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THE BEHAVIOR OF SOME TOMATO GENOTYPES UNDER CONDITIONS OF THERMAL-HYDRIC STRESS IN THE SANDY SOILS AREA

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ABSTRACT

The tomato genotypes studied (L-11/53, Monalbo, L-24/13 and AP-10) 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 registered biometric data were statistically processed, calculating for each analyzed character the mean ($\bar{x}$), the standard deviation (s), the coefficient of variability (s%), the range of variability ($k = \bar{x} \pm s$) and the frequency of individuals in the range of variability (f%).

The statistical analysis of the recorded data showed that the four tomato genotypes are uniform in terms of the variability of the main characters, the coefficient of variability having medium and low values for most of the analyzed characters, and represent a valuable material for the improvement of this species under conditions of thermal stress hydric from the area sandy soils.

INTRODUCTION

Tomatoes (*Solanum lycopersicum* L.) are part of the Solanaceae family which includes about 100 genera and 2500 species, including several other plants of agronomic importance, such as potato, eggplant, pepper (Olmstead et al., 2008).

Tomatoes are grown in semi-arid regions, having a high nutritional value due to the content of vitamins A, C, E, b-carotene and lycopene (Closas et al. 2004).Annual tomato production was over 145.5 million tons, harvested from over 4.3 million hectares with an average yield of 336 kg/ha (Saravanan et al. 2018). They are also a source of income for many small farmers in the country.Tomato culture are often exposed to extreme environmental conditions, high temperatures and drought, the frequency of which is continuously increasing due to global climate change.

Tomatoes thrive well in tropical and subtropical regions, requiring an optimum temperature in the range of 18-28^{0}C to grow vigorously and remain productive (Saeed et al. 2007).Temperatures exceeding 35 ^{0}C have been recorded to be detrimental to seed germination, seedling and vegetative growth, flowering, development and fruit ripening of tomato (Wahid et al. 2007).

It has been reported, however, that heat stress in tomato primarily affects reproductive development (Sato et al. 2006) causing excessive drop in flower number, leading to low fruit production. Firon et al. (2006) also report that day and

night temperatures exceeding 28 ^{0}C and 22 ^{0}C, respectively, adversely affect fruit production in tomato.High temperatures above 26 ^{0} C tend to shorten the period of fruit growth, reduce flower production, reduce the ability to release and the viability of pollen grains.

Also Adams et al. (2001) found that 40% of plant terminal meristems died when tomato fruits were harvested at temperatures of 26 ^{0} C or even higher.

Establishing the particularities of character variability and heredity offered the possibility of optimizing the selection program (Fasoulas, 1973).

The variety represents one of the important links of the cultivation technology, which through its genetic endowment can show a high adaptability to the stress of abiotic factors. A priority for the research activity in the area of sandy soils is the creation of tomato varieties tolerant to the conditions of thermo-hydric stress.

MATERIAL AND METHODS

The research was carried out within the Research-Development Station for Plant Culture on Dăbuleni Sands on a sandy soil in the specific climatic conditions of 2022.The experience was set up in a greenhouse-solar protected space, in three repetitions placed in a linear floor. The tomato genotypes studied *L-11/53*, *Monalbo, L-24/13* and *AP-10*were sown in alveolar cubes filled with peat on March 17, 2022 and were planted on April 28, 2022, at distance of 30 cm between plants in a row and 70 cm between rows.

The tomato genotypes obtained as a result of the breeding process were subjected to a rigorous selection, in order to increase the degree of homozygosity and stabilize the characters.The selection of advanced homozygous genotypes was made according to the phenotypic manifestation of the main quantitative characters that characterize each individual genotype.Homozygous advanced tomato genotypes (*L-11/53, Monalbo, L-24/13* and *AP-10*) were subjected to an analysis regarding the variability of the main quantitative fruit characters (fruit weight, fruit height and diameter, pericarp thickness, index of form and soluble dry matter).

The registered biometric data were statistically processed, calculating for each analyzed character the mean ($\bar{x}$), the standard deviation (s), the coefficient of variability (s%), the degree of dispersion (k= $\bar{x} \pm s$) and the frequency of the individuals included in the interval of variability (f%).

RESULTS AND DISCUSSIONS

In recent years, climate changes at the global and continental level are reflected even at the zonal level. On the sandy soils of southern Oltenia, these climate changes began to be felt, which directly influenced the growth and development of tomato plants (Table 1).

In May, out of the total number of days, in 19 days temperatures over 25 ^{0}C were recorded, of which in 12 days the maximum temperatures were between 25-30 ^{0}C and in 7 days temperatures were recorded between 30-35 ^{0}C.

