INFLUENCE OF DIFFERENT COMBINATION OF NUTRIENT ON THE LEAVES NUMBER AND AREA AND SUGAR BEET ROOTS MASS

Radmila Bojović[1], Vera Popović[2], Marijana Jovanović Todorović [3]

Abstract

Sugar beet is a plant that has been a part of our daily diet for centuries because it has been cultivated as a garden plant for 3000 years. It is mostly grown in the temperate climates of Europe and Asia. Sugar beet is a plant from which sugar - sucrose - is obtained from its roots. All parts of sugar beet are useful: root, head and leaves. Considering that the main reason for cultivation is the root, the leaves remain unused in further processing and are used mainly for animal feed. What should be emphasized is that these leaves have the potential to be used further in the food and chemical industries because they contain a large amount of protein and polyphenols. Therefore, more attention should be paid to the study of factors that would contribute to the growth of not only the roots but also the leaves of sugar beet. This paper dealt with the influence of different amounts of NPK on the number and surface area of leaves and the weight of roots in two sugar beet varieties - Original and Ventura. The experiment was carried out on the fields of "Tamiš" Institute, Pančevo, it lasted two years and the impact of 9 combinations of NPK was tested and the tenth was the control. The variety Original had the highest average number of leaves at $N_{100}P_{50}K_{50}$ and $N_{130}P_{50}K_{50}$ in the first year and at $N_{130}P_{100}K_{100}$ in the second year (25.9) and Ventura at $N_{100}P_{100}K_{100}$ in the first year (34.2) and at $N_{50}P_{50}K_{50}$ and $N_{130}P_{100}K_{100}$ (33.6). The highest average leaf area was for the Original variety in both years at $N_{130}P_{50}K_{50}$ (7493.17 cm2; 7501.12 cm2) and for the Ventura variety at $N_{100}P_{100}K_{100}$ (9805.59cm2; 9846.96 cm2). The highest average root weight in the Original variety was $N_{130}P_{130}K_{130}$ (1kg) in the first year, and $N_{100}P_{50}K_{50}$ (0.99kg) in the second year.

Key words: *Sugar beet, number and area of leaves, weight of roots.*

1 Radmila Bojović, Ph.D., Research Associate, Independent researcher, E-mail: radmilab@yahoo.com

2 Vera Popović, Ph.D, Principal Research Fellow, Full Proffesor, Institute of Field and Vegetable Crops, Novi Sad, Republic of Serbia, e-mail: vera.popovic@ifvcns.ns.ac.rs, ORCID ID (https://orcid.org/0000-0002-7701-9928)

3 Marijana Jovanović Todorović, Ph.D., Research Associate, Institute of Agricultural Economics, Volgina 15, Belgrade, Republic of Serbia, e-mail: marijana_j@iep.bg.ac.rs ORCID ID (https://orcid.org/ 0000-0003-2048-0411)

Introduction

Sugar beet is a plant that has been a part of our daily diet for centuries because it has been cultivated as a garden plant for 3000 years. It began to be cultivated for commercial production in the 18th century and in Serbia at the end of the 19th century. It is mostly grown in the temperate climates of Europe and Asia. It represents a plant whose processing produces sucrose in an amount that makes up 35% of the world's production of this sugar. Today, 120 million tons of sugar beet is produced in Europe, from which about 16 million tons of sugar are extracted, which makes up 50% of European sugar production (Caliceti et al. 2022).

Sugar beet is a plant from which sugar - sucrose - is obtained from its roots. All parts of the sugar beet are useful: root, head and leaves. Considering that the main reason for cultivation is the root, the leaves remain unused in further processing and are used mainly for animal feed. What should be emphasized is that these leaves have the potential to be used further in the food and chemical industries because they contain a large amount of protein and poly-phenols. Therefore, more attention should be paid to the study of factors that would contribute to the growth of not only the roots but also the leaves of sugar beet.

Sugar beet production is very important for many industries. All parts of the sugar beet are useful: root, head and leaves. By Milosevic (1989), the yield of leaves with root heads is about 25 t/ha if a yield of roots is 40 t/ha.

The main root is the technologically most important part of the sugar beet root. This part of the beet root represents about 79% of the length of the whole root and is on average about 27 cm long. It contains 75% water and 25% dry matter, of which 17.5% is sucrose and 7.5% is unrefined matter (Pastović, 2017). In addition to sucrose, sugar beet produces noodles and molasses, which are widely used as feed for domestic animals or raw material for further processing. Molasses is used in the production of yeast, alcohol and beverages.

In the first year, sugar beet germination leads to the development of a rosette of glabrous, dark green, glossy leaves (Elliot and Weston, 1993). Ebrahimi et al., (2022) state that sugar beet leaves can be considered as a powerful source of bioactive compounds are because they are rich in essential amino-acids, fatty acids, poly-phenols and proteins.

