RESULTS REGARDING THE BEHAVIOR OF CERTAIN ROMANIAN AND FOREIGN CORN HYBRIDS, IN THE CONDITIONDS FROM DOGORGEA, AT DIFFERENT LEVELS OF WATER SUPPLY

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Abstract

This work presents the results from an experience from 2010 and 2011, which was organized by randomized block method in three repetitions, in a field planted with corn hybrids from different germoplasm source (Romanian, KWS, Pioneer) and from the another FAO group, carried out under irrigation, with irrigation (700 mm /ha) and with 50% reduced irrigation level (350 mm/ha) in Dobrogea area at SCDA Valul lui Traian. Throughout Romania, Dobrogea by geographic location, in terms of weather conditions, has the most diverse range of climate risks. Dobrogea is located in the interference of polar air masses with the tropical area where very cold air masses and dry arctic or polar origin, causes temperature decreases, the winds that sweep the snow in winter and summer masses entering hot air tropical climate that favors summer climate risks (massive heating, prolonged droughts and heat, aridity, etc..). Although the thermal potential of the area allows corn hybrids from very late group growing, prolonged drought and heat of summer limited their cultivation. The study aims to identify resistance / tolerance to drought and heat, on corn hybrids from three germoplasm sources (Romanian, KWS, Pioneer) and three different groups FAO to be grown in non irrigated area of Dobrogea. Correlation was established between different levels of water supply and production capacity in the three groups of precocity to identify most adapted hybrids to adverse conditions (drought and heat) in the area where experience has been mounted. Early hybrids, due to short growing season, have used more water reserve in winter, while medium and especially late hybrids reacted positively with increasing water applied.

Key words: hybrid, corn, irrigation, drought, tolerance.

The thermal potential of Dobrogea allows the growing of late and very late hybrids. Their cultivation is limited to the lack of soil water necessary to achieve their production potential. On the basis of classification clues (Thornwaite, de Martone, Koncek etc.) from 1960-1970 M Botzan and C. Donciu, have demonstrated that this area of the country presents a droughty and very droughty climate (Botzan M., 1966, 1972), (Donciu C., 1959). In terms of water consumption required for the synthesis of a kilogram of dry matter, the corn falls in the requirement group, generally high. The consumption values increase as the plants advance in vegetation. The highest water consumption is registered from the issue of male inflorescence (gray) until the first phase of ripening in wax, then it is significantly reduced, the leading role in full maturation belonging to temperature (Doerge T., 2008). Corn hybrid adjustment to the variations of environmental conditions is an important contribution to increasing production and its stability by exploring its natural resources and reducing high damage stressors (Sarca Vasilchia, 2004). In Dobrogea, the deficient and unevenly distributed rainfall regime during a calendar year and from year to year, requires cultivation of early hybrids which capitalizes the reserves of water accumulated during the winter – spring season. Early hybrids, although they present a production potential inferior to the medium and late hybrids, they present the consistently high production which is why they will be cultivated in the area. Besides them it is required the cultivation of medium and late hybrids which are able to reduce physiological water processes during the periods of water stress, and when restoring soil moisture to produce a sustained pace of photo-synthesis. In the last decade, the changing climate of the area, confirmed the tendency of aridity of the South – East European continent. Within this area, for corn crops to obtain higher and effective, correction of hydric deficit applying 1-3 watering would be the most accessible solution.

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Destruction of irrigation systems, reducing water resources for irrigation with high costs of electricity, eliminates this opportunity. The acquired resistance to drought by improvement applies only to climatic conditions for which selection has been made (Mureşan, 1967) therefore, the introduction of hybrids in Dobrogea, resistant/tolerant hybrids, to the stress caused by drought and heat becomes a primary problem.

MATERIAL AND METHOD

Research has been made in SCDA Valu lui Traian conditions, Constanța, on a vermic chernozem soil, by the method of subdivided parcels with two factors:

Factor A – irrigation system with the following graduations: a0 – non irrigated; a1 – irrigated with 50% reduced time (350m3/ha); a2 – full time irrigation (700m3/ha).

