

# YIELD AND TECHNOLOGICAL QUALITY OF MODERN SUGAR BEET VARIETIES IN THE REPUBLIC OF SERBIA

Stevan Radivojević<sup>1\*</sup>, Dragica Kabić<sup>1</sup>, Vlada Filipović<sup>2</sup>, Goran Jaćimović<sup>3</sup>



UDC 633.41 (497.11) : 631. 559+543.645

<sup>1</sup>Institute for Food Technology, Novi Sad, Serbia

<sup>2</sup>Institut Tamiš, Pančevo

<sup>3</sup>Poljoprivredni fakultet, Novi Sad

**Abstract:** *The objective of the study was to determine the biological and technological characteristics of most commonly grown commercial sugar beet varieties in Serbia as well as some newly adopted varieties. Four small-scale field trials were set in 2008 which included 17 sugar beet varieties. The trials were set according to standard methods. Also, standard methods of analyses were applied in the sample testing and data processing. The trials were harvested in optimal term – second half of October.*

*The achieved mean root yield, averaged over four localities and 17 varieties was excellent at 98.13 t/ha and the highest yield (106,63 t/ha) was recorded for the variety Marcus. Moreover, the varieties yielded high average root sugar contents of 16.05%, among which the variety Esprit performed best yielding 16.75%. High root yields and root sugar contents contributed to producing excellent mean granulated sugar contents of 13.788 t/ha. The best performing variety in this parameter was Tibor with mean granulated sugar content of 15.717 t/ha.*

**Key words:** *sugar beet, yield, technological quality, variety*

## INTRODUCTION

Yield, as a major economic category, is a quantitative attribute of a complex type for most cultivated species, that is highly dependent on environmental factors and their interactions beside the influence of genotype (Čačić et al., 2005). A successful production of sugar beet under our environmental conditions is not possible without the use of varieties highly tolerant to rhizomania. In our country, rhizomania has been present since

1977. Larger infected areas were first recorded in Srem and Banat, later in Bačka. The main symptom of rhizomania is root bearding. Other symptoms like stunting, chlorosis of leaves, yellow veining and necrosis of leaf veins – often can be observed. Rhizomania is caused by Beet necrotic yellow vein virus that is transmitted by a soilborne parasitic fungus. Rhizomania occurs in almost all fields worldwide where sugar beet has been

\*Corresponding author:

e-mail: [stevan.radivojevic@fins.uns.ac.rs](mailto:stevan.radivojevic@fins.uns.ac.rs)

Tel: +381 21 485 3798; Fax: +381 21 450725

grown. According to data reported by Burcky (1995), rapid increase in areas infested with rhizomania has been recorded in France, too. Rhizomania increased from 5900 hectares in 1983 to 47700 hectares in 1993.

In our country, many field trial studies have recorded the presence of rhizomania in great extent. According to Jasnić et al. (1999), the infected areas increased from 1375 hectares in 1997 to 3790 hectares in 1998.

Beside rhizomania, areas cultivated with sugar beet are affected by another disease – fungus *Rhizoctonia solani*. Other diseases have been recorded, too.

## MATERIALS AND METHODS

In 2008, small-scale field trials which included 17 recognized varieties of sugar beet selected from the Strube-Dieckmann (Germany) collection were set at four localities in the Province of Vojvodina: Bavanište, Golubinci, Kuzmin and Temerin. The trials were planted in a randomized complete block experimental design with four replicates at each location.

The size of experimental plots was 30,0 m<sup>2</sup> (10 m x 3 m). The applied cultivation technology was similar to the usual technologies applied in field production. The crop was treated three times against *Cercospora beticola* with preparations usually applied in practice. The sugar beet was harvested in the second decade of October which is an optimal period for sugar beet. The size of basic plot used in harvest was 4.9 m<sup>2</sup>.

Chemical analyses were conducted in laboratories of the Institute for Food Technology in Novi Sad according to standard methods used in sugar industry in Serbia:

- The content of sugar in beet by the method of cold digestion,
- The content of alpha-amino nitrogen according to Stanek and Pavlas (1934/35),
- The contents of potassium and sodium by Atom Absorption Spectrophotometry (AAS).

