IMPORTANCE OF INCREASING AMOUNTS OF NPK NUTRIENTS ON SUGAR BEET YIELD

ZNAČAJ RASTUĆIH KOLIČINA NPK HRANIVA U FORMIRANJU PRINOSA ŠEĆERNE REPE

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Abstract: *The root yield, quality and sugar yield were studied in a long-term stationary trial at Rimski Šančevi (Novi Sad, Serbia) experimental station. Sugar beet was grow in a four course rotation (sugar beet, maize, sunflower and wheat). In this trial increasing amounts of NPK nutrients were investigated. The trial included 20 fertilizing variants with 50, 100 and 150 kgha^{-1} active matter of each element (N, P_2O_5 and K_2O).*

At control variant (unfertilized) in a four-year average was obtained the root yield of 44,3 tha^{-1}. With increasing amount of nitrogen to 50 kgha^{-1}, the root yield was increased at 62,9 tha^{-1} while digestion was decreased for 0,26%. As a result, sugar yield was increased for 2,15 tha^{-1}. With increasing nitrogen amount to 100 and 150 kgha^{-1} root yield was higher for 5,09 and 5,92 tha^{-1}, respectively. At the same time produced digestion was lower for 0,64% and 1,62%, while refined sugar yield was the same and lower for 0,51 tha^{-1}, respectively. By increasing amounts of phosphorus from 50 to 100 and 150 kgha^{-1} root yield was increased for 0,1 and 4,85 tha^{-1}, and sugar yield for 0 and 100 kgha^{-1}, respectively. Increased doses of potassium were produced that root yield was higher for 0,98 and 2,77 tha^{-1}, while the sugar yield for 200 and 120 kgha^{-1}, respectively.

Izvod: *Prinos i kvalitet korena te prinos šećera praćeni su na višegodišnjem stacionarnom ogledu na Rimskim Šančevima. Šećerna repa se gaji u četvoropoljnom plodoredu (šećerna repa, kukuruz, suncokret i pšenica). U ogledu se ispituju rastuće količine NPK hraniva. U ogledu je 20 različitih varijanti đubrenja sa po 50, 100 i 150 kgha^{-1} aktivne materije svakog hranjivog elementa. Prinos korena u četvorogodišnjem proseku na varijanti bez đubrenja bio je 44,3 tha^{-1}. Sa povećanjem količine azota na 50 kgha^{-1} prinos korena povećao se na 62,9 tha^{-1}, sadržaj šećera smanjio za 0,26%, a prinos šećera povećao za 2,15 tha^{-1}. Povećanjem količine azota na 100 i 150 kgha^{-1} prinos korena bio je veći za 5,09 i za 5,92 tha^{-1}. Istovremeno sadržaj šećera bio je manji za 0,64% i za 1,62%, a prinos kristalnog šećera bio je manji za 0 i za 0,51 tha^{-1}. Povećanjem količine fosfora sa 50 na 100 i 150 kgha^{-1} prinos korena se povećao za 0,1 i za 4,85 tha^{-1}, a prinos šećera povećao za 0 i 100 kgha^{-1}. Istovremeno sa povećanjem količine kalijuma prinos korena se povećao za 0,98 i za 2,77 tha^{-1}, a prinos šećera za 200 i 120 kgha^{-1}.*

Key words**:** *sugar beet, root yield, digestion, nitrogen, phosphorus, and potassium*
Ključne reči**:** *šećerna repa, đubrenje, prinos, kvalitet*

INTRODUCTION

In agriculture plant production is a part, which is identically important according as livestock production. These two terms of agricultural production together contribute to securely and costly human existence on our planet. There is no less or many important species in crop farming. However, there is plant species, which better use solar kinetic energy in compare to other.

Beyond all question, sugar beet is a crop that great amount of sunny energy turn into energy of organic matter. Thousand kilogram of sugar from sugar beet have energetic value of 17 165,9 KJ. By-product (sugar beet tops and leaves, cuttings and molasses) by root yield of 10t have energetic value like 102,6 kg of maize grain in a meat production. In order that sugar beet is able to transform a big sunny energy in organic matter, they must to have optimally growing conditions. Because of that - sugar beet often called „Queen of fields".

