IRRIGATION INFLUENCE ON SOME PARAMETERS OF THE WINTER WHEAT CROP IN THE CRIŞURILOR PLAIN

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Abstract

The researches were carried out during 1976-2010 in the research field for soil water study from Agricultural Research and Development Station Oradea. Soil moisture were determined ten to ten days and the graphs of soil water reserve dynamics on watering depth (0-50 cm) permited to count the number of days with soil water reserve bellow easily available water content and bellow wilting point; these days were considered the days with pedological drought and with strong pedological drought, respectivelly. The results emphasize the presence of the pedological drought every year and the present of the strong pedological drought in 36% from years. The irrigation determined a substantial improve of the water/temperature+light report, the increase of the daily and total plants water consumption, yield gains very significant statistically and the increase of the water use efficiency.

Key words: winter wheat, pedological drought, irrigation, yield gain.

INTRODUCTION

The wheat crops together with maize occupy the biggest part of the Crişurilor Plain surface (Domuța, 2010). The presence of the drought and the need of the irrigation determined to start the researches regarding the use of irrigation (Sabău N.C. et al, 1999, Grumeza and Klepş, 2005, Domuța, 2003, Borza et al, 2009, Domuța et al., 2009). Pedological drought is considered the situation when on the watering depth, the soil water reserve decreases bellow easily available water content (Domuța, 2008); the decrease of the soil water reserve bellow wilting point is considered strong pedological drought (Domuța, 2005, Brejea, 2009, Borza., 2010, Domuța, 2011). Based on the ten to ten determination of the soil moisture during 1976-2010, our paper emphasized the number of days with pedological and strong pedological drought in unirrigated wheat and the influence of the pedological drought on microclimate, plants water consumption, level and stability of the yield and on water use efficiency (Borza et al, 2010, Domuța, 2010, Şandor et al., 2010).

MATERIAL AND METHODS

The researches were carried in the research field for soil water balance study placed in 1976 at Agricultural Research and Development

Station Oradea. The preluvosoil from the research field has the following chemical parameters on Ap horizon: is 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 36 years of good soil management, 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.

Grumeza N. et. al. (1989) considered that the watering depth for wheat is 0-50 cm. On the watering the preluvosoil from research field has a clay content of 34.7%, a bulk density of 1.49 g/cm^3; field capacity is of 24.0% (178.7 mm/ha) wilting point is of 9.7% (72.0 mm/ha).

Easily available water content was established in function of clay content (Domuța, 2009) and the value for watering depth is of 19.2% (143.1 mm/ha).

Soil moisture data were used for realization the graphs of the soil water reserve dynamics on 0-50 cm depth and number of days bellow easily available water content and bellow wilting point were counted.

Two variants were studied: unirrigated and irrigated. In the irrigated variant, the soil water reserve on 0-50 cm depth was maintained between easily available water content and field capacity using the irrigation. Water source for irrigation is a drill; water quality is very good: SAR = 0.52; CSR = -1.7. Irrigation method: sprinkler, using a dispositive adapted for rectangular plots (Domuța C., 2006).

Plant water consumption was established using the soil water balance method:

$$Wea = WP + 2/3\ (FC-WP)$$ (Brejea R., 2010)

The microclimate conditions were quantified using the indicator "Domuța climate index" (ICD) determined using the formula: (Borza I. and Stanciu A., 2010)

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

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

RESULTS AND DISCUSSION

During the period 1976-2010 the value of the average for annual rainfall was of 620.5 mm, air temperature of 10.5^{o}C and air humidity of 78%.

Pedological and strong pedological drought in unirrigated winter wheat

During the period April-July, the soil water reserve on 0-50 cm depth decreased bellow easily available water content in 59 days, every

year. In June, every year was characterized by pedological drought. Strong pedological drought was determined in 13 years, the biggest frequency of the phenomen was registered in June too (table 1).

Table 1

Pedological drought and strong pedological drought in unirrigated winter wheat, Oradea 1976 – 2010

Specification	Month				Total in irrigation seasons
	April	May	June	July	
Days with pedological drought					
Number	13.1	22.1	23.5	9.3	59
Frequency	28	96	100	69	100
Days with strong pedological drought					
Number	-	1.7	5	2	6.7
Frequency	-	18	36	18	36

The irrigation influence on microclimate

For maintaining the soil water reserve on 0-50 cm between easily available water content and field capacity, in average, an irrigation rate of 149.0 mm/ha (variation interval 0-408.0 mm/ha) was used.

