PEDOLOGICAL DROUGHT IN DIFFERENT VARIANTS WITH WATER PROVISIONMENT AND THE INFLUENCE ON SOYBEAN YIELD IN THE CRISURILOR PLAIN CONDITION

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Abstract

Irrigation of soybean crop was studied since 1967 by Eftimie Stepanescu. The research was conducted in 2012 and 2013 at Agricultural Research and Development Station of Oradea in an experience set in 2000 on a preluvosoil. Decades determinations of soil moisture showed that in unirrigation conditions, the depth of 0-75 cm (watering depth of soybean), water reserve fell below the easily available water content in each year of the study period (53 days in 2012 and 50 days 2013), and hovering below the wilting point in 10 days in 2012 and eight days in 2013. Optimum irrigation determined increases of yield very significantly from irrigation each year: 492% in 2012 and 142% in 2013. Through the application of irrigation was realized the increasing of protein content in soybeans compared with unirrigated variant.

Key words: irrigation, soybean, yield, quality, protein

INTRODUCTION

Soybean is a plant with relatively high humidity requirements. Enciu V. (quoted by Bâlteanu Gh., 1979) considers that, compared with years when rainfall regime is optimal in drought conditions yield decrease with 31-61%.

Berbecel O. and Valuţă Gh. (1960) considers that drought during flowering period decreasing the yield with 14-52%, while the drought in the grain filling period is lower by 41-87%.

MATERIAL AND METHOD

The reaseraches were made in the experience set up by Domuţa C., in 2000 at Agricultural Research and Development Station from Oradea. The soil from research field is a luvosol (was brown luvic) with the following profile: Ap = 0-24 cm, El = 24-34 cm; BT_1 = 34-54 cm; Bt_2 = 54-78 cm; Bt / c = 78-95 cm, C = 95-145 cm. It is noted that migration of colloidal clay causes the apparition of horizon El with 31.6% colloidal clay and two horizons of colloidal clay accumulation with BT_1 and Bt_2 with 39.8% and 39.3% colloidal clay.

Luvosoil from the research field is characterized by a very high hydrostability of soil aggregates more than 0,25 mm, 47,5% of layer by 0-20

cm.

Bulk density - 1.41 g/cm3 - characterizes a poorly compacted soil at depth 0-20 cm; on other depths studied the apparent weight highlights a moderately and strongly compacted soil (Brejea R., 2010).

On watering depth (0-50 cm, 0-75 cm) and on 0-150 cm the soil is strongly compacted.

Field capacity had a middle value throughout the soil profile and wilting coefficient is also worth to middle depth of 80 cm and higher below this depth (Borza Ioana, 2011).

Active humidity interval (IUA) or useful water capacity had a high value in the depth 0-80 cm and the middle at depth 80-150 cm. On watering depth used on the research field the active humidity range had a great value (DomuțaC.,2009,2012).

Depending on soil easily available water content was set at 2/3 IUA.The soil in the research field has a slightly acid reaction throughout the depth studied, with increasing values from surface to depth.

Humus supply is poor, and the total nitrogen, low – medium on the entire depth researched. C / N ratio has a value higher on depth of 0-20 cm (8,01) and decreases with depth determination.

The soil is moderately submezobazic on the entire deep studied.

Experimental variants studied were:

V1 – Irrigated, without irrigation suspending, mainatining of soil water reserve between easily available water content and field capacity on depth by 0-75 cm; V2 – Irrigation suspending in May (vegetative growing of soybean crop); V3 – Irrigation suspending in June (vegetative growing – flowering at soybean crop); V4 – Irrigation suspending in July (flowering - fertilization); V5 – Irrigation suspending in August (fertilization – begining of seed maturation); V6 – Unirrigated

Source of water used for crops irrigation is a drilling 15 m deep

Laboratory tests effectuated in 2012 and 2013 showed a pH (7,3) which, fit the water into the category of water suitable for irrigation. After the anions content irrigation water is bicarbonato- sulphate type and after the cations content is type of calc-magnesia. The content of sodium is low, 12,9%. Fixed mineral residue (0,5 g / l) is less than the allowable limit of 0,8-1 g / l (Table 1).

