RESEARCHES REGARDING THE OPPORTUNITY OF SOYBEAN IRRIGATION IN THE CRISURILOR PLANE.

CERCETĂRI PRIVIND OPORTUNITATEA IRIGĂRII CULTURII DE SOIA ÎN CÂMPIA CRIŞURILOR

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Abstract: *The paper is based on researches carried between 1976 and 2007 in Oradea, in the soil water balance plot. The opportunity of the soybean crop irrigation is sustained by researches regarding soil water regime and show that in unirrigated conditions, the water reserve dropped under the easily available water content in every year, thus irrigation was needed in order to ensure a proper water supply. Irrigation determined the improvement of the microclimate conditions and the increase of the consumption levels, and in the end obtaining high yield gains very significant statistically. Direct correlations between the water consumption and the yield and between the climate indicator and the yield are the arguments that sustain the opportunity for irrigation of the soybean crop in the Crisurilor Plane.*

Rezumat: *Lucrarea se bazează pe cercetări efectuate între 1976 şi 2007 la Oradea, în câmpul de bilanț al apei în sol. Oportunitatea folosirii irigației la cultura de soia este argumentată prin cercetări privind regimul apei în sol şi arată că în condiții de neirigare rezerva de apă a scăzut sub plafonul minim în fiecare an, ceea ce a făcut ca irigația să fie necesară pentru a asigura aprovizionarea optimă cu apă. Irigația a determinat îmbunătățirea microclimatului, creşterea consumului de apă şi obținerea unor sporuri de producție semnificative statistic. Corelațiile directe dintre valorile indicatorului microclimatic şi producție şi dintre consumul de apă şi producție sunt argumente care susțin necesitatea irigării culturii de soia în Câmpia Crişurilor.*

Key words: *soybean, Domuța climate index, water consumption, irrigation*
Cuvinte cheie: *soia, indicele climatic Domuța, consum de apă, irigație*

INTRODUCTION

The Crişurilor Plane is situated in a favourable area for soybean (BÎLTEANU GH., 1979, MUNTEAN L. S., and all, 1993). Area researches (GRUMEZA N. et all, 1989, DOMUȚA C. et all 2000, DOMUȚA C., 2005) emphasized the presence of the hydric stress on the watering depth every year, the positive influence of the irrigation on the microclimate, the daily and total water requirement and the yield gains obtained. This paper describes the synthesis of the research results obtained during 1976-2007 in the long term trial from Oradea regarding the soil water regime, the microclimate, the water consumption, the yield, the water use efficiency in the soybean irrigated and unirrigated crop.

MATERIALS AND METHOD

The researches were carried out on the preluvosoil from Oradea. This soil has a good structure degree (47.5%). On soybean watering depth (0-75 cm), the wilting point value is of 10.1% (1158 m^3/ha), and the field capacity is of 24.2% (2782 m^3/ha). The clay content determined the easily available water content of 2/3 from a difference between field capacity and wilting point, the value of this parameter is 19.5% (2240 m^3/ha).

The chemical properties of the preluvosoil on the Ap horizon are :1.8 % humus; 6.5 pH; 131.2 ppm phosphorous (in the start of the experiment the phosphorous content was of 32.5 ppm), 210 potassium.

Irrigation water source is a drilling and the water quality is a very good one (CSR=-1.7; SAR=0.52). The irrigation method used was that of spraying water, and the irrigation equipment allowed very precise measurements of the water quantity used.

The soil moisture was determined every 10 to 10 days, until 1999 and 15 to 15 days afterwards. Soil water reserve was maintained between easily available water content and field capacity on 0 – 75 cm, using the irrigation every time it was needed.

Water consumption was determined by soil water balance method (GRUMEZA et all 1989), the depth for balance used was 0 – 150cm.

The microclimate was characterized by using the Domuta microclimate index (ICD):

$$ICD = \frac{100W + 12.9A}{\sum T + Sb}$$

In which : w= water (rainfall, irrigation, groundwater) mm; A= air humidity (%);

t= 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. Other researches (SABAU et all, 1008, PALCUT N 2003, SABAU and all 2002, PETRESCU E. 2005, referenced by DOMUȚA C., 2005) recommend these indexes in what concerns the results obtained when compared to the de Martonne aridity index, Palfai aridity index.

RESULTS AND DISCUSSIONS

The arguments for irrigation opportunity in soybean crop consists of soil water regime on watering depth (0-75 cm), the climate characterization by a specific indicator, optimum water consumption, yield gains and the improvement of water use efficiency.

There were periods with soil water reserve on 0 – 75 cm depth bellow easily available water content in all the years studied. The biggest frequency of the phenomenon was in August (table 1).

Table 1

Analysis of the periods with soil water reserve bellow easily available water content in unirrigated soybean, Oradea 1976 – 2007

Specification	Month					Period
	V	VI	VII	VIII	IX	V – IX
Number of days with WR<Wea on 0 – 75 cm depth	7	14	22	27	18	70
Frequency of the years with WR<Wea on 0 – 75 cm depth	55	76	93	100	79	100

In 27% of the period 1976 – 2007, the soil water reserve on watering depth in unirrigated variant decreased bellow wilting point too.

