

RESEARCHES CONCERNING THE HYBRID INFLUENCE ON WATER USE EFFICIENCY IN MAIZE FROM NORTH-WESTERN ROMANIA

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Abstract

This paper analysed the maize hybrids from different FAO groups concerning the yield, water use efficiency in the moderate wet area of the Crisurilor Plain. The researches were carried out in the Agriculture Research and Development Station Oradea during 2006-2008 on a preluvosoil. The paper sustains the need of the maize hybrids choose both in unirrigated and irrigated conditions because the yields and water use efficiency are different in the 6 hybrids studied.

Irrigation determined the yield gain very significant statistically in all the hybrids and the years. Irrigation determined the increase of the water use efficiency; exception was the earliest hybrid Ciclon.

Keyword: hybrid, FAO group, maize, water consumption, yield, water use efficiency, irrigation water use efficiency

INTRODUCTION

In the maize crop from North Western Romania the hybrids structure recommended is 75% late hybrids, 20% median hybrids and 5% early hybrids (Borcean I., 2003). Water use efficiency is different in function of the crops, soils and climates (Grumeza N. și colab., 1989, Grumeza N., Kleps Cr., 2005) and is influenced by the technology elements: crop rotation, cultivar or hybrid, thickness, soil tillage, fertilization, weeds, diseases and pests (Domuța C., 1995, 2005, Borza I. 2006, 2007, Ardelean I., 2006). The indicators of the water use efficiency can emphasize the quantity of the yield obtained for 1 m³ water used or quantity of water used for 1 kg yield (Domuța C., 2005, 2007, 2008). The paper analyses the water use efficiency like quantity of yield obtained for 1 m³ water and 6 representative hybrids for every FAO group were studied.

MATERIALS AND METHODS

The researches were carried out during 2006-2008 in Agricultural Research and Development Station Oradea on a preluvosoil

On the ploughed depth, the physical parameters of the soil indicate a high hidrostability of macroaggregates (47.5%), a big bulk density (1.41 g/cm³) and median values of the total porosity (46%), field capacity (24.2%) and wilting point (9.2%). The chemical parameters indicate a low acid reaction (pH= 5.8), low humus content (1.75%), median content of the total nitrogen (N= 0.127%), very high content of the mobile phosphorus (150.8 ppm), median content of the mobile potassium (120.6 ppm), magnesium (254 ppm) and active mangan (34%).

Two factors were studied in the experiment:

Factor A: Romanian representative hybrids from FAO groups: a₁: Ciclon, 100-200 FAO group; a₂: Turda super, 200-300 FAO group; a₃: Andreea, 300-400 FAO group; a₄: ZP

335, 400-500 FAO group; a₅: Fundulea 376, 500-600 FAO group; a₆: Fundulea 365, over 600 FAO group. Factor B: water regime: b₁= unirrigated; b₂: irrigated

Soil moisture from 0-75 cm depth of the soil in the irrigated variant was maintained between easily available water content and field capacity based on the twice determination of the soil moisture in one month and using the irrigation when the situation asked it. The irrigation rate used were of 1160 m³/ha in 2006, of 2950 m³/ha in 2007 and of 2950 m³/ha in 2007.

A good quality (SAR= 0.52; CSR=-1.7) had the irrigation water used in the research field. Sprinkler irrigation method with adaptation for rectangular plots was used.

Hybrids total water consumption was determined by soil water balance method and 0-150 cm was the balance depth. (Grumeza N. and al., 1989). Water use efficiency was calculated like report between the yield and total water consumption. Water use efficiency was calculated like report between the yield gain produced by the irrigation and the irrigation rate used (Domuța C., 2008)

RESULTS AND DISCUSSIONS

The hybrid influence on maize yield

Both in unirrigated and irrigated conditions, in 2006 the biggest yields were obtained in the Fundulea 376 hybrid: 8740 kg/ha and 11070 kg/ha. The smallest yields were obtained in the variant with Ciclon hybrid: 7230 kg/ha in unirrigated conditions and 9020 kg/ha in irrigated conditions. Irrigation determined the yield gains very significant in every hybrid and in average the yield gain was of 32.2% very significant statistically, too. (Table 1)

Table 1

Yield (kg/ha) obtained in the maize hybrids from different FAO groups in unirrigated and irrigated conditions, Oradea 2006

FAO group	Hibryd	Water regime		Average
		Unirrigated	Irrigated	
100-200	Ciclon	7230	9020	8125
200-300	Turda super	7860	9760	8810
300-400	Andreea	8600	10570	9585
400-500	ZP – 335	8680	10990	9835
500-600	Fundulea 376	8740	11070	9905
Over 600	Fundulea 365	8720	10980	985
Average		8305	10390	-