Factor B – used germ plasma: b1 – Turda 145; b2 – Severo; b3 – PR37D25; b4 – Oituz; b5 – Kamelias; b6 – PR36D79; b7 – Rapsodia; b8 – KWS 1394; b9 – PR35F38.

Experience has been placed in plots subdivided in three repetitions, with buffer zones 24 m wide between treatment options. Water management has been made by sprinklers. Measuring the quantity of water was performed using rainfall sprinklers placed on the column of sprinklers. The testing hybrids are from three precocity groups (early, medium and late). The technology applied in these experiments with corn hybrids was the best, recommended for the area of corn cultivation, corresponding to the climatic conditions of Dobrogea area, place of experiments. The preceding plant was: in 2009 - wheat; 2010 - peas.

Complex chemical fertilizers have been applied:

- fall: 200 kg/ha raw substance (s.b.) of the kind 20:20:0
- spring, seabed preparation: complex chemical fertilizers of the kind 28:28:0 in the amount of 200 kg/ha s.b. During the vegetation period it was supplemented with nitrogen dose by 40 kg s.a./ha. The obtained results have been statistically calculated using the analysis of variation for bi-factorial experiments placed after randomized block method and the correlation between different characters and water supply (Săulescu N.A., Săulescu N.N., 1967). Tables and graphs are the result of two years experimentation (2010-2011).

RESULTS AND DISCUSSIONS

In 2010 a total of 662,8 mm rainfall was recorded, with 230,7 mm more than the annual average, the year being particularly rainy. In 2011 368,9 mm rainfall was recorded with 63,2 mm less than the normal. The year 2011, in contrast to the previous one, was very droughty. At the time when the corn recorded the highest water consumption, June-July, in 2010 251,3 mm are recorded and in 2011 are recorded 88,1 mm of water rainfall. Although the recorded rainfall at SCDA Valu lui Traian in July of 2011 (72,0 mm) partially alleviated the effects of the drought installed in June, in 2010 the surplus of 163,2 mm, compared to the same period of the year 2011, contributed decisively to obtaining a higher production than the one achieved in 2011, on the three levels of water supply *(fig. 1).*

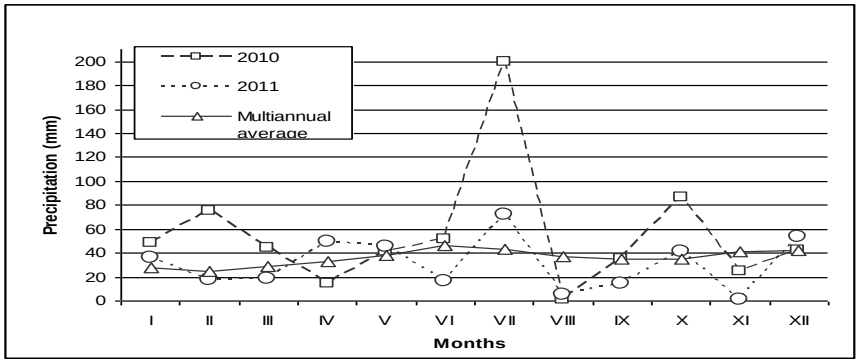

Figure 1 **Recorded rainfall in Dobrogea during the years 2010-2011**

The average temperature of the year 2010 was of 12,30 ^{o}C, with 1,4 ^{o}C above the normal of 68 years. Also, temperatures above the normal were recorded in June (+1,5 ^{o}C), July (+1,8 ^{o}C), August (+4,4 ^{o}C), and September (+1,9 ^{o}C). The average temperature of the year 2011 was of 11,19 ^{o}C, with 0,29 ^{o}C above the normal of 69 years. Temperatures above the normal were recorded during the months June (+1,3 ^{o}C), July (+1,9 ^{o}C), August (+2,3 ^{o}C), and September (+3,3 ^{o}C). The rainfall recorded in the two years of testing confirms that in Dobrogea there are generally insufficient corn crops and unevenly distributed from year to year. The temperatures recorded in the two years of testing support the aridity tendency of Dobrogea (*fig. 2).*

