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THE REACTION OF SOME COWPEA GENOTYPES TO THE THERMOHYDRIC CONDITIONS FROM THE AREA OF SANDY SOILS IN THE SOUTH OF OLTENIA

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ABSTRACT

This paper presents the results of research conducted in the period 2020-2021 on the cowpea crop, which aimed at the behavior of 4 genotypes under the termohydric conditions from the area of sandy soils in southern Oltenia. Under the study conditions, the vegetation period of the cowpea genotypes took place during 96-105 days, with a thermal requirement of 2162—2391 ^{0}C. From the point of view of the correlation of the physiological indices with the productivity of the plant, the cowpea variety Aura 26 behaved best, which at an average daily transpiration of 2.69 mmol H_2O / m^2 / s and a leaf index of 8.05, assimilated by photosynthesis about 11.57 µmol CO_2 / m^2 / s and recorded an average of 14.6 pods / plant with 8.9 grains / pod. The results obtained showed significant increases in grain production (p> 0.05) in all genotypes studied, compared to the control variety Jiana.

INTRODUCTION

The cowpea (*Vigna unguiculata* L. Walpers), native to Central Africa, is a plant with increased drought tolerance, with a wide ecological plasticity, being the main legume for grains for the population of Africa (Emongor, 2007). Having a deep root system, a waxy layer on the leaves and a good strategy to avoid dehydration of the foliar apparatus by closing the stomata, cowpea can capitalize on drought conditions with good results (Halilou et al., 2015, Munjonji et al., 2018). Cowpea, are also, an unpretentious plant in soil conditions and an important source of protein for climatically disadvantaged areas (Düzdemir et al., 2010, Matei et al., 2015), capitalizing on good results poor sandy soils (Gerrano et al., 2015). Being a leguminous plant, the cowpea forms on its roots numerous nodules, in which symbiotic bacteria of the genus Rhizobium develop, which fix the atmospheric nitrogen (Eliade et al., 1975). The process of biological nitrogen fixation has great significance, given the prospect of population growth, which requires increased production of cereals and legumes, productions that are made with very large amounts of chemical nitrogen fertilizers (Awonaike, 1990, Ndungu et al., 2018). Bacteria of the genus Rhisobium, which form in the nodules on the root of the

cowpea plant have the ability to stimulate the reduction of the effects of stress on the environment, including drought (Oliveira et al., 2017).

MATERIAL AND METHODS

The researches were carried out at RDSPCS Dabuleni, in the period 2020-2021, and aimed at the behavior of four genotypes of cowpea (*Vigna unguiculata* L. Walpers) in the thermohydric conditions in the area of sandy soils from the south of Oltenia. We studied three varieties of cowpea, created in Dăbuleni (Aura 26, Ofelia, Doljana), compared to the variety Jiana (control), created in Tâmburești. The experiment was organized by the method of randomized blocks, on a sandy soil with low natural fertility, poorly supplied with total nitrogen (0.045-0.08%), medium to normal supplied with extractable phosphorus (41-87 ppm), reduced to medium supplied in exchangeable potassium (65-97 ppm) and with a weak acid soil reaction (pH H_2O = 5.9-6.59), under irrigation conditions. During the vegetation period, determinations of biology, biometrics, physiology and plant productivity were performed, as well as the quality of production at harvest. Determinations of plant physiology (photosynthesis rate, foliar transpiration rate and stomatal conductance) were performed in the flowering phase of the plant using the LC Pro SD device. The leaf area was determined in the laboratory using the Area Metter AM 300 device, and at harvest was analyzed the quality of the cowpea (protein and fat) by the Perten method. The results were calculated and analyzed by the method of analysis of variance (ANOVA) and using mathematical functions.

RESULTS AND DISCUSSIONS

From the analysis of the climatic conditions registered during the cowpea vegetation period (Table 1), it was highlighted the accentuation of the drought phenomenon during the vegetation period, by increasing the air temperature compared to the multiannual average, which corroborated with the recorded precipitation, led to increased thermohydric stress. Thus, compared to the multiannual temperature, the average temperature during the study period increased by 1.1^0C, and the precipitations registered lower values by 39 mm. The amount of 186.4 mm of precipitation registered during the vegetation period was insufficient, in relation to the requirements of the cowpea plant, being necessary the application of 3 waterings with norms of 250 m^3 water / ha.