Table 1

Average values of chemical indexes of irrigation water used in field research, Oradea 2012-2013

Ca^{2+}	Mg^{2+}	Na^{+}	K^{-}	CO^{2-}_3	HCO_3	CL^{-}	SO_4^{2-}
mg/liter							
49,1	44,0	20,8	2,7	-	266,8	35,4	80,3

pH	Na %	*Fixed mineral residue* g/l	SAR	CSR	Clasa N.Florea *N.Florea class*
mg/liter					
7,3	12,9	0,5	0,53	-1,8	II

After CSR index (-1,8) irrigation water has a low alkalizing potential (class C.1) may be employed without restriction. Alkalizing potential (0,53) is also low (class S1), water can be used without restriction to irrigate land.

Classification of waters, after Florea N., depending on the absolute content and relative salts of Na (class Florea N) shows that the irrigation water used in the research field within the group II, good water for irrigation (Table 1.).

Based on all these qualitative indices can say that water used for irrigation in field research shows no restrictions whatsoever to plants or soil.

RESULTS AND DISCUSSION

Pedological drought at soybean crop

Decreasing of water reserve on the watering depth below the easily available water content was considered period with pedological drought (Domuța C., 2004) given that Botzan M. (1966) defines the easily available water content as the extent to which soil moisture can fall without causing significant loss of yield, and that the irrigation technique the water supply is mentioned between easily available water content and field capacity.

Taking into account that under field conditions, soil moisture and can go down below the wilting point without plants to wither and die (as wilting point coefficient should not be understood as a fixed point but a point from an interval, Canarache A., 1990) decreased of water reserve in the wilting point coefficient was considered strong pedological drought. Number of days with pedological drought or strong pedological drought determined from graphs of dynamic of soil water reserve resulting from decadal determining of soil moisture

In condition of unirrigation, pedological drought was present in 53 days in 2012 and 50 days in 2013. In months without irrigation, soil moisture in the 0-75 cm depth decreased below the easily available water content (table 2).

In unirrigated crop the soil moisture on 0-75 cm depth although decreased below the wilting point in 10 days in 2012 and for eight days in

2013 (table 3).

Table 2.

Number of days with pedolgical drought in soybean, in different water assurance variants, Oradea 2012-2013

Variant	Month					IV-VIII
	IV	V	VI	VII	VIII	
2012						
1. Without irrigation suspending	-	-	-	-	-	0
2. Irrigation suspending in May (vegetative growing)	-	7	-	-	-	7
3. Irrigation suspending in June (vegetative growing - flowering)	-	-	-	-	-	0
4. Irrigation suspending in July (flowering - fertilization)	-	-	-	15	-	15
5.Irrigation suspending in August (fertilization – begining of seed maturation)	-	-	-	-	31	31
6.Unirrigated	-	7	-	15	31	53
2013						
1. Without irrigation suspending	-		-	-	-	-
2. Irrigation suspending in May (vegetative growing)	-	-	-	-	-	-
3. Irrigation suspending in June (vegetative growing - flowering)	-	-	6	-	-	6
4. Irrigation suspending in July (flowering - fertilization)	-	-	6	13	-	19
5.Irrigation suspending in August (fertilization – begining of seed maturation)	-	-	-	-	31	31
6.Unirrigated	-		6	13	31	50

Table 3.

Number of days with strong pedological drought registered in unirrigated soybean in the conditions from Oradea

Year	*Month*					Total IV-VIII
	IV	V	VI	VII	VIII	
2012	-	-	-	-	10	10
2013	-	-	-	6	2	8

Irrigation scheduling of soybean crop

Maintaining of water reserve between easily available water content and field capacity on 0-75 cm depth of soybean crop determined following irrigation regime: in 2012: irrigation rate was 2400 m^3 / ha and a total of seven watering. The highest value of monthly irrigation rate (1200 m^3 / ha) was recorded in August. In variants with irrigation suspending in different

months of the irrigation season, the values of irrigation rate decreased (table 4).In 2013, irrigation rate had a value about 2800 m^3 / ha. Number of irrigation rate was the same (7) but monthly distribution was different (table 5).

Table 4.

