original scientific paper
Ratar. Povrt. 2020, 57(3): 72-79
doi: 10.5937/ratpov57-27962
Received: 13 August 2020
Accepted: 2 September 2020

Influence of effective microorganisms on soil biogenicity parameters in the rhizosphere of different soybean genotypes and soybean yield

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Summary: The aim of the study was to determine the effects of applying effective microorganisms (EM) on the basic microbiological parameters of soil and soybean yield biological value. The research was conducted in the period 2016-2018. Factor A are the years 2016-2018, factor B are soybean genotypes Galina, Sava, Rubin, and factor C application of EM: variant 1 was control, variant 2 was EM in soil 20 lha^{-1} and foliar treatment in the stage of plant development from three to four trefoils and budding stage, 5 lha^{-1}, variant 3 was NPK fertilizer (8:15:15), 300 $kgha^{-1}$, and variant 4 was a combination of variant 2 and variant 3. During full flowering, the basic parameters of soil biogenicity were determined by the total number of microorganisms (TNB) and the number of azotobacter (AZT) and grain yield at the end of the growing period. The examined factors had a statistically significant influence on the examined parameters. Soil biogenicity parameters in variant 4 EM + NPK were statistically significantly ($p<0.01$) higher than control and variant 3. Variant 2 affected a higher number of $p<0.01$ compared to control, while compared to other variants significance was $p<0.05$ (factor B). The highest number of all examined parameters was in the rhizosphere of Rubin genotype (factor C). Variant 2 with EM increased in yield of 13.29% compared to the control which was at the level ($p<0.05$) and with the application of EM + NPK variant 4 the yield was higher by 15.95% which was at the level ($p<0.01$) of significance.
Key words: effective microorganisms, soybean, soil biogenicity, yield

Introduction

The development of sustainable agriculture intensifies research into the application of different groups of microorganisms that have a role in preventive protection and supplementary plant nutrition. In modern research, preparations with different groups of microorganisms are increasingly used, which provide good conditions for achieving stable yields while preserving the quality of the soil. The application of effective microorganisms (EM) is today the subject of many studies in the world (Sabeti et al., 2017; Higa, 2001). Effective microorganisms (EM) are a good combination of free aerobic and anaerobic microscopic organisms, which are found in nature. The main types of microorganisms that are present in preparations with EM are lactic acid bacteria (*Lactobacillus plantarum, Lactobacillus casei, Streptococcus lactis*) photosynthetic bacteria (*Rhodopseudomonas palustris and Rhodobacter sphaeroides),* yeasts, actinomycetes and various species of fungi. These types of microorganisms produce large amounts of aminoacids, enzymes, hormones, antibiotics, vitamins and other bioactive compounds, which are directly absorbed by plants (Kim & Lee, 2000; Ranjithisar, 2007), and can be substrates for bacteria and to increase the diversity of microflora in the soil. When introduced into the soil, they accelerate the decomposition of cellulose, lignin, and substances that control the development of phytopathogenic organisms (Higa, 2000). The use of effective microorganisms (EM) can reduce the amounts of chemical fertilizers, increase the yield parameters of plants, as well as the amount of biologically active substances in fruits and seeds.

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Acknowledgements:
This research was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, grant number: 451-03-68/2020-14/200378 and 451-03-68/2020-14/200032.

Cite this article:
Abduladin E., Cvijanović G., Đukić V., Đurić N., Miladinov Z., Cvijanović M., Mussa Abduladin A. (2020). Evaluation of respiratory activity of albic luvisol contaminated by zinc and nickel during spring rapeseed cultivation. *Ratar. Povrt.,* 57 (3), 72-79.

According to Sabeti et al. (2017), the application of EM in the soil reduced the negative effect of salinity on the morphology of corn roots. They also found that the application of EM to the soil and foliar treatment of sweet corn can increase the dry weight of the roots, root volume and length of the shoot. The use of free diazotrophs in soybean production can achieve stable yields and maintain soil biogenicity (Cvijanović et al., 2007), as well as reduce the negative impact of drought (Cvijanović and Dozet, 2018).

