contamination (Chen et al. 2011) and the fact that not all algae species can grow heterotrophically. Light penetration, especially in deep bioreactors, is a problem and this appears to severely limit the growth rate in autotrophic cultivations (Huang et al. 2010). In some microalgae species, the biomass and lipid productivities are higher in heterotrophic cultivation in comparison with photoautotrophic cultivation (Xiong et al. 2008). Therefore, heterotrophic growth becomes attractive if high lipid productivity is sought in order to produce biofuels. Also, the cost of organic carbon source that should be taken into consideration for production in big scales. Therefore, low cost industrial by-products such as glycerol from biodiesel production, molasses and other industrial and municipal effluents become an attractive source of low cost carbon for heterotrophic cultivation of algae (Chojnacka & Marquez-Rocha 2004). It should be mentioned that different sources of carbon can be used for microalgae growth, such as glucose, sucrose, fructose, lactose or galactose (Perez-Garcia et al. 2011). Adequate aeration is very important heterotrophic growth as oxygen demand is high.

In general microalgae are a potential source of lipids, proteins and other antioxidants, such as carotenoids and phenolic compounds. It is well known that microalgae possess advantages over conventional plants. They can be grown in bioreactors, do not require the use of herbicides and, depending on the particular species and growth conditions, are very high on lipids (10-60%) and protein (10-70%) on a dry biomass basis (Metsoviti et al. 2019a). Also, depending on what product is sought whether it is lipids or protein and as is true in biochemical fermentations, by altering the cultivation parameters the relative content of lipids and protein can be altered during the cultivation process whether it is done autotrophically or heterotrophically.

The microalgae heterotrophic growth is influenced by different factors, such as carbon and nitrogen content, temperature, pH, aeration and mixing rate, salinity and by other macro nutrient composition (potassium and phosphorus) as well as by the micronutrient composition (Dean et al. 2010). The aim of the present study is to investigate the effect of initial carbon concentration on the kinetics of carbon uptake as well as on the biomass, lipid and protein productivities of the algal species Chlamydomonas reinhardtii grown heterotrophically with glycerol obtained from biodiesel production via the transesterification process of vegetable triglycerides.

MATERIAL AND METHODS

The microalgae *C. reinhardtii* was obtained from the University of Goettingen in Germany (EPSAG). It was cultivated (SAG, 2007) in 5 L glass circular flasks that were filled up to 4.5 L. Specifically, each litre of the culture medium contained: 0.2g KNO_3/L, 0.02 g K_2HPO_4/L, 0.02 g $MgSO_4.7H_2O$/L, 30 ml of soil extract/L and 5 ml/L, of a solution containing the following micronutrients: (1 mg $ZnSO_4.7H_2O$, 2 mg $MnSO_4.4H_2O$, 10 mg H_3BO_3, 1 mg $Co(NO_3)_2.6H_2O$, 1 mg $MoO_4.2H_2O$, 0.005 mg $CuSO_4.5H_2O$, 700 mg $FeSO_4.7H_2O$ and 800 mg EDTA)/L. Table 1 shows all the relevant initial parameters of the five experiments.

The culture medium was inoculated with a standard quantity (50 mL of *C. reinhardtii* inoculum) which was obtained directly from EPSAG and cultivated in a sterile environment until it reached an absorbance reading of 0.5. Crude glycerol was obtained from a local biodiesel manufacturing plant. Its composition is approximately 86% glycerine, 0.5% methanol, 4% free fatty acids and 7.5% H_2O. From this analysis the initial carbon content was calculated approximately so that the approximate Co/No ratios would be estimated and then, after the growth media in each bioreactor were prepared, the initial carbon content in each bioreactor in each growth medium was measured analytically and the exact ratio of the initial carbon and nitrogen concentrations, Co/No, in each medium be determined. The bioreactors, the glass tubing and the culture medium were sterilized before use. Air was continuously passed through the solution at 300 L h^{-1} though a 2 mm glass tubing positioned at the tip of a magnetic bar and the air bubbles were dispersed with a magnetic bar at the bottom of the glass flasks at a rotational speed of 500 rpm.

The determination of dissolved organic carbon was made according to the Walkey-Black analytical method. The protein content was determined by the Kjeldhal method (Pauwels et al. 1992). The lipid content was determined with extraction using co-solvents of n-hexane/isopropanol in the microalgal biomass according to the method of Bian et al. (2018) after the biomass was mechanically grinded.

Table 1.
Experimental initial conditions of the five experiments for the cultivation of *C. reinhardii.*

Bioreactor	No (mg N L^{-1})	Co Measured (g L^{-1})	Co/No	T (°C)	pH
1	45.4	0.41	9.0	30 ± 1	7 ± 0.5
2	45.4	0.73	16.1	30 ± 1	7± 0.5
3	45.4	1.17	25.8	30± 1	7± 0.5
4	45.4	3.11	68.5	30± 1	7± 0.5
5	45.4	5.73	126.2	30± 1	7± 0.5

RESULTS AND DISCUSSIONS

Figure 1 shows the experimental data for the decrease in organic carbon concentration (utilization of carbon by the algal cells) in the media as a function of cultivation time. It is noted that carbon decreases with time, but at a different rate, in all growth medium with Co/No ratios ranging from 9 to 126.2. This is due to the fact that the carbon in organic form found in the growth media is utilized by the *C. reinhardtii* cells in order that they multiply and make proteins, lipids and carbohydrates (macronutrients), as well as other organic compounds such as secondary metabolites. The initial concentrations of nitrogen are equal in all five bioreactors. It is also noted that the time needed for the organic carbon to be fully utilized increases with increasing Co/No ratio. For an initial Co/No ratio equal to 9 the carbon is utilized within 2-3 days while on the other hand for an initial Co/No of 126.2 and after 12 days only 58.6% of the carbon is utilized.

Figure 2 shows the rate of carbon utilization (uptake) as a function of the ratio Co/No. The rate of carbon uptake was determined from the average slope of the curves during the exponential phase growth which, is characterized by the sharp drop in organic carbon concentration in the curves in Figure 1. As it is noted in Figure 2 the rate of carbon utilization or bio-absorption increases with increasing Co/No ratio. The rate of carbon uptake varies by almost a factor 3.5, between 0.12 and 0.39 g/(L-d) as the Co/No ratio is increased from 9 to 126.2. When Co is varied, the combination of excess nitrogen and relatively low carbon concentrations (Co/No=9) lead to low rates of carbon uptake but as the carbon concentration is increased and for a ratio Co/No above about 25 the rate of carbon uptake becomes relatively constant. This is probably due to the fact that in the exponential growth phase the microalgal cells utilize both carbon and nitrogen for their growth so, at higher Co/No ratios the rate of carbon uptake becomes progressively independent of the carbon concentration as nitrogen, at these high organic carbon concentrations, becomes the limiting nutrient during the exponential growth phase.

Table 2 shows the biomass, lipid and protein productivities as well as the lipid and protein content of the dry biomass of *Ch. reinhardtii* for the five different initial ratios of Co/No.

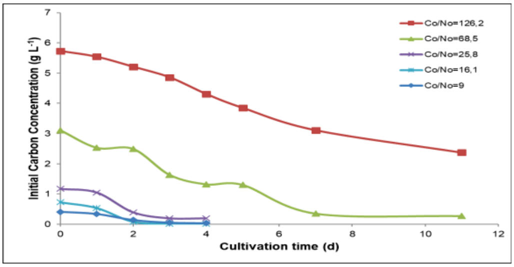

Figure 1. The decrease-utilization of organic carbon as a function of cultivation time during heterotrophic growth of *Ch. reinhardtii* and for the initial carbon and nitrogen concentrations shown on Table 1.

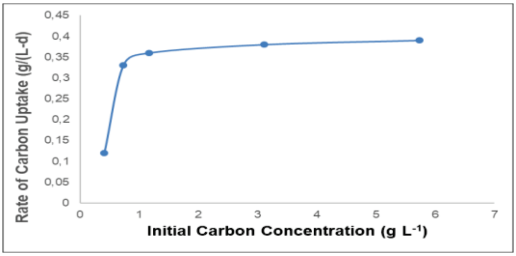

Figure 2. The rate of carbon uptake (g/(L-d)) as a function of initial carbon concentration during the heterotrophic growth of *Ch. reinhardtii*. Initial nitrogen concentration was 45.4 mg L^{-1} in all five experiments.

Table 2.

Biomass produced, lipid and protein content (on a dry mass basis) of *Chlamydomonas reinhardtii* for the initial parameters shown in Table 1.

Co (g L^{-1})	0.41	0.73	1.17	3.11	5.73
No (mg L^{-1})	45.4	45.4	45.4	45.4	45.4
Ratio Co/No	9	16.1	25.8	68.5	126.2
Biomass (g L^{-1})	0.11	0.19	0.20	0.32	1.02
Protein content C_p (%)	63.8	50.7	44.7	30.1	23.4
Lipid content C_l (%)	5.1	11.9	15.4	27.3	32.6

It is noted from Table 2 that as the initial carbon content is increasing, keeping the initial nitrogen content the same, the protein content is decreasing while the lipid content is increasing. As both nitrogen and carbon are needed for biomass growth, initially both carbon and nitrogen are used for protein and lipid synthesis but in excess carbon and as nitrogen is depleted, apparently the cells being unable to further multiply shift their metabolism to lipid synthesis. Also as the ratio of Co/No is increasing the biomass obtained per liter of growth medium at the end of each cultivation is increasing. From Figure 1 and Table 2, if most of the growth is assumed to occur during the exponential phase growth we can obtain the biomass and the respective protein and lipid productivities in g/(L-d). Thus, biomass productivities range from 0.045 g/(L-d) at Co/No=9 to about 0.09 g/(L-d) at Co/No=126.2. Protein and lipid productivities are obtained by multiplying the biomass productivities by the respective biomass content in protein and lipids. Therefore, protein productivities at Co/No=9 and Co/No=126.2 range from 0.029 to 0.021 g/(L-d) while, lipid productivities range from a low value of 0.002 at Co/No=9 to an upper value of 0.029 g/(L-d) at Co/No=126.2.

It is interesting to compare the heterotrophic growth characteristics with the corresponding ones for autotrophic growth for the same species and strain of *C. reinhardtii* reported by Metsoviti et al. (2019b). The same species and strain was grown autotrophically in full sun in a greenhouse environment during the June, October and March months. Two apparent differences are the relatively short induction period required for the heterotrophic growth, less than one day, compared to the corresponding one of 2-6 days for the autotrophic growth. The second difference is the short exponential growth phase of the heterotrophic growth, in this study ranging from 2 to 12 days, compared to a long exponential growth ranging from 12 to more than 20 days for the autotrophic growth. As a result, growth is much faster for the heterotrophic cultivation and this becomes apparent when comparing the biomass productivities. Biomass productivities during the autotrophic growth range from 0.008 g/(L-d) for cultivation in October to 0.012 g/(L-d) for cultivation in June. Biomass productivities obtained in this study are from about 5 to about 7 times faster. Also, lipid content varies from about 8% to about 16% for the autotrophic growth while in this study of heterotrophic growth by adding excess carbon a lipid content up to 32.6% was obtained.

CONCLUSIONS

During the heterotrophic growth of the microalgae species *C. reinhardtii*, the initial ratio of Co/No substantially influences both the biomass and lipid productivities. As the Co/No ratio increases, the carbon uptake rate (g C/(L-d)) initially increases sharply but, above about 25, it becomes nearly independent of the Co/No ratio apparently because nitrogen is the limiting reagent. The protein content decreases from 63.8% to 23.4%, while the lipid content increases from 5.1% to 32.6% as the Co/No ratio is increased from 9 to 126.2. Biomass and lipid productivities are 0.09 g/(L-d) and 0.029 g/(L-d)) respectively at Co/No=126.2. When compared to the autotrophic growth of the same species and strain, the heterotrophic growth leads to a shorter induction and exponential growth time. Also, both biomass and lipid productivities for heterotrophic growth are higher than the corresponding ones for the autotrophic growth. It appears that, as far as lipid productivity is concerned for obtaining bi-oil for biodiesel production, the heterotrophic growth of *C. reinhardtii* should be preferred to the autotrophic growth. However, higher lipid productivities are needed so the heterotrophic growth of other species should be investigated as well. Also, other modes of heterotrophic cultivation should be investigated such as the semi-batch operation as well as mixotrophic cultivation.

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REFERENCES

Bian X., Jin, W., Gu Q., Zhou X., Xi Y., Tu R., Han S., Xie G., Gao S., Wang Q. 2018. Subcritical n-hexane/isopropanol extraction of lipid from wet microalgal pastes of *Scenedesmus obliquus*. World Journal of Microbiology and Biotechnology, 34 (3): 39.

Chen C. Y., Yeh K. L., Aisyah R., Lee D. J., Chang J. S. 2011. Cultivation, photobioreactor design and harvesting of microalgae for biodiesel production: A critical review. Bioresource Technology, 102: 71–81.

Chojnacka K., Marquez-Rocha F.-J. 2004. Kinetic and stoichiometric relationships of the energy and carbon metabolism in the culture of Microalgae. Biotechnology, 3: 21-34.

Dean A., Sigee D., Estrada B., Pittman J. 2010. Using FTIR spectroscopy for rapid determination of lipid accumulation in response to nitrogen limitation in freshwater Microalgae. Bioresource Technology, 101: 4499–4507.

Huang G., Chen F., Wei D., Zhang X., Chen G. 2010. Biodiesel production by microalgal biotechnology, Applied Energy, 87: 38-46.

Mata T. M., Martins M. M., Caetano N. S. 2010. Microalgae for biodiesel production and other applications: A review. Renewable and Sustainable Energy Reviews, 14: 217-232.

Metsoviti M. N., Katsoulas N., Karapanagiotidis I. T., Papapolymerou G. 2019a. Effect of nitrogen concentration, two-stage and prolonged cultivation on growth rate, lipid and protein content of *Chlorella vulgaris*. Journal of Chemical Technology Biotechnology, 94: 1466–1473.

Metsoviti M. N., Papapolymerou G., Karapanagiotidis I. T., Katsoulas N. 2019b. Comparison of growth rate and nutrient content of five microalgae species cultivated in greenhouses. Plants, 8: 279.

Pauwels J. M., Van Ranst E., Verloo M., Mvondo Ze A. (1992). Manuel de laboratoire de pedologie: methodes d'analyses de sols et de plantes, equipement, gestion de stocks de verrerie et de produits chimiques.

Perez-Garcia O., Escalante F. M. E., de-Bashan L. E., Bashan Y. 2011. Heterotrophic cultures of microalgae: Metabolism and potential products. Water research, 45: 11-36.

SAG (2007). Sammlung von Algenkulturen der Universität Göttingen. Culture Collection of Algae, https://www.uni-goettingen.de/Abteilung Experimentelle Phykologie und Sammlung von Algenkulturen (EPSAG), Universität Göttingen, Deutschland. Available at: http://epsag.uni-goettingen.de.

Xiong W., Li X., Xiang J., Wu Q. 2008. High-density fermentation of microalga *Chlorella protothecoides* in bioreactor for microbio-diesel production. Applied Microbiology and Biotechnology, 78: 29-36.

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ASPECTS REGARDING THE MYCOBIOTA FROM THE *MUDDY VOLCANOES NATURE RESERVE*

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ABSTRACT

Due to the special living conditions in the Muddy Volcanoes Nature Reserve, the studies in this area regarding the mycobiota of parasitic and necrophagous species that are found on different host plants, are particularly interesting. We have identified numerous micromycetes both on the salt plants (*Nitraria schoberi, Obione verrucifera, Atriplex verrucifera, Atriplex glauca*) and on those in the areas with *vegetation at the edge of the plateaus. Most of the fungi reported are part of the orders Uredinales and Sphaeropsidales.*

INTRODUCTION

From the Buzau-Brasov national road, 20 km from Buzau, there is the Berca commune, located on the right bank of the valley. At a distance of 10 km north of Berca commune are the "Muddy Volcanoes". Because the reservation is located near the village of Paclele, it was called Pacle ("Paclele Mari Muddy Volcanoes" and "Paclele Mici Muddy Volcanoes").

From a geomorphological point of view, the "muddy volcanoes"are located in the subcarpathians of curvature, between the Buzau valleys and Slanic, on the Berca-Beciu-Arbanasi anticline, with a length of about 20 km and a north-south orientation.

The phenomenon of mud volcanoes consists of gas (hydrocarbon) emanations, which come from deep to the surface. On their way, the gases encounter sheets of water, which, also entrained to the outside, dissolve the layers of marls and clays encountered, turning them into a muddy paste, which deposits on the surface, around the craters. The height of the cones reaches 3-4 m in height.

The vegetation includes xerothermophilic species of southern, Pontic origin, Mediterranean species, and around the volcanoes, halophilic species. The study of micobiota in this reservation completes the special aspect of the region, almost unique in the world http://turismjudetulbuzau.blogspot.com/2011/10/vulcanii-noroiosi.html (accesed, 2020).

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MATERIAL AND METHODS

The micologic material has been collected from the *Muddy Volcanoes Nature Reserve* during 2018-2019.The spectrum of mycotic pathogens in the studied plants included in the working protocol the classical methods of sampling and processing of biological material.

The pathogens have been named according to the current rules of nomenclature and taxonomy recognized by the international scientific community.

RESULTS AND DISCUSSIONS

Following the processing of the biological material in the reservation, numerous interesting micromycetes were identified both from a taxonomic and practical point of view (Bontea 1986). Their determination was made according to taxonomic and nomenclature regulations (Alexopoulos 1996).

Cls. *Discomycetes*

Ordinul *Clavicipitales*

- *Claviceps purpurea* (Fr.) Tul., in spikelets of *Agropyron intermedium* (Host.) P.Beauv., Paclele Mari.
- *Epichloe typhina* (Pers. ex Fr.) Tul., on stems of *Dactylis glomerata* L., Paclele Mari.

Ordinul *Sphaeriales*

- *Gnomonia rubi* (Rehm.) Winter, on stems of *Rubus caesius* L., Paclele Mari.
- *Diaporthe* sp. on dried stems of *Galium verum* L., Paclele Mari.
- *Plagiostoma pustula* (Pers. ex Fr.) v. Arx., on the leaves of *Quercus pubescens* Willd., Paclele Mari.

Ordinul *Erysiphales*

- *Sphaerotheca euphorbiae* (Cast.) Salm. on the leaves of *Euphorbia nicaensis* All., Paclele Mari.
- *Microsphaera alphitoides* Griffon et Maublanc, on the leaves of *Quercus pubescens* Willd., Paclele Mari.
- *Erysiphe cichoracearum* (DC.) Merat, on leaves and stems of *Cirsium arvense* (L.) Scop.; pe frunze de *Inula ensifolia* L.; on the leaves of *Inula hirta* L.; on leaves and stems of *Podospermum canum* C.A.Mey., Paclele Mari.
- *E. communis* (Wallr.) Lk., on the leaves of *Scabiosa ochroleuca* L., Paclele Mari.
- *E. pisi* DC. ex St.Amans, on the leaves of *Dorycnium herbaceum* Vill., Paclele Mari.
- *Leveillula labiatarum* Golov, on the leaves of *Phlomis tuberosa* L., Paclele Mari.

Cls. *Loculoascomycetes*

Ordinul *Dothideales*

- *Mycosphaerella* sp., on the leaves of *Galium verum* L. Paclele Mari.
- *Mycosphaerella* sp., on the leaves of *Iris sintensii* Janka ssp. *brandzae* (Prod.) Prod., Paclele Mari.
- *Guignardia graminis* (Lind) Barr., on the leaves of *Agropyron intermedium* (Host) P.B., Paclele Mari.
- *Guignardia scabiosae* (Lamb. et Fautr.) v. Arx et Muller., on dried stems of *Scabiosa ochroleuca* L., Paclele Mari.
- *Guignardia sp.* on leaves and stems of *Asperula tenella* Heuff., Paclele Mari.
- *Guignardia sp.* on dried stems of *Stachys recta* L. ssp. *arenariiformis* Rouy, Paclele Mari.
- *Leptosphaerulina personata* (Niessl) Barr. on dried stems of *Agropyron*

intermedium (Host.) P.B., Paclele Mari.

Ordinul *Pleosporales*

- *Botryosphaeria festucae* (Lib.) v. Arx. et Muller on the leaves of *Dactlyllis glomerata* L. Paclele Mari.
- *Keisleriella culmifida* (Karst.) Bose on dried stems of *Agrostis moldavica* Dobr. et Beldie, Paclele Mari.
- *Leptosphaeria euphorbiae* Niessl. ap Rabenh., on dried stems of *Euphorbia nicaensis* All., Paclele Mari.
- *Leptosphaeria libanotidis* (Fuck.) Niessl., on dried stems of *Daucus carota* L., Paclele Mari.
- *Leptosphaeria millefolii* (Fuck.) Niessl., on dried stems of *Achillea* sp., Paclele Mari.
- *Leptosphaeria* sp., on dried stems of *Thalictrum minus* L., Paclele Mici.
- *Nodulosphaeria modesta* (Desm.) Munk., on dried stems of *Scabiosa ochroleuca* L., Paclele Mari.
- *Phaeosphaeria eustoma* (Fuck.) L. Holm. on dried stems of *Agrostis moldavica* Dobr. et Beldie; on the leaves of *Iris sintenisii* Janka ssp. *brandzae* (Prod.) Prod., Paclele Mari.
- *Trematosphaeria pertusa* Fuck., on dried stems of *Limonium gmelini* (Willd.) Ktze., Paclele Mari.
- *Pleospora herbarum* (Fr.) Rabenh., on dry branches of *Clematis vitalba* L., Paclele Mici.
- *Pleospora* sp. on dried stems of *Carlina vulgaris* L., Paclele Mici.
- *Pleospora vagans* Niessl. on dried stems of *Puccinellia limosa* (Schur.) Holmberg, Paclele Mici.
- *Pleospora vulgaris* Niessl. on dried stems of *Galium verum* L., Paclele Mici.
- *Cucurbitaria* sp., on dry branches of *Nitraria schoeberi* L., Paclele Mici.

Cls. *Coelomycetes*

Ordinul *Sphaeropsidales*

- *Ampelomyces quisqualis* Ces., pe miceliu de *Erysiphe cichoracearum* (DC.) Merat pe *Podospermum canum* C.A. Mey., Paclele Mici.
- *Diplodia juglandis* Brun., on dry branches of *Juglans regia L.*, Paclele Mici.
- *Diplodia thalictricola* Syd., on dried stems of *Thalictrum minus L.*, Paclele Mici.
- *Phyllosticta sp.* on the leaves of *Limonium gmelini* (Willd.) O. Ktze, Paclele Mari.
- *Phyllosticta syringae* Westend, on the leaves of *Syringa vulgaris* L., Paclele Mari.
- *Phomopsis achilleae* (Sacc.) v. Hohn., on dried stems of *Achillea* sp., Paclele Mari.
- *Phomopsis perexigua* (Sacc.) Trav., on dried stems of *Carlina vulgaris* L., Paclele Mici.
- *Phomopsis* sp., on dried stems of *Galium verum L.,* Paclele Mari.
- *Macrophoma lanceolata* (C. et Ell.) Berl. et Vogl., on dried stems of *Asparagus officinalis* L., Paclele Mari.
- *Hendersonia asparagina* Fautr., on dried stems of *Asparagus officinalis L.*, Paclele Mari.
- *Hendersonia culmicola* Sacc., on dried stems of *Phragmites australis* (Cav.) Trin. et Steud., Paclele Mici.
- *Selenophoma donacis* (Pass.) Sprague et Johnson., on leaves and stems of *Dactyllis glomerata* L., Paclele Mari.
- *Coniothyrium nitrariae* Bub., on dry branches of *Nitraria schoeberi* L., Paclele Mici.

- *Cytospora hippophaes* Thiim, on dry branches of *Hippophae rhamnoides* L., Paclele Mici.
- *Cytospora rosarum* Grev., on dry branches of *Rosa canina* L., Paclele Mici.
- *Stagonospora* sp., on dried stems of *Suaeda maritima* (L.) Dum., Paclele Mici.
- *Septoria berberidis* Niessl., on the leaves of *Berberis vulgaris* L., Paclele Mari.
- *Camarosporium* sp., on dry branches of *Nitraria schoeberi* L., Paclele Mici.
- *Septoria ebuli* Desm. et Rob, on the leaves of *Sambucus ebulis L.*, Paclele Mari
- *Rhabdospora asparagi* Syd., on dried stems of *Asparagus verticillatus L.*, Paclele Mari
- *Leptostroma* sp*.* on dried stems of *Onobrychis arenaria* (Kit.) Ser. In DC., Paclele Mari.

Ordinul *Melanconiales*

- *Coryneum* sp., on dried stems of *Artemisia maritima* L., Paclele Mici.
- *Vermicularia eryngii* (Corda) Fuck., on the leaves of *Eryngium campestre* L., Paclele Mari.
- *Vermicularia heterochaeta* Pass., on dried stems of *Muscari comosum* (L.) Mill., Paclele Mari.
- *Vermicularia liliacearum* West., on dried stems of *Ornithogalum pyramidale* L., Paclele Mari.
- *Marssonina fragariae* (Sacc.) Kleb., on the leaves of *Fragaria viridis* Duch., Paclele Mari.

Cls. *Hyphomycetes*

Ordinul *Moniliales*

- *Alternaria* sp., on the leaves of *Nitraria schoeberi* L., *Stipa capillata* L., Paclele Mici.

Cls. *Teliomycetes*

Ordinul *Uredinales*

- *Melampsora euphorbiae* (Schub.) Cast., on the leaves of *Euphorbia nicaeensis* All., Paclele Mici.
- *Uromyces limonii* (DC.) Lev., on the leaves of *Limonium gmelini* (Willd.) Ktze., Paclele Mari.
- *Uromyces onobrychidis* Bub., on the leaves of *Onobrychis arenaria* (Kit.) Ser. In DC., Paclele Mari.
- *Uromyces pisi-sativi* (Pers.) Liro., on the leaves of *Astragalus onobrychis* L., Paclele Mari.
- *Uromyces scutellatus* (Pers.) Lev., on the leaves of *Euphorbia cyparissias* L., Paclele Mici.
- *Uromyces striatus* Schroet., on the leaves of *Medicago falcata* L., Paclele Mici.
- *Uromyces tinctoriicola* Magn., on the leaves of *Euphorbia nicaensis* L., Paclele mari
- *Puccinia asperulae-cynanchicae* Th. Wurth., on leaves and stems of *Asperula tenella* Heuff., Paclele Mari.
- *Puccinia betonicae* DC., on leaves and stems of *Stachis recta* L. ssp. *arenariiformis* Rouy., Paclele Mari.
- *Puccinia calcitrapae* DC., on the leaves of *Carlina vulgaris* L.; on leaves and stems of *Centaurea micranthos* Gmel., Paclele Mari.
- *Puccinia coronata* Corda., on the leaves of *Rhamnus tinctoria* W. et K., Paclele Mari.
- *Puccinia graminis* Pers., on dried stems of *Agrostis stolonifera* L., Paclele Mari.

- *Puccinia hieracii* Mart., on leaves and stems of *Cichorium intybus* L.; pe frunze de *Leontodon hispidus* L.; on leaves and stems of *Picris hieracioides* L.; pe frunze de *Taraxacum bessarabicum* (Horn.) Hand., on the leaves of *Taraxacum serotinum* (W. et K.) Poir., Paclele Mari.
- *Puccinia iridis* Rabenh., on the leaves of *Iris sintenisii* Janka., Paclele Mari.
- *Puccinia poarum* Niels., on the leaves of *Tussilago farfara* L., Paclele Mici.
- *Puccinia phragmitis* Pers., on dried stems of *Agrostis stolonifera* L., Paclele Mari.
- *Puccinia pulsatillae* Kaichbr., on the leaves of *Anemone sylvestris* L., Paclele Mici.
- *Puccinia punctiformis* (Str.) Rohl., on the leaves of *Cirsium arvense* (L.) Scop., Paclele Mari.
- *Puccinia recondita* Rob. Ex Desm., on the leaves of *Agropyron repens* (L.) P.B., Paclele Mici.
- *Puccinia veronicae-longifoliae* Savile., on the leaves of *Veronica spicata* L., Paclele Mari.
- *Puccinia violae* DC.., on the leaves of *Viola ambigua* F.et K., Paclele Mici; on the leaves of *Viola hirta* L., Paclele Mari.
- *Phragmidium bulbosum* (Str.) Schl. on the leaves of *Rubus caesius* L., Paclele Mari.
- *Phragmidium mucronatum* (Pers.) Schl. on the leaves of *Rosa canina* L., Paclele Mari.

Ordinul *Ustilaginales*

- *Sphacelotheca andropogonis* (Opiz.) Bub. in inflorescences of *Botryochloa ischaemum* (L.) Keng., Paclele Mari.
- *Antracoidea caricis* (Pers.) Bref. in inflorescences of *Carex humilis* Leyss., Paclele Mici.
- *Schizonella melanogramma* (DC.) Schroet. in inflorescences of *Carex michelii* Host, Paclele Mici.

The numerical analysis of the taxa is presented in the figure 1. Among the fungi identified, a significant percentage is part of the order *Uredinales* (27%) , followed by the order *Sphaeropsidales* (25%) (Sutton, 1980). In general, fungi of this order have very wide ecological values because they are either saprophytes (*Sphaeropsidales*) or have several types of spores (*Uredinales*) in their life cycle.

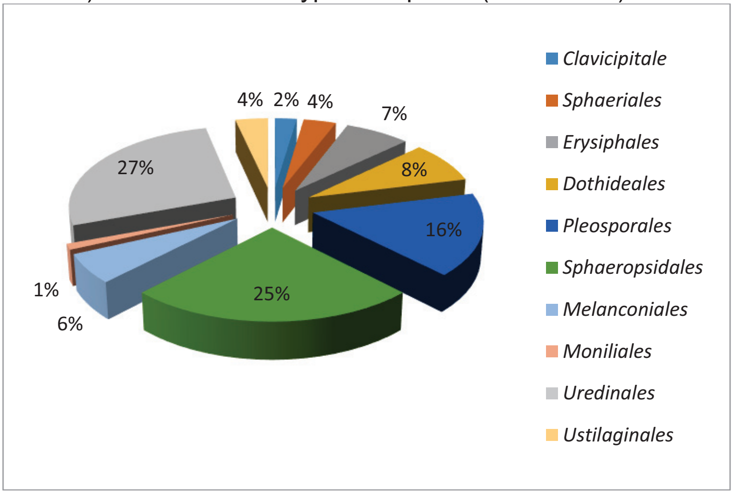

Figure 1. Numerical distribution of taxa in the present study

CONCLUSIONS

Knowing the mycobiota of an area of national interest is of great practical and theoretical importance for the protection of that area. Our studies have shown that there is a great diversity of fungi on salt plants unique in the world.

REFERENCES

Alexopoulos C.J., Mims C.W., Blackwell M. 1996. Introductory mycology, Fourth Edition, John Wiley & Sons, Inc., New York.

Bontea V. 1986. Ciuperci saprofite şi parazite din România, Ed. Acad. R.S.R.

Sutton B.C. 1980. The Coelomycetes, Commonwealth Mycological Institute, Kew., England.

http://turismjudetulbuzau.blogspot.com/2011/10/vulcanii-noroiosi.html (accesed, 2020).

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WILD BIRD SPECIES OBSERVED IN PARKS, ORCHARDS AND GARDENS IN SOUTHEASTERN ROMANIA

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Keywords: *agroecology, ecosystem, integrated pest management, insectivorous species*

ABSTRACT

Birds are bioindicators of the environment quality and their presence in a horticultural ecosystem can give clues about the type of farming practices. The ecosystem services brought by birds are very important from an economic point of view for the agronomic fields (agriculture, horticulture, forestry, fish farming), ecotourism (leisure - bird watching), ecology, etc. As for horticultural ecosystems, there is a particular interest in how birds contribute to pollination, in the control of rodents, insect, mite and other invertebrate populations.
This article aims to present the diversity of bird species met in some horticultural ecosystems in southeastern Romania, reviewing some aspects of phenology, diet and feeding that contribute to the knowledge, understanding and attraction of these beautiful and useful creatures to parks, orchards and gardens.

INTRODUCTION

Conventional agriculture is based on the use of a large amount of synthetic raw materials such as pesticides and fertilizers, which implies serious negative effects on the environment, health and the loss of biodiversity in agrosystems. The preservation and popularization of biodiversity in orchards and within their boundaries is an important area to explore (Llacuna et al. 1995, Dauwe et al. 2003, Simon et al. 2010).

In a study in central Poland, in 12 apple orchards aged between 21 and 40, 30 bird species were observed during three visits to the territory in April, May and June 2005 (Wiącek 2008).

In northern Japan, up to 33.3% more insectivorous bird species were observed in organic apple orchards than the percentage of 11.5% in conventional orchards. In contrast, granivorous species are more common in conventional orchards with 42.3% compared to 40.7% in organic ones. Omnivorous species held a percentage of 46.2% in conventional orchards, compared to 25.9% in organic orchards (Katayama 2016).

The number of bird species observed in 10 x 10 km squares was influenced by the structure of the landscape. In rural areas, where there are forests, alignments, windbreaks, natural corridors, were observed 80 species of birds. In areas with wet meadows 60 species of birds, in areas cultivated with orchards, surrounded by hedges and forest curtains 40 species and in intensive crops 15-20 species were observed (Jay et al. 2000).

This article aims to present the diversity of bird species met in some horticultural ecosystems in southeastern Romania, reviewing some aspects of phenology, diet and feeding that contribute to the knowledge, understanding and attraction of these beautiful and useful creatures to parks, orchards and gardens.

MATERIAL AND METHODS

The experiments were conducted in the southeastern Romania, where between 2015 and 2019 were made constant observations for various avifauna research topics, including the purpose of inventorying the avifauna found in some horticultural ecosystems. There were several plots as follows:

1. An orchard located in Moara Domneasca, Ilfov county, owned by USAMV Bucharest. It is placed in the Romanian Plain, in the hydrographic basin of Arges, on the Pasarea river, in the transition zone from steppe to forest-steppe. The orchard is protected on the northwest, northeast, southeast direction by windbreaks planted in 1920 (Mihai & Stănică 2018).
2. Istrița nursery orchard, from Buzau county, is located in southeastern Romania. It is a subunit of USAMV Bucharest.
3. Dendrological Park and Orchard inside the USAMV campus and a private garden in Bucharest, the city is located in southeastern Romania, in the Vlasia Plain, which is part of the Romanian Plain.
4. The Dendrological Park of Chitila is situated in Ilfov county, in the northeastern part of Bucharest. The Dendrological Park is adjacent to the lake and the Chitila forest, which contributed to the observation of some seabirds species.
5. Two gardens from Ilfov county, situated in Sitaru and Corbeanca, a garden from Nucșoara (Prahova county) and a garden from Plopșoru (Giurgiu county).

As equipment, Nikon ProStaff S 8x42 binoculars, Canon EOS 700 D DSLR camera, Canon EF 75-300 1: 4 - 5.6 III telephoto lens, Garmin VistaCx GPS (track-log ON) were used.

As methods to identify the bird species, for orchards were used the protocol published by Zoltán & Domșa (2014), the method of attracting birds with the help of artificial nests. The ringing method, used to study the dynamics and migration, helped to identify some bird species more difficult to observe. Direct observations of feeders, according to the methodology applied by RSPB for "Big Garden Birdwatch", 2012 edition (Royal Society for the Protection of Birds, 2014) were also used (Bruun et al. 1999, Ciochia et al. 2009, Ciochia 2007, Collin & Peter, 1998).

RESULTS AND DISCUSSIONS

A total of 75 species were observed in the monitored horticultural ecosystems (Table 1) as follows: 57 species were observed in orchards but 7 of them were aquatic species in transit; 50 species were observed in parks, and 25 species were observed in gardens.

In spring, 39 species were observed, of which 3 carnivorous species, 8 granivorous species, 17 insectivorous species, 2 insect-frugivorous species, 3 ichthyophagous species and 6 omnivorous species.

In summer, 30 species were observed, of which 3 carnivorous species, 7 granivorous species, 12 insectivorous species, 2 insect-frugivorous species, 3 ichthyophagous species and 5 omnivorous species.

In autumn, 32 species were observed, of which 2 carnivorous species, 7 granivorous species, 13 insectivorous species, 2 insect-frugivorous species, 2 ichthyophagous species and 6 omnivorous species.

In winter, 43 species were observed, of which 5 carnivorous species, 8 granivorous species, 10 insectivorous species, 2 insect-frugivorous species, 9 ichthyophagous species and 9 omnivorous species.

Table 1

Bird species observed in orchards, parks and gardens monitored in southeastern Romania

Species	**Type**	**I**	**II**	**III**	**IV**	**N**	**D**	**F**
Barn Swallow (*Hirundo rustica* L.)	O P G	*	*	*		*	I	A
Black Redstart (*Phoenicurus ochruros* L.)	O P G	*	*	*	*	*	I	B
Black Stork (*Ciconia nigra* L.)	P				*		IH	F
Black Woodpecker (*Dryocopus martius* L.)	O				*		I	C
Blackbird (*Turdus merula* L.)	O P G	*	*	*	*	*	IF	E
Black-headed Gull (*Chroicocephalus ridibundus* L.)	P	*			*		IH	F
Blue Tit (*Cyanistes caeruleus* L.)	O P G	*	*	*	*	*	I	B
Brambling (*Fringilla montifringilla* L.)	O P G				*		G	E
Caspian Gull (*Larus cachinnas* L.)	P	*			*		IH	F
Chaffinch (*Fringilla coelebs* L.)	O P G	*	*	*	*	*	G	E
Chiffchaff (*Phylloscopus collybita* L.)	O P	*					I	B
Coal Tit (*Periparus ater* L.)	P G				*		I	B
Collared Dove (*Streptopelia decaocto* L.)	O G	*	*	*	*	*	G	E
Common Buzzard (*Buteo buteo* L.)	O			*	*		C	E
Common Gull (*Larus canus* L.)	P				*		IH	F
Common Tern (*Sterna hirundo* L.)	O		*				IH	F
Cormorant (*Phalacrocorax carbo* L.)	O P				*		IH	F
Cuckoo (*Cuculus canorus* L.)	O		*				I	B
Dunnock (*Prunella modularis* L.)	O			*			I	E
Fieldfare (*Turdus pilaris* L.)	O P G				*		IF	E
Golden Oriole (*Oriolus oriolus* L.)	O G		*				I	B
Goldfinch (*Carduelis carduelis* L.)	O P			*			G	E
Great Egret (*Casmerodius albus* L.)	P				*		IH	F
Great Spotted Woodpecker (*Dendrocopos major* L.)	O P	*		*	*		I	C
Great Tit (*Parus major* L.)	O P	*	*	*	*	*	I	B
Green Woodpecker (*Picus viridis* L.)	O P	*	*			*	I	E
Greenfinch (*Chloris chloris* L.)	O P	*	*		*	*	G	B
Grey Heron (*Ardea cinerea* L.)	OP			*	*		IH	F

Species	Type	I	II	III	IV	N	D	F
Grey-headed Woodpecker (*Picus canus* L.)	O	*					I	C
Hawfinch (*Coccothraustes coccothraustes* L.)	O P G	*		*	*		G	B
Hobby (*Falco subbuteo* L.)	O	*					C	E
Hooded Crow (*Corvus cornix* L.)	O P G	*	*	*	*		O	E
Hoopoe (*Upupa epops* L.)	O	*					I	E
House Martin (*Delichon urbicum* L.)	O	*	*				I	A
House Sparrow(*Passer domesticus* L.)	O P	*	*	*	*	*	O	E
Icterine Warbler (*Hippolais icterina* L.)	O			*			I	B
Jay (*Garrulus glandarius* L.)	O P			*			O	B
Kestrel(*Falco tinnunculus* L.)	O P G	*	*			*	C	E
Lapwing (*Vanellus vanellus* L.)	O	*					O	D
Lesser Whitethroat (*Sylvia curruca* L.)	P G	*					I	B
Lesser Whitethroat (*Sylvia curruca* L.)	O	*					I	B
Little Egret (*Egretta garzetta* L.)	O				*		IH	F
Little Owl (*Athene noctua* L.)	O P G	*	*	*	*	*	C	E
Long-eared Owl (*Asio otus* L.)	P				*		C	E
Long-tailed Tit (*Aegithalos caudatus* L.)	G			*			I	B
Magpie (*Pica pica* L.)	O P G	*	*	*	*	*	O	E
Mallard (*Anas platyrhynchos* L.)	O P	*	*		*	*	O	F
Merlin (*Falco columbarius* L.)	P				*		C	E
Middle Spotted Woodpecker (*Dendrocopos medius* L.)	O				*		I	C
Mute Swan (*Cygnus olor* L.)	P				*		O	F
Nightingale (*Luscinia megarhynchos* L.)	O	*					I	E
Nightjar (*Caprimulus europaeus* L.)	O			*			I	B
Nuthatch (*Sitta europea* L.)	P G	*	*	*	*		I	E
Pheasant (*Phasianus colchicus* L.)	O P	*	*	*	*	*	G	E
Pied Flycatcher (*Ficedula hypoleuca* L.)	O P	*					I	B
Pygmy Cormorant (*Phalacrocorax pygmeu*s L.)	P				*		IH	F
Quail (*Coturnix coturnix* L.)	O	*					G	E
Raven (*Corvus corax* L.)	O				*		O	E
Red-backed Shrike (*Lanius collurio* L.)	O			*			I	E
Redstart (*Phoenicurus phoenicurus* L.)	P	*				*	I	B
Robin (*Erithacus rubecula* L.)	O P G			*	*		I	E
Roller (*Coracias garrulus* L.)	O		*				I	E
Rook (*Corvus frugilegus* L.)	O P G			*	*		O	E

Species	Type	I	II	III	IV	N	D	F
Scops Owl (*Otus scops* L.)	P		*			*	C	E
Shelduck (*Tadorna tadorna* L.)	P				*		O	F
Skylark (*Alauda arvensis* L.)	O	*	*				I	E
Sparrowhawk(*Accipiter nisus* L.)	O P				*		C	E
Spotted Flycatcher (*Muscicapa striata* L.)	O			*			I	B
Starling (*Sturnus vulgaris* L.)	O P G	*	*	*		*	IF	E
Swift (*Apus apus* L.)	O P G		*				I	A
Syrian Woodpecker (*Dendrocopos syriacus* L.)	P G	*	*	*	*	*	O	C
Tree Sparrow (*Passer montanus* L.)	O P G	*	*	*	*	*	G	E
White Stork (*Ciconia ciconia* L.)	O P	*	*	*		*	IH	F
Wood Pigeon (*Columba palumbus* L.)	O P	*	*	*	*	*	G	E
Wren (*Troglodytes troglodytes* L.)	O P G				*		I	E

*species observed in one of the seasons or in transit, C = carnivorous, G = granivorous, I = insectivorous, IF = insect-frugivorous, IH = ichthyophagous, O = omnivorous, A = species that procure their food in their flight., B = species that catch food from trees, C = species that get their food from the skeletal organs of trees (xylophagous), D = species that find their food in soil and swamps, E = species that collect food from soil and plants, F = species that feed in the water.

