THE INFLUENCE OF SOWING DENSITY ON CERTAIN PLANTS AND COBS CHARACTERS ON SOME EARLY MAIZE (*ZEA MAYS L.*) HYBRIDS

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Abstract. *In the 2014-2015 years there were studied eight early maize hybrids, (Zea mays L.) which were coming from ARDS Turda, and the research goal was to establish interactions between sowing density and certain characters, such as leaf length and width (leaf area) at the main cob insertion, and also cobs length and weight. It is known that leaves above the first cob are primarily considered the "kitchen plant" in the sense that it provides the necessary nutrients for cobs development.Therefore it is important to know, and that represents the stage of the research, whether there are differences between different sowing densities on these characters, and if this are manifested to all studied genotypes. The study was carried out on breeding fields, at three culture densities: first density- 40.000 plants/ha, second density- 60.000 plants/ha and third density- 80.000 plants/ha.Method of settlement of the experience was randomized block, consisting of two experimental years, eight experimental variants and two repetitions. Cob weight is a component of production which is directly correlated with production, therefore knowledge of the sowing density that influenced positively this character, is important and helpful in the process of maize improvement.The research degree of novelty is represent by studying the most recents eight hybrids omologated on ARDS Turda, under low and high densities. In both experimetal years positive correlations were identified for most variants, between sowing density 1 and 2, and the leaf lenght and width of the main cob insertion. Turda 332 hybrid was significantly positive influenced by the sowing densities of 40,000 and 80,000 pl / ha in terms of leaf area. The first and second sowing densities, had a significantly negative influence for this character for Turda 248 hybrid.Turda 248 hybrid was very significantly positive influenced for both weight and length of the cob and its distinct significantly positive influenced for kernel depth.Turda 332 and Marius TD hybrids were also distinctly positive significantly influenced for the cobs weight and kernel depth. Despite heat during pollination in 2015, affected the foliage of the plants, in the case of three early maize hybrids, were registered increased values of the studied vegetative characters. Although the two experimental years were different in terms of environmental conditions, 2014 year has proven to be favorable to maize crop, there can be detached some conclusions on the topic addressed: of the eight studied hybrids at the 3 sowing densities only 3 hybrids were noted: Turda 332, Turda 248 and Turda Favorit for cobs characters, and two hybrids: Turda 332 and Turda 248 for plants characters.*

Key words: *sowing densities, early maize hybrids, cob weight*

INTRODUCTION

Because of the great advances which improving maize achieved in, it is known that generally, how much the density of the plant increases as more their drop resistance becomes low, increase sterility, and finally grain yield is adversely affected.Increasing plant density(sowing density) beyond certain limits causes some quantitative and qualitative influences on maize plants. Quantitatively number and size of reproductive organs (tassel , ear)are influenced, and qualitative is influenced diseases resistance and biochemical composition of the kernels.(BREKKE et al., 2011)

One of the most important causes of these influences is enhanced shading that occurs at high densities. Shading lead to a poor plant photosynthetic activity and low sugar content, together with nitrogen metabolism disorder. Also by shading inhibits development cobs and creates conditions fora phenomenon that causes sterile plants(without cobs).(CRISTEA, 2004; LAMBERT, 2014)

In order to remove the negative influences of sowing on high densities, maize breeders seek tolerant genotypes, having the following characters : the robustness of the stalk, the small size of the plants, reduced sensitivity to " barren stalk ",high weightaverage of the cobs, and so on.(CRISTEA, 2004; BREKKE et al., 2011)

Promoting high densities on large areasand yields obtained on these surfaces demonstrate progresses in physiology, genetics and maize breeding, towards the creation of specialized hybrids for these densities.(TOKATLIDIS ET AL., 2005; TOKATLIDIS et al., 2011).

RESEARCH OBJECTIVES

The main purpose of experimental study was to analyze the influence of sowing density for plant character (leaf area) and cob characters like cob lenght and weight, kernel depth, and number of kernels per row.

It is known that leaves above the first cob are primarily considered the "kitchen plant " in the sense that it provides the necessary nutrients for cobs development (production).Therefore it is important to know whether there are differences between different sowing densities on these characters, and if this are manifested to allstudied genotypes.

Cob weight is a component of production which is directly correlated with production, therefore knowledge of the sowing density that influenced positively this character, is important and helpful in the process of maize improvement.Also a long cob is preferable, especially when isfavored large number on rows of kernels, but also a commercially attractive appearance.The choice of maize hybrids with these characters of cobs positively correlated with sowing density is important and necessary to promote hybrid ideotype specialized for high densities.

