

INFLUENCE OF DIFFERENT LEVELS OF WATER SUPPLY ON PRODUCTION CAPACITY AND QUALITY OF CORN GROWN IN DOBROGEA CLIMATIC CONDITIONS

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Abstract

This work presents results on 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 and from another FAO group, carried out under irrigation, with irrigation (700 mc/ha) and with 50% reduced irrigation level (350 mc/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.

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.

Analysis of quality components showed an increase in fat content and a decrease in protein and starch to increase soil moisture levels.

A longer growing season is accompanied by an increase starch content and a decrease in fat content and crude protein.

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

INTRODUCTION

The corn production capacity is a complex issue, a resulting effect of the action of genetic, ecological and technological factors (Muresan et al., 1972). For this reason, any alteration results in obtaining low, non-economic productions.

For the success of a corn crop, an enhanced diligence is needed when choosing the hybrid.

One of the main objectives of the improvement programs is the selection of the best genotypes for drought stress conditions (Richards et al., 2002).

The adaption of the corn hybrids to the climatic variations is actively contributing to the production increase and its stability, by capitalizing even better the natural resources

and diminishing the damages caused by the stress factors (Sarca Vasilichia, 2004).

An important production increase was registered by introducing large scale irrigation (Botzan, 1972; Luca et Nagy, 1999; Luca et al., 2008).

The present work aims at identifying some hybrids showing a high production stability and quality, under contrasting climatic conditions, in Dobrogea, using three water supply levels.

MATERIALS AND METHODS

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

- Factor A – irrigation system with the following graduations: a1- non irrigated; a2-

irrigated with 50% reduced time (350 m³/ha); a3- full time irrigation (700 m³/ha).

- Factor B – used germplasma: 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 obtained results have been statistically calculated using the analysis of variation for bifactorial experiments and the correlation between different characters and water supply (Saulescu N.A., Saulescu N.N., 1967).

RESULTS AND DISCUSSIONS

1. Climate conditions

The test was carried on over the course of three years (2010 – 2012). The year 2010 was an extremely rainy year, registering 662.8 mm of rainfall, 230.7 mm more than the multi-annual average on 71 years (Figure 1).

In 2011, 368.9 mm of rainfall were registered, 62.7 mm less than normal. As compared to the previous year, 2011 was extremely droughty. 2012 was the most droughty, even more droughty than 2007, a representative year for the severe drought in the last decade, especially in Dobrogea.

In the month of June-July, period in which the corn crop registers the highest water consumption, the following values of rainfall have been registered: 251.3 mm in 2010, 88.1 mm in 2011 and only 6.9 mm in 2012.

The rainfall registered in the three years of testing confirm the fact that these are, generally, insufficient for corn cultivation, that they fluctuate from one year to another and are not uniformly distributed over one calendar year.

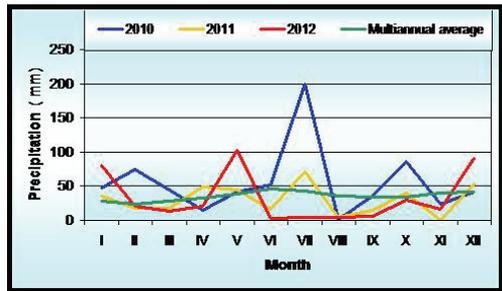


Figure 1. Rainfall registered in SCDA Valu lui Traian in 2010-2012

The average temperature of the year 2010 was of 12.30°C, with 1.3°C above the normal of 71 years (Figure 2). The average temperature of 2011 was of 11.19°C, with 0.19°C above the normal. 2012 was the hottest year of the testing, registering an annual average temperature of 13.37°C, with 2.4°C more than the multi-annual means.

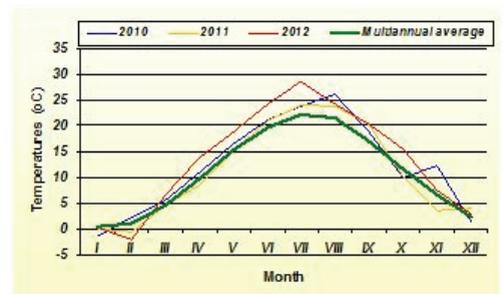


Figure 2. Temperatures registered in Dobrogea in 2010-2012

The dynamics of these climate factors led to the induction of the hydric stress and emphasizes the aridization tendency of Romania, in general, and of Dobrogea, in particular.

2. The study of the production capacity

The analysis of the significances show the presence of some distinctly significant differences regarding the production capacity, as a result of the variability of water supply level, of the testing years and of the diversity of the analyzed hybrids (Table 1). The smallest productions of the testing were obtained under non irrigation conditions (8620 kg/ha) (Table 2).

