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EFFECT OF GENOTYPE ON MORPHOLOGICAL AND QUALITY FEATURES OF SUGAR BEET

SUMMARY

The importance of sugar beet is great because it gives root yield of about 50 t ha⁻¹ and 30 - 40 t of fresh leaves and heads of beet that is used for feeding cattle. In the Republic of Serbia are favorable agro-ecological and soil conditions for the production of sugar beet. In the structure of total arable land of the Republic of Serbia, sugar beet accounts for about 2% where 94% of it is in Vojvodina, which has the most favorable climate and soil conditions, tradition and proximity of capacities for root production and processing. In addition to its adaptability to climatic conditions, sugar beet reacting quickly to changes in meteorological factors which greatly affect root yield and sugar content.

In the three-year trials it was examined morphological characteristics and the amount of α -amino N in five genotype of sugar beet. According to the survey results, the largest number of leaves at the genotypes at technological maturity had the genotype Otis (35.33) while the smallest had had genotype Severina (15.53). Genotype Otis, as a whole, had the highest leaf area (\bar{X} = 10193.13 and X_{max} = 11483.79), and the lowest had genotype Severina (\bar{X} = 4242.33; X_{min} = 3982.44). The lowest average value of the amount of α -amino N indicators were found for Chiara and Laetitia (\bar{X} = 2.23). The observed traits were largely depended on the genotypes and years. Genetic variation is necessary for successful breeding.

Keywords: sugar beet, genotype, morphological traits, α -amino N.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is dicotyls plant, belonging to the family Amaranthaceae. Although in the above genus are annual and biennial species, grown sugar beet is a biennial plant species. Genus *Beta*, is a member of the family Chenopodiaceae, which in the cultivated group comprises sugar beets

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(*Beta vulgaris saccharifera*), fodder beets (*Beta vulgaris crassa*), leaf beets (*Beta vulgaris cicla*) and garden beets (*Beta vulgaris rubra*) (Ninfale and Angelino, 2013, Trifunovic *et al.* 2015).

Sugar beet leaf is simple and consists of leaf area and stem. The first leaves are much smaller than those that appear later. The stalk is thickened and ribbed. The first pair of opposite leaves emerges for 10 - 12 days after germination. Every 2 - 3 days appear over a new leaf which emerges at an angle of 135 to the previous one. The rosette leaves are spirally arranged and rosette itself can make 50 - 60 leaves and more. Leaves from 10th to 25th have the highest leaf area. Life of leaf runs from 27 to 70 days or more depending on the order of appearance, variety and production conditions. During the growing season leaves gradually die off. The stem is straight, ribbed, branches and grows up to 2 m and from the armpit leaves formed lateral branches of the first order, from which form the branches of the second order, and so on. In the axils of leaves branches last row formed flowers (in the second year of vegetation). Pollination is by insects. The fruit is coalesced groundnut (Glamočlija, 1990, Filipović *et al.* 2007, 2009).

Compared with some major field crops in Serbia, sugar beet production in the past has been characterized by the cultivating of both domestic and foreign varieties (Nenadic *et al.* 2003). In the Republic of Serbia are favorable agro-ecological and soil conditions for the production of sugar beet. In the structure of total arable land, sugar beet accounts for about 2%. 94% of the area under sugar beet is in Vojvodina, for its favorable climate and soil conditions, tradition and proximity of root processing capacities.

The proposed percentage relationship of sugar beet types in total sowed surface creates the possibility that the sugar beet gradually collecting from the fields and processing according to the technological maturing. Bojović (2014) suggest that such a combination of types provides a good digestion from the beginning of treatment and, at the same time, successive sowing of winter crops after removing of sugar beet.

The aim of this study was to investigate the influence of variety on the productive and morphological characteristics of sugar beet in agro-ecological conditions of South Banat.

MATERIAL AND METHODS

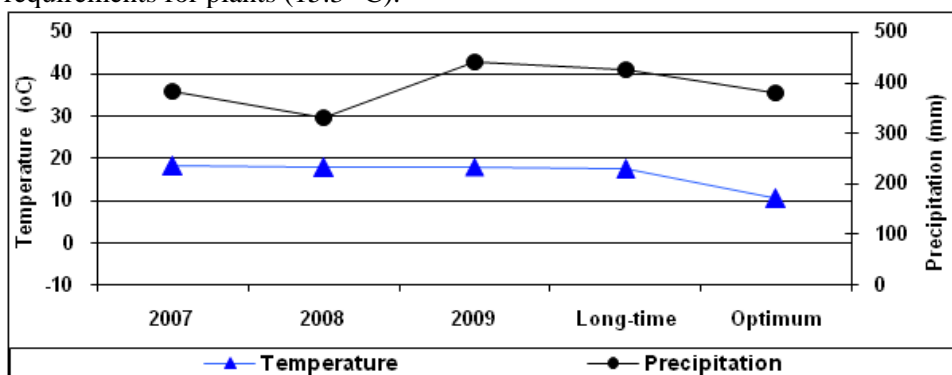
The study of the genotype influence on the morphological and technological characteristics of sugar beet was done in the period of 2007-2009. in agro-ecological conditions of South Banat at the experimental fields of the Institute Tamis PSS. Subjects of study were Otis, Chiara, Laetitia, Irina and Severina. Genotype Otis (producers Strube – Dickmann) is intended for removing the medium term. Genotypes Laetitia and Severina (producer KWS) recommended for removing medium terms. Genotype Chiara (producer KWS) is tolerant to drought conditions and is recommended for middle and later periods of extracting and NS genotype Irina (producer Institute of Field and Vegetable

