INFLUENCE OF PEDOLOGICAL DROUGHT ON SUGAR BEET CROP FROM CRISURILOR PLAIN

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Abstract

The paper presents research carried out in Oradea in the research fields of Agricultural Research and Development Station Oradea and the results have sought to establish periods of pedological drought and its influence on water consumption, yield and water efficiency. Bimonthly determinations of soil moisture shows that on depth of 0-75 cm, water reserve decreased below the easily available water content (pedological drought) in 2011 (88 days) and in 2012 (140 days) and in 2013 (73 days). Under these conditions to maintain water reserve between the easily available water content and field capacity on depth 0-75 cm was irrigated with 3300 m³ / ha in 2011, 3600 m³ / ha in 2012 and with 3300 m^3/ha in 2013. As a result the total water consumption of irrigated sugar beet increased with 73% in 2011, with 76% in 2012 and with 63% in 2013.Irrigation determined obtaining of highly statistically significant yield gain in the two years studied, relative differences to unirrigated variant was 127% in 2011, 146% in 2012 and 139% in 2013.Compared with the variant assured with irrigation, in unirrigated variant with pedological drought, the water use efficiency was smaller. The irrigation determined the increase of the water use efficiency with 31% in 2011, with 40% in 2012 and with 46% in 2013.The results obtained showed the presence of pedological drought which requires the use of irrigation in sugar beet crop as it ensures optimum water consumption, highly statistically significant gain yield and a better water use efficiency.

Key words: irrigation, sugar beet, easily available content, pedological drought, yield.

INTRODUCTION

Sugar beet provides high yields only with good supply of water throughout the vegetation period (Bîrnaure V., 1979). Plant requirements are variable throughout the vegetation period. When sowing, the soil should be well supplied with water, that seed will not sprout stages. In April and May plants consumption is not very high. From June until early September, the crop needs higher humidity level. The occurrence of drought, the plant reacts by reducing leaf area and at strong drought, leaves are dry and fall. Any reduction in foliar index cause crop losses (roots and sugar), even if the plant does not die with the ability to form new leaves when normal weather conditions return. The insufficient water supply caused accumulation of harmful nitrogen more than normal. Darpoux R.and Debelley M. (1967), quoted by Bîrnaure V. (1979) estimated that water consumption decreased by 10% compared with the real needs of the plant lead to diminish the yield by 16%. Water excess is also very damaging, removing air from the soil causing root rot.

At sugar beet for seed, drought is very damaging, especially during flowering - seed formation.

MATERIAL AND METHOD

The research was conducted in 2012 and 2013 in the research field of soil water balance set by Stepănescu E. in 1976 at the Agricultural Research and Development Station Oradea in the national research program "Operation of irrigation facilities" of the Institute of Research Technological Engineering Irrigation and Drainage, Baneasa - Giurgiu.

The researches field from Oradea was made in the preluvosoil conditions with the following profile: Ap = 0-24 cm, El = 24-34 cm; BT_1 = 34-54 cm; Bt_2 = 54-78 cm; Bt / c = 78-95 cm, C = 95-145 cm. It is noted that migration of colloidal clay causes the apparition of horizon El with 31.6% colloidal clay and two horizons of colloidal clay accumulation with BT_1 and Bt_2 with 39,8% and 39,3% colloidal clay.

Main physical and hydrophysical properties

Luvosoil from the research field is characterized by a very high hydrostability of soil aggregates more than 0,25 mm, 47,5% of layer by 0-20 cm.

Bulk density - 1.41 g/cm3 - characterizes a poorly compacted soil at depth 0-20 cm; on other depths studied the apparent weight highlights a moderately and strongly compacted soil (Brejea R., 2010). On watering depth (0-50 cm, 0-75 cm) and on 0-150 cm the soil is strongly compacted.

The soil had a total medium porosity at depth by 0-20 cm, 20-40 cm, 40-60 cm and less in depth by 6-80 cm, 80-100 cm and 100-150 cm. Total porosity values decrease on the soil profile from the surface to depth.

Hydraulic conductivity is high on the depth 0-20 cm, medium on depth by 20-40 cm and 40 cm, low and very low on the following depths studied.

Field capacity had a midLSDe value throughout the soil profile and wilting coefficient is also worth to midLSDe depth of 80 cm and higher below this depth (Borza Ioana, 2011).