The goal of this paper work is that, basically on results from long-term stationary trial, indicate on optimally fertilizing level with NPK nutrients.

MATERIALS AND METHOD

In a long-term trial which was established in 1964 year, on calcareous chernozem soil type, we are investigated influence of different doses of NPK nutrients on sugar beet root yield and quality. The trial was carried out as a randomized block design, in which sugar beet was growing in a four-course rotation (sugar beet, maize, sunflower and wheat). In this trial increasing amounts of NPK nutrients were investigated. The trial includes 20 fertilizing variants with 50, 100 and 150 kgha^{-1} active matter of N, P and K.

The trial has 20 fertilizing variants (experimental plots). Among them, three variants are single (N, P and K), three are double combinations (NP, NK, PK) and 13 variants are with different combinations of NPK nutrient amounts.

Total amounts of P and K and ½ of N were applied in autumn before deep plugging. Remaining amount of nitrogen was applied before sowing. Object of these investigations was variety Sara, selected in Institute of field and vegetable crops in Novi Sad, Serbia. In this paper we will present results obtained in period 2001 to 2004 year. Sowing was carried out in optimal sowing date. All agricultural operations during vegetative period were applied beforehand. At the end of vegetative period (in October) it was pulled root, measured yield, and determined technological quality, sugar utilization and sugar yield. Obtained results were processed by analysis of variance of factorial trial.

RESULTS AND DISCUSSION

Root yield (tha^{-1}), digestion (%), sugar utilization (%) and sugar yield (tha^{-1}) are shown in Table 1. Average (four years) root yield at control variant, without fertilization was 44,33 tha^{-1}. That is significantly smaller yield referring to the yield accomplished with variants where nutrition element were supplied. Root yield at NP variant was smaller only referring to the variants $N_{100}P_{50}K_{50}$, $N_{150}P_{100}K_{150}$ and $N_{150}P_{150}K_{150}$, and sugar yield was referring to the variant $N_{100}P_{50}K_{50}$. In relation to the rest of the variants the differences were not significantly significant. With the nitrogen amounts increasing from 50 to 100 kgha^{-1} yields increased as well, but increasing from 150 kgha^{-1} didn't influence at yield. The highest yield at 50 kgNha^{-1}, was accomplished at variant $N_{50}P_{100}K_{50}$. With the usage of 100 kg Nha^{-1} the highest yield was at the variant with 50 kg ha^{-1} of phosphorus and potassium nutrition elements, and the differences weren't statistically significant. Yield at variants with 150 kgNha^{-1} fluctuated. With the increasing of phosphorus amounts yield increased, but if we increased the amounts of potassium at the same time, yield decreased (for 1,68 and 2,25 tha^{-1}). In average, with the increasing phosphorus amounts yield increased for 0,10 and for 3,85 tha^{-1}. With the increasing potassium amounts from 50 to 100 and 150 kgha^{-1} the yield increased for 0,98 and 2,77 tha^{-1}. The stated differences weren't statistically significant.

The highest digestion and utilize was at single variants P and K, at PK variant and at control variant (without fertilization). With the increasing nitrogen amounts from 50 to 100 and 150 kgha^{-1} digestions decreased (0,64 and 0,74%,). The same thing happened with the sugar utilize (1,16 and 0,69%.). With the applying of 50 kgNha^{-1} nitrogen amounts with 50 or 100 kgha^{-1} of potassium, the digestion didn't change, but the sugar utilization slightly increased (0,05%). At the same nitrogen level, when we increased the amounts of potassium from 50 to 100 kgha^{-1} the digestion was smaller for 0,62%, and sugar utilization for 0,12%. With the amount of 100 kgha^{-1} of nitrogen, significant sugar decreasing was at variant $N_{100}P_{150}K_{150}$ (that decreasing was smaller referring to the variants with potassium applying). Similar or even the same annotation can be noted at sugar utilization as well). At the variants with 150 kgNha^{-1} digestion and utilize were the smallest. In average, with phosphorus amounts increasing from 50 to 100 and150 kgha^{-1} the digestion was smaller for 0,10 and 0,38%, and sugar utilize for a 0,10 and 0,53%. The differences between 50 and 150 kgha^{-1} in both cases was significant. The highest digestion and highest utilization was et variant 50 kgha^{-1} of potassium. With the potassium increasing (100 and 150 kg) the decreasing of sugar 0,35 and 0,47%.