According to Javid (2006), foliar application of EM with the use of NPK fertilizers in the production of peas (*Pisum sativum* L.) increases the number of nodules at the root of peas by 217% and the biomass of nodules by 167%. Also, it was found that fertilization with effective microorganisms and NPK fertilizers increased grain yield by 126%, and in combination with organic fertilizer the increase in grain yield was 145%. The same author has found that by applying the EM in wheat production can increase yield by 27% compared with the production of which are applied only chemical fertilizers. In the production of maize with the use of organic fertilizers and preparations with effective microorganisms, it is possible to increase the yield parameters and yield of maize grains (Priyadi et al., 2005). Similarly, Xiaohou et al. (2001) stated that spraying with effective microorganisms can increase the yield and quality of different crops. By adding photosynthetic bacteria to the soil, the content of other effective microorganisms increases, e.g. mycorrhizal fungi. The increase in mycorrhizal fungi in the rhizosphere is due to more available nitrogen compounds (amino acids) which are the secretions of photosynthetic bacteria. These fungi can coexist with nitrogen-fixing bacteria, increasing nitrogen-fixing ability and grain yield.

Soybean is a plant species that has an extremely great economic and agro-technical significance, so it has been the focus of many researches in recent decades. Soybean has more importance for the production of biogas in a circular economy (Milanović et al., 2020). The use of symbiotic bacteria of the Rhizobium family in the cultivation of soybeans has become a mandatory measure. Bacterial species such as *Bradyrhizobium japonicum, Bradyrhizobium elkani* and *Sinorhizobium fredii* are able to provide up to 70% of the nitrogen needed for optimal soybean production in the process of biological nitrogen fixation (Martinez-Romero and Caballero-Mellado, 1996). The remaining 30% of the nitrogen must be provided in a way which must respect the principles of good agricultural practice and preserve soil quality. One of the basic conditions for good soil quality is to increase the diversity of the soil microbial population. Increasing the total number of microorganisms as well as individual physiological groups creates good conditions for achieving high and quality yields.

The main objective of this study was to determine the impact of EM application on soil biogenicity parameters in the soybean rhizosphere and grain yield in three-year studies.

Material and Methods

The research was conducted in the period 2016-2018 on chernozem type land. The experiment was set up according to the design of a split-plot on an area of 2475 m^2 in the experimental field Rimski Šančevi at the Institute of Field and Vegetable Crops in Novi Sad. The size of the basic plot was 15 m^2 (six rows of soybeans with a row spacing of 50 cm and a row length of 5 m). Four central rows were used to analyze the examined parameters. In the experiment, three factors were set in four repetitions. All agrotechnical measures were implemented in optimal deadlines and correctly.

Factor A: years 2016-2018 (2016 with the most optimal weather conditions for soybean production, 2017, with a pronounced dry period and very high temperatures, unfavorable for soybean production and 2018, favorable for soybean production).

Factor B: genotypes of different soybean ripening groups selected by the Institute of Field and Vegetable Crops Novi Sad (1. Galina, 0 ripening group, length of vegetation period of 119 days, 2. Sava, I ripening group, vegetation period length 123 days, 3. Rubin, II ripening group, length of vegetation period 133 days).

Factor C: fertilization with the following variants:

1. Control, i.e. variant without application of NPK fertilizers and EM Aktiv preparations.
2. Variant with application of effective microorganisms in a liquid preparation under the commercial name EM Aktiv (application on the soil before sowing in the amount of 20 liters per hectare and two foliar treatments in the phase of plant development from three to four trefoils and budding phase, i.e. buds on soybean tree in the amount of 5 lha^{-1}).
3. Variant with application of NPK fertilizer during basic tillage in autumn, fertilizer formulation 8:15:15, quantity 300 kgha^{-1}.
4. Variant with application of NPK fertilizer, formulation 8:15:15, in the amount of 300 kgha^{-1}, during basic tillage in autumn and application of effective microorganisms in the form of EM Aktiv 5 lha^{-1} (incorporation into the soil before sowing in the amount of 20 liters per hectare and two foliar treatments during the vegetation - in the development phase of plants from three to four trefoils and in the budding phase, before soybean flowering in the amount of five liters per hectare).