Active humidity interval (IUA) or useful water capacity had a high value in the depth 0-80 cm and the midLSDe at depth 80-150 cm. On watering depth used on the research field the active humidity range had a great value (DomuțaC.,2009,2012). Depending on soil easily available water content was set at 2/3 IUA.

The soil in the research field has a slightly acid reaction throughout the depth studied, with increasing values from surface to depth.

Humus supply is poor, and the total nitrogen, low – medium on the

entire depth researched. C / N ratio has a value higher on depth of 0-20 cm (8,01) and decreases with depth determination.

Fertilizing every year with doses of phosphorus specific to agrotechnical irrigated soils caused raising of phosphate level of preluvosoil from research field that after 27 years of stationary research the quantity of mobile phosphorus from soil increased on layer from 22,0 ppm (midLSDe ground supplied) to 150.8 ppm (soil very well stocked).

Mobile potassium content of soil is low - medium, with values increasing from the arable layer (124.5 ppm on the 0-20 cm) to depth (145.4 ppm in the 100-150 cm).

The soil content in exchangeable magnesium on soil profile has a similar pattern with potassium content, the soil being midLSDe supplied with this item's full profile.

Manganese characterize the soil from field research like a soil with medium content at depth 0-20 cm and 20-40 cm and low content at next depths.

Irigation water used in the research yield

Source of water used for crops irrigation is a 15 m deep drilling and the quality for irrigation is " very good" one.

RESULTS AND DISSCUSION

Pedological drought on unirrigated sugar beet crop

In the "Dictionary of soil science" pedological drought is defined as "drought mainly due to low soil moisture, even under satisfactory atmospheric conditions, does not allow absorption by plants of sufficient of water in the soil" (A. Conea et al. 1977). Domuța C. (2004) considers the words "low humidity" too vague and suggests that this notion of pedological drought to be related with hydro indices and especially the easily available water content that is " point of the accessible range of moisture to the soil moisture may decrease without crops being sensitive affected "and proposed the following concepts:

- pedological drought, defined as the period where the soil reserve on watering depth of crops are below easily available water content;
- strong pedological drought , considered to be the period when the water supply of crops on irrigation depth is below the wilting point, meaning that the wilting point as a punt from fixed interval.

Bimonthly determining of soil moisture and graphic representation of soil water reserve on watering depth highlighting the soil hydro indexes allow determining the number of days with pedological drought on sugar beet. In 2011 pedological drought was present from May to September, totaling 88 days. In 2012 the total number of days with pedological drought

was 114, this phenomenon is also met since May and continuing until September. In 2013 the smallest number with pedological drought was registered (Table 1).

Table 1.

Number of days with pedological drought [+)] registered at unirrigated sugar beet crop , Oradea 2011-2013

Year	No. of days with pedological drought						
	Month						TOTAL
	IV	V	VI	VII	VIII	IX	
2011	0	5	7	15	31	30	88
2012	0	10	12	31	31	30	114
2013	0	0	5	21	31	20	76

*)Days with water reserve on watering depth below easily available water content

Optimal irrigation schedule of sugar beet

It is considered that a crop get an optimum water regime if soil moisture on irrigation depth is maintained between easily available water content and field capacity. (Grumeza N. et. al 1989). In the studied period to maintain the water reserve between easily available water content and field capacity, irrigation schedule was different from one year to another depending on rainfall.

In 2011 for optimal water supply of sugar beet have used 3300 m³ / ha water (8 irrigation were applied) and in 2012 irrigation rate used was 3600 m^3 / ha and were applied 8 irrigation. In 2013 the irrigation rate value was of 3300 m^3/ha (table 2).

Table 2.

Optimum irrigation scheduling of sugarbeet crop,Oradea 2011-2013

Year	Month												Total	
	IV		V		VI		VII		VIII		IX			
	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n
2011	-	-	300	1	500	1	800	2	1200	3	500	1	3300	8
2012	-	-	300	1	500	1	1500	2	1000	3	300	1	3600	10
2013	-	-	-	-	500	1	1500	3	1000	2	300	1	3300	7

Σm = irrigation rate (m^3/ha); n = number of irrigations

Influence of irrigation on water consumption of sugar beet crop

Total water consumption was determined by soil water balance method, the balance depth of 0-150 cm. Irrigation increased the daily water consumption values from sugar beet, as a result, total water consumption values have increased.