The average sugar yield 6,63 tha^{-1}, at control variant, and at variant NP was 8,78 tha^{-1}. At the low level of nitrogen applying (50 kgha^{-1}) the sugar yield slightly increased with the 100 kgha^{-1} of P and K nutrition applying (for 0,40 and 0,42 tha^{-1}). With 100 kg Nha^{-1} and with P and K nutrition amounts increasing the sugar yield decreased for 140 - 560 kgha^{-1}. Fertilization with 150 kg Nha^{-1} contributed to yield decreasing. Increasing the potassium amounts influenced at yield decreasing for a 270 and 420 kg ha^{-1}. All the stated differences weren't statistically significant.

Table 1

Prinos korena i šećera (tha^{-1}), sorta Sara - Root and Sugar Yield (tha^{-1}), Variety Sara

Varijanta đubrenja *Dressing variant*		Prinos korena (t/ha) *Root yield (t/ha)*	Digestija (%) *Digestion (%)*	% iskorišćenja *Sugar use (%)*	Kristalni šećer (t/ha) *Consumable sugar (t/ha)*
Ø		44.33	16.02	13.43	6.63
N_{100}		55.57	14.73	11.97	7.40
P_{100}		50.97	16.24	14.06	7.72
K_{100}		47.89	16.36	14.07	7.23
$N_{100}P_{100}$		65.15	14.76	12.29	8.78
$N_{100}K_{100}$		55.94	14.92	11.69	7.54
$P_{100}K_{100}$		54.37	16.37	13.68	8.19
$N_{50}P_{50}K_{50}$		61.37	15.37	13.47	9.04
$N_{50}P_{100}K_{50}$		63.79	15.97	13.52	9.40
$N_{50}P_{100}K_{100}$		63.70	15.35	13.35	9.42
$N_{100}P_{50}K_{50}$		70.25	15.16	12.52	9.58
$N_{100}P_{100}K_{50}$		66.48	15.07	12.11	9.02
$N_{100}P_{100}K_{100}$		66.73	15.23	12.10	9.16
$N_{100}P_{150}K_{50}$		68.42	15.23	12.64	9.45
$N_{100}P_{150}P_{150}$		68.34	14.92	12.07	9.22
$N_{150}P_{50}K_{50}$		66.26	14.44	11.52	8.57
$N_{150}P_{100}K_{50}$		68.66	11.97	11.73	8.81
$N_{150}P_{100}K_{100}$		66.98	14.43	11.60	8.54
$N_{150}P_{150}K_{100}$		72.36	14.36	11.69	9.20
$N_{150}P_{150}K_{150}$		70.11	14.31	11.48	8.78
LSD	**1%**	**15.08**	**0.41**	**0.58**	**0.91**
	5%	**4.48**	**0.30**	**0.43**	**0.68**

With the nitrogen amounts increasing the yield was smaller for 0 - 410 kgha^{-1}. With the phosphorus amounts increasing for 0 -100 kgha^{-1}and with the potassium for a 0 - 80 kgha^{-1}. The stated differences weren't statistically significant.

The yield height is dependent from the production factor, which is in minimum. Among equally important production factors, mineral nutrition has the dominant place.

Balanced and optimal mineral nutrition can assure optimal yield and good quality, as well as the good yield. According to ours researches the root yield increasing was significant up to 100 kgNha^{-1}. The next nitrogen amount increasing wasn't affected the root yield, which was agreeable with the results of MILOŠEVIĆ AND STEFANOVIĆ (1984), MARINKOVIĆ ET AL. (1998, 2007), JAĆIMOVIĆ ET AL. (2006), and not agree with the results of SARIĆ AND JOCIĆ (1977), STANAĆEV (1983), MARINKOVIĆ ET AL. (2007) which were stated that the yield increased even with the increased amount of nitrogen (100 kgha^{-1}). Also the results didn't match with the results accomplished by JAĆIMOVIĆ ET AL. (2007). They are stating that the yield of above ground parts is increasing up to 150 kgNha^{-1}.