Maintaining the soil water reserve between easily available water content and field capacity the use of irrigation every year. The irrigation rate values used were of 500 and 4340 m³/ha in direct correlation with the rainfall registered. In average in the irrigation season, the microclimate of the irrigated soybean was characterized as "wet", in comparison with the medium wet in unirrigated soybean. The microclimate was characterized by the Domuta climate index and the differences between the values of this indicator for irrigated and unirrigated microclimate were of 12 – 317%. Monthly the largest variation interval of differences between irrigated and unirrigated variant was registered in August, 0 – 3390% (Table 2). A direct link between the Domuta climate index and the yield was quantified: $y=3.8565\ x^{0.74555}$ $R^2=0.75^{xxx}$

Table 2

Influence of the irrigation on microclimate indicator
(Domuta climate index, ICD) in soybean, Oradea 1976 – 2007

Variant	Month				Period
	V	VI	VII	VIII	V – VIII
Unirrigated	9,8	11,9	9,7	7,3	9,7
Irrigated	11,3	15,8	16,4	15,3	14,7
Difference %	15,3	42,4	69,1	109,5	51,5
Variation interval of the differences	0 – 172	0 – 531	0 – 552	0 - 3390	12 – 317

Irrigation determined the increase of the daily soybean water consumption every month, the biggest relative difference was registered in August, 115%. Both in irrigated variant and in unirrigated variant, the maximum monthly water consumption was registered in August, 55.5 m³/ha/day and 37.1 m³/ha/day (Table 3)

Table 3

Irrigation influence on daily water consumption in soybean, Oradea 1976 – 2007

Variant	Month				
	V	VI	VII	VIII	IX
Unirrigated	24.2	36.6	37.1	21.5	17.4
Irrigated	26.8	42.5	55.5	46.2	22.6
Differences %	11	16	50	115	30

Ensuring the optimum water consumption was possible by using only irrigation. The irrigation participation in the optimum consumption was of 7 – 64%. Irrigation determined the increase of the total water consumption with 53%, variation interval 9 – 266% (table4) Grumeza N and all (1987), Domuta C (1995) had quantified a direct link between the soybean water consumption and yield. For the 1976 – 2007 period the mathematical expression of this link is: $y = 0.00263x^{1.1007}$ ($R^2=0.69^{xxx}$) (Table 4)

The higher water requirements of the soybean determined very significant yield gain through irrigation every year. In average on the researched period the yield obtained in the irrigated variant was of 3087 kg/ha with 68% bigger than the yield obtained in the unirrigated variant; the variation interval of the relative differences between irrigated and unirrigated variants were of 7 – 360%. Irrigation determined the improvement of the yield stability, the standard deviation value is 547 kg/ha versus 814 kg/ha in the unirrigated variant (Table 5).

Table 4

Irrigation influence on total water consumption – Σ(e+t) – in soybean, Oradea 1976 – 2007

Variant	Σ(e+t) m³/ha	Covering sources				
		Soil water reserve m³/ha	Rainfall during vegetation period		Irrigation	
			m³/ha	Variation interval %	m³/ha	Variation interval %
Unirrigated	3827	779	3049	56 – 111	-	-
Irrigated	5826	563	3049	28 - 91	2214	7 – 64

Table 5

Irrigation influence on the level and the stability of the soybean yield, Oradea 1976 – 2007

Variant	Yield				Standard deviation of the yield	
	Average		Variation interval			
	Kg/ha	%	Kg/ha	%	Kg/ha	%
Unirrigated	1836	100	300 – 3400	100	814	100
Irrigated	3087	168	1380 - 4080	107 – 460	547	67.1

The water use efficiency was analyzed using two indexes. They indicate the quantity of the yield obtained for 1 m³ of water used and the water quantity used for 1 kilogram of yield (DOMUTA C, et all 2000). The research results show the increase of the yield quantity obtained for 1 m^3 of used water (0.53 kg/m³ vs. 0.48 kg/m³) and the decrease of the water quantity used for 1 kg of yield, in unirrigated variant versus irrigated variant, 1.89 m³/kg vs. 2.08 m³/kg. (table 6).

Table 6

Influences of the irrigation on water use efficiency (WUE, IWUE) and on water use efficiency coefficient (CWUE, CIWUE) in soybean, Oradea 1976 – 2007

Variant	WUE		CWUE		IWUE		CIWUE	
	kg/m³	%	m³/kg	%	Kg gain/m³	%	m³/ kg gain/	%
Unirrigated	0.48	100	2.08	100	-	-	-	-
Irrigated	0.53	111	1.89	91	0.56	-	1.76	-

CONCLUSIONS

Ten to ten determinations of the soil moisture until 1995, and then bimonthly, emphasized the decrease of the soil water reserve on watering depth (0 – 75 cm) below easily available water content every year of the period 1976 – 2007. In these conditions the irrigation rates used for optimum plant water supply were between 500 and 4340 m³/ha.

The irrigation improved the microclimate conditions (water/temperature + sun brilliance report emphasized by Domuta Climate index) and the increase of the daily water consumption and of the total water consumption. In the covering of the optimum water consumption, the irrigation participated with 7 – 64%.

Yield gains were very significant every year (relative differences between 7 and 360% vs. the unirrigated variant) and the improvement of the yield stability (standard deviation decreased with 32.9%) are other arguments for irrigation opportunity in the soybean crops from the Crisurilor Plane. Another argument is represented by the improvement of the water use efficiency using the irrigation.

The very significant statistically correlation between microclimate and yield, water consumption – yield also sustain the soybean irrigation opportunity.

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