

## RESEARCH REGARDING THE INFLUENCE OF IRRIGATION ON WATER CONSUMPTION AND YIELD AT SOYBEAN CROP IN CONDITIONS FROM ORADEA AND IN DIFFERENT REGIONS OF ROMANIA

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### Abstract

*The researches were carried out in field of soil water balance from Agricultural Research and Development Station Oradea and in the other the same location from Romania. On irrigation depth of the soybean crop (Grumeza, 1989) has been taken to maintain the water reserve between easily available water content and field capacity. For this purpose soil samples were taken from 10 to 10 days, irrigation made it whenever the water reserve reached the minimum level. Monthly, the highest values of daily water consumption were registered at Podu Iloaiei (22 m<sup>3</sup>/ha/day) in April, Baneasa-Giurgiu in May (32 m<sup>3</sup>/ha/day) Marculesti in June (47 m<sup>3</sup>/ha/day), Baneasa-Giurgiu in July (64 m<sup>3</sup>/ha/day) Marculesti (47 m<sup>3</sup>/ha/day) in August and Marculesti and Baneasa-Giurgiu (28 m<sup>3</sup>/ha/day) in September. In descending order, the differences between yield of irrigated soybean and unirrigated were 167% at Valu lui Traian, 94% at Marculesti, 83% at Caracal, 80% in Braila, 67% in Baneasa-Giurgiu and 20% at Podu Iloaiei. In the conditions of irrigation in Oradea, the content of protein in grains of soybean crop was higher than protein content in the soybean grains obtained in condition of unirrigation.*

**Key words:** soybean, irrigation, easily available water content, yield

### INTRODUCTION

Soybean is a plant with relatively high requirements to moisture. Enciu (quoted by Borza, Stanciu 2010) believes that, compared with years when precipitation regime is optimal, in dry conditions yields decrease with 31-61%. Berbecel and Valuță, 1960 (quoted by Jude, 2012) believes that the drought during flowering determine decreasing of yield with 14-52%, while drought from grain filling period determined yield decreasing with 41-87%.

The Crisurilor Plain is situated in favorable area for soybean crop as it has fertile soils and in May-August period registered 250-340 mm rainfall, the number of tropical days (20) is low and the temperature during flowering and fructification (19-20°C) is favorable.(Muntean et al. 2008, 2011, Domuța, 2010, 2011)

### MATERIAL AND METHOD

The researches were carried out in field of soil water balance, long term trial designed by Grumeza to ICITID Baneasa-Giurgiu. Irrigation

regime was specific to each area (Grumeza et al., 1989, Grumeza, Kleps, 2005). In Oradea, in the north of Crisurilor Plain, in the period 1976-2014, the irrigation regimes of soybean crop in which water reserve that remained between easily available water content and field capacity on the 0-75 cm depth (Domuta C., 2000, Domuța – coord., 2012 ) was as follows:

| Value | Irrigation regime | No.of applications |
|-------|-------------------|--------------------|
| Minim | 500               | 1                  |
| Maxim | 4340              | 9                  |
| Media | 2235              | 5                  |

The average irrigation regime corresponds to the following scheme for the application of irrigation:

| V             | VI | VII             | VIII |
|---------------|----|-----------------|------|
| $\frac{1}{2}$ | 1  | $1 \frac{1}{2}$ | 2    |

On irrigation depth of the soybean crop (Grumeza et al., 1989) has been taken to maintain the water reserve between easily available water content and field capacity. For this purpose soil samples were taken from 10 to 10 days, irrigation made it whenever the water reserve reached the minimum level.

## RESULTS AND DISCUSSION

The results of research in the field of soil water balance placed on preluvosoil from Agricultural Research and Development Station Oradea are compared with results obtained from Podu Iloaiei (Northern Moldova), Braila and Mărculești (Baraganului Plain), Valu lui Traian and Caracal (Oltenia Plain).