Crops in Novi Sad) has well balanced root yield and sugar content and recommended for later removing from fields. The experiment was a randomized block system with four replications. Preceding crop, in all three year, was wheat. Land treatment was in two stages (August and October). Seedbed preparation and seed sowing were done at the end of March. Care and protection of crops were standard. Soil type on which are experiment derived is carbonate chernozem formed on loess terrace with high natural fertility. In texture it is loam (Bojović *et al.* 2014). Samples for determining the aboveground biomass were taken at the experimental plots. To determine the technological value of sugar beet root all the samples taken from the experimental plots were prepared for chemical analysis in the laboratory of sugar factories AD Unity in Kovacica. Laboratory analysis determined the content of "harmful" - α -amino nitrogen expressed in mmol / 1000S. The data were analyzed using the analytical statistical method STATISTICA 12 for Windows. The results are presented in tables and graphs.

Meteorological data.

In addition to the genotype and soil conditions, production technology and meteorological conditions have a great impact on the growth of plants (Djekic *et al.*, 2017; Đekić *et al.*, 2017; Živanović *et al.*, 2017; Terzić *et al.*, 2017; Ugrenović *et al.*, 2018; Maksimović *et al.* 2018, Stevanović *et al.* 2018). One of the most important agro-technical measures in the sugar beet production is sowing. Proper sowing ensures optimal crop density and high yield. In our country, sowing of sugar beet usually is in the second half of March. Thermal conditions can then be unfavorable and unstable so it needs knowledge of seed and seedling traits in relation to possible adverse conditions in the soil at sowing time, seed germination and seedling emergence (Bojović, 2014).

Based on data Hydro-meteorological Station Pančevo monthly mean air temperatures are ranged from 18.00 °C (in 2008) to 18.20 °C in 2007 (Bojović *et al.* 2014). Thermal conditions during the study were 0.5 °C higher than the perennial average (17.6 °C) and higher than the conditional-optimum requirements for plants (15.3 °C).



Graph. 1. Temperature, °C, and precipitation, mm, Pančevo, Serbia

Total monthly rainfall had the great variation by years. Smallest total precipitation was in 2008 (331 mm), then in 2007 (384mm) and the highest in 2009 (440 mm). Total precipitation average during the growing season in the study period were lower by 41 mm compared to the multi-year average (426 mm) and at the level of conditionally-optimum requirements for plants (380 mm). Total rainfall during the growing season in 2007 were at the level of conditionally-optimal needs of plants, while in 2008 they were lower by 49 mm, and in 2009 more by 60 mm compared to the level of conditionally-optimal needs of plants (380 mm) vegetation period (Graph.1).

RESULTS AND DISCUSSION

Number of leaves. According to the results, the highest average number of leaves in the technological maturity of the genotypes, had the genotype Otis (35.33), and the smallest had genotype Severina (15.53), Table 1.

Table 1. Descriptive statistics for the number of leaves of sugar beet genotypes

Genotype	X_{\min}	X_{\max}	\bar{X}	$S_{\bar{x}}$	S	Cv (%)
Otis	30.97	36.13	35.33	0.49	1.55	4.38
Chiara	27.00	27.70	27.29	0.06	0.19	0.72
Laetitia	16.77	18.50	17.47	0.17	0.55	3.13
Irina	22.77	23.37	23.05	0.06	0.20	0.88
Severina	14.70	16.17	15.53	0.13	0.40	2.58

The variation of the average values of the number of leaves of sugar beet genotypes are expressed by the coefficient of variation and standard deviation. Analysis of the data was observed low variability where the greatest variation was in the genotype Otis (CV = 4.38%) and the lowest in genotype Chiara (CV = 0.72%).

Leaf area. Variety Otis, as a whole, had the highest leaf area (\bar{X} = 10193.13 and X_{\max} = 11483.79), and the lowest genotype Severina (\bar{X} = 4242.33, X_{\min} = 3982.44).

