PEDOLOGICAL DROUGHT INFLUENCE ON WATER CONSUMPTION, YIELD AND WATER USE EFFICIENCY IN POTATO FROM CRIŞURILOR PLAIN

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Abstract

The researches were carried out during 2007-2009 on the preluvosoil from Agricultural Research and Development Station Oradea in the research field for soil water balance study. Water use efficiency (WUE) was determined as a report between yield (kg/ha) and water consumption (m^3/ha). In the irrigated variant the soil water reserve was maintained between easily available water content (2240 m^3/ha) and field capacity (2782 m^3/ha) on watering depth (0-75 cm). Crop technology was the optimum one: foreruner was the wheat, chemical ($N_{160}P_{120}K_{80}$) and organic (40 t/ha) fertilizers were used, the treatments against the diseas and pests were applied in function of the needs. The irrigation determined the increase of the daily water consumption; total water consumption increased too. There were the yield gains very significant statistically every year; the percentage of the big tuberous in the yield increased and the water use efficiency increased in comparison with unirrigated variant with 35%. The increase of the water consumption, the yield gains very significant statistically obtained every year, the increase of the big tuberous percentage in the yield and the improve of the water use efficiency are the arguments for irrigation opportunity in the Crisurilor Plain.

Key words: potato, water use efficiency, irrigation

INTRODUCTION

Pedological drought has a strong influence on potato crop because the potato is one of the plants with the biggest requirement for continously water provisionment. (Domuţa, 2005, Ciutacu, 2009). Irrigation is the main possibility for drought control in the potato crop from Crişurilor Plain, too (Grumeza et al 1989, Domuţa, 1995, 2005, Stanciu, 2006). The paper presents the influence of the pedological drought on water consumption, yield and water use efficiency based on the researches obtained in the research field for soil water balance study 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 potato 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.

Pedological drought is considered the period with soil moisture bellow easily available water content on watering depth, 0-75 cm in this case (Domuţa, 2005). The soil

moisture was determined every 10 to 10 days and the graphs were realized, the number of days with soil moisture bellow easily available water content were established using these graphs. Soil moisture 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 al., 1989), the depth for balance used was 0 – 150 cm. The yield data was calculated by variance analysis (Domuța, 2006).

RESULTS AND DISCUSSIONS

Soil moisture decreased bellow easily available water content every year and maintaining the soil water reserve on 0-75 cm depth determined to use the irrigation every year. The irrigation rate used was of 3200 m^3/ha in 2007, of 2800 m^3/ha in 2008 and of 3500 m^3/ha in 2009. The number of rates used was of 8 in 2007, of 7 in 2008 and of 9 in 2009. (table 1)

Table 1

Optimum irrigation water regime in potato crop, Oradea 2007-2009

Year	April		May		June		July		August		Total	
	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm
2007	1	400	2	900	2	800	2	800	1	400	8	3200
2008	-	-	1	500	3	1100	2	700	1	500	7	2800
2009	2	800	3	1200	2	700	2	800	-	-	9	3500
Average	1	400	2	870	2	870	2	770	1	300	8	3170

n = number of rate; Σm = irrigatin rate

Influence of the irrigation on potato water consumption

Pedological drought determined the decrease of the daily water consumption. The biggest relative differences were registered in June (38%) followed by July (36%), May (30%), April (17%) and August (16%). (table 2)

Table 2

The irrigation influence on daily water consumption in potato, Oradea 2007-2009

Year	Variant	April		May		June		July		August	
		m^3/ha	%	m^3/ha	%	m^3/ha	%	m^3/ha	%	m^3/ha	%
Average	Irrigated	27.3	100	38.1	100	58.2	100	48.1	100	28.7	100
	Unirrigated	22.6	83	26.6	70	36.2	62	30.7	64	24.2	84

In comparison with the variant with optimum water provisionment in the variant with pedological drought, the total water consumption decreased with 35% in 2007, with 29% in 2008 and with 35% in 2009. The plants used a better water quantity from soil reserve in the unirrigated variant in comparison with irrigated variant: 1037 m^3/ha vs 84 m^3/ha in 2007, 1193 m^3/ha vs. 131 m^3/ha in 2008 and 1136 m^3/ha vs. 192 m^3/ha in 2009. (table 3)

