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DRY PERIODS INFLUENCE UPON MORPHOLOGICAL CHARACTERS OF TURDA 248 MAYZE HYBRID COBS

Nicolae IONESCU, Oana Daniela BADEA, Diana Maria POPESCU, Mariana Cristina NICOLAE

Agricultural Research and Development Station Pitesti, 5 Pitesti-Slatina Road, 117030, Pitesti, Romania

Corresponding author email: nicolaeionescu50@gmail.com

Abstract

Tre current characteristics of maize plant are evolving by new breeding tolerance for dry season during vegetation period. The habit of the plant in general, but also the cobs prove true productive performances. However, the expression of the specific characteristics of the cobs is closely related to the natural provision of water. Being a moisture-loving plant, it is not uncommon to encounter periods of deficiency, especially during the deposition of dry matter in the grain. The intensity of these periods of drought causes some depressions in the morphology of the cobs and grains. The present study compares the cobs of the hybrid Turda 48 obtained in three different years, namely a relatively normal one and two years with obvious drought accents. From the data obtained, the cobs affected by the drought were 3 cm shorter and 0.2 cm thicker. The weight of the cobs decreased by 40-60 g, the number of grains on a cob decreased by 150, and the mass of the grains also decreased by 40-60 g. Grain percent of the cobs was reduced by 1-3 %. The grains formed were 0.5-1 mm shorter, the width remained at the same level, and the grain thickness was smaller by 0.6-0.8 mm. The mass of a thousand grains decreased by 20-40 g.

Key words: *cobs, grains, maize, morphological characters, variability.*

INTRODUCTION

Maize (*Zea mays* L.) is one of the most widespread cereals in the world (Tilman et al., 2002). The content of grains (Brown & Funk, 2008) is an important source of nutrients along with a variety of compounds (Lobell et al., 2011), such as carotenoids, phenolic components, phytosterols. Over time, the plant has undergone obvious evolutions through the desired characters (Doebley, 2000). Maize is considered today to be an important model (Haș et al., 2019), both for genetics and for perspective biology (Tollenaar & Lee, 2002). The origin of the plant is lost in time, so the starting point was a rustic species that produced small cobs, with a single bean 25 mm long. This cultivated plant between rows with *Zea mays mexicana* (*teosinte*), led in time to obtain several small cobs, a few centimeters, on a single plant. From that period there are currently three species of *Zea*, namely: *Z. mays* - ordinary corn, *Z. diploperennis* - *teosinte* perennial form and *Z. mays mexicana* - *teosinte* annual form. The name *Zea* comes from the Greek and means "that sustains life" and *mays*, a Taino word that means "gives life". Maize is expressed in the world both by *maize* - originally from *mahiz* (Spanish), which is the best description of the plant, and by the *corn*, which in some parts means cereal crop with expression and in a culinary context. Elsewhere, corn was developed from *Indian corn* = corn, referring to the multicolored flint horn, used for decorations (cobs with differently colored grains and woven and hanging sheets). The diploid plant contains 2n = 2x (2x10) = 20 chromosomes (Doebley, 2004), fixes the carbon on the C4 type, also having an increased efficiency of water recovery.

Being a unisexual monoecious species, maize has female flowers grouped in a spike-like inflorescence, with evident thickened axis (*spadix*). The maize spikelet has a long stigma with a role in capturing pollen grains, an ovary from which specific grains, awn and palea develop at the base. The mature cob has lengths of 3-50 cm and a diameter of 1.5-6 cm, being cylindrical, cylindrical-conical or fusiform. Their weight is between 50 and 500 g. 8-20 rows of grains are formed on a cob. The bean is a caryopsis with great variability in shape, size and color. The literature shows maize grains 2.5-22 mm long, 3-18 mm wide and 2.7-8 mm thick, and the mass of one thousand grains of 30-1200 g. The hybrid T. 248 studied has medium-sized cobs, with red spadix and normal yellow grains. The hybrid belongs to the indented form *(Zea mays* var. *indentata*, dent corn).

Research conducted to observe the variation of some characteristics of corn cobs (Lobell & Field, 2007), influenced by periods of drought (Sakurai et al., 2011) included: total length, diameter in the central portion, absolute weight, total number of grains, grain weight / cob, grain yield, grain length, width and thickness, and mass of one thousand grains (MTG).

