STUDY OF THE PARAMETERS OF THE SOIL-WATER-PLANT-ATMOSPHERE SYSTEM IN SOYBEAN CROP FROM CRISURILOR PLAIN

Jude Eugen*

*University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048 Oradea, Romania, e-mail: jdeugen@yahoo.com

Abstract

The paper is based on research conducted in 2012 and 2013 in Oradea Agricultural Research and Development Station on preluvosoil. Soil water reserve on 0-75 cm depth decreased below easily available water content minimum 81 days in 2012 and 108 days in 2013. The reserve water on depth of 0-75 cm soil decreased below the wilting point thus: 8 days in 2012 and 26 days in 2013. As a result of maintaining the water supply between the easily available water content and the field capacity of depth by 0-75 cm was irrigated with 2800 m^3 / ha in 2012 and 3300 m^3 / ha in 2013. Irrigation determined the increase of the total water consumption of soybean crop with 61% in 2012 and 52% in 2013. As a result we obtained higher yields, differences comparison with unirrigated, 2590 kg / ha (446% in 2012 and 2280 kg / ha (543%) in 2013 was statistic very significant. Water use efficiency (characterization indices of relations from soil-water-plant-atmosphere system) increased as a result of using irrigation with 231% in 2012 and by 337% 2013.

Key words: *soybean,water reserve, easily available water content, water efficiency, yield*

INTRODUCTION

Knowing each component of the system soil - water - plant - atmosphere and the interrelations between them enables specialists to optimize the adjustment of water factor, harmonizing it with the other factors of vegetation.

In the irrigation knowledge the relations from system soil - water - plant – atmosphere make conditions to increase water efficiency. The problem is particularly important in an increasingly competitive condition of the various economic sectors for limited freshwater resources. Also equipped areas for irrigation are growing in the twentieth century the area occupied with it doubled once every 33 years. Knowing these relationships could avoid apparition of salinisation and pollution and consequences for human health.

In the specialty literature this kind of indicators concerning on water use efficiency by plant of all quantity of consumed irrigation water or just the efficiency of water used. This indicators approaching the issue of water from two perspectives: one that brings first the elements of yield, highlighting the quantity of product in the consumption or using of 1 m^3 water (Craciun , Nagy , C. Domuta, etc.) and the second factor highlights

the factor - water, showing quantity of consumed water or used to obtain 1 kg of primary yield (Botzan., Grumeza, Domuta C., Tusa C. etc.).

MATERIAL AND METHOD

The research was conducted in 2012 and 2013 in the research field of soil water balance set by Stepănescu E. in 1976 at the Agricultural Research and Development Station Oradea (Foto 1). 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.

The watering depth (0-75 cm) was a fixed one (9) and field capacity (FC = 24.2% = 2782 m^3/ha) and wilting point (WP = 10.1 = 1158 m^3/ha) have median values. Easily available water content (Wea) was established in function of texture: Wea = WP + 2/3 (FC – WP).

A drill is the water source for irrigation and their quality for irrigation is very good: pH = 7,2; Na^+ = 12,9%; mineral residue = 0,5 g/l; CSR = -1,7; SAR = 0,52.

Soil moisture of 0 – 75 cm depth was determined ten to ten days. In the variant without irrigation suspending the moment of the irrigation use was when the soil water reserve on 0 – 75 cm depth decreased to easily available water content.

The results obtained were calculated using the method "analysis of variance".

Foto 1 The research field from Agricultural Research and Development Station Oradea (after Domuța Cr., 2010)

RESULTS AND DISCUSSION

Pedological drought at soybean crop

It is considered that exists pedological drought in soybean crop if the water reserve on irrigation depth (0,75 cm) decrease below easily available water content, and if it descends below the wilting point is considered that there is a period of strong pedological drought (Domuta C., 2009). Pedological drought in 2012 totaled a number of 81 days. In 2013 pedological drought was present since April, the total number of days with pedological drought from irrigation season of soybean totaling 108 days. (Table 1).