June's monthly average was 22.9 ^{0}C, 1.5 ^{0}C higher than the multi-year average. In 29 days temperatures over 25 ^{0}C were recorded, in 18 days the maximum temperatures were between 30-35 ^{0}C and in only one day there were temperatures between 35 ^{0}C-40 ^{0}C. The maximum in June was 35.7 ^{0}C.

July was unusually warm, with monthly average temperatures of 25.2 ^{0}C, 2.0 ^{0}C higher than the 66-year average. In 6 days maximum temperatures between 25-30

^{0}C were recorded, in 22 days temperatures exceeded 30 ^{0}C, and in 2 days temperatures of 40 ^{0}C were recorded.

Table 1

Temperature level during in the period May-August 2022 (weather station of R&DSPCS Dăbuleni)

Specification	The month			
	May	June	July	August
Number of days with maximum temperatures between 25-30^0 C	12	10	6	5
Number of days with maximum temperatures between 30-35^{0}C	7	18	11	16
Number of days with maximum temperatures between 35^{0}C-40^{0}C	0	1	11	9
Number of days with maximum temperatures above 40^{0}C	0	0	2	1
The monthly average (^{0}C) Average monthly temperature	18.3	22.9	25.2	25.1
The monthly maximum (^{0}C) Maximum monthly temperature	31.8	35.7	41.6	40.8
Multiannual average temperatures (1956-2020)	17.5	21.4	23.2	22.6

The month of August was particularly warm, the average monthly temperature being 2.5 ^{0}C above the multi-year average. In August, in 9 days the maximum temperatures exceeded 35^{0}C, the maximum of the month being 40.8 ^{0}C. Temperatures in 2022 showed an increasing trend, and the absolute maximum temperature recorded significant increases days in a row with values above 35 ^{0}C and sometimes even above 40 ^{0}C with unfavorable effects for tomato plants. High temperatures coincided with the period of flowering, setting and fruit growth, which caused a decrease in fruit number and weight.

In the genotype *L-11/53*, the weight of the fruit (g) showed a medium variability (17.07%), the mean of the character being 26.32 g. In the range of variability k=21.83-30.81 g there were comprised 80% of the analyzed fruits. This characteristic indicated the economic value of the genotype (Table 2).

Table 2

Variability of the main quantitative characters of the tomato genotype *L-11/53*

The analyzed character	$\bar{x}$	s	s%	The range of variability k=$\bar{x}$±s	Frequency of individuals (%)
Fruit weight (g)	26.32	4.49	17.07	21.83-30.81	80
Fruit height (cm)	5.25	0.35	6.72	4.89-5.60	80
Fruit diameter (cm)	2.92	0.30	10.21	2.62-3.22	70
Pericarp thickness (mm)	5.19	1.27	24.47	3.92-6.47	50
Shape index IF=H/D	1.82	0.28	15.27	1.54-2.10	70
Brix (%)	4.68	0.69	14.83	3.99-5.37	90

Regarding fruit height (cm), the value of the coefficient of variability was small, which demonstrated its strong genetic determinism and high stability for this character.

Pericarp thickness (mm) varied between 3 mm and 7 mm, the average being 5.19 mm, the coefficient of variability being high (24.47%).The thickness of the pericarp in the tomato fruits was a character that contributes to the achievement of the weight of the fruit and implicitly to the increase of the productivity of the genotype, being another defining character for the selection and keeping the tomato genotype in a pure state. This character can be improved by choosing fruits with values large regarding the thickness of the pericarp.

The shape index (IF=H/D) was given by the ratio between the height of the fruit and the diameter of the fruit, it has the value of 1.82 indicating an ovoid shape. The fruits were uniform regarding this character, the coefficient of variability being medium (15.27%). In the interval of variability k=1.54-2.10 were included 70% of the analyzed fruits.

The content in soluble dry matter was on average 4.68, and 90% of the analyzed fruits were included in the range of variability k=3.99-5.37.

The statistical processing of the recorded data highlighted the fact that the fruits of the tomato genotype L-11/53 were uniform in terms of the variability of the main characters, and the values of the coefficients of variability are small and medium for most of the characters analyzed, with the exception of the pericarp thickness.

Monalbo tomato fruits had an average weight between 64.18-105.07g. In the range of variability k= 65.00-95.03g, 60% of the analyzed fruits were included (Table 3).

