

THE ADAPTABILITY OF THE EARLY CORN LINES, CREATED AT S.C.D.A SUCEAVA, TO THE STRESS OF CLIMATIC FACTORS SPECIFIC TO THE S.C.D.A PITEȘTI-ALBOTA AREA

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Abstract

The increasingly variable yields of field crops are due to increasing climate change in recent years. Thus, an important objective of breeding programs in the country and abroad it consists of improving the adaptability to drought and heat of field plants (especially maize).

As a result of research, it has been found that drought and heat are very dangerous for corn, as they occur during and after pollination, as well as at different stages of grain filling. In order to reduce losses, it is recommended to identify and use genotypes that can provide an increase and stability of the harvest regardless of the climatic conditions. Thus, emphasis is placed on the expansion of early hybrids in production. Breeding maize for early sowing requires basic germplasm with germination capacity and vigorous growth under low temperature conditions.

The purpose of this research, in which we used as research material 19 early inbred lines and the Suceava M Hybrid (control); was to evaluate and identify inbred lines with tolerance and adaptability to adverse conditions. Of all the lines analyzed, the L19 line showed considerable adaptability to the dry climate, evidenced by the highest level of production, supported by a higher number of rows per cob.

Keywords: adaptability, inbred line, maize, tolerance

1. INTRODUCTION

Corn, through the large productions it makes, is an important source of food, humanity being mostly dependent on it; it has a large production capacity, but also a wide area of spread, a greater resistance to drought, heavy rains, diseases and pests.

In the context of current climate change, emphasis is placed on significantly improving the ability of maize to adapt to biotic and abiotic stress conditions (Horhocea et al., 2019). Breeding maize for climate change tolerance requires a germplasm with superior agronomic properties, and its genetic variability is the basis for the successful creation of valuable genotypes with high adaptability to low temperatures during the germination period and tolerant to drought and heat in vegetation (Sarca et al., 2004). An important factor of progress in maize cultivation is the expansion in

production of hybrids that are earlier, productive, more resistant to stem fall and break at maturity and possess ecological plasticity (Cosmin et al., 1987)

Early sowing of maize in optimal temperature and humidity conditions is the essential condition for uniform emergence and ensuring an optimal density capable of ensuring a satisfactory production.

By sowing early, the precipitation that falls during the winter is better exploited, and also the critical phenophases can be brought forward compared to periods of drought and heat.

This paper presents the results obtained within the ADER 2.1.2 project in the conditions of 2024, a project that has the following objectives:

- diversification of the genetic base of maize for more efficient use of water under conditions of thermohydraulic stress;
- study on the behavior of new maize genotypes in different pedoclimatic conditions;
- the creation of maize hybrids with high production potential, tolerant to drought and heat, resistant to the action of damage factors, with agronomic properties capable of capitalizing on the nutritional potential of the soil even in unfavorable conditions of thermohydraulic stress, intended to be cultivated in all favorable areas for this crop in Romania;
- creation of initial breeding material to form the genetic basis for early and extra-early maize hybrids, adapted to thermohydraulic stress conditions, with high production potential and good resistance of plants to breakage and fall;
- developing technical solutions to improve the management of the maize crop in order to maximize the genetic potential.

2. MATERIALS AND METHODS

The biological material used in the research carried out at S.C.D.A. Pitesti-Albota in 2024 was represented by the Suceava M (control) hybrid and 19 inbred lines, located in the collection of lines of the corn breeding laboratory at S.C.D.A. Suceava; and is being studied in the ADER 2.1.2 project.

The soil on which the research was carried out is a typical luvosol, with the following characteristics :

- low content of nutrients accessible to plants;
- poor nitrogen supply ($N_t = 0.130\%$ mg/Kg);
- moderately supplied with potassium ($KAL = 89$ mg/Kg);
- poorly fertile, with a humus content in the arable horizon of 1.96 %;
- acidic, with pH values (in aqueous suspension) of 5.02;
- with a mobile aluminium content in the arable layer 0.92-1.39 mg/Al.exchangeable/100gsoil.

Cultivation technology :

The soil tillage, the seedbed preparation works, were carried out according to the maize cultivation technology, specific for the acidic - heavy soils in the sub-Carpathian hills area.

The basic fertilization was done with complex chemical fertilizers of type 20-20-0, at a dose of 400 kg/ha, before the work of preparing the seedbed with the combiner.