The other quality parameters were derived by calculation using the following formulas:

- Sugar content in molasses (SM) (% on root) according to Reinelfeld et al. (1974):  

$$SM = 0.343 \times (K+Na) + 0.094 \times \alpha \text{ amino N} - 0.31$$
 where K, Na and  $\alpha$  amino N are given in mmol/100 g;
- Sugar utilization (SU) (% on root) according to Reinelfeld et al. (1974):  

$$SU = D - SM - 0.6$$
 where D is sugar content (%), SM is sugar content in molasses (%), 0.6 refers to total losses;
- Thick juice purity (Q) according to Wieninger and Kubadinov. (1974):  

$$Q = 99.36 - 0.1427 \times (K+Na+\alpha \text{ amino N})$$
 where K, Na and  $\alpha$  amino N are given in mmol/100 g;
- Polarized sugar yield (PSY) (t/ha):  

$$PSY = RY + D$$
 where RY is root yield (t/ha), D is sugar content (%);
- Granulated sugar yield (GSY) (t/ha):  

$$GSY = RY + SU$$

Two-way analysis of variance (ANOVA) was used for the analysis of data (Hadživuković, 1973).

## RESULTS

The mean root yield averaged over 4 localities and among 17 varieties was very high, 98.13 t/ha. The highest yielding variety was Marcus (106.63 t/ha), followed by Mauricio (105.58 t/ha), Tibor (105.26 t/ha), and the others. The lowest was Esprit (88.22 t/ha). The highest variability in the root yield among the investigated varieties was 18.41 t/ha or 17.27 %. Regarding the root sugar content, the first ranked variety was Esprit (16.75 %), followed by Tibor (16.73%), Merak (16.57 %), Victor (16.49%) and the others whereas the last ranked was Standard II (15.15 %). The extreme difference in this parameter recorded among the varieties was 1.60 % absolute or 9.55 % relative. Important parameter in the processing of sugar beet is sugar utilization which is expressed in percents on root. Mean

sugar utilization, averaged over localities and among varieties was high and amounted to 14.08%. The variety Esprit was the highest in this parameter (14.99 %) whereas Standard II was the lowest (12.75 %). Among the observed varieties, the maximal difference in this parameter was extreme, 2.24 % absolute or 14.94 % relative. The recently adopted variety Fabio demonstrated the highest thick juice purity (94.13) whereas Standard II showed the lowest purity (91.87). The maximal difference among the varieties was 2.26 that accounts for rather high value. The average thick juice purity was 93.30.

The sugar content in molasses, averaged over localities and among varieties, was low and amounted to 1.37 % on root. The variety Fabio had the lowest content of sugar in molasses (1.10 %) while Standard II was the highest with 1.79 % on root. Esprit was found to have the lowest potassium content (averaged over localities) - 17.68 mmol/100 °S whereas Standard I was the highest - 23.10 mmol/100 °S. The difference in the potassium content between the two varieties was high, 5.42 mmol/100 °S. The average potassium content was 19.73 mmol/100 °S. Low mean sodium content averaged over localities and among varieties, was recorded (6.42 mmol/100 °S). But, marked differences among the varieties were found in this parameter. The lowest sodium content of only 2.94 mmol/100 °S was found in the variety Fabio and the highest in Standard II which had 14.60 mmol/100 °S. Therefore, the extreme difference found was 11.66 mmol/100 °S which means that Fabio contained almost fivefold lower amount of sodium as compared to that of Standard II. For the average location mean, the variety Victor had the lowest alpha-amino nitrogen content of 14.79 mmol/100 °S whereas Kontrola I had the highest (18.46 mmol/100 °S). The maximal difference was 3.85 mmol/100 °S and the mean content was 16.33 mmol/100 °S. The highest yielding in the polarizing sugar was achieved by Tibor (17.589 t/ha) and the lowest by Standard II 14.030 t/ha. The maximal difference found was 3.559 t/ha or 20.23 %. The most important quality parameter in sugar beet processing is granulated

sugar yield. The varieties tended to yield high amounts of granulated sugar – mean yield averaged over localities and among varieties was 13.788 t/ha. The variety Tibor, showing the best performance in all observed parameters, produced an excellent yield of 15.717 t/ha. In contrast, the variety Standard II demonstrated the lowest yield of 11.809 t/ha. The maximal difference in granulated sugar yield among the varieties was high and amounted to 3.908 t/ha or 24.86 %.

## DISCUSSION

High differences found in the root yield for 17 investigated varieties coincide with the findings reported elsewhere (Webster et al. 1977). The maximal difference in the root sugar content of 9.55 % between the varieties reported here is similar to the findings of Märländer (1991). Similar differences in this parameter were also reported by Radivojević et al. (1997). Positive correlation coefficient was found between the sugar utilization and root sugar content and the extreme differences found among the varieties are in agreement with the findings of Radivojević et al. (1988). In addition, the results obtained for thick juice purity and sugar content in molasses are similar to those reported by Bruhns et al. (2004). The contents of non-sugar compounds (potassium, sodium, alpha-amino acid) were at similar level to values reported by Kenter et al. (2008).

The variability in the polarizing sugar content among the varieties was higher than values reported by Kovačev et al. (2008). The mean granulated sugar content was extremely high, 13.788 t/ha. The highest granulated sugar yield was produced by Tibor with a yield of 15.717 t/ha and the maximal difference in this parameter was 3.908 t/ha. This is in fine agreement with data reported by Koch (2008).