In the phenophase of full flowering - R2 (Fehr and Caviness, 1977), 0.5 cm from the central root and root hairs, samples of rhizosphere soil were taken. Samples were taken from the rhizosphere of three plants from the central rows. Microbiological analyzes were performed in the Department of Microbiology, Department of Soybeans at the Institute of Field and Vegetable Crops in Novi Sad. In the samples, the total number of bacteria (TNB × 10^{-7}), azotobacter (AZB × 10^{-2}), were determined by the method of agar plates (Trolldenier, 1996). Appropriate nutrient media were used (Hi Media Laboratories Pvt. Limited, Mumbai, India): nutrient agar for the total number of bacteria, synthetic agar for the number of actinomycetes, and azotobacter medium with mannitol for the number of azotobacter. At the end of the vegetation, the grain yield was measured and calculated at 14% moisture.

Agrometeorological conditions for the period 2016-2018

Soybean requires larger amounts of moisture in the first phases of development, and in the later stages from flowering to maturation, a good distribution of precipitation is necessary. Data on temperatures and precipitation were taken from the website of the Republic Hydrometeorological Institute for the meteorological station Rimski Šančevi (http://www.hidmet.gov.rs/ciril/ meteorologija /klimatologija_godisnjaci.php).

Based on the measurements, it was determined that the average monthly temperatures for the soybean vegetation period in the research years had higher values by 1.1 °C in 2016, 1.6 °C in 2017 and 2.5 °C in 2018 in relation to the multi-year average (18.1 °C). Precipitation was higher in 2016 by +75.6 lm^{-2} and in 2018 +60.9 lm^{-2} compared to the multi-year average (375.0 lm^{-2}), while in 2017 there was a deficit -58.5 lm^{-2} precipitation during the soybean growing season. The highest amount of precipitation per month was in 2016 (the most favorable conditions for soybean production).

At the end of the growing season, the crops were harvested and the yield change was processed to 14% moisture. The data were statistically processed using STATISTICA 10 software. The significance of the difference between the applied treatments was determined using Fisher's LSD test.

Results

The dynamics of the total number of microorganisms and individual systematic and physiological groups is a variable value and depends on a number of factors (soil structure, presence of toxicants and anthropogenic impact). The total number of microorganisms gives a picture of the overall condition of the soil and is one of the most important indicators of soil fertility. *Azotobacter* belongs to the group of the most important associative diazotrophs whose existence has been determined in the microbial niches of the rhizosphere of corn, wheat, sugar beet and sunflower. Due to its sensitivity and certain requirements for the habitat, it reacts violently with its number to all changes. Due to this property, it is a good indicator of all changes in the soil, especially degradation. In our country, free aerobic nitrogen fixers from the genus Azotobacter have been the most researched. In agricultural lands, fertilizers have a high effect on the function and structure of the microbial community (Cinnadurai et al., 2013). Organic fertilizers significantly affect the accumulation of bacteria and increase biomass in the soil (Murugan and Kumar, 2013), while mineral fertilizers significantly affect the reduction of activity and the number of the microbial community (Cvijanović et al., 2007).

Analysis of variance showed that the main sources of variation (age, genotype and fertilization) as well as their interactions had a significant impact on the examined parameters of soil biogenicity. The year as a factor had a statistically significant influence on the examined parameters at the level of $p < 0.01$. In 2017, there was statistically the smallest number TNB (97.36 × 10^{-7}) (Table 2) AZB (125.79 × 10^{-2}) (Table 3) as well as actinomycetes (22.06 × 10^{-4}) (Table 4). If 2016 is taken as the reference year, because it was the most

Table 1. Mean monthly temperatures (°C) and sum of precipitation (lm^{-2}) for soybean vegetation period 2016-2018