In 2011 the difference towards unirrigated variant was 73% (6943 m^3 / ha to 4010 m^3 / ha) and in 2013 the difference was 76% (72 020 m^3 / ha vs 4088 m^3 / ha). Sugar beet consumed a quantity of water about 1025 m^3 / ha in 2011 and 1110 m^3 / ha in 2012; in unirrigated conditions quantities of water consumed from soil reserve were lower: 658 m^3 / ha in 2011 and 624

m^3 / ha in 2012. In 2013 both I unirrigated and in irrigated conditions, the biggest quantity of water was used from soil water reserve.

The total water consumption increased in the irrigated variant with 73% in 2011, with 76% in 2012 and with 62% in 2013. The irrigation covered the following percentages: 48% in 2011, 50% in 2012 and 47% in 2013 (table 3).

Table 3.

Irrigation influence on total water used – Σ (e+t) at sugarbeet crop, Oradea 2011-2013

Year	Variant	Σ (e+t)		Covering sources					
				Ri-Rf		Pv		Σm	
		m^3/ha	%	m^3/ha	%	m^3/ha	%	m^3/ha	%
2011	Neirigat	4010	100	1025	26	2985	74	-	-
	Irigat	6943	173	658	9	2985	43	3300	48
2012	Neirigat	4088	100	1110	27	2987	73	-	-
	Irigat	7202	176	624	9	2987	41	3600	50
2013	Neirigat	4290	-	1320	31	2970	69	-	-
	Irigat	7010	163	740	11	2970	42	3300	47

Σ (e+t) = total water consumption;
R_i = Initial water reserve (at sowing);
R_f = Final water reserve (at harvest);
Pv= Rainfalls from vegetation period;
Σm = irrigation rate

Under irrigation condition, in 2011, the largest share in total coverage sources of the water consumption had the irrigations registered in the period between sowing and harvesting of sugar beet; this represented 49% from total water consumption (Fig.1.)

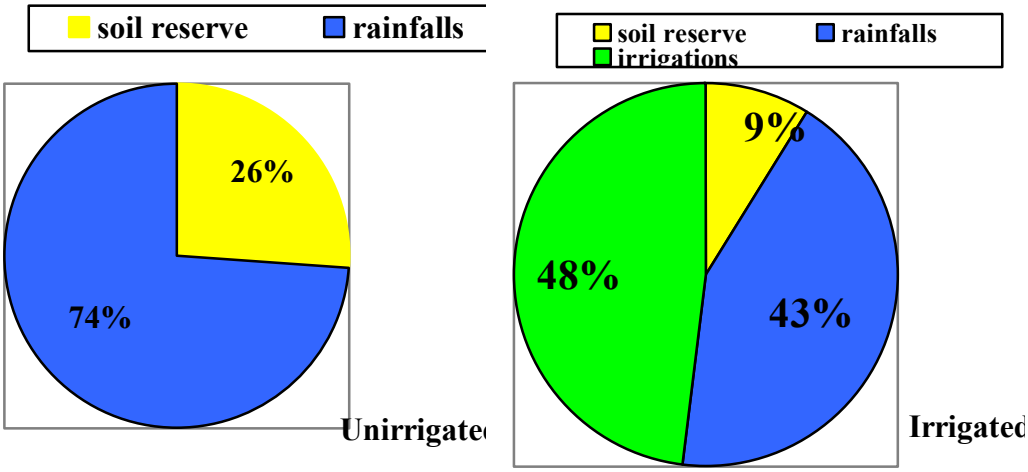

Fig. 1. Percentage of covering sources of total water consumption at sugar beet crop in irrigated and unirrigated conditions, Oradea 2012

In 2012 in the irrigation conditions, irrigation rate had the largest covering source of total water consumption (50%) and the rainfalls registered betwen period of sowing and harvesting of sugar beet reprezented 41% from total water consumption of sugar beet (Fig.2).