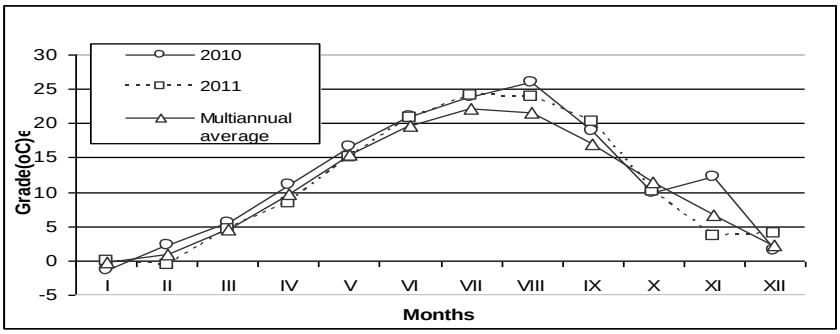

Figure 2 **Temperatures recorded in Dobrogea during the years 2010-2011**

The two years of experimentation though, in terms of weather, represent the development tendency recorded in the last decade, and therefore we consider sufficient for the interpretation of all possible outcomes, we have performed the testing both against error of experimentation and testing to the years interaction (table 1). The conclusions we have reached, we consider that, are valid if the results are repeated in the future. The lowest testing production *(table 2)* are obtained under non irrigated conditions (9490 kg/ha). This level of water supply is inferior to the average experience (nine hybrids x three levels of water supply x two years testing) with1860 kg/ha, with the shortfall probability threshold provided for P = 0.01 %. Heavy rainfall occurred in June and July in 2010 have contributed to higher yields and therefore this year experimental application of 350 c.m. water/ha was not valued. Full time irrigation (700 c.m. water/ha) led to considerable increases of more than 1900 kg/ha, ensured increases for the threshold probability of 0.01%.

Table 1

Variance analysis for experience with nine hybrids and three levels of water supply SC-DA Valu lui Traian 2010-2011

Variability cause	SP	GL	s^2	Sample F	
				Against error	Against interaction
Years	181.56	1	181.56		
Blocks	1029.57	4	257.39		
Water supply levels	41761.2	2	20880.6	120.33^{xx}	104.63
Water supply levels x years	400.09	2	200.045	1.15	
Error (a)	1388.2	8	173.525		
Hybrids	18493.05	8	2311.63	56.35^{xx}	270.36
Hybrids x years	68.41	8	8.55	0.21	
Hybrids x water supply levels	1032.89	16	64.556	1.57	0.64
Hybrids x water supply levels x years	1608.22	16	100.514	2.45^{x}	
Eroare (b)	3938.26	96	41.024		

Table 2

Response of corn hybrids PIONEER, KWS and INCDA FUNDULEA, at different levels of water stress induction at SCDA Valu lui Traian 2010-2011

No crt.	Irrigation regime	Year		Average 2010-2011	Difference from mt		Significance
		2010	2011		Kg/ha	%	
1	Not irrigated	9940	9040	9490	-1860	83,6	000
2	Irrigated ½	10490	12080	11290	-60	99,5	
3	Irrigated	13390	13170	13280	1930	117.0	***
4	Average			11350	mt	100	

DL 5% = 580 kg/ha; DL 1% = 850 kg/ha; DL 0,1% = 1280 kg/ha

The best results regarding the behavior of corn hybrids, from experiments, at different levels of water stress induction, averaged over two years of experimentation, *(table 3)* were obtained by Pioneer hybrids, from the late and medium precocity group: PR35F38 (13390 kg/ha) and PR36D79 (12570 kg/ha), which go over the average of 11660 kg/ha with gains of 1730 kg/ha that is 910 kg/ha, significant production gains. The Romanian hybrid, semi-late, Rapsodia makes a production of 12230 kg/ha with 570 kg/ha over the experienced average. The increase is ensured for the probability threshold of P=1%. Pioneer hybrid, early, PR37D25 achieves an increased production of 480 kg/ha. The increase is ensured for the probability threshold of P=5%.