**I= spring, II = summer, III= automn, IV = winter, N = nesting, D= diet, F= feeding mode

Regarding the diet, insectivorous species represented 42%, omnivorous and ichthyophagous species 15%, granivorous species 13%, carnivorous species 11%, and 4% insectivorous-frugivorous species.

As for the feeding method, 4% species were observed getting their food in flight, 24% species catching the food from trees, 7% species from the skeletal organs of trees (xylophagous), 1% species from soil and swamps, 45% species from soil and plants, and 17% species feeding on the water. For nesting in the monitored horticultural ecosystems, 22 nesting species were observed.

CONCLUSIONS

In the studied orchards from the southeast of Romania during the four seasons, 75 species of birds were observed for five years, which is 17 more than the average quoted by Jay et al (2000), and three species more in spring than those observed by Wiącek (2008). On average, it can be considered that the number was positively influenced by the natural environment, the windbreaks and by the fact that the birds were fed in winter, and artificial nests have been set up since the year 2014.

Unfortunately, fewer insectivorous species have been observed in orchards in summer, probably the intensive orchard maintenance system was causing inconvenience to birds, limiting their access to food and nesting sites (Katayama 2016). Parks and gardens were also home to an important number of bird species, with an important role in the balance of the horticultural ecosystem.

Therefore, the orchards, parks and gardens studied by the natural environment they possess, but also by the simple and environmentally friendly measures, have for the time being a natural dowry that can be used for the benefit of ecological horticulture.

REFERENCES

Bruun B., Delin H., Svensson L. 1999. Păsările din România şi Europa. Determinator ilustrat. Hamlyn Guide. Octopus Publishing Group Ltd. Londra.

Ciochia V. 2007. Mic tratat de ornitologie. Vol. I, II. Edit. Pelecanus, Brașov.

Ciochia V., Cotleanu V., Ciochia V. 2009. Păsări, cuiburi, ouă şi puii din România, Edit. Pelecanus, Braşov.

Collin H., Peter C. 1998. Bird nests, eggs and nestlings of Britain and Europe. Haper Collins Publishers, London.

Dauwe T., Chu S.G., Covaci A., Schepens P., Eens M. 2003. Great tit (*Parus major*) nestlings as biomonitors of organochlorine pollution. Arch. Environ. Contam. Toxicol. 44: 89–96, DOI: 10.1007/s00244-002-1243-y.

Jay M., Barataud M., Besancon T., Delattre P., Hents J.L., Noblet J.F., Schwaab F., Tupinier Y. 2000. Oiseaux et mammiferés, auxiliaires des cultures. CTIFL, Paris

Katayama N. 2016. Bird diversity and abundance in organic and conventional apple orchards in northern Japan. Sci. Rep. 6: 34210; doi: 10.1038/srep34210;

Llacuna S., Gorriz A., Sanpera C., Nadal J. 1995. Metal accumulation in three species of passerine birds (*Emberiza cia*, *Parus major* and *Turdus merula*) subjected to air pollution from a coal-fired power plant. Arch. Environ. Contam. Toxicol. 28: 298-303.

Mihai C.A., Stănică F. 2018. The role of windbreaks in attracting the useful avifauna – case study: Moara domnească Didactic Farm. Bulletin UASVM Horticulture 75(1): 47-52.

Royal Society for the Protection of Birds (RSPB), 2014. http://ww2.rspb.org.uk/images/bgbw_sheet_2012_tcm9-259825.pdf

Simon S., Bouvier J.C., Debras J.F., Sauphanor B., 2010. Biodiversity and pest management in orchard systems. A review. Agronomy for Sustainble Development. Volume 30. Issue 1: 139-152;

Wiącek J., Polak M., 2008. Bird community breeding in apple orchards of central Poland in relation to some habitat and management features. Polish J. of Environ. Stud. Vol. 17(6): 951-956.

Zoltán S.D., Domșa C., 2014. Ghid standard de monitorizare a a speciilor de păsări de interes comunitar din România. Edit. Noi Media Print S.A., București: 45-62.

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INVASIVE HARMFUL SPECIES FOUND IN GREEN SPACES IN THE CENTRAL AREA OF OLTENIA

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***Keywords**: harmful organisms, attack, host plants.*

ABSTRACT

The main harmful organisms found in the green spaces of Craiova are Cydalima perspectalis Walker, Metcalfa pruinosa Say and Halyomorpha halys Stål.

Cydalima perspectalis Walker being the main pest of Buxus sempervirens L, can cause weakening and death of plants, as well affects their aesthetics.

Metcalfa pruinosa Say, is a polyphagous species that has become a serious pest in agriculture and green public space, the attacked plants stop growing, the differentiation of fruit buds no longer takes place, the fruits no longer grow, and the white waxy filaments produced by nymphs, gives an unsightly appearance to plants, while affecting their commercial value.

Halyomorpha halys Stål is a polyphagous species, damage is caused by both nymphs and adults, and after the feeding process may appear scars, discolored areas on the fruit, decreasing the quality of the fruit.

INTRODUCTION

In recent years, green spaces have faced different harmful pests for spontaneous and cultivated flora.

The main harmful organisms found in the green spaces of Craiova are *Cydalima perspectalis* Walker, *Metcalfa pruinosa* Say and Halyomorpha halys Stål.

Cydalima perspectalis Walker, 1859, is a monophagous species native to the Asian Continent (Inoue1982). On the European Continent this pest was first detected in 2007 in Germany (Billen 2007), in the following years it managed to colonize more than half of the countries on the European Continent (Feldtrauer et al. 2009, Korycinska & Eyre 2009, Mitchell 2009, Iamandei 2010, Hizal et al. 2012, Seljak 2012, Bella 2013).

Metcalfa pruinosa Say, being of North American origin, an invasive species that extends its area from south-eastern Canada (Ontario - Quebec region) to Florida (Mead 2004), later spreading to other continents: Central America, North America South, Asia and Europe (Strauss 2010).

Halyomorpha halys Stål is an invasive, highly polyphagous species with over 100 host plants, reported to be native to Asia (Lee DH et al. 2013) and managed to spread to the American Continent (Hoebeke & Carter, 2003 and the European Continent (Wermelinger B. et al. 2008; Milonas & Partsinevelos 2014, Callot & Brua 2013, Macavei et al. 2015 , Dioli et al. 2016, Hemala & Kment 2017, Gapon 2016).

MATERIAL AND METHODS

The monitoring of these pests was carried out during the years 2016-2020, in the Botanical Garden "Al. Buia", "Nicolae Romanescu" Park, English Park the areas with vegetation in front of the blocks and streets, by observing and identifying the host plants, the way of attack and the damages produced.

RESULTS AND DISCUSSIONS

Cydalima perspectalis Walker, is a monophagous species, but in Asia it has been reported on other species such as*: Buxus sinica* Rehder & E.H. Wilson, *Buxus microphylla* Siebold & Zucc. , *Buxus microphylla* var. *insularis* Siebold & Zucc., *Buxus microphylla* var. *Japonica* Siebold & Zucc., *Buxus rugulosa* Hatusima, *Ilex purpurea* Hassk., *Euonymus japonicas* Thunb, *Euonymus alatus* (Thunb) Siebold, (Wan et al. 2014).

In the case of this pest, the larvae are the ones that cause damage to *Buxus sempervirens* L., the larvae of the first instar devouring the, the epidermis of the leaves, then the whole leaf, when the degree of infestation is high, can attack the bark of the host plant.

From the first report of this pest, in 2018, until now, it has managed to destroy the hedge of *Buxus sempervirens* L., from the Botanical Garden "Al. Buia", the larvae feeding excessively, thus leading to the death of the host plants.

In the images below it can be seen the effects of *Cydalima perspectalis* infestation in the absence of chemical control, so following the attack of The Box Tree Moth, the shrubs dried up and were replaced with the species *Ligustrum vulgare* L. Fig. 1.

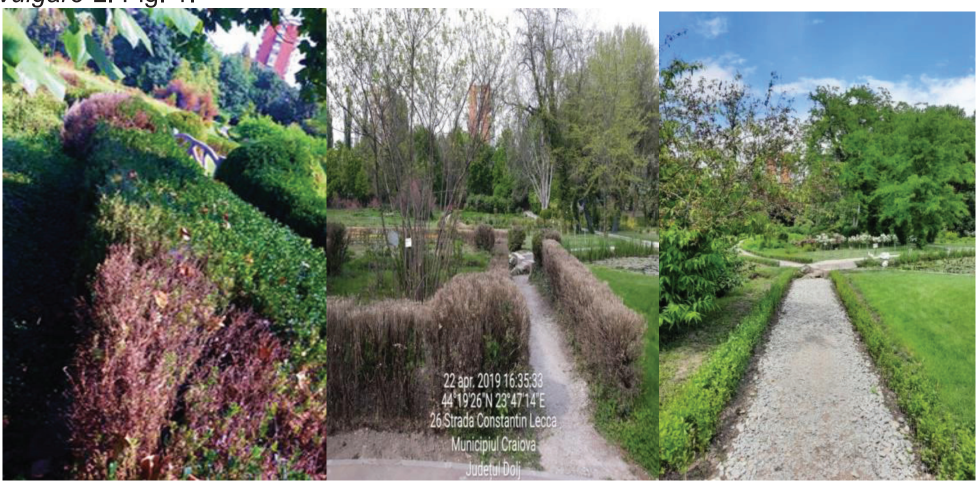

Figure 1. *Cydalima perspectalis* Walk. attack on *Buxus sempervirens* L., in 2018, (left); *Cydalima perspectalis* Walk. attack on Buxus sempervirens L., in 2019 (center) and Ligustrum vulgare L., 2020 (right) – in "Al. Buia" Botanical Garden, Original.

Metcalfa pruinosa Say, is a polyphagous species that has become a serious pest in agriculture and public green space, forming dense populations that subsequently cause serious damage to orchards, vineyards, ornamental plants and urban areas (Zangheri & Donadini 1980).

Adults and nymphs feed on the sap of plant, spreading many viruses and diseases. Following the productions of sweet secretions by the nymphs, on the surface of the leaves it develops a fungus called *Capnodium salicinum* Mont., affecting the aesthetics of the plants, but also the process of photosynthesis.

The white waxy filaments produced by the nymphs, give an unsightly appearance to the plants, affecting at the same time their commercial value.The plants attacked by *Metcalfa pruinosa* stop growing, the differentiation of fruit buds no longer takes place, the wood does not mature, and the fruits do not develop.

Limiting the spread of the species is difficult to achieve, given the large number of host plants, high migration capacity and waxy protection of the nymphs.

From the first detection until now, this pest is found in all green spaces in Craiova, such as the Botanical Garden "Al. Buia", "Nicolae Romanescu" Park, English Park, but also in areas with vegetation from streets and in front of the blocks.

In green spaces from Craiova in 2017 this pest was reported on a number of 33 host plants, the most attacked being the species *Hibiscus syriacus* L., *Paulownia tomentosa* (Thunb.) Steud, *Cornus sanguinea* L. (Mitrea I. 2017).

In 2019, following the research carried out in the Botanical Garden "Al. Buia" and "Nicolae Romanescu" Park, the presence of the pest was reported on a number of 87 species belonging to 44 botanical families (Stan & Mitrea, 2019).

And currently the most attacked species remain *Ulmus glabra* Hidds, *Amorpha fruticosa* L., *Mahonia aquifolium* (Pursh) Nutt, *Hibiscus syriacus* L., *Hederea helix* L., *Koelreuteria paniculata* L., *Acer campestre* L., *Acer pseudoplatanus* L., *Acer negundo* L. *Prunus cerasifera* Ehrh., *Buxus sempervirens* L., *Cornus sanguinea* L., *Rudbeckia* ssp. Aiton *, Iris* ssp., *Cephalaria uralensis* (Murray) Roem. & Schult., * *Hosta plantaginea* (Lamarck) Asch., *Helianthus tuberosus* L., *Solidago canadensis* L. preferring young branches, leaves and stem of the plants.

Figure 2. Attack of the *Metcalfa pruinosa* Say on Hederea helix L., (left) and *Cephalaria uralensis* (Murray) Roem. & Schult (right), original.

The brown marmorated stink bug is an extremely polyphagous invasive species, the damage are caused by both nymphs and adults, the feeding process may include scars, discolored areas, fruits, seeds or deformed pods (Leskey et al.

2009; Kuhar et al. 2012), thus leading to decreased fruit quality, abortion of flower buds, some plants may be affected in the long term (Haye et al. 2015). (Fig.3).

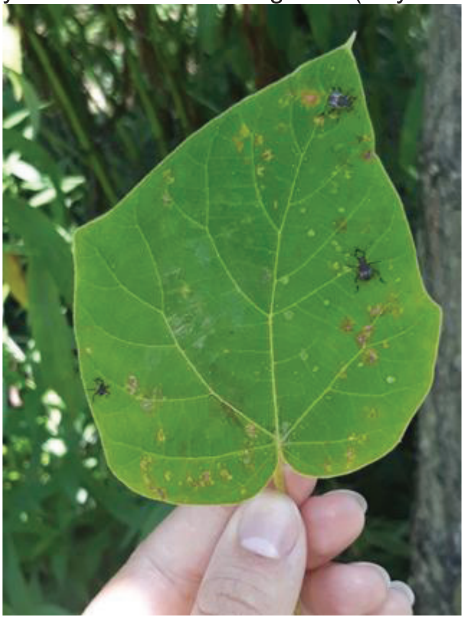

Figure 3. Scars on the leaf of *Paulownia tomentosa* Thunb. following the feeding process of The brown marmorated stink bug (Original)

Also during the feeding process it can transmit various pathogens (yeasts, bacteria, fungi) from one plant to another.

Halyomorpha halys Stål, was first observed in May 2019 in the Botanical Garden "Al. Buia" in the adult stage on the species *Hybiscus syracus* L., *Paulownia tomentosa* Thunb., Later being found in the egg stage on the species: *Buxus sempervirens* L, *Paulownia tomentosa* Thunb., *Solidago canadensis* L., *Amorpha fruticosa* L., but also in nymph stages on the following species: *Cercis siliquastrum* L., *Robinia pseudoacacia* L., *Cornus sanguinea* L. *Fraxinus excelsior* L, *Celtis australis* L, *Malus domestica* Borkh, *Liriodendron tulipifera* L, *Pyracantha coccinea* M. Roem, *Morus alba* L, *Inula helenium* L, *Helianthus tuberosus* L. *Prunus cerasifera* Ehrh. (Mitrea & Stan, 2019). This pest was also found this year on the same host plants.

CONCLUSIONS

- The massive attack of the larvae of The Box Tree Moth can cause weakening and death of plants.
- The plants attacked by *Metcalfa pruinosa* stop growing, the differentiation of fruit buds no longer takes place, the wood does not mature, and the fruits do not develop.
- The white waxy filaments produced by the nymphs, give an unsightly appearance to the plants, affecting at the same time their commercial value.
- The damages are caused by both nymphs and adults of *Halyomorpha halys*, so after the feeding process can appear scars, discolored areas, fruits, seeds or deformed pods leading to decreased fruit quality, abortion of flower buds, some plants can be affected long-term.

REFRENCES

Billen W. 2007. *Diaphania perspectalis* (Lepidoptera: Pyralidae) – a new moth in Europe. Mitt der Entom Gesell Basel 57: 135-137.

Callot H., Brua C. 2013. Halyomorphahalys (Stål al, 1855), la Punaisediabolique, nouvelle espèce pour la faune de France (HeteropteraPentatomidae). L'Entomologiste 69: 69–71;

Dioli P., Leo P., Maistrello L. 2016. Prime segnalazioni in Spagna e in Sardegnadella specie aliena Halyomorphahalys(Stål, 1855) e note sullasua distribuzione in Europa (Hemiptera, Pentatomidae) Revistagaditana de Entomología, Volumen VII núm. 1 (2016):539-548;

Feldtrauer J.F., Feldtrauer J.J., Brua C. 2009. Premiers signalements en France de la Pyrale du Buis *Diaphania perspectalis* (Walker, 1859), espèce exotique envahissante s'attaquant aux Buis (Lepidoptera, Crambidae). Bulletin de la Société Entomolologique de Mulhouse 65(4): 55-58.

Gapon D.A. 2016. First records of the brown marmorated stink bug Halyomorphahalys (Stål, 1855) (Heteroptera, Pentatomidae) in Russia, Abkhazia, and Georgia. Entomological Review, 96: 1086–1088**;**

Haye T., Gariepy T., Hoelmer K., Rossi JP., Streito JC., Tassus X., Desneux N. 2015. Range expansion of the invasive brown marmorated stinkbug, Halyomorphahalys: an increasing threat to field, fruit and vegetable crops worldwide, J Pest Sci 88: 665–673;

Hemala V., Kment P. 2017. First record of Halyomorphahalysand mass occurrence of Nezaraviridulain Slovakia.Plant Protection Science Vol. 53, 2017, No. 4: 247–253

Hizal și colab. 2012. The new pest Cydalima perspectalis (Walker, 1859) (Lepidoptera:Crambidae) în Turkey, Journal of Animal And Veterinary Advances 11 (3): 400-403.

Hoebeke E.R., Carter M.E. 2003, Halyomorphahalys (Stål) (Heteroptera: Pentatomidae): a polyphagous plant pest from Asia newly detected in North America. Proc. Entomol. Soc. Wash.105:225–237;

Iamandei Maria. 2010. *Diaphania perspectalis* (Walker, 1859) (Lepidoptera: Crambidae) a new pest of *Buxus* spp. in Romania Lucrări ştiinţifice USAMVB, Seria B, vol. LIV: 787-793;

Inoue H, 1982. Pyralidae. In: Moths of Japan 1, 2. Ed. By Inoue H, Sugi S, Kuroko H, Moriuti S, Kawabe A, Kodansha, Tokyo, 307–404 (vol. 1): 223–254; pls 36–48, 228, 296–314 (vol. 2)

Korycinska A., Eyre D. 2009. Box tree caterpillar, Diaphania perspectalis., The Food and Environment Research Agency FERA, Plant pest factsheet.(https://planthealthportal.defra.gov.uk/assets/factsheets/boxTreeCaterpillar2011.pdf, accessed 25.07.2020).

Kuhar T.P., Kamminga, K.L., Dively, G.P., Hooks, C.R.R., Hamilton, G., Herbert, D.A. 2012. The Pest Potential of Brown Marmorated Stink Bug on Vegetable Crops. Plant Health Prog. Online; https://www.plantmanagementnetwork. org/ pub/ php/brief/2012/stinkbug/

Lee D.-H., Short, B.D., Joseph, S.V., Bergh, J.C., Leskey, T.C., 2013, Review of the Biology,Ecology, and Management of Halyomorphahalys(Hemiptera: Pentatomidae) in China, Japan, andthe Republic of Korea. Environ. Entomol. 42: 627–641;

Leskey TC, Short BD, Wright SE, Brown MW 2009. Diagnosis and variation in appearance of brown stink bug (Hemiptera: Pentatomidae) injury on apple. J EntomolSci 44: 314–322;

Macavei, Ll., Bâetan, R., Oltean, I., Florian, T., Varga, M., Costi, E., Maistrello, L. 2015. First detection of Halyomorpha halys Stål,A new invasive species with a high potential of damage on agricultural crops in Romania, Lucrări Ştiinţifice, Universitatea de Ştiinţe Agricole şi Medicină Veterinară "Ion Ionescu de la Brad" Iaşi, SeriaAgronomie, 58 (1): 105–108.

Mead F.W. 2014. Citrus Flatid Planthopper, Metcalfa pruinosa (Say) (Insecta:Hemiptera: Flatidae), Florida Department of Agriculture and Consumer Service-Division of Plant Industry: Gainesville FL, online https://edis.ifas.ufl.edu/pdffiles/IN/IN60500.pdf ;

Milonas P.G., Partsinevelos G.K. 2014. First report of brown marmorated stink bug Halyomorpha halys Stål al (Hemiptera: Pentatomidae) in Greece.EPPO Bull. 44: 183–186.

Mitchell A. 2009. Box tree moth Diaphania perspectalis (Walk.) – a new pyralid moth to Britain and Ireland. Atropos 36: 17-18.

Mitrea I. 2017. Monitoring Of Metcalfa Pruinosa Species (Homopter: Fulgoroidea) In The Central Area Of Oltenia, Analele Universităţii din Craiova, seria Agricultură – Montanologie – Cadastru (Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series) Vol. XLVII: 187-191;

Mitrea Ion, Stan Raluca. 2019. Halyomorpha halys Stål (Heteroptera: Pentatomidae) A new pest for the Oltenia Area, Analele Universităţii din Craiova, seria Agricultură – Montanologie – Cadastru (Annals of the University of Craiova - Agriculture,Montanology, Cadastre Series) Vol. XLIX: 238-243.

Salvatore Bella. 2013. The Box Tree Moth Cydalima perspectalis (WALKER, 1859) Continues to spread in southern Europe: New records for Italy (LEPIDOPTERA PYRALOIDEA CRAMBIDAE), REDIA, XCVI: 51-55.

Seljak G. 2012. Six new alien phytophagous insect species recorded in Slovenia in 2011. Acta Entomologica Slovenica, 20 (1): 31-44.

Stan Raluca, Mitrea I. 2019. Metcalfa pruinosa Say, a dangerous invasive species for various plants in some landscaping from Craiova, Journal of Horticulture, Forestry and Biotechnology, Volume 23(2): 20-26;Strauss G., 2010, Pest risk analysis of Metcalfa pruinosa in Austria, J Pest Sci 83:381–390;

Strauss G. 2010. Pest risk analysis of Metcalfa pruinosa in Austria, J Pest Sci 83: 381–390.

Wan H., Haye T. , M. Kenis, S. Nacambo, H. Xu, F. Zhang & H. Li. 2014. Biology and natural enemies of Cydalima perspectalis in Asia: Is there biological control potential in Europe?, J. Appl. Entomol.: 1-8

Zangheri S.& Donadini P. 1980. Comparsa nel Veneto di un Omottero neartico: Metcalfa pruinosa Say (Homoptera ,Flatidae). Redia, 63: 301 - 304.

Wermelinger B., Wyniger, D., Forster, B.,others, 2008. First records of an invasive bug in Europe:Halyomorpha halys Stål (Heteroptera:Pentatomidae), a new pest on woodyornamentals and fruit trees? Mitteilungen-Schweiz. Entomol.Ges.81,1

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FLORISTIC ASPECTS FROM THE FOREST HABITATS FROM THE OLTENIA FOREST STEPPE SITE

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Keywords. flora, Oltenia forest steppe, Romania.

ABSTRACT.

In this paper we will find information related to the spontaneous vascular flora in the protected area Natura 2000 - Oltenia Silvostepa. This area is proposed as a site of Community importance in 2007 and is characterized by the presence of 3 types of forest habitats 91M0, 91I0, 91E0. It covers an area of 9297 ha and belongs entirely to the continental biogeographical region. The area partially overlaps with the Poiana Bujorului Natural Reserve on the outskirts of Plenița.

If the spontaneous flora is related to the surface of the area, we can say that it is relatively poor due to the anthropogenic pressure, the forest habitats being in the vicinity of the localities.

INTRODUCTION

The ROSCI0202 Oltenia forest steppe site is located in the Oltenia Plain and preserves 6 forest bodies. The forests in this area are mainly composed of sky (*Quercus cerris*) and garrison (*Quercus frainetto*), framed by the habitat 91MO -. Balkan-Pannonian forests of sky and sessile oak and less of alluvial forests (91E0 *) or of Euro-Siberian forest-steppe vegetation with *Quercus* species (91I0 *).

The territory occupied by these forests is located in an area with a temperate continental climate, with some sub-Mediterranean influences, especially in the western part of the site (Popescu 1996).

Most of the surface of the area belongs to Dolj county and is situated in the close proximity of Brabova, Întorsura, Vârvoru de Jos, Verbiţa, Vela, Sălcuţa, Seaca de Pădure, Radovan, Pleniţa, Perişor, Orodel, Cioroiaşi, Carpen. Only Bălăcița locality from Mehedinți county has territory from the site.

Floristic studies in these areas of this site can be found in several specialized works that have as objective the flora or vegetation of a certain territory Borza 1966; Buia and Popescu 1952; Buia 1959; Buia et Păun 1960a, 1960b; Cârțu 1979; Păun et al. 1971; Păun 1985; Popescu 1988; Popescu and Costache 1999; Boruz et al. 2011 et al., Răduțoiu 2008.

MATERIAL AND METHODS

For the study of the microflora from the forest habitats from the Oltenia Silvostepa protected area, a first step is the identification and familiarization with the spontaneous plants that can serve possible hosts for them.

In order to make a floristic inventory with the plants from the 3 forest habitats, numerous field trips were made, at different times during the year to have a complete picture of all species.

The determination of the vegetal material was investigated using the specialized literature (Beldie 1977, 1979; Ciocârlan 2009; Sârbu et al. 2013).

The authors' abbreviations were made according to Brummit Powell (1992).

The codes of the habitat types correspond to NATURA 2000 and the Romanian classification system (Doniţă et al. 2005; Doniţă et al. 2006, Gafta and Mountford, 2008).

RESULTS AND DISSCUSIONS

As a result of the research carried out in the forest habitats from ROSCI0202 Oltenia Silvostepa, a number of 278 were identified species, included in the following system.:

Phyl. Spermatophyta, Subphyl. Pinophytina, Cl. Pinopsida, Fam. Pinaceae: *Pinus nigra* L. (cultivated) – Ph., SE Eur.; Cl. Magnoliophytina, Fam. Aristolochiaceae: *Aristolochia clematitis* L. - G., Medit.; Fam. Ranunculaceae: *Anemone nemorosa* L. - G., Circ., *A. ranunculoídes* L. - G., Eur., *Caltha palustris* L. - H., Circ., *Clematis vitalba* L. - Ph., Eur. Centr., *Helleborus odorus* WALDST. & KIT.- H., Balc., *Isopyrum thalictroides* L. - H., Eur. Centr., *Ranunculus acris* L. subsp. *acris* - H., Euras., *R. constantinopolitanus* (DC.) D'URV. – H., Balc., *R. ficaria* L. subsp. *bulbílifer* LAMBINON - H., Euras.; *Ranunculus polyanthemos* L. subsp. *polyanthemoides* (Boreau) Ahlfvengren – H., Eur.; *R. repens* L. - H., Euras., *R. sceleratus* L. - T., Circ., *Thalictrum aquilegiifolium* L. - H., Eur., *T. minus* L. - H., Euras. Cont.; *T. simplex* L. – H., Euras. Cont.; Fam. Papaveraceae: *Chelidonium majus* L. - H., Euras.; Fam. Fumariaceae: *Corydalis cava* (L.) SCHWEIGG. & KÖRTE subsp. *marschalliana* (PALL.) HAYEK - G., Eur., *C. solida* (L.) CLAIRV. - G., Eur.; Fam. Ulmaceae: *Ulmus glabra* HUDS. em. MOSS - Ph., Euras., *U. minor* MILL. em. RICHENS - Ph., Eur.; Fam. Cannabaceae: *Cannabis sativa* L. subsp. *spontanea* (Vavilov) Serebr. – T., Cont. Euras.; Fam. Urticaceae: *Parietaria officinalis* L., H., Medit.-Submedit.; *Urtica dioica* L. - H., Cosm., *U. urens* L. T. Cosm.; ; Fam. Fagaceae: *Quercus cerris* L., Ph., Submedit., *Q. frainetto* TEN. – Ph., Balc., *Q. pubescens* WILLD. - Ph., Submedit.; *Q. robur* L. – Ph., Eur.; Fam. Betulaceae: *Alnus glutinosa* (L.) GAERTN. - Ph., Euras.; Fam. Phytolaccaceae: *Phytolacca americana* L. – H., N Am.; Fam. Caryophyllaceae: *Gypsophila muralis* L. – T., Euras.; *Lychnis coronaria* (L.) DESR., H., Medit., *L. viscaria* L. - Ch.(H.), Euras., *Myosoton aquaticum* (L.) MOENCH - H., Euras., *Silene latifolia* POIR. subsp. *alba* (MILL.) GREUTER & BURDET - T., H., Euras., *S. vulgaris* (MOENCH) GARCKE – H., Euras., *Stellaria graminea* L. – H., Euras.; *S. media* (L.) VILL. – T-HT., Cosm.; Fam. Polygonaceae: *Fallopia dumetorum* L. – T., Circ., *Polygonum lapathifolium* L. T., Cosm., *Rumex sanguineus* L. – H., Eur.; Fam. Crassulaceae: *Sedum cepaea* L. – T., Medit., *S. maximum* (L.) HOFFM. – H., Eur.; Fam. Rosaceae: *Agrimonia eupatoria* L. – H., Submedit., *Aremonia agrimonoides* (L.) DC. – H., Centr. Eur.-Medit., *Cerasus avium* (L.) MOENCH - Ph., Submedit., *Crataegus monogyna* JACQ. - Ph., Euras., *Filipendula* *vulgaris* MOENCH – H., Euras., *Fragaria vesca* L. – H., Euras., *Geum urbanum* L. – H., Circ., *Malus sylvestris* Mill. – Ph., Eur., *Padus avium* Mill. – Ph., Euras.; *Potentilla argentea* L. subsp. *argentea* – H., Euras., *P. micrantha* RAMOND ex DC. – H., Submedit., *P. recta* L. – H., Cont. Euras.; *Prunus cerasifera* Ehrh. – Ph. Pont. Balc.; *P. spinosa* L. – Ph., Eur., *Pyrus pyraster* (L.) BURGSD. - Ph., Eur., *Rosa canina* L. - Ph., Eur., *R. corymbifera* Borkh. – Ph., Eur.; *R. gallica* L. – Ph., Pont. Medit.; *R. subcanina* (Christ) Dalla Torre & Sarnth. – Ph., Eur.; *Rubus caesius* L. – Ph., Eur., *R. candicans* WEIHE EX RCHB. subsp. *thyrsanthus* (FOCKE) GÁYER – Ph., Centr. and SV.Eur., *Sanguisorba minor* Scop. – H., Euras.; Fam. Fabaceae: *Astragalus cicer* L. – H., Euras. Cont., *A. glycyphyllos* L. – H., Euras.-Submedit., *Chamaecytisus albus* (HACQ.) ROTHM. var. *pallidus* SCHRAD. - Ph., Pont.-Pan-Balc., *Ch. heuffelii* (WIERZB.) ROTHM. – Ph., Pont.-Pan.-Balc.; *Ch. supinus* (L.) Link – Ph., Centr. and S Eur.; *Coronilla varia* L. – H., Centr. Eur.-Submedit., *Dorycnium herbaceum* VILL. - Ch., Centr. and SE. Eur., *Galega officinalis* L. – H., Pont.-Medit., *Genista tinctoria* L. subsp. *elatior* (J. KOCH) NYMAN) - Ch., Euras., *Gratiola officinalis* L. – H., Circ.; *Lathyrus niger* (L.) BERNH., G., Eur. Centr., *L. venetus* (MILL.) WOHLF. – G., Pont.-Medit., *L. vernus* (L.) BERNH. – G., Euras., *Lotus corniculatus* L. – H., Euras., *Medicago lupulina* L. - T.-H., Euras., *Melilotus albus* MEDIK. - HT., Euras., *M. officinalis* Lam. - HT., Euras., *Robinia pseudoacacia* L. – Ph., Am. de N., *Trifolium alpestre* L. – H., Eur. centr. and SE; *Trifolium campestre* SCHREB. – T., Eur., *T. medium* L. subsp. *medium* – H., Euras., *Vicia cracca* L. – H., Euras., *V. grandiflora* Scop., T., Pont.-Balc.-Cauc.; *V. dumetorum* L. – H., Eur. Centr.; Fam. Lythraceae: *Peplis portula* L. – T., Eur.; Fam. Cornaceae: *Cornus mas* – Ph., Pont. Medit., *C. sanguinea* – Ph., Eur. Centr., Fam. Celastraceae: *Evonymus europaeus* L. – Ph., Eur.; Fam. Euphorbiaceae: *Euphorbia amygdaloides* L. – Ch., Centr. Eur. Subatl. Submedit., *E. agraria* Bieb. – H., Pont. Balc.; *E. cyparissias* L. – H., Euras., *E. epithymoides* L. – H., Pan.-Balc., *E. lucida* Waldst. et Kit. – H., Eur. cont.; *E. virgata* WALDST. & KIT. – H., Euras.; Fam. Rhamnaceae: *Rhamnus cathartica* L. – Ph. Euras.; Fam. Aceraceae: *Acer campestre* L. – Ph., Eur., *A. negundo* L. – Ph., Am. de N., *A. tataricum* L. – Ph., Euras. Cont.; Fam. Oxalidaceae: *Oxalis corniculata* L. - T.-H., Adv. (Medit.); Fam. Geraniaceae: *Erodium cicutarium* (L.) L' HER. – T., Cosm., *Geranium columbinum* L. – T., Euras.; *G. divaricatum* Ehrh. – T., Euras. Cont. Submedit.; *G. pusillum* L. – T., Eur.; Fam. Araliaceae: *Hedera helix* L. – Ph., Atl.-Medit.; Fam. Apiaceae: *Anthriscus cerefolium* (L.) HOFFM. subsp. *trichosperma* (SCHULT.) ARCANG. – T., Pont.-Medit., *Bupleurum affine* Sadler – T., Pont. Pan. Balc.; *Daucus carota* L. subsp. *carota* – HT., Euras., *Ferulago sylvatica* (BESSER) RCHB. – H., Pont.-Medit., *Heracleum sphondylium* L. - HT.-H., Euras., *Myrrhoides nodosa* (L.) Cannon – T., Medit; *Oenanthe banatica* Heuff. – H., Pont. Pan. Balc.; *Peucedanum alsaticum* L. – H., Eur. Centr., *P. cervaria* (L.) LAPEYR. – H., Eur. Cont., *Smyrnium perfoliatum* L. – HT., Medit.; *Tordylium maximum* L. – T.-HT:, Eur. Centr. and S., As. SW; *Torilis arvensis* (HUDS.) LINK – T., Eur. Centr.; Fam. Hypericaceae: *Hypericum perforatum* L. – H., Euras.; Fam. Tiliaceae: *Tilia tomentosa* MOENCH - Ph., Balc.-Pan.; Fam. Malvaceae: *Lavatera thuringiaca* L. – H., Euras cont.; *Malva sylvestris* L. - HT.-H., Euras. Fam. Violaceae: *Viola arvensis* MURRAY – T., Cosm., *V. canina* L. subsp. *ruppii* (ALL.) SCHÜBL. & MARTENS – H., Euras., *V. elatior* Fr. – H., Euras., *V. odorata* L. – H., Atl.-Medit.; Fam. Brassicaceae: *Alliaria petiolata* (M. BIEB.) CAVARA & GRANDE – H., Euras., *Barbarea vulgaris* R. BR. - HT.-H., Euras., *Berteroa incana* (L.) DC. - HT., Euras., *Capsella bursa-pastoris* (L.) Medik. – T-HT., Cosm.; *Cardaria draba* (L.) DESV. – H., Euras.-Medit., *Dentaria bulbifera* L. – G., Centr. Eur., *Erophila verna* (L.) CHEVALL. – T., Eur., *Rorippa austriaca* (CR.) BESS. – H., Pont., *R. sylvestris* (L.) BESS. - H., Euras., *Turritis glabra* L. – HT., Circ.; Fam. Primulaceae: *Lysimachia nummularia* L. – Ch., Euras.; *L. punctata* L. – H., Centr. and SE Eur.; *Primula acaulis* (L.) L. – H., Submedit.; Fam. Apocynaceae: *Vinca herbacea* Waldst. et Kit. – H., Pont.; Fam. Asclepiadaceae: *Vincetoxicum hirundinaria* MEDIK. – H., Euras. Cont.; Fam. Oleaceae: *Fraxinus angustifolia* VAHL. - Ph., Medit., *F. excelsior* L. – Ph., Eur., *Ligustrum vulgare* L. – Ph., Eur. (Submedit.); Fam. Solanaceae: *Physalis alkekengi* L. – H., Adv. (N Am.); *Solanum dulcamara* L. – Ch., Euras., *S. nigrum* L. – T., Cosm.; Fam. Acanthaceae: *Acanthus balcanicus* Heywood & I.B.K.Richardson – H., Balc.; Fam. Convolvulaceae: *Calystegia sepium* (L.) R. BR. - G.(H.), Euras.; Fam. Boraginaceae: *Cerinthe minor* L. - T.-HT., Centr. Eur.-Medit., *Cynoglossum hungaricum* SIMONK. – HT., Pont., *Lithospermum arvense* L. – T., Euras., *L. purpurocaeruleum* L. - H.-G., Eur. Centr.-Submedit., *Myosotis arvensis* Hill – HT., Euras.; *M. sparsiflora* Mikan ex Pohl – T., Euras. Cont.; *Symphytum tuberosum* L. – H., Centr. and V. Eur.; Fam. Lamiaceae: *Ajuga genevensis* L. – H., Euras., *A. laxmannii* (L.) BENTHAM – H., Pont. Pan. Balc., *Ballota nigra* L. – H., Centr. and NE. Eur., *Calamintha menthifolia* Host – H., Eur.; *Clinopodium vulgare* L. – H., Circ., *Glechoma hirsuta* WALDST. & KIT. - H.(Ch.), Pont.-Medit.-Centr. Eur., *Lamium maculatum* L. subsp. *maculatum* - H.(Ch.), Euras., *Leonurus cardiaca* L. – H., Euras.; *Lycopus europaeus* L. - H.(HH.), Euras., *Marrubrium peregrinum* L. – H., Pont. Pan. Balc.; *Melissa officinalis* L. – H., Medit.; *Melitis melissophyllum* L. – H., Centr. and W Eur.; *Phlomis tuberosa* L. – H., Euras. Cont.; *Prunella laciniata* (L.) L. – H., Centr. eur. medit.; *P. vulgaris* L.- H., Cosm., *Salvia pratensis* L. – H., Eur. (Submedit.), *S. verticillata* L. – H., Centr. eur. medit.; *Stachys germanica* L. – H., Pont. Medit., *S.* officinalis (L.) Trevis. – H., Euras.; *Teucrium chamaedrys* L. – Ch., Eur. Centr. (Submedit.); Fam. Plantaginaceae: *Plantago media* L. – H., Euras.; Fam. Scrophulariaceae: *Digitalis lanata* EHRH. – HT.-H., Balc.-Pan., *Scrophularia nodosa* L. – H., Euras., *Verbascum blattaria* L. - HT., Euras. (Submedit.), *V. densiflorum* Bertol. - HT., Eur., *V. phlomoides* L. – HT., Eur. Centr. şi SE., *Veronica chamaedrys* L. subsp. *chamaedrys* - H.-Ch., Euras., *V. hederifolia* L. - T., Euras., *V. officinalis* L. - Ch., Euras., *V. serpyllifolia* L. – H., Cosm.; Fam. Campanulaceae: *Campanula persicifolia* L. - H., Euras., *C. rapunculoides* L. – H., Euras., *C. rapunculus* L. – HT., Eur.; Fam. Rubiaceae: *Cruciata laevipes* OPIZ – H., Euras., *Galium aparine* L. – T., Circ., *G. mollugo* L. – H., Euras; *G. tenuissimum* M. Bieb. – T., Pont. Balc.; *G. verum* L. – H., Euras.; Fam. Valerianaceae: *Valeriana officinalis* L. – H., Euras (submedit.); *Valerianella locusta* (L.) Laterrade – T., Eur.; Fam. Caprifoliaceae: *Sambucus ebulus* L. – H., Euras. (Submedit.), *S. nigra* L. – Ph., Eur., *Viburnum lantana* L. – Ph., Eur. Centr. Submedit.); Fam. Asteraceae: *Achillea millefolium* L. – H., Euras., *Achillea nobilis* L. subsp. *neilreichii* (A. Kerner) Velen. – H., Pont. Pan. Balc.; *Ambrosia artemisiifolia* L. – T. Adv.(N. Am); *Anthemis tinctoria* L. – H., Euras. Cont., *Arctium lappa* L. – HT., Euras.; *A. minus* (J. Hill) Bernh.- HT., Eur.; *Artemisia austriaca* Jacq. – Ch., Cont. Euras.; A*. vulgaris* L. - H., Circ.; *Carlina vulgaris* L. – HT., Euras.; *Carthamus lanatus* L. – T., Pont. Medit., *Conyza canadensis* (L.) CRONQUIST – T., Adv. (Am. de N.), *Doronicum hungaricum* (SADL.) RCHB. fil. – G., Pont. Pan. Balc., *E. annuus* (L.) PERS. subsp. *strigosus* (H. L. MÜHL. ex WILLD.) WAGENITZ - T., HT., H., Adv. (Am. de N), *Inula britannica* L. - HT., Euras., *I. salicina* L. – H., Euras.; *Tanacetum corymbosum* (L.) SCH. BIP. – H., Euras., *Tussilago farfara* L. - G., Euras., *Xeranthemum cylindraceum* Sibth. et Sm.. – T., Pont.-Medit., *Crepis biennis* L. - HT., Eur., *Hieracium bauhini* SCHULT. in BESS.

subsp. *bauhini* – H., E. and Centr. Eur., *H. pilosella* L. – H., Euras.; *Hypochaeris maculata* L. – H., Euras., *Lapsana communis* L. subsp. *communis* - T.-H., Euras., *Mycelis muralis* (L.) DUMORT. – H., Eur., *Tragopogon dubius* SCOP. – T.-HT., Centr. Eur.-Medit.; Cl. Liliopsida, Fam. Butomaceae: *Butomus umbellatus* L. – HH., Euras.; Fam. Dioscoreaceae: *Tamus communis* L. – G., Submedit.; Fam. Liliaceae: *Asparagus tenuifolius* Lam. - G., Pont.-Medit., *Colchicum autumnale* L. – G., Centr. Eur., *Gagea lutea* (L.) KER.-GAWL. – G., Euras., *Muscari comosum* (L.) Mill. – G., Eur. (excepted N.), *M. tenuiflorum* Tausch – G., Pont. Pan. Balc.; *Ornithogalum orthophyllum* TEN. subsp. *kochii* (PARL.) ZAHAR. – G., Centr. Eur. Submedit., *O. pyramidale* L. – G., Centr. Eur.; *O. pyrenaicum* L. – G., Atl. Medit., *O. umbellatum* L. – G. Submedit., *Polygonatum latifolium* (JACQ.) DESF. – G., Pont.-Pan.-Balc., *Scilla bifolia* L. subsp. *drunensis* SPETA – G., Centr. and S. Eur., Fam. Alliaceae: *Allium rotundum* L. – G., Centr. Eur. Submedit. *A. vineale* – G., Eur.; Fam. Iridaceae: *Crocus flavus* Veston – G. Balc.; *Iris graminea* L. – G., Centr. eur. submedit.; *I. pseudacorus* L. – G., Eur.; *I. variegata* L. – G., Pont. Centr. eur. balc.; Fam. Orchidaceae: *Platanthera bifolia* (L.) L.C.M. Richard – G., Euras.; Fam. Cyperaceae: *Luzula campestris* (L.) DC. – H., Circ.; Fam. Cyperaceae: *Carex divulsa* STOKES - H., Circ., *C. praecox* SCHERB. – G., Euras. Cont., *Carex tomentosa* L. – G., Euras.; *C. vulpina* L. - H., Euras., *Scirpus sylvaticus* L. – G., Circ.; Fam. Poaceae: *Aegilops cylindrica* HOST – T., Cont. Euras., *Agrostis canina* L. – H., Euras.; *A. stolonifera* L. – H., Circ., *Anthoxanthum odoratum* L. – H., Euras.; *Avenula compressa* (Heuffel) W. Sauer et Chmelitschek, H., Pont. Pan. Balc.; *Brachypodium sylvaticum* (HUDS.) P. BEAUV. – H., Euras. (Submedit.), *Briza media* L. – H., Euras.; *Bromus sterilis* L. – H., Euras. (submedit.); *Calamagrostis epigejos* (L.) ROTH – G., Euras., *Dactylis glomerata* L. – H., Euras., *Elymus repens* (L.) GOULD - G., Circ., *Festuca heterophylla* Lam. – H., Centr. Eur.-Submedit., *F. rupicola* HEUFF. – H., Cont. Euras; *Holcus lanatus* L. – H., Cosm., *Hordeum murinum* L. – T., Euras., *Koeleria macrantha* (Ledeb.) Schult. – H., Circ.; *Melica ciliata* L. – H., Centr. Eur.-Medit., *M. uniflora* RETZ. - H.(G.), Centr. Eur.-Submedit., *Milium effusum* L. – H., Circ., *Phleum phleoides* (L.) Karsten – H., Cont. Euras.; *Poa pratensis* L. – H., Circ. (today Cosm.); Fam. Araceae: *Arum orientale* M. BIEB. – G., Centr. Eur.-Medit.

