MAK 2022

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PROCEEDINGS

9. MEĐUNARODNA NAUČNA AGROBIZNIS KONFERENCIJA „EVROPSKI PUT - PERSPEKTIVE I POTENCIJALI"

ZBORNIK RADOVA

Editor: MSc Milan Jovičić

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ISPITIVANJE UTICAJA PRIMENE ZEOLITA, STAJNJAKA I MIKROBIOLOŠKIH ĐUBRIVA NA SADRŽAJ MINERALNOG AZOTA U ZASADU MALINA

EXAMINATION OF THE IMPACT OF ZEOLITE, MANURE AND MICROBIOLOGICAL FERTILIZERS ON THE CONTENTS OF THE MINERAL NITROGEN IN THE LAND OF RASPBERRY PLANTATION

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Sadržaj: *U radu su prikazani rezultati prinosa maline u prvoj godini nakon sadnje. Ispitivanja su obuhvatila kombinovanu primenu đubriva i mikrobioloških hranljivih materija za povećanje upotrebljivosti parametara u proizvodnji zemljišta, kao i uticaj zeolita, đubriva i mikrobioloških đubriva na pH vrednost i sadržaj mineralnog azota u zemljištu. Dobijeni rezultati ukazuju na najbolji efekat zajedničke primene đubriva, mikrobioloških đubriva i zeolita na prinos i uslovnu malinu. Takođe, uobičajena primena ovih je veoma dobro uticala na stabilnost i upotrebljivost mineralnih elemenata u zemljištu, kao i na stabilizaciju pH vrednosti.*

Ključne reči: *maline, stajnjak, mikrobiološko đubrivo, zeolit, mineralni azot*

Abstract: *The paper presents the results of the raspberry yield in the first year after planting. The tests included the combined application of fertilizers and microbiological nutrients to increase the usability of parameters in the production of landas well as the impact of zeolite, fertilizer and microbiological fertilizers on the pH value and the content of mineral nitrogen in the soil. The obtained results indicate the best effect of joint application of fertilizers, microbiological fertilizers and zeolites on yield and conditional raspberry. Also, the usual application of these has very well influenced the stability and usability of mineral elements in the soil, as well as the pH value stabilization.*

Key words: *Raspberries, manure, microbiological fertilizer, zeolite, mineral nitrogen*

1. INTRODUCTION

1.1. GENERAL INFORMATION

According to the report of the International organization of raspberry producers and processors (International Raspberry Organization), about 372,000 tons of raspberry were

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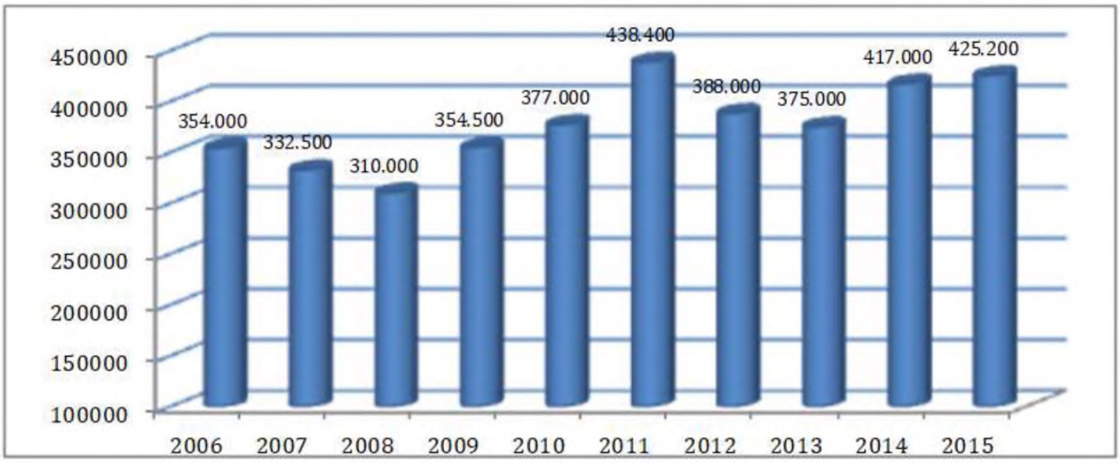
produced worldwide over the period 2006–2015 (no data for Russia included) [1] (Graph 1). With the addition of the estimated production of raspberry fruit in Russia, the inferred annual global production ranges between 450,000 and 500,000 tons.