	Hybrid	Regime	Hybrid x Regime	Regime x Hybrid
LSD 5%	200	170	190	160
LSD 1%	320	260	300	280
LSD 0,1%	510	390	490	420

In 2007, the biggest yield from unirrigated conditions, 6940 kg/ha was obtained in Fundulea 376 hybrid and the smallest yield was obtained in the Ciclon hybrid, 5790 kg/ha. The differences in comparison with the yield Ciclon hybrid are very significant statistically; there is a exception, Turda super hybrid, where the difference, 320 kg/ha is significant only. Fundulea 365 was the hybrid with the biggest yield in the irrigation conditions (13450 kg/ha) and Ciclon was the hybrid with the smallest yield (9260 kg/ha); all the yield hybrids were very significant statistically than the yield of the Ciclon hybrid. Irrigation determined the yield gains very significant statistically in every hybrid and the average of the yield gain on the experiment, 5556 kg/ha was very significant statistically, too. (Table 2)

Table 2

Yield (kg/ha) obtained in the maize hybrids from different FAO groups in unirrigated and irrigated conditions, Oradea 2007

FAO group	Hibryd	Water regime		Average
		Unirrigated	Irrigated	
100-200	Ciclon	5420	9260	7340
200-300	Turda super	5790	1078	8285
300-400	Andreea	6020	1105	8535
400-500	ZP – 335	6330	1260	9465
500-600	Fundulea 376	6940	13170	10055
Over 600	Fundulea 365	6470	13450	9960
Average		6162	11718	-

	Hybrid	Regime	Hybrid x Regime	Regime x Hybrid
LSD 5%	210	130	190	170
LSD 1%	380	210	350	300
LSD 0,1%	630	490	590	510

Both in the unirrigated and in the irrigated conditions, the biggest yield from the year 2008 were registered in Fundulea 365 hybrid, 7710 kg/ha and 14020 kg/ha. In comparison with Ciclon hybrid, in unirrigated conditions, all yields hybrids are very significant statistically bigger, the exception is Turda super hybrid with an yield gain of 360 kg/ha, significant statistically, only; in irrigated conditions, all the hybrids had the yield gains very significant statistically in comparison with the Ciclon hybrid. (table 3)

Table 3

Yield (kg/ha) obtained in the maize hybrids from different FAO groups in unirrigated and irrigated conditions, Oradea 2008

FAO group	Hibryd	Water regime		Average
		Unirrigated	Irrigated	
100-200	Ciclon	5860	9764	7812
200-300	Turda super	6220	11056	8638
300-400	Andreea	7442	11124	9283
400-500	ZP – 335	7610	1200	9805
500-600	Fundulea 376	7648	13056	10352
Over 600	Fundulea 365	7710	14020	10865
Average		7081	11837	-

	Hybrid	Regime	Hybrid x Regime	Regime x Hybrid
LSD 5%	210	170	240	220
LSD 1%	380	260	450	390
LSD 0,1%	590	430	630	580

In average on the studied period the Fundulea 376 hybrid had the biggest yield in unirrigated conditions but the differences in comparison with Fundulea 365 and ZP 335 yields are very close. In irrigated conditions, the Fundulea 365 hybrid had the biggest yield (table 4)

Table 4

The average of the yield yields (kg/ha) obtained in the maize hybrids from different FAO groups in unirrigated and irrigated conditions, Oradea 2006-2008

FAO group	Hibryd	Water regime		Average
		Unirrigated	Irrigated	
100-200	Ciclon	6170	9345	7557
200-300	Turda super	6623	10532	8577
300-400	Andreea	7354	10915	9134
400-500	ZP – 335	7540	11863	9701
500-600	Fundulea 376	7776	12432	10104
Over 600	Fundulea 365	7633	12817	10225
Average		7183	11317	-

	Hybrid	Regime	Hybrid x Regime	Regime x Hybrid
LSD 5%	206	157	207	183
LSD 1%	306	243	367	323
LSD 0,1%	577	437	570	503

Hybrid influence on water use efficiency (WUE)