An analysis of the entire floristic inventory shows that the southern elements have a fairly high percentage, against the general background of the elements that characterize the flora of our country (Eurasian) (Fig. 1).

The spectrum of bioforms highlights the presence in large numbers of bioforms classified as hemicryptophytes. If we take into account the ecological conditions in which these plants vegetate (the vegetal carpet inside the forests, clearings, bushes or the periphery of these vegetal formations) we can easily explain the high percentage registered.

If we make an analysis based on the seasons, it can be seen that the species classified as geophytes or terophytes are found in spring and early summer. Although phanerophytes are present in a low percentage, they still have a good representation in the field, giving the physiognomy of these forest habitats. The other biological forms encountered have an insignificant presence.

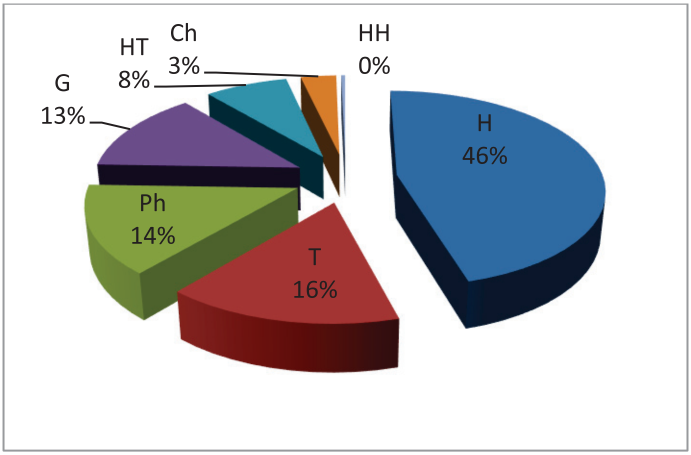

Fig. 1. Bioforms spectrum (orig.)

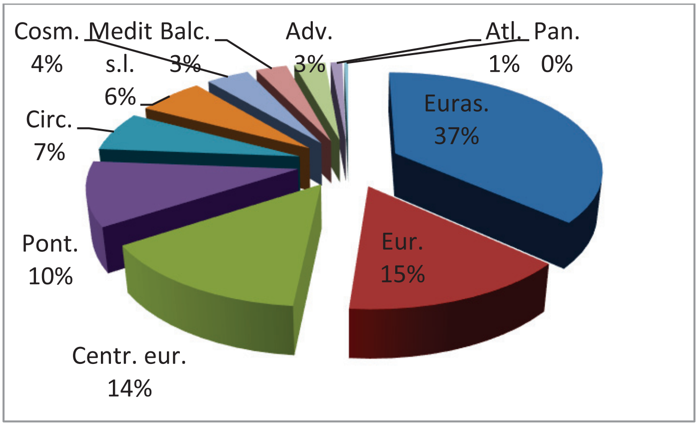

Fig. 2. Geoelements spectrum (orig.)

CONCLUSIONS

Habitat 91M0 has the widest spread in the Oltenia Silvostepa site. As in the area the cereto-garnits are the dominant forests, they are of great economic importance. The floristic composition of this habitat highlights the constancy of some recognition species *Potentilla micrantha, Lychnis coronaria, Vincetoxicum hirundinaria, Lithospermum purpuro-caeruleum* and others.

Forests that form the 91I0 *habitat are found at lower altitudes and have a coverage of up to 90%. Their physiognomy is given by the pedunculate oak or quince (*Quercus robur, Q. pedunculiflora, Q. pubescens*). The shrub layer is represented by a large number of species *Acer tataricum, Cornus sanguinea, C. mas, Crataegus monogyna, Viburnum lantana, Rosa canina, Prunus spinosa* etc.

The meadow forests classified at 91E0 * have an obvious stratification. The upper layers are built of wood species that have a uniform physiognomy, and the lower layers are strongly influenced by the size and frequency of floods during the year.

REFERENCES

Beldie Al. 1977, 1979. Flora României. Determinator ilustrat al plantelor vasculare. Editura Academiei Române. Bucureşti.1,2: 406, 412.

Brummit R.K. & Powell C.E. 1992. Authors of plant names. Royal Botanic Gardens. Kew. (EDS.) 732 pp.

Boruz Violeta, Bejenau Cornelia, Bejenaru L. E., Bărbuceanu Daniela. 2011. Botanical research in the Radovan and Perişor forests, Dolj county. Analele Universităţii din Craiova, seria Agricultură –Montanologie –Cadastru Vol. XLI 2011/2: 47-61

Borza Al. 1966. Cercetări asupra florei şi vegetaţiei din Câmpia Română I. Contrib. Bot.: 141-162. Cluj.

Buia Al., Popescu-Mihăilă Ana 1952. Contribuţii la flora regiunii Craiova. Buletin Ştiinţific. Secţiunea de Ştiinţe Biologice, Agronomice, Geologice şi Geografice. Tom. IV. nr. 3: 519-536. Bucureşti.

Buia Al. 1959. Plante rare pentru flora R.P.R. existente în Oltenia. Buletinul comisiei pentru Ocrotirea monumentelor Naturii. Edit. Acad. R.P.R.: 13-42. Bucureşti.

Buia Al., Păun M. 1960a. Plante noi şi rare din Oltenia. Contrib. Bot.: 141-148. Cluj.

Buia A. & Păun M. 1960b. Materiale pentru flora şi vegetaţia împrejurimilor oraşului Craiova. SSNG. Com. de Bot., 1957-1959, Bucureşti, 281-296.

Cârțu D. 1979. Studiul geobotanic și agroproductiv al pajiștilor naturale dintre Jiu-Desnățui-Craiova și Dunăre, jud. Dolj. Rezumatul Tezei de doctorat. Inst. Agronomic din Timișoara, Facultatea de Agronomie.

Ciocârlan V. 2009. Flora ilustrată a României. Pteridophyta et Spermatophyta. Editura Ceres, Bucureşti. 1041 pp.

Doniţă N., Paucă Comănescu M., Popescu A., Mihăilescu S., Biriş I. A., 2005. *Habitatele din România*, Ed. Tehnică Silvică, Bucureşti.

Doniţă, N., Popescu, A., Paucă-Comănescu, M., Mihăilescu, S., Biriş I.A. 2006. Habitatele din România. Modificări conform amendamentelor propuse de România şi Bulgaria la Directiva Habitate (92/43/EEC), Edit. Tehnică Silvică, Bucureşti.

Gafta D., Mountford O. (coord.), 2008. Manual de interpretare a habitatelor Natura 2000 din România, Edit. Risoprint, Cluj-Napoca.

Păun M., Georgescu L. & Fulga G. 1971. Importante puncte floristice şi de vegetaţie în cuprinsul Olteniei. Stud. Cercet. C.C.E.S. Dolj: 67-84. Craiova.

Păun M. (1985). Querco-Fagetea Br.-Bl. Vlieg. 37 în Oltenia. Contrib. Bot.: 121-130. Cluj-Napoca.

Popescu G. 1988 - Phytocoenological consideration on the *Quercus cerris* L. and *Q. frainetto* Ten. Forests of Oltenia. *Rev. Roum. Biol.-Biol. Végét.,* Tom. 33, Nr. 2: 75-91. Bucureşti: Edit. Acad. Române.

Popescu G. 1996. Contribuţii la cunoaşterea vegetaţiei din Câmpia Olteniei. Acta Bot. Hort. Bucurest.: 189-198. Bucureşti.

Popescu G. & Costache I. 1999 - Consideraţii asupra florei pădurilor din Oltenia. *Anal. Univ. Craiova,* Vol. II (XXXVIII)- 1998*,* Ser. Biol., Hort., T.P.P.A., Craiova.

Răduţoiu D. 2008. *Flora şi vegetaţia Bazinului Cernei de Olteţ*. Edit. Sitech. Craiova. 407 pg. ISBN 978-606-530-075-0.

*** Habitats Directive 92/43/EEC – Concil Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (OJ L 206, 22.7.92).

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FRAGRANT ROSES FROM THE BOTANICAL GARDEN "DIMITRIE BRANDZA" ROSARIUM IN BUCHAREST

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Keywords*: perfume, roses, Bucharest, Romania*

ABSTRACT

Since the beginning of time people were attracted to the scent of flowers, whenever we see a flower, instinctively, we take it and try to feel the aroma. Roses, from this point of view have a very wide range of flavors and with the different colors they are very attractive. In this paper we will try to present some of the most fragrant roses from the Botanical Garden Rosarium in Bucharest.

INTRODUCTION

From time immemorial, flowers have been our reliable friend, both in moments of joy and sadness. The flowers accompanied us from birth through the petals of the water to be baptized, to wedding through the bride's bouquet and until death through wreaths or garlands. The rose, through its wide range of colors and aromas, has always been one of the most appreciated flowers, being nicknamed the "Queen of Flowers" (Wagner 2002).

The name "Queen of Flowers", which remains to this day, was given by Sappho (600 BC), the most famous lyrical poet of antiquity (Wagner 2002).

Since antiquity there are data that show the presence of the rose in people's lives, when it seems that the genetic center of formation, the origin of the rose was in Asia Minor and Central Asia, from where it then spread through around the globe (Popescu 1986).

The first appearances were in the northern hemisphere, so the rose was used in perfumery, natural medicine, food, literature, music, art, being the most widespread, appreciated and painted flowering plant. From ancient times people have been fascinated by the beauty of the rose (Wagner 2002).

One of the oldest writings on roses dates back to the time of King Sargon (2600 BC), and was discovered during excavations at Ur and Akkad. According to this, the king, withdrawing from a war, brought figs, vines and roses to the Tiger and Euphrates valleys (Popescu 1986).

MATERIALS AND METHODS

Like all the people who loves roses, we are interested in those that have, besides beautiful colors, also perfume with different aromas. From the Botanical Garden collection of roses, with more than 200 varieties, we are going to present some of the fragrant ones, from different groups like: hybrid tea, floribunda, shrub, English roses or climbers:

Fig1. Photo: M. Negulici

'Abraham Darby'
Type: English rose
Fragrance: Strong, fruity fragrance
Bred by: David Austin, U. K. 1985

Fig2. Photo: M. Negulici

'Astrid Gräfin von Hardenberg'
Type: Shrub
Fragrance: Strong, honey, lemon, vanilla fragrance
Bred by: Hans Jürgen Evers, Germany 1997

Fig3. Photo: M. Negulici

'Caprice de Meilland'
Type: Hybrid Tea
Fragrance: Strong, fruity fragrance
Bred by: Meilland International, France 1997

Fig4. Photo: M. Negulici

'Chartreuse de Parme'
Type: Hybrid Tea
Fragrance: Strong, citrus, fruity, tangerine fragrance.
Bred by: G. Delbard, France 1996

Fig5. Photo: M. Negulici

'Chrysler Imperial'
Type: Hybrid Tea
Fragrance: Strong, sweet fragrance
Bred by: Dr. Walter E. Lammerts, USA 1952

Fig7. Photo: M. Negulici

‘Double Delight’
Type: Hybrid Tea
Fragrance: Strong, spice fragrance
Bred by: Herbert C. Swim, USA 1976

Fig6. Photo: M. Negulici

‘Doamna în Mov’
Type: Hybrid Tea
Fragrance: Strong, spice fragrance
Bred by: Ştefan Wagner and Gabriela Roman, Romania 1999

Fig8. Photo: M. Negulici

‘Friesia’
Type: Floribunda
Fragrance: Strong, lemon fragrance
Bred by: Reimer Kordes, Germany 1973

Fig9. Photo: M. Negulici

‘Graham Thomas’
Type: English rose
Fragrance: Strong, tea, honey, cider fragrance
Bred by: David C.H. Austin, U.K. 1983

Fig10. Photo: M. Negulici

‘Heritage’
Type: English rose
Fragrance: Strong, lemon, honey, tea fragrance
Bred by: David C.H. Austin, U.K. 1982

Fig11. Photo: M. Negulici

‘Papi Delbard’
Type: Climber
Fragrance: Strong, fruity fragrance
Bred by: G. Delbard, France 1992

Fig12. Photo: M. Negulici

‘Parole’
Type: Hybrid Tea
Fragrance: Strong, fruity fragrance
Bred by: W. Kordes & Sons, Germany 1991

Fig13. Photo: M. Negulici

‘Pierre Arditi’
Type: Hybrid Tea
Fragrance: Strong, damask, fruity, raspberry fragrance.
Bred by Alain Meilland, France 2008

Fig14. Photo: M. Negulici

‘Rhapsody in Blue’
Type: Shrub
Fragrance: Mild to strong, mosk, spice fragrance
Bred by: Frank R. Cowlishaw, U.K. 1999

Fig15. Photo: M. Negulici

‘Scentimental’
Type: Floribunda
Fragrance: Strong, damask, spice fragrance
Bred by: Tom Carruth, United States 1996

Fig16. Photo: M. Negulici

‘Sheila’s Perfume’
Type: Floribunda
Fragrance: Strong, sweet fragrance
Bred by: John Sheridan, U. K. 1979

Fig17. Photo: M. Negulici

'Mainzer Fastnacht'
Type: Hybrid Tea
Fragrance: Strong, spice fragrance
Bred by: Mathias Tantau Jr, Germany 1964

Fig18. Photo: M. Negulici

'Valencia'
Type: Hybrid Tea
Fragrance: Strong, sweet, fruity fragrance
Bred by: W. Kordes & Sons, Germany 1987

CONCLUSIONS

- Because of the very vast varieties, with so many colors and flavors, roses are indeed "Queen of flowers" and should never miss from any garden.
- Roses are one of the most popular flowers used in different occasions and also in perfumery, natural medicine, food, literature, music, art, being the most widespread, appreciated and painted flowering plant. From ancient times the people have been fascinated by the beauty of the rose.

REFERENCES

1. Popescu Stelian, 1986. Trandafirul, Editura Ceres, București
2. Wagner Stefan 2002.Trandafirul - De la mit la mileniul trei. Cluj: Edit. S.C. ArtLex S.R.L. Cluj-Napoca
3. Rosarium. 2018. Buletinul Asociatiei Amicii Rozelor din Romania, Membra a Federatiei Mondiale a Societatilor de Roze (WFRS), Nr.1-2018 (Anul XXVII – Nr. 52)
4. https://www.helpmefind.com/rose/plants.php

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THE EFFECTS OF THE TREATMENT WITH FUNGICIDES ON THE PHYSIOLOGICAL PROCESSES IN *PRUNUS CERASUS* L. ATTACKED BY *BLUMERIELLA JAAPII* (REHM) ARX.

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***Keywords**: fungicide, leaves of the plant, pathogen, physiological processes.*

ABSTRACT

The effects of treatment with fungicides on the physiological processes were observed in the leaves of sour cherries tree (Prunus cerasus L.) cultivated in the climatic conditions of Oltenia region.The physiological analyzes were performed on June 14th 2019, both for leaves treated with Topsin 70 WDG (0.07%), in four phases at 12 days interval (April 30th 2019, May 11th 2019, May 23th 2019 and June 4th 2019) and also for the leaves attacked by Blumeriella jaapi (Rehm) Arx. in which treatments have not been performed.

In the leaves of the Prunus cerasus L. attacked by Blumeriella jaapi (Rehm) Arx. is observed that the physiological processes' intensity is lower as a result of the reduction of the assimilation surface due to the formation of spots and necrosis on the leaves.

INTRODUCTION

The tree of sour cherry (*Prunus cerasus* L.) is thought to have originated as a natural hybrid between Prunus avium and Prunus fruticosa in the Eastern Europe or Iranian Plateau where the two species come into contact. The two hybrids then stabilized and interbred to form a new distinct species (Ahmad et al. 2017).

Sour cherry is similar in many aspects to sweet cherry (P. avium), but it is usually a shrub or a small tree without a well-defined trunk and with many suckers, and has smaller and firmer leaves, which do not drop. It is usually self-fertile and the fruit, bright red and sour, is mainly used for preserving (Marin & Gella 1991).

Cherry leaf spot, caused by the fungus *Blumeriella jaapi* (Rehm) var. Arx. is one of the most serious fungal diseases of sour cherries (Oszmiański & Wojdylo 2014). This disease causes early defoliation of cherry groves, fruit buds differentiate incompletely and in the following spring, even if they bloom abundantly, little fruit is formed (Nicolae & Camen 2011).

Cherry leaf spot reduces winter resistance and productivity of fruit trees and worsens fruit quality. Alternating ecological factors affect negatively the immune system of plants and induce pathogenity of disease pathogens (Valiushkaite 2002).

The attacked leaves presents chlorotic spots and necrotic lesions. Affected leaves can drop prematurely from the canopy, adversely affecting fruit quality and yield in the current year (Jones 1995) as well as bloom and fruit set in the following year (Howell 1973). Following symptom development from *Blumeriella jaapii* infection, photosynthesis of tart cherry is potentially jeopardized by disruption of multiple processes (Gruber et al. 2012). This pathogen primarily affects leaves, thus compromising photosynthetic ability, causing early defoliation, yield reduction and lower fruit quality (Iličić et al. 2019). The sour cherry productivity is dependent, in part, upon accumulated absorbed solar radiation by visibly healthy leaf area during the growing season. Johnson (Johnson 1987), Lopes and Berger (Lopes & Berger 2001) noted that some pathogens alter a leaf's ability to absorb solar radiation while others alter the efficiency of its use in the absence of visible symptoms.

MATERIAL AND METHODS

The researches were performed in the *Prunus cerasus* L. cultivated in the climatic conditions of Oltenia region. The trees are small in size, usually round-topped, with ovate leaves and white flowers which appear at the same time with the leaves. The fruits are small, globose, light red to nearly black with bark bitter, astringent. The treatments with the fungicide *Topsin* 70 WDG (0.07%) were applied on the leaves in four phases at 12 days interval (April 30th 2019, May 11th 2019, May 23th 2019 and June 4th 2019) and the physiological researches were performed on June 14th 2019, both for leaves treated with fungicide and also for the leaves in which treatments have not been performed.The estimation of the attack was made using the calculation formulae elaborated by Săvescu & Rafailă (1978). The physiological processes intensity and the physiological parameters were determined with the ultra compact system LCi. The water contents and the dry substance were determined by the gravimetric method and the chlorophyll content with the Minolta SPAD 502.

RESULTS AND DISCUSSIONS

Blumeriella jaapii (Rehm) Arx. mainly affects the leaves, but lesions may also appear on fruit, petioles and fruit stems (pedicels). In May, the botom leaves have small, circular, purple or red spots isolated with a more or less differentiated edge. The spots confluence, occupying in favourable conditions, all the leaf blade and the central portion of the spots fades, becoming whitish gray (Figure 1).

Figure 1. The leaves of the *Prunus cerasus* L. attacked by *Blumeriella jaapii* (Rehm) Arx. (Original).

Figure 2. *Blumeriella jaapii* (Rehm) Arx. - conidia (oc. 10 x ob. 20) - Original.

This presents a mycelium that develops intercellularly in the leaf tissues and fructifies on the acervuli. The conidiophores are short, cylindrical with hyaline cylindrical conidia which provide secondary infections throughout the growing season (Figure 2).

The physiological researches were performed on June 14th 2019, both for leaves of the sour cherry trees treated with *Topsin* 70 WDG fungicide and also for the attacked leaves in which treatments have not been performed.

The estimation of the attack (frequency, intensity and degree of attack) produced by *Blumeriella jaapii* in *Prunus cerasus* L. is presented in Figure 3.

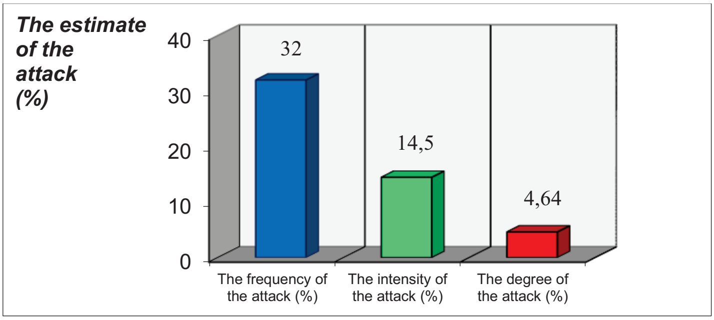

Figure 3. The estimation of the attack produced by *Blumeriella jaapii* (Rehm) Arx. in the *Prunus cerasus* L.

During the day, the photosynthesis and transpiration intensity has lower values in the attacked leaves as a result of the reduction of the assimilation surface due to necrosis of the spots on the leaves, the deterioration of the chlorophyll, but also due to the malfunctioning of stomatal apparatus (Figure 4 and Figure 5).

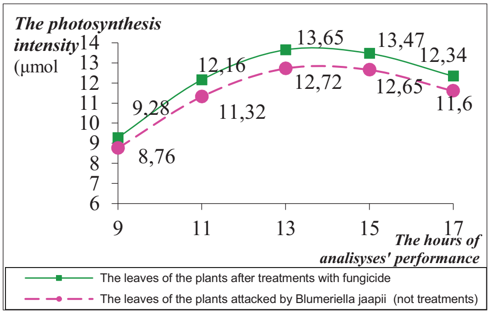

Figure 4. The photosynthesis intensity in the leaves of the *Prunus cerasus* L.

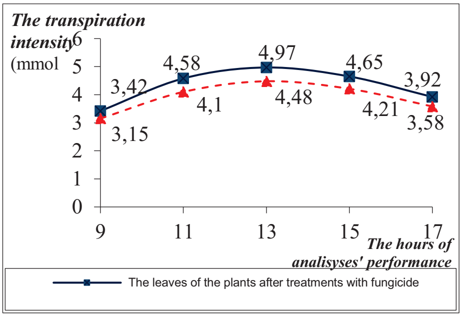

Figure 5. The transpiration intensity in the leaves of the *Prunus cerasus* L.

The intensity of the photosynthesis and transpiration are correlated with the physiological parameters, but present different values in the leaves of the sour cherry tree in which treatments have been performed, in comparison with the leaves attacked by the pathogen, a strong association being established between these.

The results obtained from the analyzes performed on the photosynthetic active radiation, leaf temperature and stomatal conductance in the leaves of the sour cherry tree are presented in the Table. 1.

Linear regression made between the photosynthesis intensity and photosynthetic active radiations shows a positive correlation between these, the coefficient of determination (R^2) was 0.85 for the leaves of the plants after treatments with fungicide and 0.84 for the leaves of the plants attacked by pathogen.

Table 1

The physiological parameters registered in the leaves of the *Prunus cerasus* L.

The recorded physiological parameters	**The leaves of the analyzed plants**	**The hours of the analyses' performance and the recorded values** (June 22[th] 2019)				
		9^{00}	11^{00}	13^{00}	15^{00}	17^{00}
The photosynthetic active radiation *(µmol / m² / s)*	The leaves of the plants after treatments with fungicide	1462	1584	1617	1590	1527
	The leaves of the plants attacked by pathogen (plants without fungicide treatments)	1427	1547	1580	1578	1487
The leaf temperature *(°C)*	The leaves of the plants after treatments with fungicide	26.4	29.1	32.2	31.3	29.4
	The leaves of the plants attacked by pathogen (plants without fungicide treatments)	26.6	29.1	32.3	31.5	29.7
The stomatal conductance *(mol / m² / s)*	The leaves of the plants after treatments with fungicide	0.10	0.12	0.14	0.13	0.12
	The leaves of the plants attacked by pathogen (plants without fungicide treatments)	0.08	0.10	0.13	0.12	0.10

Linear regression made between the transpiration intensity and photosynthetic active radiations shows a positive correlation, the coefficient of determination R^2 was 0.96 for the leaves of the plants after treatments with fungicide and 0.98 for the leaves of the plants attacked by pathogen - Figure 6 and Figure 7.

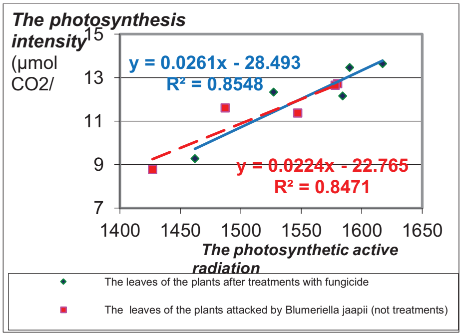

Figure 6. The correlation between the intensity of photosynthesis and the photosynthetic active radiation in the leaves of the *Prunus cerasus* L.

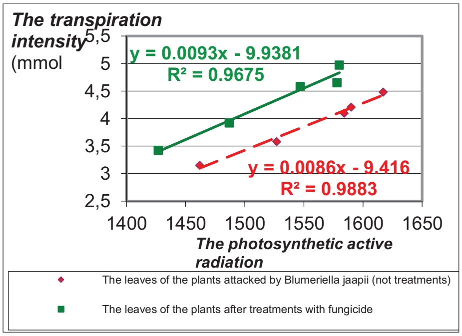

Figure 7. The correlation between the intensity of transpiration and the photosynthetic active radiation in the leaves of the *Prunus cerasus* L.

Linear regression made between photosynthesis intensity and leaf temperature shows a positive correlation, the coefficient of determination (R^2) was 0.94 for the leaves of the plants after treatments with fungicide and 0.93 for the leaves of the plants attacked by pathogen. Linear regression made between the transpiration intensity and leaf temperature shows a good positive correlation, the coefficient of determination R^2 was 0.81 for the leaves of the plants after treatments with fungicide and 0.80 for the attacked leaves of plants - Figure 8 and Figure 9.

Linear regression made between photosynthesis intensity and stomatal conductance shows a positive correlation, the coefficient of determination (R^2) was 0.93 for the leaves of the plants after treatments with fungicide and 0.87 for the leaves of the plants attacked by pathogen (plants without fungicide treatments). Linear regression made between the transpiration intensity and stomatal conductance shows a positive correlation, the coefficient of determination R^2 was 0.87 for the leaves of the plants after treatments with fungicide and 0.82 for the attacked leaves of plants - Figure 10 and Figure 11.

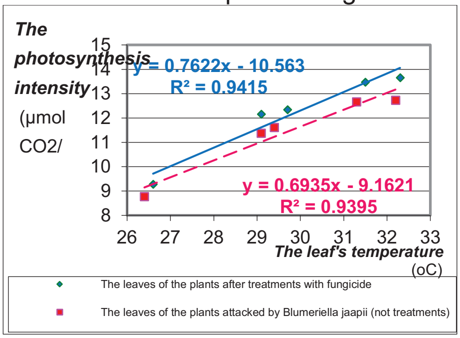

Figure 8. The correlation between the intensity of photosynthesis and the leaf temperature in the leaves of the *Prunus cerasus* L.

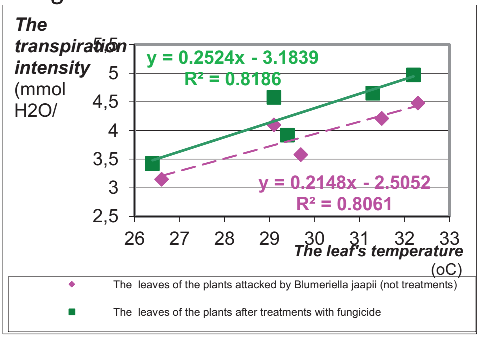

Figure 9. The correlation between the intensity of transpiration and the leaf temperature in the leaves of the *Prunus cerasus* L.

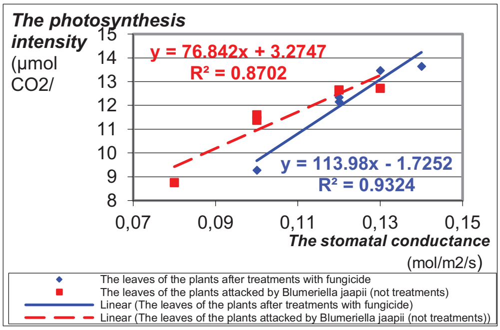

Figure 10. The correlation between the intensity of photosynthesis and the stomatal conductance in the leaves of the *Prunus cerasus* L.

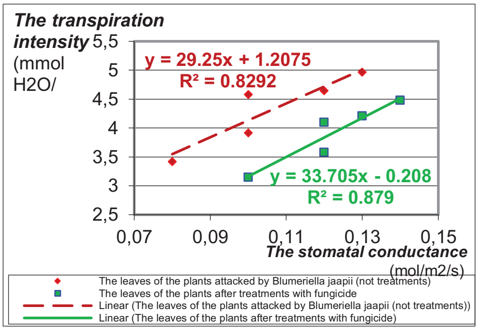

Figure 11. The correlation between the intensity of transpiration and the stomatal conductance in the leaves of the *Prunus cerasus* L.

In the leaves of the *Prunus cerasus L.* attacked by *Blumeriella jaapii* (Rehm) Arx. it was registered a lower water content and a higher dry substance content (Figure 12). In the leaves attacked by pathogen it is also registered a lower chlorophyll content, fact correlated with intensity of the photosynthesis (Figure 13).

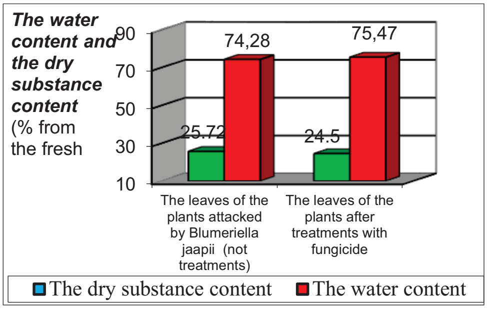

Figure 12. The water content and the dry substance content in the leaves of *Prunus cerasus* L.

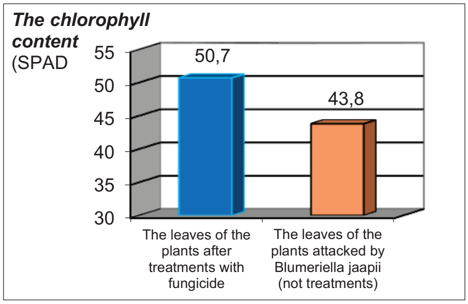

Figure 13. The chlorophyll content in the leaves of the Prunus cerasus L.

CONCLUSIONS

In the sour cherry tree (*Prunus cerasus* L.) it was observed that the intensity of the physiological processes is lower during the day in the leaves attacked by the pathogen, compared with the plants treated with *Topsin* 70 WDG fungicide, as a result of the of the reduction of the assimilation surface due to necrosis of the spots on the leaves and malfunctioning of stomatal apparatus.

The intensity of the photosynthesis and transpiration intensity are correlated with the photosynthetic active radiation, leaf temperature and stomatal conductance, but present different values in the leaves of the of the plants after treatments with fungicide, in comparison with the the leaves of the plants attacked by pathogen (plants without fungicide treatments) a positive association between these being established. In the leaves of the sour cherry tree attacked by the pathogen one can observe a decrease of chlorophyll content and the water content, with consequences on the quality and quantity of fruits.

REFERENCES

Ahmad I., Shamsi S., Zaman O. 2017. A review on sour cherry (Prunus cerasus): A high value Unani medicinal fruit, International Journal of Green Pharmacy, 11 (1): 1-6.

Gruber B. R., Kruger E. L., McManus P. S. 2012. Effects of Cherry Leaf Spot on Photosynthesis in Tart Cherry 'Montmorency' Foliage, Phytopathology, 102 (7): 656-661.

Howell G. S., Stackhouse, S. S. 1973. The effect of defoliation time on acclimation and dehardening in tart cherry (Prunus cerasus L.), Journal of the American Society for Horticultural Science. 98:132-136.

Iličić Renata, Popović Tatjana, Vlajić S., Ognjanov V. 2019. Foliar pathogens of sweet and sour cherry in Serbia, Acta Agriculturae Serbica, XXI, 48: 107-118.

Johnson, K. B. 1987. Defoliation, disease, and growth: A reply, Phytopathology, 77:1495-1497.

Jones A. L. 1995. Cherry leaf spot. Pages 21-22 in: Compendium of Stone Fruit Diseases. Ogawa J. M., Zehr E. I., Bird G. W., Ritchie D. F., Uriu K, Uyemoto J. K., American Phytopathological Society, St. Paul, MN.

Lopes D. B., Berger R. D. 2001. The effects of rust and anthracnose on the photosynthetic competence of diseased bean leaves, Phytopathology, 91:212-220.

Marin J.A., Gella R. 1991 Sour Cherry (Prunus cerasus L.), Biotechnology in Agriculture and Forestry, 16:Trees III (Edited by Y.P.S. Bajaj), Springer-Verlag Berlin Heidelberg.

Nicolae I., Camen D. 2011. Physiological modifications in Cerasus avium (L.) Moench as a result of the attack produced by Blumeriella jaapii (Rehm) Arx., Journal of Horticulture, Forestry and Biotechnology, Timișoara, Romania, 15(1): 107-112.

Oszmiański Jan, Wojdyło Aneta. 2014. Influence of cherry leaf-spot on changes in the content of phenolic compounds in sour cherry (Prunus cerasus L.) leaves, Physiological and Molecular Plant Pathology, 86: 28-34.

Săvescu A., Rafailă C. 1978. Prognoza în protectia plantelor, Editura Ceres, Bucureşti: 354.

Valiushkaite A. 2002. Investigation of Biological Peculiarities of Blumeriella jaapii, Plant Protection Science, 38 (2): 399-401.

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REASERCHES ABOUT THE VARIATION OF ADRENOCORTICOTROP HORMON (ACTH) DEPENDING ON AGE GROUP AND GENDER

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Keywords: *Suprarenal glands, Glucocorticoids, Cortisol, Corticotropin*

ABSTRACT

ACTH (The Adrenocorticotrop Hormon or Corticotropin) is a peptide hormone produced by the pituitary gland, which stimulates the formation and the secretion of the glucocorticoids at suprarenal cortex level.

ACTH's secondary properties are due to metabolics effects of glucocorticoids hormons, activating the carbohydrate, protidic and lipid metabolisms.

The adjustment of ACTH secretion realizes on neurohumoral way including the indirect participation of hipotalamus. The main humoral adjustment factor is the blood concentration of glucocorticoids hormons, especially of the cortisol. Under the influence of those, the ACTH secretion decreases, through a negative feedback mechanism, but it also increases if the circulating glucocorticoids are decreasing.

INTRODUCTION

The adrenal glands are little, in pairs, each of them weigh about 4-6 grams, and they are situated on the superior pole of each kidney, in some spaces called adrenal glands' box. Each adrenal gland is made of a conjunctiv skeleton and glandular tissue which has two parts, a peripheral one, called the adrenal corticol, and a central one, called the adrenal medulla (Drosescu & Poeană 2006, Guyton 1997, Hăulică 2007).

The adrenal corticol is situated at the outside and completely surrounds the medulla. It represents about 4/5 from the entire gland and it has mesothermic origin. Due to the large lipid content, it has a yellowish colour and it secretes hormons with variate metabolics actions (Crăițoiu 2003, Enciulescu 2011, Teodorescu Exarcu & Badiu 1993).

This contains cords and groups of epithelial cells, placed on three distinct areas which succeed themsels from the capsule to medulla: the glomerular zone (15%), at the outside, formed by a thin layer of cylindrical cells which secretes mineralocorticoids and corticosteron, the fasciculare zone (70%), formed by cords of epithelial parallel cells, by columns of cuboide cells separated through venous sinuses which secretes glucocorticoids hormons and a few androgynous hormons and the reticulate area (15%), at the inside, formed by a network of cells, created by the irregular hight of the cords of cells in which we find large blood spaces; it secretes androgynous hormons and a few glucocorticoids hormons.

The limits between the three areas are not distinct and their thickness variates depending on the functioning state of secretory cells (Crăițoiu 2003, Cristea 2005, Drosescu & Poeană 2006, Nicolescu & Albulescu 2010, Pisoschi & Stănciulescu 2006, Popa-Wagner & Buga 2011, Teodorescu Exarcu & Badiu 1993).

The secretion of adrenal glands is based on ACTH (adrenocorticotrop pituitary hormon, corticotrofin, corticostimuline) (Borundel 2000), a polypeptide with 39 amino acid radicals secreted by the adenohipophisis' basofile cells, which constitutes a part of a forerunner with a big molecule, propiomelanocortine (POMC), secreted by the corticotrope cells from the anterior hipophysis gland (Bădărău 2009).

The main action of ACTH consists on the stimulation of the synthesis and the secretion of adrenal glucocorticoids and on the proliferative activation of the fasciculate and reticulate layer of adrenal cortex (Lutan et al. 2004).

ACTH produces the increase of blood concentration of glucocorticoids androgenital hormons.

The hormon's effects are more reduced on the secretion of mineralocorticoids.

Beside the indirect action, ACTH directly stimulates the melanogenesis and the expansion of melanic pigment in the melanocite cells, producing the pigmentation of the skin (Niculescu et al. 2009).

The synthesis and the secretion of ACTH is under the direct control of corticoliberine (CRF - corticotropin releasing factor) secreted by the neurosecreting cores of the hypothalamus and under the negative feedback of pituitary ACTH and adrenal hidrocortisol.

Next to corticotrope action, ACTH also has a direct somatotrope one, helping to mobilize the stored fat and to oxidise them.

It also intensifies the cetogenesis, helps the glicogenolisis in the liver, favours to storage the glycogen in muscles and incorporates the amino acids in the cells.

ACTH intensifies the deterioration ofthe steroids in the liver and stimulates the melanofors, helping, in this way, to pigmentate the skin (Lutan et al. 2004).

The adrenocorticotrop hormon controls the development and the adrenal hormonal secretion.

It was isolated in 1943 by Li, Sayer from the sheep and pork pituitary glands and his activity was initially appreciated depending on the growth stimulation of suprarenal glandular tissue.

