PEDOLOGICAL DROUGHT INFLUENCE ON QUANTITY AND QUALITY OF THE SOYBEAN GRAINS, ORADEA 2009-2011

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Abstract

The paper is based on the researches carried out in the Agricultural and Development Research Station Oradea. Pedological drought was considered the decrease of the soil water reserve on 0-75 cm bellow easily available water content and strong pedological drought was considered the decrease of the soil water reserve bellow wilting point. Pedological drought was determined in 108 days in 2009, in 17 days in 2010 and in 110 days in 2011. Strong pedoloigical drought was determined in 2009 and 2011; maintaining the soil water reserve between easily available water content and field capacity was realized using an irrigation rates of 4300 m^3/ha in 2009, of 500 m^3/ha in 2010 and of 3200 m^3/ha in 2011. The irrigation determined the increase of the plants water consumption with 52% in 2009, with 12% in 2010 and with 87% in 2011. As consequence, the yield gains very significant statistically were obtained: 2280 kg/ha (543%) in 2009; 810 kg/ha (23%) in 2010 and 2170 kg/ha (275%) in 2011; in the years with more days with pedological drought, the values of the protein content of the soybean grains were smaller (30.2% in 2009; 32.4% in 2011) than the situation registered in the rainy year 2010 (38.5%). In every years, the irrigation determined the increase of the protein content of the soybean grains; the differences in comparison with unirrigated variant were very significant statistically (35% in 2009 and 27% in 2011) in the droughty years and distingue significant (9%) in the rainy year, 2010.

Key words: pedological drought, strong pedological drought, irrigation, water consumption, yield, protein

INTRODUCTION

The soybean crop is known over 7000 years due nourishing and agricultural value. Soybean is considered ”the gold plant” or ”the future plant” because this plant can settle the world deficit of the protein (Borza I., Stanciu A, 2010, Muntean L.S et al., 2008, Domu□a Cr.,2010 a, b, 2011, Şandor M. 2008 a,b).

Soybean water requirement are very high during the second part of the June-first part of the August.

Domuţa C. (1995, 2005) considered the pedological drought the decrease of the soil water reserve on the watering depth bellow easily available water content. The strong pedological drought is considered the decrease of the soil water reserve on the watering depth bellow wilting point; wilting point is considered a point from an interval and no a fixe point.

The researches carried out in the Crisurilor Plain (Domuța C, 1995, 2003, 2009 a,b, 2011,2012) emphasized the presence of the pedological drought and strong pedological drought in unirrigated soybean and their negative influence on plants water consumption, yield level, yield stability and water use efficiency.

This paper quantifies the period with pedological drought and strong pedological drought during 2009-2011 and theirs influence on water consumption, yield leve land water use efficiency. The influence of the pedological drought on protein content of the soybean grains is presented, too.

MATERIAL AND METHODS

The soil from research field is a preluvosoil. Research field was place dat Agricultural Research and Development Station Oradea in 1976 by Stepănescu E. in the network research of the research Institute for Irrigation and Drainage Băneasa Giurgiu. (Domuța C., 2009). After Domuța C. et al, 2012, the main properties of the luvosoil from the research field for study of the soil water balance are: humus content is of 2.1% in the Ap (0-20cm depth) horizon, pH of 6.3, phosphorus of 31.5 ppm and potassium of 190.2 ppm; the value of the bulk density is of 1.44 g/cm^3 and the total porosity is about 47%. Field capacity (24.3%) and wilting point (9.1%) have the median values. (Brejea R., 2010, Brejea R., Domuța C., 2011)

The irrigation water parameter are: pH = 7.2; Na^+ = 12.9%; mineral residue = 0.5 g/l; CSR = -1.7; SAR = 0.52. The chemical parameters of the irrigation water indicate a very good quality of the water used.

In the Crisurilor Plain conditions, the soybean watering depth is 0-75 cm. Ten to ten days the soil moisture was determined and the graphs of soil water reserve dynamic on watering depth (0-75 cm) permited to establish the days with pedological drought and strong pedological drought, respectivelly. The moment of the irrigation use was established when the soil water reserve on 0 – 75 cm depth decreased to easily available water content. Water consumption was determined using the soil water balance method.

The results research was processed by variance analysis method. (Domuța C., 2009).