### **The influence of irrigation on water consumption of soybean crop**

Monthly, the highest values of daily water consumption were registered at Podu Iloaiei (22 m<sup>3</sup>/ha/day) in April, Baneasa-Giurgiu in May (32 m<sup>3</sup>/ha/day) Marculesti in June (47 m<sup>3</sup>/ha/day), Baneasa-Giurgiu in July (64 m<sup>3</sup>/ha/day) Marculesti (47 m<sup>3</sup>/ha/day) in August and Marculesti and Baneasa-Giurgiu (28 m<sup>3</sup>/ha /day) in September (table 1).

*Table 1.*

Daily average of water consumption (m<sup>3</sup>/ha/day) at unirrigated and irrigated soybean crop in different areas of Romania

| Area              | Place           | Month |     |      |      |        |       |
|-------------------|-----------------|-------|-----|------|------|--------|-------|
|                   |                 | April | May | June | July | August | Sept. |
| Crisurilor Plain  | Oradea          | -     | 28  | 43   | 56   | 46     | 23    |
| Moldova de nord   | Podu Iloaiei    | 22    | 23  | 39   | 51   | 38     | 19    |
| Baraganului Plain | Braila          | 15    | 20  | 38   | 54   | 44     | 32    |
| Dobrogea          | Valu lui Traian | 15    | 22  | 34   | 53   | 44     | 23    |
| Baraganului Plain | Marculesti      | 14    | 26  | 47   | 59   | 47     | 28    |
| Burnasului Plain  | Băneasa Giurgiu | 19    | 32  | 45   | 64   | 43     | 28    |
| Olteniei Plain    | Caracal         | 16    | 24  | 41   | 60   | 36     | 25    |

As a result of irrigation used in terms of Oradea, the total water consumption of soybean crop has increased on average by 50.3%, variation interval 9-166%. In the conditions of maintaining the water supply between easily available water content and field capacity on the 0-75 cm depth using a medium irrigation ratio during 1976-2014 of 2235 m<sup>3</sup> / ha, representing 37.9% from total water consumption of soybean crop, over the years the weight of the total optimum consumption of water is between 7 and 64% (table 2).

*Table 2.*

Total water consumption of irrigated and unirrigated soybean crop and covering sources, Oradea 1976-2014

| Variant        | Source of covering of water consumption |                     |   |                    |                |                    |      |      |
|----------------|---|---------------------|---|--------------------|----------------|--------------------|------|------|
|                | m <sup>3</sup> /ha                      | Int. of variation % | Soil reserve (R <sub>i</sub> -R <sub>f</sub> ) m <sup>3</sup> /ha | P                  |                | Σm                 |      |      |
|                |   |                     |   | m <sup>3</sup> /ha | Int. of var. % | m <sup>3</sup> /ha | %    | %    |
| 1. Unirrigated | 3919                                    | 100                 | 836   | 3083               | 56-111         | -                  | -    | -    |
| 2. Irrigated   | 5893                                    | 109-266             | 573   | 3083               | 28-91          | 2235               | 38,3 | 7-64 |

Σ (e + t) = water consumption;

R<sub>i</sub>-R<sub>f</sub> = soil water reserve (initial reserve – final reserve)

P = precipitations in the growing season;

Σm = irrigation water

Between water consumption and soybean there is a direct connection of different forms depending on the climatic conditions of the area and within a zone mathematical expression of this link differs depending on whether dry or rainy season of a certain period (Tuşa, 1997). For the period 1987-2014, the correlation water consumption and yield in the conditions from Oradea is shown in Figure 1.

