IRRIGATION, THE METHOD FOR DROUGHT CONTROL IN ALFALFA 2ND YEAR FROM CRIŞURILOR PLAIN

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Abstract: *The researches were carried out during 2007-2009 in the Agricultural Research and Development Station Oradea on the preluvosol 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.Ten to ten day determination of the soil moisture emphasized the decrease of the soil water reserve on watering depth (0-100 cm) bellow easily available water content every yea, and the irrigation was needed for optimum water provisionment. The use of the irrigation for maintaining the soil water reserve between easily available water content and filed capacity determined the improve of the water/temperature + light report, the increase of the daily water consumption and of the total consumption and the yield gains very significant every year; the water use efficiency was (kg/m^3) was improved with 18. 7 %. The researches are part of the project" Study of the relationships in the soil-water-plant-atmosphere system on the land affected succesivelly by excess and deficit of moisture from North Western Romania regarding the improve of the yield quantity and quality"PN-II-ID-PCE-2008-2; 1103/2009.The presence of the pedological drought every year and the improves determined by irrigation-microclimate conditions, water consumption, yield gains, water use efficiency- are the arguments for irrigation use in alfalfa 2nd year in the Crisurilor Plains.*

Key words: *pedological drought, irrigation, yield gain,alfalfa.*

INTRODUCTION

The importance of the alfalfa like fodder is very known. In the Crisurilor Plain (DOMUTA C., 1995, 2003, 2005, 2009, CIOBANU GH. And DOMUŢA C., 2003) and in the other area of the Romania (GRUMEZA N. et all, 1989, GRUMEZA N. and KLEPS CR., 2005, LUCA E., NAGY Z., 1999, MAN T.E. et al., 2007) the alfalfa is the crop with the biggest water consumption and the periods with drought determined the yield losses. The researches regarding the irrigation in alfalfa from Crisurilor Plain started in 1969 and our researches purposed to study the need of the irrigation in the conditions of three years with rainfall smaller than multiannual average.

MATERIALS AND METHODS

The researches were carried out during 2007-2009 in Agricultural Research and Development Station Oradea on a preluvosoil. All the soil profile are 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 30 years of good soil management, good practices 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.

There are a big hydro stability (47.5%) of the aggregates (= 0.25 mm) on ploughingland and bulk density (1.41 g/cm^3) indicates a low settling and total porosity is median. On the subjacent depth of the ploughing layer bulk density characterizes the soil like moderate and very settled and total porosity is small and very small. Hydraulic conductivity is big (21.0 mm/h) on 0-20 cm; median (10.5 mm/h; 4.4 mm/h) on 20 – 40 cm and 40 – 60 cm and very small (1.0 mm/h) on 60 – 80 cm.

The source of irrigation water was a drill of 15 m depth. Irrigation water quality was very good: pH = 7.2; Na^+= 12.9; mineral residue = 0.5 g/l; CSR = -1.7; SAR = 0.52.

Soil moisture of 0 – 100 cm depth was determined ten to ten days and monthly on 0 – 150 cm depth. In the variant irrigated, the moment of the irrigation use was when the soil water reserve on 0 – 100 cm depth decreased to easily available water content.

The experiment data were calculated using the variance analysis method (DOMUȚA C., 2006).

RESULTS AND DISCUSSIONS

The annual rainfall during the studied period were of 556,1 mm in 2007, of 585,7 mm in 2008 and of 501,4 mm in 2009; the average temperatures were of 12,6°C in 2007, of 11,0°C in 2008 and of 11,6°C in 2009; the values of the air humidity were of 66% in 2007, of 72% in 2008 and of 70% in 2009 (table 1).

Table 1

Climate elements of the agricultural years average 2007 și 2008 (after Meteorological Station Oradea)

