The influence of the irrigation on sugar beet yield obtained in the conditions of NW Transylvania

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Abstract
The aim of this paper is to bring a significant contribution to optimize the sugar beet crop technology, regarding the influence of the irrigation regime on sugar beet yield and its economic efficiency in the conditions of the Transylvanian Plain.

The comparative analysis of the sugar beet yield registered during the experimental period 2006 - 2008, both in non-irrigated and irrigated conditions, indicated that, for a density of 100 000 plants ha⁻¹, the sugar beet productions reached the highest values in 2007, for the majority of the experimental variants analyzed. Also, the average production values were higher with 11.9% in irrigated conditions compared to the non-irrigated variants.

Key words: sugar beet, variety, crop technology, yield, economic efficiency.

Introduction
The experiences were carried out during a three years experiment, 2006-2008, in the experimental field located at the periphery of Turda Town, at approximately 30 km from the city of Cluj-Napoca.

Similar investigations were carried out on the experimental field of Irrigated Cultures of the temperate continental climate of Transylvania, by Mr. E. Luca, Professor PhD - USAMV Cluj-Napoca, who along the time made several research regarding the influence of water regime on plants. In his papers, together with his collaborators, he presented some of the results of 39 years of researches (1964-2002) regarding the water requirements of the principal field crops in Transylvania (wheat, maize, potato, soybean, sugar beet) and the influence on crops’ yields.

The analyzed perimeter is part of the Transylvanian Plain, in the inferior region of the hydrographical basin of Apuseni, where the natural conditions are very favourable for agriculture use: the land surfaces are extended and uniform, both soil and especially the existing plane relief, supporting a mechanized agriculture. Furthermore, the characteristic soil type is represented by the typical chernozem.

The research perimeter is located in a region with a rich hydrographical network, with predominant torrentially formations, belonging to the middle course of the hydrographical basin of Aries.

The general climate of the area were the experiences were carried out is characterized by the values of the elements registered at the meteorological station of Turda; the climate is characterized as a boreal one, with continental characteristics, precipitations falling all year long (a maximum at the beginning of summer), cold winters and summers enough warmly, allowing a normal growing of crops. During the experimental period, the climatic conditions allowed to perform the experiences in diverse conditions of temperature and precipitations, the three years experiment being very different.
Material and methods

Biologic material - In the three years experiment, one observed the behaviour of three sugar beet varieties, in different irrigation regimes, as follows:

**Variety ROSITA**: Country of origin - Sweden; registered/re - submitted in 2002; diploid variety, with Rz –Cr tolerance and high content of sugar; production characteristics: high genetic potential for roots and sugar productions;

**Variety GINA**: country of origin - Denmark; registered/re - submitted in 2000; diploid variety, NZ type; *Cercospora beticola* tolerance; production characteristics: high genetic potential for roots production;

**Variety BOGDANA**: country of origin - Sweden; registered/re – submitted in 1999; diploid variety, NZ type, with a very good resistance to roots’ and leafs’ diseases; resistant to *Cercospora beticola*; production characteristics: excellent genetic potential for roots and sugar productions.

Procedure - In irrigation conditions the set-up of the experiences allowed the possibility to distribute water as uniform as possible and a precise water measuring, to ensure a good isolation of variants in the experimental field, to cover enough land in order to increase the precision of the results and to reduce the execution costs.

The shape of the parcels was the rectangle one; the comparative cultures were set in a three-factorial system, with subdivided parcels, where, factor A was represented by the irrigation regime, factor B – density of plants and factor C – the variety.

For each comparative culture one ensured three repetitions; both densities and varieties of each repetition were randomized.

The research regarding the determination of sugar beet water consumption, in non-irrigated and irrigated conditions, as well as the yield obtained by the three sugar beet varieties, were carried out in a three-factorial experience.

The experimental factors taken in consideration are as follows:

- **Factor A – irrigation regime**: $a_1$ - non-irrigated; $a_2$ - irrigated at 50% of I.U.A.
- **Factor B – density plants ha$^{-1}$**: $b_1 = 80 000$; $b_2 = 100 000$; $b_3 = 120 000$.
- **Factor C – variety**: $c_1$ - Rosita; $c_2$ - Gina; $c_3$ - Bogdana.

The irrigation of the sugar beet crop was made during the second phase of plants vegetation, the phase of sugar beet rapid thickening of roots, during July and August, when the sugar beet water consumption is maximum, reaching values of 50-70 m$^3$ water ha$^{-1}$ per day. In this critical phase for humidity, the experiences were irrigated using a watering norm of 400 m$^3$ water ha$^{-1}$, applied twice, in order to ensure the water requirement and to avoid the process of wilting leaves.

The experiences included a number of three repetitions (n=3), the number of variants analyzed was 18 ($v= 2 \times 3 \times 3$) and the number of the experimental parcels 54 (N= 18 x 3).

The results of the determinations were calculated using statistical methods and the interpretations of the experimental values have the purpose to emphasize the interaction of the factors which were studied within the experiences.

Results and discussion

Within the experimental year 2006, the sugar beet yield was influenced by the water regime that one applied, by registering a very significant positive difference between the yields obtained in sugar beet irrigated experiences ($d = 7.16$ t ha$^{-1}$) and the non-irrigated ones, considered to be control plot, with 11.80% superior in relative terms, no matter the variety one used or the density of plants, which was applied (Table 1).