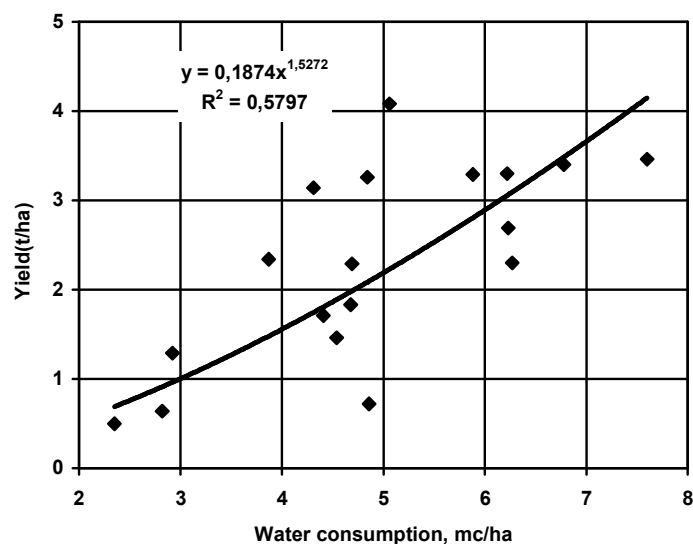


Fig. 1. Correlation between water consumption and yield at soybean crop, Oradea 1987-2014

### Influence of irrigation on soybean yield

The high requirements for moisture of soybean to cause a strong reaction to irrigation. The results of 33 years of research conducted in moderate sub-humid zone of Crisurilor Plain show that maintaining water reserve between easily available water content and field capacity on 0-75 cm depth were obtained an medium yield gain by 73% (1324 kg / ha), interval of variation of the relative differences registered over the years are between 7 to 360%. Besides a yield of 300 kg / ha registered in conditions without irrigation can say that this crop is calamity (Table 3).

Table 3.

Irrigation influence on level and stability of the yield at soybean crop, Oradea 1976-2014

| Irrigation influence on level and stability of the yield at soybean crop, Oradea 1976-2014 |         |     |                       |         |                    |      |
|--|---------|-----|-----------------------|---------|--------------------|------|
| Variant  | Yield   |     |                       |         | Standard deviation |      |
|  | Average |     | Interval of variation |         |                    |      |
|  | kg/ha   | %   | kg/ha                 | %       | kg/ha              | %    |
| Unirrigated  | 1806    | 100 | 300-3400              | 100     | 814                | 100  |
| Irrigated  | 3130    | 173 | 1380-4080             | 107-460 | 547                | 67,1 |
| LSD 5% 190; LSD 1% 310; LSD 0.1% 640;  |         |     |                       |         |                    |      |

LSD 5% 190; LSD 1% 310; LSD 0,1% 640;

In descending order, the differences between yield of irrigated soybean and unirrigated were 167% at Valu lui Traian, 94% at Marculesti, 83% at Caracal, 80% in Braila, 67% in Baneasa-Giurgiu and 20% at Podu Iloaiei (Table 4).

Table 4.

Influence of irrigation on soybean yield in different area from Romania

| Area              | Place           | Variant     | Yield |     | Differences |     |
|-------------------|-----------------|-------------|-------|-----|-------------|-----|
|                   |                 |             | Kg/ha | %   | Kg/ha       | %   |
| North of Moldova  | Podu Iloaiei    | Unirrigated | 2500  | 100 | -           | -   |
|                   |                 | Irrigated   | 3000  | 120 | 500         | 20  |
| Dobrogea          | Valu lui Traian | Unirrigated | 1200  | 100 | -           | -   |
|                   |                 | Irrigated   | 3200  | 267 | 2000        | 167 |
| Baraganului Plain | Braila          | Unirrigated | 1500  | 100 | -           | -   |
|                   |                 | Irrigated   | 2700  | 180 | 1200        | 80  |
| Baraganului Plain | Marculesti      | Unirrigated | 1700  | 100 | -           | -   |
|                   |                 | Irrigated   | 3300  | 194 | 1600        | 94  |
| Burnasului Plain  | Băneasa Giurgiu | Unirrigated | 2400  | 100 | -           | -   |
|                   |                 | Irrigated   | 4000  | 167 | 1600        | 67  |
| Olteniei Plain    | Caracal         | Unirrigated | 1800  | 100 | -           | -   |
|                   |                 | Irrigated   | 3300  | 183 | 1500        | 83  |

#### **Influence of irrigation on yield quality of soybean crop in the conditions from Oradea**

In 2012, in the conditions from Oradea protein content of soybeans grains it was 41.3% in the variant optimum irrigated. In the conditions without irrigation has resulted a difference of 10% compared to the variant optimum supplied with water.