The water reserve on 0-75 cm depth is below the wilting point, 8 days in August 2012 and 26 days in 2013 (Table 2)

Table 1

Analysis of number od days with water reserve under easily available water content on depth 0-75 cm, at soybean crop in unirrigated conditions, Oradea 2012-2013

Year	Vegetation period -days-	Days with Wr < PM					
		IV	V	VI	VII	VIII	Total
2012	168	0	6	20	24	31	81
2013	170	3	31	12	31	31	108

Wr- water reserve; EAW- easily available water content

Table 2

Analysis of number od days with water reserve below wilting point on depth 0-75 cm, at soybean crop in unirrigated conditions, Oradea 2012-2013

Year	Vegetation period -days-	Days with Wr <WP					
		IV	V	VI	VII	VIII	Total
2012	168	0	0	0	0	8	8
2013	170	0	0	3	13	10	26

Wr- water reserve; WP – wilting point

Optimal supply with water of soybean crop

Bimonthly determination of soil moisture on 0-75 cm depth as required to maintain water reserve between easily available water content and field capacity to irrigate with 2800 m^3 / ha in 2012 (6 irrigations) and 3300 m^3 / ha in 2013 (8 irrigations) (Table 3)

Table 3

Water regime necesary for maintaining water reserve between easily available water content and field capacity on irrigation depht (0-75 cm) at soybean crop in the conditions from Oradea, 2012-2013

Year	V		VI		VII		VIII		V-VIII	
	∑m	n	∑m	n	∑m	n	∑m	n	∑m	N
2012	300	1	500	1	1000	2	1000	2	2800	6
2013	300	1	500	1	1200	3	1300	3	3300	8

Influence of irrigation on total water consumption of soybean crop.

Irrigation increased the values of total water consumption by 61% in 2012 and 50% in 2013. The soybean crop was irrigated consumed a smaller amount of soil water reserve (158 m3 / ha in 2012 vs.695 268 m3 / ha vs 1140 m3 / ha in 2013) (Table 4)

Table 4

Total water consumption of soybean crop in irrigated and unirrigated conditions and covering sources of consumption fromOradea 2012-2013

Variant	Total water consumption	Covering sources of consumption					
		Soil reserve		Rainfalls		Irrigation	
	m^3/ha	m^3/ha	%	m^3/ha	%	m^3/ha	%
2012							
Unirrigated	3715	100	695	36	3020	64	-	-
Irrigated	5978	161	158	3	3020	51	2400	46
2013							
Unirrigated	3685	100	1140	31	2540	69	-	-
Irrigated	5608	152	268	5	2540	45	2800	50

Influence of irrigation on yield at soybean crop in 2012

The year 2012 was not a favorable year for soybean crop, so that under irrigation conditions was registered a yield of 580 kg / ha. Using irrigation in the moment of water reserve decreasing on the irrigation depth below easily available water content determined the obtaining of yield gains of 2590 kg / ha (446%), highly significant statistically (Table 5).

Table 5

Influence of irrigation on yield at soybean crop in 2012

Variant	Yield		Difference		Semnif. statistică
	Kg/ha	%	Kg/ha	%	
Unirrigated	580	-	-	-	Mt
Irrigated	3170	546	2590	446	XXX

$LSD_{5\%}$ 280

$LSD_{1\%}$ 512

$LSD_{0,1\%}$ 760

Influence of irrigation on yield at soybean crop in 2013

Year 2013 was also a bad year for soybean crop, so in the unirrigation condition was registered a yield of 420 kg / ha. Using irrigation in the moment of water reserve decreasing on the irrigation depth below easily available water content determined the obtaining of yield gains of 2280 kg / ha (543%), highly significant statistically (Table 6).