When applying fertilizers, it was considered to create a uniform agrofund intended to achieve proper nutrition for the experimented crop.

The precursor plant was soybeans. The experiments were sown manually, with the corn planter, ensuring 2 grains/nest. In order to assess the influence of climatic conditions on the results obtained, the temperatures and precipitation recorded at S.C.D.A. Pitesti-Albota between March and August 2024 were monitored.

In order to evaluate the influence of climatic conditions on the results obtained, the temperatures and rainfall were monitored. Since the yield of production is elaborated throughout the vegetation period, from the placement of the crop in the field to the phenophase of grain filling, through the successive formation of different components, observations and determinations were made on the experimental variants regarding : number of sprouted plants/sqm; percentage of sprouted plants / m.p.; date of appearance of panicle; date of appearance of the cob; given physiological maturity.

The productivity elements of the genotypes experimented in 2024 were determined.

Biometric parameters were studied at the level of corn cobs: cob length; cob diameter; grain length; grain thickness; grain width;

MTG, the mass of 1000 grains is known as one of the characters mostly controlled by the genetic factor. In specialized research, some authors point out that in the case of MTG, both under normal crop conditions and under drought conditions, the effects of gene dominance were greater than the additive effects.

Phenotypic methods based on biometric analysis were used as analysis methods. Biometrics were performed on 10 plants and 10 cobs of each genotype, totaling approximately 4000 individuals.

For the analysis of the experimental data, the POLIFACT program was used.

3. RESULTS AND DISCUSSIONS

1.Characterization of climatic factors in maize vegetation

For the analysis of experimental data was the Experimental General Data Portfolio, which includes in addition to general experimental data and meteorological records. Thus, the temperatures and rainfall recorded in the period March/August/2024 were monitored, in order to follow the influence of environmental factors on the evolution of plants.

The climatic data from March to August 2024 characterize the agricultural year as very hot and dry. Regarding the temperatures recorded except for May, when a negative thermal deviation of (-0.5°C) was recorded, in all the other months of the period there were positive thermal deviations, with values between +3.3°C (March) and +5.17°C (June) compared to the multiannual monthly averages. The average thermal deviation of the period was +3.4°C. (Figure1, Figure 2).