When analyzing the experimental factor irrigation regime, graduation $a_1$ – non-irrigated, the influence of the interaction of factors generated for all situations the highest
productions for a density of 100 000 plants ha$^{-1}$: 62.73 t ha$^{-1}$ for Rosita variety, 58.03 t ha$^{-1}$ for Gina variety and, respectively, 70.33 t ha$^{-1}$ for Bogdana variety, the highest yield. For the sugar beet irrigated variants, linking two factors of the three factorial experiment (2 x 3 x 3) implemented, respectively density of plants and variety, one noticed a similar situation – the highest yield was obtained for a density of 100 000 plants ha$^{-1}$ for all varieties, but from the point of view of the variety, Bogdana variety registered the best productivity – 78.70 t ha$^{-1}$.

### Table 1. The influence of the irrigation regime on the sugar beet production (Turda, 2006-2008)

<table>
<thead>
<tr>
<th>Variant</th>
<th>Average production (t ha$^{-1}$)</th>
<th>Relative production (%)</th>
<th>± d (t ha$^{-1}$)</th>
<th>Signification of the difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year 2006</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control plot (non-irrigated)</td>
<td>60.65</td>
<td>100.0</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
<td>Irrigated experience</td>
<td>67.81</td>
<td>111.8</td>
<td>7.16</td>
<td>***</td>
</tr>
<tr>
<td><strong>Year 2007</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control plot (non-irrigated)</td>
<td>63.30</td>
<td>100.0</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
<td>Irrigated experience</td>
<td>70.98</td>
<td>112.1</td>
<td>7.69</td>
<td>***</td>
</tr>
<tr>
<td><strong>Year 2008</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control plot (non-irrigated)</td>
<td>57.28</td>
<td>100.0</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
<td>Irrigated experience</td>
<td>63.48</td>
<td>110.8</td>
<td>6.20</td>
<td>**</td>
</tr>
</tbody>
</table>

2006 - DL$_{5\%}$ = 0.17; DL$_{1\%}$ = 0.39; DL$_{0.1\%}$ = 1.23; 2007 - DL$_{5\%}$ = 0.07; DL$_{1\%}$ = 0.16; DL$_{0.1\%}$ = 0.51; 2008 - DL$_{5\%}$ = 1.86; DL$_{1\%}$ = 4.30; DL$_{0.1\%}$ = 13.69

In 2007, the sugar beet yield was influenced by the water regime, one observing a very significant positive difference between the yields obtained in sugar beet irrigated experiences ($d = 7.69$ t ha$^{-1}$) compared to the non-irrigated one (the control plots), with 12.10 % superior in relative terms, whatever the variety or density of plants used. (Table 1). In 2007, in the conditions of the experimental factor A - irrigation regime, for all three repetitions, irrespective the sugar beet variety or density of plants, the obtained yield were superior for graduation $a_2$ – irrigation. The sugar beet yield, in 2008, was influenced by the water regime that one applied, by registering a distinct significant positive difference between the yields obtained in sugar beet control plots (non irrigated) and the irrigated experiences ($d = 6.20$ t ha$^{-1}$), with 10.80% superior in relative terms, whatever the sugar beet variety or density of plants (Table 1). In the conditions of the experimental factor A - irrigation regime, in 2008, for all three repetitions, irrespective the sugar beet variety or density of plants, the obtained yield were superior for graduation $a_2$ – irrigation.

**The economic efficiency of the sugar beet irrigation**

From point of view of the economic efficiency of the sugar beet irrigation, one must know that the estimation of the sugar beet economic efficiency for the two irrigation regimes, non-irrigated, respectively irrigated, was calculated using the main economic indicators, taking into account the market prices.

Concerning the sugar beet economic efficiency in irrigation conditions of the Rosita variety, one noticed that in 2006 the crop irrigation determined an increment of the profit
rate of 1.64 times (63.96%), compared to the profit obtained in non-irrigated conditions; in 2007 the profit rate increment was 3.13 time higher, and in 2008 both experience types registered loss, with the mention that loss was 49% lower in irrigated conditions.

From the point of view of the economic efficiency, the irrigations applied at Gina variety generated in 2006 a 1.44 time higher profit, compared to the non-irrigated conditions, while in 2007 it increased approximately 4 times and in 2008, also there were registered losses even for the irrigated variant, still they were 1.6 time lower.

The economic efficiency of the sugar beet irrigation for the Bogdana variety was noticeable: in 2006 the total profit was higher with 42% for the irrigated crops, while in 2007 the profit was significantly higher – appreciatively 72%, and in 2008, even there were some loss, the increase was of 1.43%.

Conclusions

The comparative analysis of the sugar beet productions registered during all experimental period, respectively the years 2006, 2007 and 2008, in non-irrigated conditions, indicated that the sugar beet productions reached the highest values in 2007, for the majority of the experimental variants analyzed.

Between 2006 and 2008, when sugar beet crops were not irrigated, the total and average production of sugar beet (t ha⁻¹), analyzed in the conditions of the experimental factor density of plants, was superior in 2007 for all densities applied.

The comparative analysis of the sugar beet productions obtained during all experimental period, respectively the years 2006, 2007 and 2008, in irrigation conditions proved that that sugar beet productions registered superior values in 2007, in the majority of the experimental variants analyzed, the average maximum production values being registered as follows: Rosita variety - 72.77 t ha⁻¹, Gina variety - 68.67 t ha⁻¹ and Bogdana variety - 79.83 t ha⁻¹, for a density of 100 000 plants ha⁻¹.

Along the three experimental years, 2006, 2007 and 2008, in the conditions of the experimental factor irrigation regime, graduation a₂ - irrigated, the sugar beet total and average production (t ha⁻¹) analyzed in the conditions of the experimental factor density of plants was superior in 2007.

During the three experimental years, the production increment registered as a result of the irrigations oscillated between 10.82% and 12.14%, depending on the specific conditions of each experimental year.

References