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STUDY OF THE VARIABILITY OF THE MAIN QUANTITATIVE CHARACTERS OF SOME HOMOZYGOUS ADVANCED TOMATO LINES

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ABSTRACT

The advanced homozygous tomato lines (L-13, L-10/9 and L-10/52) were subjected to an analysis of the variability of the main quantitative characteristics of the fruit (fruit weight, fruit height and diameter, shape index , pericarp thickness and soluble dry matter). The recorded biometric data were statistically processed, the average of the analyzed character ($\bar{x}$), the standard deviation (s), the coefficient of variability (s%), the degree of dispersion ($k = \bar{x} \pm s$) and the frequency of the individuals in the variability range (f%).

The statistical analysis of the recorded data showed that the three tomato lines are uniform in terms of variability of the main characters, the coefficient of variability having small and medium values for most of the characters analyzed, and represent a valuable material for the improvement of this species in sandy soil conditions.

INTRODUCTION

Tomatoes (*Solanum lycopersicum*) is one of the most widespread vegetable crops being consumed in all parts of the world both fresh and in various dishes and preserved.Tomato plants are often exposed to extreme environmental conditions, high temperatures and drought, their frequency being constantly increasing due to climate change taking place globally. 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).

Many authors have concluded that heat stress or high temperature has negative effects on both plant growth and reproduction (Xu, J et al. 2017; Zhou, R. 2020). According to Zinn KE, et al. 2010, the reproductive (gametophytic) phase in flowering plants is often extremely sensitive to hot or cold temperature stress, even a single hot day or cold night is sometimes fatal to the success of reproduction.

Many of the changes in the morphology of tomato flower structures have been associated with high temperatures during reproductive development, as well as causing flower fall (Lohar DP. 1998). The production potential of genotypes, which is dependent on the number of fruits / plant and fruit weight, is severely reduced by stress at high temperatures (Umesh Singh, et al. 2015).

After Firon et al. 2006, the number of fruits / plant is a measure for the tolerance of a genotype at high temperatures and this is correlated with a decrease in pollen viability in tomatoes. In general, high temperature tolerant genotypes maintain a higher level of pollen viability at high temperatures than sensitive genotypes (Dane et al. 1991).

As the variety is one of the important factors of technology, which through genetic dowry can demonstrate great adaptability to natural environmental factors, especially heat stress, the creation of varieties adapted to the specific conditions of sandy soils in the context of climate change has become a priority for research.

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 2021 year.

The tomato genotypes obtained as a result of the improvement process were subjected to a rigorous selection, in order to increase the degree of homozygosity and to stabilize the characters. The selection of advanced homozygous genotypes was made according to the phenotypic manifestation of the main quantitative characters that characterize each genotype. The advanced homozygous tomato lines (L-13, L-10/9 and L-10/52) were subjected to an analysis of the variability of the main quantitative characteristics of the fruit (fruit weight, fruit height and diameter, shape index , pericarp thickness and soluble dry matter). The recorded biometric data were statistically processed, the average of the analyzed character ($\bar{x}$), the standard deviation (s), the coefficient of variability (s%), the degree of dispersion ($k = \bar{x} \pm s$) and the frequency of the individuals in the variability range (f%).

RESULTS AND DISCUSSION

From a climatic point of view, 2021 year was a very warm year, with very high temperatures, with a direct influence on the growth and development of tomato plants.

The average temperature of May and June was close to the multiannual average temperature (the average of 1959-2020 years), and in July and August average temperatures were recorded well above the multiannual average (Table 1). In May, out of the total days, temperatures of over 25 ^{0}C were recorded in 15 days, of which in 14 days the maximum temperatures were between 25-30 ^{0}C and in a single day temperatures between 30-35 ^{0}C were recorded.

The monthly average of June was 21.7 ^{0}C, with 0.3 ^{0}C higher than the multiannual average. In 26 days temperatures were recorded over 25 ^{0}C, in 6 days the maximum temperatures were between 30-35 ^{0}C and in 5 days between 35 ^{0}C - 40 ^{0}C. The maximum in June was 39.6 ^{0}C.