## CONCLUSION

The results obtained from four small-scale field trials conducted in 2008 which included 17 varieties of sugar beet showed that:

- High mean root yield was achieved (averaged over localities and among varieties), 98.13 t/ha, and the best performing variety was Markus with a yield of 106.63 t/ha. The maximal difference in this parameter was high and amounted to 18.41 t/ha or 17.27 %.
- For the overall average, the varieties tended to be high in the root sugar content achieving the mean content of 16.05 %. The maximal difference among the varieties was 1.60 % absolute or 9.55 % relative.
- The mean values for the other investigated quality parameters indicated that the sugar beet varieties were of excellent quality.
- The varieties showed excellent performance in the yielding of granulated sugar, producing an overall mean of 13.77 t/ha. The best performing variety was Tibor (15.717 t/ha) and the poorest was Standard II (11.809 t/ha).

The above given results revealed that modern varieties of sugar beet have excellent performance characteristics. It is evident that they are capable to yield high amounts of root and sugar in addition to performing excellent technological quality characteristics. In this regard, it is apparent that yielding and technological quality characteristics of sugar beet varieties grown in Serbia are at high level, comparable to the results that have been achieved in the developed countries of Western Europe like France and Germany.

**Table 1.**

Average quality traits of sugar beet varieties obtained on the small-scale field trials at Bavanište, Golubinci, Kuzmin, Temerin in 2008.

| No.        | Variety                | Root yield t/ha | Sugar content % | Sugar utilization % on beet | Thick juice purity | Sugar in molasses % on beet | K     | Na    | alpha-amino N | Polarizing sugar yield t/ha | Granulated sugar yield t/ha |
|------------|------------------------|-----------------|-----------------|-----------------------------|--------------------|-----------------------------|-------|-------|---------------|-----------------------------|-----------------------------|
| mmol/100°S |                        |                 |                 |                             |                    |                             |       |       |               |                             |                             |
| 1          | Remos                  | 92,25           | 16,38           | 14,49                       | 93,59              | 1,29                        | 19,98 | 3,89  | 16,58         | 15,087                      | 13,350                      |
| 2          | Esprit                 | 88,22           | 16,75           | 14,99                       | 94,11              | 1,17                        | 17,68 | 3,87  | 15,22         | 14,782                      | 13,233                      |
| 3          | Mauricio Rh            | 105,58          | 15,51           | 13,47                       | 92,88              | 1,44                        | 22,41 | 5,71  | 17,30         | 16,253                      | 14,140                      |
| 4          | Stand I                | 100,88          | 15,22           | 12,99                       | 92,16              | 1,63                        | 23,10 | 9,16  | 18,17         | 15,381                      | 13,130                      |
| 5          | Tibor                  | 105,26          | 16,73           | 14,94                       | 94,09              | 1,19                        | 18,12 | 3,93  | 14,86         | 17,589                      | 15,717                      |
| 6          | Victor                 | 103,38          | 16,49           | 14,72                       | 94,08              | 1,17                        | 18,12 | 4,08  | 14,79         | 17,014                      | 15,177                      |
| 7          | Libero                 | 98,67           | 15,94           | 14,04                       | 93,49              | 1,29                        | 18,71 | 6,26  | 16,19         | 15,645                      | 13,781                      |
| 8          | Kontrola I Rh          | 93,73           | 16,19           | 13,90                       | 92,28              | 1,69                        | 20,87 | 10,10 | 18,64         | 15,094                      | 12,959                      |
| 9          | Merak                  | 95,48           | 16,57           | 14,49                       | 93,13              | 1,48                        | 20,16 | 6,63  | 16,86         | 15,771                      | 13,821                      |
| 10         | Prestige Rh            | 102,92          | 16,11           | 14,12                       | 93,35              | 1,38                        | 18,29 | 7,86  | 15,99         | 16,508                      | 14,509                      |
| 11         | Markus                 | 106,63          | 16,33           | 14,37                       | 93,57              | 1,36                        | 19,59 | 6,01  | 14,96         | 17,351                      | 15,312                      |
| 12         | Stand II               | 93,08           | 15,15           | 12,75                       | 91,87              | 1,79                        | 21,31 | 14,60 | 16,59         | 14,030                      | 11,809                      |
| 13         | Elmo                   | 98,98           | 15,45           | 13,48                       | 93,02              | 1,37                        | 20,99 | 6,14  | 17,28         | 15,193                      | 13,247                      |
| 14         | Akku                   | 104,20          | 16,05           | 14,15                       | 93,63              | 1,30                        | 18,90 | 6,18  | 15,08         | 16,648                      | 14,717                      |
| 15         | Fabio                  | 95,02           | 16,19           | 14,49                       | 94,13              | 1,10                        | 18,19 | 2,94  | 15,55         | 15,375                      | 13,763                      |
| 16         | Kontrola II Santino Rh | 91,11           | 15,72           | 13,82                       | 93,45              | 1,30                        | 18,36 | 7,12  | 15,92         | 14,300                      | 12,590                      |
| 17         |                        | 92,84           | 16,10           | 14,15                       | 93,24              | 1,35                        | 20,64 | 4,62  | 17,60         | 14,927                      | 13,135                      |
| Average    |                        | 98,13           | 16,05           | 14,08                       | 93,30              | 1,37                        | 19,73 | 6,42  | 16,33         | 15,703                      | 13,788                      |
| LSD        | Variety                | 0,05            | 6,61            | 0,28                        | 0,31               | 0,23                        | 0,04  | 0,93  | 0,43          | 1,06                        | 0,94                        |
|            |                        | 0,01            | 8,73            | 0,37                        | 0,40               | 0,30                        | 0,06  | 1,22  | 0,56          | 1,41                        | 1,25                        |
|            | Locality               | 0,05            | 3,20            | 0,13                        | 0,15               | 0,11                        | 0,02  | 0,45  | 0,21          | 0,52                        | 0,46                        |
|            |                        | 0,01            | 4,23            | 0,18                        | 0,20               | 0,15                        | 0,03  | 0,59  | 0,27          | 0,68                        | 0,60                        |
|            | Variety x Locality     | 0,05            | 13,21           | 0,55                        | 0,61               | 0,46                        | 0,09  | 1,85  | 0,85          | 2,13                        | 1,89                        |
|            |                        | 0,01            | 17,46           | 0,73                        | 0,81               | 0,60                        | 0,12  | 2,45  | 1,13          | 2,81                        | 2,50                        |
|            | Cv (%)                 |                 | 8,30            | 2,10                        | 2,70               | 0,30                        | 4,10  | 5,80  | 8,20          | 8,40                        | 8,50                        |