According to Stanaćev (1979), flour from dried beet heads and leaves has the following average chemical composition: organic matter about 73%, mineral matter about 18% and water 9%. Organic matter consists of 49% nitrogen-free extractives, 13% crude proteins, 8% crude cellulose and 3% crude fat.

Sugar beet leaves are an underutilized source of protein in the diet. About 400-600 kg/ha of protein is present in its leaves, similar to the protein of soy (450-600 kg/ha) and cereals (570 kg/ha) (van Krimpen et al., 2013).

Soil and agro-ecological conditions, agro-technical measures, as well as seed quality (Petrović et al. 1997) and planting density (Filipović et al. 2008) affect the yield and quality of sugar beet roots.

Sugar beet is an important food, industrial and strategic foodstuff (Bojović et al. 2024). Considering the great importance of sugar beet, it is necessary to find ways to increase the yields since the increase in the area on which it is grown is difficult to increase to a greater extent. Achieving an increase in yield is done by various measures. One of the most important is the use of mineral nutrients. Glamočlija et al. (1990) conclude that the influence of NPK mineral nutrients is significant on the yield of sugar beet roots.

Agro-ecological conditions

Precipitation

Average amounts of precipitation in the growing season were in May, June and July of the first year and in May, June and August of the second year higher than the multi-year average. The total average amount of precipitation in the vegetation period of the first year (330.9 mm) was lower than the average (376.4 mm) by 45.5 mm, and in the second year (429.8 mm) it was higher by 53.4 mm. The total amount of precipitation in the first year was lower (543.2 mm), and in the second year higher (736.5 mm) than the multi-year average (669.6 mm).

Temperature

The average annual temperatures in the examined years were close to the long-term average (12.8°C), 12.6°C in the first year and 12.8°C in the second. In the first year, during the growing season, temperatures in April, June, August and September were higher than the long-term average, and in the second year, they were only in July.

Material and Method

The study of the influence of increasing amounts of mineral fertilizer on the weight of roots and the number and surface area of sugar beet leaves was carried out in the course of two years in the area of southern Banat on the experimental fields of PSS Institute Tamiš. Two varieties of sugar beet were used in the experiment – Original (Sesvanderhave) and Ventura (Maribo). The experiment was carried out on carbonate chernozem type soil according to a random block system in four repetitions.

Basic processing was carried out at autumn, and pre-sowing preparation and sowing at the end of March. The main crop for both years was wheat. Care and protection measures were standard. The supplemental nutrition system included 10 variants of using mineral nutrients, half of the amount by basic processing and the rest by pre-sowing. The following variants are applied:

1. $N_0P_0K_0$	6. $N_{100}P_{50}K_{50}$
2. $N_{100}P_0K_0$	7. $N_{100}P_{100}K_{100}$
3. $N_0P_{100}K_0$	8. $N_{130}P_{50}K_{50}$
4. $N_0P_0K_{100}$	9. $N_{130}P_{100}K_{100}$
5. $N_{50}P_{50}K_{50}$	10. $N_{130}P_{130}K_{130}$

Leaf data were recorded during August. Extraction of the roots was done during autumn.

Research results

The variety Original had the highest average number of leaves at $N_{100}P_{50}K_{50}$ and $N_{130}P_{50}K_{50}$ in the first year and at $N_{130}P_{100}K_{100}$ in the second year (25.9). Ventura had the highest average of leaf number at $N_{100}P_{100}K_{100}$ in the first year (34.2) and at $N_{50}P_{50}K_{50}$ and $N_{130}P_{100}K_{100}$ (33.6) in the second year. There was a smaller variation in the number of leaves in the second observed year. The variety Original had the lowest average number of leaves in the first year in the control (23.5) and in the second at $N_{100}P_0K_0$ (24.0), while the variety Ventura had the lowest number of leaves in both the first and second year at $N_0P_{100}K_0$ (30.3/32.4).

Tabela 1. *Number of leaves (average by year)*

	Average number of leaves			
	Original		Ventura	
	I	II	I	II
$N_0P_0K_0$	23,5	24,5	31,0	33,0
$N_{100}P_0K_0$	24,2	24,0	32,0	33,4
$N_0P_{100}K_0$	24,2	24,7	30,3	32,4
$N_0P_0K_{100}$	25,2	24,4	31,5	32,7
$N_{50}P_{50}K_{50}$	24,2	25,5	32,3	33,6
$N_{100}P_{50}K_{50}$	25,9	25,2	32,4	32,5
$N_{100}P_{100}K_{100}$	25,2	24,8	34,2	33,4
$N_{130}P_{50}K_{50}$	25,9	25,3	32,2	33,2
$N_{130}P_{100}K_{100}$	24,5	25,9	33,7	33,6
$N_{130}P_{130}K_{130}$	24,8	25,8	32,7	32,8

The highest average leaf area was for the Original variety in both years at $N_{130}P_{50}K_{50}$ (7493.17 cm^2; 7501.12 cm^2) and for the Ventura variety at $N_{100}P_{100}K_{100}$ (9805.59cm2; 9846.96 cm^2). The average leaf area was higher in the second year for both cultivars, except for Ventura which at $N_{130}P_{130}K_{130}$ had smaler average leaf area at second than at first year. The Original variety had the smallest average leaf area both years in the control (6275.52/6449.63 cm^2), and the Ventura variety had it both years at $N_0P_{100}K_0$ (8133.35/8983.32 cm^2).