In 1948, Sayers noticed the depletion of ascorbic acid after administrating ACTH in a proportional dose, proposing the action as a method to determinate its hormonal activity.

In 1954, Bell established the chemical structure of ATCH, and in 1963, Li rachieved its synthetisis.

ACTH's synthetisis takes place in basophilic adenopituitary cells which have little red granulations from a forerunner with a 31000 daltons weight, named Propiomelanocortin (Hăulică 2007).

The main factors which controls the release of ATCH are CRH, the plasmatic concentration of free cortisol, stress and circadian cicle.

ACTH is intermitently released with a circadian rithm. After a normal sleep, the concentration of ACTH riches the highest level in the morning (about 4 a.m.) and the lowest level in the evening. The daytime normal rythm of plasmatic cortisol produces as a result of ACTH's changes rates.

In the primar corticoadrenal insufficiency (Addison desease), the concentration of cortisol is low and the ACTH one is high, giving a hiperpigmentation, because the ACTH stimulates the melanocites.

The administration of cortisol suppresses the release of ACTH, a phenomenon which is dependent on the increase rate of cortisol and on its absolute concentration.

The rased level of plasmatic cortisol suppresses the release of ACTH produced through CRH and it could suppress the release of CRH (Fauci et al. 2003).

The stress, including hypocalcaemia, the surgical interventions, the psychological exhaustion, stimulates the release of ACTH, partial with the increase of CRH's release.

However, the released quantity of ACTH is bigger than it could be achieved through maximal stimulation of CRH.

In normal persones cases, circulant ACTH level is low – 2-18 pmoli/l (10-80 pg/ml).

The plasmatic concentration of ACTH is the result of the dynamic balance between the intensity of secretion processes and those of inactivation.

In the absence of pituitary ACTH, the corticoadrenal glands atrophies.

The biological characteristics of ACTH are primary and secundary. The primary ones belong to the hormon itself and they consist in stimulating the fasciculate area of the corticoadrenal gland which secreate glucocorticoids (cortisol and corticosteron). Under the influence of ACTHSub influenţa ACTH, their secretion rapidly and proportionaly increases with the dose in a short time inteval of 7-8 minutes (Hăulică 2007).

Along with the activation of the synthesis and the secretion of glucocorticoids, ACTH stimulates the reticulate area, and to a small extent, it stimulates even the glomerulate area of corticoadrenals.

The adjustment of ACTH secretion realises through negative or positive feedback reactions of direct pituitary and indirect hypothalamic way, with CRH participation released at the level of median intelligence, a neurohormon with a peptidic structure, whose secretion seems to be stimulated both in a nervous way and in a humoral one.

While the absence of circulant glucocorticoids activates the CRF secretion, their excess in the plasma inhibits it. The neurons of mediane intelligence block the sinthesys and the CRF secretion, so the big doses of ACTH secretion inhibits it on the stressfull period.

The main humoral factor is the blood concentration of glucocorticoids hormons reprezented at the human level by the cortisol. Under its influence, the ACTH secretion decreases giving a negative feedback mechanism, and, otherwise, increases in the absence of circulating glucocorticoids.

The synthetisis and the release of pituitary ACTH depend on the glucocorticoids' concentration from the plasma (Hăulică 2007).

The stressfull information determine the stimulation of corticoadrenal with the obligatory participation of pituitary ACTH.

The mechanism of stimulating the ACTH secretion during the stressfull period is independent regarding the feedback reactions between cortisol and ACTH (Hăulică 2007).The halve time of circulating ACTH is lower than 10 minutes.

Also, the action of ACTH is rapid and the concentration of steroids from the adrenal venous blood raises in few minutes from its circulating release (Fauci et al. 2003).

MATERIAL AND METHODS

A very important role in functioning exploration is taken by the dosage of corticoadrenal hormons in the plasma and in the urine, but also the provocative methods based on the call of adjustment and control mechanisms.

The base hormonal investigations frequently used are: the dosage of 17 urine hidroxicorticosteroids, the dosage of 17 plasmatic hidroxicorticosteroids, the dosage of urine cetosteroids and the provocative tests (Slătineanu & Costuleanu 1998).

This paper material is based on a retrospectiv study which gatered an whole lot of patiens tested between 15.04.2019 – 15.10.2019, which came at Synevo Blood Drive Râmnicu Vâlcea, for determining ACTH values.

The source of this study is represented by the analisys' results from the medical records. We took in consideration both the normal results and pathological high of ACTH' values.

References values 0,0 - 46 pg/m (1.6-13.9 pmol/L) were established in the time interval 7 - 10 a.m..

The used working method was the imunochemical one with the help of electrochemiluminescent (https://www.synevo.ro/acth/).

117 patiens, men and women between 0 and 85 years old, who requested the value of ACTH, were included in the study.

The patiens were divided after both clinical criterions, with normal results or pathological ones of ACTH, or epidemiological criterions (age and sex which were noted in the medical record of each patient).

Through statistical processing of the results from patients' medical records, we made a database which was used to realise the graphical representation, to interpret the results and to discuss them, and, also, to draw some conclusions after reading them.

The patiens of the study were divided depending on gender (men and women), on age group (0-20 years, 21-40 years, 41-60 years, 61-85 years) and on the values of ACTH (Table 1).

Table 1

The Level of ACTH depending on gender and age group

Age group	ACTH Women		ACTH Men	
	High	Normal	High	Normal
0-20 years	2	0	2	0
21-40 years	3	0	3	24
41-60 years	15	5	10	22
61-85 years	9	7	10	5
Total	29	12	25	51

RESULTS AND DISCUSSIONS

An analysis of the patiens depending on the value of ACTH (normal or high) revealed an unbalanced rate, the number of normal ACTH patiens (63) (53,84%) is bigger than the number of high ACTH patiens (54) (46,11%) (Table 1, Figure 1).

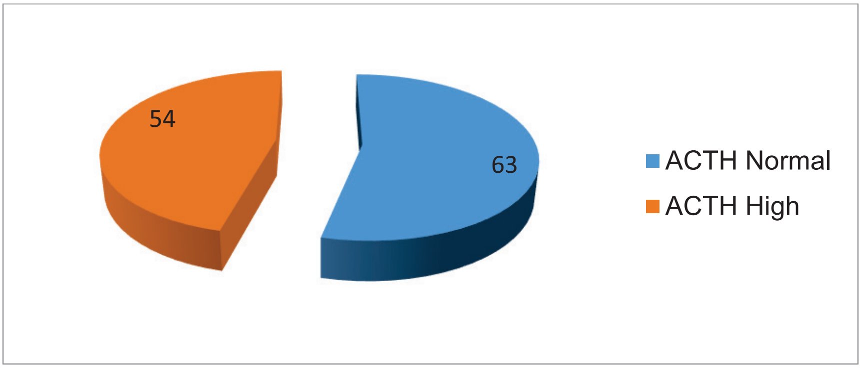

Figure 1. The distribution of patiens depending on the value of ACTH (normal or high)

We analysed the distribution of the 29th women-patiens (53,7%) with high values of ACTH depending on the age group and we realised that the group 41 – 60 years has a bigger rate - 15 patiens (51,72%) and the group 61 - 85 years has 9 patiens (31,03%). Less affected were the groups 21 - 40 years with 3 patiens (10,34%) and the group 0 – 20 years with 2 patiens (6,9%) (Table 1, Figure 2).

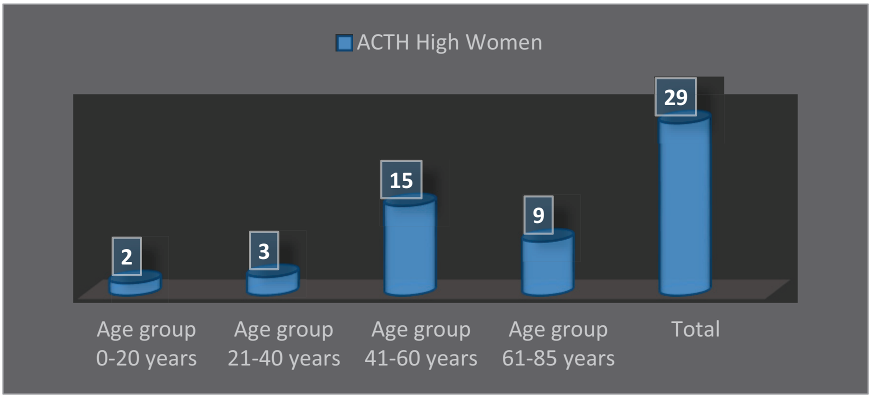

Figure 2. The distribution of women patiens with high ACTH depending on level of age group

Similar with the distribution of women patiens was the distribution of the 25th men patiens with high ACTH values (46,3%). This shows that the groups 41 – 60 years and 61 - 85 years were affected, with a rate of 10 patiens (40%). Less affected were the groups 21 – 40 years with 3 patiens (12%) and the group 0 - 20 years, with 2 patiens (8%) (Table 1, Figure 3).

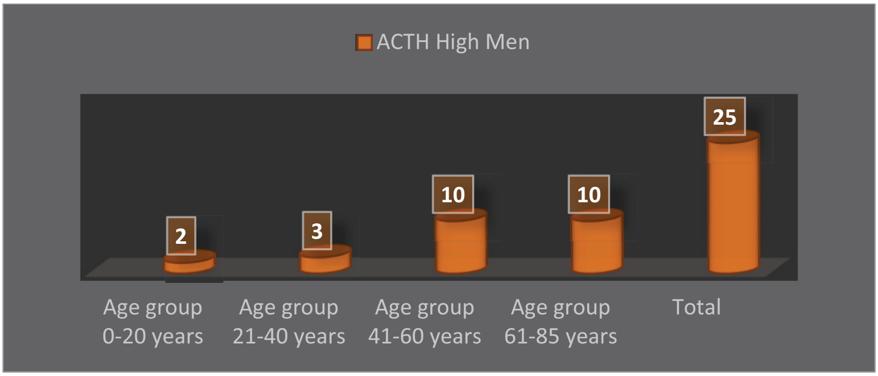

Figure 3. The distribution of men patiens with high ACTH value depending on age group

Regarding the distribution of patiens with high ACTH values depending on gender and age group, we observe that there is a disruption in distribute these patiens, because the number of women 29 (53,7%) is bigger than the number of men, 25 (46,3%).

Also, depending on the age group, we observe that the groups between 41 – 60 years (25 patiens, of which 15 women (51,72%) and 10 men (40%)) and the group between 61 – 85 years (19 patiens of which 9 women (31,03%) and 10 men (40%)) were most affected. Fewest patiens were at the group between 21 – 40 (6 patiens of which 3 women (10,34%) and 3 men (12%)) and the group between 0 – 20 (4 patiens of which 2 women (6,9%) and 2 men (8%)) (Table 1, Figure 4).

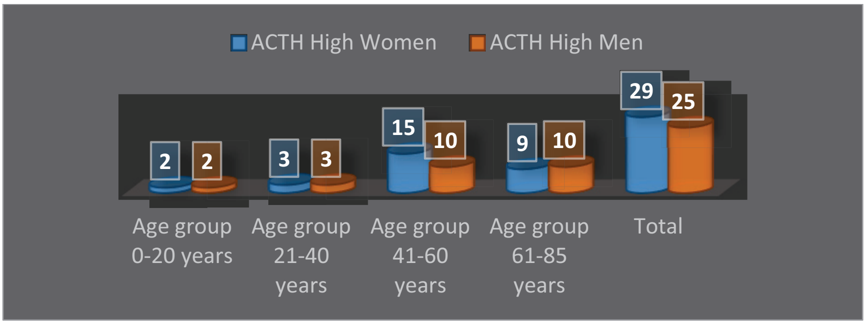

Figure 4. The distribution of patiens with high ACTH depending on gender and age group

The results of our study confirms the information from the medical literature records.

The Cushing Syndrom represents the hipersecretion of ACTH by an pituitary adenom. It is a microadenom which usualy has ACTH and sometimes has POMC, giving bilateral corticoadrenal hiperplazia with cortisol hipersecretion. (Bistriceanu 2000).

Cushing desease have been reported by patiens which received big and long doses of cortisol. (Borundel, 2000).

The frequency of adrenal pituitary hiperplazia on women is three times bigger than men. This frequency is higher between 30 – 40 years.

The diagnose of Cushing Syndrom depends on emphasizing the high production of cortisol and the insufficient supression of normal endogene secretion of cortisol when administrating dexametazone. Once we have a diagnostic, the additional investigations are used to determinate the hipercortisol's ethiology. (Fauci et al. 2003).

The hormonal tests are very important in diagnose the desease. Collecting samples needs a special attention both from the patient and the medical stuff who carries the samples to the laboratory.

To appreciate the adrenal glands' activity we have to focus on the concentration of adrenal steroids hormons in plasma and urine. The tests from plasma are very laborious and they are made only in special laboratories. (Borundel 2000).

As a initial screening test it is recommended the supression night test with dexametazone. Regarding difficult cases (for example, obesity) it can be used as a test the sceening and determination of free cortisol in 24 hours urine. (Fauci et al. 2003).

A hormonal particularity in Cushing desease it is the loss of nictemeral rythm, because the secretion of adrenal hormons is higher in the morning than night. (Borundel 2000).

CONCLUSIONS

The serum determinations of this studied hormon situated in the normal limits of age. There was an intra- and interindividuality closed to normal distributions of this hormon's values, and, sometimes, the references ranges were tighter or larger.

According to this study, in the distribution of patiens with high ACTH values depending on gender, we observe an unbalanced damage, because the number of women with high ACTH values is bigger than of men.

If we analyse the distribution of patiens depending on age group, we observe that the values of ACTH are higher when the patiens are age advanced. Age groups that are more affected are between 41 – 60 years and 61 – 85 years. Few cases were found on groups between 0 – 20 years and 21 – 40 years.

It would be necessary to introduce as a routine investigation, a hormonal exploration, on older groups, because the modified values of some hormons could become predictive in diagnose some deseases, for example the Cushing Syndrom.

REFERENCES

Bădărău Anca 2009. Fiziologie. Ghid de lucrări practice. Editura Universitară Carol Davila, București.

Bistriceanu M. 2000. Endocrinologie clinică. Curs. Editura de Sud, Craiova.

Borundel C. 2000. Manual de medicină internă pentru cadre medii. Editura ALL, Bucureşti.

Crăițoiu Ștefania 2003. Curs de histologie specială. Sisteme și organe. Editura Medicală Universitară, Craiova.

Cristea Aurelia Nicoleta 2005. Tratat de farmacologie. Editura Medicală, București.

Drosescu Paula, Poeană Mihaela 2006. Anatomia. Editura Medicală, Iași.

Enciulescu C. 2011. Embriologie specială. Organogeneză. Malformaţii. Vol. 2, Universitatea de Medicină şi Farmacie, Târgu Mureş.

Fauci A. S., Braunwald E., Isselbacher K. J., Wilson J. D., Martin J. B., Kasper D. L., Hauser S. L., Longo D. L. 2003. Harrison - Principiile medicinei interne. Editura Teora.Ediţia a XIV-a, Bucureşti.

Guyton A. C. 1997. Fiziologie. Fiziologie umană și mecanismele bolilor. Editura Medicală Amaltea, București.

Hăulică I. 2007. Fiziologie umană. Editura Medicală, Bucureşti.

Lutan V., Cazacu P., Iarovoi A., Gafencu V., Borş Eleonora, Todiraş Stela, Vişnevschi A. 2004. Fiziopatologie medicală. Procese patologice în organe şi sisteme. Vol. II, Centrul Editorial-Poligrafic Medicina, Chişinău.

Nicolescu Iuliana, Albulescu Dana Maria 2010. Anatomia omului. Vol. II, Editura Medicală Universitară, Craiova.

Niculescu C. Th., Cârmaciu R., Voiculescu B., Sălăvăstru C., Niţă C., Ciornei C. 2009. Anatomia şi fiziologia omului: compendiu. Editura Corint, Bucureşti.

Pisoschi Cătălina, Stănciulescu Camelia 2006. Compendiu de Biochimie. Editura Medicală Universitară, Craiova.

Popa-Wagner A., Buga Ana-Maria 2011. Metabolisme. Biochimie integrativă. Editura Sitech, Craiova.

Slătineanu Simona Mihaela, Costuleanu Angela 1998. Fiziologie. Ghid pentru lucrări practice. Facultatea de Medicină, Iaşi.

Teodorescu Exarcu I., Badiu G. 1993. Fiziologie. Editura Medicală, Bucureşti.

***https://www.synevo.ro/acth/

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INCIDENCE OF SMOKING AMONG PREGNANT WOMEN

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Keywords: *smoking, pregnancy, incidence*

ABSTRACT

The aim of this study was to evaluate the incidence of the smoking during pregnancy. There were evaluated 192 pregnant women. 32.48% of them stated that they starting smoking at a young age and they still do. 67.65% started smoking at 14-15 years of age. The majority of them consumed more than one pack of cigarettes daily. Most pregnant women (52.95%) reduced the number of cigarettes consumed daily, 20.59% of them consumed the same number of cigarettes daily and 26.47% quit smoking. 56 pregnant women who smoke, representing a percentage of 82.35%, have smoker husbands, so it is very difficult and unlikely that they will change this habit.

INTRODUCTION

Tobacco use causes multiple consequences on the respiratory system, cardiovascular system and almost on every organ system in the human body. It is the main cause of lung, bronchus and tracheal cancer and is involved in the development of oral cavity cancer, pharynx, larynx cancer, esophageal, gastric, colon and pancreatic cancer (Drope et al. 2018).

In Romania, according to the Romanian Society of Pneumology, 85% of patients with lung cancer are smokers (insp.gov.ro).

Worldwide, 1.1 billion persons are smokers, of which over 80% are men. According to the World Health Organisation, the highest incidence of smoking among young people over the age of 15 is in Europe (28%). In European countries, 19% of girls aged 15 and over are smoking, compared to 2-3% in African and Asian countries (WHO, 2016).

There are approximately 176 million adult women who smoke worldwide (Drope et al. 2018, Oncken et al. 2010).

In Romania, with regard to children, the incidence of smoking was higher in boys than in girls (WHO, 2017).

More than 6 million people per year die from tobacco use across the globe. A regular smoker loses at least 10 years of life to tobacco on average (Drope et al. 2018).

MATERIAL AND METHODS

The study was conducted on a group of 192 pregnant women, aged between 22 and 42 years, who went to the medical office to perform an ultrasound of the foetus or requested a consultation for various reasons, between October 2019 and March 2020.

An anamnesis study has been conducted covering the following aspects:

- the age;
- the presence of smoking habit;
- the age at which they started smoking;
- the number of cigarettes consumed per day before pregnancy;
- continued smoking during pregnancy;
- modification in the number of cigarettes consumed daily;
- smoking husband or not;
- awareness of the dangers of tobacco use.

RESULTS AND DISCUSSIONS

1. Assessing the incidence of smoking among pregnant women

From the group of 192 pregnant women included in the study, a number of 68 stated that they started smoking at a young age. This represents a percentage of 35.42%, meaning a fairly high value (Figure 1).

In 2010 the incidence of smoking during pregnancy was 12.3% (Tong et al., 2013).

In the United States, in 2012, about 15% of adult women were smoking (Centers for Diseases Control and Prevention, 2015).

The incidence of smoking during pregnancy varies in different countries between 0.1% and 50% (WHO, 2019).

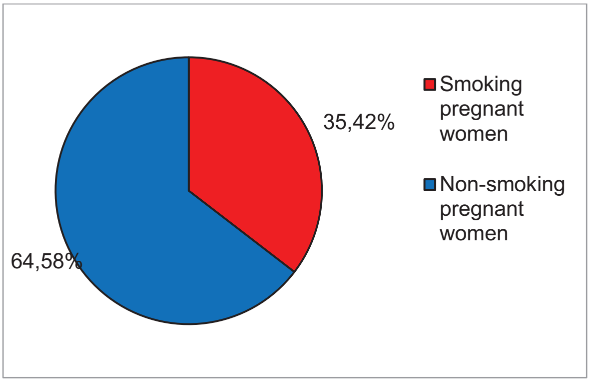

Figure 1. The repartition of the cases according to smoker status

2. Evaluation of the onset age of smoking

The lot of pregnant smoking women was divided into two groups:

- those who started smoking before the age of 18;
- those who started smoking after the age of 18.

46 patients, representing a percentage of 67.65%, started smoking at a young age, mostly at 14-15 years of age, so they currently have a history of smoking of at least 8-10 years. A small percentage of patients started smoking after the age of 18 (Table 1).

Table 1

The repartition of the cases depending on the onset age of smoking

The onset age of smoking	Before the age of 18	After the age of 18
No. of cases	46	22
Percentage	67.65%	32.35%

According to the study conducted by the European Commission, tobacco consumption in Romania is high, with an incidence of 28% among young people over the age of 15, close to the European average of 26% (Eurobarometer, 2017).

The incidence of smoking among women in Romania is 19%, compared to the European average of 22%, and among men it is 38% (European average 30%) (WHO, 2019).

The incidence of smoking in the 15-24 age group was 33% and in the 25-39 age group it was 37%. Statistical data show that the percentage of young people who start smoking in the 15-24 age group increased from 25% in 2014 to 29% in 2017 (Eurobarometer, 2017).

Compared to 1990, the incidence of smoking in women has doubled (www.insp.gov.ro).

According to a study conducted in 2015 by the Centre for Marketing and Social Forecasting, the age of 19 is the average age to start smoking. 82% of smokers started smoking at less than 20 years of age and 44% of smokers started smoking before the age of 18 (www.insp.gov.ro).

3. Evaluation of the number of cigarettes consumed daily before pregnancy

The studied group was divided into 3 categories:

- occasional smoke;
- smoke less than 1 pack of cigarettes per day;
- smoke over 1 pack of cigarettes per day.

The conclusion was that the majority of women consumed more than 1 pack of cigarettes a day (55.88%) (Table 2).

Table 2

The repartition of the smoking pregnant women

The category	No. of cases	Percentage
Occasional smoke	6	8,82%
Smoke less than 1 pack	24	35.29%
Smoke over 1 pack	38	55.88%

According to a study conducted by the World Health Organization most smokers consume tobacco daily, on average 14.1 cigarettes/day (WHO, 2019).

According to a study conducted by the Romanian Institute for Evaluation and Strategy (IRES) 8% of smokers consume more than one pack of cigarettes daily (www.ires.ro).

4. Behavioural changes during pregnancy

The 68 pregnant smokers were divided into 3 groups:

- pregnant women who have given up smoking;
- pregnant women who have reduced the number of cigarettes consumed daily;
- pregnant women who consumed the same number of cigarettes every day.

Most patients (52.95%) reduced the number of cigarettes consumed daily. 20.59% of them consumed the same number of cigarettes daily and 26.47% quit smoking (Table 3, Figure 2).

According to various studies, up to 46% of women quit smoking when they find out that they have become pregnant (Chamberlain et al. 2013; ACOG 2010).

Unfortunately, 50-60% of them resume smoking in the first 4 months postpartum (Tong et al. 2013; ACOG, 2010).

Table 3

The repartition of the cases

The category	No. of cases	Percentage
Quit smoking	18	26.47%
Reducing the number of cigarettes	36	52.95%
Consume the same number of cigarettes	14	20.59%

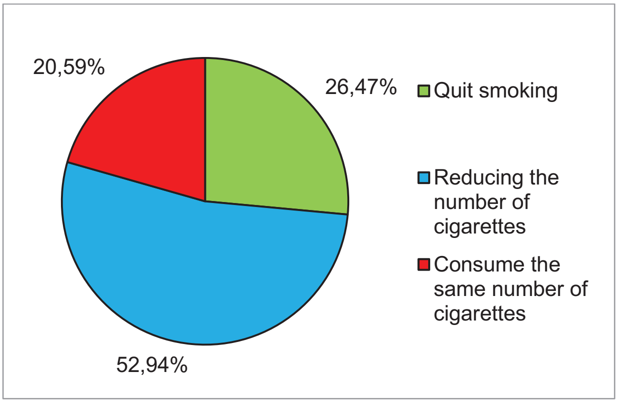

Figure 2. The repartition of the cases

5. The existence of a smoking husband

58 non-smoking pregnant women, representing a percentage of 46.77% have husbands who smoke in their presence, which means that they are exposed to passive smoking, which is as harmful as active smoking.

56 pregnant women who smoke, representing a percentage of 82.35%, have smoker husbands, so it is very difficult and unlikely that they will change this habit.

Approximately 25% of non-smokers are exposed to passive smoking in the workplace (insp.gov.ro). In most countries, between 15 and 50% of the population is affected by passive smoking (WHO, 2019).

All pregnant women stated that they know the harmful effects of smoking, as they are also shown by illustrations on cigarette packs, but they cannot give up this habit.

Smoking during pregnancy is a risk factor that can lead to multiple consequences: loss of pregnancy, premature rupture of membranes, premature birth, premature plancental abruption, low birth weight, foetal death and perinatal morbidity (England et al. 2010, Tolosa & Stamilio 2019).

Cigarette smoke contains over 7,000 chemicals that affect almost all the organs of the foetus. Nicotine and carbon monoxide have a foetal neurotoxic effect. Nicotine crosses the placental barrier and is detected in foetal blood circulation at a value 15% higher than in maternal blood. In the amniotic fluid it can have a value 88% higher than in maternal blood. It causes abnormalities in neuronal cell proliferation and differentiation and affects synaptic activity (Dempsey & Benowitz 2001).

Other toxic compounds such as ammonia, polycyclic aromatic hydrocarbons, hydrogen cyanide, nitrogen oxide may cause damage to foetal genetic material (Chica et al. 2005).

The foetus suffers from poor oxygenation due to vasoconstriction, with short- and long-term effects. Carbon monoxide crosses the placental barrier and, by association with haemoglobin, forms carboxy-haemoglobin that competes with oxy-haemoglobin and thus causes decreased oxygenation of tissues and organs (Tolosa & Stamilio 2019).

The immediate effects are increased foetal heart rate and reduced respiratory movements. Animal studies have shown that foetal exposure to nicotine is involved in increasing the risk of adult hypertensive heart disease, obesity, type II diabetes mellitus and respiratory dysfunction (Bruin et al. 2010).

The development of public health policies led to the adoption of Law no. 15/2016 which prohibited smoking in public spaces, respectively at the workplace, in public transport, in taxis, at children's playgrounds. The aim of this law was mainly to reduce the exposure of non-smokers. Romania thus joined the 94 countries that completely banned smoking in public spaces (www.insp.gov.ro).

Public information and education campaigns have also been conducted and cigarette packs have been imprinted with the dangers of tobacco use (www.ms.ro).

Any woman who smokes during pregnancy should receive behavioural and educational counselling, highlighting the risks to which she is exposed during pregnancy, but also in the long term. Women are considered most likely to quit smoking during pregnancy (Chamberlain et. al. 2013).

CONCLUSIONS

32.48% of pregnant women stated that they starting smoking at a young age and they still do. 67.65% started smoking at 14-15 years of age. The majority of them consumed more than one pack of cigarettes daily.

During pregnancy 52.95% of women reduced the number of cigarettes consumed daily, 20.59% of them consumed the same number of cigarettes daily and 26.47% quit smoking.

56 pregnant women who smoke, representing a percentage of 82.35%, have smoker husbands, so it is very difficult and unlikely that they will change this habit.

REFERENCES

Bruin JE, Hertzel CG, Holloway AC. 2010. Long-term consequences of fetal and neonatal nicotine exposure: A critical review. Toxicol Sci; 116:364-74.

Chamberlain C., O'Mara-Eves A, Oliver S, Caird JR, Perien SM, Eades SJ, Thomas J. 2013. Psychosocial interventions for supporting women to stop smoking in pregnancy. Cochrane Database System Rev, 10: CD001055. Doi:10.1002/14651858.CD001055.pub4.

Chica Rosa Ana, Ribas Isabel, Giraldo J, Egozcue J, Fuster C. 2005. Chromosomal instability in amniocytes from fetuses of mothers who smoke. JAMA; 293(10):1212-22.

Dempsey DA, Benowitz NL. 2001. Risks and benefits of nicotine to aid smoking cessation in pregnancy. Drug Safety; 24:277-322.

Drope J., Schluger N., Cahn Z., Hamil S., Islami F., Liber A., Nargis N., Stoklosa M. 2018. The Tobacco Atlas. Sixth Edition. Atlanta American Cancer Society, pp. 24-28.

England J Lucinda, Kim Y.S., Tomar S.L., Ray S Cecily, Gupta P.C., Eissenberg T., Cnattingius S., Bernert J.T., Therenet N Tita, Winn M Deborah, Djordjevic V Mirjana, Lambe M., Stamilio D., Chipato T., Tolosa J.E. 2010. Non-cigarette tobacco use among women and adverse pregnancy outcomes. Acta Obstet Gynecol Scand; 89(4):454-64.

Oncken Cheryl, Dietz Patricia, Tong V.T., Belizan J.M., Tolosa J.E., Berghella V., Goldenberg R.L., Lande H.A., Samet J. M., Bloch H.M. 2010. Prenantal tobacco prevention and cessation interventions for women in low- and middle-income countries. Acta Obstet Gynecol Scand; 89(4):442-53.

Tolosa JE, Stamilio D. 2019. Fumatul. În: Ghiduri şi Protocoale în Medicina Materno-fetală. Ediţia a treia. Editura Hipocrate, Bucureşti, pp. 196-205.

Tong V.T., Dietz Patricia, Morrow B., D'Angelo Denise, Farr Sherry, Rockhill M., England J Lucinda. 2013. Center for Disease Control and Prevention. Trends in smoking before, during and after pregnancy – Pregnancy Risk Assessment Monitoring System (PRAMS), United States, 40 sites, 2000 – 2010, MMWR Surveill Summ; 62(6):1-19.

*** ACOG. 2010. Smoking cessation during pregnancy. ACOG Committee Opinion No. 471. Obstet Gynecol 2010; 116(5):1241-4.

*** Centers for Disease Control and Prevention. 2015. Current cigarette smoking among adults – United States, 2005-2014. MMWR; 64(44):1233-40.

*** Tobacco Control Database for the WHO European Region. 2016. [online database]. Copenhagen: WHO Regional Office for Europe; (http://data.euro.who.int/tobacco/).

*** IRES. 2016. Fumatul în România (http://www.ires.ro/articol/310/fumatul-in-romania)

*** Eurobarometer. 2017. (http://data.europa.eu)

*** https://www.insp.gov.ro/cnepss/2017/10/PDF

*** WHO. 2017. Europe. Global Youth Tobacco Survey (2004-2017). Fact sheet Romania 2017.pdf (http://www.who. int/fctc/en/)

*** WHO report on the global tobacco epidemic: raising taxes on tobacco. 2019. Geneva: World Health Organization; (http://www.who.int/tobacco/global_report/2019/en/).

*** www.ms.ro/strategia-nationala-de-sanatate-2014-2020/

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PHYSICO-CHEMICAL PARAMETERS OF GROUNDWATER IN SOUTHERN ROMANIA – A STUDY CASE

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Keywords*: groundwater, physico chemical parameters, pollution*

ABSTRACT

The focus of the present study was to determine the suitability of groundwater collected from South part of Romania for drinking purpose, on the basis of various water quality physico chemical parameters. In order to assess the groundwater quality, samples were collected from 6 different wells of selected study area and parameters such as pH, Electrical conductivity, Al^{3+}, NH^{4+}, NO^{2-}, Ca^{2+}, Cl, Total hardness, Fe^{2+}+Fe^{3+}, PO_4^{3+}, Mg^{2+}, Mn^{2+}, TDS, CCO-Mn, SO_4^{2-}, F were determined using standard procedures. The majority of the observed parameters of all wells are under the permissible limit, apart from calcium, total hardness, iron, magnesium and organic substances which exceed the permitted limit. Nontheless, these indicators are part of the category of general chemical indicators and do not influence the toxicity of drinking water from wells.

INTRODUCTION

Water remains an essential resource for human existence. Every process of water use leaves its mark on its quality and on natural aquatic systems, even if the water is intended for consumption or if it is infested with pollutants. According to the requirements of modern life, water quality has gradually lost its character as an abstract notion, becoming, along with quantity, one of the "dimensions" of water, which can be "measured" by determining a set of elements called *"quality indicators*". Groundwater - resulting from rain and melting snow, as well as water from lakes and rivers that seep through loose soil, accumulating above impermeable layers - is a natural wealth whose importance is linked to its increasing use in drinking water supply of urban and rural localities, in industrial activities or to cover the growing needs of agriculture (Popa 2006). Water quality is a consequence of both natural process and human activities and its determination involves the measurements of physico-chemical and biological parameters (Ejoh et al. 2018). Some agencies such as the World Health Organization (WHO) and Centers for Disease Control (CDC) set exposure standards or safe limits of chemical contaminants in drinking water (Akter et al. 2016).

Groundwater quality depends on the quality of recharged water, atmospheric precipitation, inland surface water, and on sub-surface geochemical processes

(Vasanthavigar et al. 2010). Soil erosion, deforestation, and traditional shifting cultivation activities have a major contribution to improper leaching of chemical constituents into the groundwater (Rao and Latha, 2019). Thus groundwater quality for drinking purpose should be continuously monitored so that risk from geochemical contaminants can be reduced by appropriate treatment method (Acharya et al. 2018).

We should take into account the fact that according to the report on the implementation of the Nitrates Directive published by the European Commission, Southern Romania is among the areas in the EU where groundwater contain elevated levels of nitrates, due to use of chemical fertilizers and organic nitrates, as a major source of water pollution (Popa et al. 2016). The main object of the present study was to determine the suitability for drinking purpose of groundwater collected from rural wells situated nearby waste dumps in the south area of Romania.

MATERIAL AND METHODS

In order to reach the proposed objectives, sampling stations were chosen on the basis of their proximity to facilities, or human activities that could potentially affect water quality, particularly in this study: waste dumps, nearby Slatina City, Romania. The municipality of Slatina is located in the South of Romania, on the left bank of the Olt River, in the historic Oltenia region, in the contact area between the Getic Plateau and the Romanian Plain. In Slatina, a number of economic operators (development of non-ferrous metallurgical industry in the field of obtaining and processing primary aluminium but also processing of other non-ferrous materials), operate in complex production processes using a series of substances that due to chemical composition may be factors of risk. Therefore, the groundwater samples were collected between April and August 2019, from 6 wells (public and private) in 3 villages nearby Slatina city, located in the area of the waste dumps, respectively:

- Satu Nou Dump - located 2 km northeast of the plant, in the vicinity of the village of the same name, in the ravine that originally existed along the Ștreangului brook. The storage was done starting with 1988; the dump was covered with layers of fertile soil as it was filled.

- Priseaca Dump - located at approx. 10 km northeast of Slatina, near the village of Priseaca. Waste was stored until 10 years ago. At present, the dump is not covered.

- Milcovul din Deal Dump - located at approx. 10 km southwest of the company, on the outskirts of the town of the same name. The waste was stored until 1989 in a valley located on the edge of the village. The dump was covered on the horizontal surface and slightly sloping with a layer of earth over which weeds grew. The lake-facing slope is not covered.

Water samples were collected in a plastic container of 1-L capacity after they were washed thoroughly with distilled water and dried before being filled with water samples. The samples were collected, transported to the laboratory on the same day and stored below 4°C.

Groundwater quality parameters – pH, Electrical conductivity, Al^{3+}, NH_4^+, NO_{2-}, Ca^{2+}, Cl, Total hardness, Fe^{2+}+Fe^{3+}, PO_4^{3+}, Mg^{2+}, Mn^{2+}, TDS, CCO-Mn, SO_4^2, F - were analysed using standard procedures and suggested precautions were taken to prevent contamination. Note that these parameters can only express the quality level of potable water in underground resources of the study area (Saeedi et al. 2009).

RESULTS AND DISCUSSIONS

Untreated wastewater from human settlements (cities and villages - the most concentrated inhabited areas) contributes to surface and groundwater pollution. Industrial wastewater includes domestic wastewater from sanitary facilities, water used in the technological flow, washing water and conventionally clean cooling water. The most important contamination is present to the water resulting from the technological flow, which varies depending on the type of industry. The characteristics of these waters may differ even within the same industry. In Romania, the quality of these waters must correspond to the requirements regarding the technical quality conditions for drinking water contained in STAS no.1342-1391. The results of in the in-situ tests and laboratory analyzes of the water samples from the 6 wells in the areas of the waste dumps are shown in Table 1.

Table 1

Physico-chemical analyses of groundwater samples

No.	Parameter	Satu Nou		Priseaca		Milcovul din Deal	
		Private Well	Public well	Private Well	Public well	Private Well	Public well
1	pH	7,55	7,08	7,33	7,15	7,07	7,42
2	Electrical conductivity (mS/cm)	795	1405	1420	2080	2780	1585
3	Al^{3+} (mg/dm^3)	0,054	0,031	0,054	0,065	0	0
4	NH_4^+ (mg/dm^3)	0	0	0,042	0,42	0.052	0
5	NO_{2-} (mg/dm^3)	0,016	0,016	0,04	0,1	0,016	0,08
6	**Ca^{2+} (mg/dm^3)**	**58,8**	**32,3**	**106,0**	**66,7**	**268,9**	**145,2**
7	Cl (mg/dm^3)	56,7	212,7	113,4	170,2	28.3,6	177,3
8	**Total hardness (mg/dm^3)**	**18,9**	**24,7**	**36,5**	**41.4**	**70,0**	**37,3**
9	**Fe^{2+}+Fe^{3+} (mg/dm^3)**	**0,8**	**0,37**	**0,5.3**	**0,96**	**0,53**	**0,32**
10	PO_4^{3+} (mg/dm^3)	0,17	0,16	0,26	0,35	0.16	0.16
11	**Mg^{2+} (mg/dm^3)**	**46,2**	**87,2**	**9.3,7**	**138,9**	**140,0**	**73,5**
12	Mn^{2+} (mg/dm^3)	0	0	0	0	0	0
13	TDS (mg/dm^3)	1179	1028	6.38	1195	920	959
14	**CCO-Mn (mg/dm^3)**	**2,0**	**2,39**	**3,11**	**6,23**	**2,6**	**3,99**
15	SO_4^{2-} (mg/dm^3)	48.9	106,1	102,8	208.5	104,5	88,4
16	F (mg/dm^3)	0,067	0,11	0,072	0,066	0,14	0,14

In a general approach, to express groundwater resources quality suitable for human consumption, researchers compare individual chemical parameters with recommended allowable limits (Baba et al. 2020).

In this study the obtained results were compared, as is showed in table 2, with the permitted concentrations – PC - and exceptionally permitted concentrations – EPC.

Table 2

Physical and chemical indicators according to the Permitted Concentration and Exceptional Permitted Concentration

No.	Physical and chemical indicators	MU	Permitted Concentration	Exceptional Permitted Concentration
1	pH	Unit/pH	6.5-7.4	8.5
2	Electrical conductivity	mS/cm	1000	3000
3	Al^{3+}	mg/dm^3	0.05	0.2
4	NH_4^+	mg/dm^3	0	0.5
5	NO_{2-}	mg/dm^3	0	0.3
6	Ca^{2+}	mg/dm^3	100	180
7	Cl	mg/dm^3	250	400
8	Total hardness	0G	20	30
9	Fe^{2+}+Fe^{3+}	mg/dm^3	0.1	0.3
10	PO_4^{3+}	mg/dm^3	0.1	0,5
11	Mg^{2+}	mg/dm^3	50	80
12	Mn^{2+}	mg/dm^3	0.05	0.3
13	TDS	mg/dm^3	800	1200
14	CCO-Mn	mg/dm^3	2.510	3.012
15	SO_4^{2-}	mg/dm^3	200	400
16	F	mg/dm^3	1.2	-

The values of the physico-chemical indicators obtained from the 6 water samples taken from the wells in the proximity of the waste dumps areas show their compliance with the technical quality conditions for drinking water, except for 5 chemical indicators (calcium, total hardness, iron, magnesium and organic substances) which shows in some tests values higher than the value exceptionally permitted by romanian legislation for drinkind water. These indicators are part of the category of general chemical indicators and do not influence the toxicity of drinking water from wells.

It should be noted that the values of the only toxic chemical indicator present in these waters, fluorine varies between 0.066 and 0.14 mg/dm^3, values much lower than the maximum allowed limit of 1.2 mg/dm^3, thus this parametrs pose no concern for the water in the sampled wells.

Values of total hardness between 18.9 and 70 show an increase in the amount of organic matter in water, synonymous with water pollution, a dangerous phenomenon because it can promote the persistence of microbial germs for long periods, including pathogens.

CONCLUSIONS

Following the study conducted on physical and chemical parameters of the water samples from the 6 wells in the areas of the waste dumps, it was found that:

- ✓ Groundwater quality should be continuously monitored for drinking purpose, so that risk from geochemical contaminants can be reduced by appropriate treatment method.

- ✓ The values of the physico-chemical indicators of the waters taken from the wells placed in the area of the waste dumps are generally within the limits allowed by STAS no. 1342-91 (quality conditions for drinking water).
- ✓ No negative influence of dumps on groundwater quality was found until the date of the study.

However, there is an imminent danger that over time the quality of the water in the ground and, implicitly, of the drinking water in the area of the dumps (the wells of the citizens from the respective localities) will deteriorate, which is not reported at present.

With a view to avoid contamination of surface water and groundwater, it is recommended the following:

- ✓ Covering and waterproofing the surfaces of Satu Nou and Priseaca dumps;
- ✓ Treatment of seepage water to reduce fluoride concentrations;
- ✓ Covering the slope of the Milcovul din Deal dump, dismantling the lake at the foot of the dump, covering it and evacuating the meteoric waters directly into the emissary.

REFERENCES

Acharya S., Sharma S.K., Khandegar V. 2018. Assessment of groundwater quality by water quality indices for irrigation and drinking in South West Delhi, India. Data in Brief;18:2019-2028. DOI: 10.1016/j.dib.2018.04.120.

