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EFFECT OF GENOTYPE ON SUGAR BEET YIELD AND QUALITY

N. Nenadić,[1] M. Nedić,[1] Lj. Živanović,[1] Lj. Kolarić,[1] and T. Gujaničić[2]

Abstract: The effect of a considerable number of both domestic and foreign sugar beet genotypes on root yield and quality was investigated. The data demonstrated the most favourable results of some genotypes for root yield and sugar content. Trials were conducted on rhizomania infested soil, thus tolerant genotypes were used. Susceptible cultivars represented the control.

In the trial root yield was high and sugar content low. On average, in the genotypes tested, root yield varied from 73.98 to 93.30 t/ha and sugar content from 11.90 to 13.36%, depending on weather conditions. Root yield of the genotypes investigated varied from 30.61 to 112.64 t/ha and sugar content from 10.60 to 14.20%. The Swedish cultivar Dorotea (tolerant to both rhizomania and cercospora) was the most yielding. The least yielding (susceptible to both rhizomania and cercospora) was the domestic cultivar Dana.

Key words: sugar beet, genotype, root yield, sugar content, biological sugar yield.

I n t r o d u c t i o n

Compared with some major field crops in our country, sugar beet production in the past has been characterized by the growth of both domestic and foreign cultivars. In addition, the variety of this industrial crop has undergone dynamic changes. New cultivars were easily accepted and older abandoned, and one of the reasons being that producers had insufficient information on the yielding properties of both.

[1] Nedeljko Nenadić, PhD., Professor Milan Nedić, PhD., Professor, Ljubiša Živanović, B.Sc., Assistant, Ljubiša Kolarić, B.Sc., Assistant, Faculty of Agriculture, 11081 Belgrade-Zemun, Nemanjina 6, Serbia and Montenegro

[2] Tihomir Gujaničić, M.Sc., Research Associate, Agricultural Institute "Tamiš", 26000 Pančevo, Serbia and Montenegro

There has been no research focused on the degree of adaptibility of the genotypes, except for the experiments conducted by the Business Association "Jugošećer". Therefore, the need has arisen to study the differences between the cultivars with regard to the effect of agroecological conditions on the cultivar (Karpenko, 1964; Stanaćev, 1979; Nenadić et al., 1991; Radivojević, 1995, etc.), mineral nutrition (Goodman, 1966; Nenadić et al., 1990; Škrbić, 1994), sowing date, plant density and root extraction date (Kovačević et al., 1978; Stanaćev et al., 1980; Sarić, 1985; Škrbić, 1994; Gujaničić, 1996). Investigations focused on the effect of rhizomania infested soil on the cultivar were of major interest (Rožić, 1984; Veselinović et al., 1987; Milovanović, 1989; Škrbić, 1994; Nenadić et al., 1998; Gujaničić, 1996; Nenadić et al., 2000). These investigations demonstrated a 50-80% lower root yield, 3.1-4.1% lower sugar content and 37-50% lower sugar yield. According to Milovanović, 1995 and Nenadić et al., 1997, rhizomania tolerant cultivars were not lower yielding.

Therefore, research focused on the properties of a cultivar are of major importance and can be justifiable.

Materials and Method

The effect of genotype on the yield and quality of sugar beet was studied on the experimental plots of DD Stari Tamiš, Pančevo, from 1998-2002 on the chernozem soil type. The plots were rhizomania infested. Due to the drought in 2000, the results achieved were very poor (most of the plants were dehydrated) and therefore these results are not shown in this paper. Field microexperiments were carried out at random, using four replications. The size of the main plot was 10.80 m^2 (6.0x1.8 m).

Of the numerous sugar beet genotypes (42-55) of both domestic and foreign origin, which were tested, the results for 8 domestic and 12 foreign are shown in the paper. Two domestic genotypes (Dana and Al omona) were more susceptible to rhizomania and all the other genotypes were tolerant to the pathogen.

Experiments were conducted on plots using modern and intensive growing technology. Therefore, average sugar beet root yield over the past years has been 65-75 t/ha. Winter wheat was a preceding crop. Conventional basic and presowing soil tillage was employed. Stubble field was tilled one month later and 45-50 t of manure per ha was used, whereby entire amounts of phosphorus and potassium and 2/3 of the entire amount of nitrogen were used. The remaining amount of nitrogen was used in spring during seedbed preparation. During study years the following average amounts of nutrients were used: N 113 kg/ha, P_2O_5 120 and K_2O 173 kg/ha.

Manual sowing was employed from 18 and 25 March, depending on the study year. Interrow distance was 45 cm and the distance between the plants in a row 27.8 cm. Thus, plant density amounted to 79,936 plants per hectare. Four to 5 seeds were used when planting in hill. Thinning was employed in order to obtain even distance between the plants in a row and appropriate plant population.