Graph 1: Global raspberry production over 2005−2015 (in thousand tons)

In Serbia, raspberry has been cultivated since 1880, when immigrants brought the first cultivated variety 'Marlboro' first to Valjevo and somewhat later to Čačak region. This cultivar was quickly domesticated and named 'Valjevka'. By the 1950s of the past century, raspberry production in Serbia was mostly natural in character, unorganized, ranging annually from 120 to 150 tons.
It was not until 1956 when industrial infrastructure for fruit processing was established in western Serbia (Valjevo, Pozega, Sabac) that organized raspberry production took off. From 1946 to 1966, the production was almost dozen times doubled (from 120 tons in 1946 to 12,661 tons in 1966). During that period, the regions of Valjevo, Kosjeric and Cacak had the highest production of raspberry fruits in Serbia.

Since the early 1970s, under the influence of the global market and the development of new raspberry processing technologies, primarily freezing, raspberry growing and production was gradually intensified, first in Arilje and later in Valjevo and other parts of western Serbia. High-yielding, quality cultivars were introduced into production as well as the trellis system which replaced bush system. Additionally, a new concept of technological innovations in the field of planting, soil management, cultural practices, fertilization and plant protection, as well as harvesting and transportation of fruits was introduced. Also, modern processing capacities were built, new raspberry growing regions were established and competitive positions on global market attained accordingly.
As a result, from 1981 to 2016 raspberry production in Serbia has been dramatically on the rise (Tab. 1).

Period	Average	Lowest	Highest
1981–1990	34,834	17,047 (1981)	66,719 (1990)
1991–2000	50,907	41,117 (1991)	64,680 (1999)
2001–2010	75,145	59,000 (2005)	94,366 (2002)
2011–2016	70,400	42,300 (2012)	110,000 (2015)

Table 1: Raspberry production in Serbia 1981−2016 (in tons)

Based on the reports of the Ministry of Agriculture of the Republic of Serbia, in 2015, some 110,000 tons of raspberry fruits were produced in Serbia.
In Serbia, raspberry is grown on an acreage of about 14.000 hectares, primarily being concentrated in western Serbia (over 80%), in two raspberry growing areas: West Morava and Podrinje-Kolubara regions. In 2016, some 83,000 tons of raspberry fruits were produced. Adverse weather conditions over the greater part of 2017 decimated the production in raspberry growing areas [2].

The largest raspberry growing regions are as follows: Arilje (which includes the territory of the municipalities of Arilje, Ivanjica, Kosjerić, Požega, with parts of the municipalities of Užice and Lučani) and Valjevo regions. In recent years, new raspberry growing regions have rapidly evolved, i.e. Podrinje, Kopaonik, Šabac, Zlatar (Nova Varoš, Prijepolje and Priboj) and Sirinić-Sredska (Štrpce, Prizren). Also, a trend of establishing primocane raspberry cultivars was observed in Vojvodina.

Owing to unemployment and relatively favourable selling prices of raspberry fruit, raspberry has been increasingly grown in parts of Serbia which typically have unfavourable environmental and other conditions for growing of this fruit, which consequently has resulted in marked fluctuations in raspberry production by years. This tendency has an adverse impact on fruit quality and selling prices and has affected the overall ranking of raspberry on global market.

