RESEARCH REGARDING OF THE IRRIGATION INFLUENCE ON SUGAR BEET CROP IN THE CRISURILOR PLAIN CONDITIONS

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Abstract

The paper presents the results researches carried out during 1976-2014 in the research field for soil water balance study from Agricultural Research and Development Station Oradea. On the watering depth (0-75 cm) the soil water reserve was maintained between easily available water content and field capacity and the average of the irrigation rate used were of 2655 m^3/ha. The irrigation determined the improve of the microclimate conditions (water/temperature+light report; wet I in comparison with median wet) the increase of the daily water consumption and finally of the total water consumption with 49.7%. The irrigation determined the yield gains very significant every year; the relative differences in comparison with unirrigated variant were of 60.5%, variation interval 9-227%; the yield stabilities were improved, standard deviation decreased with 25.1%. The irrigation determined the increase of the yield quantity obtained for 1 m^3 of water used with 7%. The results research sustain the irrigation opportunity in sugar beet from Crişurilor Plain.

Keywords: sugar beet, irrigation, Domuţa climate index, pedological drought

INTRODUCTION

The Crişurilor Plain is situated in the North-Western part of Romania in a moderate wet are (Domuţa, 2003). Muntean L.S. et al., 2011, consider this area like very favorable for sugarbeet crop, the exception are the glay humic soils, the sandy soils and the salinization soils. The researches regarding the irrigation use in sugarbeet started in 1969 at Girşu de Criş on the chernozem and the influence of different watering depth and different easily available water content were studied (Domuţa, 2009).

Starting 1976, the researches regarding the soil water balance in 10 crops were carried out on the preluvosoil from Agricultural Research and Development Station Oradea and our paper realized a syntesis of the researches regarding the pedological drought in unirrigated sugarbeet, the irrigation influence on microclimate, plants water consumption, level and stability of the yield and water use efficiency.

MATERIAL AND METHOD

The research field for soil water balance study from Oradea was a component of the Romanian network wich included a number of 30 research field situated in the all areas interested for irrigation in Romania.

All the soil profile are low acid (6.11 – 6.8), humus content (1.44 – 1.75%) is small and total nitrogen is low median (0.127 – 0.157). After 34 years of good soil management, good practices the soil phosphorus content became very good (from 22.0 ppm to 150.8 ppm) on ploughing depth, potassium content (124.5 ppm) is median.

A drill is the water source for irrigation and their quality for irrigation is very good: pH = 7.2; Na^+ = 12.9%; mineral residue = 0.5 g/l; CSR = -1.7; SAR = 0.52.The watering depth for sugarbeet was a fixe one, 0-75 cm. The clay content on the watering depth is of 36.4%, bulk density value is of 1.53 g/ cm^3, the field capacity (FC) is of 24.2% (278.2 mm/ha), the wilting point (WP) is of 10.1 % (115.8 mm/ha). Because the clay content is high the easily available water content (Wea) was established using the following formula:

Wea= WP + 2/3 (FC-WP) (2)

Microclimate conditions were quantified using the indicator "Domuța climate index" (ICD) determined using the formula: (Brejea, 2010)

$$IcD = \frac{100W + 12.9A}{\sum t + Sb}$$ in wich:

W= water (mm); A= air humidity (%); Σt = sum of the monthly average temperature (^oC); Sb= sun brilliance.

The characterization limits for ICD are:<3 excessive drought; 3.1 – 5 very droughty; 5.1 – 7 drought; 7.1 – 9 median drought; 9.1 – 12 median wet; 12.1 – 15 wet I; 15.1 – 18 wet II; 18.1 – 25 wet III; >25 excessive wet.