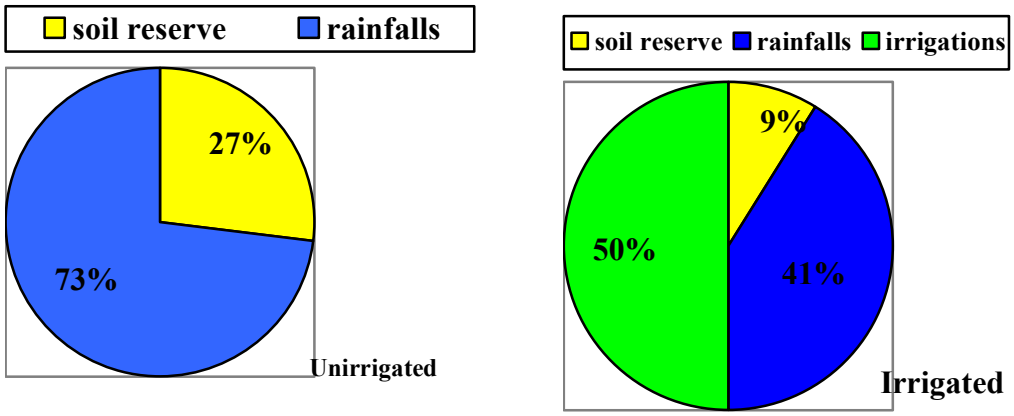

Fig. 2. Percentage of covering sources of total water consumption at sugar beet crop in irrigated and unirrigated conditions, Oradea 2012

Influence of irrigation on yield at sugarbeet crop

In 2012, the irrigation use determined an yield gain of 43800 kg/ha, very significant statistically (table 4).

Table 4.

Influence of the irrigation on yield in sugar beet crop, Oradea 2012

Variant	Yield		Difference		Statistic semnific.
	Kg/ha	%	Kg/ha	%	
Unirrigated	33800	100	-	-	Mt
Irrigated	76900	227	43800	127	***

$LSD_{5\%}$ 2100
$LSD_{1\%}$ 3460
$LSD_{0,1\%}$ 5900

In 2012, dry year, under unirrigation condition was obtained an yield of 30150 kg / ha for sugar beet crop and in conditions of irrigation, the yield increased by 146%, resulting an yield of 74200 kg / ha roots of sugar beet. (Table 5).

Table 5.

Influence of the irrigation on yield in sugar beet crop, Oradea 2012

Variant	Yield		Difference		Statistic semnific.
	Kg/ha	%	Kg/ha	%	
Unirrigated	30150	100	-	-	Mt
Irrigated	74200	246	44050	146	***

$LSD_{5\%}$ 1970;
$LSD_{1\%}$ 3840;
$LSD_{0,1\%}$ 5820

In 2013, yields obtained under irrigation (32710 kg / ha) and unirrigation conditions (78000 kg / ha) was higher than the previous year. The difference between the two variants of maintenance crop: non-irrigated and irrigated (45290 kg / ha) is highly statistically significant, through applying irrigation was obtained a yield gain of 139%. (Table 6).

Table 6.

Influence of the irrigation on yield at sugar beet crop, Oradea 2013

Variant	Yield		Difference		Statistic semnif.
	Kg/ha	%	Kg/ha	%	
Unirigated	32710	100	-	-	Mt
Irrigated	78000	239	45290	139	***

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

Influence of pedological drought on water use efficiency

Water use efficiency was calculated as the ratio between the yield of sugar beet roots and total water consumption of this crop (Table 7).

Table 7.

Influence of pedological drought on water use efficiency (EVA) from sugar beet, Oradea 2011-2013

Year	Varianta				Difference	
	Unirrigated		Irrigated			
	Kg/m^3	%	Kg/m^3	%	Kg/m^3	%
2011	8.42	100	11,10	131	+2,68	31
2012	7,37	100	10,30	140	+2,93	40
2013	7,62	100	11,12	146	+3,50	46

CONCLUSIONS

Sugar beet is one of the crop with excess water requirements, and research conducted in 2011 - 2013 in the field research of the soil water balance at the Agricultural Research and Development Station Oradea establish the periods of pedological drought and it's influences on water consumption, yield and water efficiency.

Pedological drought determined the following values of the water use efficiency: 8,42 kg/m^3 in 2011, 7,37 kg/m^3 in 2012 and 7,62 kg/m^3 in 2013. Optimum using of the irrigation determined the increase of the water use efficiency with 31% in 2011, with 40% in 2012 and with 46% in 2013.

Bimonthly determinations of soil moisture shows that on depth of 0-75 cm, water reserve decreased below the easily available water content (pedological drought) in 2011 (88 days) and in 2012 (140 days) and in 2013 (73 days). Under these conditions to maintain water reserve between the easily available water content and field capacity on depth 0-75 cm was

irrigated with 3300 m³ / ha in 2011, 3600 m³ / ha in 2012 and with 3300 m^3/ha in 2013. As a result the total water consumption of irrigated sugar beet increased with 73% in 2011, with 76% in 2012 and with 63% in 2013.

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