At this level of water supply, the average crop of corn hybrids was situated 2030 kg/ha under the test average values (nine hybrids x three levels of water supply x three years of testing) a very significant negative difference.

Table 1. Variance analysis experience with nine hybrids and three water levels insurance at SCDA Valu lui Traian 2010-2012

Variability cause	SP	GL	s ²	Sample F	
				Against error	Against interaction
Years	48371.11	2			
Blocks	1238.16	6			
Agrofunds (Water supply levels)	53117.58	2	26558.79	140.49 ^{xx} (6,93)	37.07 ^{xx} (18,0)
Agrofunds (Water supply levels)x years	2859.73	4	714.94	3.79 (3,26)	
Error (a)	2268.5	12	189.05		
Hybrids	22155.96	8	2769.50	48.59 ^{xx} (2,53)	22.03 ^{xx} (3,89)
Hybrids x years	2011.68	16	125.73	2.21 ^{xx} (2,12)	
Hybrids x Agrofunds (Water supply levels)	1591.35	16	99.46	1.75 (1,71)	1.45 (1,99)
Hybrids x Agrofunds (Water supply levels)x years	2198.16	32	68.7	1.21 (1,83)	
Eroare (b)	8206.86	144	57.0		

Table 2. Influence of different levels of water supply on the yield obtained at SCDA Valu lui Traian in 2010 - 2012

No. crt	Irrigation regime	Production(kg/ha)				Difference from mt		Significance
		2010	2011	2012	Average	kg/ha	%	
1	Not irrigated	9940	9040	6870	8620	-2030	81	⁰⁰⁰
2	Irrigated with 350 m ³ /ha	12230	12080	9070	11130	480	104	*
3	Irrigated with 700 m ³ /ha	13390	13170	10080	12210	1560	115	***
Average		11850	11430	8670	10650	Mt	100	
						DL 5% = 470 kg/ha DL 1% = 660 kg/ha DL 0.1% = 930 kg/ha		

Table 3. Production results obtained from nine maize hybrids at three levels of water supply in SCDA Valu lui Traian 2010 to 2012

No. crt.	Hybrid	Production(kg/ha)				Difference from mt		Significance
		Not irrigated	Irrigated with 350 m ³ /ha	Irrigated with 700 m ³ /ha	Average	kg/ha	%	
Early hybrids								
1	Turda 145	7110	10050	9750	8970	-1680	84	⁰⁰⁰
2	Severo	7420	10270	11310	9670	-980	91	⁰⁰⁰
3	PR37D25	8840	11670	12780	11100	450	104	*
Medium hybrids								
4	Oituz	7850	9980	11640	9820	-830	92	⁰⁰⁰
5	Kamelias	8720	11340	12560	10870	220	102	
6	PR36D79	9260	11770	12970	11330	680	106	**
Late hybrids								
7	Rapsodia	9520	10880	13180	11420	770	107	***
8	KWS 1394	8570	7290	11830	10420	-230	98	
9	PR35F38	10270	12650	13960	12270	1620	115	***
Exp. average		8620	11130	12210	10650	mt	100	
						DI 5% = 410 kg/ha DI 1% = 540 kg/ha DI 0.1% = 690 kg/ha		

The best results regarding the behaviour of corn hybrids involved in the testing, at different levels of water stress induction, averaged over three years of testing, were obtained by the Pioneer hybrids (Table 3):

- on the early precocity group, the PR37D25 hybrid makes a significant production gain of 450 kg/ha;
- on the medium precocity group, the PR36D79 hybrid makes a significantly different production gain of 680 kg/ha;

- on the late group, the PR35F38 hybrid makes a very significant production gain of 1620 kg/ha. Also, in the same group, the Romanian hybrid Rapsodia is noticed, for its performance of a very significant production gain, of 770 kg/ha. The hybrids: Oituz, Severo and Turda 145 have placed themselves, with 830 kg/ha; 980 kg/ha, and 1680 kg/ha respectively, under the average for testing, with very significantly negative differences.

The results regarding the behaviour of the corn hybrids on different irrigation regimes, averaged over three years of testing, have emphasized the PR35F38 hybrid, which showed significant production increase under all water supply conditions (Table 4).

The smallest productions were shown by:

- under non-irrigated conditions, the Turda 145 hybrid (7110 kg/ha), 1510 kg/ha below the average, a difference ensured for P=5%;
- irrigated with 350 m³/ha, the KWS 1394 hybrid (7290 kg/ha), showed 3840 kg/ha below the average, a difference ensured for P=0.1%;
- for full-time irrigation (700 m³/ha), the Turda 145 hybrid obtained a production of 9750 kg/ha, with 2460 kg/ha below the average of the testing, a difference ensured for P=1%.