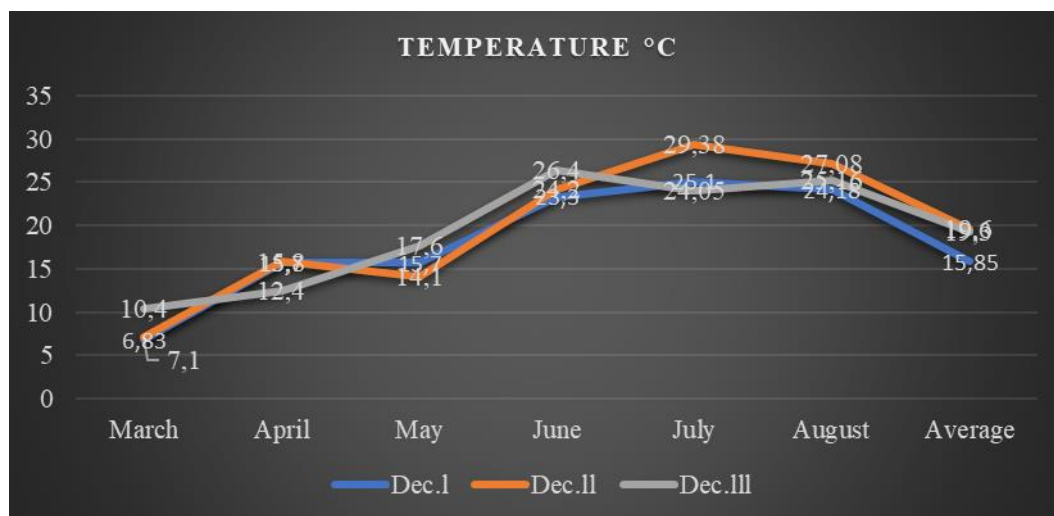


Figure 1. Temperatures recorded between March and August in 2024

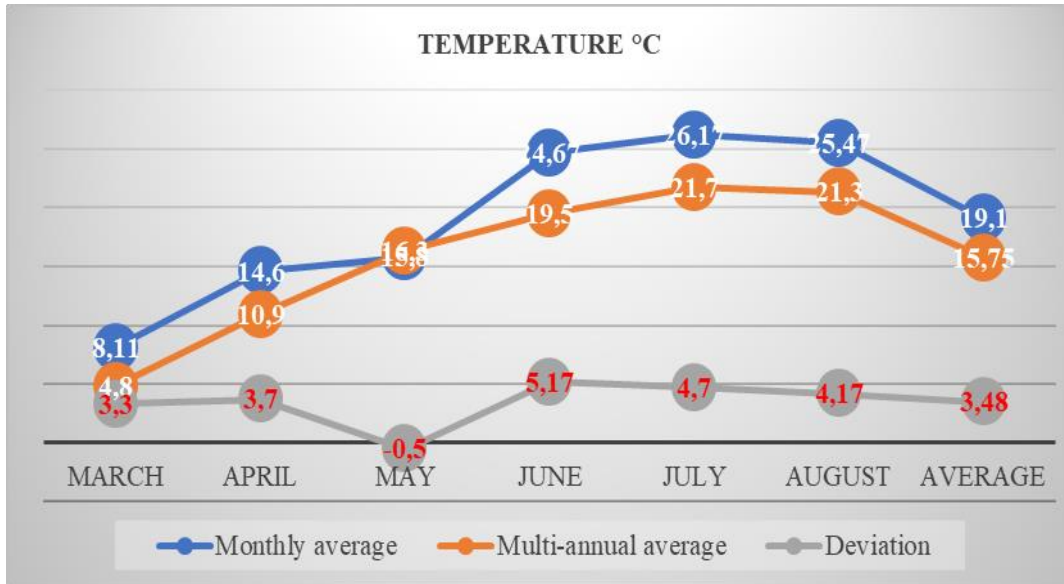


Figure 2. Average and temperature deviation recorded March-August in 2024

From the point of view of the rainfall regime, in March the rainfall fell within normal limits, with an excess of 3.5 mm compared to the multiannual average of the month, while in the months: April, May, June, July and August, the recorded rainfall was deficient, with negative deviations compared to the multiannual monthly rainfall, with values between : -10.8 mm in April and -78.1mm in June. Overall, the period (March-August 2024) was characterized as a warm period, with a positive thermal deviation of +3.38 °C, compared to the multiannual average of the 40-year period and with a precipitation deficit of -246.3 mm (Figure 3, Figure 4)