MATERIAL AND METHODS

The biological material was represented by eight experimental early maize hybrids, germplasm derived from ARDS Turda. The study was conducted in 2 experimental years (2014-2015), the biological material being sowed at three different densities: the first density 40,000 pl / ha, the second density 60,000 pl / ha and the third density 80,000 pl / ha.Method of settlement experience was randomized blocks, consisting of two years, eight experimental variants and two repetitions.

THERMAL AND RAINFALL CONDITIONS

Air average temperature(°C)	2014						
	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.
Month average	11.4	5.1	8.5	20.4	9.9	6.6	10.8
Average 57 years	9.8	4.7	7.7	19.6	9.2	4.9	9.6
Deviation	+1.6	0.4	0.8	+0.8	0.7	1.7	+1.2
Characteristics	warm	normal	normal	normal	normal	warm	warm
Rainfall(mm)	2014						
	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.
Month average	72.0	6.2	8.4	144.4	3.8	8.4	67.4
Average 57 years	44.7	7.7	4.5	76.7	5.9	0.3	32.0
Deviation	+27.3	1.5	36.1	67.7	27.9	8.1	+35.4
Characteristics	excessively rainy	normal	very hot	excessively rainy	very rainy	lightly rainy	excessively rainy

Air average temperature(°C)	2015						
	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.
Month average	9.6	5.8	9.4	2.3	1.9	17.3	9.7
Average 57 years	9.8	4.7	7.7	9.6	9.2	14.9	9.6
Deviation	-0.2	1.1	1.7	2.7	2.7	+2.4	+0.1
Characteristics	normal	warm	warm	hot	hot	hot	normal
Rainfall (mm)	2015						
	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.
Month average	32.2	6.0	15.7	2.2	2.2	172.6	45.4
Average 57 years	44.7	7.7	4.5	6.7	5.9	40.3	32.0
Deviation	-12.5	1.7	31.2	24.5	16.3	+132.3	+13.4
Characteristics	slightly hot	normal	very rainy	very hot	rainy	excessively rainy	very rainy

RESULTS AND DISCUSSIONS

I. Obtained results for plant characters

Table of variance analysis for leaf length and width of the main cob insertion, shows very significant highlights differences between hybrids in the expression of those characters.

Hybrids and sowing densities, along interaction between hybrids and experimental years influenced very significantly leaf area of hybrids plants.

Table.1

Sowing density influence of leaf area, for some early maize hybrids - Turda 2014-2015

Variability source	DOF	Leaf lenght Cm		Leaf width cm		Leaf area cm^2	
		s^2	F test	s^2	F test	s^2	F test
Total	95						
Years(Y)	1	12.9	32.2 -	3.11	7.08 -	6037.2	3.51-
Repetitions (R)	1	3.84		1.95		9466.4	
Erorr (Y)	1	0.40		0.44		1717.8	
Densities (D)	2	4.43	0.63 -	11.82	12.5*	51902.8	8.11*
Interaction Y x D	2	2.51	0.36 -	0.81	0.86 -	3915.1	0.61-
Erorr (D)	4	6.93		0.94		6397.1	
Hybrids (H)	7	198.69	117.8 **	5.58	56.15 **	9198.2	17.43**
Y x H	7	16.44	9.75 **	0.23	2.39 *	2938.1	5.56**
D x H	14	2.76	1.63 -	0.10	1.03 -	658.4	1.24 -
Y x D x H	14	1.67	0.99 -	0.05	0.56 -	305.8	0.58 -
Erorr (H)	42	1.68		0.09		527.7	

Turda 332 hybrid was significantly positive influenced by the sowing densities of 40,000 and 80,000 pl / ha in terms of leaf area. The first and second sowing densities, had a significantly negative influence for this character for Turda 248 hybrid.

Table 2

Influence of sowing density on certain plant characters, for some maize hybrids (Turda 2014-2015)

Hybrid	**Density**	**Leaf area**		
		cm^2	±control	Semnification
Density average		**685.04**	**0.00**	**Control**
HS(E330R-12)	D1	672.48	-12.57	-
HS(D398-1)		659.43	-25.62	-
HS(A451-3)		711.88	26.83	-
Turda 228		699.78	14.73	-
Turda Favorit		679.38	-5.67	-

