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

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Abstract

The paper presents the result regarding the weeds influence on water use efficiency in unirrigated and irrigated Turda super maize hybrid; the researches were carried out in the Agricultute Research and Development Station Oradea in the period 2001-2008.

Both unirrigated and irrigated variant there were the species: Amaranthus retroflexus, Echinochloa crus galli, Chenopodium album, Polygonum persicaria, Solanum nigrum, Convolvulus arvensis. The weeds determined very important yield losses and the decrease of the water use efficiency.

Key word: maize, water consumption, water use efficiency, irrigation water use efficiency, weeds

INTRODUCTION

Roots system of the weeds is more development than the plants crop and this think help them in the competition for nutrients and water (Budoi and Penescu, 1996; Guş et al, 1998; Bogdan I. et al, 2003; Domuţa C., 2006). Nutrient resources and especially water reserve of the soil in the agricultural year are limited and more consumers means smaller quantity of nutrients and especially of water for every plants and finally smaller yields (Domuţa C., 1995, 2005, Borza I., 2006). The paper presents the influence of the weeds from the maize crop on water use efficiency in the conditions of the moderate wet area of the Crişurilor Plain.

MATERIALS AND METHODS

The researches were carried out in Oradea during 2001-2008. The preluvosoil from the research field is characterized by the high hydrostability of the soil aggregates bigger than 0.25 mm (47.5%) on the 0-20 cm depth; bulk density is big (1.41 g/cm^3); total porosity (46%) is median, field capacity (24.2%) and wilting point (9.2%) are median, too.

Chemical parameters of the preluvosoil indicate a low acid reaction (pH= 5.8), low humus content (1.75%), median content of 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 mangan (34%).

Two factors were studied:

Factor A: weeds

a_1= without weeding and herbicides

a_2= herbicides and 2 manual weedings

Factor B: water regime

b_1= unirrigated

b_2= irrigated

The experiment was placed using the subdivised plots method. Number of repetition: 4: Experiment surface plot: 30 m^2. Cultivar used: Turda super, Herbicide used: Sanolt combi 1.5 l/ha.

The annual rainfall registered during the research period were of 868.5 mm in 2001, 437.5 mm in 2002, 501.1 mm in 2003, 737.5 mm in 2004, 722 mm in 2005, in 2006, 684.7 mm in 2007 and 585.7 mm in 2008.

Soil moisture on 0-75 cm depth was maintained between easily available water content and field capacity by soil sample ten to ten days and using the irrigation. The irrigation rate used were of 480 m^3/ha in 2001, of 2040 m^3/ha in 2002, of 2680 m^3/ha in 2003, of 1550 m^3/ha in 2004, of 750 m^3/ha in 2005, of 1160 m^3/ha in 2006, of 2950 m^3/ha in 2007 and of 3320 m^3/ha in 2008.

Irrigation water used had a good quality (SAR = 0.52; CSR = -1.7). Irrigation method used was the sprinckler with adaptation for rectangular plots.

Total water consumption of the maize was determined by the soil water balance method using the balance depth of 0-150 cm (Grumeza N. et al, 1989)

Water use efficiency was calculated like report between the yield and total water consumption; irrigation water use efficiency was calculated like report between the yield gain determined by the irrigation and the irrigation rate used (Domuța C., 2008).

RESULTS AND DISSCUSIONS

The weeds from maize crop

Six species were met in the maize crop, 1 annual monocotiledoneous (*Echinochloa crus galli*) 4 annual dicotiledoneous (*Amaranthus retroflexus, Polygonum persicaria, Chenopodium album, Solanum nigrum*) and 1 perennial dicotiledoneous (*Convolvulus arvensis.* In irrigated conditions *Amaranthus retroflexus,* had the biggest presence (74 plants/m^2); it was followed by *Echinochloa crus galli* (19 plants/m^2), *Polygonum convolvulus* and *Chenopodium album* (11 plants/m^2 everyone), *Solanum nigrum* (5 plants/m^2) and *Convolvulus arvensis* (1 plants/m^2); total number of weeds: 121 plants/m^2.