Specification	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	Sum/ Average
Air temperature, °C													
Agricultural year 2007	11.2	6.6	2,3	4.3	4.7	8.7	12,2	18.2	22.2	23.6	22.3	14.4	12.6
Agricultural year 2008	10.3	3.7	-0,4	1.4	3.4	6.5	11.6	16.9	21.0	20.9	22.0	15.4	11.0
Agricultural year 2009	12.3	6.7	3.2	-1.0	0.3	5.4	14.4	17.3	19.8	23.1	22.2	15.5	11.6
Multianual average*	10.7	5.3	0,6	-2.0	0.3	5.0	10.4	15.8	19.0	20.8	20.3	16.2	10.2
Rainfall, mm													
Agricultural year 2007	24,4	27,4	9.7	36.8	69.3	13.0	3.2	80.6	50.5	67.6	82.4	91.2	556.1
Agricultural year 2008	75,1	62,6	29.4	21.3	12.5	67.9	43.3	38.9	92.1	69.3	27.3	46.0	585.7
Agricultural year 2009	29.9	33.7	62.6	21.2	36.1	60.2	13.3	27.1	97.6	21.9	89.4	8.4	501.4
Multianual average*	39.9	48.9	50.2	34.5	38.8	34.3	46.6	61.6	84.7	71.5	58.3	45.8	615.1
Air humidity, %													
Agricultural year 2007	70	79	84	79	81	63	46	61	59	53	63	72	66
Agricultural year 2008	77	82	86	82	74	71	67	65	68	67	61	67	72
Agricultural year 2009	75	74	81	85	82	73	53	53	64	57	91	56	70
Multianual average*	79	84	88	85	86	77	72	72	73	69	71	75	78

1936-2007

Pedological drought in unirrigated alfalfa

Pedological drought is considered the periods with soil water reserve on watering depth bellow easily available water content (DOMUTA C., 2005). The periods with soil water

reserve bellow wilting point is considered strong pedological drought (DOMUTA C., 2005; 2009). The annual graphs of the soil water reserve dynamics realized by soil sample emphasized the values bellow easily available water content in every month of the alfalfa vegetation period. Total days with pedological drought were of 164 in 2007, of 163 in 2008 and of 165 in 2009 (table 2).

Table 2

Number of days with pedological drought in unirrigated alfalfa 2nd year, Oradea 2007-2009

Year	Month						Total
	April	May	June	July	August	September	
2007	30	31	26	31	28	18	164
2008	24	31	30	31	31	14	161
2009	28	31	18	31	27	30	165
Average	27	31	25	31	29	21	164

Strong pedological drought was determined every year: 14 days (10 days in July and 4 days in August) in 2007, 30 days (7 days in July, 13 days in August and 10 days in September) in 2008 and 58 days (12 days in June, 13 days in July, 16 days in August and 17 days in September) in 2009 (table 3).

Table 3

Number of days with strong pedological drought in unirrigated alfalfa 2nd year, Oradea 2007-2009

Year	Month						Total
	April	May	June	July	August	September	
2007	0	0	0	10	4	-	14
2008	0	0	0	7	13	10	30
2009	0	0	12	13	16	17	58
Average	0	0	4	10	11	9	34

Optimum irrigation regime

For maintaining the soil water reserve on watering depth (0-100 cm) between easily available water content the irrigation was needed every year. Irrigation rate used in 2007 was of 4650 m^3/ha, in 2008 of 5300 m^3/ha and in 2009 of 5400 m^3/ha. The number of rates were of 10 in 2007, of 11 in 2008 and of 12 in 2009. The biggest month irrigation rate were used in Aprilie (1150 m^3/ha) in 2007, in July (1500 m^3/ha) in 2008 and in May and July (1300 m^3/ha) in 2009 (table 4).

Table 4

Optimum irrigation regime in alfalfa 2nd year, Oradea 2007-2009

Year	April		May		June		July		August		September		Total	
	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm
2007	2	1150	3	1100	2	900	2	1000	1	500	-	-	10	4650
2008	2	1100	3	1300	1	500	3	1500	2	900	-	-	11	5300
2009	2	900	3	1300	2	900	3	1300	2	1000	-	-	12	5400
Average	2	1050	3	1230	2	770	3	1270	2	800	-	-	12	5120

The irrigation influence on alfalfa daily water consumption

Irrigation determined the increase of the daily water consumption. The biggest relative differences in comparison with unirrigated variant were registered in May (117%) in 2007, in May, too (146%) in 2008 and in June (128%) in 2009. The average of the research period show

that the maximum daily water consumption were registered in June (59,5 m^3/ha/day) in irrigated conditions and in July (36,4 m^3/ha/day) in unirrigated conditions. The relative maximum difference between irrigated and unirrigated variant was registered in May (129%) (table 5).