Table 3

Production results obtained at 9 corn hybrids on three water supply levels at SCDA Valu lui Traian 2010 - 2011

No. crt.	HYBRID	Production (kg/ha) on irrigation regime (average 2010-2011)			Average production kg/ha (2010-2011)	Difference		Significance
		Non irrirgated	Irrigated 50%	Irrigated		Kg/ha	%	
Early hybrids								
1	Turda 145	7450	11280	10410	9710	-1940	83	000
2	Severo	7910	11390	12170	10490	-1160	90	000
3	PR37D25	9680	12920	13780	12130	480	104	*
Medium hybrids								
4	Oituz	8540	11220	13170	10980	-670	94	00
5	Kamelias	9870	12370	13610	11950	300	102	
6	PR36D79	10350	12870	14480	12570	920	108	***
Late hybrids								
7	Rapsodia	10620	12090	13970	12230	580	105	**
8	KWS 1394	9610	11680	12760	11350	-300	97	
9	PR35F38	11430	13600	15200	1341o	1760	115	***
10	Exp. average				**11650**	**mt**	**100**	

Dl 5% = 420 kg/ha; Dl 1% = 560 kg/ha; Dl 0,1% = 720 kg/ha

The lowest productions are achieved by Turda 145 hybrids with a difference of 1940 kg/ha and Severo with a difference of 1160 kg/ha. Distinct differences significantly negative.

The hybrid from INCDA Fundulea, Oituz from the medium precocity group, achieves a low production with 670 kg/ha significantly negative difference.

The best results regarding the behavior of corn hybrids, from testing, at different water supply levels, on a two years experimenting average, *(table 4)* have been obtained:

- ✓ At non irrigated, hybrids: PR35F38 (11430 kg/ha), Rapsodia (10620 kg/ha) and PR36D79 (10350 kg/ha). The increases obtained are provided for P = 1%;
- ✓ At irrigated 50 %, hybrids: PR35F38 (13600 kg/ha), PR37D25 (12920 kg/ha) and PR36D79 (12870 kg/ha). The increases obtained are provided for P = 0.1% and P = 1%;
- ✓ At full time irrigation, hybrids: PR35F38 (15200 kg/ha), PR36D79 (14480 kg/ha), Rapsodia (13970 kg/ha) and PR37D25 (13780 kg/ha). The increases obtained are ensured for P = 5%, P = 1% and P = 0.1%.

The lowest productions were achieved:

- ✓ At non irrigated, hybrids: Turda 145 (7450 kg/ha), Severo (7910 kg/ha) and Oituz (8540 kg/ha). The differences from control are provided for P = 1%;
- ✓ At irrigated 50 %, hybrids: Oituz (11220/ha), Turda 145 (11280 kg/ha), Severo (11390 kg/ha) and KWS 1394 (11680 kg/ha). The differences from control are provided for P = 5%, P = 1% and P = 0.1%;
- ✓ At full time irrigation, hybrids: Turda 145 (10410 kg/ha), Severo (12170 kg/ha) and KWS 1394 (12760 kg/ha). The differences from control are provided for P = 5% and P = 0.1%.

Table 4

The behavior of nine corn hybrids at different irrigation regimes at SCDA Valu lui Traian

No crt.	Irrigation regime	Hybrid	Average production on years (kg/ha)		Average	Difference from mt		Significance
			2010	**2011**		**Kg/ha**	**%**	
1	NON IRRIGATED	Turda 145	7800	7090	7450	-2040	78	000
2		Severo	8370	7440	7910	-1580	83	000
3		PR37D25	9970	9380	9680	190	102	
4		Oituz	9040	8030	8540	-950	90	000
5		Kamelias	10530	9200	9870	380	104	
6		PR36D79	11000	9690	10350	860	109	***
7		Rapsodia	11030	10200	10620	1130	111	***
8		KWS 1394	9920	9300	9610	120	101	
9		PR35F38	11820	11030	11430	1940	120	***
10		**Average**	**9940**	**9040**	**9490**	**mt**	**100**	