Akter T, Jhohura F.T., Akter F., Chowdhury T.R., Mistry S.K., Dey D., Barua M.K., Islam M.A., Rahman M. 2016. Water Quality Index for measuring drinking water quality in rural Bangladesh: a cross-sectional study. J Health Popul Nutr. 35:4. doi: 10.1186/s41043-016-0041-5.

Ejoh A.S., Unuakpa B.A., Ibadin F.H., Edeki S.O. 2018. Dataset on the assessment of water quality and water quality index of Ubogo and Egini rivers, Udu LGA, Delta State Nigeria. Data Brief.19:1716-1726. doi:10.1016/j.dib.2018.06.053

Baba E., Kayastha, P., Huysmans, M., De Smedt, F. 2020. Evaluation of the Groundwater Quality Using the Water Quality Index and Geostatistical Analysis in the Dier al-Balah Governorate, Gaza Strip, Palestine. Water, 12, 262.

Popa D., Prunisoara (Schiopu) C., Cârlan C. 2016. Aspects concerning the monitoring of the qualitative parameters of groundwaters from Bălești – Tămășești area, Gorj County, Romania – a nitrate vulnerable zone. AgroLife Scientific Journal, Volume 5, Number 2, ISSN 2285-5718, 119-124.

Popa D. 2006. Apa – mediu pentru microorganisme, Editura Universitaria

Rao K.N., Latha P.S. 2019, Groundwater quality assessment using water quality index with a special focus on vulnerable tribal region of Eastern Ghats hard rock terrain, Southern India. Arab J Geosci 12, 267
https://doi.org/10.1007/s12517-019-4440-y

Saeedi M., Abessi O., Sharifi F., Meraji H. 2010. Development of groundwater quality index. Environ Monit Assess 163:327–33

Vasanthavigar M., Srinivasamoorthy K., Vijayaragavan K. 2010. Application of water quality index for groundwater quality assessment: Thirumanimuttar sub-basin, Tamilnadu, India. Environ Monit Assess 171, 595–609. https://doi.org/10.1007/s10661-009-1302-1

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MANAGEMENT AND IMPLEMENTATION OF ENVIRONMENTAL PROJECTS IN PRE-UNIVERSITY EDUCATION

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Keywords: *project management, environmental education, outdoor activities*

ABSTRACT

This paper aims to analyze the management and implementation of environmental projects in pre-university education, wanting to highlight some theoretical and practical aspects, providing information about the characteristics of such a project. Project management is a way of acting on the basis of an elaborated plan, in order to achieve the objectives, in a limited period of time and with limited resources. The findings of this study shows the elements of relationship between the student and the environmental education activities indicating that implementing these kind of programs might promote pro-environmental behavior, suggesting the importance of infusing environmental education programs as an integral part of schools' activities.

INTRODUCTION

Project management is the process of organizing and supervising the project to ensure its implementation as planned by meeting the proposed objectives, within budget and according to established specifications. Project planning and development follows a scheme known as the project cycle (Fig. 1). It starts with identifying an idea, developed into a work plan, that can be implemented and evaluated. Once a project has been planned and financial support has been secured, the most important part begins - its implementation. The implementation of the project is in fact the fulfillment of the planned objectives. Very rarely, however, a project is carried out according to plan. It is not at all unusual for a project to take a course that was not anticipated at all during planning.

Due to the current globalization and modernization, humans explore natural resources excessively without applying remediation measures or rehabilitation of natural resources and environmental degradation becomes a critical issue (Verma & Dhull 2017). The responsibility for environmental protection and remediation, can be reached through education. Therefore environmental education should be incorporated into the formal education curriculum or in diferrent extracurricular activities and projects (Ketlhoilwe 2007, Loubser & Simalumba 2016).

Figure 1. Project Cycle

In Romania, for pre-university education, environmental projects can be carried out either with non-reimbursable funding or projects that involve only voluntary work and very few financial resources, respectively:

• non-reimbursable projects - eg Erasmus + projects, ESF (European Structural Funds) projects, programs and projects initiated by various organizations (NGOs) or institutions (Ministry of Environment, …);

• unfunded projects - eg eTwinning projects, extracurricular projects, etc.

MATERIAL AND METHODS

A good opportunity to finance environmental projects is the Erasmus + program-EU7 funding program. Recommended for pre-university education are inter-school partnership projects (KA 229), in which partner schools (usually 4-5 partners from different countries) exchange best practices, mutual learning activities and workshops. One such model of environmental project proposed for funding through the Erasmus + program, KA 229 is the Sm@rtSchool project, with a duration of 24 months, involving schools from several European countries. The schools involved in this project are from isolated areas and are concerned with conserving biodiversity and reducing environmental pollution and also want to use new technologies in teaching activities and understand that the future of education is represented by their use, being aware of the need to develop key competences: technological and digital literacy, development of scientific and technological skills, critical thinking, adaptation to new situations, interculturality, respect for the environment, etc.

These kind of projects seek to provide the pupils with knowledge, attitudes, and skills which will train them for critical and environmental thinking, independent learning, and conscientious environmental behaviour, thereby turning them into more environmentally conscientious citizens such that they may continuously experience sustainability on a daily basis (Marcus 2012).

The target group consists of students (girls and boys) aged between 10-17 years. Approximately 100 students and 50 teachers will be involved in the project, directly, by participating in mobilities and indirectly, over 1000 students and 100 teachers will be involved, as well as the communities to which the schools belong (parents, local authorities, local partners, etc). Before each Learning Teaching Training Activities (LTTA), all students will benefit from the activities organized by the school, and 20 students from each country will participate directly in the LTTA. The rest of the students will be the target group of the dissemination carried out by colleagues who directly benefit from LTTA, dissemination that will be done after each mobility. There will also be a number of approximately 10 teachers from each country who participate directly in transnational events. They will be involved in the preparation of all project activities, by designing, planning and supporting lessons and activities before and during each LTTA. Moreover teachers have an important role in disseminating project activities and results to parents, local authorities and colleagues. The project will be managed by teachers organized in teams, each team establishing its responsibilities clearly and transparently.

Also, the project will involve the families of students, belonging to the host partner, who can host, in their own homes, students who come to "visit", but can also be guides of project participants in cultural trips and socialize with visitors.

RESULTS AND DISCUSSIONS

A logical and consistent management strategy will be created, within which the coordinating partner, in this case-Romania, will ensure the management of the partnership, in its broadest sense. To do this, template documents will be created for use by all partners (procedures, forms, etc.), after the tasks and deadlines have been negotiated with all partners in advance. An implementation plan (Gantt chart) will also be designed, which will include all the activities, stages and management teams of each partner involved in the project. There will also be monthly calendars (using Google calendar), which include all events and project organization. This will allow all partners' activities to be monitored and the risks that may arise will be reduced to a minimum. For dissemination, a strategy will be established that takes into account the relevant activities and details (purpose, responsibilities, dissemination, evaluation, etc.) and the project will be promoted in all possible ways of communication.

Before each planned meeting, the partners will prepare all the necessary data to address the issue of mobility, so that each partner will participate in achieving the objectives.

LTTA 1, Coordinating partner - each partner school will present an initial report on the need to conserve biodiversity and reduce environmental pollution and the use of new technologies in its own educational instructional process. This meeting will be an opportunity for partners to get to know each other and introduce their school communities. In fact, the positive and negative aspects of their own education systems will be discussed and they will participate in a course – ”Introduction on the need to conserve biodiversity and reduce environmental pollution and the use of new technologies in the educational process”. The course will focus on applications and practice, aiming at the acquisition, development and improvement of participants' digital, scientific and technological skills, so that these skills are subsequently successfully applied in their own schools.

LTTA 2, Partner 1 - exchange of students, with the theme: "Conservation of biodiversity and the environment". Each partner will prepare, together with the participating students, at least one learning activity, on the topic of mobility, an activity that will be presented during the meeting to the participating students and teachers. Prior to the meeting, teachers and students will organize online meetings, where they will discuss the objectives and share good practices, so that during the meeting a variety of examples of digital activities and content are provided.

The next LTTAs will follow the same procedure.

LTTA 3, Partner 2 - subject: ” Pollution reduction and efficient recycling”;

LTTA 4, Partner 3 – subject: ” Hiking and nature trips - an effective alternative for developing scientific and technological skills ”;

LTTA 5, Partner 4 - subject: ” The efficiency of new technologies in conserving biodiversity and reducing environmental pollution”.

Achieving the objectives will be measured by applying feedback questionnaires and evaluation forms. The host institution will make a report, which will also include the data collected and share it with the partners, so that it will be possible to analyze the strengths and weaknesses of the mobilities, so that future LTTAs can be improved. All project results (videos, pictures, lessons created, reports, etc.) will also be uploaded to the eTwinning platform, so as to give colleagues and other interestedteachers the opportunity to have free access to its results.

CONCLUSIONS

International educational projects and especially eTwinning and Erasmus + projects are an opportunity for quality educational activities and a safe way to implement environmental projects in pre-university education. The method of implementing projects in education is considered to be effective, by the fact that the student becomes an active member of his own learning, the educational process becoming a natural and efficient one.

The participants will really benefit from the planned activities, because they will acquire new knowledge and information and will also develop their digital, scientific and technological knowledge and skills, necessary for the teaching activity. In fact, they will have the opportunity to learn about how new technologies are implemented and what are the concrete activities for conserving biodiversity and reducing environmental pollution in schools and partner countries. Through the interactive and collaborative methods used, they will become better prepared to integrate the knowledge and information acquired in the approaches and teaching activities and in the daily activity. There is also a close link between personal and professional development and respect for the surrounding nature, so the integration of environmental projects in teaching is a necessary goal.

REFERENCES

Verma G., Dhull P. 2017. Environmental education as a subject in schools. Int. J. Adv. Res. 5(8), 1547-1552.

Loubser C., Simalumba P. 2016. The Implementation of Environmental Education in Geography (Grades 8–10) in the Caprivi Region, Namibia. Southern African Journal of Environmental Education, Vol. 32, 51-65.

Ketlhoilwe M.J. 2007. Environmental Education Policy Implementation Challenges in Botswana Schools. Southern African Journal of Environmental Education, Vol. 22, 171–184.

Marcus A. 2012. Implementation of environmental education case study: activating the "Green School" program among elementary school students in Israel. Geographia Technica, No. 2, pp. 52-58.

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CONTAMINATION WITH FUNGI AND MYCOTOXINS OF SOME VEGETAL SUBSTRATES USED IN ANIMAL FEED

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ABSTRACT

For the purpose of the investigations, 80 samples of plant substrates were analyzed, such as: maize grains (20), soy beans (20), triticals (20) and combined feed (20) from a mycological and mycotoxinic point of view in a farm in Iași county. The determinations showed a varied fungal contamination, the number of units forming colonies ranges between 0-1300g/product, depending on the assortment and storage conditions. Fungal contamination recorded values between 5 x 10^{-3} and 1300 x 10^{-3}/g for maize grains, zero and 149 x 10^{-3}/g for soy beans, 10 x 10^{-3} and 166 x 10^{-3}/g in triticals (wheat, rye) and 99 x 10^{-3} and 472 x 10^{-3}/g in combined feed. Mycotoxin examination identified 4 mycotoxins, such as aflatoxin B1 (1) - combined feed, sterigmatocystin (2) - maize grains and ochratoxin (1) - maize grains.

INTRODUCTION

The phenomenon of fungal and mycotoxin contamination has grown, becoming a planetary pollutant. All stored foods serve as a suitable substrate for mold growth and mycotoxin production. Regarding the occurrence and impact of mycotoxins, a comprehensive understanding of crop biology, fungal ecology, harvesting methods, storage conditions and feed processing is required. Mycotoxins have a ubiquitous character, predominating in cereal grains, legumes, in their products and by-products, vegetables, fruits. Currently, mycotoxins are no longer only risk factors but also causes serious diseases (Sofia et al. 2020).

Mushrooms of the Aspergillaceae family are well known for their ability to produce secondary metabolites, the latter most likely playing key roles in fungal ecology and exhibiting various harmful or beneficial biological activities in human well-being (Stierle & Stierle 2015). For example, aflatoxin is produced by Aspergillus flavus - one of the most toxic and carcinogenic (Keller et al. 2005).

It significantly influences reproduction through reduced food intake and affects metabolic function, especially the liver (Kanora & Maes 2009). Aflatoxins thrive in regions with high temperatures and humidity, which are optimal sources for mold growth and toxin production (Omotayo et al. 2019). The genera Aspergillus and Penicillium synthesize the mycotoxin ochratoxin A in optimal environmental and storage conditions. Among the multiple dangers of ochratoxin exposure are renal dysfunction, namely the effects of teratogenicity, immunotoxicity, nephrotoxicity, carcinogenicity, embryotoxicity, hepatotoxicity and, in particular, nephrotoxicity in laboratory and farm animals. Ochratoxins are found naturally in plant products such as cereals, coffee, beans, vegetables and dried fruits (Duarte et al. 2010).

The genus Penicillium belongs to the category of ascomycete fungi, with a high degree of ubiquity. It is an opportunistic, phytopathogenic agent, whose reproduction is achieved both asexually and sexually. Depending on certain factors (water activity, temperature, pH) it develops in almost any condition. Penicillium micromycetes are isolated in cereals, such as wheat, corn, barley, rye and sorghum either in the field or during processing, storage, but also in the production chain (Kange et al. 2015).

The genus Fusarium can be found in all plant substrates, also the most affected cereals are corn, wheat, sorghum, oats. Fusarium is slightly sensitive and can barely survive a low oxygen, pH environment at silage and disappears in a few days (Federica et al. 2013). Zearalenone is a secondary metabolite resulting from *Fusarium graminearum* and is present in rice, corn and hazelnut samples (Niculita et al. 2016). Zearalenone (ZEA), also called estrogenic mycotoxin, causes reproductive and fertility disorders in mammals and has a hepatotoxic, immunotoxic, carcinogenic and nephrotoxic effect.

Both micromycetes and metabolic products - mycotoxins are a threat to the raw material, but also to the finished product, to human and animal health, leading to massive losses in the agricultural industry and beyond. Efforts have been made to control these opportunists, but not enough (Villafana et al. 2019).

MATERIAL AND METHODS

A number of 80 samples collected from a farm in Iași County were subjected to a quantitative and qualitative mycological examination, as well as a mycotoxicological examination. The samples were represented of vegetal substrates used in animal feed - maize grains, soy beans, cereal mixture (wheat, rye) and combined feed. Regarding the isolation and numerical evaluation of micromycetes, the usual laboratory techniques were used - the serial dilution technique according to SR EN ISO 6887-1/2017 and the culture medium used was PDA (potato dextrose agar). We were also interested in the appearance of the colonies and their corroboration with the morphostructural peculiarities of the fruiting bodies to facilitate the identification and taxonomic classification of the dominant species of micromycetes. The technique of thin layer chromatography (CSS) with vertical development was used for the separation, highlighting, identification of fluorescent mycotoxins in UV light.

RESULTS AND DISCUSSIONS

In the present research it was wanted to identify and quantitatively evaluate the genera of micromycetes involved in animal pathology. Regarding the fungal load of the samples (ISO 6887-1:2017), values between 5 x 10^{-3} and 1300 x 10^{-3}/g were recorded in maize grains, zero and 149 x 10^{-3}/g in soy beans, 10 x 10^{-3} and 166 x 10^{-3}/g in cereal mixture (wheat, rye) and 99 x 10^{-3} and 472 x 10^{-3}/g in combined feed. The most contaminated mycological sample was that of maize grains (table 1).

Table 1

Results of quantitative mycological control of samples

Nr. crt.	Sample	The number of samples determined	Limits of variation ufc ($x10^{-3}/g$)
1.	Maize grains	20	5-1300
2.	Soy beans	20	0-149
3.	Triticals (wheat, rye)	20	10-166
4.	Combined feed	20	99-472

The percentage expression of the main genera of micromycetes indicated wide limits of variation, well highlighted depending on the nature of the substrate and the affiliation of the taxon. The species characteristic of the genus Penicillium were found in all samples and ranged in percentage between 49.2% and 72.1%. The genus Aspergillus predominated most in soy beans, with a percentage of 70.3%, while the genus Fusarium had a somewhat remarkable distribution, in the sense that the number of micromycetes of this genus was very high in the case of triticals (wheat, rye), with an average value of 76.00% and very small in the soy beans sample, more precisely 15.1%, while in the maize grains or in the combined feed there were values of 71.5%, respectively 64.6% (table 2).

Table 2

Results of qualitative mycological control of samples

Nr. crt.	Sample	Percentage of micromycete genera in the analyzed samples (%)				
		Penicillium	Aspergillus	Fusarium	Cladosporium	Other genera
1.	Maize grains	72.1	58.4	71.5	23.6	62.7
2.	Soy beans	56.8	70.3	15.1	27.9	71.2
3.	Triticals	49.2	24.6	76.00	52.3	85.4
4.	Combined feed	64.6	64.6	64.6	28.9	28.9

This is confirmed most likely by the fluctuation of the humidity gradient that has an influence on the vegetative forms of multiplication.

The genus Fusarium is one of the most important groups of pathogenic fungi and largely affects a wide variety of crops in all climatic zones of the globe. It also produces several extremely important mycotoxins in foods that have harmful effects on animals and humans. The metabolic diversity of Fusarium fungi determines whether the fungus-plant interaction is essential or harmful. Secondary metabolites allow the colonization of host plants in a systematic way, following a survival and then determining virulence. Fungal species produce plant-specific secondary metabolites, and environmental changes affect this aspect (Villafana et al. 2019).

The genus Cladosporium fungi were found in relatively low percentages in the analyzed samples, but it is important to note that this fungus predominates in different plant substrates due to its ecological capacity, even if its presence is low.

Following mycotoxinic control, mycotoxins that may affect animal health have been identified in the analyzed samples (table 3).

Table 3

Results of mycotoxinic control of samples

Nr. crt.	Sample	The proportion of mycotoxins identified in the analyzed samples			
		Aflatoxin	Sterigmatocystin	Ochratoxin	Zearalenone
1.	Maize grains	-	2	1	-
2.	Soy beans	-	-	-	-
3.	Triticals	-	-	-	-
4.	Combined feed	1	-	-	-

The most contaminated sample from a mycotoxinic point of view, it is the one represented by maize grains, two samples being contaminated with sterigmatocystin, and one with ochratoxin A. Sterigmatocystin is a toxic metabolite, which is synthesized by species belonging to the genus Aspergillus. It should also be borne in mind that maize grains are part of the combined feed, and that the possibility of these mycotoxins reaching the animal feed is somewhat likely. We find that in the case of combined feed, aflatoxin appeared, while in the samples of triticale and soy beans no toxic metabolites were identified.

CONCLUSIONS

Fungal contamination was uneven, with the number of colony-forming units (ufc) ranging from 0-1300 x 10^{-3}/g depending on the assortment and storage conditions. The most contaminated sample was that represented by maize grains, and the least contaminated was that represented by soy beans. The fungal flora was dominated by filamentous fungi belonging to the genera Penicillium, Aspergillus, Fusarium and Cladosporium. The fluorescent mycotoxins that were the subject of our study were sterigmatocystin and ochratoxin in maize grains and aflatoxin in combined feed.

REFERENCES

Duarte S., Pena A., Lino C. 2010. A review on ochratoxin A occurrence and effects of processing of cereal and cereal derived food products. Food Microbiol. *27*, 187-198.

Federica C., Anna C., Vittorio D. O. 2013. Fungal populations and mycotoxins in silages: From occurrence to analysis. Animal Feed Science and Technology Volume 183, Issues 1–2, 28 June 2013, Pages 1-16.

Kange A. M., Cheruiyot E. K., Ogendo J. O., Arama P. F. 2015. Effect of sorghum (Sorghum bicolor L. Moench) grain conditions on occurrence of mycotoxin-producing fungi. Agriculture & Food Security 4, 1.

Kanora A., Maes. 2009. The role of mycotoxins in pig reproduction: a review. Vet. Med. 54, 565–576.

Keller N. P., Turner G., Bennett J. W. 2005. Fungal secondary metabolism - from biochemistry to genomics. Nat Rev Microbiol 3:937–947.

Niculita H., Hantier H., Storti G., Plateel F. G., Roger T. 2016. Frequent occupational exposure to Fusarium mycotoxins of workers in the swiss grain industry. Toxins. 8*,* 370.

Omotayo O. P., Omotayo A. O., Mwanza M., Babalola O. O. 2019. Prevalence of Mycotoxins and Their Consequences on Human Health. Toxicological Research, 35(1), 1–7.

Sofia A., Eygenia S., Theodoros V. 2020. Advances in Occurrence, Importance, and Mycotoxin Control Strategies: Prevention and Detoxification in Foods. Foods, 9(2), 137.

Stierle A. A., Stierle D. B. 2015. Bioactive secondary metabolites produced by the fungal endophytes of conifers. Nat Prod Commun 10:1671–1682.

Villafana R. T., Ramdass A. C., Rampersad S. N., 2019. Selection of Fusarium trichothecene toxin genes for molecular detection depends on TRI gene cluster organization and gene function. Toxins. 11:36.

*** 2017, ASRO - SR ISO 6887-1, Microbiology of the food chain - Preparation of test samples, initial suspension and decimal dilutions for microbiological examination - Part 1: General rules for the preparation of the initial suspension and decimal dilutions.

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ANALYSIS OF THE ABUNDANCE AND DOMINANCE OF HARMFUL INSECTS PRESENT IN RAPE CROPS IN 2018/2019 IN THE S-W OF THE BOIAN PLAIN

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Keywords*: abundance; dominant; rape; pests*

ABSTRACT

In the agricultural year 2018/2019 a total number of 1684 harmful insects belonging to 11 different species was collected. The main pests, depending on their abundance, identified in rapeseed crops in the southern part of the Boian Plain are represented by: Ceutorhynchus napi; Ceutorhynchus assimilis and Meligethes aeneus, whose participation percentage is 80.87% of the total catch. Abundance varies between 4 specimens in the case of Pieris brassicae and 591 specimens in the case of Ceutorhynchus napi. Depending on the percentage of dominance, the insects were classified in 5 classes, noting as eudominant the following species: Ceutorhynchus napi; Ceutorhynchus assimilis and Meligethes aeneus.

INTRODUCTION

The rape is the culture that has seen the largest expansion in Romania in recent years, due to the fact that the production obtained is easy to capitalize and the selling price is quite good. From 2015 to 2018, the areas cultivated with rapeseed were in a continuous increase from 367.9 thousand ha in 2015 to 632.7 thousand ha in 2018. Regarding the level of production obtained, they ranged between 2499 kg / ha and 2835 kg / ha, the lowest production being recorded in 2015 and the highest in 2016 (INS Statistical Yearbook of Romania).

Due to the unfavourable climatic conditions in the sowing-emergence period, in 2019 the area cultivated with rapeseed decreased considerably compared to 2018, this being 419.0 thousand ha, and the production obtained was approximately 2000 kg / ha (INS Press release 85 / 31.03.2020- Provisional data).

The main pests that attack rapeseed plants are: *Brevicoryne brassicae* L. (Cabbage aphid); *Phyllotreta attra* F. (Cabbage flea beetle); *Phyllotreta nemorum* (Striped flea beetle); Psylliodes chrysocephala L. (Cabbage stem flea beetle); *Athalia rosae* L. (Cabbage leaf sawfly); *Pieris brassicae* (Large cabbage white); *Autographa gamma* L. (Silver-y moth); *Delia radicum* L. (Cabbage root fly); Mamestra brassicae (Cabbage moth); *Ceutorhynchus assimilis* (Cabbage seed weevil); *Ceutorhynchus napi* (Rape stem weevil); *Ceutorhynchus quadridens* (Cabbage stem weevil); *Epicometis hirta* (Balssom beetle); *Melighetes aeneus* (Rape beetle); *Dasineura brassicae* (Brassica pod midge) (Rîșnoveanu 2010; Trotuș et al. 2009).

Meligethes aeneus is one of the most harmful and widespread insects, the damage threshold being 3-5 insects / plant. The distribution within a soil is uneven so that at the edge of the soil the number of insects is higher and inside it can be smaller. If this is not taken into account, insecticide treatments can be performed erroneously and thus the control will not be done properly.

The larvae of Athaia rosae are particularly harmful because they attack the tissue of the leaf, forming galleries, then consuming the limb to the skeleton. The larvae are very voracious and can consume twice their weight in 24 hours. Very great damage occurs in the years favourable to the attack in the autumn.

MATERIALS AND METHODS

The researches were carried out in the agricultural year 2018-2019 and consisted of:

- Ground surveys using the 0.5 m side metric frame
- Installation of sticky yellow traps
- Installation of bowl-yellow traps

The collection of entomological material took place at different dates using yellow bowl traps, sticky yellow traps and metric frame. The results obtained from the species identification of the insects were interpreted using the following ecological indicators:

Abundance (A) is the totality of individuals of a species caught in a given place at a given date. The other indicators are calculated based on the value of this indicator. By this value the present species can be considered as: rare, a little rare, abundant and very abundant.

Dominance (D) shows the percentage of participation of each species in the catch. This indicator is calculated according to the formula:

$D_A=\frac{nA}{N}*100$where

DA- dominance of species A

nA - total number of individuals of species A, from the analyzed samples

N - total number of individuals of all species present in the analyzed samples

Depending on the value of the percentage that expresses dominance, the species are distributed in the following classes:

- D1 - surplus below 1.1%
- D2 - recurrence between 1.1% - 2.0%
- D3 - subdominant between 2.1% - 5.0%
- D4 - dominant between 5.1% - 10.0%
- D5 - eudominant over 10.1%

RESULTS AND DISCUSSIONS

According to table 1, in the agricultural year 2018/2019 was collected using sticky yellow traps, yellow bowl and metric frame a total number of 1684 harmful insects divided into 11 species as follows:

Table 1

The structure of the harmful entomofauna collected in the agricultural year 2018/2019

No crt.	Harmful species	Number of specimens / trap type		Total copies
		Yellow-sticky / metric frame	Bol- yellow	
1	Athaliarosae L (larvae)	34	-	34
2	Ceutorhynchus assimilis	83	224	307
3	Ceutorhynchus napi	162	429	591
4	Phyllotreta attra	67	31	98
5	Phyllotreta nemorum	23	9	32
6	Psylliodes chrysocephala	15	5	20
7	Delia radicum	5	-	5
8	Epicometishyrta poda.	42	52	94
9	Meligethes aeneus	120	344	464
10	Entomoscelis adonidis	10	25	35
11	Pierisbrassicae (larvae)	4	-	4
Grand total		565	1119	1684

Table 2

Abundance and dominance of harmful entomofauna in the agricultural year 2018/2019

No crt.	Species	Abundance (A)	Dominance (D)	Dominance class
1	Athaliarosae L.	34	2.01	D3
2	Ceutorhynchus assimilis	307	18.23	D5
3	Ceutorhynchus napi	591	35.09	D5
4	Phyllotreta attra	98	5.81	D4
5	Phyllotreta nemorum	32	1.90	D2
6	Psylliodes chrysocephala	20	1.18	D2
7	Delia radicum	5	0.29	D1
8	Epicometis hyrta	94	5.58	D4
9	Meligethes aeneus	464	27.55	D5
10	Entomoscelis adonidis	35	2.07	D3
11	Pieris brassicae	4	0.23	D1

Of the total of collected insects, 35.09% belong to the species *Ceutorhynchus napi*, 27.55% belong to the species *Meligethes aeneus* and 18.23% are represented by *Ceutorhynchus assimilis*.

The abundance of harmful insects varies between 4 and 591 specimens, the most important representatives being: *Ceutorhynchus napi*; *Ceutorhynchus assimilis* and *Meligethes aeneus*.

The dominance percentage of pests present in the rapeseed crop in the agricultural year 2018-2019 has values between 0.23% in the case of *Pieris brassicae* and 35.09% in *Ceutorhynchus napi*, the situation being that in table 2.

Depending on the calculated dominance percentage, they are divided into 5 classes as follows:

Class D1 (precedent) with two representatives: *Delia radicum* and *Pieris brassicae*.

Class D2 (recessive) with two representatives: *Phyllotreta nemorum* and *Psylliodes chrysocephala*.

Class D3 (subdominant) also having two representatives: Athaliarosae L. and *Entomoscelis adonidis*.

Class D4 (dominant) with two representatives: *Phyllotreta attra* and *Epicometis hyrta*.

Class D5 (eudominant) with three representatives: *Ceutorhynchus assimilis*; *Ceutorhynchus napi* and *Meligethes aeneus*.

CONCLUSIONS

• In the agricultural year 2018/2019, 1684 harmful insects were collected, 565 being collected with the help of the metric frame and the sticky yellow trap, and 1119 being collected with the help of the bowl-yellow type trap.

• The abundance of insects varies between 4 specimens in the case of the species Pierisbrassicae and 591 in the case of the gargle of rapeseed stems (Ceutorhynchusnapi)

• Depending on the percentage of dominance, which varies between 0.23% and 35.09%, the collected insects fall into 5 classes

REFERENCES

Rîşnoveanu Luxiţa. 2010. Influenţaunor factori fitotehnic iasupra populaţiei de dăunători la rapiţa de toamnă în zona Bărăganului de Nord-Est. Teză de doctorat. USAMV Bucharest

Trotuş Elena, Popov C., Rîşnoveanu Luxiţa, Stoica V., Mureşan Felicia, Nae Margareta, 2009 – Managementulprotecţieiculturilor de rapiţăfaţă de ataculinsectelordăunătoare. An. INCDA Fundulea, LXXVII: 211-222.

*National Institute of Statistics- StatisticalYearbook of Romania

*National Institute of StatisticsPress release 85/31.03.2020 – provisional data

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PRELIMINARY DATA REGARDING THE SPONTANEOUS FLORA, FROM CRASNA – GORJ COUNTY (ROMANIA)

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Keywords*: vascular flora, Crasna, Oltenia, Romania*

ABSTRACT

The paper presents preliminary data on the spontaneous vascular flora in and around Crasna. The floristic researches were carried out during 2 years and consisted in making numerous trips in the field to make an inventory as complete as possible and in determining in the laboratory the taxa whose determination was not possible in the natural environment. A floral arrangement was made totaling 541 taxa. Its analysis shows us the great diversity in this part of Gorj County.

INTRODUCTION

Writing about the commune and the native village is a sign of love and faith in the permanence of existence, in traditions, in people, but especially it is a meeting with the world of childhood, with nature, with the diversity of places but also with your road that never forgets .

The first written data regarding the flora of the Gilort basin and implicitly of the territory researched by us, date from the years 1879-1883, during which time D. Brandza published the work “Prodromul Flora Românei”. Subsequently, the botanical researches are continued by D. Grecescu who publishes "The Summary of Flora României" (1898) and "Supplement to Summary Flora României" (1909), and I. Prodan publishes the works "Flora for determining and describing plants growing in Romania" (1939) and the monographs of the genera Centaurea (1930) and Achillea (1931).

Al. Buia, in collaboration with M. Păun, C. Maloş, M. Olaru publishes the work "Materials for the flora of the Parâng Massif" (1962), and Al.Buia and M.Păun describe in the work "New and rare plants from Oltenia" (1960a) some new science taxa in the Gilort Basin area. Valuable data on the spread of plants in this territory can also be found in the monumental work Flora R.P.R. I-X and Flora R.S.R. vol.XI and XII.

Al.Buia, in collaboration with M.Păun, I.Safta and M.Pop, describes in the work “Geobotanical contributions on the pastures and hayfields from Oltenia” (1960b) a series of cenotaxones from the Gilort basin.

Reference studies on flora and vegetation in Oltenia were carried out by Al. Buia et al. 1962; Păun 1963; Maloş 1968; Mariana Cârţu 1970, Cârţu 1971; Păun et Popescu 1971; Popescu 1974; Păun et al. 1972; Popescu et Costache 1999; Popescu et al. 2001a, 2002b; Niculescu 2009.

MATERIAL AND METHODS

Crasna commune is located in the northeastern extremity of Gorj county. The administrative territory includes nine rural settlements, located between 400-600 meters altitude Aninișul din Deal, Aninișul din Vale, Radoș, Crasna, Crasna Deal, Drăgoești, Dumbrăveni, Buzești and Cărpiniș.

Crasna commune has as neighbors Novaci town to the east, Voineasa commune / Vâlcea county to the northeast, Petrila and Petroșani towns to the north and northwest, Mușetești commune to the west, Bălănești commune to the southwest, Săcelu spa resort and Ciocadia Bengești commune to the south.

From the point of view of geological composition and mineral resources, Crasna commune has a petrographic substrate represented by crystalline rocks crossed by old eruptive rocks, mostly between which the boundaries are predominant, while the sedimentary deposits are in subordination relations. compared to the lens.

Crasna commune is windowed by numerous waters. At the eastern extremity of Crasna commune flows the Aniniș brook. To the north of the village of Crasna Deal it joins the Ciocăzeaua Mică which springs from the Runcu Peak and heads south between the plains and the Ciocăzelelor peak.

Blahnița is one of the most important rivers and flows into Gilort.

The identification of spontaneous plants was made on plant material preserved in dry state or on living material, using the determinants existing in Romania and abroad (Săvulescu et al. 1952 -1976; Tutin et al. 1964 –1980; Beldie 1977, 1979; Rothmaler 2002; Ciocârlan 2009, Sârbu et al. 2013.

Information on bioform, geoelement and moisture index can be found on each plant in the survey.

RESULTS AND DISCUSSIONS

The analysis of all the data collected from the field and subsequently processed in the laboratory led to the creation of a floristic inventory that means 541 plant taxa. Their arrangement is made on families, in alphabetical order to contribute to an easy identification in the text:

Fam. Aceraceae: *Acer campestre* L. - Ph., xeromez.-mez, Eur.; *Acer pseudoplatanus* L. - Ph. mez., Eur. centr.; *Acer tataricum* L. – Ph. xeromez, Euras.cont., Fam. Alliaceae; *Allium scorodoprasum* L. - G., xeromez.-mez. Centr. eur.; *Allium ursinum* subsp. *ucrainicum* L. - G., mezohigr., Pont.- medit.; *Allium vineale* L. – G. xeromez.-mez. Eur.; Fam. Amaranthaceae; *Amaranthus crispus* (Lesp. et Thev.) N . Terracc - T. Adv. (Argentina); *Amaranthus powellii* S. Watson – T. Adv. (N Am.).; *Amaranthus retroflexus* L. - T. xeromez.-mez. Adv. (N Am.); Fam. Chenopodiaceae: *Chenopodium album* L. - T. mez. Cosm.; *Chenopodium botrys* L. - T. Cosm.; *Chenopodium hybridum* L . - T. mez. Cosm.; Fam. Amaryllidaceae: *Galanthus nivalis* L. – G. mez. Centr. eur.-submedit.; *Leucojum vernum* L. - G. Sp. mez.-mezohigr. Centr. Eur.; Fam. Apiaceae: *Aegopodium podagraria* L. - H.(G.). mez.- mezohigr. Euras.; *Angelica archangelica* L. - Ht.-H. mezohigr.-higr. Euras. Bor.; *Angelica sylvestris* L. Ht.-H. mezohigr.-higr. Euras.; *Anthriscus nemorosa* (M.

Bieb.) Spreng. - H. mez, helscia, scia. Pont.-medit.; *Anthriscus cerefolium* subsp. *trichosperma* (L.) Hoffm. – T. mez. Pont.-medit.; *Caucalis platycarpos* L. – T. xeromez. Centr. eur.-medit.; *Chaerophyllum aromaticum* L. - H. mez.- mezohigr. Eur. centr.; *Ch. hirsutum* L. - H. mezohigr.-higr. Eur. centr. (mont.).; *Ch. temulum* L. – Ht. xeromez.-mezohigr. Eur.; *Conium maculatum* L. - Ht. xeromez.-mezohigr. Euras.; *Daucus carota* L. - Ht. eurif. Euras.; *Eryngium campestre* L. - H. xer.- xeromez. Pont.-medit.; *Eryngium planum* L. - H. xeromez.-mez. Euras.; *Falcaria vulgaris* Bernh. – Ht.(T,H.). xer.-xeromez. Euras. (submedit.).; *Heracleum sphondylium* L. - Ht.- H. xeromez.-mezohigr. Euras.; *Oenanthe banatica* Heuff. – H. mezohigr.-higr. Pont.-pan.-balc.; *Oenanthe silaifolia* M. Bieb. - H. mezohigr. Submedit.-medit.; *Orlaya grandiflora* L. Hoffm. – T. xer.-xeromez. Submedit.; *Pastinaca sativa* ssp. *urens* L. – Ht. xeromez.- mezohigr. Centr. eur.-submedit.; *Peucedanum alsaticum* L. - H. xer.-xeromez. Eur. centr.; *Peucedanum cervaria* L. Lapeyr. - H. xeromez.-mez. Eur. cont.; *Peucedanum oreoselinum* L. Moench - H. xeromez.-mez. Eur. cont.; *Pimpinella saxifraga* L. - H. Euras. (submedit.); *Sanicula europaea* L. - H. xeromez.-mezohigr. Euras.; *Tordylium maximum* L. - T.-Ht. Sp. xer.-xeromez. Eur. centr. and S, As. SV.; *Torilis arvensis* (Huds.) Link. – T. xeromez. Eur. Cent.; *Torilis japonica* (Houtt.) DC. – T. xeromez. Euras.; Fam. Apocynaceae: *Vinca minor* L. - Ch. mez. Centr. eur.-medit.; *Vincetoxicum hirundinaria* Medik.- H. xeromez, subterm. Euras. cont.; Fam. Asteraceae: *Achillea millefolium* L. – H. mez. Euras.; *Ambrosia artemisiifolia* L. – T. Adv. (N. Am.).; *Anthemis austriaca* Jacq. - T. xeromez., subterm. Centr. eur.-pont.; *Arctium lappa* L. – Ht. xeromez.-mezohigr. Euras.; *Bellis perennis* L. - H. mez.-mezohigr. Eur.; *Bidens tripartita* L. - T. mezohigr.-higr. Euras.; *Carlina brevibracteata* (Andrae) K . Werner - Ht. Centr. eur.; *Centaurea cyanus* L. - T.-Ht. xeromez.-mez. Medit. today Cosm.; *Cichorium intybus* L. – H. eurif. Euras.; *Cirsium arvense* (L.) Scop. - G. xeromez.-mezohigr. Euras.; *Cirsium boujartii* (Pilier et Mitterp.) Sch.-Bip. - Ht. Daco.-balc.; *C. creticum* (Lam.) D'Urv. - G. Medit.; *Eringeron annuus* (L.) Pers. ssp. *strigosus* (H. L . Miihl. ex Willd.) Wagenitz - T, Ht, H. mez. Adv. (N. Am.).; *Eupatorium cannabinum* L. - H. mezohigr. Euras.; *Galisogna ciliata* (Rafin.) Blake - T. Adv. (Am. deS.); *Galisogna quadriradiata* Ruiz et Pavon s. str. - T. Adv. S. Am.; *Hieracium murorum* L. - H. mez. Eur.; *Inula britannica* L. - Ht. mez.-mezohigr., Euras.; *Inula hirta* L. – H. xeromez. Cont. euras.; *Matricaria perforata* Merat – T.-Ht. mez. Euras.; *M. recutita* L. - T. xeromez.-mez. Euras.; *Sigesbeckia orientalis* L. – T. V. As.; *Taraxacum officinale* Weber ex F.H.Wigg. – H. xeromez.-mez. Euras.; *Tragopogon orientalis* L. - Ht. –H. mez. Eur. centr. and E.; *Tussilago farfara* L. - G. mez.- mezohigr. Euras.; *Xanthium italicum* Moretti - T. mez.-mezohigr. S. Eur.; *X. strumarium* L. - T. mez.-mezohigr. Euras. today cosm. Fam. Betulaceae: *Corylus avellana* L. - Ph. mez.-mezohigr. Eur.; *Carpinus betulus* L . – Ph. mez., helscia. Centr. eur. Fam. Boraginaceae: *Anchusa officinalis* L. - H.(Ht.). xer.-xeromez. Eur.; *Cerinthe minor* L. - T.-Ht. xeromez. Centr. eur.-medit.; *Cynoglossum officinale* L. - Ht. xeromez. Euras. cont.; *Echium vulgare* L. - Ht. xeromez. Euras.; *Lappula squarrosa* (Retz.) Dumort. - T.-Ht. xeromez., mezoterm. Euras.; *Lithospermum arvense* L. - T. Euras.; *L. officinale* L. - H. xeromez.-mez. Euras.; *L. purpuro-caeruleum* L. - H.-G. xeromez.-mez., subterm. Eur. centr.-submedit.; *Myosotis sylvatica* Ehrh. ex Hoffm. - Ht. mez.-mezohigr. Eur.; *M. sparsiflora* Pohl. - T. mez.-mezohigr., Euras. Cont.; *M. scorpioides* L.– H. higr. Euras.; *M. arvensis* (L.) Hill. - Ht. Euras.; *Pulmonaria officinalis* L. s. str. - H. helscia., mez. Eur.; *P. mollis* Wulfen ex Hornem. – H. helscia, xeromez.-mez. Eur. centr. and S-E.; *Symphytum officinale* L. s. str. – H. mezohigr. Euras.; *S. tuberosum* L. – H. mezohigr, Eur. centr.