Plants water consumption was established using the soil water balance method on the 0-150 cm depth. The balance ecuation was:

Ri+Pv+Σm = Rf +Σ(e+t) in wich:

Ri = initial soil water reserve;
Pv = rainfall during the vegetation;
Σm = irrigation rate;
Rf = final soil water reserve;
Σ(e+t) = water consumption

Water use efficiency was calculated like report between yield and total water consumpttion and irrigation water use efficiency was calculated like report between yield gain and irrigation rate (Borza, Stanciu, 2010)

The significant of the yield differences was calculated using the variance analysis method and standard deviation was established using the usually method (Domuta, 2006)

RESULTS AND DISCUSSION

Pedological drought in unirrigated sugarbeet

Pedological drought is considered the decrease of the soil water reserve on watering depth bellow easily available water content; the decrease of the soil water reserve bellow wilting point is considered a strong pedological drought (Domuța, 2005).

In the every year of the research period (1976-2010), ten to ten days, the soil moisture was determined. The methods used for soil moisture were the gravimetric one till 1985 and gravimetric (0-150)+neutron (50-150 cm) after that. The annual graphs of soil water reserve dynamics were realized and these graphs permeted to count the days with soil water reserve bellow easily available water content and the days with soil water reserve bellow wilting point.

In unirrigated sugar beet, the pedological drought was detemined every year, the biggest monthly number with pedological drought was determined in August, 27.7. August was the month with the high fequency, 100% strong pedological drought was determined in 7 years of the studied period (table 1, 2).

Table 1

The days with pedological drought in unirrigated sugarbeet, Oradea 1976 – 2010

Specification	Month						Total
	April	May	June	July	August	September	
No. of days with pedological drought	6.1	10.2	21.0	26.7	27.7	23.7	115
Frequency	38	55	90	93	100	90	100

Table 2

The days with strong pedological drought in unirrigated sugarbeet, Oradea 1976 – 2010

Specification	Month						Total
	April	May	June	July	August	September	
No. of days with strong pedological drought	-	-	1.6	6.3	8.0	4.8	21
Frequency	-	3	6	11	19	6	19

Irrigation influence on microclimate

Mainataining of the soil water reserve on 0-75 cm depth between easily available water content and field capacity, determined to use an average of the irrigation rate of 266.5 mm, variation interval 50.0-509.0 mm.

The irrigation determined the improve of the report between water and temperature +light. In average on the period May-September, the value of the indicators "Domuța climate index" increased with 48% in comparison with unirrigated sugarbeet. Monthly differences were of 12% in May, of 36% in June, of 76% in July, of 127% in August and of 12% in September. The characterization classes of the monthly microclimate were different in irrigated variant in comparison with unirrigated variant (table 3).

Table 3

Influence of the irrigation influence on the sugarbeet microclimate (Domuta climate index, ICD), Oradea 1976 – 2014

Variant	Specification		Month					
			May	June	July	August	September	May-September
Unirrigated	ICD	Value	9.8	11.9	9.7	7.3	10.5	9.8
		%	100	100	100	100	100	100
		Characterization	Median wet	Median wet	Median wet	Median wet	Median wet	Median wet
Irrigated	ICD	Value	11.0	16.2	17.1	16.6	11.8	14.5
		%	112	136	176	227	112	148
		Characterization	Median wet	Wet III	Wet II	Wet II	Median wet	Wet I

The irrigation influence on plant water consumption

Daily water consumption of the irrigated sugar beet increased in comparison with unirrigated sugar beet 19.9% in April, with 17.2% in May, with 48.9% in June, with 56% in July, with 46.8% in August and 29.7% in September (table 4).

Table 4

The influence of the irrigation on sugarbeet daily water consumption, Oradea 1976 – 2014

Variant	Specification	Month					
		April	May	June	July	August	September
Unirrigated	mm/ha/day	2.01	2.78	3.73	3.56	2.52	1.84
	%	100	100	100	100	100	100
Irrigated	mm/ha/day	2.41	3.26	4.89	5.66	4.68	2.97
	%	119.9	117.2	148.9	156.6	146.8	129.7

As consequence, the total water consumption of irrigated sugar beet was of 705.8 mm/ha in comparison with 471.4 mm/ha, the total water consumption of the unirrigated sugar beet. The variation interval of the relative differences between total water consumption of the unirrigated and irrigated sugar beet was between 11% and 154%. The irrigation covered 37.4% from optimum water consumption of the sugar beet, variation interval 8.3-67.9%. In unirrigated conditions the rainfall during the vegetation period of the sugar beet was the main sources for water consumption covering but for optimum water

provisionment there were years (Domuța, 2009) when the irrigation was the main covering sources of the sugar beet water consumption. (table 5).