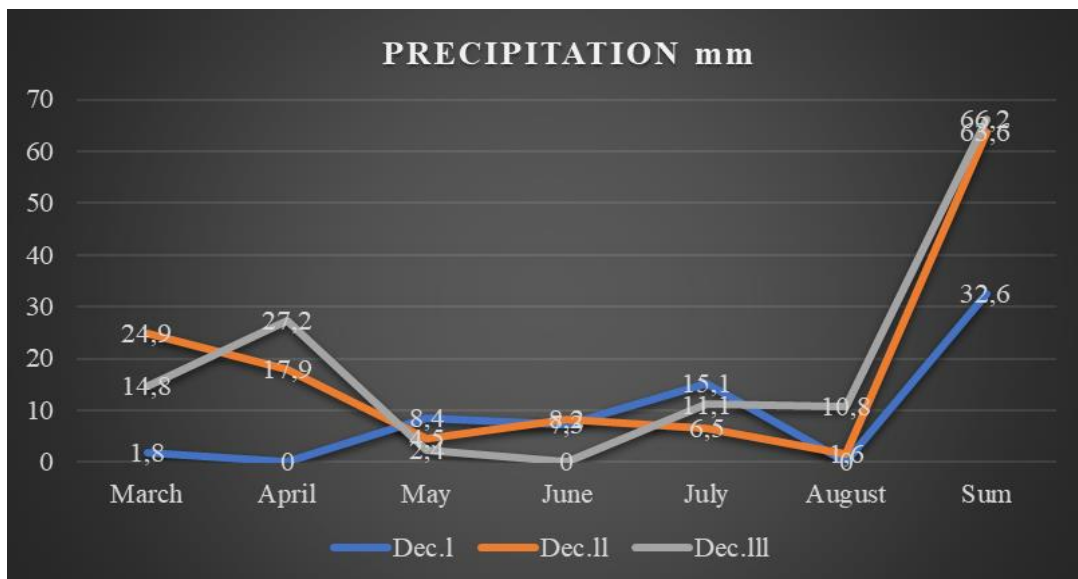


Figure 3. Monthly rainfall recorded between March and August 2024

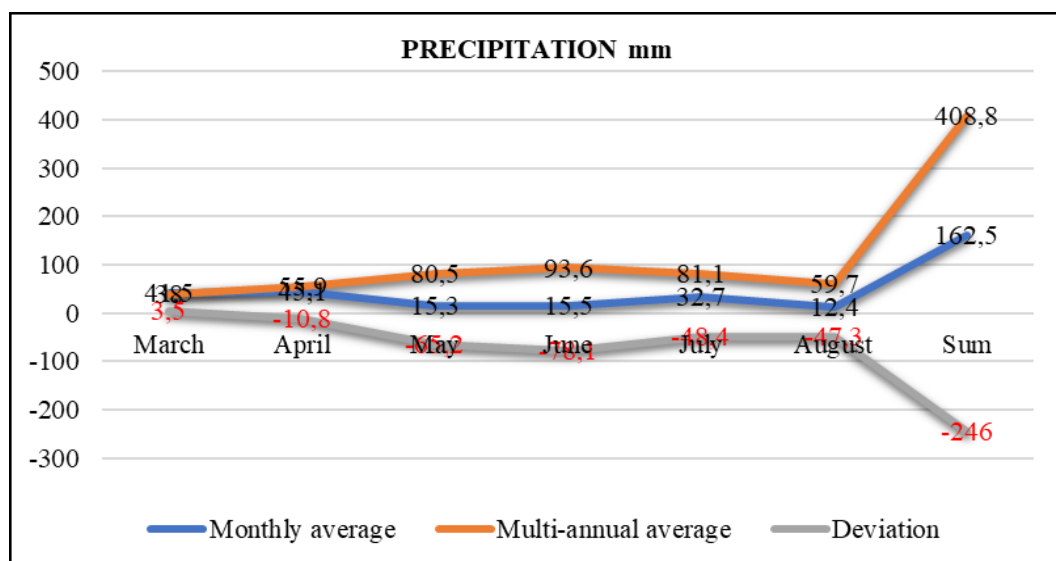


Figure 4. Average and precipitation deviation recorded March-August in 2024

Under these climatic conditions, with temperatures with positive thermal deviation and rainfall with negative deviation, compared to the multiannual average, the corn crop sown at the optimal time suffered, with negative repercussions on the phenological phases of corn, with a negative impact on production.

From the data obtained in 2024, obvious periods of drought were found. Under these conditions, the new lines obtained in Suceava have shown a certain decrease in the characters of the cobs obtained.

2. Grain production and the characters studied.

As for the average grain production, levels between 1200 and 3500 kg/ha were found. Of all the lines studied, 50% obtained yields below 2000 kg/ha, and 50% over 2000 kg/ha. Compared to the assortment of lines studied, the Suceava M (Mt) hybrid performed relatively well, with a production of 2395 kg/ha. Better results obtained compared to the control ensured the L1, L17, L13, L19 line. Statistically, there were no significant differences in production. Percentage-wise, the lines highlighted as production levels demonstrated an increase in production between 7% and 47% (Table 1).

The main character studied in the case of all the lines was the length of the cob. The variation limits were between 13.3 cm and 19.7 cm, compared to the control, the following lines were noted by the length of the cob: L1, L5, L6, L13, L14, L17, L18. From a statistical point of view, significant differences were found, in this regard the following lines were noted: L5, L6, L7, L13, L17 (Tabel 1).

The dimensions regarding the diameter of the cob were specific and ranged between 31 mm and 43 mm, they corresponded to the L14 line and the L13 line. The Suceava M hybrid stands out, which had a cob diameter of 39 mm, and the L6, L13, L15, L16, L19 lines, which exceeded it in size. From a statistical point of view, it was found that the differences were within the limit of errors (Tabel 1).

Table 1. Production and the main morphoproduative properties of the lines from Suceava and of the control hybrid.