With the nitrogen amounts increasing, the digestion decreased for 0,79 and 2,07%. The similar results gain STANAĆEV AND PAVLOVIĆ (1981), MARINKOVIĆ ET AL. (2006), ŠOLTYSOVA (2003). With the increasing of the phosphorus amounts, the digestion decreased for 0,10 and 0,48%, and with the increasing of the potassium amounts, the digestion decreased for a 0,35 and 0,57%. Similar or the same results are present at the sugar utilization. With the increasing of the phosphorus amounts, sugar utilization decreased for 1,16 and 1,85%. With the applying of the larger amounts of phosphorus mineral nutrition, the decreasing was 0,10 and 0,53% and with potassium for 0,31 and 0,72%. Our results were similar with the results of many authors, which stated the decreasing of the sugar quality for 0,33% Šoltysova (2003), DRAYCOTT ET AL. (1974), FROSTGARD (1989), CAMPBELL (2002) etc. A large number of native authors claimed that the increasing of NPK nutrition elements (over 100 kgha^{-1}), influenced at quality decreasing: SARIĆ AND JOCIĆ (1977), STANAĆEV (1983), NEDIĆ ET AL. (1990, 2003), MARINKOVIĆ ET AL (2003, 2004, 2006).

The sugar yield is depending from the digestion and sugar utilization. In our research, the amounts of refined sugar was decreasing when the NPK amount were higher than 100 kgha^{-1}. The accomplished results were similar with the results of JAĆIMOVIĆ (2006), JOCIĆ (1992), MARINKOVIĆ ET AL. (1998 and 2001), although the differences between the amounts of 50 and 100 kgha^{-1} NPK nutrition were higher. The stated results are in agreement with the results of ŠOLTYSOVA (2003), COMPBELL (2002) and the other authors.

CONCLUSIONS

Based on the gain results the next conclusions can be made:

Sugar and root yield are dependent from the year of research.

With the nitrogen amounts increasing from 50 to 100 and 150 kgha^{-1} the root yield was higher for 5,09 and 5,92 tha^{-1}, and sugar yield smaller for 0 and510 kgha^{-1}.

With the phosphorus amounts increasing from 50 kgha^{-1} the root yield was higher for 0,1 and 3,85 tha^{-1}, and sugar yield smaller for 0 and 100 kgha^{-1}.

With the applying of the larger amounts of potassium –larger from 50 kgha^{-1} the root yield was higher for 0,98 and 2,77 tha^{-1}, and sugar yield smaller for 200 kgha^{1} or 80 kgha^{-1}.

With the nitrogen amounts increasing from 50 to 100 and 150 kgha^{-1} sugar digestion was smaller for 0,64 and 0,74%, and sugar utilization was smaller for 1,16 and 0,69%.

The optimal fertilization variant for the root yield was $N_{100}P_{50}K_{50}$.

The optimal fertilization variant for the quality and sugar yield was $N_{50}P_{50}K_{50}$.

The proper fertilization reference can be given only based on the soil fertility. We must save the soil for the next generation that will come.