Water regime of soybean in different variants of water assurance in the conditions from Oradea, 2012

Varaiant of irrigation	April		May		June		July		August		Total	
	∑m	n	∑m	n	∑m	n	∑m	n	∑m	n	∑m	n
1. Without irrigation suspending	-	-	600	2	-	-	600	2	1200	3	2400	7
2. Irrigation suspending in May (vegetative growing)	-	-	-	-	-	-	600	2	1200	3	1800	5
3. Irrigation suspending in June (vegetative growing - flowering)	-	-	600	2	-	-	600	2	1200	3	2400	7
4. Irrigation suspending in July (flowering - fertilization)	-	-	600	2	-	-	-	-	1200	3	1800	5
5.Irrigation suspending in August (fertilization – begining of seed maturation)	-	-	600	2	-	-	600	2	-	-	1200	4

∑m= irrigation rate; n = watering number

Table 5.

Water regime of soybean in different variants of water assurance in the conditions from Oradea, 2013

Varaiant of irrigation	**April**		**May**		**June**		**July**		**August**		**Total**	
	∑m	**n**	**∑m**	**n**	**∑m**	**n**	**∑m**	**n**	**∑m**	**n**	**∑m**	**n**
1. Without irrigation suspending	-	-	-	-	400	1	1200	3	1200	3	2800	7
2. Irrigation suspending in May (vegetative growing)	-	-	-	-	-	-	1200	3	1200	3	2800	7
3. Irrigation suspending in June (vegetative growing - flowering)	-	-	-	-	400	1	1200	3	1200	3	2400	6
4. Irrigation suspending in July (flowering - fertilization)	-	-	-	-	400	1	-	-	1200	3	1600	4
5.Irrigation suspending in August (fertilization – begining of seed maturation)	-	-	-	-	400	1	1200	3	-	-	1600	4

∑m= irrigation rate; n = watering number

Influence of irrigation on yield level in soybean

In 2012, in variant without irrigation suspending irrigation in season months of the soybean crop irrigation obtained a yield of 3080 kg / ha. Irrigation suspending in May resulted in a loss of yield (610 kg / ha, 20%) statistically distinct significant. In June was not necessary irrigation and as a result yield was close to that obtained in the variant without irrigation suspending. Irrigation suspending in other months determined losses statistically significant: 44% by irrigation suspending in August and 34,0% by irrigation suspending in July. In unirrigated variant, soybean yield was only 520 kg / ha with 83% lower than yield obtained in the variant optimum water supplied using irrigation (table 6).

Table 6.

Suspending irrigation influence in different month of vegetation period on yield in soybean crop, in the conditions from Oradea 2012

Variant	Yield		Difference		Statistically significant
	Kg/ha	%	kg/ha	%	
1. Without irrigation suspending	3080	100	-	-	Mt
2. Irrigation suspending in May (vegetative growing)	2470	80	-610	-20	00
3. Irrigation suspending in June (vegetative growing - flowering)	3030	98	-50	-2	-
4. Irrigation suspending in July (flowering - fertilization)	2030	66	-1050	-34	000
5.Irrigation suspending in August (fertilization – begining of seed maturation)	173	56	-1350	-44	000
6. Unirrigated	520	17	-2560	-83	000

LSD5% = 170 LSD1% = 310 LSD 0,1% = 680

In 2013, in unirrigated condition (1390 kg / ha) and in variant without irrigation suspending (3370 kg / ha) was obtained the smallest and largest soybean yield. In May were not necessary irrigations and as a result yield was close to that obtained in the variant without irrigation suspending. Suspending irrigation in the others month from irrigation season determined yield losses very statistically assured compared with variant without irrigation suspension, the higher loss of yield (1590 kg / ha - 47%) was registered in the variant with irrigation suspending in August (table 7) .

Table 7.

