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RESEARCHES ABOUT THE INFLUENCE OF THE HYBRID AND THE IRRIGATION REGIME ON THE SIZE FEATURES OF THE MAIZE COB

Viorel MIRCEA[1], Celzin AEDIN[2], Doru Ioan MARIN[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest, Romania
[2]SC Micul Agricultor SRL, Osmancea, Constanta County, Romania

Corresponding author email: mirceaviorel8@gmail.com

Abstract

This paper presents the results of a study conducted at ARDS Marculesti in 2017 and 2018 on the influence of 5 new maize hybrids under different irrigation conditions on the size features of the maize cobs, namely the number of rows per cob and the number of grains per row. The experiment was set up using the two-factor subdivided plot method, the A-factor was the maize hybrid and B factor-irrigation regime. The subdivisions of A factor: a1- P9175 (FAO 330), a2 - KWS BELLAVISTA (FAO 330), a3 - KWS SMARAGD (FAO 350), a4 - KWS KASHMIR (FAO 370) and a5 - KWS DURANGO (FAO 480). The subdivisions of B factor: b1 – unirrigated; b2 – stressed at and after flowering; b3 – stressed before flowering and b4 – full irrigated throughout the vegetation period. Regarding the number of rows on the cob, the best results were obtained by the hybrids KWS Bellavista and KWS Smaragd and the lowest, by the hybrid P9175.

Key words*: maize hybrids, maize cob size features, irrigation, water stress.*

INTRODUCTION

In the current context, when the global climate is constantly changing and tends to reach air temperature values that have not yet been observed since meteorological measurements, the maize crop encounters challenges related particularly on pollen grain fertility (Jonghan K. & Piccinni G., 2009; Lizaso J.I. et al., 2018; Năescu V. & Eliana Alionte, 2008; NeSmith D.S. & Ritchie J.T., 1992; Niaz Ahmad & Rameshwar S. Kanwar, 1991; Oşvat I.M., 2015).

Maize is the main staple crop at national level. In the climatic conditions present during the last 15 years there have been problems with adapting the new hybrids to the warmer climate conditions and to the lower atmospheric humidity recorded by the meteorological stations in the major agricultural areas of the country.

The hydric stress encountered by the maize plant during the formation of the floral primordia is of great importance in the perspective of obtaining cobs with a high number of rows and grains in a row (Schoper John B. et al., 1987; Setter Tim L. et al., 2001; Stegman E.C., 1982).

In this context, we considered to set up an experiment that takes into account the stress that the maize plant undergoes before, during and after flowering. It was also taken into account the duration in days of coincidence of female and male flowers in order to ensure pollination.

MATERIALS AND METHODS

The researches have been done in the experimental field of Agricultural Research and Development Station (ARDS) Marculesti, on a clayey vermic loamy soil and it had 2 factors, the factor A - maize hybrid and the factor B - irrigation regime. The setting up method was randomized blocks, with three replications. The investigated hybrids (factor A) were: a1- P9175 (FAO 330), a2 - KWS BELLAVISTA (FAO 330), a3 - KWS SMARAGD (FAO 350), a4 - KWS KASHMIR (FAO 370) and a5 - KWS DURANGO (FAO 480). The B factor (irrigation regime and period) had 4 graduations, namely: b1 - unirrigated; b2 - stressed at and after flowering; b3 - stressed before flowering and b4 - full irrigated throughout the vegetation period. The

irrigation method was drip to drip and there were automatic sensors to determine the actual soil moisture. Sowing and harvesting were done mechanically using the seed drilling machine and BAURAL SP2100 combine harvester. The production obtained on each experimental plot, the humidity of the grains at harvesting and the hectolitric mass were determined automatically with the equipment installed on the combine.

The mass of a thousand grains was calculated using a photocell device for counting, along with a precision balance.

Along with these determinations, measurements were made on the height of the cob's insertion and the height of the plant. The statistical interpretation was made by variance analysis.