Table 6

Influence of irrigation on yield at soybean crop in 2013

Variant	Yield		Difference		Statistically semnif.
	Kg/ha	%	Kg/ha	%	
Unirrigated	420	-	-	-	Mt
Irrigated	2700	643	2280	543	XXX

$LSD_{5\%}$ 240

$LSD_{1\%}$ 370

$LSD_{0,1\%}$ 630

The water use efficiency by soybean crop

Were used indicators like water used efficiency (WUE) and irrigation water used efficiency (IWUE) calculated by the following formulas:

$$WUE = \frac{Yield}{\Sigma (e + t)} ; (kg/m^3) ;$$

In which:

EVA = water used efficiency, kg/m^3

$\Sigma (e + t)$ = plants water consumption; m^3/ha

$$IWUE = \frac{Yield\ gain}{\Sigma m} (kg\ gain / m^3)$$

In which:

EVAI = irrigation water used efficiency, kg sp

Yield spore = Yield on irrigated crop – Yield on unirrigated crop

Σm = irrigation rate; m^3/ha

Irrigation determined the increase of efficiency of consumed water by 231% in 2012 (0,53 kg / m^3 vs. 0,16 kg / m^3) and 337% in 2013 (0,48 kg / m^3 vs. 0,11 kg / m^3) (Table 7).

Efficiency of irrigation water was lower in 2013 than year 2012 with 25% (Table 8).

Table 7

Influence of irrigation on water used efficiency (WUE) by soybean crop, Oradea 2012-2013

Variant	WUE		Difference	
	Kg/m^3	%	Kg/m^3	%
2012				
Unirrigated	0,15	100	-	-
Irrigated	0,53	331	0,37	231
2013				
Neirigat	0,11	-	-	-
Irigat	0,48	437	0,37	337

Table 8

Irrigation water used efficiency (IWUE) by soybean crop,
Oradea 2012-2013

Year	IWUE		Difference	
	Kg gain/m^3	%	Kg gain /m^3	%
2012	0,92	100	-	-
2013	0,69	75	-0,23	-25

CONCLUSIONS

Compared to the suitability of pedoclimatic conditions, economic and agronomic importance, soybean crop occupies small areas in Crisurilor Plain, one of the reasons being the drought which can even compromise the culture. The paper is based on research conducted in 2012 and 2013 in Oradea Agricultural Research and Development Station on preluvosoil and conclusions resulted are as follows:

❖ Soil water reserve on 0-75 cm depth decreased below easily available water content minimum 81 days in 2012 and 108 days in 2013. The reserve water on depth of 0-75 cm soil decreased below the wilting point thus: 8 days in 2012 and 26 days in 2013. As a result of maintaining the water supply between the easily available water content and the field capacity of depth by 0-75 cm was irrigated with 2800 m^3 / ha in 2012 and 3300 m^3 / ha in 2013.

❖ Irrigation determined the increase of the total water consumption of soybean crop with 61% in 2012 and 52% in 2013. As a result we obtained higher yields, differences comparison with unirrigated, 2590 kg / ha (446% in 2012 and 2280 kg / ha (543%) in 2013 was statistic very significant.

❖ Water use efficiency (characterization indices of relations from soil-water-plant-atmosphere system) increased as a result of using irrigation with 231% in 2012 and by 337% 2013.

The results obtained argue the necessity of irrigation at soybean crop from Crisurilor Plain, as it improves the parameters of soil- water -plant-atmosphere system.

ACKNOWLEDGEMENT

This paper has been financially supported within the project entitled ***"Horizon 2020 - Doctoral and Postdoctoral Studies: Promoting the National Interest through Excellence, Competitiveness and Responsibility in the Field of Romanian Fundamental and Applied Scientific Research",*** contract number POSDRU/159/1.5/S/140106. This project is co-financed by European Social Fund through Sectoral Operational Programme for Human Resources Development 2007-2013. **Investing in people!**