Sugar beet roots were extracted mid-October. Thus the length of the vegetation period was approx. 180-200 days. Sugar content was analyzed in the Sugar Factory "Jedinstvo", Kovačica.

Weather conditions during the investigations

The data on the mean monthly temperatures and rainfall amounts during the sugar beet vegetation period are shown in Table 1.

Tab. 1. - Mean monthly temperatures and rainfall amounts during the sugar beet vegetation period in Pančevo

Year	Months							Mean
	III	IV	V	VI	VII	VIII	IX	
	Temperatures, ^{0}C							
1998	4.3	14.2	17.6	23.4	23.2	24.3	17.6	17.8
1999	8.7	14.3	17.9	22.1	22.9	23.5	21.0	18.6
2001	11.8	12.5	18.8	19.4	24.2	24.9	17.6	18.4
2002	10.2	12.9	20.6	23.4	25.4	23.0	18.4	19.1
Mean	8.7	13.5	18.7	22.1	23.9	23.9	18.6	
1990-2000	6.6	12.8	18.1	21.9	23.0	23.8	18.7	
	Amount of precipitation, mm							Sum
1998	27.1	45.3	50.9	68.5	28.2	58.5	98.9	377.4
1999	14.1	102.8	60.1	14.,6	231.8	94.5	68.5	718.4
2001	68.7	137.5	79.0	160.8	51.3	69.4	198.6	765.3
2002	15.0	41.0	24.8	56.6	43.2	76.1	80.6	337.3
Mean	31.2	81.6	53.7	108.1	88.6	74.6	111.6	
1990-2000	32.6	61.5	48.0	74.5	81.9	61.4	54.9	

During the trial period both ambient temperatures and humidity favoured the development and growth of sugar beet plants. Mean monthly temperatures and rainfall amounts during the vegetation period were mostly higher compared with the average for the period 1990-2000. A comparison between the optimal temperatures and humidity during the sugar beet vegetation period over the study years in our country and those in Germany conducted by Roemer and Wohltman (Lüdecke, 1956) showed the results to be in our favour. These had also a positive effect on the amount of root yield.

Total rainfall amount during the sugar beet vegetation period in 1998 and 2002 was more than two-fold smaller compared with the other two study years.

However, high root yield was achieved because precipitation was evenly distributed.

Results and Discussion

The effect of genotype on the following major sugar beet properties: root yield, sugar content and biological sugar yield was investigated under the conditions of intensive production technology. The results obtained are given below.

Tab. 2. - Root yield of different sugar beet genotypes (t/ha)

Cultivar	Year				Average	Index
	1998	1999	2001	2002		
Rama 4	88.19	97.92	96.54	74.75	89.35	86.19
Rama 5	86.15	99.77	86.30	79.99	88.05	84.94
Rama 6	81.09	97.45	92.41	82.41	88.34	85.22
Dorotea	97.41	112.64	101.05	103.55	103.66	100.00
Ippolita	86.48	109.07	97.19	83.18	93.98	90.66
Gina	73.05	86.11	94.17	83.12	84.41	81.14
H 4671	68.76	97.22	83.35	68.08	79.35	76.54
H 6851	80.79	108.10	88.49	73.08	87.61	84.52
Sara	56.36	82.41	79.44	75.74	73.49	70.89
NS-H-8r	63.91	80.56	84.81	80.72	77.50	74.76
Dana	57.73	84.72	68.08	30.61	60.28	58.15
Al omona	59.27	81.71	69.15	35.77	61.47	59.30
NS-H-1r	62.57	77.59	83.33	-	-	-
Esprit	-	90.97	97.59	96.71	-	-
Al-H-841r	-	-	92.59	70.21	-	-
Al-H-961r	-	-	86.11	73.92	-	-
Al-H-962r	-	-	81.30	70.18	-	-
Georgina	-	-	98.01	89.20	-	-
Katja	-	-	90.56	80.22	-	-
Belinda	-	-	87.07	80.40	-	-
Average	73.98	93.30	87.38	75.36		
$LSD_{0,05}$	6.05	6.42	4.77	11.87		
$LSD_{0,01}$	8.11	8.61	6.34	15.92		

Root yield. - In a four-year trial using 20 sugar beet genotypes root yield was very high (Table 2) amounting to 82.50 t/ha. Even earlier investigations conducted at Stari Tamiš by Sarić (1985) and Nenadić et al. (1991). showed high root yields. During the period 1975-1989, on the sugar beet sowing area of 500-700 ha, average root yield amounted to over 65.0 t/ha. In 1989 using the cv. KW on an area of 114 ha sugar beet root yield amounted to 76.0 t/ha. Root and sugar yield of the cultivars grown so far (susceptible to rhizomania) declined rapidly with the incidence of rhizomania in the sugar beet growing regions. However, the introduction of new, tolerant cultivars raised the yield of roots to the

level preceding the incidence of the pathogen but not the content of sugar. It needs to be stressed that high root yield was achieved on rhizomania infested soil using tolerant cultivars (Milovanović, 1995; Nenadić et al., 2000).