Turda 248		644.95	-40.09	0
Turda 332		729.28	44.23	**
Marius TD		683.18	-1.87	-
Density average		**623.55**	**0.00**	**Control**
HS(E330R-12)	D2	612.05	-11.50	-
HS(D398-1)		593.73	-29.82	-
HS(A451-3)		648.48	24.93	-
Turda 228		663.68	40.13	*
Turda Favorit		609.20	-14.35	-
Turda 248		580.88	-42.67	0
Turda 332		654.05	30.50	-
Marius TD		626.33	2.78	-
Density average		**609.24**	**0.00**	**Control**
HS(E330R-12)	D3	586.68	-22.57	-
HS(D398-1)		563.50	-45.74	00
HS(A451-3)		618.38	9.13	-
Turda 228		625.25	16.01	-
Turda Favorit		632.18	22.93	-
Turda 248		588.33	-20.92	-
Turda 332		662.08	52.83	**
Marius TD		597.55	-11.69	-
LSD (p 5%)		32.75		
LSD (p 1%)		43.79		
LSD (p 0.1%)		57.47		

II. Results obtained for cobs characters

In the expression of the studied cobs characters, we note very significant influence for densities, hybrids, hybrids and experimental years interactions, densities and hybrids interactions.

Table 3

Analysis of variance on studied cobs characters for maize hybrids, depending on the experimental years and densities- Turda 2014-2015

Variability source	DOF	Cob weight g		Cob lenght cm		Kernel depth cm		Numbers of rows per cob no	
		s^2	F test	s^2	F test	s^2	F test	s^2	F test
Total	95								
Years (Y)	1	77822.1	1041.37 *	97.20	115.2 -	0.144	263.0*	64.51	42.30 -

Repetitions (R)	1	520.33		0.20		0.076		1.02	
Erorr (Y)	1	74.72		0.84		0.005		1.52	
Densities (D)	2	10283.5	147.36 **	12.93	248.3 **	0.041	33.0**	24.78	9.18*
Interaction Y x D	2	227.71	3.26 -	0.24	4.77 -	0.006	5.0 -	5.89	2.18 -
Erorr (D)	4	69.78		0.05		0.001		2.69	
Hybrids (H)	7	12104.9	87.14 **	24.99	91.70 **	0.100	64.5**	64.06	35.01**
Y x H	7	611.17	4.40 **	2.23	8.19 **	0.012	7.8**	8.85	4.84**
D x H	14	578.38	4.16 **	1.60	5.88 **	0.006	4.4**	5.09	2.78**
Y x D x H	14	108.54	0.78 -	0.34	1.25 -	0.004	2.8**	0.60	0.33 -
Erorr (H)	42	138.9		0.27		0.001		1.82	

1. Sowing at the Istdensity (40,000 pl./ha)

In both experimental years, Turda 248 was very significantly positive influenced for both weight and length of the cob and its distinct significantly positive influenced for kernel depth. Hybrids Turda 332 and Marius TD were also distinctly positive significantly influenced for the cobs weight and kernel depth.

2. Sowing at the IInddensity (60,000 pl./ha)

There can be recommended for Turda 332 using second density, which had the most positive influence for all production characters studied. Very significant positive influence were registered on IInddensity for Marius TD hybrid, in terms of cobs weight and length in both experimental years, therefore we recommend the sowing of this hybrid at a density of 60,000 pl./ha that seems to be the best in expression of the studied characters. Regarding the length of the cobs, very significant positive influence of this density, was observed for Turda 248, Turda Favorit and Marius TDhybrids.

3. Sowing at the IIIrddensity (80,000 pl./ha)

Although this density is higher, two of the studied hybrids reacted positively to its influence, there were significantly positive differences for weight and length of the cobs, but also for the kernel depth both in Turda 332, and Turda 248.

Table 4

Influence of sowing density on certain cobs characters, for some maize hybrids (Turda 2014-2015)

Hybrid	**Density**	**Cob weight**			**Kernel depth**		
		gr	± control	Semnification	cm	±control	Semnification
Density average		**188.22**	**0.00**	**Control**	**0.95**	**0.00**	**Control**
HS(E330R-12)	D1	151.53	-36.69	000	0.87	-0.08	00
HS(D398-1)		179.63	-8.59	-	0.96	0.01	-
HS(A451-3)		162.93	-25.29	00	0.90	-0.05	-
Turda 228		136.68	-51.54	000	0.79	-0.17	000
Turda Favorit		204.95	16.73	-	0.90	-0.05	-