The July was unusually warm, with a monthly average temperature of 25.8 ^{0}C, 2.6 ^{0}C C higher than the average of the last 65 years. In 5 days maximum temperatures were recorded between 25-30 ^{0}C, in 13 days the maximum temperatures were between 25-30 ^{0}C, in 12 days the temperatures were between 35 ^{0}C -40 ^{0}C and in one day the maximum of 40.4 ^{0}C was recorded.

Table 1

The climatic conditions during the research period, 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	14	15	5	7
Number of days with maximum temperatures between 30-35^{0}C	1	6	13	11
Number of days with maximum temperatures between 35 ^{0}C-40 ^{0}C	0	5	12	9
Number of days with maximum temperatures above 40 ^{0}C	0	0	1	4
The monthly average (^{0}C)	17.6	21.7	25.8	24.7
The monthly maximum (^{0}C)	31.8	39.6	40.4	41.2
Multiannual average temperatures (1956-2020)	17.5	21.4	23.2	22.6

August was particularly hot, with an average monthly temperature of 2.1 ^{0}C above the multiannual average. In August, in 4 days the maximum temperatures were above 40 ^{0}C, the maximum of the month being of 41.2 ^{0}C.

The data presented show a continuous trend of increasing temperatures. The absolute maximum temperature registers significant increases every day with values above 35 ^{0}C and sometimes even above 40 ^{0}C with unfavorable effects for tomato plants.

The high temperatures coincided with the flowering period, the binding and growth of the fruit, which led to a decrease in the number of fruits and their weight at the sensitive lines.

At the line L-13, the weight of the fruit shows a great variability (27.8%), the fruits having a weight between 49 grams and 103 grams, the average weight being 76.7 grams. In the range of variability k = 55.4- 98 g are included 60% of the analyzed fruits Table 2.

Table 2

The variability of the main quantitative characters of the tomato line L - 13

The character	x	s	s%	Significance after s%	k=x±s	Frequency (%)
Fruit weight	76.7	21.312	27.8	Large	55.4-98.0	60
Fruit height	2.6	0.137	5.3	Small	2.5-2.7	80
Fruit diameter	2.9	0.223	7.7	Small	2.7-3.1	70
Shape index	0.91	0.077	7.8	Small	0.84-0.98	60
Pericarp thickness	4.3	1.059	2.5	Small	3.2-5.3	60
% Brix	5.7	0.944	16.6	Medium	4.8-6.6	80

At the line *L-13*, the weight of the fruit shows a great variability (27.8%), the fruits having a weight between 49 grams and 103 grams, the average weight being 76.7 grams. In the range of variability k = 55.4- 98.0 g are included 60% of the analyzed fruits.

The shape index is given by the ratio between the height of the fruit and the diameter of the fruit. It has the value of 0.91, indicating a slightly flattened globular shape. The fruits are very uniform in this character, the coefficient of variability being small (7.8%). In the range of variability k = 0.84-0.98 are included 60% of the analyzed fruits;

The thickness of the pericarp varies between 3 mm and 6 mm, the average being 5.7 mm. The fruits are very uniform in this character, the coefficient of variability being small (2.5%);

The sugar content is on average 5.7%, 8o% of the analyzed fruits being in the range of variability.

From the analysis of the variability of the characters results an large variability for the fruit weight, medium variability for %Brix and small variety for the other characters.

At the line *L10/9*, the weight of the fruit (g) shows a very high variability (31.1%), the fruits having an average weight of 58.3 g. In the range of variability k = 40.2-68.4 g are included 60 % of the analyzed fruits (table 3).

Table 3

The variability of the main quantitative characters of the tomato line L – 10/9

The character	x	s	s%	Significance after s%	k=x±s	Frequency (%)
Fruit weight	58.3	18.117	31.1	Very large	40.2-68.4	60
Fruit height	4.7	0.472	10.0	Medium	4.2-5.2	70
Fruit diameter	5.2	0.621	11.9	Medium	4.6-5.8	60
Shape index	0.9	0.095	10.3	Medium	0.81-0.99	70
Pericarp thickness	4.4	0.253	5.7	Small	4.1-4.7	80
% Brix	5,4	0,371	6,9	Small	5,0-5,8	80

Height of fruit was of 4.7 cm and a diameter of 5.2 cm, giving it a flattened globular shape. The thickness of the pericarp is 4.4 mm. The fruits are very uniform in this character, the coefficient of variability being small (5,7%).

The sugar content is on average 5.4%, 8o% of the analyzed fruits being in the range of variability.

