IRRIGATION, A COMPONENT OF THE SUGARBEET SUSTAINABLE TECHNOLOGY IN THE CRISURILOR PLAIN CONDITIONS

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Abstract

The researches were carried out during 2009-2011 in the field for soil water balance study from Agricultural Research and Development Station Oradea determined. Ten to ten determination of the soil moisture on the watering depth (0-75 cm) of the the sugarbeet and the graphs of the soil water reserve dynamic emphasized the presence of the pedological drought every year: 133 days in 2009, 24 days in 2010 and 140 days in 2011. Maintaining the soil water reserve on 0-75 cm between easily available water content and field capacity determined to use an irrigation rates of 4600 m^3/ha in 2009, of 500 m^3/ha in 2010 and of 3800 m^3/ha in 2011. The irrigation determined bigger values of the daily water consumption of the sugarbeet. As consequence, the total water consumption from irrigated variant increased with 47% in 2009, with 14% in 2010 and with 78% in 2011. The yield gains obtained in the irrigated variant in comparison with unirrigated variant was of 52% in 2009, of 12% in 2010 and of 115% in 2011. In average on the studied period the irrigation use determined the improve of the water use efficiency with 6% but in the rainy year the value of the water use efficiency in the irrigated was a little smaller (13.9 kg/m^3 vs 14.1 kg/m^3) than the values determined in the unirrigated variant.

The results research sustain the irrigation like a component of the sustainable technology in the sugarbeet from Crisurilor Plain.

Key words: pedological drought, optimum irrigation rate, water consumption, yield, irrigation

INTRODUCTION

Sugarbeet is one of the crop with big water requirement (Grumeza et all, 1989, Bîlteanu Gh., Bîrnaure V., 1979) and the paper wants to emphasize the periods with pedological drought in the last three years, irrigation regime for optimum water consumption, irrigation influence on water consumption, yield and water use efficiency.

Pedological drought is the phenomenon of the decrease of the soil water reserve on the watering depth bellow easily available water content and strong pedological drought is considered the decrease of the soil water reserve on the watering depth bellow wilting point; wilting point is considered a point from an interval and no a fixe point. (Domuţa C., 2005; Brejea R., 2009, 2010, 2011)

The plants' water consumption was provided by the decade control of the soil moisture and by the application of irrigation when the water reserve decreased at the easily available water content on the watering depth of the sugarbeet crop (0-75 cm). The optimum water consumption results at the

end of the vegetation period, after the water balance in the soil. (Domuta C., 1995, Domuța Cr., 2010, 2011).

The water use efficiency (WUE) was calculated as a ratio between yield and water consumption. (Domuta C., 1995).

The irrigation is an important component of the sugarbeet sustainable technology, (Domuța C., 2009; Şandor M., 2008) and the purpose of the researches is to determinate the pedological drought, optimum irrigation regime, total water consumption and water use efficiency in sugarbeet crop.

MATERIAL AND METHODS

The research were carried out in Oradea during 2009-2011, in the soil water balance research field. The experiment was placed in 1976 on a preluvosoil from Agricultural Research and Development Station Oradea. The preluvosoil from the research field is a low acid one, with a low humus content and with a median phosphorus and potassium content. The wilting point and the field capacity values were median. The soil texture determined an easily available water content of 2/3 from the difference between the field capaciy and the wilting point. The irrigation depth in sugarbeet from this area is of 0-75 cm (Grumeza N., Klepş Cr., 2005).

The soil's moisture was determined twice during ten to ten days; when the value of the soil water reserve on the 0-75 cm depth decreased at easily available water content the irrigation was used in order to maintain the soil water reserve between the easily available water content and the field capacity; as a consequence, the optimum water consumption was registered in the irrigation variant. The plants water consumption was established using the method of the water balance in the soil.

The significant of the differences between the yield registered in the irrigated and unirrigated variants were determined using the variance analysis method (Domuța C., 2006).