Turda 248		220.13	31.91	***	1.04	0.09	**
Turda 332		236.25	48.03	***	1.13	0.17	***
Marius TD		213.68	25.46	**	1.05	0.09	**
Density average		**167.59**	**0.00**	**Control**	**0.90**	**0.00**	**Control**
HS(E330R-12)	D2	139.50	-28.09	00	0.87	-0.03	-
HS(D398-1)		150.58	-17.01	0	0.94	0.04	-
HS(A451-3)		148.70	-18.89	0	0.92	0.02	-
Turda 228		107.75	-59.84	000	0.75	-0.15	000
Turda Favorit		178.65	11.06	-	0.83	-0.07	0
Turda 248		181.48	13.89	-	0.85	-0.05	-
Turda 332		231.23	63.64	***	1.09	0.19	***
Marius TD		202.83	35.24	***	0.95	0.05	-
Density average		**152.51**	**0.00**	**Control**	**0.88**	**0.00**	**Control**
HS(E330R-12)	D3	130.48	-22.03	0	0.86	-0.02	-
HS(D398-1)		150.50	-2.01	-	0.91	0.03	-
HS(A451-3)		147.55	-4.96	-	0.92	0.04	-
Turda 228		119.35	-33.16	000	0.78	-0.11	000
Turda Favorit		149.38	-3.13	-	0.81	-0.07	0
Turda 248		175.78	23.27	**	0.85	-0.04	-
Turda 332		190.38	37.87	***	1.02	0.13	***
Marius TD		156.68	4.17	-	0.94	0.06	-
		LSD (p 5%)		16.80			0.06
		LSD (p 1%)		22.47			0.08
		LSD (p 0.1%)		29.48			0.10

Table 5

Influence of sowing density on certain production elements, for some maize hybrids
(Turda 2014-2015)

Hybrid	**Density**	**Cob lenght**			**Number of kernel per row**		
		cm	±control	Semnification	no	± control	Semnification
Density average		**18.98**	**0.00**	**Control**	**38.21**	**0.00**	**Control**
HS(E330R-12)	D1	17.55	-1.43	000	33.95	-4.26	000
HS(D398-1)		16.98	-2.00	000	35.50	-2.71	00
HS(A451-3)		18.28	-0.70	-	39.50	1.29	-
Turda 228		17.43	-1.55	000	39.70	1.49	-
Turda Favorit		21.43	2.45	***	40.65	2.44	*
Turda 248		21.18	2.20	***	40.60	2.39	*
Turda 332		19.48	0.50	-	37.45	-0.76	-
Marius TD		19.50	0.52	-	38.35	0.14	-

Density average		**18.21**	**0.00**	**Control**	**37.38**	**0.00**	**Control**
HS(E330R-12)	D2	17.05	-1.16	00	32.55	-4.83	000
HS(D398-1)		15.85	-2.36	000	35.75	-1.63	-
HS(A451-3)		17.68	-0.54	-	38.10	0.72	-
Turda 228		16.53	-1.69	000	38.75	1.37	-
Turda Favorit		20.80	2.59	***	40.30	2.92	**
Turda 248		19.65	1.44	***	38.35	0.97	-
Turda 332		18.78	0.56	-	36.85	-0.53	-
Marius TD		19.38	1.16	**	38.40	1.02	-
Density average		**17.71**	**0.00**	**Control**	**36.45**	**0.00**	**Control**
HS(E330R-12)	D3	16.93	-0.79	0	32.45	-4.00	000
HS(D398-1)		16.53	-1.19	00	36.50	0.05	-
HS(A451-3)		18.05	0.34	-	39.10	2.65	**
Turda 228		17.18	-0.54	-	39.65	3.20	**
Turda Favorit		19.33	1.61	***	37.93	1.47	-
Turda 248		19.40	1.69	***	37.65	1.20	-
Turda 332		17.30	-0.41	-	33.20	-3.25	00
Marius TD		17.00	-0.71	-	35.15	-1.30	-
LSD (p 5%)				0.71			1.93
LSD (p 1%)				0.96			2.58
LSD (p 0.1%)				1.29			3.38

CONCLUSIONS AND RECOMMENDATIONS

Although the two experimental years were different in terms of environmental conditions, 2014 year has proven to be favorable to maize crop, there can be detached some conclusions on the topic addressed: of the eightstudied hybrids at the 3 sowing densitiesonly 3 hybrids were noted: Turda 332, Turda 248 and Turda Favorit for cobs characters, and two hybrids: Turda 332 and Turda 248 for plants characters.

Based on the results obtained in the two years of experimentation we can make the following recommendations:

- Turda 332 hybrid has the highest cob weight at all 3 densities and can be sowed at any of the three densities, because is a early maize hybrid with good stability ;
- Marius TD and Turda 248 hybrids are recommended at sowing densities of 40,000-60,000 plants / ha .

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