IRRIGATION INFLUENCE (1976-2009) ON THE LEVEL STABILITY AND QUALITY OF THE WHEAT AND ON THE WATER USE EFFICIENCY IN THE CRIŞURILOR PLAIN CONDITIONS

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Abstract: *The researches were carried out in the research field for establishing the soil water balance from Agricultural and Development Research Station Oradea during 1976-2009. The preluvosoil from the research field is characterized by the presence of the horizons Bt_1 (34-54 cm depth) and Bt_2 (54-78 cm depth); the colloid clay eluviation determined to appear the El horizon with 31.6% colloid clay. On 0-20 cm depth, the soil has a big percentage of macroagregates (Φ > 0.25 mm), 47.5% bulk density is of 1.41 g/cm^3 and total porosity is median one, hydraulic conductivity is of 21.0 mm/h. The values of the pH indicates a low acid soil, humus, total nitrogen, phosphorus and potassium content are low. The source of irrigation water was a drill of 15 m depth. The chemical parameters of the irrigation water were the following: fixed mineral residue 0.5 g/l; SAR index 0.52; CSR index= -1.7%; N. Florea class = II; there are not some problemes regarding the use of irrigation use.Two variant were studied: unirrigated; irrigated. The soil water reserve from irrigated variant was maintained between easily available water content and field capacity on 0-50 cm depth. The stability of the yields was analized by standard deviation and panification indexes was determined by usually method; the water use efficiency was calculated as a report between yield and water consumption; the water consumption was establishing directly by soil water balance method. In average on the studied period, the irrigation determined an yield gain of 38.5% very significant statistically. The panification index had smaller values in irrigated variant; water use efficiency improved with 2.0% but in 4 years water use efficiency from irrigated was smaller than the value registered in the unirrrigated variant. The research results emphasized the irrigation opportunity to obtain the high and stability wheat yield in the Crişurilor Plain.The research results are part in the project: PN–II–ID–PCE–2008 2; 690/2009 " The study of influences of some technological elements upon the wheat yield quality in the conditions of the North-Western part of Romania".*

Key words: *pedological drought, irrigation, water consumption, yield, panification index, wheat*

INTRODUCTION

The researches carried out in the Crişurilor Plain regarding the soil water reserve in unirrigated conditions, the influence of irrigation on plants water consumption level and yield stability, correlations between water consumption and yield emphasized the opportunity of the irrigation to obtain the high and stabilityand good quality wheat yield (GRUMEZA N., DOMUŢA C., 1995,2005,2009 2005, 2009)

In irrigation conditions, the wheat grain content in proteic substances is lower in comparison with that in the non-irrigation conditions. (MUNTEAN L.S. et co 2008). In the case of proper irrigations, the differences between the bakery indices (protein, wet gluten, dry gluten, dropping index, deformation index) of the irrigated wheat were not significantly different from a statistical point of view, in comparison with the bakery indices determined in irrigation conditions (ARDELEAN I., 2007, DOMUŢA C., 2007); in the wheat monocrop, the

difference between irrigated and non-irrigated wheat was higher in comparison with the wheat-maize, respectively wheat-maize-soybean crop rotation.

The paper presents the results research obtained during the longest research period (1976-2009) in the research field for soil water balance from Agricultural Research and Development Station Oradea.

MATERIAL AND METHODS

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

Pedological drought in unirrigated wheat

The decrease of the soil water reserve on the watering depth (0-50 cm in this case) bellow easily available water content is considered the period with pedological drought and the decrease of the sol water reserve bellow wilting point is considered the period with strong pedological drought.

All the years of the studied period soil water reserve decreased bellow easily available water content and the pedological drought was registered. The biggest frecquency of the pedological drought was registered in June, 100% (table 1)

Other researches from this area (ARDELEAN I., 2007, DOMUTA C., 2009, ȘANDOR M., 2008) established an inverse link, statistically assured, between number of days with pedological drought and wheat yield and direct link between number of days with pedological drought and yield gains determined by the irrigation; the correlation between number of days

with strong pedological drought with yield has better correlation coefficient than the correlation between the pedological drought and yields

Table 1

Pedological dought in unirrigated wheat, Oradea 1976-2009

Speciffication	IV	V	VI	VII	IV-VI
Nb of days with Ra<Wea on 0-50cm	13.1	22.1	23.5	9.3	58
Year frecquency Ra<Wea	28	96	100	69	100

Ra = water reserve ; Wea = easily available water content

Strong pedological drought was registered in 36% from the years of the studied period; the biggest number of days with strong pedological drought was registered in June, 5 days (table 2)

Table 2

Strong pedological drought in unirrigated wheat, Oradea 1976-2009

Speciffication	IV	V	VI	VII	IV-VI
Nb of days with Ra<WP on 0-50cm	-	1.7	5	2	6.8
Year frecquency Ra<WP	-	18	36	18	36

WP = wilting point

The irrigation influence on microcliamte

The irrigation determined the improve of the water/temperature+light report with 18.7 % in April, with 69.4% in May and with 56.3% in June; in average on the period April-June the difference was of 45.5%. (table 3)

There is a direct link, statistically assured, between the water /temperature + light report (Domuta climate index, ICD) and wheat yields (DOMUTA C., 2007, 2009).