MATERIALS AND METHODS

The variants have been cultivated in the last 3 years (2019-2021) with the hybrid Turda 248, from the semi-early group, FAO 380-390. The experience was set up according to the block method, with variants of 25 m^2 in 4 repetitions. The technology used was the one recommended by the resort. At full maturity, 25 cobs were randomly selected from each repetition (a total of 100), cut and brought to the laboratory. The 100 cobs were measured and determined: total length, thickness in the central area, weight, total number of grains, total grain weight, grain percent, grain length, grain width and thickness, mass of one thousand grains. The quality determined in the last year refers to the contents in protein, starch, oil and moisture at harvest. The morphological characters obtained were analyzed by the method of histograms (frequency polygons). In their expression, the class intervals established according to the specific sequence of values obtained were used. The study highlighted several aspects, namely: a) the mode values (with the highest frequencies), b) the limits of the intervals of variability of the studied characters and c) the specifics of each character of the maize ecotype in the analyzed area. Correlations were established between the analyzed characters, with the help of which their tendencies within the studied hybrid could be observed. Excel was used to express values. The significance of the correlation coefficients was obtained by comparing with the r_{max} values for the levels of 5%, 1% and 0.1% of the transgression probabilities. The quality indices were obtained with the help of the Perkin Elmer Inframatic 9500 analyzer. In the statistical calculation of all the values obtained, the analysis of variance (Anova test) was used on the variation strings. Statistical parameters were calculated using the formulas: $\bar{a} = \Sigma x/n$, where $\bar{a}$ = average of the determinations, and x = determined values, S^2 (variance) = $1/n\text{-}1[\Sigma x^2\text{-} (\Sigma x)^2/n]$, S (standard error) = $\sqrt{S^2}$ and CV% (coefficient of variation) = $S/\bar{a}.100$.

RESULTS AND DISCUSSIONS

Climatic characterization of maize vegetation. In general, the crop area has a favorable climatic regime (Sárvári & Pepo, 2014), from the beginning of vegetation to flowering (Table 1). The peak of rainfall is in May-June, after which the water deficit is installed until harvest. Lack of water (Dorland, 2000) thus affects the deposition of nutrients in the grain (Andersen et al., 2001; Rimski-Korsakov et al., 2009; Jolánkai et al., 2013), in close connection with the level of water supply in soil (Taylor et al., 2013). The normal thermal regime was exceeded in August the first year and in the period July-August in the other two years. For maize vegetation, the average temperatures exceeded the multiannual values by 0.66^0C, 0.78^0C and 1.08^0C, respectively.

The regime of rain falls in the maize vegetation (Huang et al., 2015) highlights the possibilities that the plant had in the formation of cobs and grains. As the volume of precipitation approached the necessary, consumption, the favorability of that year was more obvious. Of the three years analyzed, 2019 came closest to the necessary, being followed by the other two years with significant deficits. The hydroclimatic index (the ratio between rainfall and ETP) in 2019 had a positive balance, while in the other two years the balance was negative.

Variability of cobs and maize grains. The appearance and dimensions of the cob of this corn hybrid showed characteristic aspects. Thus, at the level of the three years, the length was generally between 13 and 24 cm. They dominated the lengths of 21 cm in the first year and 18 cm in the other two years (Figure 1). The graph shows the influence of the rainfall regime in the formation of cobs, of which the favorable year 2019 was highlighted. The thickness of the cobs in their central portion was generally between 3 and 4.8 cm (Figure 2). Dominant thicknesses were 4 cm in the second year (2020) year and 3.8 cm in the other two years.