Month	Mean monthly temperatures (°C)			Multi-year average 1964-2015	Average monthly precipitation (lm^{-2})			Multi-year average 1964-2015
	2016	2017	2018		2016	2017	2018	
April	14.2	11.4	17.2	11.7	74.5	57.0	49.0	46.9
May	16.9	17.6	20.4	17.0	85.0	82.9	64.2	67.1
June	21.7	23.2	21.5	20.0	143.2	65.7	163.2	86.5
July	22.8	24.3	22.0	21.7	68.4	12.0	81.2	67.4
August	21.1	24.8	24.0	21.2	45.8	17.4	51.2	59.3
September	18.5	16.9	18.5	16.9	33.7	81.5	27.1	47.8
Average/Sum	19.2	19.7	20.6	18.1	450.6	316.5	435.9	375.0

favorable for soybean production, a significant decrease in the number of microbes was found in 2017 (TNB by 59.64%, AZB by 11.5%) because it was the largest deficit of precipitation. In 2018, the TNB was determined to be 159.16 × 10^{-7}, which was statistically significantly less than in 2016, although the most rain fell in June. The number of AZB was the highest in 2018 (150.76 × 10^{-2}), which was a statistically significantly higher number only compared to 2017 (142.12 × 10^{-2}), while compared to 2016 (142.12 × 10^{-2}) no significant difference was found. This ratio of the number of AZB in 2016 and 2018 is assumed to be the result of approximately the same values of the measured temperature and the amount of precipitation in June, when soil samples were taken.

Factor C significantly influenced the change in abundance in the soybean rhizosphere. There were statistically significant differences between the variants where EM was applied in relation to the control and application of NPK, while there was no statistical significance between the variants with EM. On average for all three years of research, TNB in control was 136.85 × 10^{-7}, and with the application of NPK 126.03 × 10^{-7}. Both variants had a statistically significantly lower number than in the application of EM in variant 2 (208.56 × 10^{-7}) and in variant 3 (197.91 × 10^{-7}). The number of AZB applications of EM in variant 2 (150.84 × 10^{-2}), as well as variant 3 with NPK (151.43 × 10^{-2}) was statistically significantly higher compared to the control (123.67 × 10^{-2}) ($p<0.01$). Variant 4 (143.78 × 10^{-2}) increased the number of azotobacter to the level of significance of $p<0.05$ compared to the control, while in relation to variants 2 and 3 the number was smaller but not statistically significant.

Similar results were obtained by Đukić et al. (2012) in the study the application of the mixture cultures of *Azotobacter chroococcum, A. vinelandi, Derxia sp.*, *Bacillus megatherium, B. licheniformis* and *B. subtilis* increased total number of microorganisms, number of oligonitrophiles, actinomycetes, azotobacter and fungi during the plant growing season.

The use of effective microorganisms (EM) as soil inoculants is based on the principles of natural ecosystems that are maintained, such as: greater diversity and abundance of organisms, greater interaction and a more stable ecosystem. Owing to them, a small contribution is made to the application of these principles in agricultural land and to change the microbiological balance in favor of increased growth, production and plant protection (Higa, 1991). Effective microorganisms are not a substitute for other agrotechnical measures related to plants and soil. Used properly, they can significantly increase the beneficial effects of these measures (Higa and Wididana, 1991) and represent an additional dimension for optimal production.

Table 2. Total number of microorganisms (TNB × 10^{-7})

Year (A)	Genotype (B)	Fertilizer (C) 1. Control	2. EM Activ	3. NPK	4. EMActiv + NPK	$\bar{x}$ A×B	$\bar{x}$ A
2016	Galina	208.24	297.61	186.27	275.26	241.85	241.26
	Sava	198.63	264.55	172.19	272.82	227.02	
	Rubin	220.07	312.64	195.45	291.43	254.90	
	$\bar{x}$ A×C	208.98	291.60	184.63	279.84		
2017	Galina	56.25	132.47	72.73	119.46	95.23	97.36
	Sava	68.49	129.61	65.09	120.77	95.99	
	Rubin	62.35	138.86	80.22	126.05	100.87	
	$\bar{x}$ A×C	62.36	133.67	72.68	122.09		
2018	Galina	126.53	198.81	118.54	184.47	157.09	159.16
	Sava	130.67	185.49	122.22	167.11	151.37	
	Rubin	144.28	205.17	126.40	200.59	169.11	
	$\bar{x}$ A×C	133.83	163.16	122.39	184.06	$\bar{x}$ B	
$\bar{x}$ B×C	Galina	130.34	209.63	125.84	193.06	164.71	
	Sava	132.59	197.65	119.83	186.90	159.24	
	Rubin	142.23	218.89	134.02	206.02	175.29	
	$\bar{x}$ C	135.05	208.72	126.59	195.51		
Average 2016-2018						166.41	