The total number of weeds from unirrigated variants was smaller with 13% than irrigated variant. *Amaranthus retroflexus* (62 plants/m^2), *Echinochloa crus gali* (15 plants/m^2), *Chenopodium album* (11 plants/m^2), *Polygonum persicaria* (9 plants/m^2), *Solanum nigrum* (5 plants/m^2) and *Convolvulus arvensis* (1 plant/m^2). The biggest decrease of number of plants in comparison with irrigated variant was registered in *Echinochloa crus gali,* 21%. (table 1).

Table 1

The weeds from unirrigated and irrigated maize, Oradea 2001-2008

Specie	Water regime		Difference	
	Unirrigated	Irrigated	plants/m^2	%
	plants/m^2			
1. Echinochloa crus gali	15	19	4	21
2. Amaranthus retroflexus	62	74	12	16
3. Solanum nigrum	5	5	-	-
4. Polygonum persicaria	9	11	2	18
5. Chenopodium album	11	11	-	-
6. Convolvulus arvensis	4	1	-3	-75
Total	106	121	15	14.2

Only in specie *Convolvulus arvensis,* the number of plants decreased in irrigated variant in comparison with unirrigated variant.

Weeds influence on yields maize

Every years, the weeds determined yield losses very significant statistically both in unirrigated and irrigated variant. The yield losses registered in comparison with the variant

herbicided and with 2 manual weeding in the unirrigated conditions were of 54.4% in 2001 of 85.9% in 2002, of 80.8% in 2003, of 57.1% in 2004, of 54% in 2005, of 56.9% in 2006, of 85.8% in 2007 and of 79.3% in 2008. In irrigated conditions the relative yield losses were smaller than in unirrigated conditions but the absolute yield losses are bigger (table 2)

In average on the studied period the weeds determined an yield losses of 54.53 q/ha (65.84%) in unirrigated conditions and of 71.13 q/ha (61.46%) in irrigated conditions.

Irrigation determined yield gains very significant both in the variant with weeds and in the variant with herbicide and 2 manual weeding every year. In average on the studied variants the yield relative difference is comparison with unirrigated variant were of 52.7% in 2001, of 82.3% in 2002, of 79.6% in 2003, of 50,1% in 2004, of 52.4% in 2005, of 44,8% in 2006, of 79,0% in 2007 and of 65.6% in 2008. In average of the studied period the difference was of 63.65%.

Table 2

Weeds influence on yields maize, Oradea 2001-2008

Water regime	Variant				Average on regime
	Weeding		Without weeding		
	q/ha	%	q/ha	%	
The year 2001					
Unirrigated	111.9***	100	51.1Mt	45.6	81.5Mt
Irrigated	120.1	100	58.6	48.8	89.4*
Average	116.0Mt	100	54.85ooo	47.3	-
	Water regime	Weeds	Weeds x Water regime		Water regime x Weeds
LSD 5%	5.97	6.10	8.62		8.45
LSD 1%	10.98	9.24	13.06		13.97
LSD 0,1%	24.32	14.84	20.98		26.52
The year 2002					
Unirrigated	65.3	100	9.2Mt	14.1	37.25Mt
Irrigated	104.8	100	20.9	19.9	62.85***
Average	85.05Mt	100	15.05ooo	17.7	-
	Water regime	Weeds	Weeds x Water regime		Water regime x Weeds
LSD 5%	1.56	3.04	4.28		3.39
LSD 1%	2.86	4.60	6.49		5.32
LSD 0.1%	6.34	7.39	10.43		9.20
The year 2003					
Unirrigated	42.72***	100	8.21Mt	19.2	25.47Mt
Irrigated	93.12	100	19.46	20.9	56.29***
Average	67.92Mt	100	13.84ooo	20.4	-
	Water regime	Weeds	Weeds x Water regime		Water regime x Weeds
LSD 5%	1.32	2.28	4.18		3.30
LSD 1%	2.75	3.96	6.12		5.26
LSD 0.1%	5.98	6.42	9.86		9.16
The year 2004					
Unirrigated	72.56	100	31.20Mt	42.9	51.88Mt
Irrigated	100.24	100	55.13	54.9	77.69***
Average	86.4Mt	100	43.16ooo	49.9	-
	Water regime	Weeds	Weeds x Water regime		Water regime x Weeds
LSD 5%	1.75	2.76	4.26		3.12
LSD 1%	3.28	4.52	6.42		5.32
LSD 0.1%	6.46	7.13	10.22		9.58
The year 2005					
Unirrigated	113.6	100	52.26	46.0	82.93Mt
Irrigated	130.2	100	63.80	49.0	97.00ooo
Average	121.9Mt	100	58.03ooo	47.6	-
	Water regime	Weeds	Weeds x Water regime		Water regime x Weeds
LSD 5%	3.6	1.9	3.1		2.9
LSD 1%	5.2	3.2	4.9		3.7
LSD 0.1%	7.9	5.1	6.8		5.8