No. crt	Lines Suceava	Cob length (cm)			Cob diameter (mm)			Production kg/ha		
		Aver.	%	Diff.	Aver.	%	Diff.	Aver.	%	Diff.
	Suceava M (Control)	15.3	100	0.0	39.0	100	0.0	2.395	100	0.0
1	Line 1	16.9	110.4	1.6	36.1	91.8	-3.2	2.553	107	158*
2	Line 2	13.8	90.1	-1.5	36.2	92.0	-3.2	1.444	60	-951
3	Line 3	14.6	95.3	-0.7	33.7	85.9	-5.5	2.121	89	-274
4	Line 4	15.4	100.7	0.1	35.5	90.3	-3.8	1.538	64	-857
5	Line 5	17.5	114.7	2.3*	32.7	83.3	-6.6	2.285	95	-110
6	Line 6	18.6	121.2	3.3**	39.8	101.3	0.5	2.173	91	-222
7	Line 7	15.2	99.0	-0.2	38.0	96.8	-1.3	2.340	98	-55
8	Line 8	15.9	104.1	0.6	35.5	90.3	-3.8	2.265	95	-130
9	Line 9	14.0	91.4	-1.3	34.6	88.2	-4.6	1.351	56	-1044
10	Line 10	14.5	93.8	-0.9	36.8	93.6	-2.5	1.872	78	-523
11	Line 11	17.2	112.1	1.8	34.7	88.4	-4.6	1.551	65	-844
12	Line 12	14.8	96.9	-0.5	37.4	95.1	-1.9	1.212	51	-1183
13	Line 13	19.1	124.8	3.8***	42.6	108.3	3.3	3.303	134	908***
14	Line 14	16.9	110.4	1.6	31.5	80.2	-7.8	1.535	64	-860
15	Line 15	17.0	111.1	1.7	41.6	105.8	2.3	2.165	90	-230
16	Line 16	13.3	87.1	-1.1	40.3	102.7	1.0	1.859	78	-536
17	Line 17	19.7	128.5	4.38***	38.5	98.1	-0.7	2.456	103	61
18	Line 18	16.7	109.5	1.45	33.7	85.8	-5.6	1.799	75	-596
19	Line19	15.1	98.4	-0.25	39.9	101.6	0.6	3.529	147	1134***
	DL 5%		2.04			4.02			1232.11	
	DL 1%		2.71			5.35			1686.05	
	DL 0.1%		3.53			6.97			2287.37	

No.crt-Current number, Diff.-Difference, Aver.-Average

As for the character expressed by the number of rows of grains on the cobs, the limits were between 11 and 17 rows on the cobs. The Suceava M hybrid formed an average number of 13 rows on the cobs and was surpassed by most of the lines taken in the study. This fact demonstrates a genetic gain in the number of rows on the cobs. From the point of view of significance, lines with the number of rows of grains on significant cobs were found, namely the lines: L1, L9, L12, L13, L15, L19 (Tabel 2).

The number of grains per row was also specific, ranging from 24 to 39. The line with the lowest number of grains per row was the L10 line, and the line with the highest number of grains per row was the L13 line. Through statistical analysis, insignificant differences were found between all the variants studied (Table 2).

The variability of the mass of a thousand grains at the lines studied was quite vast, ranging from 146 g to 276 g. The line with the highest MTG was the L6 line. From the data obtained, it was found that in general, grains with a relatively low absolute weight were formed. And yet, significant

differences were observed on lines L6 and L13. In the other variants, no significant differences were found (Table 2).

Table 2. The main morphoproductive properties of the lines from Suceava and of the control hybrid