According to the reports of the Chamber of Commerce of Serbia, raspberry export has a net foreign exchange inflow of 250– 300 million dollars a year. Primocane cvs 'Willamette' and 'Meeker' are the predominant cultivars in commercial raspberry growing plantings, while 'Polana' and 'Polka' are principally grown floricane cultivars [3]. Among primocane cultivars 'Tulamen', 'Glen Ample', 'Fertodi Zamatos' and 'Tula Magic' are also grown, as well as floricane 'Heritage', 'Autumn Bliss', 'Erica' and 'Himbo Top'. Critical issues of raspberry production in Serbia are the following: lack of quality planting material, the occurrence and identification of newly developed diseases and pests, high sensitivity to adverse weather and climate factors, lack of technological discipline in the production process, sensitivity of fresh fruits to inadequate transport and storage, irrational organization of purchase and sale on the world market.

In contrast, in recent years, a wide range of technological innovations with respect to the planting establishment, cultural practices, maintenance and protection of plantings, as well as harvesting and transport of fruits have been employed in our country. New plantations are being set up provided with different irrigation systems (trickle irrigation and sprinkling). In addition, a significantly high share of production is performed under controlled conditions (greenhouses, and only rarely glasshouses). This type of production is more expensive compared to conventional one. However, supplying market with raspberries out of season ensures markedly higher selling prices. Semi-protected methods applied in raspberry growing e.g. the use of polyethylene canopies, screenhouses and hale-protection nets have greatly improved safety aspects of raspberry production. Also, modern processing capacities are being built encompassing established quality standards and new products that are gaining positions on both the existing and new markets around the world.

Due to the higher selling prices, raspberry production based on the organic concept is increasingly more attractive to producers in a number of regions of our country. The concept emphasizes highly important specific methods of maintenance and improvement of production capacity of the soil and weed control. The advancement of production capacity of

the planting is influenced primarily by proper selection of soil type and location for the planting, as well as by the use of manure, compost, lumbricum (from organic or extensive farms), organic solid and liquid nutrients, green manure, and microbiological fertilizers. The expression which reads "feed the soil to feed the plants" has now been reformulated with "feed the microorganisms to feed plants" which clearly points up the vital role of microorganisms. Aimed at eliminating perennial weeds (by methods of exhaustion, competition, allelopathic activity), weed control begins before setting up a plantation by sowing rye, buckwheat, vetch and oats, and continues with planting cover crops in the inter-row area and mulching or intra-row practices. Bioherbicides (formulations of pelargonic acid, limonoids, microorganisms) are also used globally to this aim.
Unlike conventional organic production, it is important to avoid establishing plantations beyond the typical area of growing of specific fruit species, which is often disobeyed in Serbia.

The organic production of fruits, both in terms of quality and quantity, would be greatly improved by observing the following aspects: raising awareness and improving knowledge of both producers and consumers, establishing modern plantings with newly developed and domestic, less sensitive fruit cultivars, market registration of new biopesticides and fertilizers, higher subsidies, fair trade (higher prices to primary producers), etc.

1.2. ON ZEOLITE IN GENERAL

Due to the capacity of absorbing water and retaining high capacity of ionic changes, natural zeolite enables creation of the most favourable condition for nutrient uptake in plant nutrition. Zeolite prevents leaching of mineral fertilizers from soil, thus reducing the overall losses. The presence of a three-dimensional aluminosilicate-oxygene framework, creating systems of cavities and channels in which alkaline and alkaline- earth cations and water molecules are located is common to all zeolite group minerals. Cations and water molecules are loosely bound to the body, which can be partially or completely preconditioned by ion exchange and dehydrataion.
Hence, the application of zeolite in soil, enhances plant nutrition, develops the plant root system, intensifies fertility and growth and reduces plant diseases. Should the soil is enriched with zeolite, the plant immunity will improve accordingly. What is more, zeolite contains essential elements for plant growth: magnesium, potassium and calcium [4].
Numerous research and studies point to zeolite’s capacity to improve soil structure but also to reduce soil acidity which is of vast importance to agricultural production, being carried out on soils, which under the influence of various factors, are more susceptible to changes, i.e. a drop in pH value.