RESULTS AND DISCUSSIONS

The climatic conditions of the experimental years, 2017 and 2018, in comparison with the multiannual average, are presented in Figures 1 and 2.

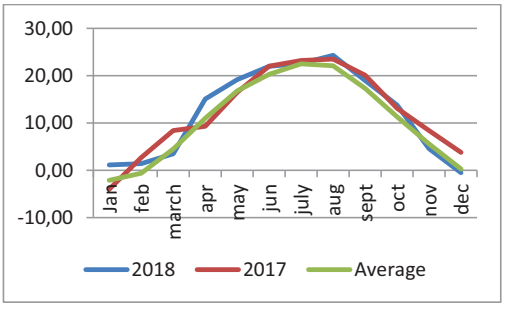

Figure 1. The temperature of 2017 and 2018 years in comparison with the multiannual average, at ARDS Marculesti

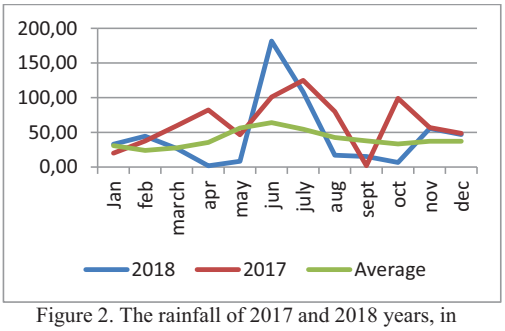

Figure 2. The rainfall of 2017 and 2018 years, in comparison with multiannual average, at ARDS Marculesti

As far as rainfall is concerned, we can see from this data that the year 2017 recorded a very rainy period in April, June, July and August, the quantities registered being more than double than the monthly multiannual average. The highest values were registered in June and July, over 100 and 120 mm respectively. September was very dry, with only 4 mm of precipitation, but this did not affect the maize vegetation.

Due to the rainfall recorded during this year's vegetation period, we can consider very favorable conditions for the growth and development of maize, as evidenced by the yields obtained.

In terms of air temperature, in 2017 there were values close to the multiannual average of the area.

The year 2018 recorded a very droughty period in the spring, in April and May, when extremely small rainfall was recorded, only 10 mm in two months. This has greatly affected germination and growth in the early stages of maize growth. The situation changed radically in the summer months, June and July, when record rainfall was 180 mm in June and 108 mm in July. The extremely abundant precipitation of this period favored the growth and development of maize plants under optimal conditions. August and September were droughty but this did not affect the production of maize.

The temperatures recorded in 2018 were generally lower than the multiannual average during June and July, due to the extremely abundant rainfall recorded. These climatic conditions have led to a very good viability and fertility of maize pollen.

a. The influence of hybrid and irrigation regime on the number of rows per cob.

The first table comprises the number of rows per cob in 2017. From this data it can be seen that with the irrigated regime the largest number of rows per cob was recorded at KWS Bellavista and KWS Smaragd hybrids and the smallest, with the hybrid KWS Durango (Table1).

With the case of irrigation before flowering, the largest number of rows of kernels on the cob was recorded with the hybrids KWS Bellavista and KWS Smaragd, too, with positive significant differences for hybrid KWS

Bellavista and significantly positive for hybrid KWS Smaragd, as compared to hybrid P9175 taken as control (Table 1).

When irrigation was done after flowering, the KWS Bellavista hybrid recorded 18.67 rows per ear and KWS Durango hybrid produced 15.33 rows per ear.

With the irrigation throughout the vegetation period, the best results were also obtained at the KWS Bellavista hybrid, with a difference of two more lines, distinctly significant, compared to the P9175 control (Table 1).

As regard the differences between hybrids at the average of irrigation regimes, the KWS Bellavista hybrid showed a very significant positive difference from the control, the P9175 hybrid and the KWS Durango hybrid recorded a significantly negative difference compared to the same control variant (Table 1).

As concerned on the irrigation regime (Table 1), the stressed before and after flowering have given positive significant difference over the unirrigated treatment, taken as control as well as over the irrigated treatment.