Table 2. Descriptive statistics of the studied genotypes of leaf area

Genotype	X_{\min}	X_{\max}	\bar{X}	$S_{\bar{x}}$	S	Cv (%)
Otis	8471.68	11483.79	10193.13	237.89	752.26	7.38
Chiara	8135.79	9340.91	8579.29	127.94	404.59	4.72
Laetitia	5047.58	6376.05	5584.02	143.95	455.20	8.15
Irina	6056.21	6902.36	6410.64	75.50	238.75	3.72
Severina	3982.44	4426.29	4242.33	44.09	139.41	3.29

The coefficient of variation, as a measure of dispersion, with this indicator ranged 3.29% <Cv <8.15% which leads to the conclusion that it is a relatively low level of variation of this indicator within the genotype (Table 2).

The amount of α -amino nitrogen content. Smallest average value of α -amino N were at the genotypes Chiara and Laetitia ($\bar{X} = 2.23$). The largest amount of this indicator ($\bar{X} = 5.88$ and $X_{\max} = 6.50$) had a genotype Irina. For other genotypes values digestion almost halved (tab. 3).

The dispersion of the observed indicators of the highest in the genotype Chiara (Cv = 45.08%).

Table 3. Descriptive statistics for the amount of the α -amino N studied varieties

Variety	X_{\min}	X_{\max}	\bar{X}	$S_{\bar{x}}$	S	Cv (%)
Otis	2.71	3.58	3.19	0.10	0.31	9.70
Chiara	1.47	4.53	2.23	0.32	1.00	45.08
Laetitia	1.59	2.93	2.23	0.14	0.44	19.93
Irina	5.27	6.50	5.88	0.14	0.43	7.41
Severina	2.10	3.22	2.59	0.13	0.42	16.17

Correlation between the studied parameters of sugar beet.

Studied correlation indicators were expressed by Pearson's correlation coefficient. Among the indicators there is a weak dependence if $|0.00| < r < |0.50|$, medium dependence if $|0.50| < r < |0.75|$, dependence strong if $|0.75| < r < |0.90|$ and very strong dependence if $|0.90| < r < |0.99|$.

Correlation between the studied indicators individually for each genotype, are given in Table 4.

Based on the strength connections between the studied indicators, we can conclude that there was a correlation connection of all indicators, but of different intensities (tab. 4). Very strong positive correlation was between the number of leaves and leaf area ($r = 0.828$) and between the leaf surface and α amino N ($r = 0.628$) in average for all examined genotypes.

The observed traits largely depend on the genotypes. Genetic variation is necessary for successful breeding. In a breeding program it is therefore of utmost interest to quantify the variation among breeding lines and wild relatives of the crop (Ghasemi *et al.* 2014).

From sugar beet, beside the main products - sucrose, by various technological processes, from harvest residues obtained after processing we are getting a large number of different products. The heads and leaves that remain in the field, have great nutritional value as they contain 13% dry matter, of which

6.8% BEM, 2.4% of total protein, 2.4% of mineral salts and 0.9% cellulose 0.5 % of oil (Glamočlija, 1986). The yield and technological quality of roots were significantly associated with climatic conditions, soil (composition, structure and processing) and the most important agro agrotechnical measures, tillage, sowing, the correct choice of varieties, plant nutrition and crop protection. Size of root is in inverse proportion to the sugar content (Dobrovnaya *et al.*, 2009, Bojović, 2014).

The great importance of the sugar beet is show in data that the yield of 50 t ha⁻¹ of root gives 7 tons of sugar, 2.5 tons of dry noodles, 2 tons of molasses and 2.5 t saturation sludge. Further processing of molasses it can be obtained 650 liters of alcohol or more than 1250 kg of yeast. There is also a 30 - 40 t of fresh leaves and heads of beet for feeding cattle (Bojović *et al.* 2014).

Table 4. Correlation matrix parameters examined

Indicators	Number of leaves	The leaf area	The amount of α amino N
Correlation matrix for all examined genotypes			
Number of leaves	1	0.828**	0.189 ^{ns}
The leaf area	-	1	0.628*
The amount of α -amino N	-	-	1
Correlation matrix for genotype Otis			
Number of leaves	1	0.801**	-0.362 ^{ns}
The leaf area	-	1	0.001 ^{ns}
The amount of α - amino N	-	-	1
Correlation matrix for genotype Chiara			
Number of leaves	1	0.770**	-0.724*
The leaf area	-	1	0.629*
The amount of α - amino N	-	-	1
Correlation matrix for genotype Laetitia			
Number of leaves	1	0.990**	0.418 ^{ns}
The leaf area	-	1	0.405 ^{ns}
The amount of α - amino N	-	-	1
Correlation matrix for genotype Irina			
Number of leaves	1	0.485 ^{ns}	0.197 ^{ns}
The leaf area	-	1	0.133 ^{ns}
The amount of α - amino N	-	-	1
Correlation matrix for genotype Severina			
Number of leaves	1	0.361**	0.057 ^{ns}
The leaf area	-	1	0.219 ^{ns}
The amount of α - amino N	-	-	1
ns-without a significant correlation; * and **- significant correlation - p<0.05 i p<0.01;			