1.3. FERTILIZATION NEEDS IN RASPBERRY PRODUCTION

Soil is the habitat for root system providing a plant with nutrients, water, oxygen and carbon dioxide [5]. Raspberry plants and fruits take up more than 74 chemical elements of which most important and most common are nitrogen, phosphorus and potassium. Other elements such as calcium, magnesium, manganese, copper, zinc, cobalt, boron, iron and other (so-called, microelements) are also essential, though in much smaller amounts. Raspberry prefers deep (more than 1,0 m), loose, well permeable, medium heavy (50% clay), fertile (with approx 4−5% humus), moderately humid, low acidic soils (pH from 5,5 to 6,5), with favourable water, air and thermal regime, containing 0,20% N, 8−10 mg P2O5 and 18−20 mg K2O per 100 grammes of air-dry soil.

Organic and mineral nutrient uptake is also a very important factor for the life and growth of plants. Soil nutrient dynamics depends on the intensity of physical, chemical and biological processes [6]. The major path to soil enrichment is decomposition of organic matter in the soil using microorganisms and then utilizing mineral ingredients from the plant humus. To accelerate humification process and better uptake of mineral substances, it is possible to use microorganisms that, in this way, apart from enrichment, also generate better conditions in soil for longer stay of certain elements susceptible to leaching into deeper layers. For quality plant growth, nitrogen, as the element with highest mobility in soil [7] has a key role, due to which it often represents a limiting factor of the successful plant production. The lack of this element in soil can be compensated by appropriate technological procedures in primary production, which is one of the major goals of this paper.

2. EXPERIMENT

In the experiment related to the first year of raspberry fertility, with the examination of the combined application of manure and microbiological fertilizers to increase the reliability of soil fertility parameters, we also examined the influence of zeolite, manure and microbiological fertilizers on pH and mineral nitrogen content in soil. At the end of the dry period, we took average soil samples from the plant root zone, which referred to the application of manure and microbiological fertilizers, i.e. to the application of zeolite, manure and microbiological fertilizers.

Figure 1. Application of lime and manure
Source: Personal archive, April 7, 2019.

Figure 2. Appearance of the experiment after the application of zeolite
Source: Personal archive, April 7, 2019.

Figure 3. Application of zeolite and microbiological fertilizers in raspberry orchards
Source: Personal archive, April 7, 2019.

Figure 4. Appearance of an experiment in an apple orchard with the use of manure, zeolite and microbiological fertilizers, Source: Personal archive, April 7, 2019.

In the experiment that referred to the first year of birth of raspberries, we applied the following variants of fertilization:
1. Control, without fertilization in the bank between the rows (code B-0)
2. Lime in strips on both sides of the row + NPK 1000 kg / ha (marking B – a – 0)
3. NPK 1000 kg / ha + EM Naturally active 70 l / ha (marking B-a – 1)
4. NPK 1000 kg / ha + Zeolite 10 t / ha + EM Naturally active 70 l / ha (marking B – b – 1)
5. NPK 1000 kg / ha + Manure 70 t / ha (marking B – a – 2)
6. NPK 1000 kg / ha + Zeolite 10 t / ha + Manure 70 t / ha (marking B – b – 2)
7. NPK 1000 kg / ha + Manure 70 t / ha + EM Naturally active 70 l / ha (marking B – a – 3)
8. NPK 1000 kg / ha + Zeolite 10 t / ha + Manure 70 t / ha + EM Naturally active 70 l/ha (marking B – b – 3)
9. NPK 1000 kg / ha + Manure 70 t / ha + EM bio 70 l / ha (marking B – a – 4)
10. NPK 1000 kg / ha + Zeolite 10 t / ha + Manure 70 t / ha + EM bio 70 l/ha (marking B – b – 4)
11. NPK 1000 kg / ha + Manure 70 t / ha + EM Naturally active 35 l/ha + EM bio 35 l/ha (marking B – a – 5)
12. NPK 1000 kg / ha + Zeolite 10 t / ha + Manure 70 t / ha + EM Naturally active 35 l / ha + EM bio 35 l / ha (marking B – b – 5)
13. NPK 1000 kg / ha + EM Naturally active 35 l / ha + EM bio 35 l / ha (marking B – a – 6)
14. NPK 1000 kg / ha + Zeolite 10 t / ha + Variant no. 3 (marking B – c – 1)
15. NPK 1000 kg / ha + Zeolite 10 t / ha + Variant no. 5 (marking B – c – 2)