The quantification of the irrigation influence on winter wheat microclimate was made using the indicator "Domuța climate index". This indicator includes four climate factors: water (rainfall), air humidity, temperature, sun brilliance. In unirrigated winter wheat the microclimate was characterized like "median wet" every month. The use of the irrigation determined the increase of the climate index values and the change of the characterization. The relative difference in comparison with unirrigated variant were of 40% in May, of 39% in June, of 92% in July; in average on the period May-July, the difference was of 55%. (table 2)

Table 2

Modifications of the water/temperature+light report (Domuta climate index, ICD) in winter wheat under the irrigation influence, Oradea 1976 – 2010

Variant	Specification		Month			May-July
			May	June	July	
Unirrigated	ICD	Value	9.8	11.9	9.7	10.5
		%	100	100	100	100
		Characterization	Med. wet	Med. wet	Med. wet	Med. wet
Irrigated	ICD	Value	13.7	16.6	18.6	16.3
		%	140	139	192	155
		Characterization	Wet I	Wet II	Wet III	Wet II

Winter wheat water consumption in unirrigated and irrigated variant

Both in unirrigated and irrigated conditions, the biggest values of the daily water consumption was registered in June, 3.3 mm/day in unirrigated variant and 4.8 mm/day in irrigated variant (table 3).

Table 3

The irrigation influence on daily water consumption in winter wheat, Oradea 1976 – 2010

Variant	April		May		June		July	
	mm/ha/day	%	mm/ha/day	%	mm/ha/day	%	mm/ha/day	%
Unirrigated	2.59	100	3.26	100	3.3	100	1.69	100
Irrigated	3.09	119	4.50	137	4.8	148	2.04	156

As consequences, the value of the total water consumption increased in average with 37% (432.9 mm/ha vs. 316.0 mm/ha), variation interval 3-103%. (table 4).

Table 4

The irrigation influence on total water consumption – Σ (e+t) in winter wheat, Oradea 1976 – 2010

Variant	Σ (e+t)		
	Average		Variation interval
	mm/ha	%	%
Unirrigated	316.0	100	100
Irrigated	432.9	137	103 – 203

The main covering sources of the optimum water consumption was the rainfall felt during the spring-summer vegetation period of the winter wheat; the average of the participation in the covering sources is 65.9%, variation interval 22%-88%; the irrigation covered 34.4% from plants water consumption, variation interval 0-54%. In unirrigated conditions the rainfall covered 90.3% from total water consumption, the difference (9.7%) was covered from soil water reserve (table 5).

Table 5

The covering sources of the total water consumption in winter wheat, Oradea 1976 – 2010

Variant	Covering sources					
	Soil water reserve (mm/ha)	Spring rainfall		Irrigation rate		
		mm/ha	Variation interval	mm/ha	Variation rate	
					mm/ha	%
Unirrigated	80.6	285.4	38-108	-	-	-
Irrigated	40.5	285.4	22-88	149.0	0-408.0	0-54

The irrigation influence on yield

In average on the studied period in unirrigsted conditions, the yield winter wheat was of 4620 kg/ha, variation interval 2736-7100 kg/ha. The irrigation determined a yield gain of 38.5%, variation interval 5-121%. The yield stability increased, the standard deviation decreased with 30.8%. (table 6).

Table 6

The irrigation influence on yield in winter wheat, Oradea 1976 – 2010

Yield	Specification	Variant	
		Unirrigated	Irrigated
Average	Kg/ha	4620	6399
	%	100	138.5
Variation interval	Kg/ha	2736-7100	3993-8300
	%	100	105-221
Standard deviation	Kg/ha	922	642
	%	100	69.2

Irrigation influence on water use efficiency

In comparison with water use efficiency determined in unirrigated variant, 14.7 kg/mm, the irrigation determined an increase of 2.0%. Not all the years, the irrigation determined an increase of the water use efficiency. Irrigation water use efficiency had an average value of 12.7 kg/mm, variation interval 1.8-24.5 kg/mm yield gain determined by irrigation water (table 7).

Table 7

Water use efficiency (WUE) and irrigation water use efficiency (IWUE) in winter wheat, Oradea 1976 – 2010

Specification		Variant			
		Unirrigated		Irrigated	
		Kg/mm	%	Kg/mm	%
WUE	Average	14.7	100	15.0	102.0
	Variation interval	4.9-24.5	100	6.8-24.6	22-262
IWUE	Average	-	-	12.7	-
	Variation interval	-	-	1.8-24.5	-

CONCLUSIONS

Ten to ten days determination of the soil moisture during 1976-2010 permeted the following conclusions regarding the winter wheat from Crişurilor Plain:

- Soil water reserve on watering depth decreased bellow easily available water content every year. In 36% from year the soil water reserve decreased bellow wilting point.
- The use of the irrigation determined the improve of the microclimate conditions, the increase of the daily water consumption and finally of the total water consumption. The irrigation covered 34.4% from optimum water consumption (variation interval 0-54%).
- The irrigation determined the yield gain very significant statistically every year. The relative difference in comparison with unirrigated variant was of 38.5%, variation interval 5-121%. The yield stability increased in irrigated conditions, the value of the standard deviation decreased with 30.8%.
- Water use efficiency increased in average on the studied period but not all the years the irrigation didn't determine the increase of the yield quantity obtained for 1 m^3 of water used.

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