No. Crt	Lines Suceava	Number of rows/cobs			Number grain/row			MTG g		
		Aver.	%	Diff.	Aver.	%	Diff.	Aver.	%	Diff.
	Suceava M (Control)	13	100	0.0	37	100	0.0	188	100	0.0
1	Line 1	16	123.1	3.0**	34	91.2	-3.3	146	71.9	-57.0
2	Line 2	14	111.5	1.5	31	85.0	-5.5	191	94.1	-12.0
3	Line 3	14	107.7	1.0	27	73.5	-9.7	148	72.9	-55.0
4	Line 4	13	103.8	0.5	30	82.3	-6.5	175	86.0	-28.5
5	Line 5	14	103.8	0.5	34	91.8	-3.0	163	80.0	-40.5
6	Line 6	13	100.0	0.0	33	90.5	-3.5	276	135.7	72.5**
7	Line 7	14	103.8	0.5	33	89.1	-4.0	192	94.3	-11.5
8	Line 8	14	107.7	1.0	31	83.0	-6.3	208	102.2	4.5
9	Line 9	15	119.2	2.5*	31	83.0	-6.3	129	63.7	-73.8
10	Line 10	12	96.2	-0.5	24	63.9	-13.3	209	103.0	6.0
11	Line 11	14	109.6	1.3	31	83.7	-6.0	185	91.1	-18.0
12	Line 12	15	115.4	2.0*	31	83.0	-6.3	164	80.5	-39.5
13	Line 13	16	123.1	3.0**	39	104.8	1.7	231	113.5	27.5
14	Line 14	14	111.5	1.5	33	88.4	-4.3	136	66.7	-67.5
15	Line 15	16	119.2	2.5*	37	100.7	0.3	169	95.3	-9.5
16	Line 16	14	107.7	1.0	34	91.2	-3.3	184	90.4	-19.5
17	Line 17	14	103.8	0.5	35	94.6	-2.0	163	80.0	-40.5
18	Line 18	11	84.6	-2.0	36	97.3	-1.0	212	104.4	9.0
19	Line 19	17	126.9	3.5***	32	87.8	-4.5	160	78.8	-43.0
	DL 5%		1.92			5.09			42.11	
	DL 1%		2.56			6.77			56.05	
	DL 0.1%		3.33			8.81			72.94	

No.crt-Current number, Diff.-Difference, Aver.-Average, MTG- mass of 1000 grains.

Other important morphological characters refer to the size of the corn grain and their viability. Thus, the grain length varied from 7.9 mm (L14) to 10.9 mm (L13), thus it is found that this size was generally below 10 mm, demonstrating a relative influence of drought on this character. Significant differences in grain length were observed at 3 lines, namely the lines: L6, L10, L13 (Table 3).

The second characteristic, namely the width of the maize grain, was between 6,9 mm (L1, L9) and 8,7 mm (L6); For the other lines studied, the width of the grain had a negative significance, this fact demonstrates that the grains by this character were negatively influenced by climatic factors (Table 3).

The third characteristic, namely grain thickness, had a size variability between 3.8 for the Suceava M hybrid and 5.0 for the L1 line. Except for two lines that had this parameter below 4 mm, all the others exceeded 4 mm. In conclusion, the thickness of the corn kernel demonstrated a certain positive influence on the corn cob compared to the studied control (Table 3).

Table 3. The main morphoproductive properties of the lines from Suceava and of the control hybrid

No. Crt.	Lines Suceava	Grain length (mm)			Grain width (mm)			Grain thickness (mm)		
		Aver.	%	Diff.	Aver.	%	Diff.	Aver.	%	Diff.
	Suceava M (control)	9.3	100.0	0.0	8.15	100	0.0	3.80	100	0.0
1	Line 1	8.3	90.2	-0.9	6.9	84.2	-1.3	5.0	132.7	1.2***
2	Line 2	9.6	103.3	0.3	8.4	103.0	0.25	4.4	115.5	0.6
3	Line 3	8.5	92.3	-0.7	7.0	86.5	-1.1	4.7	123.4	0.9**
4	Line 4	8.3	89.1	-1.0	8.0	98.6	-0.11	4.7	124.7	0.9**
5	Line 5	8.3	89.2	-1.0	7.4	90.7	-0.8	4.7	122.9	0.9**
6	Line 6	10.4	112.4	1.2*	8.7	106.9	0.6	4.8	126.0	1.0**
7	Line 7	9.4	101.2	0.1	7.7	93.8	-0.5	3.9	103.4	0.1
8	Line 8	8.8	95.5	-0.4	8.6	105.3	0.43	4.5	118.6	0.7**
9	Line 9	8.6	92.5	-0.7	6.9	85.3	-1.2	4.4	115.7	0.6
10	Line 10	10.1	109.2	0.8	8.2	100.6	0.1	4.7	124.9	1.0**
11	Line 11	8.8	95.7	-0.4	7.2	89.3	-0.9	4.9	128.4	1.1**
12	Line 12	9.2	99.2	-0.1	7.3	89.1	-0.9	4.3	113.8	0.5
13	Line 13	10.9	121.4	1.2***	7.8	95.5	-0.4	4.6	120.5	0.8*
14	Line 14	7.9	84.8	-1.4	6.9	75.2	-2.0 ⁰⁰⁰	4.8	127.4	1.0**
15	Line 15	9.9	107.6	0.7	7.2	88.7	-0.9	4.3	112.6	0.5
16	Line 16	9.9	107.3	0.7	7.9	96.9	-0.3	3.9	102.6	0.1
17	Line 17	8.0	86.9	-1.2	7.5	92.0	-0.7	4.8	125.0	1.0**
18	Line 18	8.8	95.4	-0.4	8.3	102.1	0.2	4.5	117.8	0.7*
19	Line 19	9.1	98.6	-0.1	7.5	91.4	-0.7	4.0	105.3	0.2
	DL 5%	0.88			0.97			0.64		
	DL 1%	1.18			1.29			0.86		
	DL 0.1%	1.53			1.68			1.11		