Note:
From variant number 2 to variant number 15, lime was applied in strips on both sides of the raspberry row and NPK fertilizer 16:16:16 in the application amount of 1000 kg / ha.
The true amount of zeolite in the experiment was obtained on the basis of the amount of zeolite applied per hectare (ha), by calculating the amount of zeolite applied in strips 0.50 m wide on both sides of the row of raspberries. As the row spacing in the raspberry plantation is

2.70 m, this means that no fertilizers were applied to the bank between the rows 1.70 m wide. The real amount of zeolite applied in the experiment was 3300 kg / ha.

Taking into account the fact that we set up the experiment on pseudogley soil type, variants number 14 and number 15 referred to the marginal end of the experiment with a slightly sunnier part of the experiment location and with the appearance of faster drying of the soil. Experiment was conducted in 2019, on April 7, on a plot that from the point of ecological preconditions fully meets the requirements for growing raspberries. The terrain on the plot is slightly sloping and bordered on three sides by beech forest. On the geographical map of Dragačevo, this microlocation is marked as "Bukovac".

2.1. RESULTS OF THE EXPERIMENT

The results of the experiment are shown in Table 1. It can be seen that on the variants of fertilization with the use of zeolite and microbiological fertilizer EM Naturalnie aktywni (variant number 4, ie on the same variant number 14 - mark B – b – 1, ie B – c – 1) the pH value in nKCl was higher in relation to the fertilization variants with the use of the microbiological fertilizer EM Naturalnie aktywni (variant no. 3. - designation B – a – 1). Also, on the variants with the use of zeolite, manure and microbiological fertilizer EM Naturalnie aktywni (variants no. 8, no. 10 and no. 12), the pH value in nKCl was higher compared to the variants with the application of manure and microbiological fertilizer EM Naturalnie aktywni (variants number 7, number 9 and number 11).

Variant number	Laboratory number	Our label	pH H_2O	pH nKCl	pH H_2O-nKCl	Moisture %	Kg N/ha Abs. dry
1.	7	B-0	4,96	3,86	1,10	1,36	35,47
2.	8	B-a-0	6,46	5,79	0,67	1,81	51,65
3.	9	B-a-1	5,65	4,00	1,65	1,42	20,08
4.	15	B-b-1	5,72	4,38	1,34	1,75	8,28
5.	10	B-a-2	6,25	5,02	1,23	1,50	14,32
6.	16	B-b-2	6,17	4,82	1,35	2,02	15,22
7.	11	B-a-3	5,47	4,19	1,28	1,50	20,10
8.	17	B-b-3	6,19	5,11	1,08	2,19	14,42
9.	12	B-a-4	5,41	4,25	1,16	1,46	18,99
10.	18	B-b-4	5,86	4,66	1,20	2,15	9,70
11.	13	B-a-5	5,52	4,23	1,29	1,96	14,66
12.	19	B-b-5	6,05	4,80	1,25	2,17	13,31
13.	14	B-a-6	5,29	4,00	1,29	1,85	6,63
14.	20	B-c-1	5,35	4,07	1,28	2,73	10,04
15.	21	B-c-2	5,80	4,51	1,29	2,80	9,77