RESULTS AND DISCUSSIONS

Pedological drought in unirrigated soybean

Ten to ten determination of the moisture emphasized the presence of the pedological drought in 108 days in 2009: 3 days in April, 31 days in May, 12 days in June, 31 days in July and August. In the rainy year 2010,

the pedological drought was registered in 17 days, only: 7 days in July and 10 days in August. In the year 2011, the biggest number with pedological drought were registered, 110 days: 6 days in April, 31 days in May and August, 30 days in June, 12 days in July. (table 1)

Table 1

Pedological drought in unirrigatd soybean, Oradea 2009-2011

Year	Days with WR<Wea					
	April	May	June	July	August	Total
2009	3	31	12	31	31	108
2010	-	-	-	7	10	17
2011	6	31	30	12	31	110

WR= water reserve; Wea= easily available water content

Strong pedological drought in unirrigated soybean

Soil water reserve on the watering depth decreased bellow wilting point a number of 26 days (3 days in June, 13 days in July and 10 days in August) in 2009 and a number of 18 days (1 day in June, 10 days in July and 7 days in August) in 2011. (table 2)

Table 2

Strong pedological drought in unirrigatd soybean, Oradea 2009-2011

Year	Days with WR<WP					
	April	May	June	July	August	Total
2009	0	0	3	13	10	26
2010	-	-	-	-	-	0
2011	-	-	1	10	7	18

WR= Water reserve; WP= Wilting point

Optimum water regime of irrigation

For maintaining the soil water reserve between easily available water content and field capacity an irrigation rates of 4300 m^3/ha was used in 2009 (400 m^3/ha in April; 900 m^3/ha in May; 500 m^3/ha in June; 1200 m^3/ha in June and 1300 m^3/ha in July) of 500 m^3/ha (in July) in 2010 and of 3200 m^3/ha (300 m^3/ha in April; 600 m^3/ha in May; 1200 m^3/ha in June; 600 m^3/ha in July and 500 m^3/ha in August) in 2011. (table 3)

Table 3

Optimum irrigation regime in soybean, Oradea 2009-2011

Year	April		May		June		July		August		September		Total	
	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n
2009	400	1	900	2	500	1	1200	3	1300	3	-	-	4300	10
2010	-	-	-	-	-	-	500	-	-	-	-	-	500	1
2011	300	1	600	2	1200	3	600	2	500	2	-	-	3200	10

Σm= Irrigation rate; n= number of rates

Irrigation influence of the soybean water consumption

In the year 2009, the irrigation determined the increase of the total water consumption with 52% (7105 m^3/ha vs 4684 m^3/ha) in the irrigated

variant in comparison with unirrigated variant. In the covering sources of the optimum water consumption the irrigation participated with 61%. The water quantity used from soil water reserve (2269 m^3/ha) in the unirrigated variant was bigger than the water quantity used from soil water reserve in the irrigated variant (385 m^3/ha); in the year 2010 the values were close (203 m^3/ha in the unirrigated variant and 293 m^3/ha in the irrigated variant) and in the year 2011 the water used from soil reserve in the unirrigated variant (790 m^3/ha) was bigger than the value registered in the irrigated variant (54 m^3/ha) with 1363% (table 4).

Table 4

Soybean total water consumption and the covering sources in unirrigated and irrigated conditions, Oradea 2009-2011

Year	Variant	Σ(e+t)		Ri-Rf		Pv		Σm	
		m^3/ha	%	m^3/ha	%	m^3/ha	%	m^3/ha	%
2009	Unirrigated	4684	100	2269	48	2415	52	-	-
	Irrigated	7105	152	385	5	2415	34	4300	61
2010	Unirrigated	4830	100	203	4	4627	96	-	-
	Irrigated	5420	112	293	5	4627	85	500	10
2011	Unirrigated	3385	100	790	23	2595	77	-	-
	Irrigated	6335	187	54	8	2595	41	3200	51

Σ(e+t) = Total water consumption; Ri= Initial water reserve (at seeding); Rf= Final water reserve (at harvesting); Pv= Rainfall during the vegetation period; Σm= Irrigation rate

Irrigation influence on soybean yield

The pedological drought registered in unirrigated conditions in 2009 determined to obtain a small soybean yield, 420 kg/ha only. The maintain the soil water reserve between easily available water content and field capacity on 0-75 cm determined a difference of 543%, very significant statistically. (table 5)

Table 5

Irrigation influence on soybean yield, Oradea 2009

Variant	Yield		Difference		Statistically significant
	Kg/ha	%	Kg/ha	%	
Unirrigated	420	100	-	-	Control
Irrigated	2700	643	2280	543	***