No.crt-Current number, Diff.-Difference, Aver.-Average

3. Correlations between the characters studied

From the multitude of characters studied, a series of links have been highlighted that can be useful in the recommendations for production. Thus, the link between grain production and cob diameter proved to be distinctly significantly positive ($r= 0.598^{**}$), this means that among the lines studied, the higher harvest level was obtained in the case of larger diameter cobs. The correlation between these two characters proved to be close, in a percentage of 36% (Figure.5). Of the analyzed elements, the correlation between production and grain thickness showed negative trends, the correlation coefficient was only -0.112. In this case, the determination between the two elements was around 1%. Thus, it is found that the level of production was not influenced by the thickness of the grain (Figure.6).

One of the interesting correlations turned out to be between production and MTG, where the link was close to 0 (figures. 7). The explanation lies in the fact that the weight parameter of the grains expressed by MTG is genetically controlled. From the figures 7 it is also evident that most of the MTG values were below 200 g.

Although the correlation between the length of the cobs and the number of grains per row is positive and therefore increasing, and the correlation coefficient is very significantly positive (0.483^{***}), the determination was only 23%. As for the number of grains per row, positive aspects

are found in terms of value, namely: on cobs with a length of 18-19 cm, the number of grains was greater than 30 (Figure.8).

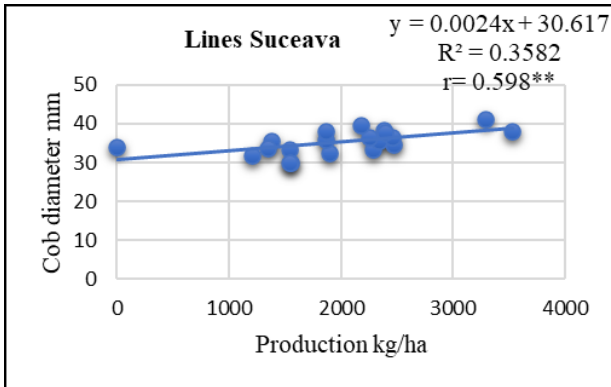


Figure 5. Correlation between production and cob diameter

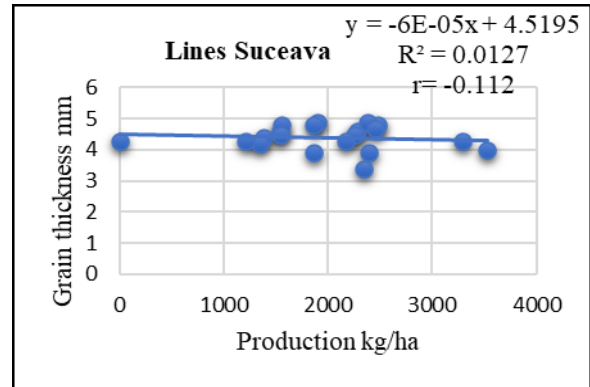


Figure 6. Correlation between production and grain thickness

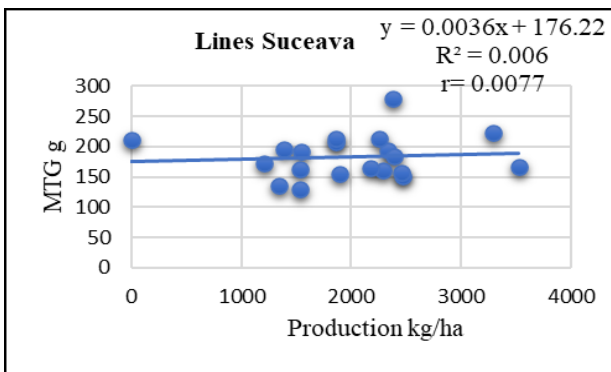


Figure 7. Correlation between production and mass of 1000 grains

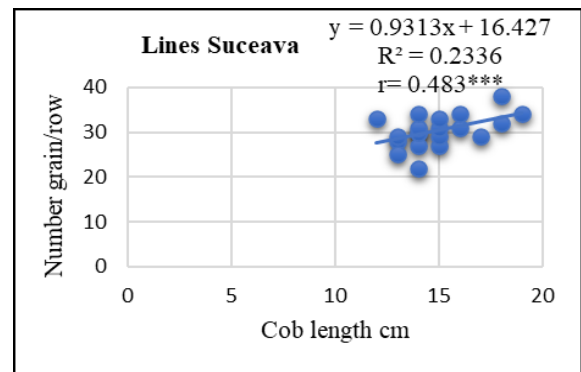


Figure 8. Correlation between cob length and number grain/row