Table 1. The number of rows of grains per cob in function of maize hybrid and irrigation regime in 2017 at ARDS Marculesti

Hybrid	b1 –unirrigated				b2 – stressed during and after flowering				b3 – stressed before flowering			
	Number of rows	%	Diff.	Sign	Number of rows	%	Diff.	Sign	Number of rows	%	Diff.	Sign
a1-P9175	16.00	100	Mt	-	16.00	100	Mt	-	16.00	100	Mt	-
a2-KWS Bellavista	17.33	108.3	1.33	*	20.00	125	4.00	***	18.67	116.6	2.67	***
a3-KWS Smaragd	15.33	95.8	-0.6	-	15.33	95.8	-0.67	-	16.00	100	0.00	-
a4-KWS Kashmir	17.33	108.3	1.33	*	17.33	108.3	1.33	*	18.00	112.5	2.00	**
a5-KWS Durango	14.67	91.6	-1.3	0	15.33	95.8	-0.67	-	15.33	95.8	-0.6	-
LSD5%=1.21; LSD 1%=1.66; LSD 0.1%=2.25												

Hybrid	b4 –full time irrigated				Average of irrigation regimes				Irr. Regime	Number of rows	%	Diff.	Sign
	Number of rows	%	Diff.	Sign	Number of rows	%	Diff.	Sign					
a1-P9175	16.00	100	Mt	-	16	100	Mt	-	b1–unirrigated	16,13	100	Ctrl	-
a2-KWS Bellavista	18.00	112.5	2.00	**	18.5	115.6	2.5	***					
a3-KWS Smaragd	16.00	100	0.00	-	15.6	97.9	-0.33	-	b2 – stressed during and after flowering	16,80	103	0,67	*
a4-KWS Kashmir	17.33	108.3	1.33	*	17.5	109.3	1.5	**	b3 – stressed before flowering	16,80	103	0,67	*
a5-KWS Durango	14.67	91.6	-1.33	0	15	93.7	-1	0	b4 –full time irrigated	16,40	101	0,27	-
LSD 5%=1.21; LSD 1%=1.66; LSD 0.1%=2.25					LSD 5%=0.82; LSD 1%=1.20; LSD 0.1%=1.80				LSD 5%=0.64; LSD 1%=0.87; LSD 0.1%=1.15				

The feature of the number of rows on the cob, in 2018, is shown in (Table 2).

This year, the smallest number of rows on the maize cob was recorded with hybrid P9175, i.e., 15.6 rows. The differences between KWS Bellavista and KWS Smaragd hybrids compared to P9175 were significantly positive and those between the KWS Kashmir and KWS Durango hybrids to the control were insignificant (Table 2).

Regarding the irrigation regimes, the recorded data does not lead to a clear conclusion on the influence of the experimental treatments, probably due to the extreme rainfall quantities, too little at the beginning of the vegetation and too high during the growing and fructification period. Thus, the P9175 hybrid recorded the same number of rows per year on all irrigation regimens. With the KWS Bellavista hybrid, the best results were given by irrigation before flowering, and with the KWS Smaragd hybrid, the highest number of rows on the cob were counted with the irrigation after flowering treatment. Overall, unirrigated treatment gave the lowest results (Table 2).

The irrigation on the whole vegetation period has given the best results on the number of rows per cob in 2018. Nevertheless, the irrigation after flowering (stressed before flowering) has recorded no significance over the unirrigated control because during that period there were recorded lots of rainfall and the irrigation regime has had less influence on the formation of the rows on the cob (Table 2)

Table 2. The number of rows of grains per cob in function of maize hybrid and irrigation regime in 2018 at ARDS Marculesti