The quality of sugar beet is complex characteristic, caused by genetic differences between varieties and diverse environmental conditions in the area of cultivation (Rosso and Candolo, 2001). In all cultivated plants there is interaction between genotype (variety) and external environment (Čačić *et al.*, 1997, Pejić *et al.*, 2010, Kolarić *et al.* 2015).

Sugar beet, in addition to its adaptability to climatic conditions, reacts quickly to changes in meteorological factors which greatly affect root yield and sugar content. For a good yield it requires a mean temperature of 15.3 to 16.4 °C (Bojović *et al.* 2014). Klenter *et al.* (2006), in their experiments, found that the optimum for plant growth is at 18 °C. The high temperatures in July and August reduced the yield, but, at the end of season plant growth is not dependent on thermal conditions.

Surplus moisture in the air leads to a decrease in transpiration and productivity and, in the period of technological maturity, a negative impact on the accumulation of sugar. Great need sugar beet has in water, which provides over ¾ of its yield. For successful production, optimal amount of rainfall is 600 mm, although irrigation significantly increased the root yield (Bojović *et al.* 2014).

Drought is a major limiting factor in sugar beet yields in many areas. Varieties with increased tolerance to drought can partially mitigated the harmful consequences of drought. These varieties have certain genotypic and phenotypic characteristics. Genotypic characteristics is the root system with a larger absorption surface, more developed palisade tissue, thicker cuticle, fewer stomata, higher content of bound water, more osmotic active substances and the like. From phenotypic characteristics should be noted that these varieties have larger leaves shine, greater turgescence in petioles and leaflets, easily breakable leaves and susceptible to stretching. Particularly important is the rapid growth in the spring of these plants because if a drought occurs in the early stages of growth of root growth is slowing down, which can lead to yield losses of up to 46%, while in the later stages of the growth this loss is less significant. Proper protection of crops is very important for a good sugar beet yield. Proper protection is use of chemical preparates on seeds and young plants. In the area of South Banat (where experiments are performed) recorded the presence of 160 weed species (Nestorović, 2009). Suppression of herbicides is justified only if they achieve high yield (Ivanović *et al.* 1999). The most common diseases on sugar beet causing pathogens *Cercospora* and *Rhizomania* with which must be combated with chemical preparations. In the absence of chemical treatment of the foliage can be completely collapse, leading to a complete loss of yield. Attack of the parasites can reduce 1-2% of sugar content in the roots (Kuzevski *et al.* 2008, Bojović *et al.* 2014). Soil characteristics influence nutrient solubility, but also microbial activity and root growth (Knežević *et al.* 2009, 2014).

The proper selection of varieties for a particular production area contributes to greater and more stable production of cultivated plants. In order to cost-effective production and processing of sugar beet cultivation it is reasonable

to saw varieties in all three main directions of selection: Z (high content of sugar), N (normal) and E (high yield). The proposed manufacturing process for beet varieties share in the total sowed surface should be: 20% Z, 50% of N and 30% E type, but each manufacturer must be free to determine the basis of its own organizational and economic opportunities (Bojovic *et al.* 2014).

CONCLUSIONS

Based on the results obtained in this research can be done the following conclusions:

- The highest leaves number were formed at the genotype Otis, both individually and overall average, while the lowest leaves number have a genotype Severina. The variation in the number of formed leaves per nutrition variants was highest in genotype Laetitia and lowest at the genotype Otis.
- The largest leaf area, in total and individual average had genotype Otis and lowest values of this parameter had the genotype Severina. Variations in leaf area was the highest at genotype Leatitia and smallest in the genotype Severina.
- Indicator of root technological quality, amount of α -amino N, was the largest individually and in overall at the genotype Irina, while the lowest individual value had Chiara. The lowest average of amount of α -amino N had Chiara and Laetitia (2.33 mmol / 1000S). Difference between the largest and smallest average amount of α -amino N was highly significant (around 160%).
- Based on the strength of the connection between the studied indicators, we can conclude that there was a correlation connection of all indicators, but of different intensity. Very strong positive correlation was between the number of leaves and leaf area ($r = 0.828$) and between the leaf surface and α -amino N ($r = 0.628$) in average for all examined genotypes.

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