and V.; Fam. Brassicaceae: *Alliaria petiolata* (M. Bieb.) Cavara et Grande - Ht.-H. mez. Euras.; *Alyssum alyssoides* (L.) L. - T.-Ht. xer.-xeromez. Euras. cont.; *A. desertorum* Stapf - T. xer.-xeromez. Euras. cont.; *Arabidopsis thaliana* (L.) Heynh. - T.-Ht. xeromez. Cosm.; *Arabis hirsuta* (L.) Scop. s.str. - Ht.-H. Euras.-medit.; *Arabis turrita* L. - Ht.-H. xeromez.-mez. Centr. eur.-medit.; **Armoracia rusticana* P.Gaertn, B. Mey. et Scherb. - H.(G.). Adv. (SE. Eur. and As. V.).; *Barbarea vulgaris* W. T. Aiton - Ht.-H. mez.-mezohigr. Euras.; *Berteroa incana* (L.). DC. - Ht. xeromez.-mez. Euras.; *Bunias orientalis* L. - Ht.-H. xeromez.-mez. Euras. cont.; *Calepina irregularis* (Asso) Thell. - T.-Ht. xeromez. Pont.-medit.; *Camelina microcarpa* Andrz. ex DC. - T.-Ht. Euras. cont.; *Capsella bursa-pastoris* (L.) Medik. –T.-Ht. eurif. Cosm.; *Cardamine amara* L. – H. higr. Euras.; *C. hirsuta* L. - T.-Ht. mez. Euras.; *C. impatiens* L. - Ht. mezohigr. Euras.; *C. pratensis* L. - H. mezohigr.-higr. Circ.; *Cardaminopsis arenosa* (L.) Hayek - T.-Ht, H. xeromez.-mez. Eur. centr.; *Cardaria draba* (L.) Desv. - H. xeromez. Euras. medit.; *Dentaria bulbifera* L. – G. mez. Centr.-eur.; *D. glandulosa* Waldst. et Kit. - G. mez.-mezohigr. End. carp.; *Descurainia sophia* (L.) Webb ex Prantl - T.-Ht. xeromez.-mez. Euras.; *Diplotaxis muralis* (L.) DC. - T.-Ht. eurif. Centr. eur.-medit.; *Erophila verna* (L.) Chevall. – T. xeromez. Eur.; *Erysimum diffusum* Ehrh. – Ht.-H. xer.-xeromez. Euras. cont.; *Lepidium campestre* (L.) R. Br. – T.-Ht. xeromez.-mez. Eur.; *L. ruderale* L. - T.-Ht. xeromez.-mez. Euras.; *Myagrum perfoliatum* L. - T.-Ht. xeromez. Medit.; *Nasturtium officinale* W. T. Aiton – HH. Cosm.; *Rorippa austriaca* (Crantz) Besser - H. higr. Pont.; *R. pyrenaica* (L.) Rchb. – H. mez. Eur.; *R. sylvestris* (L.) Besser - H. mezo-higr. Euras.; *Sinapis arvensis* L. - T. mez.-xeromez. Euras.; *Sisymbrium altissimum* L. - T.-Ht. xeromez. Euras. cont.; *S. officinale* (L.) Scop. - T.-Ht. xeromez.-mez. Euras.; *S. orientale* L. - T, Ht. xer.-xeromez. Pont.-medit.; *S. strictissimum* L. - H. mez.-mezohigr. Eur. cont.; *Thlaspi alliaceum* L. – T. mez. Centr.-eur.-medit.; *T. arvense* L. - T.- Ht. xeromez.-mez. Euras.; *Turritis glabra* L. - Ht. xeromez. Circ.; Fam. Campanulaceae: *Campanula glomerata* L. - H. xeromez.-mez. Euras.; *C. patula* L. - Ht. mez.-mezohigr. Eur.; *C. persicifolia* L. – H. xeromez.-mez. Euras.; *C. rapunculus* L. - Ht. xeromez. Eur.; *C. rapunculoides* L. - H. mez. Euras.; Fam. Caryophyllaceae: *Agrostemma githago* L. - T. Cosm.; *Arenaria serpyllifolia* L. - T. - xer.-xeromez. Circ.; *Cerastium arvense* L. - Ch. Circ.; *C. brachypetalum* Pers. - T. mezoxer., Centr.-eur.; *C. glomeratum* Thuill. - T. mezohigr. Cosm.; *C. semidecandrum* L. - T. mez. Eur.; *Cucubalus baccifer* L. - H. Euras.; *Dianthus armeria* L. - T., xeromez. Eur.; *D. carthusianorum* L. - H. mezoxer. Eur.; *Gypsophila muralis* L. - T. Euras.; *Herniaria glabra* L. - T.-H. xeromez. Euras.; *Holosteum umbellatum* L. - T. xeromez., Euras.; *Kohlrauschia prolifera* (L.) Kunth - T. xer. Atl.-medit.; *Lychnis coronaria* (L.) Desr. - H. Centr. SE eur.; *L. flos-cuculi* L. - H. mezohigr.-higr. Euras.; *L. viscaria* L. - Ch.(H). mezoxer. Euras.; *Moehringia trinervia* (L.) Clairv. - T.-H. xeromez., Euras.; *Myosoton aquaticum* (L.) Moench – H. mezohigr., Euras.; *Sagina apetala* Ard. - T. Centr. and S. Eur.; *Saponaria officinalis* L. - H. mez.-mezohigr., Euras.; *Scleranthus annuus* L. – T. Euras.; *S. perennis* L. – H. xeromez. Eur.; *Silene latifolia* subsp. *alba* (Mill.) Greuter et Burdet - T.-H. mezoxer. Euras.; *S. vulgaris* (Moench) Garcke - H. xeromez., Euras.; *Spergularia rubra* (L.) J. et C. Presl - T.-H. xeromez., Circ.; *S. graminea* L. - Rocoţea. H. mez.-mezohigr. Euras.; *S. holostea* L. - H. mez. Euras.; *S. media* (L.) Vili. - T.-Ht. mez. Cosm.; *S. nemorum* L. - H. mezohigr. Eur.; Fam. Caprifoliaceae: *Lonicera nigra* L. - Ph. mez. Centr. eur. (mont.); *Sambucus ebulus* L. - H. xeromez.-mezohigr. Euras. (submed.).; *S. nigra* L. - Ph. mez.-mezohigr. Eur.; *Viburnum opulus* L. - Ph,. mezohigr. Circ.; *V. lantana* L. - Ph. xeromez.- mez. Eur. centr. (submedit.).;

Fam. Convolvulaceae: *Calystegia sepium* (L.) R.Br. - G.(H.). mezohigr.-higr. Euras.; *Calystegia sylvatica* (Kit.) Griseb. - G.(H.). Medit.; *Convolvulus arvensis* L. - (G.)H. mez. Cosm.; Fam. Cornaceae: *Cornus mas* L. - Ph. xeromez.-mez., Pont.-medit.; *Cornus sanguinea* L. – Ph. mez.- mezohigr. Eur. centr.; Fam. Dennstaedtiaceae: *Pteridium aquilinum* (L.) Kuhn - G. mezoxer.-mez., Cosm.; Fam. Dipsacaceae: *Cephalaria transylvanica* (L.) Roem. et Schult. - Ht. xer.-xeromez. Pont.-medit.; *Dipsacus fullonum* L. - Ht. Sp. mez. Submedit.; *D. laciniatus* L. - Ht. mezohigr. Euras. cont.; *D. pilosus* L. - Ht. mez.-mezohigr. Eur. centr. and V.; *Knautia arvensis* (L.) J.M. Coult. – H. xeromez.-mez. Eur.; *Scabiosa ochroleuca* L. - Ht.-H. xeromez. Euras. cont.; *Succisa pratensis* Moench. – H. mez.- mezohigr. Euras.; Fam. Euphorbiaceae: *Euphorbia amygdaloides* L. - Ch. mez. Centr. eur., subatl., submedit.; *E. cyparissias* L. – Ch. xeromez., Euras.; *E. epithymoides* L. - H. xeromez.-mez. Pan.-balc.; *E. helioscopia* L.- T. xeromez.-mez. Euras.; *E. salicifolia* Host. – H. xeromez.-mezohigr. Pont.-pan.; *E. stricta* L. - T. mezohigr. Eur. cont.; *E. virgata* Waldst. et Kit. – H. xeromez.-mez. Euras. cont.; Fam. Equisetaceae: *Equisetum arvense* L. - G. eurif. Cosm.; *E. hyemale* L. - G. higr. Circ.; *E. palustre* L. - G. higr. Circ.; *E. telmateia* Ehrh. - G. higr. Circ.; Fam. Fabaceae: *Amorpha fruticosa* L. - Ph. eurif., Am. de N.; *Astragalus cicer* L. - H. xeromez. Euras.cont.; *A. glycyphyllos* L. - H. xeromez.-mez., Euras.-submedit.; *A. onobrychis* L. - H. xer.- xeromez. Euras. cont.; *Chamaecytisus albus* (Hacq.) Rothm. - Ph. xeromez. Pont.-pan.-balc.; *Ch. hirsutus* ssp. *leucotrichus* (L.) Link –Ph. xeromez. Balc.-pan.; *Coronilla varia* L. - H. xeromez. Centr.-eur. – submedit.; *Dorycnium herbaceum* Vill. - Ch. xer.-xeromez., Eur. centr. and SE.; *Galega officinalis* L. - H. higr. Pont.-medit.; *Genista tinctoria* L. –Ch. Eur.; *Genistella sagittalis* (L.) Gams - Ch. xeromez.-mez. Atl.-centr. eur.-medit.; *Lathyrus aphaca* L. - T. xeromez.-mez. Medit.; *L. hallersteinii* Baumg. – H. mez. Carp.-balc.; *L. niger* (L.) Bernh. - G. xeromez.-mez. Eur. centr.; *L. nissolia* L. - T. eurif. Atl.- medit.; *L. pratensis* L. - H. xeromez.- mezohigr. Euras.; *L. sphaericus* Retz. - T. xer.- xeromez. Medit.; *L. sylvestris* L. - H. xeromez.-mez. Eur.; *L. tuberosus* L. - H. xeromez.-mez. Euras.; *L. venetus* (Mill.) Wohlf. - G. mez. Pont.- medit.; *L. vernus* (L.) Bernh. -. G. mez. Euras.; *Lotus corniculatus* L. - H. mez. Euras.; *Medicago arabica* (L.) Huds. - T. xeromez.- mez. Atl.-medit.; *M. lupulina* L. - T.-H. xeromez.- mezohigr. Euras.; *M. minima* (L.) L. - T. xer.-xeromez., Submedit.; **M. sativa* L. – Ch.-H. Medit.; *Melilotus albus* Medik. - Ht. xeromez.-mez. Euras.; *M. officinalis* (L.) Lam. - Ht. xeromez.-mez. Euras.; *Onobrychis viciifolia* Scop. –H. xeromez. Euras.; *Ononis arvensis* L. - H. mez.- mezohigr. Cont. euras.; *O. spinosa* L . - Ch.-H. xeromez., Eur.; **Robinia pseudoacacia* L. - Ph. eurif. Am. de N.; *Trifolium arvense* L. –T. xeromez. Euras.; *T. campestre* Schreb. - T. xeromez.-mez. Eur.; *T. dubium* Sibth. – *T.* xeromez. -mez., Eur.; *T. fragiferum* subsp. *bonannii* L. - H. mezohigr. Submedit.; *T. hybridum* L.- H. mezohigr.-higr. Atl.-eur.; *T. medium* L. – H. xeromez-mez. Euras.; *T. montanum* L. – H. xeromez.-mez. Euras. cont.; *T. pannonicus* Jacq. – H. xeromez-mez. Pont. medit.; *T. pratense* L. - H. xeromez.-mez. Euras.; *T. repens* L. - H. mez. Euras.; *T. striatum* ssp. *tenuiflorum* L. – T. xer.-xeromez. Atl.-medit.; *Vicia angustifolia* L. - T. xeromez. Euras.; *Vicia cracca* L. – H. eurif. Euras.; *V. grandiflora* Scop – T. xeromez. Pont.-balc.-cauc.; *V. hirsuta* (L.) S.F.Gray - T. eurif.. Euras.; *V. lathyroides* L. - T.-Ht. xeromez.-mez. Eur.; *V. lutea* L. - T. xeromez., Atl.-medit.; *V. tetrasperma* (L.) Schreb. – T. xeromez.-mez. Euras.; *V. villosa* Roth - T.-Ht. xeromez. Eur.; Fam. Fagaceae: *Fagus sylvatica* L. ssp. *moesiaca* - Ph. mez.-mezohigr. Balc; *Quercus cerris* L. - Ph. mezoxer. Submedit.; *Q. dalechampii* Ten. – Ph. mezoxer. E. medit.-carp.-balc.; *Q. frainetto* Ten. - Ph. xeromez. Balc.; *Q. polycarpa* Schur - Ph. mezoxer. Carp.-balc.-

cauc.; *Q. robur* L. - Ph. eurif. Eur.; Fam. Geraniaceae: *Erodium cicutarium* (L.) L'Herit. – T. xeromez. Cosm.; *G. dissectum* L. – T. xeromez.-mez. Euras.; *G. phaeum* L. - H. mezohigr. Eur. centr.; *G. pusillum* Burm. f. - T. xeromez.-mez. Eur.; *G. robertianum* L. – T.-Ht. mez.- mezohigr. Cosm.; Fam. Hypericaceae: *Hypericum hirsutum* L. – H. mez. Euras.; *H. perforatum* L. - H. xeromez.-mez. Euras.; Fam. Iridaceae: *Crocus reticulatus* Steven – G. mez. Pont.-medit.; *C. vernus* (L.) Hill - G. mez. Carp.-balc.; *Gladiolus imbricatus* L. - G. mezohigr. Cont. euras.; *Iris pseudacorus* L. – G. higr. Eur.; Fam. Juglandaceae: **Juglans regia* L. - Ph. eurif. Centr. eur.-balc.-cauc.; Fam. Lamiaceae: *Acinos arvensis* (Lam.) Dandy - T.-Ht. xer.-xeromez. Eur.; *Ajuga genevensis* L. - H. xeromez.-mez. Euras.; *A. reptans* L. - H. mez. Eur.; *Ballota nigra* L. - H. xeromez.-mez. Eur. centr. and NE.; *Calamintha menthifolia* Host - H. xeromez.-mez. Eur. excl. N.; *C. sylvatica* Jord. – H. mez. Centr. eur.- submedit.; *Clinopodium vulgare* L. - H. eurif. Circ.; *Galeobdolon luteum* Huds. - H. (Ch.). mez.-mezohigr. Eur. centr.; *Galeopsis speciosa* Mill. – T. mez.-mezohigr. Euras.; *G. tetrahit* L. - T. mez. Eur.; *Glechoma hederacea* L. - H. (Ch.). mez.-mezohigr. Euras.; *G. hirsuta* Waldst. et Kit. - H. (Ch.). mez. Pont.-medit.-centr. eur.; *Lamium amplexicaule* L. - Th. xeromez.-mez. Euras.; *L. maculatum* L. - H.(Ch.). mez.-mezohigr. Euras.; *L. purpureum* L. - T.-Th. xeromez.-mez. Euras.; *Lycopus europaeus* L. - H.(HH.). higr. Euras.; *L. exaltatus* L. fil. - H.(HH.). higr. Euras. cont.; *Melitis melissophyllum* L. - H. xeromez.-mez. Eur. centr. and V.; *Mentha aquatica* - H.(HH.) higr. Eur.; *M. longifolia* L. - H. mezohigr.-higr. Euras.; *M. pulegium* L. - H. mezohigr. Euras. (submedit.).; *Nepeta cataria* L. - H. xeromez.- mez. Euras. (submedit.).; *Nepeta nuda* L. - H. xeromez. Euras. cont.; *Origanum vulgare* L. - H. xeromez.-mez. Euras.; *Prunella grandiflora* (L.) Scholler - H. xeromez.-mez. Eur.; *Prunella vulgaris* L. - H. mez.-mezohigr. Cosm.; *Salvia glutinosa* L. - H. mezohigr., Euras. (mont.).; *S. nemorosa* L. - H. xer.-xeromez. Pont.- medit.-centr. eur.; *S. pratensis* L. - H. xeromez. Eur. (submedit.).; *S. verticillata* L. - H. xeromez, Centr. eur.-medit.; *Scutellaria altissima* L. – H. xeromez.-mez. Pont.-medit.; *Scutellaria galericulata* L. - H. higr. Circ.; *Stachys annua* L. –T. xeromez. Eur. (submedit.).; *S. officinalis* (L.) Trevis. - H. xeromez.-mez. Euras.; *S. palustris* L. - H. higr. Circ.; *S. recta* L. - H. xer. Pont.- medit.-centr. eur.; *S. sylvatica* L. - H. mezohigr. Euras.; *Teucrium chamaedrys* L. - Ch. xer.- xeromez. Eur. centr. (submedit.).; *Thymus glabrescens* Willd. – Ch. xer.-xeromez. Pont.-centr.-eur.-medit.; *T. pannonicus* All. - Ch. xer.- xeromez. Pont. pan.; Fam. Liliaceae: *Asparagus tenuifolius* Lam. - G. xeromez. Pont.-medit.; *Colchium autumnale* L. - G. mez.-mezohigr. Centr. eur.; *Erythronium dens-canis* L. ssp. *niveum* (Baumg.) Buia et Păun - G. mez. V. and SV. Ro. End.; *Gagea lutea* (L.) Ker Gawl. - G. mez. Euras.; *G. minima* (L.) Ker. Gawl. - G. xeromez.-mez. Euras. cont.; *G. pratensis* (Pers.) Dumort. - G. xeromez.-mez. Eur.; *G. villosa* (M. Bieb.) Sweet - G. xeromez.-mez. Eur.; *Lilium martagon* L. - G. mez. Euras.; *Maianthemum bifolium* (L.) F.W.Schmidt - G. mez. Euras.; *Ornithogalum ortophyllum* ssp. *kochii* Ten. – G. mezoxer. Centr. eur.-submedit.; *O. pyramidale* L. - G. xeromez.-mez. Centr. Eur.; *O. pyrenaicum* L. – G. mez. Atl.-medit.; *O. umbellatum* L. – G. xeromez. Submedit.-centr.-eur.; *Polygonatum latifolium* (Jacq.) Desf. - G. mez. Pont.-pan.-balc.; *P. multiflorum* (L.) All. - G. mez., Euras.; *Scilla bifolia* L. – G. mez. Eur. centr. and S.; Fam. Loranthaceae: *Loranthus europaeus* Jacq. - Ep. Eur.; Fam. Lythraceae: *Lythrum salicaria* L. – H. higr. Circ.; Fam. Malvaceae: *Althaea cannabina* L. – H. xeromez., Pont.-medit.; *Hibiscus trionum* L. - T. xeromez.-mez. Euras.; *Lavatera thuringiaca* L. - H. xeromez. Euras. cont.; *Malva neglecta* Wallr. - T. xeromez.-mez. Euras.; *M. sylvestris* L. - Ht-H.

xeromez.-mez. Euras.; Fam. Oleaceae: *Fraxinus angustifolia* Vahl - Ph. mezohigr.-higr. V . medit.; *F. excelsior* L. - Ph. mez.-mezohigr. Eur.; *F. ornus* L. - Ph. xeromez.-mez. Submedit.; *Ligustrum vulgare* L. – Ph. xeromez.-mez. Eur. (submedit.); *Syringa vulgaris* L. - Ph. xeromez. Carp.-balc.-anat.; Fam. Orchidaceae: *Anacamptis pyramidalis* (L.) Rich. - G. xeromez.-mez. Centr. eur.- submedit.-atl.; *Cephalanthera longifolia* (L.) Fritsch - G. mez. Eur.; *Dactylorhiza incarnata* (L.) Soo – G. mezohigr. Euras.; *Epipactis helleborine* (L.) Crantz - G. Euras.; *Listera ovata* (L.) R.Br. - G. mez. Euras.; *Neottia nidus-avis* (L.) Rich. - G. mez. Euras.; *Orchis coriophora* L. – G. mez.-mezohigr. Centr. Eur.; *O. laxiflora* Lam. ssp. *elegans* (Heuff.) Soo. – G. mezohigr. Pont.-pan.; *O. morio* L. ssp. *picta* (Loisel.) K. Richt. - G. xeromez.-mez. Eur.; *O. ustulata* L. – G. mez. Eur.; *Platanthera longifolia* (L.) Rich. - G. mez. Euras.; *P. montana* (F. W.Schmidt) Rchb. f. - G. mez. Euras. (submedit.); Fam. Oxalidaceae: *Oxalis acetosella* L. - H.(G.). mez- mezohigr. Circ.; *O. corniculata* L. - T.-H. Adv. (Medit.); Fam. Papaveraceae: *Chelidonium majus* L. - H. mez. Euras.; *Papaver dubium* L. - T. xeromez. Eur.; *P. rhoeas* L. - T. mezoxer. Cosm.; Fam. Plantaginaceae: *Plantago lanceolata* L. - H. eurif. Euras.; *P. major* L. - H. mez. Euras.; *P. media* L. - H. xeromez.-mez. Euras.; Fam. Poaceae: *Agrostis capillaris* L. - H.(G). mez. Circ.; *A. stolonifera* L. - H. mezohig-higr. Euras., *Aegilops cylindrica* Host - T. xeromez. Cont. euras.; *Alopecurus pratensis* L. – H. mezohigr. Euras.; *Anthoxanthum odoratum* L. - H. mez. Euras.; *Apera spica-venti* (L.) Beauv. - T. xeromez.-mez. Euras.; *Arrhenatherum elatius* (L.) Beauv. ex J. et C. Presl - H. mez. Euras.; *Avena fatua* L. - T. xeromez. Euras.; *Avenula compressa* (Heuff.) W. Sauer et Chmelitschek – H. xeromez.- mez. Pont.-pan.-balc.; *Brachypodiun pinnatum* (L.) Beauv. – H. xeromez.-mez. Euras.; *B. sylvaticum* (Huds.) Beauv. – H. mez.-mezohigr. Euras. (submedit.), *Briza media* L. – H. xeromez.-mez. Euras.; *Bromus arvensis* L. - T.-Ht. xeromez. Euras. (submedit.); *B. hordeaceus* L. - T.-Ht. mez. Euras. (submedit.); *B. inermis* Leyss. - H. xeromez. Cont. euras.; *B. japonicus* Thunb. - T.-Ht. xeromez. Cont. euras.; *B. tectorum* L. - T. xer.-xeromez. Euras. cont.; *Calamagrostis arundinacea* (L.) Roth. - H. mez. Cont. euras.; *C. epigeios* (L.) Roth. - G. eurif, Euras.; *Catabrosa aquatica* (L.) Beauv. - H. mezohigr.-higr. Circ.; *Chrysopogon gryllus* (L.) Trin. - G. xer.-xeromez. Submedit.; *Cynodon dactylon* (L.) Pers. - G. xeromez. Cosm.; *Cynosurus cristatus* L. - H. mez. Eur.; *Dactyllis glomerata* L. – H. xeromez.-mez. Euras.; *Danthonia alpina* Vest – H. xeromez. Centr. eur.-medit.; *Danthonia decumbens* (L.) DC. – H. mez. Eur.; *Dichanthium ischaemum* (L.) Roberty - H. xer.-xeromez. Euras. (submedit.).; *Digitaria sanguinalis* (L.) Scop. – T. xeromez.-mez. Cosm.; *Echinocola crus-galli* (L.) Beauv. - T. mez.-mezohigr. (higr.). Cosm.; *Elymus caninus* (L.) L. - H. mez.- mezohigr. Circ.; *Elymus repens* (L.) Gould - G. mez. Circ.; *Eragrostis minor* Host - T. xer., xeromez. Centr. eur.-medit.; *Festuca arundinacea* subsp. *orientalis* Schreb. – H. mezohigr. Eur. centr. şi SE.; *F. gigantea* (L.) Vili . – H. mezohigr. Euras.; *F. pratensis* Huds. - H. mez.-mezohigr, eutr. Euras.; *F. rubra* L. - H. mez.-mezohigr. Circ.; *F. rupicola* Heuff. – H. xeromez. Cont. euras.; *Glyceria notata* Chevall. - H.(HH). Circ.; *Holcus lanatus* L. - H. mez.-mezohigr. Cosm.; *Hordelymus asper* (L.) Jessen ex Harz - H. mez. Eur. centr.; *Hordeum murinum* L. - T. xeromez. Euras.; *Koeleria macrantha* (Ledeb.) Schult. – H. xeromez. Circ.; *Lolium perenne* L. - H. Sp. mez. Cosm.; *Melica ciliata* L. – H. xer.-xeromez. Centr. eur.-medit.; *Melica uniflora* Retz. - H.(G.). mez. Centr. eur.-submedit.; *Milium effusum* L. - H. mez. Circ.; *Phalaris arundinacea* L. – HH. mezohigr.-higr. Circ.; *Phleum pratense* L. – H. mez., Euras.; *Phragmites australis* (Cav.) Steud. - G.(HH.), higr. Cosm.; *Poa annuua* L. - T.-H. Mez. Cosm.; *P. bulbosa*

L. - H. xeromez. Euras.; *P. palustris* L. - H. mezohigr. Circ.; *P. pratensis* L. - H. mez.-mezohigr. Circ. (astăzi cosm.).; *Sclerochloa dura* (L.) Beauv. – T. xeromez.; *Setaria pumilla* (Poir.) Roem. et Schult. - T. mez.-mezohigr. Cosm.; *Setaria viridis* (L.) Beauv. - T. xeromez.-mez. Euras., azi Cosm.; *Sorghum halepense* (L.) Pers. - G. mez.-mezohigr. Medit.; *Taeniatherum caput-medusae* (L.) Nevski – T. xeromez. Pont.-medit.; *Ventenata dubia* (Leers) Coss. - T. xeromez. Centr. eur.-medit.; *Vulpia myuros* (L.) C.C. Gmel. - T., Ht. xeromez. Euras. (Cosm.).; *Zingeria pisidica* (Boiss.) Tutin– T. mez.-mezohigr. RO. Anat, Cauc.; Fam. Polygonaceae: *Fallopia convolvulus* (L.) A. Love - T. Circ.; *F. dumetorum* (L.) Holub. - T. mezoxer. Circ.; *Polygonum aviculare* L. - T. Cosm.; *P. lapathifolium* L. - T. mez.-mezohigr. Cosm.; *P. persicaria* L. - T. mezohigr. Cosm.; *Rumex acetosa* L. - H. mez.-mezohigr. Cosm.; *R. acetosella* L. - H. mezoxer. Centr. and NV Eur.; *R. conglomeratus* Murray - H. mezohigr.-higr. Circ.; *R. crispus* L. – H. mez.- mezohigr. Euras.; *R. pulcher* L. - Ht.-H. Centr. and S. Eur.; *R. sanguineus* L. – H. mezohigr., Eur.; Fam. Primulaceae: *Anagallis arvensis* L. - T.-Ht. mez. Circ.; *Lysimachia nummularia* L. - Ch. mezohigr. Euras., Am. De N.; *L. vulgaris* L. – H. higr. Euras.; *Primula veris* subsp. *columnae* L. - H. mez. Euras. *P. vulgaris* Huds. - Griciorei. H. mez. Euras.; Fam. Ranunculaceae: *Actaea spicata* L. – G. mezohigr. Euras.; *Anemone nemorosa* L. - G. mez. Circ.; *A. ranunculoides* L. - G. mez. Eur.; *Caltha palustris* L. - H. higr. Circ.; *Clematis vitalba* L. - Ph. mez. Eur. centr.; *Consolioda regalis* S.F. Gray - T. mezoxer., Eur.; *Helleborus odorus* Waldst. et Kit. - H. xeromez. Balc.; *Hepatica nobilis* Schreb. - H. mez. Circ.; *Ranunculus arvensis* L. - T. mez.-mezoxer. Euras.; *R. auricomus* L. – H. mezohigr. Euras.; *R. bulbosus* L. - H.(G.). Centr. and N . Eur; *R. ficaria* L. - H. mez.-mezohigr. Euras.; *R. repens* L. - H. mezohigr.-higr. Euras.; *R. sardous* Cr. - T. mezohigr. Eur.; *R. sceleratus* L. - T. Circ.; *Thalictrum lucidum* L. - H. mezohigr.-higr. Eur. cont.; *Th. minus* L. - H. xeromez. Euras. cont.; Fam. Rosaceae: *Agrimonia eupatoria* L. - H. xeromez. Euras.; *Aphanes arvensis* L. - T. mezoxer. Eur.; *A. australis* Rydb. – T. mezoxer. Eur. centr.; *Aremonia agrimonoides* (L.) DC. - H. mez. Centr. eur.-medit.; *Cerasus avium* (L.) Moench - Ph. mez. Submedit. *Crataegus monogyna* Jacq. Ph. mezoxer.-mez. Euras.; **Cydonia oblonga* Mill. - Ph. xeromez. As. SV.; *Filipendula vulgaris* Moench - H. xeromez.-mez. Euras.; *Fragaria vesca* L. - H. mez. Euras.; *F. viridis* (Duchesne) Weston - H. xeromez. Euras.; *Geum urbanum* L. - H. mez.-mezohigr. Circ.; *Malus sylvestris* L. – Ph. mez. Eur.; *Potentilla anserina* L. - H. mezohigr.-higr. Cosm.; *P. argentea* L. - H. xeromez. Euras.; *P. micrantha* Ramond ex DC - H. mezoxer. Centr. eur.-submedit.; *P. recta* L. - H. xeromez. Cont. Euras.; *P. reptans* L. – H., mezohigr. Euras.; *P. supina* L. - Th.-H. mezohigr.-higr. Euras.-submedit.; *Prunus spinosa* L. - Ph. xeromez.-mez. Eur.; *Pyrus pyraster* (L.) Burgsd. - Ph. mezoxer. Eur.; *Rosa arvensis* - Huds. Ph. mez. Eur. centr., S. and V.; *R. canina* L. s.l. – Ph. xeromez.-mez. Eur.; *R. gallica* L. - Ph. xer.-xeromez. Pont.-medit.; *Rubus candicans* Lib. ex Lej. Ph., xeromez. Eur.; *R. canescens* DC. – Ph. xer. Centr. eur.-medit.; *R. caesius* L. - Ph. mezohigr. Eur.; *Sanguisorba minor* Scop. – H., xeromez. Euras.; *S. officinalis* L. – H. mezohigr. Circ.; *Sorbus torminalis* (L.) Cr. - Ph. Centr. eur.; Fam. Rubiaceae: *Asperula cynanchica* L. – H. xer.-xeromez. Centr. eur.-medit.; *Asperula taurina* subsp. *leucanthera* L. - H. mez, Medit.; *Cruciata laevipes* Opiz - H. xeromez.-mez. Euras.; *Galium aparine* L. - T. mez.-mezohigr. Circ.; *G. humifusum* M. Bieb. - H. xer.-xeromez. Pont.-balc.; *G. mollugo* L. - H. mez.-xeromez. Euras.; *G. odoratum* (L.) Scop. - G. mez. Euras.; G. *pseudaristatum* Schur. – H. xeromez. Carp.-balc.; *G. verum* L. - H. xeromez.- mez. Euras.; *Sherardia arvensis* L. – T. xeromez.-mez. Euras.; Fam. Salicaceae: *Populus nigra* L. - Ph. mezohigr.-higr.

Euras.; *P. tremula* L. - Ph. eurif. Euras.; *Salix cinerea* L. - Ph. higr. Euras.; *S. fragilis* L. - Ph. Euras.; *S. purpurea* L. - Ph. higr. Euras.; Fam. Saxifragaceae: *Chrysosplenium alternifolium* L. – H. mezohigr.-higr. Circ.; Fam. Scrophulariaceae: *Euphrasia rostkoviana* (Hayne) F. Towns. T., mez. - Eur.; *E. stricta* D.Wolff ex I.F.Lehm. - T. xeromez.Eur.; *Gratiola officinalis* L. - H. mezohigr.-higr. Circ.; *Kicksia elatine* (L.) Dumort. - T. mez. Centr. eur.-medit.; *Lathraea squamaria* L. - G. mez.-mezohigr. Euras.; *Linaria vulgaris* Mill. – H. xeromez. Euras.; *Linaria genistifolia* (L.) Mill. – H. xer.- xeromez. Cont. euras.; *Melampyrum bihariense* A. Kern. - T. mez. Dacic.; *Rhinanthus minor* L. – T. mez.-mezohigr. Euras.; *R. rumelicus* Velen. – T. mez. Pont.-pan.-balc.; *Scrophularia nodosa* L. - H. mez.-mezohigr. Euras.; *Verbascum densiflorum* Bertol. – Ht. mez. Eur.; *V. phlomoides* L. – Ht. xeromez.-mez. Eur. centr. and SE.; *V. phoeniceum* L. - H. xeromez. Euras. Cont.; *Veronica arvensis* L. – T. xeromez.-mez. Euras.; *V. austriaca* L. - H. xer.-xeromez. Pont.-centr.-eur.-medit.; *V. chamaedrys* L . - H.-Ch. xeromez.-mez. Euras.; *V. hederifolia* L. – T. mez. Euras.; *V. persica* Poir. - T. mez. Adv. (As. de SV.).; *V. polita* Fr. – T. mez. Euras.; *V. serpyllifolia* L. - H. mez. Cosm.; *V. teucrium* L. - H. xeromez.-mez. Cont. euras.; *V. spicata* L. – H. xeromez. Cont. Euras.; Fam. Solanaceae: *Datura stramonium* L. - T. xeromez.-mez. Cosm.; *Physalis alkekengi* L. - H. mez. Adv. (N. Am.).; *Solanum dulcamara* L. – Ch. mezohigr.-higr. Euras.; *S. nigrum* L. - T. mez. Cosm.; Fam. Ulmaceae: *Ulmus glabra* Huds. - Ph. mez. Euras.; *U. minor* Mill. - Ph. mezoxer., Eur.; Fam. Urticaceae: *Urtica dioica* L. - H. mez.-mezohigr. Cosm. *U. urens* L. – T. mez. Cosm.; Fam. Violaceae: *Viola alba* Bess. - H. xeromez.-mez. Centr. Eur. (submedit.).; *V. arvensis* Murray - T. xeromez.-mez. Cosm.; *V. canina* L. - H. xeromez.-mez. Euras.; *V. odorata* L. – H. mez. Atl.-medit.; *V. reichenbachiana* Jord. ex Boreau - H. mez. Euras.; *V. tricolor* L. - T-Ht. xeromez.-mez. Euras.; Fam. Vitaceae: *Vitis sylvestris* C.C. Gmel. - Ph. mezohigr. Pont.-medit.

From the analysis of the spectrum of geoelements it can be seen that the Eurasian elements have the best representation (Fig. 1). They are followed at a great distance by the Central European and European ones. The rest of the categories are under-represented. Taken as a whole, the southern elements have a good representation in this part of Oltenia.

The bioforms found in this area belong to 8 main types (Fig. 2). The predominance of hemicryptophytes is explicable if we take into account the fact that they are dominant in the flora of the meadows and in the grassy carpet of the forest.The second place of the terophytes shows us that in certain areas the degree of coverage is lower. They have a good representation in the phytocenoses in formation.

The presence of cameites and phanerophytes in the studied meadows shows that some areas, where they are encountered, have a poor management, and nature regains its lost territory in the fight with man.

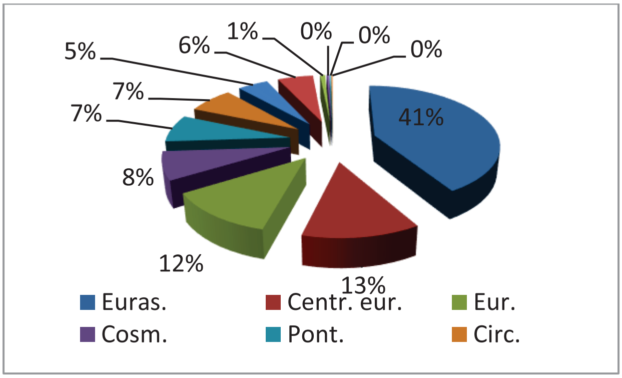

Fig. 1. Spectrum of geoelements (orig.)

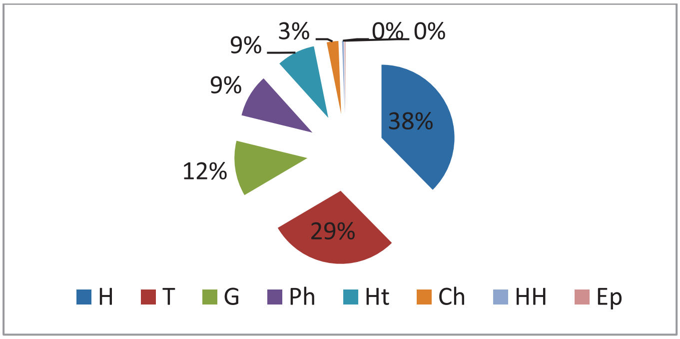

Fig. 2. The spectrum of bioforms (orig.)

This graphic representation shows us once again the xeromesophilic character of these places (Fig. 3). The mesophilic or mesohygrophilous species identified in the area were recorded during the rainy periods of May, October and partly June.

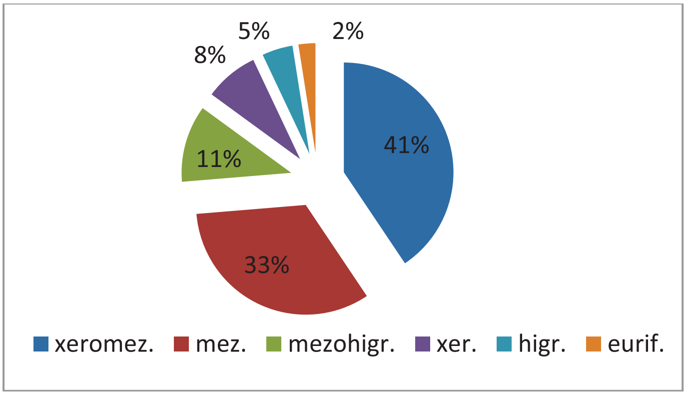

Fig. 3. Spectrum of the humidity index (orig.

CONCLUSIONS

In conclusion, we can say that the diversity of these places is reflected in good forage meadows, forests in good health and a rich floristic composition.

The ruderal and segetal places in the researched territory are true floristic banks, especially in May, for the nearby seminatural vegetation.

REFERENCES

Beldie Al. 1977, 1979. Flora României. Determinator ilustrat al plantelor vasculare. 406, 412 pag. Vol. I, II. Edit. Acad. R.S.R. Bucureşti.

Buia Al., Păun M. 1960°. Plante noi şi rare din Oltenia. Contrib. Bot.: 141-148. Cluj.

Buia Al., Păun M., Safta I. & Pop M., 1960b. Contribuţii geobotanice asupra păşunilor şi fâneţelor din Oltenia. Lucr. Şt. Inst. Agron. “T. Vladimirescu”: 93-180. Craiova.

Buia A., Safta I., Păun M. & Pavel C. 1962. Pajiştile din Masivul Parâng şi îmbunătăţirea lor. Studiul geobotanic al pajiştilor. Edit. Agro-Silvică. Bucureşti: 143-274.

Ciocârlan V. 2009. Flora ilustrată a României. Pteridophyta et Spermatophyta. Edit. Ceres, Bucureşti. 1041 pp

Cîrţu D. 1971. Vegetaţia ruderală de pajişti, căi de comunicaţie şi terenuri bătătorite din interfluviul Jiu-Desnăţui. Subcomisia OMN, filiala Oltenia, Gorj. Stud. Cerc.: 223-228. Craiova.

Cîrţu Mariana 1970. Aspecte privind vegetaţia lemnoasă din Bazinul Amaradiei. Anal. Univ. Craiova. Ser. A-II-a, Biol.-Şt. Agricole Vol. II (XII): 85-91. Edit. Ceres, Bucureşti.

Grecescu D. 1898. Conspectul Florei României: 836 pag. Bucureşti.

Grecescu D. 1909. Suplement la Conspectul Florei României.: 220 pag. Bucureşti.

Maloş C. 1968. Contribuţii la studiul florei şi vegetaţiei din Bazinul Superior al Motrului. Buletin Ştiinţific. Nr. X.: 72-83.

Niculescu Mariana 2009. Flora şi vegetaţia bazinului superior al Luncavăţului. 351 pag. Edit. Sitech, Craiova.

Păun M. 1963. Materiale pentru flora şi vegetaţia Raionului Balş, Reg. Oltenia. Lucrările Ştiinţifice Vol. VI. Institutul. Agronomic " T. Vladimirescu ": 35-67. Craiova.

Păun M. & Popescu G. 1971. Flora spontană din cursul superior al văii Olteţului. Com. Bot. Vol. XII: 163-172. Bucureşti.

Păun M. & al. 1972. Pajiştile mezofile de dealuri din zona subcarpatică a Olteniei. Stud. Cercet.: 40-51,194-200. Tg. Jiu. Întrep. Poligrafică Oltenia, Craiova.

Popescu G. 1974. Studiul floristic şi geobotanic al Bazinului hidrografic al Bistriţei-Vîlcii. 303 pag. Teza de doctorat, Bucureşti.

Popescu G. & Costache I. 1999. Consideraţii asupra florei pădurilor din Oltenia. Anal. Univ. Craiova, Vol. II (XXXVIII)- 1998, Ser. Biol., Hort., T.P.P.A., Craiova.

Popescu G., Răduţoiu D. & Costache I. 2001a. Contribuţii la studiul fitocenologic al pădurilor din zona subcarpatică a Olteniei. The Annals of the University of Craiova, Vol. VI (XLII): 3-10. Craiova.

Popescu G., Răduţoiu D. & Gămăneci G. 2001b. The flora and the vegetation of the Jilţ Basin, between the localities Negomir and Turceni, Gorj County. Acta Horti Botanici Bucurestiensis 29: 171-197. Bucureşti.

Prodan I. 1930. Centaureele României. Institutul de arte grafice "Ardealul": 256 pag., 63 de tablouri şi 3 hărţi. Cluj.

Prodan I. 1931. Achileele României. Tipografia "Cartea Românească": 68 pag., 43 de tablouri, 5 figuri şi 4 hărţi. Cluj.