LITERATURE

1. CAMPBELL, L., G., "*Sugar beet quality improvement*" Journal of Crop Production, Vol. 5, No. 1/2,2002 pg. 395-413.

2. DRAYCOTT, A. P., DURANT, M. J., LAST, P. Z., *"Effect of Fertilizers on Sugar Beet Quality"*, International Sugar Journal, 76, London, 1974, pg 335-338.
3. JOCIĆ, B.," *Long-term researches of mineral nutrition influence at sugar beet*", Book of proceedings, Institute for Field and Vegetable Crops, vol. 20, 1992, p. 139-151.
4. KARADŽIĆ, V., GRBIĆ, J., ĐURA, J., " *Rating of the sugar beet quality based on the results gained with automatic sugar-analytic lines*", Food industry, vol. 1, br. 3-4,1990 str. 59-64.
5. MARINKOVIĆ B., CRNOBARAC J., JAĆIMOVIĆ G., "*Sugar beet fertilization with the nitrogen, phosphorus and potassium in function of the yield and quality*", Book of proceedings, Institute for Field and Vegetable Crops, Novi Sad, Book 40, 2004, p. 373-378.
6. MARINKOVIĆ, B., STARČEVIĆ, LJ., CRNOBARAC, J., JAĆIMOVIĆ, G., JANKOVIĆ SNEŽANA, LATKOVIĆ DRAGANA,*" The yield and quality of sugar beet root depending on the quantity and the position of easily approachable N. Practical Solutions for Managing Optimum C and N Content in Agricultural Soils"*, 2003, II International Workshop, Czech University of Agriculture, Prague, Czech Republic, pg. 138-143.
7. MARINKOVIĆ B., CRNOBARAC J., JAĆIMOVIĆ G., LATKOVIĆ DRAGANA, TYR Š., MIRCOV V. D., FLORIN I.*" The influence of some practical measures at quantitative properties of sugar beet in long-term trials and production*", Book of proceedings, Institute for Field and Vegetable Crops, Book 43. 2007, p. 169-182
8. MARINKOVIĆ,B., STARČEVIĆ,LJ., CRNOBARAC,J., *„Korekcija optimalne gustine setve u zavisnosti od ekoloških uslova"* Savremena poljoprivreda broj 11-12, 1989, str.551-558, R-71 (1,5).
9. MARINKOVIĆ,B., BALEŠEVIĆ SVETLANA, HADŽIĆ,V., NIKOLIĆ,R., ĐUKIĆ,D., *„Uticaj sabijenosti zemljišta na prinos ratarskih biljaka"* Monografija: Uticaj sabijanja zemljišta na prinos poljoprivrednih kultura,IV, str. 47-63, Institut za poljoprivrednu tehniku i Institut za ratarstvo ipovrtarstvo, 1993, Novi Sad, R-13 (3)
10. MARINKOVIĆ,B., HADŽIĆ,V., GOVEDARICA,M., MILOŠEVIĆ NADA, JARAK MIRJANA, NIKOLIĆ,R., ĐUKIĆ,D., KUNC,V., BALEŠEVIĆ SVETLANA: *"Uticaj sabijanja zemljišta na prinos poljoprivrednih kultura."* Naučni skup: Problemi sabijanja zemljišta, Novi Sad-Bečej, juni 1993. R-72 (1,5)
11. MARINKOVIĆ,B., STARČEVIĆ,LJ., CRNOBARAC,J., BALEŠEVIĆ SVETLANA, LATKOVIĆ DRAGANA *" Uticaj zaoravanja žetvenih ostataka na premeštanje mineralnog azota u dublje slojeve zemljišta"*. Zbornik radova međunarodnog naučnog skupa Zaštita životne sredine i poljoprivreda,EKO-93, broj 6, str.266-267 EKO-93, Novi Sad, 1993. R-54 (1,0)
12. MARINKOVIĆ,B., ĆIROVIĆ,M., KOVAČEV,L., CRNOBARAC,J., RAJIĆ,M., BALEŠEVIĆ SVETLANA, HADŽIĆ,V., NIKOLIČ,R., ERIĆ,P., ŠKRBIĆ KATICA, *"Privredni značaj i tehnologija proizvodnje šećerne repe". Monografija "Mehanizovana proizvodnja šećerne repe",* Poljoprivredni fakultet, Institut za poljoprivrednu tehniku,1996,Novi Sad, str.1-31. R-23 (2)
13. MARINKOVIĆ,B., HADŽIĆ,V., GOVEDARICA,M., CRNOBARAC,J., JARAK MIRJANA, BALEŠEVIĆ SVETLANA, VASIN,J., BELIČ,M., MILOŠEVIĆ NADA, *"Uticaj sabijenosti zemljišta na promene njegovih fizičkih osobina i prinos šećerne repe. Savremena poljoprivredna tehnika"*, Cont.Agr.Engng Vol.22, No.7, p.405-413, 1996, Novi Sad, R-23 (2)
14. MARINKOVIĆ,B., STARČEVIĆ,LJ., CRNOBARAC,J., SVETLANA BALEŠEVIĆ, *"Prilagođavanje đubrenja i gustine useva nepovoljnim vremenskim uslovima. Zbornik radova naučnog skupa .Suša i biljna proizvodnja"* Organizator skupa Institut Srbija, Lepenski Vir 1996", str.186, 1997, R-72 (0,5)
15. MARINKOVIĆ,B., CRNOBARAC,J., BALEŠEVIĆ SVETLANA, RAJIĆ,M., *"Prilagođavanje tehnologije proizvodnje šećerne repe planiranom prinosu i agroekološkim uslovima..Zbornik radova"* Instituta za ratarstvo i povrtarstvo Novi Sad, sv.29, 1997, p.463-473, R-62 (1,5)
16. MARINKOVIĆ,B., CRNOBARAC,J., RAJIĆ,M., *" Sugar beet fertilization with NPK in function of root and sugar yield".* Proceedings of 5th Congress European Society for Agronomy Vol.I, 1998, p 299/300., Nitra The Slovak Republic. R-54 (1)