Regarding the specific reaction of each corn hybrid on irrigation, it was found that the KWS 1394 hybrid is the only one that, when a 350 mc/ha irrigation was applied, obtained a lower gain, 1280 kg/ha lower, a significantly negative difference (Table 5). For the same irrigation level, the Rapsodia hybrid offers a production increase of 1360 kg/ha, a significantly distinct gain. The increase of 850 kg/ha obtained by the Severo hybrid was within the testing error limits. The other hybrids showed very significant production increases when the reduced time irrigation of 50% was applied. When using a 700 c.m./ha water supply, all the hybrids showed very significant production increases.

The best reaction on irrigations was of the hybrids: Oituz, with an increase of 148%, PR37D25 with an increase of 145% and Kamelias, with an increase of 144%.

3. Production quality

The corn production quality is estimated by the contents of protein, gross fat, starch and their quality.

For these reasons, any alteration of any of the constituting components is mirrored in the obtainment of low quality crops.

During the last decade, Dobrogea faces extreme climatic changes (excessively rainy years, with over 200 mm above thove normal values – such as 2010, years when rainfall is 60-70 mm below the regular values, such as 2011 and years with higher temperatures that average – such as 2012: 2.4°C), years with very harsh winters, as well as years with very bland winters.

These contrasting conditions provoke significant fluctuations of the crop sizes and of the crop quality.

The starch content is high and oscilates within tight limits on the three irrigation levels.

For non irrigation, the average contents for the tested hybrids was of 72.65%, for 350 mc/ha irrigation it was reduced with 0.13% and for 700 mc/ha irrigation it was reduced with 0.16% (Figure 3).

There are higher differences among the precocity groups. Thus, the early hybrid Turda 145 has the lower starch content in all of the irrigation regims, while the more late hybrids PR36D79, KWS 1394 and PR35F38 show, under the same water supply conditions, the highest values.

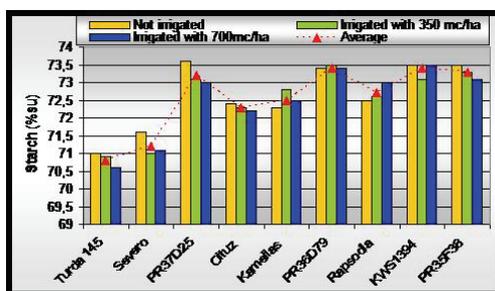


Figure 3. Starch content

The fat content showed amplitudes comprised between 3.84% for KWS1394 and 5.14% for Turda 145 (Figure 4). The following intermediate values were registered: 3.84% for the KWS1394 hybrid; 3.87% for the PR35F38 hybrid.

Amongst the three precocity groups, the highest fat content was shown by the early group (4.62%), for the medium group it decreased to 4.07% and reached the value of 4.0% for the late group.

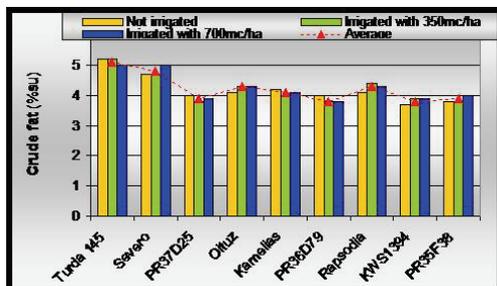


Figure 4. Fat content

The gross protein content had relatively reduced average values, their amplitude ranging from 8.64% for PR36D79 to 10.54% for Turda 145 (Figure 5). The highest average values of the protein content in the corn seeds was present in the early hybrids (9.89%) and medium hybrids (9.72%), as compared to the late hybrids, which registered the value of 8.84%.

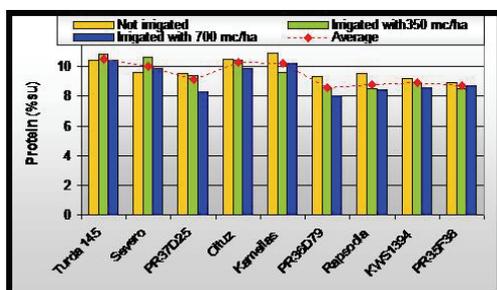


Figure 5. Protein content

Table 4. The behavior of nine corn hybrids at different irrigation regimes at SCDAValu lui Traian