During a four-year period, of the 18 tested cultivars tolerant to rhizomania, the highest and most stable root yield was achieved using the cv. Dorotea (103.66 t/ha). Root yield of the other tolerant genotypes was lower by 9.34 to 29.11%. The average root yield, when using domestic and foreign tolerant genotypes, amounted to 78.23 t/ha and 89.30 t/ha respectively. The average root yield of susceptible cultivars (Dana and Al omona), compared with the tolerant, was lower by 42.17%. This is in accordance with the results obtained by Rožić (1984), Veselinović et al. (1987), Milovanović (1989), Škrbić (1994), Gujaničić (1996), Nenadić (1998) etc.

During the study years the average sugar beet root yield varied from 73.98 to 93.30 t/ha and was primarily affected by the amount of precipitation. The difference in the amount of root yield of the sugar beet genotypes was significant and very significant.

Sugar content. - In our country the incidence of rhizomania has contributed to the significant decline of sugar content in the root of sugar beet both in trials and in

Tab. 3. - Sugar content in the root of sugar beet genotypes (%)

Cultivar	Year				Average
	1998	1999	2001	2002	
Rama 4	13.37	11.70	14.10	12.33	12.87
Rama 5	13.10	12.60	13.40	13.03	13.03
Rama 6	13.24	12.60	14.13	11.23	12.80
Dorotea	12.95	11.80	13.87	11.87	12.62
Ippolita	13.98	12.20	12.93	11.33	12.61
Gina	13.90	11.40	12.75	12.60	12.66
Esprit	-	12.00	13.65	12.37	-
H 4671	13.11	11.60	12.50	10.60	11.95
H 6851	13.33	11.30	13.65	12.70	12.74
Sara	13.62	11.30	13.30	12.17	12.60
NS-H-1r	13.84	11.80	12.70	-	-
NS-H-8r	13.57	11.10	12.20	12.33	12.30
Al-H-841r	-	-	13.20	11.33	-
Al-H-961r	-	-	13.53	12.13	-
Al-H-962r	-	-	12.80	12.53	-
Dana	13.22	12.60	11.10	11.77	12.17
Al omona	12.44	12.60	11.20	11.70	11.98
Georgina	-	-	12.40	12.73	-
Katja	-	-	12.85	12.63	-
Belinda	-	-	14.20	13.53	-
Average	13.36	11.90	13.02	12.15	
$LSD_{0,05}$	0.48	0.74	0.70	0.68	
$LSD_{0,01}$	0.65	0.99	0.93	0.91	

practice (Milovanović, 1989; Škrbić, 1994; Gujaničić, 1996; Nenadić et al. 1997).

Sugar content of the tested genotypes was not just low but varied significantly (Table 3). During a four-year trial the average sugar content of the genotypes tested amounted to 12.61% varying, however, from 11.90 to 13.36%. This is considered substantially lower from the accepted standard value (15.5%). The smallest average content (11.90%) was registered sowing genotypes in 1999 which was the most humid and the highest root yielding year. Therefore, there was a negative correlation between sugar content and root yield (Stanaćev, 1979; Nenadić et al., 1990). In 2002, which was characterized by small precipitation, sugar content was low (12.15%) because during the third part of the vegetation period (August-October), when sugar beet is known to accumulate sugar, there was a lot of rainfall which provoked retrovegetation and decline of sugar accumulation (Stanaćev, 1980). Sugar content varied less significantly between the tested genotypes with regard to the study years.

*Biological sugar yield***.** - Biological sugar content being the product of root yield and sugar percentage in roots is primarily affected by root yield. Genotypes with the highest root yield (Dorotea, Ippolita, Rama 4, Rama 5 and Rama 6, etc.) had the highest biological sugar content (Table 4). The smallest biological sugar content was registered with the least root yielding genotypes (Dana, Al omona).