RESULTS AND DISCUSSIONS

Pedological drought in unirrigated sugarbeet

In the year 2009, in the all the days of the months May, July and August soil water reserve on 0-75 cm depth decreased bellow easily available water content; in June number of days with pedological drought was of 14 in June and of 6 in Aprilie. In the year 2010, pedological drought was registered in 24 days (12 days in July and August respectivelly). The biggest number of days with pedological drought was registered in 2011, 140 days (all the days of the May, June, August and September, 8 days in April and 10 days in July).(table 1)

Table 1

Number of days with pedological drought (PD) in unirrigatd sugarbeet, Oradea 2009-2011

Variant	Days with PD						
	April	May	June	July	August	September	Total
2009	6	31	14	31	31	0	133
2010	0	0	0	12	12	0	24
2011	8	31	30	10	31	30	140

As consequence, for maintaining the soil water reserve on 0-75 cm depth between easily available water content and field capacity the following irrigation rates were used: 4600 m^3/ha in 2009, 500 m^3/ha in 2010 and 3800 m^3/ha in 2011. Number of rates were of 11 in 2009, of 1 in 2010 and of 12 in 2011. The biggest monthly irrigation rate was registered in July and August (1200 m^3/ha) in 2009, in July (500 m^3/ha) in 2010 and in June (1200 m^3/ha) in 2011. (table 2)

Table 2

Optimum irrigation rate in sugarbeet, Oradea 2009-2011

Year	April		May		June		July		August		September		Total	
	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n
2009	500	1	1000	2	700	2	1200	3	1200	3			4600	11
2010	-	-	-	-	-	-	500	1	-	-	-	-	500	1
2011	300	1	600	2	1200	3	600	2	600	2	500	2	3800	12

Σm= Irrigation rate; n= number of rates

Irrigation influence on the sugarbeet daily water consumption

Irrigation determined the increase of the daily water consumption of the plants; the biggest differennces in comparison with unirrigated variants were registered in August, in 2009 (95%) and 2011 (96%); in the year 2010 the biggest difference was registered in July (14%).(table 3).

Table 3

Irrigation influence on daily water consumption in sugarbeet, Oradea 2009-2011

Variant	April		May		June		July		August		September	
	m^3/ha/ zi	%	m^3/ha/ zi	%	m^3/ha/ zi	%	m^3/ha/ zi	%	m^3/ha/ zi	%	m^3/ha/ zi	%
2009												
Unirrigated	25.0	100	31.0	100	44.3	100	39.7	100	26.0	100	24.0	100
Irrigated	27.1	109	36.7	110	57.8	131	69.8	176	50.6	195	29.6	124
2010												
Unirrigated	20.1	100	36.5	100	41.7	100	52.6	100	47.2	100	29.7	100
Irrigated	21.2	106	36.8	101	42.1	101	60.1	114	54.2	115	30.1	102
2011												
Unirrigated	24.0	100	30.7	100	45.6	100	38.5	100	27.9	100	25.0	100
Irrigated	28.6	120	35.9	117	59.6	131	70.1	182	54.6	196	30.3	121

The irrigation use determined the increase of the total water consumption with 47% (7230 m^3/ha vs 4903 m^3/ha) in 2009, with 14 %

(5820 m^3/ha vs 5100 m^3/ha) in 2010 and with 78 % (6977 m^3/ha vs 3927 m^3/ha) in 2011. The main sources for covering the optimum total water consumption was the irrigation in 2009 (4600 m^3/ha, 64%) and in 2011 (3800 m^3/ha, 54%), in the year 2010, the rainfall (5202 m^3/ha, 89%) were the main source for covering the optimum water consumption. (table 4)

Table 4

Irrigation influence on total water consumption -Σ(e+t)- in sugarbeet, Oradea 2009-2011

Year	Variant	Σ(e+t)		Ri-Rf		Pv		Σm	
		m^3/ha	%	m^3/ha	%	m^3/ha	%	m^3/ha	%
2009	Unirrigated	4903	100	2447	50	2456	50	-	-
	Irrigated	7230	147	174	2	2456	34	4600	64
2010	Unirrigated	5100	100	-102	-2	5202	102	-	-
	Irrigated	5820	114	118	2	5202	89	500	9
2011	Unirrigated	3927	100	1170	17	2757	83	-	-
	Irrigated	6977	178	420	6	2757	40	3800	54

Σ(e+t) = Total water consumption; Ri= Initial water reserve (at seeding); Rf= Final water reserve (at harvesting); Pv= Rainfall during the vegetation period; Σm= Irrigation rate