Table 1. Climatic factors evolution from maize vegetation

Month	Temperatures, tn^{0}C				Rain, mm				Hydroclimatic index,HI*,%			
	Multi	2019	2020	2021	Multi	2019	2020	2021	Multi	2019	2020	2021
Apr.	11.0	11.3	11.8	9.0	56	50	24	47	86	77	37	72
May	16.3	16.4	15.8	16.0	81	68	**92**	**95**	105	88	**119**	**123**
June	19.5	21.8	19.9	19.9	94	**187**	**138**	80	99	**197**	**145**	84
July	21.7	21.8	**22.6**	**24.5**	81	48	10	50	53	32	7	35
Aug.	21.3	**23.9**	**23.6**	**23.7**	60	8	33	47	54	7	30	42
Mean, sum	17.96	19.04	18.74	18.62	372	361	297	319	79.4	80.2	67.6	71.2
±		+1.08	+0.78	+0.66	±	-11	-75	-53	±	**+0.8**	**-11.8**	**-8.2**

HI* % = P mm/ETP.100 (ETP, evapotranspiration potential)

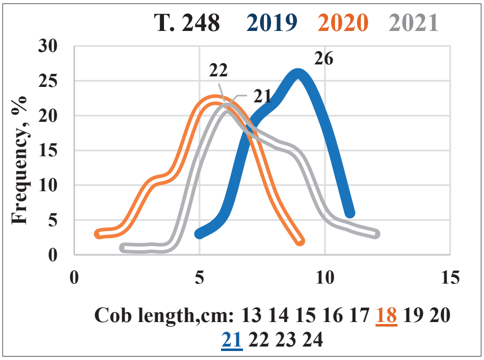

Figure 1. Frequencies of maize cob length

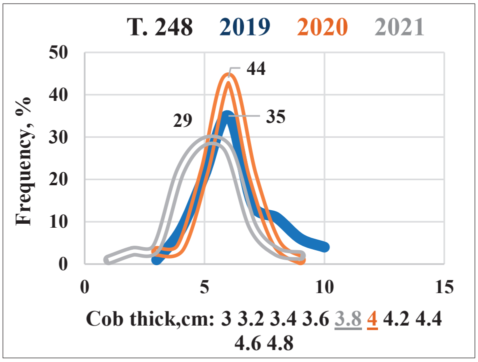

Figure 2. Frequencies of maize cob thick

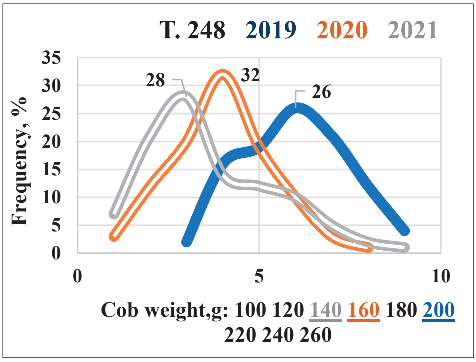

Figure 3. Frequencies of cob weight

Figure 4. The cobs aspect of Turda 248 hybrid

The weight of the cobs was generally between 100 and 260 g (Figure 3). The dominant cobs weighed 200 g in the favorable first year, 160 g in the second year and 140 g in the last year, respectively. The appearance, color and size of the cobs of this hybrid are shown in Figure 4.

The number of grains/cobs was between 400 and 850, at the level of the three years of cultivation (Figure 5). Of these, the cobs with 750 grains dominated in 2019 and the ones with 600 berries in the other two years. Regarding the weight of these grains on a cob, the values were between 80 and 220 g (Figure 6). Dominant were the grain biomasses of 180 g/cob in the favorable climate year 2019 and 140 g, respectively 120 g in the other two years, with the dry regime, 2020 and 2021 respectively. Grain percent of the cobs was within a wide range of values: 75% to 87%. Of these, 84% were dominant in the first year, 83% in the second year and 81% in the last year (Figure 7). Characteristics of the grains of this hybrid are shown in Figure 8.

The grain sizes were inscribed at values characteristic of the hybrid and the researched period. Thus, the length (or height) of the grains was generally between 8 and 13.5 mm (Figure 9). The dominant values were 11 mm in the first year, 10.5 mm in the second year and 10 mm in the last year. The width of these grains was 5.5 mm and 9 mm (Figure 10). The mod values of the three years were similar, namely at 7 mm. The third dimension, the grain thickness was between 3.6 mm and 5.4 mm (Figure 11). The grains with higher dominant thicknesses were in the first year, 4.8 mm. In the other two years, the grain thickness of 4.2 mm and 4 mm, respectively, are dominant.