Suspending irrigation influence in different month of vegetation period on yield in soybean crop, in the conditions from Oradea 2013

Variant	Yield		Difference		Statistically significant
	Kg/ha	%	kg/ha	%	
1. Without irrigation suspending	3370	100	-	-	Mt
2. Irrigation suspending in May (vegetative growing)	3350	99	-20	-1	-
3. Irrigation suspending in June (vegetative growing - flowering)	2890	86	-480	-14	000
4. Irrigation suspending in July (flowering - fertilization)	2310	69	-1060	-31	000
5.Irrigation suspending in August (fertilization – begining of seed maturation)	1780	53	-1590	-47	000
6. Unirrigated	1390	41	-1980	-59	000

LSD5% =210 LSD1% = 396 LSD 0,1% = 720

Irrigation influence on yield quality in soybean crop

In 2012, the protein content of soybean grains was 41, 2% in the variant with optimum irrigation regime.

Protein content of soybean grains decreased statistically unsignificant in variant with irrigation suspending in May and June; irrigation suspending in July and August determined losses of yield statistically assured; and in terms of unirrigated conditions was registered the biggest difference (25%) compared to variant without irrigation suspending (table 8).

In 2013, in unirrigated conditions and in variant without irrigation suspending was obtained the lowest (31,2%) and the higher value (41,1%) of protein content in soybean grains (41,2%).

In months that were required irrigations, irrigation suspending caused decreases of the protein content, the differences in comparison with the variant without irrigation suspending is statistically assured (table 9).

Table 8.

Suspending irrigation influence in different month of vegetation period on protein content of soybean crop, in the conditions from Oradea 2012

Variant	Protein		Difference		Statistically significant
	%	%	%	%	
1. Without irrigation suspending	41,2	100	-	-	Mt
2. Irrigation suspending in May (vegetative growing)	39,6	96	-1,6	-4	-
3. Irrigation suspending in June (vegetative growing - flowering)	41,0	99	-0,2	-1	000
4. Irrigation suspending in July (flowering - fertilization)	35,4	86	-5,8	-14	00
5.Irrigation suspending in August (fertilization – begining of seed maturation)	34,7	84	-6,5	-16	000
6. Unirrigated	30,7	75	-10,5	-25	000

LSD5% = 1,2 LSD1% = 3,4 LSD 0,1% = 5,7

Table 9.

Suspending irrigation influence in different month of vegetation period on protein content of soybean crop, in the conditions from Oradea 2013

Variant	Protein		Difference		Statistically significant
	%	**%**	**%**	**%**	
1. Without irrigation suspending	41,1	100	-	-	Mt
2. Irrigation suspending in May (vegetative growing)	41,0	99	-0,1	-1	-
3. Irrigation suspending in June (vegetative growing - flowering)	39,3	96	-1,8	-4	0
4. Irrigation suspending in July (flowering - fertilization)	34,6	84	-6,5	-16	000
5.Irrigation suspending in August (fertilization – begining of seed maturation)	32,0	78	9,1	-22	000
6. Unirrigated	31,2	76	7,6	-24	000

LSD5% = 1,3 LSD1% = 3,7 LSD 0,1% = 6,1

CONCLUSIONS

Researches were made between 2012-2013 at the Agricultural Research Development Station Oradea in experience set up in 2000 on luvosoil.The results led to the following conclusions:

- Decade's determinations of the soil moisture showed that in unirrigation conditions, on depth of 0-75 cm (depth of soybean watering), water reserve decreased below the easily available water content in each year of the period studied (53 days in 2012, 50 days in 2013), ranking below

the wilting point in 10 days in 2012 and in 8 days in 2013. Although in the variants with irrigation suspending pedological drought phenomena was registered in the months in which irrigation was needed and not irrigated.

- Correctly establishing of the irrigation moment and the optimum irrigation regime determined yield gain very significant statistically every year: 492% in 2012 and 142% in 2013. Through the irrigation suspending were obtained lower values of yield compared with variant without irrigation suspending. Differences towards variant without irrigation suspending were statistically significant.

- Through irrigation application determined the increasing of protein content in soybean grains compared with unirrigated variant. Irrigation suspending in different months determined the decreasing of the protein content, the differences being statistically assured.

Since pedological drought was present both in 2012 and in 2013, it must be optimal use of the soybean crop irrigation and yield gain towards to unirrigated variant are statistically assured and yield quality is improving. It is not recommended the suspending of irrigation of any of the months of the irrigation season in soybean crop because yield losses occur and the protein content is lower.

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