Another important feature of the grains on the cobs is the thickness of the grain. From the correlation obtained (Figure.9) there is a negative dependence ($r = -0.402$), an insignificant value. And in the case of this correlation, the thickness of the grains of over 4 mm was formed in the case of 20-25 grains per row. It is possible that in the case of the two determined traits number of grains per row and grain thickness, the dry climate background had a negative influence (Figure.9).

In the end, a significant positive correlation was obtained between the length and width of the grain. Thus, in the lines with grains of 8 mm in length, the width of the grain was 7 mm, and in the case of grains with a length of more than 10 mm, grains around 8 mm wide were formed. In the case of this correlation, a determination between the two traits was found at the level of 23% (Figure.10).

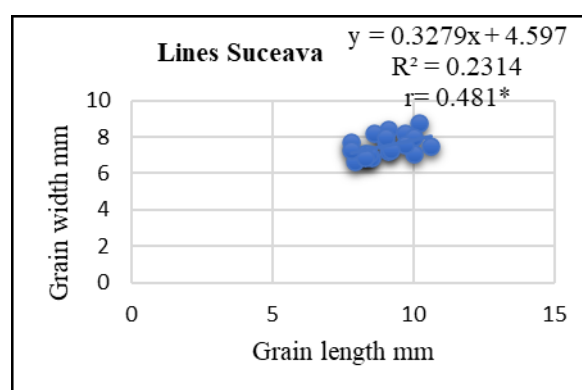
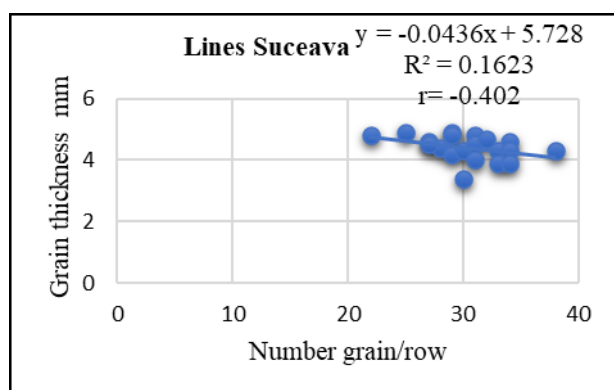


Figure 9. Correlation between number grain/row and grain thickness **Figure 10.** Correlation between grain length and grain width

4. CONCLUSIONS

Considering the increasingly diverse and unpredictable climatic conditions for maize vegetation, a series of lines with short vegetation period respectively from the early category were taken into study.

The first element on which the drought had a specific influence was grain production. Compared to the Suceava M hybrid (control), there was an increase in production, but insignificant on the lines: L13, L17, L19.

Among the dimensions of the cobs, 5 lines that exceeded the length of its cob stood out compared to the control hybrid, and in terms of the diameter of the cob, it was within the limit of errors. Under the conditions of line 17 which had the longest cob with a higher production than the control, the diameter of the cob had a slightly lower value.

As for the other morphological indices studied, exceedances of the control hybrid were found in the case of: the number of rows per cob (L19), the number of grains per row (L13) and the mass of one thousand grains (L6).

As for the other morphological indices studied, exceedances of the control hybrid were found in the case of: the number of rows per cob (L19), the number of grains per row (L13) and the mass of one thousand grains (L6).

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