Table 2. Presentation of the results of pH values and mineral nitrogen content in the soil.
Source: Results from the experiments that were posted on April 7, 2019

The highest pH value in KCl was achieved with the use of zeolite, manure and microbiological fertilizer EM Naturalnie aktywni and amounted to 5.11 (Variant No. 8).
The difference in pH value in H_2O and nKCl with the use of microbiological fertilizer EM Naturalnie aktywni (variant number 9) was greater than the value of the same difference in the variant with the use of zeolite and microbiological fertilizer EM Naturalnie aktywni (variant number 4 and variant number 14). Also, the value of the same difference on the variant with the application of manure and microbiological fertilizer EM Naturalnie aktywni and microbiological fertilizer EM bio (variants no. 11, no. 12 and no. 13) was higher in relation to the same variants with the application of zeolite. From the results of the difference in the pH value of the soil, it can be concluded that the application of zeolite reduces the clay content of the soil, while with the application of microbiological fertilizers, the clay content of the soil increases.

The application of zeolite and microbiological fertilizer EM Naturalnie aktywni, i.e. the application of zeolite, manure and microbiological fertilizers EM Naturalnie aktywni as well as microbiological fertilizer EM bio had an impact on increasing the moisture content in the soil compared to the variants without the use of zeolite. With the application of zeolite, manure and microbiological fertilizer EM Naturalnie aktywni the value of moisture content in the soil determined gravimetrically was 2.19%.

The content of mineral nitrogen in the soil with the application of zeolite and microbiological fertilizer EM Naturalnie aktywni (variant number 4) was 8.28 kg / ha and was lower than the content of mineral nitrogen with the application of microbiological fertilizer EM Naturalnie aktywni (variant number 3). Also on the variants with the application of zeolite, manure and microbiological fertilizers EM Naturalnie aktywni and EM bio (variants no. 8, no. 10 and no. 12), a lower content of mineral nitrogen in the soil was achieved in relation to variants no. 7, no. 9 and no. 11. of mineral nitrogen in the soil on the variants with the application of zeolite, manure and microbiological fertilizers ranged from 9.70 kg / ha to 14.42 kg / ha.
The application of zeolite with the application of manure and microbiological fertilizers had an impact on the retention of moisture in the soil during the dry period of the year as well as on the manifestation of its catalytic properties in relation to the chemical and microbiological properties of the soil. In all variants with the use of zeolite, manure and microbiological fertilizers, the content of mineral nitrogen in the soil at the end of the dry period was lower than the content of mineral nitrogen with the use of manure and microbiological fertilizers, which means that the removal of mineral nitrogen by raspberry roots was the evening.

3. CONCLUSION

Based on the results of the experiment related to the value of mineral nitrogen content in the soil with the application of NPK fertilizer, zeolite, manure and microbiological fertilizer EM Naturalnie aktywni (variant number 8), of 14.42 kg / ha, it can be concluded that to achieve optimal values of mineral nitrogen content of 20.0 kg / ha, it is necessary to reduce the amount of zeolite application from 3300 kg / ha to 2379 kg / ha. Also, the amount of application of the microbiological fertilizer EM Naturalnie aktywni from 70 l / ha to 49 l / ha should be reduced.
When applying NPK fertilizer, zeolite, manure and microbiological fertilizer EM Naturalnie aktywni in raspberry orchards, to obtain a harmonious physiologically optimal value of mineral nitrogen content at the end of the dry season of 20.00 kg / ha, it is necessary to implement the following activities:

- Perform standard chemical analyses of the soil before applying the fertilizer

- In the first year of raspberry orchard fertilization of the production area with NPK fertilizer, manure, zeolite and microbiological fertilizer EM Naturalnie aktywni, in an amount that depends on the results of standard chemical analyses of average soil samples. The amount application of zeolite and microbiological fertilizer EM Natural active to adjust the quantity and quality of applied manure.

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