Tabela 2. *Average leaf area (cm^2)*

	Average leaf area (cm^2)			
	Original		Ventura	
	I	II	I	II
$N_0P_0K_0$	6275,52	6449,63	8562,51	9298,70
$N_{100}P_0K_0$	6679,06	6771,60	8554,90	9126,22
$N_0P_{100}K_0$	6382,41	6702,35	8133,35	8983,32
$N_0P_0K_{100}$	6363,44	6472,71	8418,04	8994,54
$N_{50}P_{50}K_{50}$	6419,66	6835,60	9189,32	9537,85
$N_{100}P_{50}K_{50}$	6876,92	7046,56	9013,94	9302,60
$N_{100}P_{100}K_{100}$	6903,34	7280,06	9805,59	9846,96
$N_{130}P_{50}K_{50}$	7493,17	7501,12	9348,22	9638,44
$N_{130}P_{100}K_{100}$	6946,58	7343,52	9751,63	9819,53
$N_{130}P_{130}K_{130}$	6634,73	6886,41	9510,16	9461,53

The highest average root weight in the Original variety was $N_{130}P_{130}K_{130}$ (1kg) in the first year, and $N_{100}P_{50}K_{50}$ (0.99kg) in the second year. In the Ventura variety, the highest root weight was at $N_{130}P_{100}K_{100}$ (0.65kg) in the first year and at $N_{100}P_{50}K_{50}$ (0.69kg) in the second year. The lowest average root weight for the variety Original was at $N_0P_0K_{100}$ in the first year (0.67kg) and at $N_0P_{100}K_0$ (0.60kg) in the second year. In the Ventura variety, the lowest average root weight was at control ($N_0P_0K_0$) in the first year (0.40kg) and at $N_{100}P_0K_0$ in the first (0.40kg) and second year (0.38kg).

Tabela 3. *Average root weight (kg)*

	Average root weight (kg)			
	Original		Ventura	
	I	II	I	II
$N_0P_0K_0$	0,72	0,86	0,40	0,41
$N_{100}P_0K_0$	0,80	0,80	0,40	0,38
$N_0P_{100}K_0$	0,77	0,60	0,49	0,59
$N_0P_0K_{100}$	0,67	0,88	0,45	0,51
$N_{50}P_{50}K_{50}$	0,79	0,82	0,53	0,58
$N_{100}P_{50}K_{50}$	0,79	0,99	0,51	0,69
$N_{100}P_{100}K_{100}$	0,87	0,92	0,54	0,57
$N_{130}P_{50}K_{50}$	0,92	0,80	0,64	0,52
$N_{130}P_{100}K_{100}$	0,94	0,92	0,65	0,61
$N_{130}P_{130}K_{130}$	1,00	0,81	0,64	0,60

Conclusion

- Sugar beet is a plant from whose roots sugar - sucrose - is obtained. All parts of the sugar beet are useful: root, root head and leaves.
- The main root is the technologically most important part of the sugar beet root.). It contains 75% water and 25% dry matter, of which 17.5% is sucrose and 7.5% is unrefined matter.
- Sugar beet leaves are rich in essential amino acids and fatty acids, proteins and poly-phenols. Because of these many beneficial properties, there has been an increased interest in the development of extraction methods for obtaining proteins and poly-phenolic compounds.

- ❖ Given the great importance of sugar beet, it is necessary to find ways to increase yields. Achieving an increase in yield is done by various measures. One of the most important is the use of mineral nutrients.
- ❖ In the observational view at the observed location, the influence of different amounts of used nutrients was evident, more on the average weight of the roots and the area of the leaves than on the leaf number.
- ❖ In the second observed year with more precipitation, the number of leaves was higher at a higher concentration of N nutrients N_{100} and N_{130}.
- ❖ For leaf area, the best ratio was $N_{100}P_{100}K_{100}$ for Original and $N_{130}P_{50}K_{50}$ for Ventura in both years.
- ❖ The highest average root weight in the first year for the Original variety was with the combination of $N_{130}P_{130}K_{130}$ and for the Ventura variety at $N_{130}P_{100}K_{100}$ and in the second year with the combination of $N_{100}P_{50}K_{50}$ for both varieties.
- ❖ Combination of nutrients that is best for root is not best combination for leaves, but has the positive influence.

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