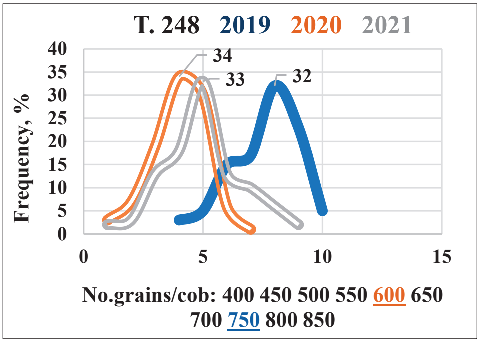

Figure 5. Frequencies of no. grains/cob

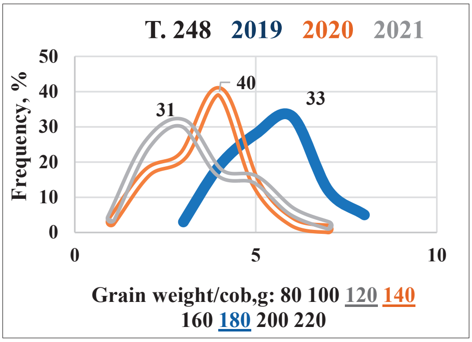

Figure 6. Frequencies of grains weight/cob

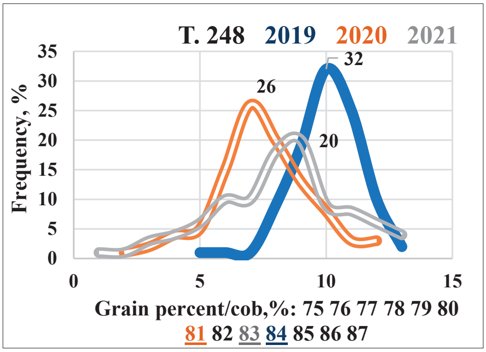

Figure 7. Frequencies of grain percent/cob

Figure 8. The grains aspect of Turda 248 hybrid

The absolute mass of the grains (thousand grains weight-TGW) was between 140 and 320 g (Figure 12). Dominant were grains with TGW of 240 g in the first year, 220 g in the second year and 200 g in the third year. Drought periods have obviously influenced the biomass of the grains of this hybrid.

From a qualitative point of view, the grains contained 7.0-7.4% protein, 4.1-4.5% oil, 72-74% starch, at the grain humidity of 16-18%.