LSD	A	B	C	A × B	A × C	B × C	A×B×C
1 %	68.73	20.64	64.37	29.62	66.50	49.62	66.12
5 %	50.24	14.14	48.54	22.45	47.92	36.18	48.06

Plant-microbial interactions through various mechanisms can positively affect plant growth (Moulin et al., 2001). The effects of plant species are important variables in determining the bacterial composition of the rhizosphere. Plants with their secretions have a significant influence on the interaction with microbes from soil niches. Sugars and acids are present in the secretions, and the number and diversity of the rhizosphere microflora depend on their quantity. Depending on the mass of the roots, the amount of exudate that the plants release into the environment also depends. On average, for all years of research and applied variants, the largest total number was determined in the rhizosphere in the cultivar Rubin (factor B) (175.29×10^{-7}), which is of the II ripening group and which has the largest green mass. Compared to total number in the rhizosphere of the Sava variety (159.24×10^{-7}), a statistically significantly higher total number ($p<0.05$) was found in the Rubin variety, while there was no statistically significant difference compared to the Galina variety. On average for the whole period of study the interaction of B × C was the highest total number of the cultivar Rubin in variant 2: fertilization with EM (218.89×10^{-7}), which was also the increase of 53.89% compared to the control (136.89×10^{-7}). In variant 4, the increase was 44.84%.

According to the years of research, the largest increase was determined by the application of EM in variant 2 (49.60%) and variant 4 (33.90%) in 2017. The obtained results are a significant indicator that the application of EM can reduce the negative impact of agroclimatic conditions. On average, the control variant had the lowest total number of microorganisms.

The influence of the cultivar on the abundance of azotobacter was greatest in the rhizosphere of the cultivar Rubin (181.51×10^{-2}). The determined number on average for all variants in the period 2016-2018 research was statistically significantly higher ($p<0.01$) than in the cultivar Galina (111.95×10^{-2}) and the cultivar Sava (138.86×10^{-2}).

The number of AZ was highest in the rhizosphere of the Rubin variety using NPK variant 3 (2012.23×10^{2}), which is 39.30% higher than the control (152.35×10^{-2}). EM in variant 2 (205.91×10^{-2}), increased the yield of AZ by 35.15% compared to the control, while variant 4 (155.53×10^{-2}) had the lowest percentage increase of 2.08% compared to control (155.53×10^{-2}).

In the interaction of cultivars and fertilization by years of research, it was determined that the cultivar Rubin in 2016 had the highest number in variant 3 (156.82×10^{-2}), in 2017 in variant 2 (234.51×10^{-2}). In 2018, the largest number of AZ was in the rhizosphere of the Rubin variety in variant 2 (253.66×10^{-2}).

Table 3. The number of AZ in soybean rhizosphere (AZB × 10^{-2})