Hybrid	b1 –unirrigated				b2 – stressed during and after flowering				b3 – stressed before flowering			
	Number of rows	%	Diff.	Sign	Number of rows	%	Diff.	Sign	Number of rows	%	Diff.	Sign
a1-P9175	15.33	100	Mt	-	16	100	Mt	-	15.33	100	Mt	-
a2-KWS Bellavista	17.33	113.0	2.00	**	19.33	120.8	3.33	***	18.66	121.7	3.33	***
a3-KWS Smaragd	16	104.3	0.67	-	16.66	104.1	0.67	-	16	104.3	0.67	-
a4-KWS Kashmir	17.33	113.0	2.00	**	18	112.5	2.00	**	16.66	108.6	1.33	*
a5-KWS Durango	16	104.3	0.67	-	16.66	104.1	0.67		15.33	100	0.00	-
LSD 5%=1.21; LSD 1%=1.65; LSD 0,1%=2.25												

Hybrid	b4 –full time irrigated				Average of irrigation regimes				Irr. Regime	Number of rows	%	Diff.	Sign
	Number of rows	%	Diff.	Sign	Number of rows	%	Diff.	Sign					
a1-P9175	16	100	Mt	-	15.66	100	Mt	-	b1–unirrigated	16,4	100	Ctrl	-
a2-KWS Bellavista	20	125	4.00	***	18.83	120.2	3.16	***					
a3-KWS Smaragd	16.66	104.16	0.67	-	16.33	104.2	0.66	-	b2 – stressed during and after flowering	17,3	105	0,9	*
a4-KWS Kashmir	18	112.5	2.00	**	17.5	111.7	1.83	***	b3 – stressed before flowering	16,4	100	-	-
a5-KWS Durango	16.66	104.16	0.67	-	16.16	103.1	0.5	-	b4 –full time irrigated	17,4	106	1,0	**
LSD 5%=1.21; LSD 1%=1.65; LSD 0.1%=2.25					LSD 5%=0.77; LSD 1%=1.13; LSD 0.1%=1.70				LSD 5%=0.68; LSD 1%=0.92; LSD 0.1%=1.22				

The number of rows per cob as average of the two experimental years is presented in the (Table 3).

The average values of the two years of trials show very and distinct significant differences between hybrids KWS Bellavista and KWS Smaragd over P9175 hybrid taken as control (Table 3). There, also, can be seen that full irrigated and stressed after flowering gave higher values of the number of rows per cob (Table 3).

Table 3. The number of rows of grains per cob in function of maize hybrid and irrigation regime as average of 2017 and 2018 years, at ARDS Marculesti

Hybrid	b1 –unirrigated				b2 – stressed during and after flowering				b3 – stressed before flowering			
	Number of rows	%	Diff.	Sign	Number of rows	%	Diff.	Sign	Number of rows	%	Diff.	Sign
a1-P9175	15.6	100	Mt	-	16	100	Mt	-	15.6	100	Mt	-
a2-KWS Bellavista	17.3	110.6	1.67	**	19,6	122.9	3.67	***	18.6	119.1	3.00	***
a3-KWS Smaragd	17.3	110.6	1.67	**	17,6	110.4	1.67	**	17.3	110.6	1.67	**
a4-KWS Kashmir	15.6	100	0.00	-	16	100	0.00	-	16	102.1	0.33	-
a5-KWS Durango	15.3	97.8	-0.3	-	16	100	0.00	-	15.3	97.8	-0.3	-
LSD 5%=1.21; LSD 1%=1.66; LSD 0.1%=2.25												

Hybrid	b4 –full time irrigated				Average of irrigation regimes			
	Number of rows	%	Diff.	Sign	Number of rows	%	Diff.	Sign
a1-P9175	16	100	Mt	-	15.8	100	Mt	-
a2-KWS Bellavista	19	118.7	3,00	***	18.6	117.8	2.8	***
a3-KWS Smaragd	17.6	110.4	1,67	**	17.5	110.5	1.6	**
a4-KWS Kashmir	16.3	102.0	0,33	-	16	101.0	0.1	-
a5-KWS Durango	15.6	97.9	-0,33	-	15.5	98.4	-0.2	-
LSD 5%=1.21; LSD 1%=1.66; LSD 0.1%=2.25					LSD 5%=0.79; LSD 1%=1.16; LSD 0.1%=1.75			