REFERENCES

1. Berindei I. O., Măhăra Gh., Pop Gr. P., Aurelia Posea, 1977, Câmpia Crişurilor, Crişul Repede, Ţara Beiuşului. Editura Ştiinţifică şi Enciclopedică, Bucureşti,
2. Borza Ioana Maria, Alina Ştefania Stanciu, 2010, Fitotehnie, Ed. Universităţii Oradea
3. Borza Ioana**,** Domuţa Cristian, Researches Regarding the Relationships Between Different Parameters of the Soil Water-Plant-Atmosphere System and Yield in Soybean from Crişurilor Plain, Natural resources and Sustainable Development, pg. 29-36 Oradea 2011
4. Botzan M., 1984, Apele în viaţa poporului român. Editura CERES, Bucureşti.
5. Brejea R., 2009, Practicum de pedologie. Editura Universitatii din Oradea
6. Brejea R., 2009, Tehnologii de protecţie sau refacere a solurilor. Editura Universităţii din Oradea
7. Canarache A., 1990, Fizica solurilor agricole, Editura CERES, Bucureşti.
8. Ciobanu Gh., 2003, Agrochimia. Ed. Universităţii din Oradea.
9. Ciobanu Gh., Domuţa C., 2003, Cercetări agricole în Crişana.Ed. Universităţii Oradea
10. Domuţa C., 2003, Oportunitatea irigaţiilor în Câmpia Crişurilor. Editura Universităţii din Oradea.
11. Domuţa C., 2005, Irigarea culturilor. Ed. Universităţii din Oradea.
12. Domuta Cornel coord., 2009, Irigatiile in Campia Crisurilor Editura Universitatii din Oradea
13. Domuţa C., M. Şandor coord., Cr. Domuţa, V. Şcheau, I. Borza, M. Cărbunar, V. Zoltan, N.C. Sabău, R. Brejea, M. Gîtea, A. Vuşcan, Cr. Oneţ, Relaţii în sistemul sol-apă –atmosferă în Câmpia Crişurilor, Ed. Univ. din Oradea 294 p, 2011
14. Domuta Cornel coord., 2012, 50 de ani de cercetări agricole în Oradea, Fascicula Culturi de Camp si Furajere Editura Universitatii din Oradea
15. Domuţa Cr., 2010, Cercetări privind influenţa irigaţiei asupra culturilor de porumb, soia şi sfeclă de zahăr în condiţiile Câmpiei Crişurilor, Teză de doctorat Universitatea de Ştiinţe Agricole şi Medicină Veterinară Cluj-Napoca.
16. Domuţa Cr.**,** C. Domuta, 2010, Materii prime vegetale,Editura Universităţii din Oradea
17. Domuţa Cr., 2011, Subasigurarea cu apă a porumbului, soiei şi sfeclei de zahar din Câmpia Crişurilor. Editura Universităţii din Oradea
18. Grumeza N. şi colab., 1989, Prognoza şi programarea aplicării udărilor în sistemele de irigaţii. Editura CERES, Bucureşti.
19. Guş P., şi colab., 1998, Agrotehnica. Ed. Risoprint, Cluj-Napoca.
20. Ionescu Şişeşti Vl., 1986, Irigarea culturilor. Editura CERES, Bucuresti
21. Luca E., Nagy Z., 1999, Irigarea culturilor, Editura Genesis Tipo Cluj-Napoca, pp. 188-195.
22. Muntean L.S. şi colab., 2011, Fitotehnie. Ed. Risoprint Cluj-Napoca

23. Neamțu T., 1996, Ecologie, eroziune şi agrotehnică antierozională. Ed. Ceres Bucureşti.
24. Nițu I., şi colab., 2000, Lucrările agropedoameliorative. Editura CERES, Bucureşti
25. Săulescu N.A., Săulescu I.D., 1967, Câmpul de experiență Editura. Agro-silvică, Bucureşti.
26. Şandor Maria, 2007, Combaterea excesului de umiditate în Câmpia Crişurilor. Editura Universității din Oradea
27. Timariu Gh., 1992 - Fondul funciar al României şi măsurile de inventariere, conservare, ameliorare şi folosire rațională. Ed. Tehnică agricolă.
28. Tuşa C. 1992, Cercetări privind consumul de apă al culturilor de soia în condițiile Câmpiei Burnasului, zona Băneasa-Giurgiu, Sesiunea ICITID 25-26 martie.