11	IRRIGATED 50%	Turda 145	11500	11050	11280	-880	93	000
12		Severo	11450	11340	11390	-770	94	00
13		PR37D25	12980	12850	12920	760	106	**
14		Oituz	11270	11160	11220	-940	92	000
15		Kamelias	12410	12320	12370	210	102	
16		PR36D79	12920	12810	12870	710	106	**
17		Rapsodia	12150	12020	12090	-70	99	
18		KWS 1394	11800	11550	11680	-480	96	0
19		PR35F38	13600	13590	13600	1440	112	***
20		**Average**	**12230**	**12080**	**12160**	**Mt**	**100**	
21	IRRIGATED	Turda 145	10650	10160	10410	-2870	78	000
22		Severo	12250	12080	12170	-1110	92	000
23		PR37D25	13900	13650	13780	500	104	*
24		Oituz	13270	13070	13170	-110	99	
25		Kamelias	13770	13440	13610	330	102	
26		PR36D79	14580	14370	14480	1200	109	***
27		Rapsodia	14010	13930	13970	690	105	**
28		KWS 1394	12830	12690	12760	-520	96	0
29		PR35F38	15240	15160	15200	1920	114	***
30		**Average**	**13390**	**13170**	**13280**	**mt**	**100**	

Dl 5% = 390 kg/ha; l 1% = 560 kg/ha; Dl 0,1% = 850 kg/ha

Regarding the specific reaction of each hybrid to induce water stress *(table 5)*, except for Rapsodia hybrid, that at reduced-time irrigation of 50% obtains, in irrigated conditions to a significantly distinct increased production, the other 8 hybrids accomplish very significant production increases to splashing either with 350 c.m. water/ha either full time (700 c.m. water/ha). Regarding the specific reaction of each hybrid to induce water stress, except for Rapsodia hybrid, that at irrigated with 350 c.m./ha obtains, compared to non irrigated conditions, a significantly distinct increased production, the other 8 hybrids accomplish very significant production increases to splashing either with 350 c.m./ha either full time (700 c.m./ha). Analyzed on precocity groups we notice that from the group of early hybrids:

- ✓ When using 350 c.m./ha water, Turda 145 hybrid achieves an increase of 3830 kg/ha (151%); Severo hybrid achieves an increase of 3710 kg/ha (147%), then followed by hybrid PR37D25 that achieves an increase of 3240 kg/ha (133%) ;
- ✓ When using a 700 c.m../ha water, Severo hybrid achieves an increase of 4260 kg/ha (154%); PR37D25 hybrid achieves an increase of 4100 kg/ha (142%) Turda145 hybrid achieves an increase of 2960 kg/ha (140 %);

From the group of medium hybrids:

- ✓ When using 350 c.m./ha water, Oituz hybrid achieves an increase of 2460 kg/ha (128%); Kamelias hybrid achieves an increase of 2500 kg/ha (125%), PR36D79 hybrid not far away from Kamelias hybrid achieves an increase of 2520 kg/ha (124%);
- ✓ When using a 700 c.m./ha water, Oituz hybrid achieves an increase of 4410 kg/ha (150%); PR36D79 hybrid, with 4130 kg/ha (140%) places itself before Kamelias hybrid which achieves an increase of 3740 kg/ha (138%);

From the group of late hybrids:

- ✓ When using 350 c.m./ha water, KWS 1394 hybrid achieves an increase of 2070 kg/ha (122%); PR35F38 hybrid achieves an increase of 2240 kg/ha (120%), then Rapsodia hybrid achieves an increase of 1470 kg/ha (114 %);