Year (A)	Genotype (B)	Fertilizer (C)				$\bar{x}$ A×B	$\bar{x}$ A
		1. Control	2. EM Activ	3. NPK	4. EM Activ NPK		
2016	Galina	152.43	136.92	140.65	150.88	145.22	142.12
	Sava	86.25	145.38	97.36	201.24	132.56	
	Rubin	161.57	129.55	232.46	154.76	169.59	
	$\bar{x}$ A×C	133.42	137.28	156.82	168.96		
2017	Galina	64.29	85.60	58.80	64.54	68.31	125.79
	Sava	116.24	92.49	108.28	145.81	115.71	
	Rubin	171.28	234.51	199.28	168.33	193.35	
	$\bar{x}$ A×C	117.27	144.06	122.12	126.23		
2018	Galina	136.12	127.37	128.63	97.26	122.35	150.76
	Sava	100.60	132.54	192.53	167.69	148.34	
	Rubin	124.20	253.66	204.95	143.50	181.58	
	$\bar{x}$ A×C	120.30	171.19	175.37	136.15	$\bar{x}$ B	
$\bar{x}$ B×C	Galina	117.61	116.63	109.36	104.23	111.95	
	Sava	101.03	123.47	132.72	171.58	132.25	
	Rubin	152.35	205.91	212.23	155.53	181.51	
	$\bar{x}$ C	123.67	150.84	151.43	143.78		
Average 2016-2018						141,90	

LSD	A	B	C	A × B	A × C	B × C	A×B×C
1 %	24.8	44.86	25.17	40.29	27.44	37.61	34.82
5 %	17.52	33.18	18.64	29.71	20.29	27.78	25.72

Table 4. Influence of EM on grain yield (kg ha^{-1})

Year (A)	Genotype (B)	Fertilizer (C)				$\bar{x}$ A×B	$\bar{x}$ A
		1. Control	2. EM Activ	3. NPK	4. EM Activ + NPK		
2016	Galina	4098.75	4461.94	4485.95	4597.14	4410.95	4700.32
	Sava	4223.51	4696.34	4658.83	4792.95	4592.91	
	Rubin	4651.84	5240.94	4963.52	5332.10	5097.10	
	$\bar{x}$ A×C	4324.70	4799.74	4769.43	4907.40		
2017	Galina	2442.34	2911.91	2796.86	2902.38	2763.37	2993.14
	Sava	2604.15	2799.39	2941.24	3067.14	2852.98	
	Rubin	2724.15	3610.89	3462.63	3654.63	3363.07	
	$\bar{x}$ A×C	2590.21	3107.40	3066.91	3208.05		
2018	Galina	3756.12	4185.37	4122.59	4228.10	4073.04	4411.05
	Sava	4060.04	4439.75	4433.50	4565.09	4374.59	
	Rubin	4352.21	4942.55	4823.96	5023.33	4785.51	
	$\bar{x}$ A×C	4056.56	4522.56	4460.02	4605.51	B	
$\bar{x}$ B×C	Galina	3432.40	3853.07	3801.80	3909.21	3999.12	
	Sava	3629.23	3978.49	4011.19	4141.73	3940.16	
	Rubin	3909.40	4598.13	4416.70	4670.02	4105.03	
	$\bar{x}$ C	3657.01	4143.23	4076.56	4240.32		
			Average 2016-2018			4118.17	
LSD	A	B	C	A × B	A × C	B × C	A×B×C
1 %	536.42	397.48	552.14	612.23	572.61	607.08	682.01
5 %	380.20	288.69	398.47	446.82	408.16	440.22	524.62

The obtained results are compatible with the results of Sangakkara and Higa (1994) who studied the effect of EM on rhizobacteria (i.e. on nodulation in beans) on soils with low and high population of rhizobacteria. The application of EM significantly increased the number of bacteria in the soil. The biggest changes were in soils with a small population of microorganisms. Nodulation and nitrogenase activity were significantly increased by the application of EM especially in nutrient-poor soils. Javaid (2000) observed a significant increase in mycorrhizal colonization of *Vigna radiata* due to the application of beneficial microorganisms. In order for populations of beneficial microorganisms to be effective after inoculation, it is important that their initial population in the soil be at a certain critical level. This ensures that the amount of bioactive substances they produce is sufficient to achieve the desired effect in production and/or protection in plants.

The average yield of soybeans in 2016 was 4700.32 kgha^{-1}, and in 2018 4411.05 kgha^{-1} and these values were statistically very significantly higher compared to 2017 (2993.14 kgha^{-1}).