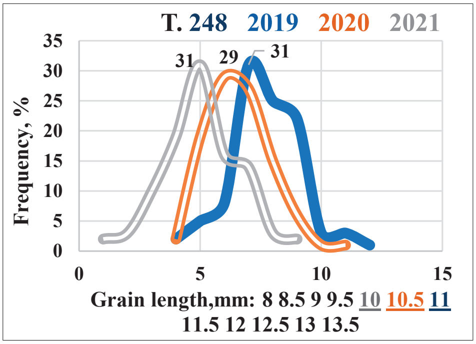

Figure 9. Frequencies of grain length

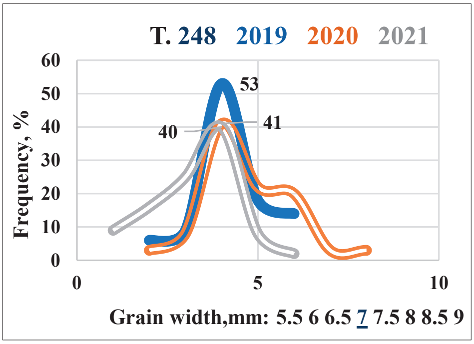

Figure 10. Frequencies of grain width

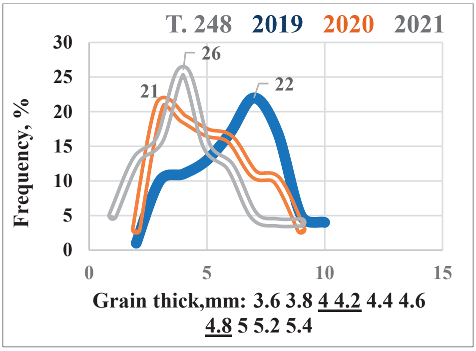

Figure 11. Frequencies of grain thick

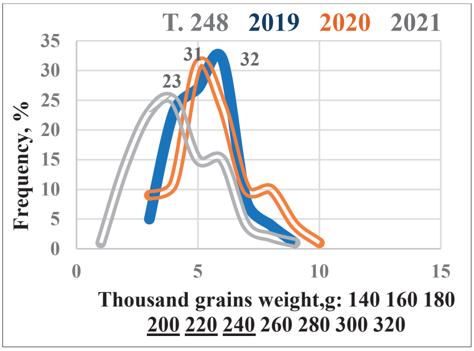

Figure 12. Frequencies of thousand grains weight

Correlations between main characters. If we analyze the whole set of correlations between all the analyzed characters, we find both positive and negative situations. Very obvious positive correlations were observed between the characteristics of the cob: length, thickness, weight, total number of grains, total weight of the grains. Negative correlations of different intensities of significance were observed in a higher proportion in the last year, 2021, a year with longer periods of drought (Table 2).

Statistical analysis of the variability of morphological characters in maize. The results obtained in the morphological analysis of the characters of the hybrid T. 248 in the three years showed specific aspects. Thus, the length of the cob was between 17.3 cm in 2020 and 20.4 cm in 2021. The variability showed small coefficients (7.2-10.9%). The thickness of the cob measured 3.80 cm to 4.01 cm, with a variation also reduced (5.2-10.4%), and its weight was between 145.1 g to 190.2 g (with medium to high variation). The grain percent/cob was between 81.4% in the second year and 84.0% in the first year. The average number of grains on a cob was 524.3 and 705.2 (average variability in all years) (Table 3). The weight of grains on the cob was 117.4 g to 159.6 g, with medium to high variability. The absolute weight of the grains (TGW) was on average between 203.3 g in 2021, 225.3 g in the first year and 234.8 g in the second year of cultivation. The variability of this character was reduced to average. The three grain sizes, namely length, width and thickness, had the lowest values in 2021 and the highest in the relatively more favorable year, 2019. From the average values obtained, differences emerged that explain the influence of drought in the last years of cultivation and more obviously in the last period of vegetation (Table 4).

Table 2. Correlations between the main characters of Turda 248 cobs and grains

Indices	Cob width cm	Cob weight g	No. grains	Grains weight g	% grains/ cob	Grain length mm	Grain width mm	Grain thick mm	TGW, g
	2019								
Cob length, cm	**.376**	**.827**	**.461**	**.805**	**-.238**	**.439**	**.358**	.075	**.699**
Cob width, cm	1	**.587**	**.387**	**.609**	.046	**.409**	**-.632**	-.119	**.489**
Cob weight, g		1	**.703**	**.989**	**-.245**	**.650**	.094	.059	**.702**
No. grains/cob			1	**.716**	-.033	**.449**	**-.292**	-.103	.020
Grains weight, g				1	-.107	**.648**	.061	.045	**.707**
% grains/cob					1	-.133	**-.254**	-.129	-.126
Grain length, mm						1	.086	.037	**.473**
Grain width, mm							1	.087	**.411**
Grain thick, mm								1	.188
	2020								
Cob length, cm	**.238**	**.797**	**.481**	**.799**	-.169	**.385**	**.261**	.140	**.596**
Cob width, cm	1	**.623**	**.489**	**.633**	-.069	**.480**	.108	.053	**.357**
Cob weight, g		1	**.582**	**.987**	**-.285**	**.569**	**.281**	.140	**.706**
No.grains/cob			1	**.606**	.006	**.364**	-.173	-.159	-.050
Grains weight, g				1	-.130	**.569**	**.286**	.132	**.697**
% grains/cob					1	-.136	.024	.075	.183
Grain length, mm						1	.166	.084	**.418**
Grain width, mm							1	**.222**	**.545**
Grain thick, mm								1	**.259**
	2021								
Cob length, cm	**.267**	**.687**	**.713**	**.708**	**-.236**	.116	.073	.031	**.217**
Cob width, cm	1	**.342**	**.232**	**.357**	-.081	-.009	-.030	-.030	**.223**
Cob weight, g		1	**.737**	**.991**	**-.246**	-.086	**-.205**	**-.237**	.062
No.grains/cob			1	**.756**	.080	**.258**	-.184	-.095	-.183
Grains weight, g				1	**-.422**	**-.222**	**-.262**	**-.303**	**.561**
% grains/cob					1	**.440**	**.497**	**.364**	**-.392**
Grain length, mm						1	**.726**	**.548**	-.244
Grain width, mm							1	**.735**	**-.225**
Grain thick, mm								1	**-.303**
	LSD 5 % = .190 LSD 1 % = .250 LSD 0.1 % = .320								