$LSD_{5\%}$= 240; $LSD_{1\%}$= 370; $LSD_{0.1\%}$=630

The year 2010 was favorable for soybean crop and the yield registered in the unirrigated variant was of 3570 kg/ha. The irrigation applied in July (500 m^3/ha) determined an yield gain of 810 kg/ha (23%) very significant statistically. (table 6)

Table 6

Irrigation influence on soybean yield, Oradea 2010

Variant	Yield		Difference		Statistically significant
	Kg/ha	%	Kg/ha	%	
Unirrigated	3570	-	-	-	Control
Irrigated	4380	123	810	23	***

$LSD_{5\%}$= 210; $LSD_{1\%}$= 390; $LSD_{0.1\%}$=640

In the year 2011, pedological drought was registered, too. In this conditions, the yield from unirrigated variant was of 790 kg/ha, only. The irrigation determined an yield gain of 2170 kg/ha (75%), very significant statistically. (table 7)

Table 7

Irrigation influence on soybean yield, Oradea 2011

Variant	Yield		Difference		Statistically significant
	Kg/ha	%	Kg/ha	%	
Unirrigated	790	100	-	-	Control
Irrigated	2960	375	2170	275	***

$LSD_{5\%}$= 240; $LSD_{1\%}$= 410; $LSD_{0.1\%}$=640

Irrigation influence on the protein content of the soybean gains

In the droughty year, the protein content of the soybean grains registered the smallest values, 30.2% in 2009 and 32.4% in 2011; in the rainy year 2010, the protein content of soybean grains were bigger, 38.5%. Irrigation determined the increase of the protein content of the soybean grains; the differences in comparison with unirrigateed variant were very significant statistically in 2009 (10.5%; 35%) and in 2011 (8.5%; 27%). In 2010 the difference was distingue significant statistically: 3.2% and 9% (table 8, 9 ,10).

Table 8

The influence of the irrigations on protein content of the soybean grains, Oradea 2009

Variant	Protein content		Difference		Statistically significant
	%	%	%	%	
Unirrigated	30.2	100	-	-	Control
Irrigated	40.7	135	10.5	35	***

$LSD_{5\%}$= 1.5; $LSD_{1\%}$= 2.8; $LSD_{0.1\%}$=5.9

Table 9

The influence of the irrigations on protein content of the soybean grains, Oradea 2010

Variant	Protein content		Difference		Statistically significant
	%	%	%	%	
Unirrigated	38.5	100	-	-	Control
Irrigated	41.7	109	3.2	9	***

$LSD_{5\%}$= 1.3; $LSD_{1\%}$= 2.4; $LSD_{0.1\%}$=4.6

Table 10

The influence of the irrigations on protein content of the soybean grains, Oradea 2011

Variant	Protein content		Difference		Statistically significant
	%	%	%	%	
Unirrigated	32.4	100	-	-	Control
Irrigated	40.9	127	8.5	27	***

$LSD_{5\%}$= 1.9; $LSD_{1\%}$= 3.2; $LSD_{0.1\%}$=6.8

CONCLUSIONS

The researches carried out during 2009-2011 in the research field for soil water balance study from Agricultural Research and Development Station Oradea determined the following conclusions:

- pedological drought was determined in 108 days in 2009, in 17 days in 2010 and in 110 days in 2011. Strong pedoloigical drought was determined in 2009 and 2011;
- to maintain the soil water reserve between easily available water content and field capacity was realized using an irrigation rates of 4300 m^3/ha in 2009, of 500 m^3/ha in 2010 and of 3200 m^3/ha in 2011;
- the irrigation determined the increase of the plants water consumption with 52% in 2009, with 12% in 2010 and with 87% in 2011. As consequence, the yield gains very significant statistically were obtained: 2280 kg/ha (543%) in 2009; 810 kg/ha (23%) in 2010 and 2170 kg/ha (275%) in 2011;
- in the years with more days with pedological drought, the values of the protein content of the soybean grains were smaller (30.2% in 2009; 32.4% in 2011) than the situation registered in the rainy year 2010 (38.5%). In every years, the irrigation determined the increase of the protein content of the soybean grains; the differences in comparison with unirrigated variant were very significant statistically (35% in 2009 and 27% in 2011) in the droughty years and distingue significant (9%) in the rainy year, 2010.

The results researches emphasized the presence of the pedological drought both in the droughty years and in the rainy year and the positive influence of the irrigation on water consumption, yield and protein content of the soybean grains. These are the arguments for irrigation in soybean in the moderate wet of the Crişurilor Plain.

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