Table 5

Total water consumption – Σ (e+t) of the unirrigated and irrigated sugarbeet and the covering sources, Oradea 1976 – 2014

Variant	Σ (e+t)		Covering sources of the water consumption					
			Soil water reserve	Rainfall		Irrigation rate		
	Average mm/ha	Variation interval %	mm/ha	mm/ha	Variation interval %	mm/ha	%	Variation interval %
Unirrigated	471.4	100	119.9	351.6	38-99	-	-	-
Irrigated	705.8	111-254	87.7	351.6	15-89	266.5	37.8	8.3-67.9

The irrigation influence on yields

The irrigation determined the yields gain very significant statistically every year. The average of the relative difference between the yield from irrigated and unirrigated variant was of 60.5%, variation interval 9-227%. The stability of the yields increased in the irrigated sugar beet, the value of the standard deviation decreased with 25.1% in comparison with the value of the standard deviation of the yields from unirrigated sugar beet (table 6).

Table 6

The irrigation influence on level and stability of the yield in sugarbeet, Oradea 1976 – 2014

Variant	Average yield		Variation interval		Standard deviation	
	Kg/ha	%	Kg/ha	%	Kg/ha	%
Unirrigated	41360	100	18960-80900	100	9240	100
Irrigated	66394	160.5	44850-87800	109-327	6920	74.9

The irrigation influence on water use efficiency

The quantity of the sugar beet yield obtained for 1 mm water used increased in the irrigated variant with 7% (94.0 kg/mm vs. 87.7 kg/mm). In one year (1978) with much rainfall the water use efficiency from irrigated variant was smaller than the value registered in the unirrigated variant. The maximum value of the relative difference between water use efficiency from irrigated and unirrigated variant was of 52%. The average of the irrigation water use efficiency was of 93.9%. (table 7).

Table 7

Water use efficiency (WUE) and irrigation water use efficiency (IWUE) in sugarbeet, Oradea 1976 - 2014

Variant	WUE				IWUE
	Average		Variation interval		
	Kg/mm	%	Kg/mm	%	Kg yield gain/mm
Unirrigated	87.7	100	54.7-107.3	100	-
Irrigated	94.0	107	83.1-116.3	99-152	93.9

CONCLUSION

The results researches carried out during 1976-2014 in Agricultural Research and Development Station Oradea determined the following conclusions:

- The pedological drought was determined every year in unirrigated sugar beet because ten to ten days determinetion of the soil moisture emphasized the decrease of soil water reserve on watering depth decreased bellow easily available water content; in 7 years the soil water reserve decreased bellow wilting point, too.
- Maintaining the soil water reserve on 0-75 cm depth between easily available water content and field capacity determined to use an irrigation rate of 266.5 mm, variation interval 50.0-509.0 mm. The irrigation determined the improve of the microclimate conditions (Domuța climate index increased with 48.0% in comparison with unirrigated variant), the increase of the daily water consumption and of the total water consumption; in the covering of the total water consumption the irrigation participated with 37.8%, variation interval 8.3-67.9%.
- The irrigation determined the yields gains very significant statistically every year of the studied period. The relative differences between the yields registered in the irrigated and unirrigated variant had an average value of 60.5%, variation interval 9-227%. The yield stability was improved in irrigated variant because the value of the standard deviation (6920 kg/ha) decreased with 25.1% in comparison with the value of the standard deviation from unirrigated variant, 9240 kg/ha.
- In average on the period studied, in irrigated variant was obtained a bigger quantity of yield for 1 mm water but in one year (1978) with much rainfall the value of the water use efficiency determined in irrigated variant was smaller than the value of unirrigated variant.

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