The number of grains per row, in 2017 and the statistical interpretation are shown in table 4. Regarding the number of grains per row, in the year 2017, the P9175 hybrid, which is taken as control, is very clear emphasized. Thus, in the unirrigated condition, the KWS Bellavista hybrid recorded very significant negative differences compared to the control P9175 and the other 3 tried hybrids (KWS Kashmir, KWS Smaragd and KWS Durango) recorded distinctly significant differences. These differences were maintained in the other irrigation regimes but more mildly (Table 4).

Regarding the irrigation regimes, the worst results were obtained with rainfed treatment, where there were 30.9 grains in a row and the highest number of grains was recorded in full time irrigated treatment, i.e. 35.8 grains in a row. The difference between these two irrigation regimes was very significant. All three irrigation treatments gave very significant positive differences as compared with the unirrigated control treatment (Table 4)

Table 4. The number of grains in a row in function of maize hybrid and irrigation regime, in 2017, at ARDS Marculesti

Hybrid	b1 –unirrigated				b2 – stressed during and after flowering				b3			
	Number of grains in a row	%	Diff.	Sign	Number of grains in a row	%	Diff.	Sign	Number of grains in a row	%	Diff.	Sign
a1-P9175	33.00	100	Mt	-	35.33	100	Mt	-	36.67	100	Mt	-
a2-KWS Bellavista	29.67	89.8	-3.3	000	31.00	87.7	-4.33	000	32.33	88.1	-4.3	000
a3-KWS Smaragd	30.67	92.9	-2.3	00	34.67	98.1	-0.67	-	35.33	96.3	-1.3	-
a4-KWS Kashmir	30.67	92.9	-2.3	00	35.00	99.0	-0.33	-	35.33	96.3	-1.3	-
a5-KWS Durango	30.67	92.9	-2.3	00	32.33	91.5	-3.00	000	35.67	97.2	-1.0	-
LSD 5%=1.34; LSD 1%=1.83; LSD 0.1%=2.49												

Hybrid	b4 –full time irrigated				Average of irrigation regimes				Irr. Regime	Number of rows	%	Diff.	Sign
	Number of grains in a row	%	Diff.	Sign	Number of grains in a row	%	Diff.	Sign					
a1-P9175	37.33	100	Mt	-	35.53	100	Mt	-	b1–unirrigated	30,93	100	Ctrl	-
a2-KWS Bellavista	33.00	88.3	-4.33	000	31.5	88.52	-4.08	000					
a3-KWS Smaragd	36.00	96.4	-1.33	-	34.16	96.01	-1.41	00	b2 – stressed during and after flowering	33,66	108	2,73	***
a4-KWS Kashmir	36.67	98.2	-0.67	-	34.41	96.72	-1.16	00	b3 – stressed before flowering	35,06	113	4,13	***
a5-KWS Durango	36.00	96.4	-1.33	-	33.66	94.61	-1.91	000	b4 –full time irrigated	35,80	115	4,87	***
LSD 5%=1.34; LSD 1%=1.83; LSD 0.1%=2.49					LSD 5%=0.76; LSD 1%=1.10; LSD 0.1%=1.66				LSD 5%=1,01; LSD 1%=1,36; LSD 0.1%=1.80				

The number of grains per row in 2018 is shown in (Table 5). In 2018, the highest number of grains were recorded by the hybrids KWS Smaragd and KWS Durango, but the value recorded by these two hybrids is very close to that recorded by hybrid P9175 (37.6 vs. 37.1). The lowest values of this character were recorded by the KWS Bellavista hybrid, with 33.3 grains per row, the difference from the P9175 being very significant negative (Table 5).

Irrigation regimes have influenced the number of grains in a row, from unirrigated to irrigated throughout the vegetation period. The treatments: irrigated before and after flowering yielded intermediate results. However, hybrids P9175 and KWS Bellavista recorded very significant positive differences between the unirrigated variant, taken as a control, and the one irrigated during the entire period of maize vegetation (Table 5).