The year 2006					
Unirrigated	114.2	100	49.22	43.1	81.71^{Mt}
Irrigated	138.6	100	62.64	45.2	100.62***
Average	126.4^{Mt}	100	55.93^{ooo}	44.15	-
	Water regime	Weeds	Weeds x Water regime	Water regime x Weeds	
LSD $_{5\%}$	4.1	2.7	3.9	3.8	
LSD $_{1\%}$	5.9	4.2	5.2	4.6	
LSD $_{0.1\%}$	9.8	6.8	7.9	6.4	

The year 2007					
Unirrigated	67.2	100	9.6	14.2	38.4
Irrigated	120.8	100	25.4	21.0	73.1
Average	94.0	100	17.5	18.6	-
	Water regime	Weeds	Weeds x Water regime	Water regime x Weeds	
LSD $_{5\%}$	3.1	2.1	2.9	2.4	
LSD $_{1\%}$	5.3	3.3	4.8	3.9	
LSD $_{0.1\%}$	7.9	5.8	6.7	5.6	

The year 2008					
Unirrigated	75.2	100	15.60	20.7	45.40^{Mt}
Irrigated	118.0	100	50.80	43.0	84.40***
Average	96.60	100	33.20^{ooo}	34.40	-
	Water regime	Weeds	Weeds x Water regime	Water regime x Weeds	
LSD $_{5\%}$	2.10	1.70	3.14	2.50	
LSD $_{1\%}$	3.80	2.90	4.90	3.80	
LSD $_{0.1\%}$	6.26	4.60	7.30	6.10	

Average 2001- 2008					
Unirrigated	82.83	100	28.3^{Mt}	34.16	55.56^{Mt}
Irrigated	115.73	100	44.6	38.54	80.16
Average	99.28	100	36.45	36.35	-
	Water regime	Weeds	Weeds x Water regime	Water regime x Weeds	
LSD $_{5\%}$	2.94	2.82	4.29	3.73	
LSD $_{1\%}$	5.0	4.49	6.49	5.73	
LSD $_{0.1\%}$	9.37	7.26	10.02	9.79	

Weeds influence on total water consumption of the maize

In the weeded variant the values of the total water consumption of the maize crop were bigger than the values from the variant with herbicide and 2 weeding every year because the plants used a bigger quantity of water from soil water reserve and the maize harvesting moment, the soil moisture was smaller than the soil moisture from the variant with herbicide and 2 weeding. (table 3)

Both in the weeded variant and in the herbicided variant, the irrigation determined the increase of the total water consumption of the maize. The relative differences in comparison with unirrigated variant were of 6.1% and 2.9% in 2001, of 59.7% and 55.6% in 2002, of 69,5% and 67,8% in 2003, of 25.2% and 24.6% in 2004, of 11% and 11.1 % in 2005, of 23% in 2006, of 65% and 67% in 2007, of 87% and 83% in 2008. In the covering sources of the total water consumption of the maize crop, the irrigation represented 7% in the weeded variant and 9% in the herbicided variant in 2006, 36% and 37% in 2002, 44% and 46% in 2003, 22% and 24% in 2004, 11% and 12% in 2005, 17% in 2006, 40% in 2007, 47% and 46% in 2008. (table 3)

Table 3

Total water consumption and the covering sources in weeding and without weeding maize, Oradea 2001-2008