In 2013, the content in protein of soybeans was lower than the previous year. In the variant without irrigation suspension was determined a protein content of 40.9%; and in conditions without irrigation protein content was 10% lower (39.3%) but the difference is not statistically significant; differences registered in variants suspending irrigation in June and July, the differences (3.5%; 4.8%) are distinct statistically significant, and the differences registered with suspending irrigation in August or unirrigated, differences compared with variant without irrigation suspension (9.0% and 10.0%) are highly statistically significant.

In 2014, in the variant without suspending irrigation and in unirrigated conditions were registered the higher and smallest values of the content in protein in the studied period (39.9% and 29.2%) (Table 5).

Table 5.

Influence of suspending irrigation in different month of vegetation period on protein content at soybean grains, in the conditions from Oradea, 2012-2014

| Variant           | Protein |      | Differences |       | Statistically<br>signification           |
|-------------------|---------|------|-------------|-------|--|
|                   | %       | %    | %           | %     |  |
| 2012              |         |      |             |       |  |
| Irrigated         | 41.3    | 100  | -           | -     | Ct                                       |
| Unirrigated       | 31.3    | 75,8 | -10,0       | -24,2 | 000                                      |
|                   |         |      |             |       | LSD 5% 1.4<br>LSD 1% 2.5<br>LSD 0,1% 5.6 |
| 2013              |         |      |             |       |  |
| Irrigated         | 40.9    | 100  | -           | -     | Ct                                       |
| Unirrigated       | 30.1    | 73,6 | -10,8       | -26,4 | 000                                      |
|                   |         |      |             |       | LSD 5% 1.7<br>LSD 1% 3.1<br>LSD 0.1% 6.4 |
| 2014              |         |      |             |       |  |
| Irrigated         | 39.9    | 100  | -           | -     | Ct                                       |
| Unirrigated       | 29.2    | 73   | -10,7       | -27   | 000                                      |
|                   |         |      |             |       | LSD 5% 1.3<br>LSD 1% 2.8<br>LSD 0,1% 5.6 |
| Average 2012-2014 |         |      |             |       |  |
| Irrigated         | 40.7    | -    | -           | -     | Ct                                       |
| Unirrigated       | 30.2    | 74   | -10,5       | -26   | 000                                      |
|                   |         |      |             |       | LSD 5% 1.5<br>LSD 1% 2.8<br>LSD 0,1% 5.9 |

## CONCLUSIONS

Research carried out in the fields of soil water balance located in different regions of Romania led to the following conclusions:

➤ Monthly, the highest values of daily water consumption were registered at Podu Iloaiei (22 m<sup>3</sup>/ha/day) in April, Baneasa-Giurgiu in May (32 m<sup>3</sup>/ha/day) Marculesti in June (47 m<sup>3</sup>/ha/day), Baneasa-Giurgiu in July (64 m<sup>3</sup>/ha/day) Marculesti (47 m<sup>3</sup>/ha/day) in August and Marculesti and Baneasa-Giurgiu (28 m<sup>3</sup>/ha /day) in September;

➤ A direct link, very significant statistically was quantified between soybean water consumption and yield obtained;

➤ The results of 33 years of research conducted in moderate sub-humid zone of Crisurilor Plain show that maintaining water reserve between easily available water content and field capacity on 0-75 cm depth were

obtained an medium yield gain by 73% (1324 kg/ha), interval of variation of the relative differences registered over the years are between 7 to 360%;

➤ In descending order, the differences between yield of irrigated soybean and unirrigated were 167% at Valu lui Traian, 94% at Marculesti, 83% at Caracal, 80% in Braila, 67% in Baneasa-Giurgiu and 20% at Podu Iloaiei;

➤ In the conditions of the irrigation use, the content of protein in soybean grains were higher than protein content in the soybean grains obtained in unirrigated conditions.

Results obtained in Oradea and in the other Romanian's region sustain the necessity of irrigation on soybean crop in areas studied.

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