Tab. 4. - Biological sugar yield of sugar beet genotypes (t/ha)

Cultivar	Year				Average	Index
	1998	1999	2001	2002		
Rama 4	11.79	11.43	13.61	9.22	11.51	88.20
Rama 5	11.28	12.57	11.56	10.42	11.46	87.82
Rama 6	10.73	12.28	13.05	9.25	11.33	86.82
Dorotea	12.61	13.29	14.01	12.29	13.05	100.00
Ippolita	12.09	13.31	12.57	9.42	11.85	90.80
Gina	10.15	9.82	12.01	10.47	10.61	81.30
H 4671	9.01	11.28	10.42	7.22	9.48	72.64
H 6851	10.77	12.21	12.08	9.28	11.08	84.90
Sara	7.68	9.31	10.56	9.22	9.19	70.42
NS-H-8r	8.67	8.94	10.35	9.95	9.48	72.64
Dana	7.63	10.67	7.56	3.60	7.36	56.40
Al omona	7.37	10.29	7.74	4.18	7.39	56.63
NS-H-1r	8.66	9.15	10.58	-	-	-
Esprit	-	10.92	13.32	11.96	-	-
Al-H-841r	-	-	12.22	7.95	-	-
Al-H-961r	-	-	10.79	8.97	-	-
Al-H-962r	-	-	10.40	8.79	-	-
Georgina	-	-	12.15	11.35	-	-
Katja	-	-	11.64	10.13	-	-
Belinda	-	-	12.36	10.87	-	
Average	9.88	11.10	11.45	9.19		

The least average biological sugar yield (9.88 t/ha) was registered in 1998 because the average root yield of the investigated sugar beet genotypes was low (73.98 t/ha), although sugar content in roots was the highest (13.36%).

Conclusion

Based on the results obtained in the study focused on the yielding properties and quality of a number of sugar beet genotypes grown under the conditions of southern parts of Banat, the following conclusions can be drawn:

- According to the study years, root yield, sugar content in the root and biological sugar yield were found to be significantly affected by weather conditions, especially humidity;
- On average and according to genotypes, due to the substantially greater rainfall amounts in 1999 and 2001, root yield and biological sugar content were significantly higher compared with 1998 and 2002. There was a negative correlation between sugar content and root yield;
- Root yield, sugar content in root and biological sugar content ranged from 73.98 to 93.30 t/ha, 11.90-13.36 and 9.19-11.45 t/ha respectively;
- Rhizomania tolerant genotypes (primarily Dorotea, Ippolita, Rama 4, Rama 5 and Rama 6) yielded over 42% greater root amounts compared with the susceptible genotypes (Dana, Al omona). However, sugar content in the roots of these genotypes grown on rhizomania infested soil was not raised. Biological sugar yield was directly affected by root yield per unit area.
- Dorotea, Ippolita, Rama 4, Rama 5, Rama 6, H-6851, Gina and NS-H-8r were shown to be the highest yielding genotypes in the study.

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UTICAJ GENOTIPA NA PRINOS I KVALITET ŠEĆERNE REPE

N.Nenadić,[1] M.Nedić,[1] Lj. Živanović,[1] Lj. Kolarić[1] i T. Gujaničić[2]

R e z i m e

U radu je proučavan uticaj velikog broja domaćih i inostranih genotipova šećerne repe na prinos i tehnološki kvalitet korena. Ogledi su izvedeni na DD Stari Tamiš u Pančevu, u periodu 1998-2002. godine, na zemljištu tipa černozem, zaraženom rizomanijom.

[1] Dr Nedeljko Nenadić, profesor, dr Milan Nedić, profesor, Ljubiša Živanović, dipl.ing., asistent i Ljubiša Kolarić, dipl.ing., asistent, Poljoprivredni fakultet, 11081 Beograd-Zemun, Nemanjina 6, Srbija i Crna Gora

[2] Mr Tihomir Gujaničić, istraživač saradnik, Institut "Tamiš", 26000 Pančevo, Srbija i Crna Gora

Od velikog broja testiranih genotipova (42-55), u radu su prikazani rezultati za 8 domaćih i 12 inostranih. Među ovim genotipovima dve domaće sorte (Dana i Al omona) su osetljive na rizomaniju, a sve ostale su tolerantne prema pomenutom patogenu.

U istraživanjima su postignuti sledeći važniji rezultati:

Prosečno variranje prinosa korena proučavanih genotipova kretalo se u granicama od 73,98 do 93,30 t/ha, sadržaj šećera u korenu od 11,90 do 13,36% i prinosa biološkog šećera od 9,19 do 11,45 t/ha.

Genotipovi tolerantni na rizomaniju dali su u proseku za preko 42% veći prinos korena od osetljivih genotipova.

Prinos biološkog šećera je pokazao direktnu zavisnost od prinosa korena po jedinici površine.

Kao najproduktivniji genotipovi u ovim istraživanjima pokazali su se: Dorotea, Ippolita, Rama 4, Rama 5, Rama 6, H-6851, Gina i NS-H-8r.

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