The results regarding the biometrics and the productivity of the plant showed differentiations according to genotype (Table 2). The Jiana variety has developed a rich vegetative mass, given the high values of plant height (104.9 cm) and leaf index (8.76), which is why it can be recommended for incorporation into the soil as a green fertilizer. The analysis of the productivity elements of the plant, highlighted the Aura 26 cowpea variety, by registering 14.6 pods / plant, with 8.9 grains / pod and 14 cm average length of the pod. From germination to the end of the vegetation period, all the vital processes of the plant took place in high temperature conditions, above 10^0C. Under the study conditions, the vegetation period of the cowpea genotypes took place during 96-105 days, with a thermal requirement of 2162—2391^0C. Compared to the Jiana variety, which is very late, the Aura 26 and Doljana genotypes were highlighted at an early age of 9 days.

Table 1

Climatic conditions registered at the weather station of at RDSPCS Dăbuleni during the cowpea vegetation period

Climatic conditions		May	June	July	August	Average (^{0}C) / Sum (mm)
Average temperature (^{0}C)	2020/2021	17.4	21.8	25.1	24.6	22.2
	1956-2021	17.1	21.6	23.1	22.7	21.1
Deviation (^{0}C) from the multiannual		0.3	0.2	2.0	2.1	1.1
Ranfall (mm)	2020/2021	57.1	54.4	44.9	30	186.4
	1956-2021	62.7	70.2	55.4	32.6	220.9
Deviation (mm) from the multiannual		-5.6	-15.8	-10.5	-2.6	-39.0

Table 2

Results regarding the value of some morphology, biology and productivity characters in some cowpea varieties

Cowpea variety	Plant size (cm)	No pods / plant	No. grains / pods	Pod length (cm)	Leaf area index	Vegetation period days	Thermal resources required (^{0}C)
Jiana	104.9	8.5	8.8	13.9	8.76	105	2390.9
Aura 26	83.9	14.6	8.9	14	8.05	96	2165.8
Ofelia	82.7	13.1	8.3	12.5	6.6	98	2204.3
Doljana	69.2	12.0	8.7	13.1	5.78	96	2161.8

The determinations regarding the physiology of the plant revealed a diurnal variation of the processes of photosynthesis and perspiration, the results being differentiated according to the climatic conditions of the year and varieties. (Table 3, Figure 1).

Table 3

Meteorological indices recorded in the LC Pro SD device at the time of cowpea physiological determinations

Diurnal variation of meteorological indices	Year 2020			Year 2021		
	9 o'clock	12 o'clock	15 o'clock	9 o'clock	12 o'clock	15 o'clock
Active solar radiation in photosynthesis (µmol/m^2/s)	1640-1660	1826-1884	1874-1887	1290-1318	1710-1720	1573-1760
Temperature (^{o}C)	27.6-29.7	30-32	35-35.4	32.8-33.1	39.8-40	45.1-46.4
Atmospheric pressure (hPa)	1008	1008	1007	1009	1009	1007

Temperatures above 35 ^{0}C, which were recorded at the foliar level, intensified the thermohydric stress, the cowpea varieties reacting by reducing the photosynthesis process and intensifying the sweating process. Compared to 2020, in 2021, when higher temperatures were recorded in the air, the daily accumulation

rate of CO_2 through the photosynthesis process was lower by 6.91 µmol $CO_2/m^2/s$, and water losses through sweating were also lower by 0.72 mmol $H_2O/m^2/s$ due to stomatal closure Due to the plant's biological properties, increased drought resistance and low soil fertility requirements, cowpea can be a good alternative to bean and soybean crops, which are very sensitive to stressors in areas with excessive drought (Drăghici, 2018, Gnankambary et. al., 2020). The degree of stomatal opening is an important indicator of the intensity of physiological processes in the cowpea plant (Munjonji et al., 2018). The positive effect of stomatal closure, resulting in the limitation of water loss from plants, also had a negative effect, by reducing the rate of penetration of carbon dioxide, necessary for the process of photosynthesis.