Variant	Water regime	Σ (e + t)		The covering sources					
		m^3/ha	%	R_i-R_f		P_v		Σm	
				m^3/ha	%	m^3/ha	%	m^3/ha	%
The year 2001									
Without weeding	Unirrigated	5867	100	1036	18	4831	82	-	-
	Irrigated	6230	106,1	919	15	4831	78	480	7
Weeding	Unirrigated	5567	100	736	13	4831	87	-	-
	Irrigated	5730	102,9	419	7	4831	84	480	9
The year 2002									
Without weeding	Unirrigated	3538	100	644	18	2894	82	-	-
	Irrigated	5648	159,7	714	13	2894	51	2040	36
Weeding	Unirrigated	3473	100	579	17	2894	83	-	-
	Irrigated	5402	155,6	468	9	2894	54	2040	37
The year 2003									
Without weeding	Unirrigated	3610	100	1661	46	1949	54	-	-
	Irrigated	6120	169,5	1491	24	1949	32	2680	44
Weeding	Unirrigated	3450	100	1501	44	1949	56	-	-
	Irrigated	5790	167,8	1161	20	1949	34	2680	46
The year 2004									
Without weeding	Unirrigated	5432	100	1712	32	3720	68	-	-
	Irrigated	6800	125,2	1530	23	3720	55	1550	22
Weeding	Unirrigated	5248	100	1528	29	3720	71	-	-
	Irrigated	6540	124,6	1270	19	3720	57	1550	24
The year 2005									
Without weeding	Unirrigated	6073	100	1880	31	4193	69	-	-
	Irrigated	6703	110	1760	26	4193	63	750	11
Weeding	Unirrigated	5983	100	1790	30	4193	70	-	-
	Irrigated	6613	111	1670	25	4193	63	750	12
The year 2006									
Without weeding	Unirrigated	5490	100	1940	35	3550	65	-	-
	Irrigated	6760	123	2050	30	3550	53	1160	17
Weeding	Unirrigated	5372	100	1822	34	3550	66	-	-
	Irrigated	6615	123	1905	29	3550	54	1160	17
The year 2007									
Without weeding	Unirrigated	4502	100	690	15	3812	85	-	-
	Irrigated	7442	165	680	9	3812	51	2950	40
Weeding	Unirrigated	4402	100	590	13	3812	87	-	-
	Irrigated	7342	167	580	8	3812	52	2950	40
The year 2008									
Without weeding	Unirrigated	3830	100	720	19	3110	81	-	-
	Irrigated	7150	187	720	10	3110	43	3320	47
Weeding	Unirrigated	3820	100	710	19	3110	81	-	-
	Irrigated	7020	183	590	8	3110	44	3320	48
The average 2001 - 2008									
Without weeding	Unirrigated	4793	100	1285	27	3507	73	-	-
	Irrigated	6607	138	1233	19	3507	53	1866	28
Weeding	Unirrigated	4664	100	1157	25	3507	75	-	-
	Irrigated	6381	137	1008	16	3507	55	1866	29

Σ (e + t) = water consumption;

P_v = rainfall during the vegetation period,

R_i-R_f = Water reserve (initial reserve – final reserve);

Σm = irrigation rate

Weeds influence on water use efficiency

Both in unirrigated and irrigated conditions the weeds determined smaller values of the water use efficiency, the quantity of yield obtained for 1 m^3 water used decreased. The values of the water use efficiency from unirrigated conditions in the weeded variant

were smaller than the values from herbicided variant with 56.7% in 2001, with 86.2% in 2002, with 82.26% in 2003, with 58.7% in 2004, with 55% in 2005, with 58% in 2006, with 86.3% in 2007, with 79% in 2008. In irrigated conditions, the differences were of 55% in 2001, of 80.9% in 2002, of 80.75% in 2003, of 47.06% in 2004, of 52% in 2005, of 56% in 2006, of 79.3% in 2007, of 56% in 2008. (table 4)