Influence of the irrigation on the level of the sugarbeet yield

The yield obtained in 2009 in the irrigated variant was bigger than the yield obtained in unirrigated variant with 53%; the yield gain was of 25680 kg/ha, very significant statistically. (table 5)

Table 5

Irrigation influence on sugarbeet yield, Oradea 2009

Variant	Yield		Difference		Statistically significant
	Kg/ha	%	Kg/ha	%	
Unirrigated	49420	100	-	-	Control
Irrigated	75100	152	25680	52	***

$LSD_{5\%}$ = 410; $LSD_{1\%}$= 680; $LSD_{0,1\%}$ =1040

In the rainy year 2010, the yield obtained in unirrigated conditions (72000 kg/ha) was bigger than the yield obtained in 2009 with 46%. The irrigation use determined an yield gain very significant statistically, 8680 kg/ha (12%).(table 6)

Table 6

Irrigation influence on sugarbeet yield, Oradea 2010

Variant	Yield		Difference		Statistically significant
	Kg/ha	%	Kg/ha	%	
Unirrigated	72000	100	-	-	Control
Irrigated	80680	112	8680	12	***

$LSD_{5\%}$ = 2160; $LSD_{1\%}$= 4210; $LSD_{0,1\%}$ =6320

The yield gain obtained in 2011 using the irrigation was of 39100 kg/ha (115%), very significant statistically and the biggest yield gain from the studied period. (table 7)

Table 7

Irrigation influence on sugarbeet yield, Oradea 2011

Variant	Yield		Difference		Statistically significant
	Kg/ha	%	Kg/ha	%	
Unirrigated	34100	100	-	-	Control
Irrigated	73200	215	39100	115	***

$LSD_{5\%}$ = 1210; $LSD_{1\%}$= 3910; $LSD_{0,1\%}$ =7030

Irrigation influence on water use efficiency

In average on the studied period the irrigation determined the improve of the water use efficiency with 6% , but in the rainy year 2010, the value of the water use efficiency from irrigated variant was smaller than the value registered in the unirrigated variant (13.9 kg/m^3 vs 14.1 kg/m^3). The biggest difference between irrigated variant and unirrigated variant (29%) was registered in the droughty year 2011. (table 8)

Table 8

Irrigation influence on water use efficiency (WUE) in sugarbeet, Oradea 2009-2011

Variant	WUE		Difference	
	Kg/ m^3	%	Kg/ m^3	%
2009				
Unirrigated	10.1	100	-	-
Irrigated	10.4	103	0.3	3
2010				
Unirrigated	14.1	100	-	-
Irrigated	13.9	99	-0.2	-1
2011				
Unirrigated	8.69	100	-	-
Irrigated	10.50	129	1.81	29
2009-2011				
Unirrigated	10.98	100	-	-
Irrigated	11.6	106	0.62	6

CONCLUSIONS

Researches carried out during 2009-2011 in the field for soil water balance study from Agricultural Research and Development Station Oradea and its determined the following conclusions:

- ten to ten determination of the soil moisture on the watering depth (0-75 cm) of the the sugarbeet and the graphs of the soil water reserve dynamic emphasized the presence of the pedological drought every year: 133 days in 2009, 24 days in 2010 and 140 days in 2011;
- maintaining the soil water reserve on 0-75 cm determined to use an irrigation rates of 4600 m^3/ha in 2009, of 500 m^3/ha in 2010 and of 3800 m^3/ha in 2011;

- the irrigation determined bigger values of the daily water consumption of the sugarbeet. As consequence, the total water consumption from irrigated variant increased with 47% in 2009, with 14% in 2010 and with 78% in 2011;

- the yield gains obtained in the irrigated variant in comparison with unirrigated variant was of 52% in 2009, of 12% in 2010 and of 115% in 2011;

- in average on the studied period the irrigation use determined the improve of the water use efficiency with 6% but in the rainy year the value of the water use efficiency in the irrigated was a little smaller (13.9 kg/m^3 vs 14.1 kg/m^3) than the values determined in the unirrigated variant.

The results research sustain the irrigation like an important component of the sustainable technology in the sugarbeet from Crisurilor Plain.

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