Observing the average values for grain yield by individual varieties, it is noticed that the highest value was recorded in the variety of soybean Rubin (4105.03 kgha^{-1}), which is statistically very significantly ($p<0.01$) higher value compared to the yields in varieties Sava (3940.16 kgha^{-1}) and Galina (3999,12 kgha^{-1}).The average yield by fertilization variants is observed to be the highest value recorded on the variant with EM variant 4 (4240.32 kgha^{-1}), which is statistically very significantly ($p<0.01$) higher value compared to the control variant of the experiment (3657 .01 kgha^{-1}) by 15.95%. In variant 2 with the application of EM, the yield was (4143.23 kgha^{-1}), which is a significant increase ($p<0.05$) by 13.29% compared to the control. The application of NPK (4076.56 kgha^{-1}) did not statistically significantly increase the yield compared to the control. The highest percentage increase in yield compared to the control (2590.21 kgha^{-1}) with the application of EM was recorded in 2017. Variant 2 (3107.40 kgha^{-1}) increased grain yield by 19.96% and variant 4 (3208.05 kgha^{-1}) by 23.85%. According to Trnka et al. (2011) in large parts of southern and central

Europe, changes in agroclimatic conditions are expressed through increased plant stress and shortening of vegetation, which increases the risk of yield loss (Trnka et al., 2014). Based on the obtained results, it can be said that the application of EM in droughts can alleviate the effect of stress and achieve safer production.

Conclusion

The use of effective microorganisms can increase the total number of microorganisms, the number of azotobacter and actinomycetes. The increases in the total number are at the level of statistical significance $p < 0.01$ in relation to the control and application of NPK fertilizers only. The differences in the number of examined groups of microorganisms in the application of EM and EM + NPK were not at the level of statistical significance. The largest percentage increase in the examined parameters was in 2017, when water deficit was the highest. Rubin variety, on average, had the largest number of examined groups of microorganisms during the research period. The application of EM can affect a statistically significant increase in the number of microorganisms in conditions when agroclimatic conditions are unfavorable for soybean cultivation. The application of EM can increase the grain yield by 13.29% using only EM, and in combination with NPK the increase was 15.95%.

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Uticaj efektivnih mikroorganizama na parametre biogenosti zemljišta u rizosferi različitih genotipova soje i prinosa soje

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Sažetak: Cilj istraživanja bio je da se utvrdi efekat primene efektivnih mikroorganizama (EM) na osnovne mikrobiološke parametre biogenosti zemljišta i visinu prinosa zrna soje. Istraživanja su sprovedena u periodu 2016-2018. Faktor A su godine 2016-2018; faktor B genotip soje Galina, Sava, Rubin i faktor C primena EM: varijanta 1-kontrola, varijanta 2-EM u zemljište 20 l/ha i folijarni tretmana u fazi razvoja biljaka od tri do četiri troliske i fazi butonizacije, 5 lha^{-1}); varijanta 3-NPK đubriva (8:15:15), 300 $kgha^{-1}$ i varijanta 4 - varijanta 2 + varijanta 3. U toku punog cvetanja utvrđeni su osnovni parametri biogenosti zemljišta ukupan broj mikroorganizama (TNB) i brojnost azotobaktera (AZB) i visinu prinosa zrna na kraju vegetacije. Ispitivani faktori su imali statistički značajan uticaj na ispitivane parametre. Parametri biogenosti zemljišta kod varijante 4 EM+NPK statistički značajno ($p<0,01$) bili veći od kontrole i varijante 3. Varijanta 2 uticala je naveću brojnost $p<0,01$ u odnosu na kontrolu dok u odnosu na druge varijante značajnost je bila $p<0,05$ (factor B). U rizosferi genotipa Rubin utvrđena je najveća brojnost svih ispitivanih parametara (faktor C). Varijanta 2 sa EM uticala je na povećanje prinosa od 13,29% u odnosu na kontrolu što je bilo na nivou ($p<0,05$), a sa primenom EM+NPK varijanta 4 prinos je bio veći za 15,95% što je bilo na nivou ($p<0,01$) značajnosti.

Ključne reči: efektivni mikroorganizmi, soja, biogenost zemljišta, prinos