In general, the influence of the irrigation regime in 2018 year was not concludent because of high rainfall which were recorded during the vegetation period of maize (Table 5).

Table 5. The number of grains in a row in function of maize hybrid and irrigation regime, in 2018, at ARDS Marculesti

Hybrid	b1 –unirrigated				b2 – stressed during and after flowering				b3 – stressed before flowering			
	Number of grains in a row	%	Diff.	Sign	Number of grains in a row	%	Diff.	Sign	Number of grains in a row	%	Diff.	Sign
a1-P9175	36.66	100	Mt	-	37.33	100	Mt	-	36.66	100	Mt	-
a2-KWS Bellavista	32.67	89.0	-4.00	000	34.00	91.07	-3.33	000	32.67	89.0	-4.00	000
a3-KWS Smaragd	35.33	96.3	-1.33	-	36.66	98.2	-0.67	-	35.33	96.3	-1.33	-
a4-KWS Kashmir	36.66	100	0.00	-	38.66	103.5	1.33	-	36.66	100	0.00	-
a5-KWS Durango	36.67	100	0.00	-	38.00	101.7	0.67	-	37.33	101.8	0.67	-
LSD 5%=1.62; LSD 1%=2.22; LSD 0.1%=3.01												

Hybrid	b4 –full time irrigated				Average of irrigation regimes				Irr. Regime	Number of rows	%	Diff.	Sign
	Number of grains in a row	%	Diff.	Sign	Number of grains in a row	%	Diff.	Sign					
a1-P9175	38	100	Mt	-	37.16	100	Mt	-	b1–unirrigated	35,6	100	Ctrl	-
a2-KWS Bellavista	34.00	89.4	-4.00	000	33.33	89.6	-3.83	000					
a3-KWS Smaragd	37.33	98.2	-0.67	-	36.16	97.3	-1	-	b2 – stressed during and after flowering	36,9	103	1,3	**
a4-KWS Kashmir	38.66	101.7	0.67	-	37.66	101.3	0.5	-	b3 – stressed before flowering	35,7	100	0,1	-
a5-KWS Durango	38.67	101.7	0.67	-	37.66	101.3	0.5	-	b4 –full time irrigated	37,3	104	1,7	***
LSD 5%=1.62; LSD 1%=2.22; LSD 0.1%=3.01					LSD 5%=1.73;LSD 1%=2.51; LSD 0.1%=3.77				LSD 5%=0,93; LSD 1%=1,26; LSD 0.1%=1.67				

The average values of the two years of trials on the number of grains in a row in function on the hybrid and the irrigation regime are presented in the (Table 6). These values show in very clear way that the KWS Bellavista hybrid recorded very significant negative differences over the control P9175 (Table 6). This fact can be explained by shorter period of vegetation of this hybrid (FAO 330)

Table 6. The number of grains in a row in function of maize hybrid and irrigation regime (average of 2017 and 2018), at ARDS Marculesti

Hybrid	b1 –unirrigated				b2 – stressed during and after flowering				b3 – stressed before flowering			
	Number of grains per row	%	Diff.	Sign	Number of grains per row	%	Diff.	Sign	Number of grains per row	%	Diff.	Sign
a1-P9175	34.8	100	Mt		36.3	100	Mt		36.6	100	Mt	
a2-KWS Bellavista	31.1	89.4	-3.6	000	32.5	89.4	-3,83	000	32.5	88.6	-4.1	000
a3-KWS Smaragd	33.6	96.6	-1.1	-	36.8	101.3	0,50	-	36	98.1	-0.6	-
a4-KWS Kashmir	33	94.7	-1.8	0	35.6	98.1	-0.67	-	35.3	96.3	-1.3	-
a5-KWS Durango	33.6	96.6	-1.1	-	35.1	96.7	-1.17	-	36.5	99.5	-0.1	-
LSD 5%=1.48; LSD 1%=2.02; LSD 0.1%=2.75												