Table 3

Variability of the main quantitative characters of the tomato genotype*Monalbo*

The analyzed character	$\bar{x}$	s	s%	The range of variability k=$\bar{x}$±s	Frequency of individuals (%)
Fruit weight (g)	80.02	15.02	18.77	65.00-95.03	60
Fruit height (cm)	6.61	0.37	5.54	6.24-6.97	60
Fruit diameter (cm)	8.08	0.41	5.07	7.67-8.49	70
Pericarp thickness (mm)	5.94	0.86	14.51	5.07-6.80	80
Shape index IF=H/D	0.82	0.04	4.68	0.78-0.86	70
Brix (%)	4.54	0.58	12.78	3.96-5.12	80

Pericarp thickness (mm) varies between 4.26 mm and 7.10 mm, the average being 5.94 mm. The fruits were uniform regarding this character, and the value of the coefficient of variability is medium (14.51%). The thickness of the pericarp gives the quality and firmness of the fruit.The shape index (IF=H/D) is given by the ratio between the height of the fruit and the diameter of the fruit, it has a value of 0.82, indicating a slightly flattened globular shape. The fruits were very uniform regarding this character, the coefficient of variability being small (4.68%). In the interval of variability k=0.78-0.86 were included 70% of the analyzed fruits.

The statistical processing of the recorded data highlighted the fact that the fruits of the *Monalbo* tomato genotype show medium and low variability for all the analyzed quantitative characters.

Table 4

Variability of the main quantitative characters of the tomato genotype *L-24/13*

The analyzed character	x̄	s	s%	The range of variability k=x̄±s	Frequency of individuals (%)
Fruit weight (g)	69.07	13.47	19.51	55.60-82.54	70
Fruit height (cm)	3.67	0.17	4.64	3.50-3.83	80
Fruit diameter (cm)	5.39	0.42	7.72	4.97-5.80	60
Pericarp thickness (mm)	4.16	0.56	13.54	3.60-4.72	80
Shape index IF=H/D	0.68	0.05	7.25	0.63-0.73	80
Brix (%)	5.30	0.46	8.62	4.84-5.76	80

In the case of genotype *L-24/13*, the weight of the fruit (g) showed a medium variability (19.51%), the fruits having an average weight of 69.07 g (Table 4) In the range of variability k=40.2-68.4 g included 60% of the analyzed fruits. The average height of the fruit was 3.67 cm, and the average diameter of the fruits of genotype *L-24/13* was 5.39 cm, giving it a flattened globular shape. The thickness of the pericarp (mm) varies between 3.51 mm and 5.18 mm, the average being 4.16 mm. The coefficient of variability for this character was medium (13.54%).

Regarding the shape index, the value of the coefficient of variability is small (7.25%), and in the range of variability k= 0.63-0.73 are included 80% of the analyzed fruits. The sugar content was on average 5.30%, and 80% of the analyzed fruits being included in the range of variability k= 4.84-5.76.

The fruits of genotype *L-24/13* showed a medium variability for fruit weight, pericarp thickness and a small variability for the rest of the analyzed characters.

Regarding the weight of the fruit in genotype *AP-10*, the value of the coefficient of variability was medium (19.57%), with an average of 113.81 g (Table 5).

Table 5

Variability of the main quantitative characters of the tomato genotype *AP-10*

The analyzed character	x̄	s	s%	The range of variability k=x̄±s	Frequency of individuals (%)
Fruit weight(g)	113.81	22.27	19.57	91.54-136.09	70
Fruit height (cm)	5.84	0.74	12.69	5.10-6.59	60
Fruit diameter (cm)	7.43	1.21	16.28	6.22-8.63	60
Pericarp thickness (mm)	5.37	0.47	8.72	4.90-5.83	70
Shape index IF=H/D	0.80	0.10	12.88	0.69-0.90	70
Brix (%)	4.19	0.54	12.80	3.65-4.73	70

The shape index is given by the ratio between the height of the fruit and the diameter of the fruit, which defines the shape of the fruit, being a defining character in the selection of the tomato genotype. The value of 0.80 of this character indicated a slightly flattened globular shape of the genotype.

The calculation and analysis of the variability of the characters studied in the AP-10 tomato genotype revealed a medium variability for all the quantitative characters studied, except for the thickness of the pericarp which presented a value of the coefficient of variability low (8.72%).

CONCLUSIONS

In order to maintain the authenticity and biological uniformity of the tomato genotypes, it was aimed to restrict the variability of the main characters analyzed within the limits of medium and small coefficients of variation.

Among the four studied tomato genotypes, the *L-11/53* genotype stood out for its pericarp thickness (mm).

The sugar content had values between 4.19-5.30%, the *L-24/13* genotype standing out from this point of view.

All four analyzed genotypes showed resistance to the special climatic conditions of 2022 and represent valuable material for the improvement of this species.

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