Prodan I. 1939. Flora pentru determinarea şi descrierea plantelor ce cresc în România. Vol. II. Noţiuni generale de Fitogeografie. Fiziografia generală a României. Fitogeografia României. 713 pag. Tipografia “Cartea Românească” Cluj.

Rothmaler W. 2002. Exkursionsflora von Deutschland Gefabpflanzen: Kritischer Band. 4. 948 pag. Spektrum Akademischer Verlag Heidelberg – Berlin.

Săvulescu T. & al. (Edit.). 1952-1976. Flora R.P.R. - R.S.R. - Vol. I-XIII. Edit. Acad. Române. Bucureşti.

Sârbu I., Ştefan N. & Oprea A. (2013). Plante vasculare din România. Determinator ilustrat de teren. Edit. VictorBVictor, Bucureşti, 1320 pp

Tutin T. G., Heywood V. H., Burges N. A., Valentine D. H., Walters S. M., Webb D. A., et al. 1964 -1980. Flora Europaea. Vol. I-V. Cambridge University Press. Cambridge.

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VARIABILITY OF THE MAIN QUANTITATIVE CHARACTERISTICS OF THE *ROMEC 554j* TOMATO VARIETY

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***Key words**: tomatoes, conservative selectio,.variety*

ABSTRACT

Character variability is of particular importance being determined by both genotype and environmental factors. In order to maintain the genetic integrity and biological purity of the Romec 554j variet,. in the process of conservative selection, biometric determinations and morphological observations were made on the main quantitative traits and qualitative characteristics.

INTRODUCTION

Tomatoes (*Solanum lycopersicum L.)* are the most important vegetable globally in Europe (FAO. 2018). Tomato is the vegetable with the highest consumption per capita, of 24.9 kg per year (Federal Institute for Agriculture and Food. 2015). *Solanum lycopersicum L*. were the second crop after potatoes in terms of consumption level, as well as the largest popular garden crop (http://faostat.fao.org.). This was largely due to taste. special dietary and medicinal properties (Avdeev Iu., 1982).

According to FAO data, tomatoes have been grown worldwide on an area of 4 million hectares. The most significant areas were in China (974.000 ha) and India (520.000 ha). Obviously, there has been an increase in interest in this culture. In 2009, Moldova produced 84.070 tons of tomatoes (http://faostat.fao.org/).

One of the main reasons for the current increase in organic food production is the demand of consumers of local foods produced by safe methods, with minimal negative impact on the environment (Ordóñez-Santos L. E. et all., 2009). The increase of agricultural crop yields was due to the optimization of their growing conditions and the use of more productive and resistant genotypes. Under these conditions. cultivated plant varieties and hybrids have played a crucial role in the progress of innovation in agriculture, which has led to a sufficient quantity of high quality products (Mihnea N. 2015).

Progressive optimization and efficiency programs for tomato improvement were inconceivable without knowing the genetic basis of the characters for which research was performed and. therefore, technologies were developed for genotypes with desired characters (Agong S.G.et all. 2000). Relatively recent studies have shown that there was a high genotypic and phenotypic variability of fruit weight, number of flowers in inflorescence, number of branches (Haydar A. et all., 2007, Mohamed S.M. et all., 2012), which provided opportunities for the creation of valuable genotypes with a successful combination of characters, elucidating the impact of environmental conditions on the manifestation of hereditary character and transmission capacity.

Of particular importance was the knowledge of the variability of the characters that were determined by both genotype and environmental factors. The degree of variability of the characters indicated the particularities of the response norms of the genotype in different environmental conditions (Haydar et al. 2007, Mohamed et all. 2012, Mohanty 2002), optimization of the selection program (Fasoulas 1973).

Most valuable traits for tomatoes were quantitative and therefore the assessment of their variability and heredity drew special attention primarily to the development of genetic and breeding programs and the successful completion of the selection process (Agong et al. 2000, Mihne 2008).

MATERIAL AND METHODS

The biological material is the tomato variety with determined growth *Romec 554j,* in conservative selection since 2013, at SCDCPN Dăbuleni.

Conservative selection of tomatoes includes the following links: Field of choice, Field of study of offspring, Field of seed B (Basic) and Field of seed C (Certified). An individual selection with a single choice in the CA (Choice field) is applied.

The experience was established by a 50-day-old seedling in 2018. and in 2019 by a 43-day-old seedling on an area of 0.05 ha. Seed production technology specific to this species has been applied.

In order to maintain the genetic integrity and biological purity of the variety in the process of conservative selection, biometric determinations and morphological observations were made on the main quantitative traits and qualitative characteristics in the field of choice.

The number of individuals in whom the determinations were made was 100.

The determination of the inheritance of quantitative characters was performed based on Borojevic S., 1990. The morphological description was made in accordance with the general principles and methodology of performing tests on distinctiveness, uniformity and stability TG / 44/11 UPOV (2011).

During the vegetation period, observations were made regarding the main phenophases (sowing, sunrise, planting, flowering, fruit formation, maturity).

At fruit maturity, the following quantitative and morphological characteristics were analyzed biometrically: fruit weight (g), fruit height (cm), fruit diameter (cm), shape index (IF), pericarp thickness (mm), soluble dry matter (SUS%).

Biometric data were processed statistically, calculated for each character $\overline{x}$ = average; s = standard deviation; s% = coefficient of variability; k = degree of dispersion (Săulescu N., 1968).

Based on the establishment of the coefficient of variability (s%) and dispersion (k) for each character, the choice was made of the biological material that expresses the genotype of the *Romec 554j* tomato variety.

RESULTS AND DISCUSSIONS

The variable climate of southern Oltenia, where summers are dry and hot, offers favorable conditions for tomato crops for industrialization. Tomatoes being considered thermophilic plants have different thermal requirements depending on phenophases, the optimum temperature being 24°C-30°C (Petrescu C., 1992). and above 30°C the plants no longer bear fruit, because the pollen no longer germinates (table 1). When temperatures exceed 35° C, plant growth is stagnant. Very high temperatures lead to a decrease in yield in terms of fruit production. The amount of precipitation recorded in May-August was 482 mm in 2018 and 210 mm in 2019, being insufficient for the normal development of plant metabolism. The water deficit was filled by applying a watering norm of 300 m^3 apa / ha.

Table 1

Climatic data recorded at the weather station of SCDCPN Dăbuleni in the period 2018-2019

Climatic elements / year	2018				2019			
	May	June	July	August	May	June	July	August
Decade I	21.6	23.5	22.3	26.1	15.0	21.0	24.8	24.6
Decade II	19.2	23.4	24.1	24.7	17.2	25.0	21.0	25.1
Decade III	21.4	20.6	24.4	24.4	20.0	24.3	25.7	26.4
Monthly average (°C)	20.7	22.5	23.6	25.1	17.4	23.4	23.8	25.4
Monthly maximum (°C)	31.8	35.7	34.9	35.7	31.0	34.5	37.6	38.4
Monthly minimum (°C)	10.6	12.5	14.1	14.1	4.7	13.3	11.0	12.9
Rainfall (mm)	106.6	195.2	148.7	30.0	55.4	87.2	54.8	12.0

Table 2 shows the main phenophases recorded in the *Romec 554j* variety during the vegetation period.

Table 2

Phenological data recorded for the *Romec 554j* variety in the period 2018-2019

Variety	2018					2019				
	Sowing	Risen	Planted	Blooming	Physiological maturity	Sowing	Risen	Planted	Blooming	Physiological maturity
Romec 554j	29.III	05.IV	17.V	06.VI	16.VII	02.IV	09.IV	15.V	30.VI	23.VII

From the analysis of the variability of the quantitative characters (table 3). expressed in the population of the choice field. we can say the following:

Regarding the weight of the fruit. at this character the population included individuals in the two years of study with an average $\overline{x}$ = 65.5 and 62.7 and 62.7 and with a coefficient of variability s% = 18.5 and 15.5 and 15.5. These coefficients indicate an average variability of the character regarding the average weight of the fruit, being a main characteristic because it indicates the economic value of the character.

The elite fruits had an average height $\overline{x}$ = 5.1 cm in 2018, respectively 5.4 cm in 2019 and a low coefficient of variability. The low variability demonstrates its strong genetic determinism.

Fruit diameter - for this character there is a small variability of the values of the arithmetic mean, and the values of the coefficient of variation are small, which shows that the variability of the variety for this character is small, ie s% = 9.8 and 9.05 respectively.

The shape index is given by the ratio between the height of the fruit and the diameter of the fruit. at this character the average of the individuals being $\overline{x}$ = 1.2 and with a coefficient of variability s% = 11.3 and 10.0 respectively in 2019, which indicates a medium variability for this character.The value of the average of the individuals $\overline{x}$ = 1.2 expresses the shape of the fruit, elongated, egg-shaped that easily detaches from the pedicel, an important characteristic of the typicality and stability of the variety.

The thickness of the pericarp was very important for determining the shape and quality of the fruits, the values of the coefficients of variability, s% = 21.8 and 13.11 respectively being large and medium, influenced by environmental conditions and technological factors.

Regarding the nutritional quality of the fruit, the soluble dry matter showed average values of the coefficient of variability.

Table 3

The variability of the main characters analyzed for the *Romec 554j* variety registered in the period 2018-2019

The analyzed character	2018				2019			
	$\overline{x}$	s	s%	k	$\bar{x}$	s	s%	k
Fruit weight (g)	65.5	12.1	18.5	53.4-77.6	62.7	9.78	15.5	52.93-72.49
Fruit height (cm)	5.1	0.44	8.8	4.6-5.5	5.4	0.48	8.8	4.97-5.93
Fruit diameter (cm)	4.3	0.42	9.8	3.9-4.7	4.5	0.41	9.05	4.12-4.94
Shape index (IF)	1.2	0.13	11.3	1.06-1.30	1.2	0.12	10.0	1.08-1.32
Pericarp thickness (mm)	6.1	1.32	21.8	4.8-7.4	6.4	0.85	13.11	5.63-7.33
Soluble dry matter (SUS%)	5.4	0.78	14.5	4.6-6.2	6.4	0.67	10.4	5.77-7.11

CONCLUSIONS

In the field of choice, the elites of the *Romec 554j* variety showed a medium variability (11.3% and 10.0%, respectively) of the shape index and a small variability (8.8%) of the fruit height, demonstrating the uniformity of the fruits of this variety. The

Romec 554j variety constitutes a homogeneous, uniform and stable population for the main studied characters.

The biological seed material retained for the continuation of the conservative selection process falls within the range of variability (k = dispersion), specific to the *Romec 554j* variety for the studied characters.

Knowing the variability of characters and the limits of variability is of particular importance for conservative selection in the sense that it allows a directed selection, which will result in maintaining the variety in intervals of specificity and authenticity.

REFERENCES

Agong S.G., Schittenhelm S., Friedt W., 2000. Genotipic variation of Kenyan tomato (*Lycopersicon esculentum L.)* germoplasm. in: Plant Gen. Res. Newsl., p. 61-67.

Avdeev Iu., 1982. Ameliorarea tomatelor. Ştiinţa, Chişinău.

Borojevic S., 1990. Principles and Methods of Plant Breeding. Berlin: Acad.-Verlag.

Fasoulas A. Ph.D., 1973. A new approach to breeding superior yielding varieties. Dept.

Haydar A. et al. 2007. Studies on genetic variability and interrelationship among the different traits in tomato (*Lycopersicon esculentum Mill*.). In: Middle-East J. of Scient. Res., 2 (3-4):139-142.

Ordóñez-SantosL. E., Arbones-MaciñeiraE., Fernández- PerejónJ., Lombardero-Fernández M., Vázquez-OdérizL. andRomero-RodríguezA.,2009 “Comparison of physicochemical, microscopic and sensory characteristics of ecologically and conventionally grown crops of two cultivars of tomato *(Lycopersicon esculentum Mill*.),” Journal of the Science of Food and Agriculture, vol. 89, no. 5, pp. 743–749.

Mihnea N., 2008. Variabilitatea fenotipică a caracterelor valoroase ale fructului de tomate. Probleme actuale ale geneticii, fiziologiei şi ameliorării plantelor. Materialele Conferinţei Naţionale cu participare Internaţională, 567-573.

Mihnea N., 2015. ”Manifestation of variability and heritability of some quantitative characters in tomato Scientific Papers. Series B, Horticulture. Vol. LIX, 2015

Mohamed S.M., Ali E.E., Mohamed T.Y., 2012. Study of Heritability and Genetic Variability among Different Plant and Fruit Characters of Tomato (*Solanum lycopersicon L*.). In: Int. J. of Scientific & Technology Research, Vol.1, Issue 2: 55-58

Mohanty B.K., 2002. Studies on variability, heritability interrelationship and path analysis in tomato. In: Ann. Agric. Res.2 (1): 65-69.

Petrescu C., Butnariu H., Radu Gr.,1992. Legumicultură, Editura Didactică și Pedagogică, București.

Săulescu N., 1968. Câmpul de experiență. Editura Agrosilvică, București

*** FAO, Tomato, Food and Agriculture Organization, 2018, http://www.fao.org/faostat/en/#data/QC/.

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ENTOMOFAUNA FROM THE GHIDICI - DOLJ AREA

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Keywords: *entomofauna, harmful species, predators species, parasites species*

ABSTRACT

From our observation regarding the entomofauna of Ghidici area during the research, 89 species of Arthropods were collected and identified (belonging to the orders: Acari, Orthoptera, Dermaptera, Thysanoptera, Homoptera, Hymenoptera, Coleoptera, Lepidoptera, Diptera) of which 72 species are harmful and 17 species are useful parasites or predators. The most numerous order was Coleoptera (44.18%), followed by the order Lepidoptera (13.95%), the order Heteroptera (12.79%), the order Orthoptera and Hymenoptera (7.8%), the order Acari (4, 4%), the order Diptera (3.37%), the orders Homoptera and Neuroptera and Thysanoptera (2.2%) and the order Dermaptera (1.1%).

INTRODUCTION

Ghidici is located in the southern extremity of Dolj County, having as its southern border the Danube river. The total surface of the commune is 4448 ha, of which agricultural 2457 ha (wheat, corn, sunflower, vegetable crops, fruit trees, vines, grassy pastures, forest curtains) and non-agricultural 1522 ha (ponds, roads, constructions). (www.primariaghidici.ro)

The entomofauna is represented both by harmful species specific to the crops in the area, as well as by useful antagonistic species formed by parasites and predators, as well as indifferent species present in the area of ponds or forest curtains to protect the Danube bank.

A series of specific antagonistic relationships are established between harmful and useful species, which under human influence, in the case of agricultural ecosystems, determine the structure of the entomofauna at a certain moment.

Usually in natural ecosystems the balance is established by parasites and predators but also by other abiotic factors such as:physical, chemical, mechanical and biotic ones: pathogens, also called "natural enemies", antagonists, as well food and competition (Toncea 2011)

Classical biological control (natural enemy introductions) has long served as a paradigm for the role of predators and parasitoids in insect herbivore population dynamics, and it is widely held that there is no fundamental difference between successful biological control and the action of native natural enemies 'natural control' (Bradford et al. 1999).

MATERIAL AND METHODS

Observations were conducted during 2019-2020 in the Ghidici – Dolj area.

To determine the structure of the harmful entomofauna were made collection of material using various means and methods: directly by hand from plants or soil, frame metric, soil surveys and soil surface collected, visual inspection, collection with sticky traps for flying insects, light traps, analyzing samples with binocular magnifier glass directly in the field or laboratory.

After collecting of biological material was made the material collected was analyzed and determined with the binocular magnifier glass using the Identification Manual (Panin 1951, Chatened du Gaetan 1990, Chinery 1998, Godeanu 2002,).

For as little impact on the ecosystem we have preferred to capture images with the camera than to capture live specimens were subsequently removed from their natural environment.

RESULTS AND DISCUSSIONS

During the research, 89 species of Arthropods were collected and identified (belonging to the orders: Acari, Orthoptera, Dermaptera, Thysanoptera, Homoptera, Hymenoptera, Coleoptera, Lepidoptera, Diptera) of which 72 species are harmful and 17 species are useful parasites or predators (table no. 1)

Table nr.1

Entomofauna from Ghidici-Dolj area identified during 2019-2020

	Ordinul	
		Harmful species
1.	**ACARI (4 species)**	*Eryophyes vitis Page*
2.		*Tetranychus urticae Koch*
		Beneficial species
1.		*Typhlodromus* spp.
2.		*Amblyseius* spp.
		Harmful species
1.	**ORTHOPTERA (7 species)**	*Gryllotalpa gryllotalpa L.*
2.		*Gryllus campestris L.*
3.		*Gryllus desertus L.*
4.		*Ephippiger ephippiger Fieb.*
5.		*Caliptamus italicus L.*
6.		*Locusta migratoria L.*
7.		*Dociostaurus maroccanus Thunb.*
	DERMAPTERA (1 specie)	***Harmful species***
1.		*Forficula auricularia*
		Harmful species
1.	**THYSANOPTERA (2 specii)**	*Anaphotrips vitis Priesner*
2.		*Haplothrips tritici Kurdj.*
	HOMOPTERA (2 species)	***Harmful species***
1.		*Phylloxera vastatrix Planc*
2.		*Pulvinaria vitis Targ.* vie
		Harmful species
1.	**HETEROPTERA**	*Lygus pratensis L.*
2.		*Dolycoris baccarum L.*
3.		*Eurygaster maura L.*
4.		*Eurygaster austriaca schr.*
5.		*Aelia acuminata L.*
6.		*Aelia rostrata Boh.*

7. 8. 9. 10. 11	**HETEROPTERA (11 species)**	*Eurygaster integriceps L.* *Pirocorys apterus L.* *Eurydema oleracea L.* *Eurydema ornata L.* *Grafosoma lineatum L.*
 1. 2. 3.	**HYMENOPTERA (7 species)**	***Harmful species*** *Vespa vulgaris L.* *Viespea germanica L.* *Vespa crabro L.*
 1. 2. 3. 4.		***Beneficial species*** *Trichograma spp. West.* *Scolia flavifrons F.* *Bombis terestris L.* *Syrcopa violaceea F.*
 1. 2.	**NEUROPTERA (2 species)**	***Beneficial species*** *Crisopa carnea Ste.* *Crisopa perla Steph.*
 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13.	**COLEOPTERA (38 species)**	***Harmful species*** *Melolontha melolontha L.* *Amphimalon solstitialis L.* *Rhizothrogus aequinoctialis Herb.* *Polyphila fullo F.* *Anoxia orientalis L.* *Anomala solida Er.* *Lethrus apterus L.* *Phylopertha horticola L.* *Agriotes obscurus L.* *Agriotes ustulatus schall:* *Agriotes lineatus L.* *Byctiscus betulae L.* *Otiorrhynchus ligustici L.*
14 15 16 17 18 19 20 21 22 23. 24. 25 26 27. 28. 29. 30. 31.		*Epicometis hirta Poda.* *Cetonia aurata L.* *Oxythyrea funesta Poda.* *Anisoplia segetum Herb.* *Anisoplia austrica Herb.* *Anisoplia agricola Poda.* *Zabrus tenebricoides Goeze.* *Melasoma populi L.* *Leptinotarsa decemlineata Say.* *Melasoma populi L.* *Sitona lineatus L.* *Bothynoderes punctiventris Germ.* *Tanymecus palliatus F.* *Tanymecus dilaticollis Gyll.* *Opatrum sabulosum L.* *Subcoccinella 24 punctata L.* *Phytodecta furnicata L.* *Ruguloscolytus rugulosus Ratg.*
 1. 2. 3.	**COLEOPTERA**	***Beneficial species*** *Adalia decimpunctata L.* *Adalia bipunctata L.* *Coccinella 7 punctata L*

4.		*Carabus ulrichi L.*
5.		*Carabus violaceus L.*
6.		*Carabus cancelatus L.*
7.		*Calosoma sycophanta L.*
		Harmful species
1.		*Lobesia botrana Den et Schif*
2.		*Sparganotis pilleriana Den et Schif.*
3.		*Clysia ambiguelia Hb.*
4		*Hyphantria cunea Drury*
5.	**LEPIDOPTERA**	*Agrotis segetum schiff.*
6.	**(12 species)**	*Plusia gamma L.*
7.		*Mamestra brassicae L.*
8.		Zeuzera pyrina L.
9.		*Pieris brassicae l.*
10.		*Pieris rapae L.*
11		*Aporia crataegi L.*
12		*Pieris napi L.*
		Beneficial species
1.		*Syrphus ribesii L.*
2.	**DYPTERA**	*Syrphus torvus L.*
	(3 species)	***Harmful species***
1.		*Musca domestica L.*

The most numerous order was Coleoptera with 38 species (44.18%), out of a total of 89 species of arthropods collected, followed by the order Lepidoptera with 12 species collected (13.95%), the order Heteroptera with 11 species collected (12 , 79%), the order Orthoptera and Hymenoptera with 7 species each collected (7.8%), the order Acari with 4 species (4.4%), the order Diptera with 3 species collected (3.37%), the orders Homoptera and Neuroptera and Thysanoptera with 2 species collected (2.2%), the order Dermaptera with only one species collected (1.1%). (Fig. 1.)

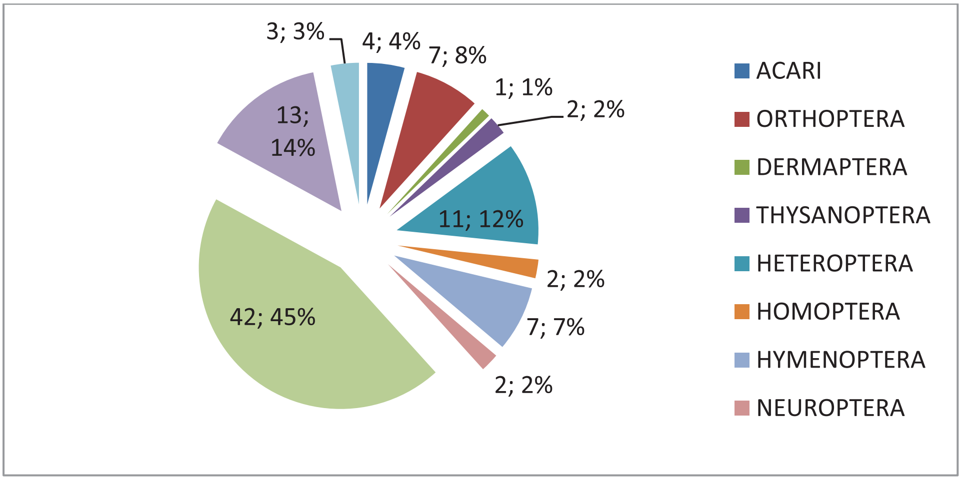

Fig. 1. Systematic distribution of the identified entomofauna

Analyzing from the point of view of the damages caused to the cultivated or spontaneous plants, the structure of the entomofauna characteristic of the studied area, it can be observed that out of the 89 species collected 74.83% are harmful species and 15.17% useful species (parasites and predators) (Fig. 2.)

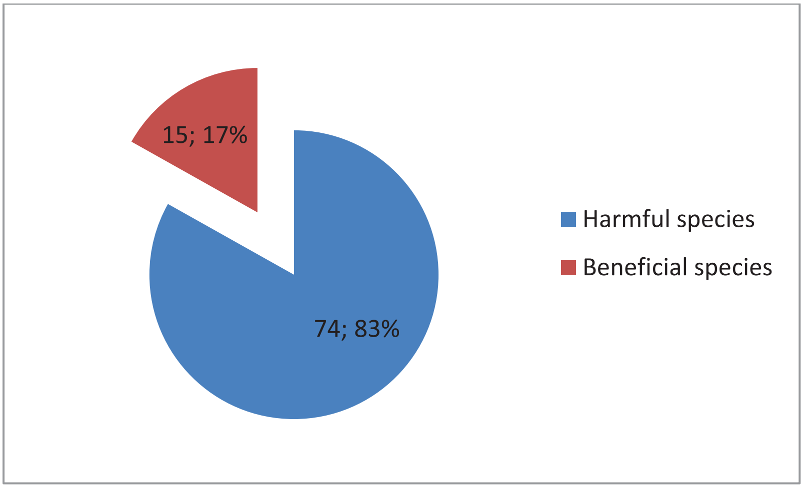

Fig. 2. Identified entomofauna structure

Regarding the useful entomofauna (parasites and predators), from the agroecosystems studied, 17 species were collected, mostly from the order Coleoptera (7 species), the order Hymenoptera (4 species), the orders Acari, Neuroptera and Diptera with 2 species each (table no.2).

Table nr. 2

Beneficial entomofauna

Nr. crt.	Order	Scientific name
1. 2.	**ACARI**	*Typhlodromus* spp. *Amblyseius* spp.
1. 2. 3. 4.	**HYMENOPTERA**	*Trichograma spp. West.* *Scolia flavifrons F.* *Bombis terestris L.* *Syrcopa violaceea F.*
1. 2.	**NEUROPTERA**	*Crisopa carnea Ste.* *Crisopa perla Steph.*
1. 2. 3. 4. 5. 6. 7.	**COLEOPTERA**	*Adalia decimpunctata L.* *Adalia bipunctata L.* *Coccinella 7 punctata L* *Carabus ulrichi L.* *Carabus violaceus L.* *Carabus cancelatus L.* *Calosoma sycophanta L.*
1. 2.	**DYPTERA**	*Syrphus ribesii L.* *Syrphus torvus L.*

Different crops and orchards from Ghidici area

CONCLUSIONS

The entomofauna identified in the Ghidici area corresponds to the agricultural or natural ecosystems in the area. Some of the species identified as pests, for example *Forficula auricularia* or *Vespa* spp. They feed on other insect species, becoming useful at a certain time.

Along with the useful entomofauna in the studied area, there is a rich avifauna that also contributes to the regulation of harmful populations.

There is also a wide variety of mammal species both beneficial and harmful, which feed on insects, in the studied area.

In the area bordering the Danube there are also reptiles and amphibians in which they also consume insects during the period of biological activity of the respective species.

All these species considered useful fully contribute to the regulation of harmful populations, but the greatest contribution has man especially in the arable area (crops, vegetables, orchards, etc.) where it intervenes on harmful species when the economic threshold is exceeded. of damage.

REFERENCES

Bradford A. Hawkins, Nick J. Mills, Mark A. Jervis and Peter W. Price, 1999. *Oikos* Vol. 86, No. 3 (Sep., 1999), pp. 493-506. Published by: Wiley-Blackwell, http://www.jstor.org/stable/3546654.

Chatened du Gaetan, 1990. Guide des Coleopteres d'Europe. Delacrois et Niestle, Paris.

Chinery M., 1998. Guida degli inseti d"Europa. Grupo editoriale Franco Muzzio editore, Padova, Italy.

Godeanu S.P.,2002: Diversitatea lumii vii. Determinatorul ilustrat al florei şi faunei României, Ed. Bucura Mond, Bucureşti, 2002.

Panin L, 1951. Determinatorul Coleopterelor dăunătoare şi folositoare din R.P.R. Editura de Stat, Bucureşti.

Toncea I., 2011. Perspective in controlul populatiilor de insecte Revista Fermierul online :martie 2011. ISSN 1843-0821.

www.primariaghidici.ro pentru informatii despre zona studiata.

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BEHAVIOR OF MAIZE TO THERMOHYDRICAL STRESS IN THE AREA OF SANDY SOILS, ACCORDING TO THE FERTIRIGATION REGIME

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***Keywords**: sand, humidity deficit, stress, yield, maize*

ABSTRACT

Studies conducted on maize, located on sandy soils in southern Oltenia, were focused on the influence of root and foliar fertilization, correlated with underground irrigation on soil moisture dynamics during the growing season also on morphological, physiological and productivity parameters of the plant. Soil moisture determinations revealed a moisture deficit on the depth of 0-20 cm, between -105.2-31.2 m^3/ha, at the watering minimum limit of 1/3 of active humidity range (a.h.r). and -90.53… 86.5 m^3/ha, at the limit of 1/2 of a.h.r, deficit more pronounced during July, in the phase of appearance of the panicle until the formation of grains on cobs, accentuate the importance of irrigation on sandy soils.

Maize best exploited the microclimate achieved by underground irrigation at the minimum limit of 1/2 in the range of active soil moisture, by fertilizing with $N_{150}P_{80}K_{80}$ + foliar fertilization with ALBIT product at a dose of 40 ml/ha, recording a maximum yield of 9089 kg/ha, with a distinctly significant difference of 3919 kg/ha, compared to the non-fertilized variant.

INTRODUCTIONS

Under sustainable agriculture conditions, obtaining high and stable maize yields cannot be accomplished without the controlled application of macro- and microelement fertilizers, as a means of restoring in the soil the mineral elements extracted at harvest (Yu H. et. al 2009). Soil fertility requisite are an important issue, which determines the development of the root system. In case of fertile soils, the roots go deeper underground and are much more branched than in less fertile soils (Florin CRISTA et al. 2010). Foliar fertilizers are unanimously considered as products with stimulating and correction effect of mineral nutrition, with secondary fertilizing role, which causes a significant increase in productive consumption of soil elements, without substituting fertilization methods through the root system, against which foliar fertilizers have additional (complementary) role in balancing and optimizing the respective fertilization system applied to agricultural plants (El Hallof Nóra 2007, Rusu M. et al. 2008). The results obtained in the Oltenia region showed that the drought in the flowering phase, of maize, significantly reduced the yield of the plant by 60.5%, especially due to the increase in the number of sterile plants by 220.5% (Bonea & Urechean 2017). Efficient use of water by modern irrigation systems is becoming increasingly important in arid and semi-arid regions with limited water resources (E. El-Hendawy et al. 2008). Maize has a maximum sensitivity to drought starting with the phase of formation of reproductive organs and until after fecundation, especially at the formation of the ovule, the embryo sac and in macrosporogenesis (Mureșan et al. 1975). Research conducted by Dorina Bonea and Viorica Urechean, 2011, showed that in the region of southern Oltenia, the tolerance of 21 maize hybrids is significantly influenced by increasing the water stress of the plant. In this sense, research was initiated on the maize crop located in the vegetation house of SCDCPN Dăbuleni, which aimed to reduce the negative effect of thermohydric stress by ensuring an optimal fertigation regime.

MATERIALS AND METHODS

The researches were carried out in the period 2019-2020 at R&DSPCS Dăbuleni, and focused on the reaction of the maize plant to the thermohydric stress in the south of Oltenia, depending on the fertigation regime. The study was carried out in a controlled regime, by sowing maize in the vegetation house, in vessels filled with sand with a low natural fertility, having a low total nitrogen content (0.044% - 0.085%) and a medium supply of extractable phosphorus (27- 35 ppm) and exchangeable potassium (45-80 ppm), Figure 1. The experiment was designed according to the method of plots subdivided with two factors, following the effect of underground fertigation at the level of two soil humidity limits. At the time of filling the pots with sand, it was fertilized with complex fertilizers type $N_{16}P_{16}K_{16}$, in a dose of $N_{80}P_{80}K_{80}$. In the phenophase of 5-7 leaves of maize plants, the difference of the nitrogen dose, respectively N_{70}, was applied, through underground fertilization, according to the fertilization variant. Foliar fertilization was done with the biostimulator (protective and stimulating agent) ALBIT, at a dose of 40 ml/ha. The soil moisture was determined dynamically with the help of the ThetaKit device - portable kit and hydrophysical indices were calculated to establish the watering rate, according to the two irrigation limits, of 1/3 and 1/2 of the active humidity range.

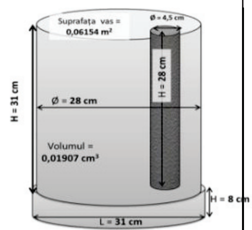

Figure 1. Experimental pot

Hydrophysical soil indices were calculated using the following calculation formulas:

Current supply = (100*H*Da*W)

W = soil humidity (%); H = depth of soil (m); Da = apparent soil density

Wilting coefficient (WC) = 100*H*Da* WC

Field capacity (FC) = 100*H*Da*FC

Minimum limit for water (1/3 of a.h.r. to a depth of 30 cm) = WC +1/3 (FC - WC)

Water supply = Momentary supply – Minimum limit

Water deficit = Current supply – Field capacity

Hydrophysical indices of sandy soil: Da=1.38-1.46 g/cm^3; WC = 2; FC = 9

Determinations regarding plant physiology (water forms), productivity and quality of plant nutrition were performed: total N (Kjeldahl method), total P (colorimetric method), total K (emission photometry dosing method in flame). The water forms and the dry matter in the leaves were determined gravimetrically. The calculation and interpretation of the results was performed according to the experimental technique (ANOVA Program).

RESULTS AND DISCUSSIONS

The results obtained, regarding the soil humidity, performed by determinations at intervals of 7-10 days between June 22 (the developmental phase of the foliar apparatus) - August 13 (the milk-dough phase of the grain), were correlated both with the developmental phase of the plant, as well as with the fertigation regime of the plant, the lowest values of soil humidity and implicitly the highest consumption being registered in the period 2-19 July, which corresponds to the phenophases of panicle occurrence-grain formation. Analyzing the soil humidity in the layer 0-20 cm, relating with the minimum irrigation limit, it is distinguish with the best results when irrigation was performed at the limit, of 1/2 in the range of active humidity, the value of humidity recorded was 0.21% higher compared with the one recorded at the limit of 1/3 of a.h.r. (Figure 2).

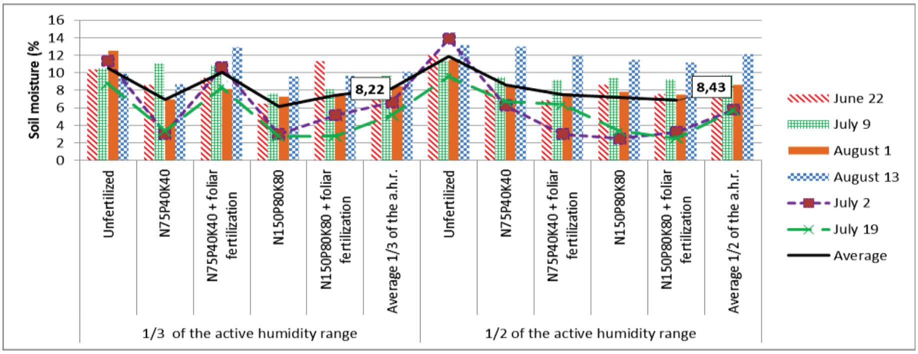

Figure 2. Soil humidity dynamics during the maize vegetation period

Soil humidity determinations showed a humidity deficit at a depth of 0-20 cm, between -105.2…-31.2 m^3/ha, at the watering limit of 1/3 of i.u.a. and -90.53…86.5 m^3/ha, at the limit of 1/2 of a.h.r., a more pronounced deficit during July, in the phase of the appearance of the panicle until the formation of grains on cobs, accentuate the importance of irrigation on sandy soils (Figure 3).

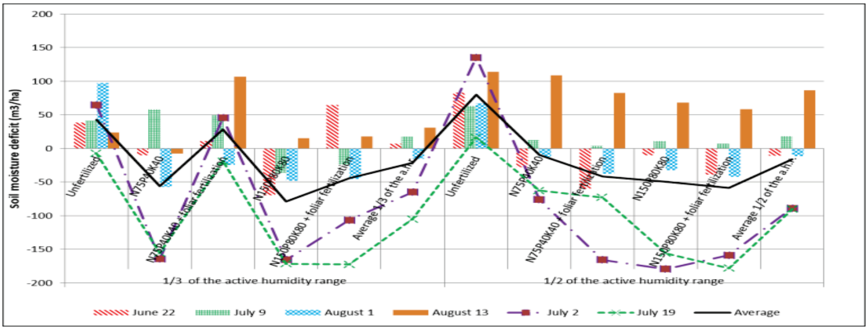

Figure 3. Evolution of the deficit compared to the field capacity on the soil profile during the water consumption period of the maize plant

Because optimally fertilized plants have a high water consumption, the water deficit in these variants was higher, compared to the non-fertilized variant, requiring a higher irrigation rate. In order to ensure an irrigation norm of 300 m^3 per hectare, in the small development phases of the plant and of 400 m^3/ha, in the phases of maximum consumption for water (July 9 – August 13), the irrigation norm were calculated, between 0.72-1.92 liters/vegetation pot (June 22) and between 3.03-3.3 liters/vegetation pot (July 19). Subjected to thermal stress, maize plants irrigated with 1/3 of a.h.r. recorded a higher bound water content (3.29%) compared to plants to which a higher amount of irrigation water is applied (3.14%), Table 1. It was particularly distinguished the variant fertilized with $N_{150}P_{80}K_{80}$ + foliar fertilization, with a bound water content of 5.34%, this value being a response of plants to thermo-hydric stress correlated with high doses of chemical fertilizers. Also, the concentration of vacuolar juice that shows a reaction of plants to defend under stress conditions was positively correlated with rates of irrigation and fertilization, the values of this physiological index was situated in range of 5.3-9.1%. Research conducted in Iran showed that underground maize irrigation in arid and semi-arid regions has a higher efficiency on reducing thermohydric stress compared to surface irrigation (Sepaskhah et al. 2003).

Table 1

Influence of fertigation on physiological indices in maize grown under stress conditions 2019/2020

Irrigation variants	Fertilization variants	Dry substance (%)	Total water (%)	Free water (%)	Bound water (%)	Vacuolar juice (%)
1/3 of a.h.r.	Unfertilized	23.52	76.48	73.63	2.85	5.3
	$N_{75}P_{40}K_{40}$	23.91	76.09	73.53	2.56	5.9
	$N_{75}P_{40}K_{40}$ + foliar fertilization	20.09	79.91	77.3	2.6	6.1
	$N_{150}P_{80}K_{80}$	26.59	73.41	70.29	3.12	5.6
	$N_{150}P_{80}K_{80}$ + foliar fertilization	22.16	77.84	72.49	5.34	6.7
Average 1/3 of the a.h.r.		23.25	76.75	73.45	3.29	5.92
1/2 of a.h.r.	Unfertilized	21.22	78.78	76.12	2.65	6.8
	$N_{75}P_{40}K_{40}$	25.04	74.96	71.87	3.08	6.1
	$N_{75}P_{40}K_{40}$ + foliar fertilization	23.05	76.95	73.43	3.53	7.6
	$N_{150}P_{80}K_{80}$	23.38	76.62	73.78	2.84	9.1
	$N_{150}P_{80}K_{80}$ + foliar fertilization	21.05	78.95	76.51	2.44	8.2
Average 1/2 of the a.h.r.		23.08	76.92	73.88	3.14	7.56

Maize crop yield has been improved by using underground irrigation in combination with balanced fertigation and adequate irrigation scheduling (Table 2). Ensuring a balanced nutrition by applying a fertilization with $N_{150}P_{80}K_{80}$ + foliar fertilization with 40 ml/ha *ALBIT*, at a minimum humidity limit of 1/2 of the active humidity range provided by underground irrigation, led to the best yield results (9089 kg/ha). Fertilization brought statistically assured yield increases compared to non-fertilized, which were between 3232-4565 kg/ha at the limit of 1/3 of a.h.r. and 2448-3910 kg/ha at the limit of 1/2 of a.h.r.. The results obtained regarding the nutritional status of the foliar apparatus emphasized a reduced supply in total nitrogen and total potassium and a normal to high supply state in total phosphorus. The literature mentions that underground drip fertigation can increase the production of corn cobs compared to surface fertigation, because immobile nutrients are applied in the soil, at the root and not in the top of the soil, having an essential role in stimulating plant rooting (Martinez Hernandez et al 1990, Junaid Nawaz Chauhdary 2019).

Table 2

Influence of fertigation on foliar diagnosis and on the production of cobs at maize sown under thermohydric stress conditions

Irrigation variants	Fertilization variants	Production of cobs		Nutritional status of foliage (%)		
		kg/ha	The difference compared to the control (kg/ha)	Total nitrogen	Total phosphorus	Total potassium
1/3 of a.h.r.	Unfertilized	4111	Control	1.95	0.44	2.29
	$N_{75}P_{40}K_{40}$	7343	3232.0**	2.04	0.51	2.58
	$N_{75}P_{40}K_{40}$ + foliar fertilization	8511	4400.0**	2.20	0.54	3.42
	$N_{150}P_{80}K_{80}$	7961	3850.0**	2.29	0.53	2.44
	$N_{150}P_{80}K_{80}$ + foliar fertilization	8676	4565.0***	2.22	0.82	2.54
1/2 of a.h.r.	Unfertilized	5170	Control	1.86	0.52	2.28
	$N_{75}P_{40}K_{40}$	7618	2448.0*	2.09	0.62	2.53
	$N_{75}P_{40}K_{40}$ + foliar fertilization	8580	3410.0**	2.19	0.63	2.50
	$N_{150}P_{80}K_{80}$	8649	3479.0**	2.20	0.56	2.65
	$N_{150}P_{80}K_{80}$ + foliar fertilization	9089	3919.0**	2.31	0.64	2.81
	LSD 5%		2062	Optimal supply field (after C. Răuță, 1980)		
	LSD 1%		3000			
	LSD 0.1%		4500	3.5-5	0.3-0.5	3-4

CONCLUSIONS

Soil humidity determinations showed a humidity moisture deficit at a depth of 0-20 cm, between -105.2… -31.2 m^3/ha, at the watering limit of 1/3 of a.h.r. and -90.53…86.5 m^3/ha, at the limit of 1/2 in a.h.r.

The concentration of vacuolar juice which is a reaction of plants to defend themselves under stress conditions has been positively correlated with norms of irrigation and fertilization, the values of this physiological index were in the range of 5.3-9.1%.

There was an improvement in the quality of the maize plant by underground fertilization with $N_{150}P_{80}K_{80}$ and foliar fertilization with 40 ml/ha *ALBIT*, applied in the phase of 6-8 leaves of the plant.

Ensuring a balanced nutrition by applying a fertilization with $N_{150}P_{80}K_{80}$ + foliar fertilization with 40 ml/ha *ALBIT*, at a minimum humidity limit of 1/2 of the active humidity range, ensured by underground irrigation, led to the best results production (9089 kg/ha).