Table 5

The behavior on different irrigation levels at SCDA Valu lui Traian

o. Crt.	HYBRID	Irrigation regime	Production (Average 2010-2011) Kg/Ha	Difference of Mt		Significance
				kg/ha	%	
1	Turda 145	non irrigated	7450	Mt	100	
		50% irrigated	11280	3830	151	***
		irigat	10410	2960	140	***
2	Severo	non irrigated	7910	Mt	100	
		50% irrigated	11620	3710	147	***
		irrigated	12170	4260	154	***
3	PR37D25	non irrigated	9680	Mt	100	
		50% irrigated	12920	3240	133	***
		irrigated	13780	4100	142	***
4	Oituz	non irrigated	8760	Mt	100	
		irigat 50%	11220	2460	128	***
		irrigated	13170	4410	150	***

5	Kamelias	non irrigated	9870	Mt	100	
		50% irrigated	12370	2500	125	***
		irrigated	13610	3740	138	***
6	PR36D79	non irrigated	10350	Mt	100	
		50% irrigated	12870	2520	124	***
		irrigated	14480	4130	140	***
7	Rapsodia	non irrigated	10620	Mt	100	
		50% irrigated	12090	1470	114	**
		irrigated	13970	3350	132	***
8	KWS 1394	non irrigated	9610	Mt	100	
		50% irrigated	11680	2070	122	***
		irrigated	12760	3150	133	***
9	PR35F38	non irrigated	11430	Mt	100	
		50% irrigated	13600	2240	120	***
		irrigated	15200	3840	134	***

Dl 5% =1060 kg/ha; Dl 1% = 1430 kg/ha; Dl 0,1% = 1910 kg/ha

When using 700 c.m./ha water, PR35F38 hybrid achieves an increase of 3840 kg/ha(134%); KWS 1394 hybrid achieves an increase of 3150 kg/ha (133%), followed by Rapsodia hybrid which achieves an increase of 3350 kg/ha (132%);

CONCLUSIONS

The recorded rainfall in the two years of testing confirm the fact that in Dobrogea rainfall is, generally insufficient for corn and unevenly distributed from year to year. The recorded temperatures in the two years of testing highlight the aridity tendency of Dobrogea, the years 2010 and 2011 were the hottest with 1,4 ^{o}C and 0,3 ^{o}C than normal. The lowest production during testing is obtained under non irrigated conditions (9490 kg/ha). Irrigation with 350 c.m./ha generates an increase of production with 1800 kg/ha while irrigation with 700 c.m./ha achieves an increase of 3790 kg/ha. At different levels of induce water stress, on average for the two testing years, the hybrids Pioneer, PR35F38 (13390 kg/ha), PR36D79 (12570 kg/ha) INCDA Fundulea hybrid, Rapsodia, achieve the highest productions.

The best results in non irrigated have been achieved by the following hybrids: PR35F38 (11430 kg/ha), Rapsodia (10620 kg/ha) and PR36D79 (10350 kg/ha). The best results in irrigated with 350 c.m./ha have been achieved by the following hybrids: PR35F38 (13600/ha), PR37D25 (12920 kg/ha) and PR36D79 (12870 kg/ha). At irrigated with 700 c.m./ha the best results have been achieved by the following hybrids: PR35F38 (15200 kg/ha), PR36D79(14480 kg/ha), Rapsodia (13970 kg/ha) and PR37D25 (13780 kg/ha).

Regarding the specific reaction of each hybrid to induce water stress, all hybrids are reacting positively to the application and increase of watering rate. As far the specific reaction of each hybrid to induce water stress is concerned, all hybrids react positively to the application of watering as well as high standard watering rate. In Dobrogea area (SCDA Valu lui Traian), late hybrids have achieved, in non irrigated, the highest productions. The best results, on all levels of water supply, were obtained by hybrids created by Pioneer company, even in harsh climatic conditions recorded between the years 2010-2011 – prolonged drought, heat, inadequate and unevenly distributed rainfall. Romanian hybrids have a very good behavior and place themselves immediately after Pioneer hybrids. The other hybrids, of KWS origin had a lower behavior.

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