Table 3

The irrigation influence on total water consumption (Σ(e+t) and the covering sources in potato crop, Oradea 2007-2009

Year	Variant	Σ(e+t)		Covering sources		
				Soil water reserve	Rainfall	Irrigation
		m^3/ha	%	m^3/ha	m^3/ha	m^3/ha
2007	Irrigated	5915	100	84	2831	3000
	Unirrigated	3868	65	1037	2831	-
2008	Irrigated	5975	100	131	3044	2800
	Unirrigated	4237	71	1193	3044	-
2009	Irrigated	6353	100	360	2493	3500
	Unirrigated	3670	58	1170	2493	-
Average	Irrigated	6081	100	192	2789	3100
	Unirrigated	3927	65	1136	2789	-

Pedological drought influenced on yield

In unirrigated variant the yield losses very significant statistically were registered every day. The relative differences in comparison with the variant with optimum water provisionment, were of 53% in 2007, of 56% in 2008 and of 68% in 2009; the average of the relative difference on the studied period was of 58%. (table 4)

Table 4

The irrigation influence on yield in potato crop, Oradea 2007-2009

Variant	Yield		Difference		Statistically significant
	Kg/ha	%	Kg/ha	%	
2007					
Irrigated	37100	100	-	-	Control
Unirrigated	17600	47	-19500	-53	***
$LSD_{5\%}$ 270		$LSD_{1\%}$ 490		$LSD_{0.1\%}$ 830	
2008					
Irrigated	34000	100	-	-	Control
Unirrigated	15500	46	-18500	-56	***
$LSD_{5\%}$ 430		$LSD_{1\%}$ 690		$LSD_{0.1\%}$ 1070	
2009					
Irrigated	31500	100	-	-	Control
Unirrigated	10160	32	-21340	-68	***
$LSD_{5\%}$ 510		$LSD_{1\%}$ 720		$LSD_{0.1\%}$ 1150	
Average 2007-2009					
Irrigated	34200	100	-	-	Control
Unirrigated	14420	42	-19780	-58	***
$LSD_{5\%}$ 403		$LSD_{1\%}$ 633		$LSD_{0.1\%}$ 1017	

Pedological drought influenced on water use efficiency

Pedological drought determined a smaller yield quantity for 1 m^3 water used; the relative differences registered were of 27% in 2007, of 36% in 2008 and of 27% in 2009. (table 5)

Table 5

The irrigation influence on water use efficiency (WUE) in potato, Oradea 2007-2009

Variant	WUE		Difference	
	Kg/ m^3	%	Kg/ m^3	%
2007				
Irrigated	6.27	100	-	-
Unirrigated	4.55	73	-1.27	-27
2008				
Irrigated	5.69	100	-	-
Unirrigated	3.66	64	-2.03	-36
2009				
Irrigated	5.38	100	-	-
Unirrigated	3.93	73	-1.45	-27
Average 2007-2009				
Irrigated	5.78	100	-	-
Unirrigated	4.05	70	-1.73	-30

CONCLUSIONS

The paper based on the results carried out in Agricultural and Development Research Station Oradea during 2007-2009 and the conclusions are the following:

- Pedological drought was determined every year and maintaining the soil water reserve on watering depth between easily available water content determined to use the irrigation every year. The irrigation rate used are of 3200 m^3/ha in 2007, of 2800 m^3/ha in 2008 and of 3500 m^3/ha in 2009.
- Pedological drought determined the decrease of the daily water consumption and total consumption decreased with 35% in 2007, with 29% in 2008 and with 42% in 2009.
- There were the yield losses very significant statistically every year, -53% in 2007, -56% in 2008, and -68% in 2009.
- The irrigation determined the decrease of the water use efficiency every year studied; the relative differences in comparison with unirrigated variant were of 27% in 2007, of 36% in 2008, of 27% in 2009.

The results researches sustain the need of the irrigation in the pedological drought control.

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