Table 5

The irrigation influence on daily water consumption in alfalfa 2nd year, Oradea 2007-2009

Year	Variant	April		May		June		July		August		September	
		m^3/ha/ day	%	m^3/ha/ day	%	m^3/ha/ day	%	m^3/ha/ day	%	m^3/ha/ day	%	m^3/ha /day	%
2007	Unirrigated	23.5	100	24.0	100	25.6	100	33.1	100	26.9	100	14.4	100
	Irrigated	45.9	195	52.0	217	51.5	202	45.7	138	39.2	146	21.4	149
2008	Unirrigated	29.0	100	25.5	100	33.2	100	38.6	100	27.9	100	22.6	100
	Irrigated	46.1	159	62.7	246	67.1	203	60.0	155	43.8	157	29.0	128
2009	Unirrigated	27.4	100	24.9	100	30.0	100	37.6	100	27.0	100	18.3	100
	Irrigated	43.0	157	56.8	228	60.0	200	54.7	145	40.9	151	26.5	145
Average	Unirrigated	26.6	100	24.9	100	29.6	100	36.4	100	27.3	100	18.4	100
	Irrigated	45.0	169	57.2	229	59.5	201	53.5	147	41.3	151	25.6	139

The irrigation influence on total water consumption

The irrigation determined the increase of the total water consumption with 70% in 2007, with 92% in 2008 and with 114% in 2009. The irrigation was the main source for optimum water consumption covering; their participation was of 53% in 2007, of 51% in 2008 and of 54% in 2009. In the irrigated variant, the alfalfa used a smaller quantity from soil water reserve in comparison with alfalfa from unirrigated variant (table 6).

Table 6

The irrigation influence on total water consumption [Σ(e+t)] and the covering sources in alfalfa 2nd year, 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	Unirrigated	5237	100	1295	25	3942	75	-	-
	Irrigated	8883	170	291	3	3942	44	4650	53
2008	Unirrigated	5385	100	1571	29	3814	71	-	-
	Irrigated	10342	192	1228	12	3814	37	5300	51
2009	Unirrigated	4677	100	2100	45	2577	55	-	-
	Irrigated	9977	214	2020	20	2577	26	5400	54
Average	Unirrigated	5100	100	1656	32	3444	68	-	-
	Irrigated	9734	191	1173	12	3444	35	5117	53

The irrigation influence on yield

The irrigation determined the yield gain very significant statistically every year studied: 58200 kg/ha (42%) in 2007, 44800 kg/ha (108,4%) in 2008 and 44400 kg/ha (126,5%) in 2009. The biggest relative yield gain was obtained in the year 2009, the droughtest year.

In average on the studied period the yield in irrigated variant, the yield (88967 kg/ha) was bigger than the yield from unirrigated variant with 126,5% (table 7).

Table 7

The irrigation influence on yield in alfalfa 2nd year, Oradea 2007-2009

Variant	Yield		Difference		Statistically significant
	kg/ha	%	kg/ha	%	
2007					
Unirrigated	40100	100	-	-	Control
Irrigated	98300	142	58200	42	xxx
		LSD 5%	710		
		LSD 1%	1240		
		LSD 0.1%	1990		
2008					
Unirrigated	41300	100	-	-	Control
Irrigated	86100	208,4	44800	108,4	xxx
		LSD 5%	610		
		LSD 1%	990		
		LSD 0.1%	1470		
2009					
Unirrigated	35100	100	-	-	Control
Irrigated	79500	226,5	49400	126,5	xxx
		LSD 5%	820		
		LSD 1%	1310		
		LSD 0.1%	2200		
Average 2007-2009					
Unirrigated	38830	100	-	-	Control
Irrigated	87967	226,5	49137	126,5	xxx
		LSD 5%	713		
		LSD 1%	1180		
		LSD 0.1%	1887		

CONCLUSIONS

The researches carried aut during 2007-2009 on the preluvosoil from Agricultural Research and Development Station Oradea determined the following conclusions:

- Ten to ten determination of the soil moisture on the watering depth emphasized the presence of the pedological drought in 164 days in 2007, in 163 days in 2008 and in 165 days in 2009; the soil moisture decreased bellow wilting point 14 days in 2007, 30 days in 2008 and 58 days in 2009.
- Maintaining the soil water reserve between easily available water content and field capacity determined to use the irrigation: 4650 m^3/ha in 2007, 5300 m^3/ha in 2008 and 5400 m^3/ha in 2009.
- The irrigation determined the increase of the daily water consumption and, finally, total water consumption increased with 70% in 2007, with 92% in 2008 and with 114% in 2009. The irrigation was the mai source for water consumption covering all the year.
- The influence of the irrigation on yield was the yield gain very significant statistically every year: 42% in 2007, 108,4% in 2008 and 126,5% in 2009.
- The presence of the pedological drought and of the strong pedological drought every year and the yield gains very significant statistically are the arguments that the irrigation is a main method for drought control.

Acknowledgments

The researches were carried out in the project: PN-II-ID-PCE-2008; 1103/2009 ”Study of the relationships in the soil-water-plant-atmosphere system on the land affected succesivelly by excess and deficit of moisture from North Western Romania regarding the improve of the yield quantity and quality”.

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