Table 4

Weeding influence on water use efficiency (WUE) in maize, Oradea 2001-2008

Water regime	Variants	WUE		Difference
		Kg/m^3	%	%
The year 2001				
Unirrigated	Weeding	2.01	100	-
	Without weeding	0.87	43,3	-56,7
Irrigated	Weeding	2.09	100	-
	Without weeding	0.94	45,0	-55
The year 2002				
Unirrigated	Weeding	1.88	100	-
	Without weeding	0.26	13.8	-86.2
Irrigated	Weeding	1.94	100	-
	Without weeding	0.37	19.1	-80.9
The year 2003				
Unirrigated	Weeding	1.24	100	-
	Without weeding	0.22	17.74	-82.26
Irrigated	Weeding	1.61	100	-
	Without weeding	0.31	19.25	-80.75
The year 2004				
Unirrigated	Weeding	1.38	100	-
	Without weeding	0.57	41.3	-58.7
Irrigated	Weeding	1.53	100	-
	Without weeding	0.81	52.94	-47.06
The year 2005				
Unirrigated	Weeding	1.90	100	-
	Without weeding	0.86	45	-55
Irrigated	Weeding	1.97	100	-
	Without weeding	0.95	48	-52
The year 2006				
Unirrigated	Weeding	2.13	100	-
	Without weeding	0.90	42	-58
Irrigated	Weeding	2.09	100	-
	Without weeding	0.93	44	-56
The year 2007				
Unirrigated	Weeding	1.53	100	-
	Without weeding	0.21	13.7	-86.3
Irrigated	Weeding	1.64	100	-
	Without weeding	0.34	20.7	-79.3
The year 2008				
Unirrigated	Weeding	1.97	100	-
	Without weeding	0.40	21	-79
Irrigated	Weeding	1.63	100	-
	Without weeding	0.71	44	-56
Average 2001-2008				
Unirrigated	Weeding	1.75	100	-
	Without weeding	0.54	31	-69
Irrigated	Weeding	1.81	100	-
	Without weeding	0.67	37	-63

Weeds influence on irrigation water use efficiency

Weeds determined the decrease of the yield gain obtained for 1 m^3 of irrigation water used. The differences in comparison with weeding variant were of 8.8% in 2001, of 70.6% in 2002, of 77.6% in 2003, of 13.7% in 2004, of 30.3% in 2005, of 49.1% in 2006, of 70.4% in 2007, of 18% in 2008 (table 5)

Table 5

Weeding influence on irrigation water use efficiency (IWUE) in maize, Oradea 2001-2008

Variant	IWUE		Difference	
	Kg gain/m^3	%	Kg gain/m^3	%
The year 2001				
Weeding	1.71	100	-	-
Without weeding	1.56	91.2	-0.15	-8.8
The year 2002				
Weeding	1.94	100	-	-
Without weeding	0.57	29.4	-1.37	-70.6
The year 2003				
Weeding	1.88	100	-	-
Without weeding	0.42	22.34	-1.46	-77.66
The year 2004				
Weeding	1.79	100	-	-
Without weeding	1.54	86.3	-0.25	-13.7
The year 2005				
Weeding	2.21	100	-	-
Without weeding	1.54	69.7	-0.67	-30.3
The year 2006				
Weeding	2.10	100	-	-
Without weeding	1.07	50.9	-1.03	- 49.1
The year 2007				
Weeding	1.82	100	-	-
Without weeding	0.54	29.6	-1.28	- 70.4
The year 2008				
Weeding	1.29	100	-	-
Without weeding	1.06	82	-0.23	-18
Average 2001 - 2008				
Weeding	1.84	100	-	-
Without weeding	1.04	56.5	-0.8	-43.5

CONCLUSIONS

The researches were carried out during 2001-2008 in Oradea and show the presence of the weeds in the maize crop from variant without weeding and herbicides: 106 plants/m^2 in unirrigated conditions and 121 plants/m^2 in irrigated variant. Both unirrigated and irrigated variant there were the species: *Amaranthus retroflexus, Echinochloa crus galli, Chenopodium album, Polygonum persicaria, Solanum nigrum, Convolvulus arvensis.* In irrigated conditions, number of *Convolvulus arvensis* decreased only (1 plants/m^2 vs. 4 plants/m^2).

Weeds determined yield losses very significant statistically both unirrigated and irrigated variant, the relative differences in comparison with the weeding and herbicided variant were between 54% and 85.9% in unirrigated and between 45.1% and 80.1% in irrigated conditions.

The values of the total water consumption from the weeded variants had the bigger values than herbicided and weeding variants because the plants used bigger quantity of water from soil reserve. Irrigation represented between 7% and 47% from covering sources of the maize crop.

Weeds determined smaller values of the water use efficiency, the quantity of yield obtained using 1 m^3 of water was smaller in comparison with herbicided and weeding variant; the relative differences were between 56.7% and 86.3% in unirrigated conditions and between 47.06% and 80.9% in irrigated conditions.

Irrigation water use efficiency had smaller value in the variant with weeds, in comparison with herbicided and weeding variant, the differences were between 8.8% and 77.6%.

The researches sustain the need of the good protection against the weeds both in unirrigated and irrigated conditions because the weeds determined very important yield losses and the decrease of the water use efficiency.

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