The fruits of line 10/9 show a very high variability for fruit weight, medium variety for fruit diameter and shape index and small for fruit height, pericarp thickness and% Brix

At the line *L-10/52*, the weight of the fruit is of 62,9 g. (table 4).

Table 4

The variability of the main quantitative characters of the tomato line L - 10/52

The character	x	s	s%	Significance after s%	k=x±s	Frequency (%)
Fruit weight	62.9	10.89 8	17.3	Medium	52.0-73.8	80
Fruit height	4.0	0.915	22.9	Large	3.1-4.9	60
Fruit diameter	3.8	0.732	18.3	Medium	3.1-4.5	60
Shape index	1.05	0.083	8.0	Small	0.97-1.13	70
Pericarp thickness	5.4	1.350	25.00	Large	4.0-6.8	60
% Brix	5.0	0.417	8.3	Small	4.6-5.4	70

In the range of variability k = 52,0- 73,8 g are included 80% of the analyzed fruits.

The shape index has the value of 1,05, indicating a globular shape. In the range of variability k = 0.97- 1,13 are included 70% of the analyzed fruits.

The thickness of the pericarp has the average of 5.4 mm, and the sugar content is on average 5%, 7o% of the analyzed fruits being in the range of variability.

The statistical processing of the recorded data showed that the fruits of the tomato line L – 10/52 have a high variability for pericarp thickness, medium variability for fruit weight and fruit diameter and low variability for shape index and % Brix.

CONCLUSIONS

The statistical analysis of the recorded data showed that the three tomato lines are uniform in terms of variability of the main characters, the coefficient of variability having small and medium values for most of the characters analyzed.

The weight of the fruits was 58.3 g for L 9/10, 62.9 g for L-10/52 and 76.7 g for L-13, this character having the highest coefficient of variability for all lines analyzed.

The thickness of the pericarp was between 4.3-5.4 mm, the L10 / 52 line being remarque by this character.

The sugar content had values between 5.0-5.7%, as the highest value was recorded at L-13.

All three genotypes analyzed showed resistance to the special climatic conditions of 2021 year and represent a valuable material for the improvement of this species in sandy soil conditions.

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REFERENCE

Dane F, Hunter AG, Chambliss OL.1991. Fruit set, pollen fertility, and combining ability of selected tomato genotypes under high temperature field conditions. J Am Soc Hortic Sci 116(906–910): 906–910

Firon N, Shaked R, Peet MM, Pharr DM, Zamski E, Rosenfeld K, Althan L, Pressman E. 2006 Pollen grains of heat tolerant tomato cultivars retain higher carbohydrate concentration under heat stress conditions. Sci Hortic 109(3): 212–217. doi:10.1016/j.scienta.2006.03.007

Lohar DP, Peat WE. 1998. Floral characteristics of heat-tolerant and heat-sensitive tomato (*Lycopersicon esculentum* Mill.) cultivars at high temperature. Sci Hortic. 1998;73:53–60.

Umesh Singh, Pradeep Kumar Patel, Amit Kumar Singh, Vivek Tiwari, Rajesh Kumar, N Rai, Anant Bahadur, Shailesh K Tiwari, Major Singh and B Singh.2015. Screening of tomato genotypes underhigh temperature stress for reproductive traits. Vegetable Science 42 (2): 52-55.

Voican V., Lacatuș V. 1998. Cultura protejată a legumelor în sere și solarii. Edit. Ceres, București.

Xu, J.; Driedonks, N.; Rutten, M.J.M.; Vriezen, W.H.; De Boer, G.-J.; Rieu, I.2017. Mapping quantitative trait loci for heat tolerance of reproductive traits in tomato (Solanum lycopersicum). Mol. Breed. 37, 1–9.

Zhou, R.; Yu, X.; Li, X.; Dos Santos, T.M.; Rosenqvist, E.; Ottosen, C.-O. 2020.Combined high light and heat stress induced complex response in tomato with better leaf cooling after heat priming. Plant Physiol. Biochem. 151, 1–9.

Zinn KE, Tunc-Ozdemir M, Harper JF. 2010. Temperature stress and plant sexual reproduction: uncovering the weakest links. J Exp Bot. ; 61 (7): 1959-68. doi: 10.1093 / jxb / erq053.