## REFERENCES

1. Bruhns, M., Lemes, R., Schick jr R. (2004) Verarbeitungseigenschaften von Rhizoctonia-geschädigten Rüben. *Zuckerindustrie* 129, Nr 2, 105-111.
2. Burcky, K. (1995). Rhisomania: So stellen Sie Befall fest, Pflanzenproduktion, *Zuckerrubensbau*, 45-48.
3. Čačić, N., Kovačev, L., Mezei, S., Nagl, N., Rajić, M. (2005). Adaptabilnost i stabilnost NS sorti šećerne repe u različitim agroekološkim uslovima gajenja, *Zbornik radova, sveska 41*, 135-145, Novi Sad.
4. Jasnić, S., Kovačev, L., Čačić, N., Sklenar, P. (1999). Rasprostranjenost rizomanije šećerne repe u Vojvodini, *Zbornik radova, Naučni institut za ratarstvo i povrtarstvo, sveska 32*, 149-156, Novi Sad.
5. Kenter, C., Hoffmann, C. (2008). Einfluss von Trockenstress auf die Qualität und Lagerfähigkeit von Zuckerrüben. *Zuckerindustrie* 133, Nr-3, 155-160.
6. Koch, G. (2008). Genetisch - züchterische Grundlagen des Ertragspotenzials von Zuckerrüben. *Zuckerindustrie* 132, Nr 1, 43-49.
7. Kovačev, L., Čačić, N., Mezei, S., Stojaković, Ž. (2007). Produktivnost NS hibridnih sorti šećerne repe u dvogodišnjim multilokacijskim ogledima. *Zbornik radova, Instituta za ratarstvo i povrtarstvo*, 43,161-168, Novi Sad.
8. Märlander, B., (1991). Zuckerrüben, Optimierung von Anbauverfahren Züchtungsfortschritt, Sortenwahl, Stadthagen, Deutschland.
9. Radivojević, S., Obradović, S., Kabić, D. (1997). Rezultati sortnih mikroogleda sa zastupljenim sortama u proizvodnji šećerne repe u 1996. godini. *Hemijska industrija- Industrija šećera*, 3-4, 41-49 Beograd.
10. Radivojević, S., Obradović, S., Kabić, D., Karadžić, V. (1998). Tehnološki kvalitet, adaptibilnost i stabilnost različitih sorti šećerne repe. *Savremena poljoprivreda*, 46, 3-4, 61-66, Novi Sad.
11. Webster, R., Hodge, C., A., H., Draycott, A., P., Durrant, M., J. (1977). The effect of soil type and related factors on sugar-beet yield. *J. agric. Sci. Camb.* 88, 455-469.