Fertilization brought statistically assured production increases compared to non-fertilized, which were between 3232-4565 kg/ha at the limit of 1/3 of a.h.r. and 2448-3910 kg/ha at the limit of 1/2 of a.h.r.

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REFERENCES

Bonea Dorina, Viorica Urechean, 2017. Study on the selection for drought tolerance of some semi-late maize hybrids cultivated at A.R.D.S. SIMNIC. Analele Universităţii din Craiova, seria Agricultură – Montanologie – Cadastru (Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series) Vol. XLVII: 41-49.

CRISTA Florin, Florin SALA, Isidora RADULOV, Laura CRISTA, 2010. The impact of mineral fertilization upon some maize hybrids crop from zemun polje. Research Journal of Agricultural Science, 42 (3), 2010, p. 88-91.

Dorina Bonea, Viorica Urechean, 2011. The evaluation of water stress in maize (zea mays l.) using selection indices. ROMANIAN AGRICULTURAL RESEARCH, NO. 28, 2011. Print ISSN 1222-4227; Online ISSN 2067-5720, pag. 79-86

E. El-Hendawy, Essam A. Abd El-Lattief, Mohamed S.Ahmed, Urs Schmidhalter, 2008. Irrigation rate and plant density effects on yield and water use efficiency of drip-irrigated corn. Agricultural Water Management. Volume 95, Pages 836-844.

El Hallof Nóra, 2007. Effect of nutrient supply on yield quality and quantity of maize (Zea mays L.) hybrids, In: Acta Agronomica Óváriensis, vol. 49, number 2/1, University of West Hungary, Faculty of Agricultural and Food Sciences, Mosonmagyaróvár, pag. 237-241.

Junaid Nawaz Chauhdary, Allah Bakhsh, Bernard A. Engel, Ragab Ragab, 2018. Improving corn production by adopting efficient fertigation practices: Experimental and modeling approach. Agricultural Water Management, Volume 221, Pages 449-46.

Marinică Gh. Nicolescu M., 1996. Rezultate experimentale privind consumul de apă şi regimul de irigaţii la cultura porumbului pentru boabe pe nisipuri modelate. Lucrări ştiinţifice ale SCCCPN Dăbuleni, România.

Martinez Hernandez, J.J., Bar-Yosef, B., Kafkafi U., 1990. Effect of surface and subsurface drip fertigation on sweet corn rooting, uptake, dry matter production and yield. Irrigation Science, Vol.12, pag.153-159.

Mureşan T., Ţerbea Maria, Hurduc N., Ţîrcomnicu Marina. 1975. Contribuţii la studiul rezistenţei fiziologice a hibrizilor de porumb la atacul de Fusarium moniliforme. An. ICCPT, 40, 187-19.

Rusu M., Marghitas Marilena, Mihaiescu Tania, Oroian I., Todea Al., Rusu Mihaela, Bordea C., Toader C. 2008. Fertilizantii foliari – conditii agrochimice de aplicare. Lucrarile Conf. XVIII-a SNRSS 2006, vol. 2, 75-85.

Sepaskhah A.R, Kanooni A, Ghasemi M.M, 2003. Estimating water table contributions to corn and sorghum water use. Agricultural Water Management, Volume 58, Pages 67-79.

Yu H., G. Chen, D. Liu, 2009. Research and application of precision fertilization on maize, In: IFIP International Federation for Information Processing, Volume 293, Computer and Computing Technologies in Agriculture II, Volume 1, eds. D. Li, Z. Chunjiang, (Boston: Springer), pag. 477-486.

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STUDIES REGARDING THE ABUNDANCE AND DOMINANCE OF SOME INSECTS SPECIES FROM AN VEGETABLE FARM FROM BRĂDEȘTI AREA, DOLJ

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Keywords: *entomofauna, harmful species,beneficial species, abundance, dominance*

ABSTRACT

The study was conducted in 2019 during the months of May to September in Brădești (Dolj) area. In this vegetable farm there is a strong correlation between areas of vegetation (which provides food and shelter) and territorial distribution of entomofauna.During our research we have captured a total of 33 species belonging to 10 orders and 21 families. Following our studies we hve determined the abundance and the dominance of the collected species.

INTRODUCTION

Importance of the entomofaunistic study lies in highlighting and determine the distribution of insect species in a given area, of particular importance in achieving ecological studies in highlighting the biodiversity of a given area (Țucă et al. 2013).

Insects are the largest systematic unity of the animal kingdom, with a million extant species, that is several times more than all other living taxa together, is still a very conservative estimate, and their real number is for sure many times more. They are incomparably diverse in terms of their size, structure and way of life. (Rasnitsyn 2002).

They have permeated the diverse and essential natural processes that sustain biological systems, making up over 75% of known species of animals. Indeed, our present ecosystems would not function without insects and arachnids. They can live in just about any situation or climate. Certain insects are helpful to us by producing products we can use (for example, honey), by pollinating our crops, or by attacking pest insects. Knowledge of arthropods also is essential to conserve or manage ecosystems, because a skewed focus only on large and conspicuous organisms misrepresents ecosystem dynamics (Kremen et al. 1993; Finnamore 1996).

MATERIAL AND METHODS

The study was conducted in 2019 during the months of May to September in Brădești (Dolj) area. In this vegetable farm there is a strong correlation between areas of vegetation (which provides food and shelter) and territorial distribution of entomofauna.

To determine the structure of the harmful and beneficial populations were made collection of material using various means and methods: directly by hand from plants or soil, frame metric, soil surveys and soil surface collected with entomological net, visual inspection, collection with sticky traps for flying insects, analyzing samples with binocular magnifier glass directly in the field or laboratory (Stan et al. 2012). Collecting the biological material has been made every two weeks, after that the entomological material was analyzed and determin. For as little impact on the ecosystem we have preferred to capture images with the camera than to capture live specimens were subsequently removed from their natural environment.

In order to establish the species dominance we have used the formula:

$D_A = n_A \backslash N \times 100$

n_A = the total number of individuals of species A, found in the research samples

N = total number of individuals of all species present in the investigated samples

D_A = dominance of the respective species

The clasification of the species from the dominance point of view has been made acording to:

D_1 - subrecedent - less than 1.1%

D_2 - receding - between 1.1 - 2%

D_3- subdominant - between 2.1 - 5%

D4- dominant - between 5.1 - 10%

D5- eudominant - over 10%

RESULTS AND DISCUSSIONS

The studies were carried out during May and September 2019 in a vegetable farm in Brădești, Dolj County, vegetable species grown eggplant, peppers, cabbage.

The collection of biological material was done in the following dates: 20.05; 1.06; 15.06; 4.07; 13.07; 5.08; 17.08; 31.08; 18.09.

In 2019, the results regarding the structure of the entomofauna from a vegetable farm in the Bradesti area, included the identification of 33 species belonging to the Insecta class, summing a number of 435 specimens collected.

The collected insects were systematically classified in 9 orders (Orthoptera - 14 species, Homoptera - 3 species, Hetroptera - 3 species, Hymenoptera - 5 species,, Odonata - 1 species, Mecoptera - 1 species, Coleoptera - 26 species, Lepidoptera - 7 species and Diptera - 1 species belonging to 21 families.

Table nr.1

Abundance and dominance of the species collected in an vegetable farm from Brădești, during 2019

Nr.	Denumirea specie	Abundance	Dominance
1.	*Gryllotalpa gryllotalpa*	8	1,83
2.	*Gryllus campestris L*	13	2,98
3.	*Gryllus desertus L*	9	2,06
4.	*Dociostaurus maroccanus* Thunberg	15	3,44
5.	*Graphysoma lineatum L*	13	2,98
6.	*Eurydema ornate L*	18	4,13
7.	*Eurydema oleraceae L*	17	3,90

8.	*B0mbus terrestris*	11	2,52
9.	*Apis melifera L.*	9	2,06
10.	*Xilocopa violaceae* L.	7	1,65
11.	*Vespa vulgaris L*	10	2,29
12.	*Vespa germanica L*	9	2,06
213.	*Libelula depresa L*	6	1,37
14.	*Panorpa communis L.*	5	1,14
15.	*Leptinotarsa decemlineata*	14	3,21
16	*Phyllotreta atra L.*	22	5,05
17.	*Phyllotreta nemorum L.*	25	5,74
18	*Carabus cancellatus*	4	0,91
19.	*Carabus violaceus*	5	1,14
20.	*Calosoma sycophanta*	7	1,60
21.	*Adalia bipunctata*	18	4,13
22.	*Coccinella septempunctata*	23	5,28
23.	*Amara crenata*	3	0,68
24.	*Melolontha melolontha L.*	6	1,37
25.	*Pterostichus niger*	15	3,44
26.	*Harpalus afinis*	7	1,60
27.	*Opatrum sabulosum*	11	2,52
28.	*Pieris Brassicae L.*	26	5,97
29.	*Pieris rape L.*	23	5,28
30.	*Pieris napi L.*	25	5,74
31.	*Mamestra brassicae L.*	16	3,67
32.	*Autographa gamma L.*	4	0,91
33	*Daphnis nerii L.*	5	1,14
34.	*Arginis paphya*	4	0,91
35.	*Delia brassicae*	4	5,05
Total		435	

D_1 - subrecedent - less than 1.1%: *Carabus cancellatus, Amara crenata, Autographa gamma L Arginis paphya* 4 species

D_2 - receding - between 1.1 - 2% *Gryllotalpa gryllotalpa, Xilocopa violaceae L., Libelula depresa L, Panorpa communis L., Carabus violaceus,, Calosoma sycophanta, Melolontha melolontha L., Harpalus affinis, Daphnis nerii L*., 9 species

D_3- subdominant - between 2.1 - 5% *Gryllus campestris L, Gryllus desertus L, Dociostaurus maroccanus Thunberg, Graphysoma lineatum L, Eurydema ornate L, Eurydema oleraceae L, B0mbus terrestris, Apis melifera L., Vespa vulgaris L, Vespa german , Leptinotarsa decemlineata, Phyllotreta atra L., Phyllotreta nemorum L., Adalia bipunctata, Coccinella septempunctata, Pterostichus niger, Opatrum sabulosum, Pieris Brassicae L., Pieris rape L., Pieris napi L., Mamestra brassicae L. Delia brassicae*. 22 species

CONCLUSIONS

From the analysis of the data on the dominance of the species collected and identified from some vegetable crops, it results that the largest share had the subdominant species (22 species), followed by the receding species (9 species) and 4 subreciding species.

Among the dominated species (22 species) were identified 4 useful species *Bombus terrestris, Apis melifera L., Adalia bipunctata, Coccinella septempunctata*.

From the total of 35 species 20 species are harmful, among these some with high economical importance such as: *Agriotes lineatus L., Dociostaurus maroccanus Thngb., Gryllotalpa gryllotalpa L., Mamestra brassicae L., Autographa gamma L., Mamestra brassicae L., Pieris brassicae L., Pieris rapae L*.

REFERENCES

Finnamore A.T. 1996. The advantages of using arthropods in ecosystem management in A brief from the Biological Survey of Canada (Terrestrial Arthropods).

Kremen C., R. K. Colwell T. L. Erwin D. D. Murphy R. F. Noss and Sanjayan M. A. 1993. Terrestrial arthropod assemblages: their use in conservation planning. Conservation Biology 7: 796-808.

Rasnitsyn A.P. 2002. History of Insects. Kluwer Academic Publishers,

Stan C., Țucă O., Ștefănescu M., Ciupeanu Călugăru Eleonora Daniela, Roșca Camelia Aida. 2012. Harmful and beneficial species and the relationships Between them within the ecosystem Nicolae Romanescu park. Annales of the University of Craiova, vol. XVII (LIII): 825 – 831.

Ţucă O. , Stan C., Mitrea, 2013, Entomofauna from the plenita (dolj) area. Annales of the University of Craiova, vol. XVIII (LIV): 657 – 660.

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STUDY ON GASTROESOPHAGEAL REFLUX DISEASE

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***Keywords**: hiatal hernia, gastroesophageal reflux, diagnosis*

ABSTRACT

The objective of this study is to evaluate clinical, etiopathology and diagnosis of gastroesophageal reflux disease. There were examined clinically and radiologically 5 patients who presented the symptoms suggestive of this diagnosis. The indicated treatment was customized according to the determining causes of the disease and the associated pathology, indicating the change of lifestyle with combating against obesity, smoking, hygienic-dietary diet, probiotics, medication such as proton pump inhibitors, or surgery. in severe cases.

INTRODUCTION

Hiatal hernia is the protrusion of the stomach into the supradiaphragmatic floor. Most hernias are asymptomatic, but the increased incidence of acid reflux leads to symptoms of gastroesophageal reflux disease. (GERD). (Diaconu 2016)

In some situations paraclinical methods are required for diagnosis, mainly upper digestive endoscopy, computed tomography and esophageal pH-metry. (Harrison 2014).

Gastroesophageal reflux disease (GERD) patients have a high prevalence of airway symptoms, including chronic cough, wheezing, hoarseness, frequent throat clearing, throat discomfort or pain, and voice fatigue.(Tustumi 2020).

Patients with gastroesophageal reflux disease report an altered state of health, with decreased work capacity, sleep disorders and, hence, decreased quality of life. (Diaconu 2016).

Normally, the body has a number of mechanisms that prevent prolonged, frequent reflux of gastric contents into the esophagus, and alteration of these mechanisms causes pathological gastroesophageal reflux. At present, there is no known treatment for gastroesophageal reflux disease that would lead to a normalization of patients' quality of life in all cases. The existing treatment is represented both by acid suppression therapy with proton pump inhibitors (PPIs) and changes in lifestyle and diet, and by surgical fundoplication, preferably laparoscopically.

MATERIAL AND METHODS

The study was represented by a group of 5 patients with symptoms suggestive of gastroesophageal reflux disease. They were clinically examined by the following methods: standard radiological examination, radiological examination with contrast agent, computed tomography, ultrasound, scintigraphy.

Radiological examination - The sensitivity of radiology in detecting gastroesophageal reflux is about 40%, but provides details of anatomical changes such as hiatal hernia, esophageal motility and may reveal structural damage: esophageal stenosis, ulcers, diverticula, tumors, etc. It is also useful because it shows the existence of spontaneous or induced reflux. The use of radiology in gastroesophageal reflux disease is quite little used today, being used mainly in the evaluation of long segments of stenosis that cannot be crossed with the endoscope and in the diagnosis of hiatal hernia.

Standard radiological examination - It is relatively easy to perform and is required in the preoperative protocol, as it can detect the presence of indirect signs of hiatal hernia.

RESULTS AND DISCUSSIONS

From the 5 patients selected, the most representative case was patient R. D., aged 64, presented homself to the specialist clinic, with the following symptoms: heartburn, abdominal pain in the right hypochondrium, nausea, vomiting, acid regurgitation, epigastralgia, marked physical and mental asthenia. From the personal pathological antecedents the following are retained: chronic viral hepatitis B, circulatory insufficiency. For the diagnosis, radiological examinations were performed.

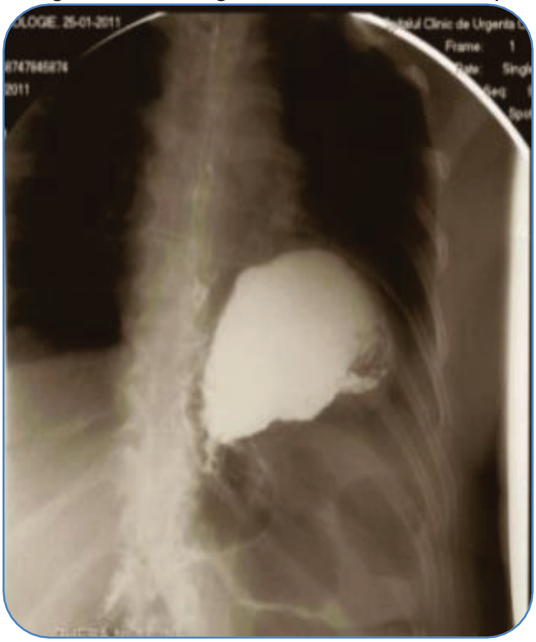

Fig. 1. Radiological aspect of voluminous hiatal hernia, fixed intrathoracically

Based on the symptoms, the diagnosis of gastroesophageal reflux disease was suspected, for which simple thoraco-pulmonary radiographs were performed. as a result of which he was diagnosed with a hiatal hernia.

The treatment is based on the symptoms of GERD. Medical treatment with proton pump inhibitors is effective in most patients, but can be time consuming and expensive.

Fig. 2. Hiatal hernia - simple chest X-ray

Among the risk factors for gastroesophageal reflux disease are: alcohol consumption, smoking, obesity, consumption of spicy or aromatic foods, administration of drugs.

Smoking decreases the ability of the lower esophageal sphincter to function properly, increases acid secretion, reduces salivation that helps neutralize the acid. So far, it is not known whether smoking, nicotine or both trigger gastroesophageal reflux disease. Some people who use nicotine patches to quit smoking have heartburn, but it is not known if they are nicotine products or stress. In addition, smoking can lead to emphysema, which is itself a risk factor for gastroesophageal reflux disease.

Alcohol has mixed effects on gastroesophageal reflux disease: it relaxes the muscles and the lower esophageal sphincter, but large amounts of alcohol can irritate the lining of the esophagus, while small amounts can actually protect the lining of the lining.

Both caffeinated coffee and decaffeinated coffee reduce the pressure of the lower esophageal sphincter, increasing gastroesophageal reflux.

CONCLUSIONS

The main symptoms that cause patients to see a doctor and that lead to the diagnosis of gastroesophageal reflux disease are: heartburn, abdominal pain, gastric acidity, regurgitation, nausea, etc.

Increased prevalence of hiatal hernia, increased intra-abdominal pressure and vagal abnormalities in obese patients may cause increased secretion of bile and pancreatic enzymes, so these components of reflux increase aggression on the esophageal mucosa.

There is no predilection for one sex or the other: gastroesophageal reflux disease is common in both men and women, but, nevertheless, the male-female ratio for the incidence of reflux esophagitis is 2:01-03:01. Gastroesophageal reflux disease is common in all age groups, but the occurrence of esophageal reflux at a younger age in male patients may be related to differences in lifestyle between men and women.

Interest in the surgical treatment of pathological gastroesophageal reflux has increased due, on the one hand, to the appearance of laparoscopy and, on the other hand, to the awareness that reflux esophagitis is a major risk factor for Barrett's esophagus and esogastric junction adenocarcinoma.

Some medications, such as sedatives, tranquilizers, and beta-blockers, may be a cause of gastroesophageal reflux disease.

REFERENCES

Diaconu Camelia: Explorari functionale in medicina interna, Editura All, 2016.

Diaconu Camelia, Bartos Daniela. 2015. De la Simptom la diagnostic in medicina interna, Editura All.

Francisco Tustumi, Wanderley Marques Bernardo, Julio Rafael Mariano da Rocha, Sergio Szachnowicz, Francisco Carlos Bernal da Costa Seguro, Edno Tales Bianchi, Fl_avio Roberto Takeda, Antonio Afonso de Miranda Neto, Rubens Antonio Aissar Sallum, Ivan Cecconello: Anti-reflux surgery for controlling respiratory symptoms of gastroesophageal reflux disease: A systematic review and meta-analysis. Asian Journal of Surgery xxx (xxxx) xxx.https://doi.org/10.1016/j.asjsur.2020.04.017.

Harrison. 2014., Editia XVIII, Manual de medicina interna, Editura All.

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THE RIPARIAN FOREST OF ALNUS GLUTINOSA OF AESON RIVER CENTRAL MACEDONIA, N. GREECE

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ABSTRACT

Aeson river is the largest river in the prefecture of Pieria in central Macedonia. A riparian forest with rich biodiversity grows along the river. Purpose of this research is to study the structure of riparian alder stands, to assess the ecological value.

The survey recorded that the riparian forest of Alnus glutinosa is a young stand, in wich the average Dbh is 10.30 cm and Height 5.45m. 86% of number trees is upper – storey. The natural regeneration of riparian forest species is non-existed. The stands of common alder need management measures because of the strong presence of human activities in the area.

Key words: *riparian forest, Aison river, C. Macedonia, Alnus glutinosa*

INTRODUCTION

The riparian forests of alder are found in riparian areas of central and mainly northern Greece. The study of riparian forest structure is the basic tool for ecological assessment and proper management (Efthimiou, 2000; 2012; Efthimiou et al 2015). The species of alder that dominates the riparian forests of Greece is mainly *Alnus glutinosa* (L.) Gaertn.

The alder is a riparian forest specie that occurs to a limited extent in the remaining riparian forests of the country (Efthimiou et al. 2016). Forests of *Alnus glutinosa* are characterized as priority habitat with code 91E0 and protected in accordance with the European Directive 92/43/EEC. It is a riparian forest specie with medicinal properties (http://mediplantepirus.med.uoi.gr)

An important river of central Macedonia is the Aeson river with its ancient Greek name. It originates on the eastern side of Mount Olympus (the mountain of the ancient Greek gods) and with a length of 50 km, flows into the Thermaic Gulf (Lycopoulou 2020). In the area of Neokaisaria, at a distance of 7 km from Katerini, capital of the prefecture of Pieria, grows an important riparian forest mainly with plane trees, on either side of the riverbed of the river Aeson. In this riparian forest are found pure clusters of alder, which increase its biodiversity (Figure 1).

Map. 1. The case study
https://www.geogreece.gr

Figure 1. *Alnus glutinosa* plots
(photo: Ch. Lycopoulou)

The aim of this study is to research the structure of riparian forest of *Alnus glutinosa*.

MATERIALS AND METHODS

In order to study the structure of the riparian forest of Neokessaria, representative sample plots were established, 0.1 hectare (Ha) in size. In each sample plot were measured diameter at breast height (Dbh) and total height of all trees with a diameter greater than 4 cm. The measurements were made in Autumn 2019. Additionally all trees were classified according to the IUFRO classification system. The statistical analysis was carried out by the use of SPSS ver. 22.

Figure 2. *Alnus glutinosa* plots (photo: Ch. Lycopoulou)

RESULTS AND DISCUSION

The natural riparian forest of the study area occurs on a substrate comprising the fan alluvial, alluvial deposits, alluvial valleys, with Dominant species: *Salix alba, Platanus orientalis, Juglans regia, Ulmus minor, Alnus glutinosa, Celtis australis*. Also important is the presence of climbing plants, *Periploca graeca, Humulus lupulus, Hedera helix*. In understorey *Rubus sp, Sambucus ebulus*, *Aristolochia clematitis* and *Urtica dioica* dominate.

Alnus glutinosa is found in pure young clusters next to the Aeson riverbed (Figure 2), with an average diameter (Dbh) of 10.3 cm and an average height of 5.45 m (Table 1). The stand density is 580 trees per hectare (N / Ha), of which 86% (500 trees per Ha) in the upper - storey) and 14% (80 trees per Ha) in the middle - storey. It is a stand in the transitional stage of thin bodies to thick bodies. Diameter (Dbh) ranges from 4 cm to 23 cm and height (H) ranges between 3m and 9m. The trees of middle - storey have diameter (Dbh) from 4 cm to 7 cm while these of upper- storey from 4 cm to 23 cm (Table 1).

Table 1. Stand parameter statistics of *Alnus glutinosa* pure stand.

Stand parameter	***Upper storey***	***Middle storey***	***Total***
Dbh (cm) [1]			**10.30**
Dbh [min – max]	4 - 23	4 - 7	4 - 23
H (m) [2]			**5.45**
H [min – max]	5 - 9	3- 4	3 - 9
N/Ha [3]	500	80	580

[1] Dbh = diameter at breast height, [2] H = total tree height, [3] number of trees per hectare, [4] mean height of the 100 tallest trees per hectare

In Figure 3, is given the histogram of diameter distribution in which it appears that Alnus glutrinosa are dominating at the diameter 8-12 cm and 4-8 cm that is at the stage of slim bodies. The bigger number of the trees (55%) belongs to the heights from 6 to 8 m (Figure 4).

In Figure 5 is given the histogram of diameter distribution per storey in which it appears that ‘middle-storey individuals only appear in diameters from 4 to 8 cm.

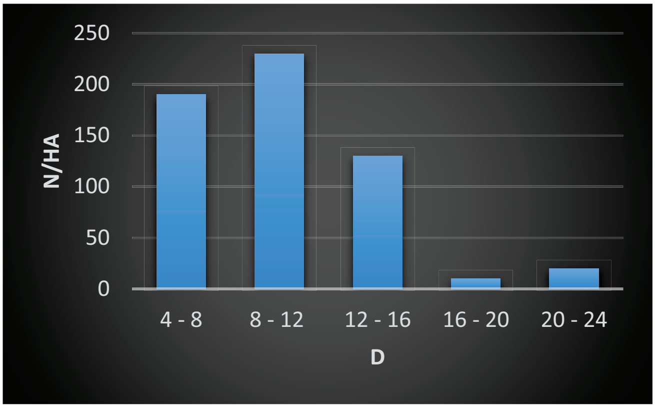

Figure 3. Histogram of diameter (D) distribution of *Alnus glutinosa* plots.

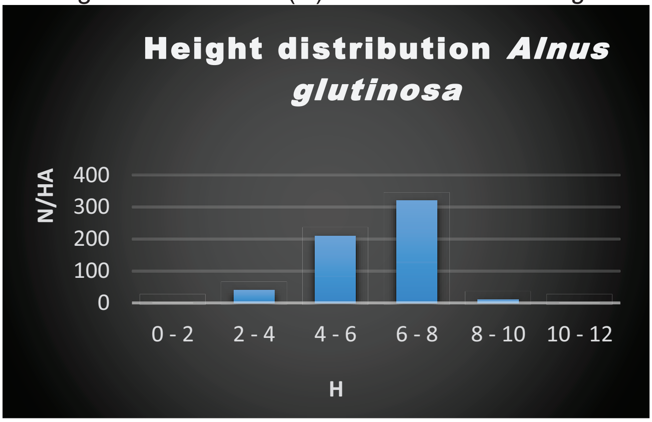

Figure 4. Histogram of height (H) distribution of *Alnus glutinosa* plots

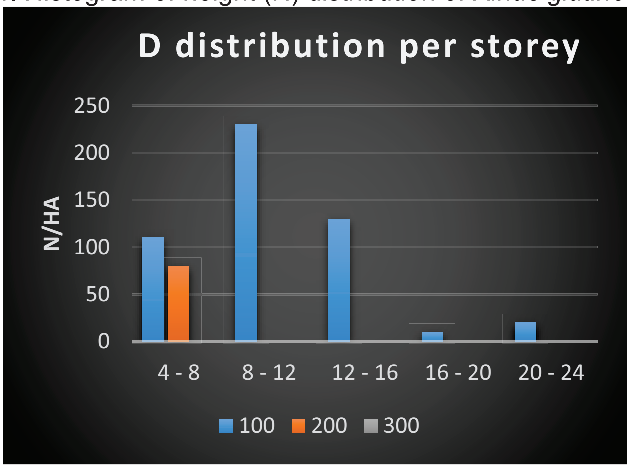

Figure 5. Histogram of diameter (D) distribution per storey of *Alnus glutinosa* plots. (100=Upper-storey, 200=Middle-storey 300=Under-storey)

CONCLUSIONS

The distribution of diameter's classes (Figure 1) shows a young stands of alder, next to the main bed of the river.

Some other measures of riparian forest management are the most effective and intensive protection, creation of fence in forest in places in which doesn't exist, and of course putting obstacles to prevent direct and easy access to the forest. Traffic must be strictly controlled to guide accompaniment for ecotourism, environmental education and research.

The artificial reforestation with alder may be another appropriate management measure, after scientific study drawing where appropriate locations will be indicated. This management measure will contribute to the development of the riparian forest of Aeson as the plane tree forest has already been infected by *Ceratocystis fimbriata f. sp platani* and if immediate and drastic measures are not taken to reduce the fungus, unfortunately the future of the riparian forest is uncertain both in its composition and in its extent.

REFERENCES

Efthimiou, G., 2000, Structure analysis, dynamic and ecological interpretation of riparian forests of Nestos, PhD Thesis, Aristotle University of Thessaloniki, 407 pp. (in Greek).

Efthimiou, G., 2012, The slenderness of the softwood Riparian forest species Salix alba L. and Salix fragilis L. in the protected area of Nestos Delta, Greece, Journal of Ecology and the Natural Environment, 4(1): 1-7.

Efthimiou, G., Goudelis, G., Theodosiou, G., 2015, Reseasch and Management of riparian forest of Richios river (Macedonian Tempi) N. Greece, Annals of the University of Craiova, XX(LVI): 421-426.

Efthimiou, G., Ratzas D., Karras N., 2016, Stucture research and management measures of Alder riparian forest in lake Volvi, N. Greece. Annals of the University of Craiova, XXI(LVII): 71-74.

Lycopoulou Ch. 2020. The plain forest of Neokaisaria, Pieria Prefecture. Agricultural University of Athens, General Dept., Karpenissi, p.112

https://www.geogreece.gr/

http://mediplantepirus.med.uoi.gr/pharmacology/plant_details.php?id=213

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THE RIPARIAN ECOSYSTEMS OF TRICHONIDA LAKE (GR 2310009), W. GREECE. A SURVEY OF LITERATURE

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ABSTRACT

Lake Trichonida (GR 2310009) is the largest natural lake in Greece. The aim of the research is to study the ecological value of the lake's ecosystems through the recording of scientific publications on the lake. A total of 158 scientific articles have been published for the last 60 years, (1960-2019) of which 45.57% have been published in scientific journals and the first publication on the lake was published in 1967. Of the last 30 years there has been a strong research interest in Lake Trichonida and in particular in hydrology and hydrogeology (26,45%) for the fauna (29.11%) of the lake as show by the percentages of publications. The coastal ecosystems of the lake with their enormous ecological importance need further research as they gather only 8.39% the publication for Lake Trichonida.

Key words: *riparian forest, lake Trichonida, biodiversity*

INTRODUCTION

Lakes are wetland ecosystems of great importance for the biodiversity of a region but also for meeting a multitude of human needs. The importance of a lake indirectly can be assessed by its large or small scientific and research interest. The recording of scientific publications can be considered an indirect evaluative indicator for a wetland ecosystem. Lake Trichonida is one of the most important and cleanest natural lakes in Greece.

Lake Trichonida (map. 1) is located 6 km southwest of Agrinio, the prefecture of Aitoloakarnania and is a hydrological and hydrographic part of catchment area of lower Acheloos. Named after the ancient town of Trichonio located next to the lake. Has an area of 98 km^2 maximum depth of 58 m.and volume of water about 2,8 x 10^9 m^3 (Doulka 2010). Is the largest natural lake in our country and the second deepest lake (Doulka 2010). Its shape is open kidneys. Has a maximum length of about 19 km, maximum width about 6 km perimeter around 51 km and an average depth of 29.1 m.

Map. 1. The case study
https://www.geogreece.gr

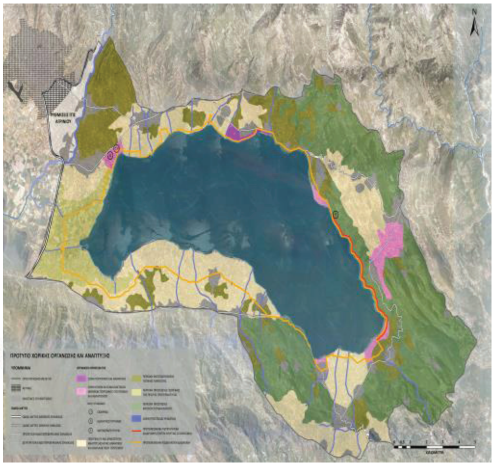

Figure 1. Map of land use Trichonida's lake
https://consortis.gr/el/lake-trichonida-2nd-award

Lake Trichonida belongs to the protected areas of the Natura 2000 (GR 2310009) with an area of 1434 9.46 Ha. Today the riparian vegetation remains rich compared to other large lakes. Consists of *Platanus orientalis*, *Fraxinus angustifolia*, *Populus nigra varietes*, *Salix alba*, *Ulmus minor*, λυγαριές *Vitex-agnus-castus*, Nerium *oleander, Rubus sp* etc.

More than 200 species of birds have been observed in Lake Trichonida, of which 50 (25%), have been declared endangered species. The main species of birds are: *Egretta garzetta*, *Ardea cinerea*, *Phalacrocorax carbo, Anas platyrhynchos, Mareca penelope, Anas acuta* etc. (Stefa 2011). The ecosystem of Trichonida gathers 19% of freshwater fish and 27% of the endemic species of the country. To date, 20 species have been recorded, of which 18 are found in the lake and only two of them (*Telestes pleurobipunctatus)* and (*Barbus peloponnesius)* live permanently in the streams. (Daoulas 1993).

The hydrological basin of Lake Trichonida is a closed basin with a surface-controlled outflow of water from Lake Trichonida to the neighboring lake Lysimachia. (Economou et.al,2001). The most important seasonal watercourses that end in Lake Trichonida and carry significant amounts of water are the "Dry land", the "Mega stream", "the Judging stream", the "Forked stream" and the "Botsaris" (Zotos 2006). Although Lake Trichonida receives many effects from livestock activities and urban wastewater manages to counteract them due to the rapid renewal of the large volume of its waters. (Kousouris 2015).

The main land use in the areas around the wetland is the crops smaller parts are covered by forests and settlement (Figure 1). It is concluded that the rural landscape of the area is changeable and the local farmers often change crops for the purpose of economic benefit (Paparizos 2018 and Karathanasi 2018).

The main problems in the area of Lake Trichonida come mainly from human activities as a result the burden of the lake environment with pollutants from urban wastewater and the intensification of agricultural crops with the use of fertilizers and pesticides

in fairly large quantities. Another major factor is the uncontrolled dumping of waste and inert materials in the surrounding area of the lake which has created small but numerous and scattered sources of contamination in the surrounding area of the lake (Zacharias et.al.2003).
The aim of this study is to research the present ecosystems of the Trichonida lake through the published literature over the last 60 years from 1960 to 2019.

MATERIALS AND METHODS

To complete the study, an internet search was conducted, up today published literature on the lake Trichonida. The publications were grouped according their means of publication and by their subject. In grouping according to the publication's type there were created eleven (11) different types: 1. journal international, 2. journal national, 3. books, 4. conference international, 5. Conference national, 6. workshops (workshops), 7. PhD, 8. Master, 9. bachelor thesis (Graduate), 10 researches and 11. research report from research programs - technical reports, maps and various other articles.
The publications included in our study, are products of scientific research. Our second criterion is the subject of the publications (9) categories: 1) riparian and aquatic vegetation - riparian forests 2) hydrology - hydrogeology - pollution 3) ground - Look - geology 4) fauna 5) history- archeology- mythology 6) geothermal energy - sources and 7) protection - management – ecosystems 8) tourism 9) climate meteorology. For creation of the graphs we used the Excel.

RESULTS AND DISCUSION

The records about the Lake Trichonida are referring to the last 60 years, from 1960 to 2019. We retrieved more than 158 publications scientifically published articles as they were categorized by type and subject of publication. The first publication about the lake was made by Leontaris S. in 1967 and concerned geomorphological research on the basin of Aitoloakarnania lakes.

Publications Types

The results referring to publication types are given in Table 1. The largest share is allocated to international journals, 46 recorded documents or 29.11%, followed by a research report, technical report maps with a frequency of 23 or 14.56% of the total publications. Impressive is the fact of the published project for Lake Trichonida that concerns the doctoral dissertations with number 15 recorded with a percentage of 9.49%. The books published for Lake Trichonida amount to 12 or 7.59%. This is followed by the postgraduate theses with number 9 or 5.70%, the articles in international conferences with number 7 or 4.43%, the theses with number 9 or 5.70%, the articles in national journals with number 9 or the 5.70%. Articles in international conferences, papers, and newspaper articles with a number of 7 or 4.43% appear smaller in number and percentages. The lowest number related to Lake Trichonida have the published studies with number 2 or 1.27%.

Publications according per subject Research

The published studies for Lake Trichonida have been grouped according to the scientific object and are given in Table 2. It is evident from our results that the largest portion of the publications are focused on issues of fauna with 46 papers (29.11%). Publications on issues of hydrology, hydrogeology and pollution gather 41 documents or 26.45%, while a great deal of research has been done on protection, environmental management and ecosystems with the number 37 or 22.50%.

Table 1. Publication for Trichonida lake per publication type

Type of publication	Number	%
Journal international	46	29,11
Journal national	9	5,70
Books	12	7,59
Conference international	7	4,43
Conference national	10	6,33
Workshops	7	4,43
PhD	15	9,49
Master	11	6,96
Bacelor theisis	9	5,70
Studies	2	1,27
Researsh & technical report & maps	23	14,56
Newspaper article	7	4,43
Total	**158**	**100.00**

Following are publications on riparian and aquatic vegetation, with number 14 or 8.39% and the soil, riverbed and geology of the lake with number 10 or 6.30%. Tourism, history, climate and geothermal of Lake Trichonida appear smaller in number and percentages with a total number of 10 and a total percentage of 6.91%. Finally, no relevant publications were found on geothermal energy and springs in the area.

Table 2. Publications for Trichonida lake per Subject Research

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Subject research	Number	%
Riparian vegetation & forest	14	8.39
Hydrology -hydrogeology -pollution	41	26.45
Soil - Bank - Geology	10	6.30
Fauna	46	29.11
History - Archaeology -Mythology	4	2.53
Geothermic - Spings	-	-
Protection - Management - Ecosystems	37	22.50
Tourism	5	3.75
Climate - Meteorology	1	0.63
Total	**158**	**100.00**

Publications per decade
Table 3 shows the temporal distribution of posts per decade from 1960 until 2019. today. From Table 2 and the Figure 2 it appears that the greatest scientific interest was manifested in three decades, those of (1990-99, 2000-2009 & 2010-2019), with24, 56 and 59 papers respectively.
During the last 30 years the 86.6% of the total publications were published.

Decade	Number	%
1960-1969	1	0.64
1970-1979	2	1.30
1980-1989	16	10.12
1990-1999	24	15.18
2000-2009	56	35.44
2010-2019	59	37.34
Total	**158**	**100.00**

Table 3. Publications for Trichonida lake per decade

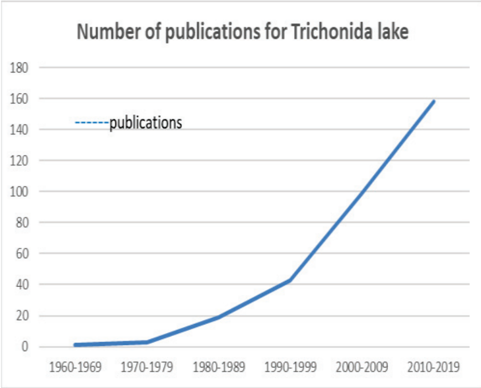

Figure 2. Evolution of publications for Trichonida lake.

CONCLUSIONS

The great ecological importance of the lake Trichonida is shown by the large number of publications that have recorded. The increase of scientific interest in it over the last 30 years is mainly due to the inclusion of the lake in the (Natura 2000) protected areas, the creation and operation management body for the wider area of the lake. Of course, the research for the fauna and the hydrology of the lake dominates while the research for the riparian vegetation and mainly for the riparian forests of the lake and the important role that they perform in its biodiversity.

REFERENCES

Daoulas Ch., (1993). "Limnology, Ichthyology and Fisery investigation of lake Trichonida", National Center for Marine Research Institute of Internal Water, Athens.

Dimitriou H., Zacharias I., Kousouris Th., (2001). European Program, LIFE-NATURE ’99, “Study on the water balance of the hydrological basin of Lake Trichonida” National Center for Marine Research (EKTHE), Internal Institutes.

Doulka H. E., (2010). “Contribution to the study of the zoo planetary bio-society of Lake Trichonida” Doctoral Thesis, Department of Environmental & Natural Resources Management, University of Ioannina, Agrinio.

Georgiou N., (2013). "Hydrological study of the aquifer in the northern part of Lake Trichonida", Diploma Thesis, University of Patras, Patras.

Kousouris ST., (2015). "The Lakes of Greece", Athens.

Leontaris S. (1967). “Geomorphological surveys on the basin of Aitoloakarnania lakes”, Athens.

Karathanasi E., (2018). "Water Management and Environmental Protection at Lake Trichonida”, Bachelor’s thesis. Greek Open University, School of Sciences & Technology, Environmental Design of Infrastructure Projects, Patras.

Oikonomou A., Giakoumi S, Kousouris Th., Stouboudi M., Barbieri R., Skoulikidis N., Bertachas H., Daoulas Ch., Psarras Th., Papadakis V., (2001). "Study of fisheries management of lakes (natural and artificial) utilization of water resources of mountainous and disadvantaged areas of the Prefectures of Aitoloakarnania, Evritania, Karditsa, Boeotia, Arcadia, Ilia and Achaia. Phase A, Final Report, 599 pages.

Paparizos G., (2018), "Strategic plan for sustainable management of the wetland Trichonida Lysimachia", Thesis, University of Thessaly, Department of Spatial Engineering Urban Planning and Regional Development, Volos.

Stefa I., (2011), "Morphometric study of alluvial faults and the corresponding catchments on the northern shores of Lake Trichonida in the prefecture of Aitoloakarnania", Thesis, Harokopio University, Athens.

Zacharias I. and Kousouris Th., (2003). “Actions for the protection of the limestone swamps of lake Trichonida”, National Center for Marine Research (N.C.M.R), Institute of Inland Waters, PGI-Athens Technical Exhibition.

Zotos G.A, (2006), “Flora, Vegetation Ecology and proposals for the management of wet meadows and reeds in lakes Trichonida and Lysimachia (Western Greece)” Doctoral Thesis, Department of Environmental and Natural Resources Management, University of Ioannina, University of Ioannina, page 7.

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