17. MARINKOVIĆ,B., CRNOBARAC,J., RAJIĆ,M., *"Sugar beet yield and quality as affected by fertilization with NPK nutrients. Cultivation practices for field crops".* Proceeding of 2nd Balkan Symposium on Field Crops 16-20 June, str.385-388, 1998, Novi Sad, Jugoslavija.R-54 (1)
18. MARINKOVIĆ B., CRNOBARAC J. I RAJIĆ M., *« Prinos i kvalitet šećerne repe u zavisnosti od đubrenja»* I Zbornik internacionalne konferencija TEMPO-HP `98. Čačak (Savremena poljoprivreda, Vol 46. Vanredni broj, 1998, str 333-336. R-54 (1)
19. MILIĆ MIRJANA, KARADŽIĆ VERA, OBRADOVIĆ SMILJKA *"Laboratory methods for the sugar beet factory process control"*, Faculty of technology Department for sugar beet technology,1992, Novi Sad.
20. MILOŠEVIĆ, R., STEFANOVIĆ, D., *„Nitrogen influence of sugar beet yield and quality".* Savremena poljoprivreda, Vol. 32, br. 7-8, 1984, str. 305-316.
21. NENADIĆ, N., ZARIĆ, D., SLOVIĆ, S., VIDOJEVIĆ, S., *„Yield and quality of sugar beet cultivars in relation to the nitrogen nutrition"* Book of proceedings, Faculty of Agriculture, Beograd,. 35, Book. 594, 1990, p. 9-24.
22. NENADIĆ, N., NEDIĆ, M., ŽIVANOVIĆ, LJ., KOLARIĆ, LJ., GUJANIČIĆ, T., „ *Effect of genotype on Sugar Beet Yield and Quality*", Journal of Agricultural Sciences, Vol. 48. No. 1, 2003, Pages 1-9.
23. POSPIŠIL, M., "Measures *for sugar beet production"*, Plant protection, and year. 27, n. 5, Zagreb, 2004, p. 108-113.
24. RADIVOJEVIĆ, S., *"Influence of the different amounts of mineral nutrition's at some sugar beet quality indicators"*, Agro chemistry, n. 5-6, Beograd, 1978, p. 211-218.
25. RADIVOJEVIĆ, S., "Nitrogen *influence on sugar accumulation in sugar beet*", Faculty of Agriculture, 1981, Novi Sad.
26. SARIĆ, M., "*Dependency of used mineral nutrition from the plant species. Report for Control of soil fertility and mineral nutrition applying*", Novi Sad, n.1, 1997, p. 67-71.
27. SARIĆ, M., JOCIĆ, B., *"Study of sugar beet mineral nutrition effects"*, Savremena poljoprivreda, 11-12, 1977, p. 19-29.
28. STANAĆEV, S., MILOŠEVIĆ, R., STEFANOVIĆ, D., *"Influence of fertilization at sugar beet yield and quality in intensive culture*", Book of proceedings, Institute for Field and Vegetable Crops Novi Sad, Book. 13, 1983, p. 71-81.
29. STANAĆEV, S., PAVLOVIĆ, S., "Influence *of different amounts of mineral nutrition's at productivity and some properties of sugar beet*", Soil and Plant, vol. 30, n. 3, 1981, p. 285-291.
30. ŠOLTYSOVA, B., "*Účinok hnojenia na zmeny kvantitativnych a kvalitativnych parametrov repy cukrovej*", V celoslovenska vedecka reparska konferencia, Nitra, Zbornik vedeckej konferencie z medzinarodnou učastou, 2003, pg. 162-166.