THE IRRIGATION INFLUENCE ON MAIN PARAMETERS OF THE SOIL-WATER-PLANT-ATMOPHERE IN WINTER WHEAT FROM CRISURILOR PLAIN

Borza Ioana*, Domuţa Cornel, Şandor Maria, Domuţa Cristian, Brejea Radu, Jude Eugen, Albu Ramona

*University of Oradea, Faculty of Environmental Protection, Oradea, Romania
e-mail: borzaioanamaria@yahoo.com

Abstract

The paper is based on the researches carried out during 1976-2014 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.

Keywords: pedological drought, irrigation, yield gain, wheat.

INTRODUCTION

The main parameters of the soil-water-plant-atmosphere system are considered the following: pedological drought, climate indicator, water consumption, yield and water use efficiency. (Domuţa, 2009)

The wheat crop together with maize occupy the biggest part of the Crişurilor Plain surface. The presence of the drought and the need of the irrigation determined to start the researches regarding the use of irrigation (Domuta, 2009). Pedological drought is considered the situation when on the watering depth, the soil water reserve decreases bellow easily available water content; the decrease of the soil water reserve bellow wilting point is considered strong pedological drought (Brejea, 2009; Domuţa, 2009, 2011). Based on the ten to ten determination of the soil moisture during 1976-2014, 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.

MATERIAL AND METHOD

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.

Pedological drought is considered the decreased 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 strong pedological drought. (Domuţa, 2009)

Grumeza 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 (Brejea, 2010) 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: unirrigted 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.

Plant water consumption was established using the soil water balance method, the balance depth was 0-150 cm.

The microclimate conditions were quantified using the indicator "Domuţa climate index" (ICD) determined using the formula: (Domuţa, 2009)

$$IcD = \frac{100W + 12.9A}{\sum t + Sb}$$ 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 1976-2014 the value of the average for annual rainfall was of 620.5 mm, air temperature of 10.5°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 67 days, every year. In June, every year was characterized by pedological drought. Strong pedological drought was determined in every 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 – 2014

Specification	Month				Total in irrigation seasons
	April	May	June	July	
Days with pedological drought					
Number	13	21	24	9	67
Frequency	28	96	100	69	100
Days with strong pedological drought					
Number	-	2	6	2	10
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 156.8 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 "Domuţa 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 – 2014

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 – 2014

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 38% (440.0 mm/ha vs. 318.0 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 – 2014

Variant	Σ (e+t)		
	Average		Variation interval %
	mm/ha	%	
Unirrigated	318	100	100
Irrigated	440	138	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 56.01%, variation interval 22%-88%; the irrigation covered 35.6% from plants water consumption, variation interval 0-54%. In unirrigated conditions the rainfall covered 77.8% from total water consumption, the difference (13.2%) was covered from soil water reserve (table 5)

Table 5

The covering sources of the total water consumption in winter wheat, Oradea 1976 – 2014

Variant	Covering sources					
	Soil water reserve (mm/ha)	Spring rainfall		Irrigation rate		
		mm/ha	Variation interval %	mm/ha	Variation rate	
					mm/ha	%
Unirrigated	70.5	247.5	38-108	-	-	-
Irrigated	35.7	247.5	22-88	156.8	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 4730 kg/ha, variation interval 2736-7100 kg/ha. The irrigation determined an yield gain of 43%, 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 – 2014

Yield	Specification	Variant	
		Unirrigated	Irrigated
Average	Kg/ha	4730	6780
	%	100	143
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, 15.0 kg/mm, the irrigation determined an increase of 1.0%. Not all the years, the irrigation determined an increase of the water use efficiency. Irrigation water use efficiency had a 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 – 2014

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	-

CONCLUSION

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

- Ten to ten days determination of the soil moisture look like the 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 35.6% 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 43%, 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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