The values of the total water consumption increased from the hybrid with the short vegetation period to the hybrid with longest vegetation period. In the year 2006, the values of the total water consumption in unirrigated conditions were of 5630 m³/ha in Ciclon, of 5640 m³/ha in Turda super, of 5650 m³/ha in Andreea, of 5680 m³/ha in ZP 335, of 5730 m³/ha in Fundulea 376 and Fundulea 365; in irrigated conditions the values of the total water consumption are of 6740 m³/ha in Ciclon hybrid, of 6750 m³/ha in Turda super, of 6760 m³/ha in Andreea, of 6830 m³/ha in ZP335, of 6820 m³/ha in Fundulea 365 and of 6870 m³/ha in Fundulea 365. The values of the total water consumption from 2007 decreased in unirrigated condition and increased in irrigated conditions: 3954 m³/ha in Ciclon, 3915 m³/ha in Turda super, 4246 m³/ha in Andreea, 4222 m³/ha in ZP 335, 4302 m³/ha in Fundulea 376, 4312 m³/ha in Fundulea 365 for unirrigated conditions and in irrigated conditions of 6905 m³/ha in Ciclon, of 6915 m³/ha in Turda super, of 7242 m³/ha in Andreea, of 7252 m³/ha in ZP 335, of 7292 m³/ha in Fundulea 376 and of 7302 m³/ha in Fundulea 365. The values of the total water consumption in unirrigated condition in 2008 are: 4000 m³/ha in Ciclon hybrid, 4065 m³/ha in Turda super, 4084 m³/ha in Andreea, 4090 m³/ha in ZP 335, 4120 m³/ha in Fundulea 376, 4160 m³/ha in Fundulea 365; the values for irrigated condition are: 6870 m³/ha in Ciclon, 6910 m³/ha in Turda super, 6960 m³/ha in ZP 335, 7050 m³/ha in Fundulea 376 and 7070 m³/ha in Fundulea 365.

In 2006, the smallest value of the water use efficiency for unirrigated conditions was obtained in Ciclon hybrid, 1.28 kg/m³; the biggest water use efficiency was obtained in ZP 335 and Fundulea 376; 1.53 kg/m³. The irrigation determined the increase of the water use efficiency in every hybrid studied; the smallest value was registered in Ciclon hybrid (1.33 kg/m³) and the biggest in Fundulea 376 (1.62 kg/m³) (Table 5)

Table 5

Water use efficiency (WUE) from diferent FAO group maize hybrids, Oradea 2006

FAO Group	Hybrid	Variant	WUE		Difference
			Kg/m ³	%	
100-200	Ciclon	Nonirrigated	1.28	100	-
		Irrigated	1.33	105	+5
200-300	Turda super	Nonirrigated	1.39	100	-
		Irrigated	1.45	104	+4
300-400	Andreea	Nonirrigated	1.52	100	-
		Irrigated	1.53	101	+1
400-500	ZP – 335	Nonirrigated	1.53	100	-
		Irrigated	1.61	105	+5
500-600	Fundulea 376	Nonirrigated	1.53	100	-
		Irrigated	1.62	106	+6
Over 600	Fundulea 365	Nonirrigated	1.52	100	-
		Irrigated	1.59	105	+5

The values of the water use efficiency registered in the year 2007, are bigger than the values from 2006. In unirrigated conditions, the smallest value (1.37 kg/m³) was registered in Ciclon hybrid and the biggest (1.61 kg/m³) in Fundulea 376. Irrigation determined the increase of the water use efficiency but Ciclon hybrid was a exception; the smallest value was registered in Ciclon (1.34 kg/m³) and the biggest (1.84 kg/m³) in Fundulea 365. (Table 6)

Table 6

Water use efficiency (WUE) from diferent FAO group maize hybrids, Oradea 2007

FAO Group	Hybrid	Variant	WUE		Difference
			Kg/m ³	%	%
100-200	Ciclon	Nonirrigated	1.37	100	-
		Irrigated	1.34	97	-3
200-300	Turda super	Nonirrigated	1.47	100	-
		Irrigated	1.56	106	+6
300-400	Andreea	Nonirrigated	1.41	100	-
		Irrigated	1.52	108	+8
400-500	ZP – 335	Nonirrigated	1.50	100	-
		Irrigated	1.73	115	+15
500-600	Fundulea 376	Nonirrigated	1.61	100	-
		Irrigated	1.81	112	+12
Peste 600	Fundulea 365	Nonirrigated	1.50	100	-
		Irrigated	1.84	123	+23

The biggest value of the water use efficiency were obtained in the year 2008. In unirrigated conditions the values were situated between 1.47 kg/m³ (Ciclon) and 1.89 kg/m³ (Fundulea). Irrigation determined the increase of the water use efficiency, (exception is Ciclon hybrid) and the values were situated between 1.42 kg/m³ (Ciclon) and 1.98 (Fundulea 365) (Table 7)

Table 7

Water use efficiency (WUE) from diferent FAO group maize hybrids, Oradea 2008

FAO Group	Hybrid	Variant	WUE		Difference
			Kg/m ³	%	%
100-200	Ciclon	Nonirrigated	1.47	100	-
		Irrigated	1.42	97	-3
200-300	Turda super	Nonirrigated	1.53	100	-
		Irrigated	1.60	105	+5
300-400	Andreea	Nonirrigated	1.78	100	-
		Irrigated	1.60	90	-10
400-500	ZP – 335	Nonirrigated	1.88	100	-
		Irrigated	1.73	92	-8
500-600	Fundulea 376	Nonirrigated	1.86	100	-
		Irrigated	1.85	99	-1
Peste 600	Fundulea 365	Nonirrigated	1.89	100	-
		Irrigated	1.98	105	+5