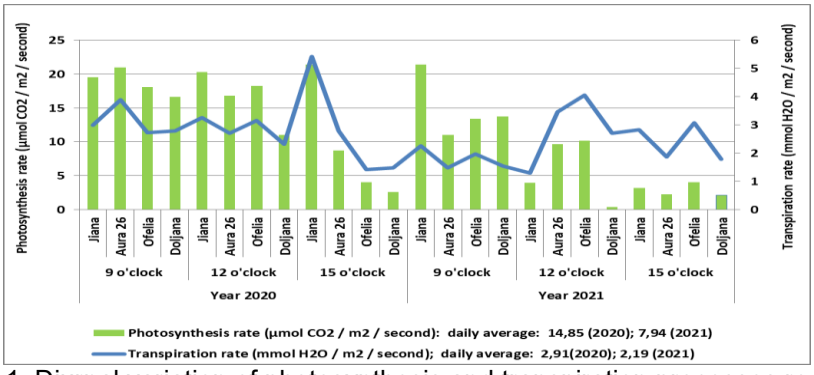

Figure 1. Diurnal variation of photosynthesis and transpiration processes recorded in some cowpea varieties in the period 2020-2021

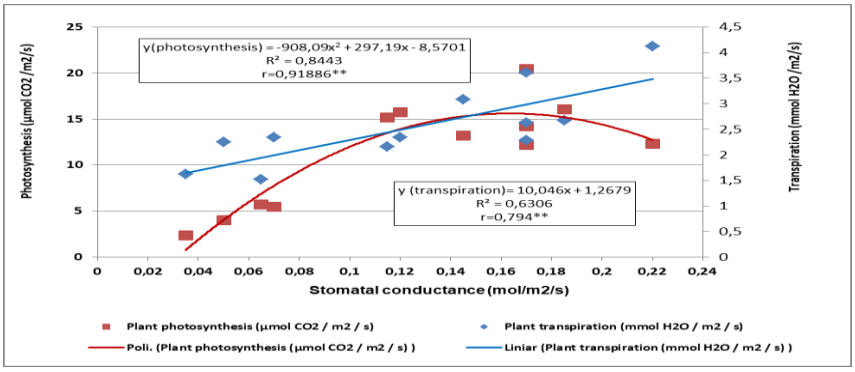

Figure 2. Correlation between stomatal conductance and transpiration and photosynthesis processes registered to some varieties of cowpea

Thus, at low values of stomatal conductance both transpiration and photosynthesis were reduced. The analysis of the functional link between the stomatal conductance and the photosynthesis process (average 2020-2021) is presented by the polynomial function of degree 2 (r = -0.9189 **), which shows an intensification of CO_2 accumulation at a stomata opening of maximum 0.16 mol / m^2 / s, after which the rate photosynthesis is reduced (Figure 2). Stomach conductance was distinctly positively correlated with transpiration rate (r = 0.794 **). The results

obtained at harvest have relevant yields between 1607.1-2797.6 kg / ha of grains, depending on the variety (Table 4). Compared to the Jiana variety, taken as a control, the varieties Aura 26 and Ofelia were highlighted by production increases of 1019.9-1190.5 kg / ha, statistically assured as distinctly significant. Analysis of the nutritional quality of grains in some bean genotypes (Table 4) highlighted a protein content of 21.7-22.4% and a fat content of 3.1-4.2%. The Aura 26 variety was highlighted, which achieved the highest amount of protein per unit area (626.7 kg / ha).

Table 4

Production results obtained for some cowpea varieties in the period 2020-2021

Cowpea variety	Grain yield		The difference compared to the control		Quality		Protein (kg/ha)
	(Kg/ha)	(%)	(Kg/ha)	The significance	Protein (%)	Fats (%)	
Jiana	1607.1	100.0	Control	Control	22	4.2	353.6
Aura 26	2797.6	174.1	1190.5	**	22.4	3.6	626.7
Ofelia	2627	163.5	1019.9	**	21.7	3.1	570.1
Doljana	2297.6	143	690.5	*	21.5	3.5	494.0

LSD 5% =669.6 kg/ha; LSD 1% = 1014.0 kg/ha; LSD 0.1% = 1629.0 kg/ha

CONCLUSIONS

Under the study conditions, the vegetation period of the cowpea varieties took place during 96-105 days, with a thermal requirement of 2162—2391 ^{0}C, highlighting the varieties Aura 26 and Doljana through an earlyness of 9 days, compared to Jiana variety (control).

From the point of view of the correlation of the physiological indices with the productivity of the plant, the cowpea variety Aura 26 behaved best, which at an average daily transpiration of 2.69 mmol H_2O / m^2 / s and a leaf index of 8.05, assimilated by photosynthesis about 11.57 µmol CO_2 / m^2 / s and recorded a production of 2797.6 kg / ha.

The results obtained showed significant increases in grain production ($p > 0.05$) in all cowpea genotypes studied, compared to the control variety (Jiana), which recorded a high value of the leaf surface index.

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