Table 3

Modifications of the water/temperature+light report (Domuța climate index, ICD) under the irrigation influence in wheat, Oradea 1976-2009

Variant	Month			IV-VI
	IV	V	VI	
Unirrigated	11.6 (median wet)	9,8 (median drought)	11.9 (median wet)	11.2 (median wet)
Irrigted	13.7 Wet I	16.6 Wet II	18.6 Wet III	16.3 Wet II
Difference%	18.7	69.4	56.3	45.5

The irrigation influence on water consumption

Daily water consumption of the wheat from irrigated variant increased in comparison with unirrigated variant with 19% in April, with 37% in May, with 48% in June and 56% in July (table 4)

Table 4

Irrigation influence on daily water consumption in wheat, Oradea 1976-2009

Variant	IV		V		VI		VII	
	m^3/ha/day	%	m^3/ha/day	%	m^3/ha/day	%	m^3/ha/day	%
Unirrigated	25.9	100	32.59	100	33.0	100	16.9	100
Irrigated	30.9	119	45.0	137	48.9	148	20.4	156

The values of the total water consumption of the wheat from irrigated variant increased with 37%, variation interval 3-103%. The irrigation covered 34.4% from optimum water consumption, variation interval 0-54% (table 5).

Table 5

Total water consumption Σ (e+t) in unirrigated and irrigated wheat and the covering sources, Oradea 1976-2009

Variant	Total water consumption			Covering sources					
				Water reserve (Ri-Rf)	Pv		Σm		
	m^3/ha	%	Variation interval %	m^3/ha	m^3/ha	Variation interval %	m^3/ha	Variation interval	
								m^3/ha	%
Unirrigated	3160	100	100	806	2354	38-108	-	-	-
Irrigated	4329	137	103-203	485	2354	22-88	1490	0-4080	0-54

Ri-Rf = initial reserve – final reserve ; Pv = rainfall during the vegetation period; Σm = irrigation rate

Irrigation influence on the level and yield stability

The use of the irrigation, maintaining the soil water reserve between easily available water content and field capacity on 0-50 cm depth and using the optimum soil management, an yield gain of 38.5% was obtained; the differences registered during the research period were between 5 and 121%. The irrigation determined the improve of the yield stability, the standard deviation value decreased with 30.8% (table 6)

The direct link, very significant statistically, was established between the wheat water consumption and yields obtained (GRUMEZA N., et all 1989, DOMUTA C. 2007, 2009).

Table 6

The irrigation influence on level and stability of the yield wheat in the conditions of the Crişurilor Plain, Oradea 1976-2009

Variant	Yield				Standard deviation	
	Average		Variation interval			
	Kg/ha	%	Kg/ha	%	Kg/ha	%
Unirrigated	4620	100	2736-7100	100	922	100
Irrigated	6399	138,5	3993-8300	105-221	642	69,2

LSD 5% 230; LSD 1% 370; LSD 0,1% 630

Irrigation influence on panification indexes

In the irrigated variant, all the panification indexes studied – protein, wet gluten, dry gluten, deformation index, fall index - had the values smaller than the values registered in the unirrigated variant but the differences are unsignificant statistically (table 7)

Table 7

The irrigation influence on panification indexes of the wheat, Oradea 2007-2009

Panification index	Unit	Variant		Differences
		Unirrigated	Irrigated	
Protein	%	10.6	9.8	-0.8 LSD 5% 0.9
Wet gluten	%	27.7	26.9	-0.8 LSD 5% 1.0
Dry gluten	%	12.0	11.5	-0.5 LSD 5% 0.8
Deformation index	mm	22.4	22.0	-0.4 LSD 5% 0.7
Fall index	seconds	254	240	-14 LSD 5% 16

The irrigation influence on water use efficiency

Irrigation determined the improve of the water use efficiency with 2.0% (1.5 kg/m^2 vs 1.47 kg/m^3) but in the 4 years the water use efficiency had the bigger values in the unirrigated variant (table 8) The average of the irrigation water use efficiency was of 1.27 kg yield gain/m^3, variation interval 0.18-2.45 Kg yield gain/m^3. (table 8)

Table 8

Irrigation influence on water use efficiency (WUE) and irrigation water use efficiency (IWUE) in wheat, Oradea 1976-2009

Variant	WUE				IWUE Kg yield gain/m^3	
	Average		Variation interval			
	Kg/m^3	%	Kg/m^3	%		
Unirrigated	1.47	100	0.49-2.45	100	-	-
Irrigated	1.5	102,0	0.68-2.46	22-262	1.27	0.18-2.45

CONCLUSIONS

The paper is based on the researches carried out during 1976-2009 in the research field for soil water balance from Oradea and the conclusions are:

- Pedological drought was registered every year, soil water reserve on 0-50 cm depth decreased bellow easily available water content and in 36% of year soil water reserve decreased bellow wilting point.
- The irrigation determined the increase of the water/temperature+light report (Domuța climate index, ICD) with 45.5%, the increase of the daily wter consumption and of the total water consumption. In the optimum total water consumption the irrigation participated with 34.4%, variation interval 0-54%.
- The irrigation determined the increase of the yield, the average of the yield gain is of 38.5%, variation intetrval 5-121%. The yield stability was improved with 30.8%.
- The panification indexes had smaller values in the irrigated variant but the differences in comparison with unirrigated variant were not significant statistically.
- The irrigation determined the improve of the water use efficiency but in 4 years the values obtained were smaller than the values from unirrigated variant.

The results research sustain the irrigation opportunity in the wheat from Crişurilor Plain.

Acknowledgments

The research results are part in the project: PN–II–ID–PCE–2008 2; 690/2009 ”The study of influences of some technological elements upon the wheat yield quality in the conditions of the North-Western part of Romania”.

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