In average on the studied period in unirrigated conditions the smallest water use efficiency was registered in Ciclon hybrid (1.47 kg/m³) and the biggest in Fundulea 365 (1.89 kg/m³). In irrigated conditions the values were situated between 1.42 Kg/m³ (Ciclon) and 1.98 Kg/m³ (Fundulea 365) (Table 8)

Table 8

Water use efficiency (WUE) from diferent FAO group maize hybrids, Oradea average 2006-2008

FAO Group	Hybrid	Variant	WUE		Difference
			Kg/m ³	%	%
100-200	Ciclon	Nonirrigated	1.37	100	-
		Irrigated	1.36	99	-1
200-300	Turda super	Nonirrigated	1.46	100	-
		Irrigated	1.54	105	+5
300-400	Andreea	Nonirrigated	1.57	100	-
		Irrigated	1.55	99	-1
400-500	ZP – 335	Nonirrigated	1.64	100	-
		Irrigated	1.69	103	+3
500-600	Fundulea 376	Nonirrigated	1.67	100	-
		Irrigated	1.76	105	+5
Over 600	Fundulea 365	Nonirrigated	1.64	100	-
		Irrigated	1.80	110	+10

Hybrid influence on irrigation water use efficiency (IWUE)

In the year 2006 the values of the irrigation water use efficiency were situated between 1.54 kg yield gain/m³ of irrigation water used (Ciclon) and 2.00 kg yield gain/m³ of irrigation water used (Fundulea 376). Irrigation water use efficiency in 2007 had the smallest value in Ciclon (1.30 kg yield gain/1 m³ irrigation water) but the biggest value was registered in Fundulea 365, 2.37 kg yield gain/1 m³ irrigation water used. The same situation was registered in 2008. In average on the studied period, the smallest irrigation water use efficiency was registered in Ciclon, 1.39 kg yield gain/1 m³ irrigation water and the biggest was registered in Fundulea 365, 2.15 kg yield gain/1 m³ irrigation water used. (Table 9)

Table 9

Irrigation water use efficiency (IWUE) from different FAO group maize hybrids Oradea 2006-2008

FAO Group	Hybrid	IWUE		Difference
		Kg gain/m ³	%	%
The year 2006				
100-200	Ciclon	1.54	100	-
200-300	Turda super	1.64	106	+6
300-400	Andreea	1.70	110	+10
400-500	ZP – 335	1.99	129	+29
500-600	Fundulea 376	2.00	130	+30
Peste 600	Fundulea 365	1.95	127	+27
The year 2007				
100-200	Ciclon	1.30	100	-
200-300	Turda super	1.69	130	+30
300-400	Andreea	1.71	131	+31
400-500	ZP – 335	2.13	163	+63
500-600	Fundulea 376	2.11	162	+62
Peste 600	Fundulea 365	2.37	182	+82
The year 2008				
100-200	Ciclon	1.32	100	-
200-300	Turda super	1.64	124	24
300-400	Andreea	1.25	95	-5
400-500	ZP – 335	1.49	113	13
500-600	Fundulea 376	1.83	139	39
Over 600	Fundulea 365	2.14	162	62
Average 2006-2008				
100-200	Ciclon	1.39	100	-
200-300	Turda super	1.66	119	19
300-400	Andreea	1.55	111	11
400-500	ZP – 335	1.87	134	34
500-600	Fundulea 376	1.98	142	42
Over 600	Fundulea 365	2.15	155	55

CONCLUSIONS

The researches carried out during 2006-2008 in Oradea emphasized the different behaviour of the 6 maize hybrids regarding the yield, water consumption, water use efficiency and irrigation water use efficiency.

The hybrid Ciclon from 100-200 FAO group had the smallest yield. Water consumption, water use efficiency and irrigation water use efficiency.

There were not big difference between the total water consumption of the maize hybrids studied, but later hybrids used a bigger quantity of water from soil reserve.

Irrigation determined the yield gain very significant statistically in all the hybrids and the years. Irrigation determined the increase of the water use efficiency; exception was the earliest hybrid Ciclon.

In average on the studied period, the hybrid Fundulea 365 had the biggest yield gain for every one m³ of irrigation water used (2.15) and Ciclon had the smallest (1.39).

The paper sustains the need of the maize hybrids choise both in unirrigated and irrigated conditions because the yields and water use efficiency are different in the 6 hybrids from different FAO group.

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