Hybrid	b4 –full time irrigated				Average of irrigation regimes			
	Number of grains per row	%	Diff.	Sign	Number of grains per row	%	Diff.	Sign
a1-P9175	37.6	100	Mt	-	36.3	100	Mt	-
a2-KWS Bellavista	33.5	88.9	-4.17	000	32.4	89.1	-3.9	000
a3-KWS Smaragd	37.6	100	0.00	-	36.0	99.0	-0.3	-
a4-KWS Kashmir	36.6	97.3	-1.00	-	35.1	96.6	-1.2	0
a5-KWS Durango	37.3	99.1	-0.33	-	35.6	98.0	-0.7	-
LSD 5%=1.48; LSD 1%=2.02; LSD 0.1%=2,75					LSD5%=0.74; LSD 1%=1.80; LSD 0.1%=2.72			

CONCLUSIONS

Maize is a plant that responds positively to irrigation. The water consumption of the maize plant differs according to the phenophase in which it is and it can influences the final production, no matter when it occurs.

There were very significant differences in both the number of rows per cob and the number of grains per row, depending on the moment of the application of irrigation as well as the time of precipitation (19 vs. 16 rows and 33 vs. 37 grains per row)

If the water deficit was between the emergence and the blossom time, in the 5-6 leaf stage, there was recorded a decrease in the number of rows per cob because this is the time to differentiate the primordia of the maize cob and the number of fertile flowers on the ears.

The second situation when the water deficit was after flowering shows that the number of grains, in turn, decreased significantly in treatments with a lower water intake.

The vegetation period of the investigated hybrids significantly influenced both the number of rows on the ears and the number of grains per row in the sense that with tardy hybrids these values were higher.

As regard the number of rows of kernels on the cob the best results were given by the hybrids KWS Bellavista (18.6) and KWS Smaragd (17.5), with distinct and very significant positive differences over the P 9175 hybrid (15.8) which was taken as control.

In return, the KWS Bellavista hybrid recorded the lowest results about the number of grains in a row (32.4) with very significant negative difference over the control, P 9175 hybrid (36.3).

REFERENCES

Jonghan, K., Piccinni, G. (2009). Maize yield responses under crop evapotranspiration-based irrigation management. *Agricultural Water Management, 209*, 65–84.

Lizaso, J.I., Ruiz-Ramos, M., Rodríguez, L., Gabaldon-Leal, C. (2018). Impact of high temperatures in maize: Phenology and yield components. *Field Crops Research, 216*, 129–140.

Năescu, V., Alionte, E. (2008). Importanţa irigării, la principalele culturi de câmp, în condiţiile unui an cu secetă accentuată. *Analele INCDA Fundulea, LXXVI.*

NeSmith, D.S., Ritchie, J.T. (1992). Effects of soil water-deficits during tassel emergence on development and yield component of maize (*Zea mays*). *Field Crops Research, 28*(3), 251–256.

Niaz A., and Rameshwar S.K. (1991). Effect of Different Moisture Stress Levels on Maize Growth in Field Lysimeters. *Agricultural and biosystems engineering publications,* Iowa State University.

Oşvat, I.M., (2015). Water use in maize crop on sloping soils from N-W region of Romania. *Fundamental Economic Research in the Field of Agriculture, Food Safety and Security. Timisoara, Vol. 2*.

Schoper, J., Robert, B., Lambert, J., Bruce, L., Vasilas, M., Westgate, E. (1987). The Influence of Silk, Pollen, and Ear-Leaf Water Status and Tassel Heat Treatment at Pollination. *Plant physiology*, *8*, 83–121.

Setter Tim, L., Brian, A. F., Jeff, M. (2001). Loss of Kernel Set Due to Water Deficit and Shade in Maize. *Crop Science*, *41*(5), 1530–1540.

Stegman, E.C. (1982). Maize grain yield as influenced by timing of evapotranspiration deficits. *Irrigation Science, 3*(2), 75–87.