No crt.	Hybrids	Production (kg/ha)	Difference from mt		Significance
			(kg/ha)	(%)	
Not irrigated					
1	Turda 145	7110	-1510	82	00
2	Severo	7420	-1200	86	
3	PR37D25	8840	220	102	
4	Oituz	7850	-770	91	
5	Kamelias	8720	100	101	
6	PR36D79	9260	1000	107	
7	Rapsodia	9520	900	110	
8	KWS 1394	8570	-50	99	
9	PR35F38	10270	1650	119	*
Average		8620	mt	100	
Irrigated with 350 m ³ /ha					
1	Turda 145	10050	-1080	90	
2	Severo	10270	-860	92	
3	PR37D25	11670	540	105	
4	Oituz	9980	-1150	90	
5	Kamelias	11340	210	102	
6	PR36D79	11770	640	106	
7	Rapsodia	10880	-250	98	
8	KWS 1394	7290	-3840	65	000
9	PR35F38	12650	1520	114	*
Average		11130	mt	100	
Irrigated with 700 m ³ /ha					
1	Turda 145	9750	-2460	80	00
2	Severo	11310	-900	93	
3	PR37D25	12780	570	105	
4	Oituz	11640	-570	95	
5	Kamelias	12560	350	103	
6	PR36D79	12970	760	106	
7	Rapsodia	13180	970	108	
8	KWS 1394	11830	-380	97	
9	PR35F38	13960	1750	114	*
Average		12210	mt	100	

DI 5% = 1220 kg/ha

DI 1% = 1770 kg/ha

DI 0.1% = 2660 kg/ha

CONCLUSIONS

During the testing period, having a critical pluviometric regime, temperatures above the multi-annual average values were registered. The dynamics of these two climatic factors, as well as the relatively low humidity and a higher sunshine duration, show an aridization tendency of Dobrogea.

For non-irrigation regime, the hybrids of the testing were placed 2030 kg/ha below the average of the three water supply levels. The

irrigation with 350 mc/ha of water brings an increase of 2510 kg/ha, while the irrigation of 700 mc/ha of water brings an increase of 3590 kg/ha.

The early hybrids, averaged on the three water supply levels, showed 820 kg/ha, below the average production of the medium hybrids and 2360 kg/ha below the average production of late hybrids.

The late hybrid PR35F38 showed the highest productions for the three water supply levels and a good tolerance to the pedological drought, best capitalizing the irrigation water, both for the 50% irrigation regime and for the full time irrigation regime.

The Romanian hybrid Rapsodia shows a production stability under all testing conditions and effectively capitalizes the limited water resources, out of rainfall.

For the 350 mc/ha irrigation regime, the hybrid KWS 1394 was the only one diminishing the usual production, 3840 kg/ha below the average for the said water supply.

The maximum production potential of the Turda 145 hybrid was shown when the 350 mc/ha water supply regime was applied.

The 700 m/ha water supply regime did not lead to increase of production, the water excedent from irrigation not being capitalized by this hybrid.

Related to the water supply level, a tendency of increase of the average fat content and a tendency of decrease of the

starch and protein content are noticed, when a 700 m.c./ha water supply regime is applied (+0.6% fat and 0.16% starch and 0.60% protein, respectively), as compared to non irrigation.

Related to the period of vegetation, a tendency of increase of the average starch content and a tendency of decrease of fat and protein are noticed, for the more late hybrids (+1.4% starch, and respectively 0.62% fat and 1.06% protein) as compared to early hybrids.

Table 5. The individual behavior of nine corn hybrids at different irrigation regimes at SCDA Valu lui Traian

Precocity	Hybrids	Agrofundus	Production (Kg/ha)	Difference from mt		Significance
				kg/ha	%	
Early hybrids	Turda 145	a1	7110	Mt	100	
		a2	10050	2940	141	***
		a3	9750	2640	137	***
	Severo	a1	9420	Mt	100	
		a2	10270	850	109	
		a3	11310	1890	120	***
	PR37D25	a1	8840	Mt	100	
		a2	11670	2830	132	***
		a3	12780	3940	145	***
Medium hybrids	Oituz	a1	7850	Mt	100	
		a2	9980	2130	127	***
		a3	11640	3790	148	***
	Kamelias	a1	8720	Mt	100	
		a2	11340	2620	130	***
		a3	12560	3840	144	***
	PR36D79	a1	9260	Mt	100	
		a2	11770	2510	127	***
		a3	12970	3710	140	***
Late hybrids	Rapsodia	a1	9520	Mt	100	
		a2	10880	1360	114	**
		a3	13180	3660	138	***
	KWS 1394	a1	8570	Mt	100	
		a2	7290	-1280	85	0
		a3	11830	3260	138	***
	PR35F38	a1	10270	Mt	100	
		a2	12650	2380	123	***
		a3	13960	3690	136	***

DI 5% = 930 kg/ha

DI 1% = 1240 kg/ha

DI 0.1% = 1600 kg/ha

ACKNOWLEDGEMENTS

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