Table 3. Statistical indices of Turda 248 maize cobs

Indices	Cob length, cm	Cob width, cm	Cob weight, g	% grains/ cob	No. grains/ cob
			2019		
Mean, ā	**20.4**	**4.01**	**190.2**	**84.0**	**705.2**
Variance, s^2	2.15	0.06	805.2	2.87	4973
Std. error. s	1.46	0.24	28.35	1.69	70.52
Var. coef., s%	**7.2**	**6.0**	**15.0**	**2.01**	**10.0**
			2020		
Mean, ā	**17.3**	**3.95**	**150.0**	**81.4**	**524.3**
Variance, s^2	3.55	0.04	750.6	2.66	3767
Std. error, s	1.88	0.21	27.4	1.63	61.37
Var. coef., s%	**10.9**	**5.2**	**18.3**	**2.01**	**11.7**
			2021		
Mean, ā	**19.1**	**3.80**	**145.1**	**82.1**	**571.4**
Variance, s^2	4.30	0.11	1293	7.60	6847
Std. error. s	2.09	0.32	35.9	2.71	82.7
Var. coef., s%	**10.9**	**10.4**	**24.7**	**3.3**	**14.4**

S^2 variance, s standard deviation, VC variation coefficient

Table 4. Statistical indices of Turda 248 maize grains

Indices	Grains weight, g	TGW, g	Grain length, mm	Grain width, mm	Grain thick, mm
2019					
Mean, ā	**159.6**	**225.3**	**11.3**	**7.13**	**4.58**
Variance, s^2	543.5	482.1	3.04	0.14	0.20
Std. error s	23.31	21.95	1.74	0.37	0.44
Var. coef., s%	**14.6**	**9.7**	**15.4**	**5.18**	**9.6**
2020					
Mean, ā	**117.4**	**234.8**	**10.8**	**7.20**	**4.44**
Variance, s^2	1555	1125	0.39	2.83	0.16
Std. error s	39.4	33.5	0.63	1.68	0.39
Var. coef., s%	**33.6**	**14.3**	**5.8**	**23.4**	**8.9**
2021					
Mean, ā	**118.7**	**203.3**	**9.22**	**6.33**	**4.05**
Variance, s^2	746.8	960.7	3.91	1.04	0.44
Std. error s	27.3	30.9	1.93	1.02	0.58
Var. coef., s%	**23.1**	**15.2**	**21.6**	**16.2**	**15.8**

CONCLUSIONS

From a climatic point of view, the multiannual average of the hydroclimatic index (HI) is about 80% of what is needed for maize vegetation. In the first year this threshold was slightly exceeded, which means a relatively normal degree of favorability. In the other two years HI had deficiencies and characterize years with periods of drought.

The morphological characteristics of the cobs obtained in the three years, a relatively normal year - 2019 and the last two years with obvious periods of drought, were specific. Thus, in the dry years the average length of the cobs lost 3 cm, and their thickness decreased by 0.2 cm. The cobs weighed less by 40-60 g and formed with 150 grains less. The grains on the cobs weighed less by 40-60 g and had a mass of one thousand grains reduced by 20-40 g. The grain percent of the cobs was reduced by 3%. The grain of corn had lengths of 1.0 mm, the width remained constant, and the thickness decreased by 0.6-0.8 mm.

Simple correlations were established between all the studied characters, with some differentiations. The correlations between the size and biomass of cobs and grains were positive and very significant. Negative correlations were observed between the grain yield of the cobs with all the other characters, in all years. Of the three years, the most severe periods of drought in the last year have had the most unfavorable influence on the grains, in percentage, size and absolute weight.

The statistical indices studied showed average values affected by the drought periods of those years, and the variability of the analyzed characters ranged from low to medium and rarely very high.

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