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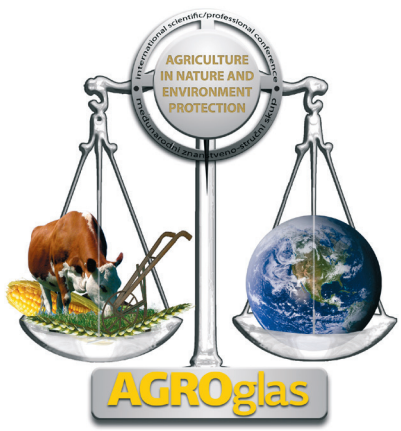

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The importance of using organic inputs and electromagnetic waves in soybean production

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Abstract

In order to environmental elements preservation it is necessary to support natural cycles and organisms that participate in them by various methods. The aim of this study was to determine the biological value of soil in soybean production by using organic fertilizers, beneficial microorganisms mixture and seed treatments by electromagnetic waves EMW (frequencies 15 Hz and exposure time 30 minutes). Necessary nutrients were provided by use of granulated poultry manure and beneficial microorganisms mixture (lactic acid bacteria, yeasts, fungi and actinomycetes). During the research the basic parameters of biological value of soil and yield were followed. The results showed significant increase of soybean yield (3052.17 kg ha^{-1}) in the version with electromagnetic waves EMW treatment (4.27%), than without the use of EMW (2927.08 kg ha^{-1}). Also, there was detected significantly higher number of total microorganisms in the soil, the number of azotobacters was smaller and the number of ammonifiers was uniform. The most intense microbial dynamics in both versions of experiment showed fertilizing with 750 kg ha^{-1}. The results of investigated biogeny parameters of soil were compatible with soybean yield.

Key words: microorganisms, electromagnetic waves, soybean, yield

Introduction

For centuries, in order to achieve the highest possible economic gain, human population with its activities affect the complex structure of ecosystem. The intensification of agricultural production, brought many benefits to human society, but mankind identified negative effects at the end of the 20th century, such as erosion, soil degradation, biodiversity reduction, presence of chemical residues in plant products. In contrast to intensive production, which is based on monoculture, reduced engagement of workforce and application of chemicals over large areas, sustainable production relies on a semi-intensive systems, crop rotation, natural plant resources. Increasing knowledge about ecosystem disturbance and endangerment of living world in general, resulted in need of agricultural production to stimulate biological cycles of biogenic elements. More complex demands of safe food production, as alternative to some

chemical compounds, lead to the solutions in the fields of microbiology and biophysics. As a relatively new science, biophysics is of great importance for agricultural production. Application of E-treatment (electromagnetic waves of low frequency or low energy electrons) is in the initial phase of implementation by us. Researches of Marinković et al. (2000), about the effects of electromagnetic waves on the growth of wheat seedlings gave positive results. According to research, Marinković et al. (2002), electrons are ejected from the cathode through the free atmosphere and they stimulate electrons in seed, which causes the rapid germination and seedling growth. Similar results got Malešević et al. (2002) who explored resonance impulse electromagnetic stimulation and its contribution to wheat production, while Lazetić et al (1990) investigated the effect on the wheat germ development. Considering that crop rotation is the best phytosanitary measure, it is recommended that in sustainable production it should be represented with a bigger number of plots. In crop rotation is suggested rather to rotate crops that have greater need for nitrogen adoption than crops which leave nitrogen in the soil. Therefore, legume species are preferred, where soybean has a prominent place.

The aim of this study was to determine the biological value of soil and soybean yield by using organic fertilizer, mixture of beneficial microorganisms and seed treatments by low frequency electromagnetic waves.

Material and methods

The experiment was set up in four replications on chernozem soil type in the experimental field of the Institute of Field and Vegetable Crops in Novi Sad. Valjevka soybean variety was used, group 0, length of growing season is up to 120 days. Necessary nutrients were provided by use of granulated poultry manure of formulation: N 4.5%, P_2O_5 2.7%, K_2O 2.2% in amount of: C-control (no fertilizer), F1-750 and F2-1300 kg ha^{-1}. Also, before sowing (10 days) soil was treated, at a depth of 8-10 cm, by microbial preparation containing a mixture of the following types of microorganisms: Lactobacillus plantarum, Lactobacillus casei, Streptococcus lactis, Rhodopseudomonas palustris, Rodobacter sphaeroides, carevisiae Saccharomyces, Candida utilis , Streptomyces albus, Streptomyces griseus, Aspergillus oryzae, Mucor hiemalis. Just before sowing seed treatment was performed by electromagnetic waves (EMW) (frequencies 15 Hz and exposure 30 minutes). After harvesting the experimental plots, grain mass and moisture content were measured and grain yield was calculated (kg ha^{-1}), based on 14% moisture content. At the end of the growing season soil biogenity was determined by number of individual systematic and physiological groups of microorganisms on selective media by standard microbiological methods (Pochon and Tardieux 1962). The obtained results were statistically analyzed using a two-factor split-plot experiment in analysis of variance (MSTAT-C), and significance of differences between treatments was tested with the LSD test.

Results and Discussion

Rhizosphere microorganisms have an important role in the community with plants, according to that that they react by their population density and enzymatic activity in the presence of pollutants, and are a good indicator of changes in soil (Cvijanović et al. 2006) microorganisms give an informative score about the health of the soil and ecotoxicity (Milosević et al. 2007). In order to keep beneficial microorganisms on a high population density level it is necessary to use the food production methods which promote the growth and speed of biochemical reactions of these groups of microorganisms. Treating the soil by certain groups of diazotroph microorganisms, beneficial microorganisms are stimulated, which significantly affects the in-

tensity of the production of biologically active substances and the synthesis of enzymes involved in all biochemical processes of soil, improve soil structure and increase germination and resistance of plants to phytopathogens (Cvijanović et al. 2012). Researches (Dozet et al. 2009; Cvijanović et al. 2011), show that the application of microelements Co and Mo in soybean production can have a positive influence on the dynamics of the basic parameters of soil biogeny. Measures in production technology should provide better conditions for the higher activity of microorganisms, because they by their enzymes and products of metabolism participate in the formation of mature humus, which is rich with easily degradable organic matter and the narrow ratio of carbon and nitrogen (Mišustin, 1975).

Table 1: The number of microorganisms in the rhizosphere of soil without radiation of soybean seeds

Variants	Azotobacter		Total number of microorganisms		Ammonifiers	
	10^2	I.N.	10^7	I.N.	10^4	I.N.
Control	89.17	100	143.07	100	55.73	100
Fertilization 1	31.50	35.33	246.33	172.17	72.10	129.37
Fertilization 2	0.00	0.00	176.87	123.64	107.67	149.33
Average	40.22	45.11	188.76	131.93	78.50	140.85

According to the results obtained (Table 1 and Table 2) different dynamics of microorganisms number was determined, depending on the amount of organic fertilizer and application of electromagnetic waves. In variant with EMW treatment, on average, there was a higher number of ammonifiers and the total number of microorganisms. The total number of microorganisms was significantly higher (250.55x107g^{-1}soil) than in the variant without the EMW seed treatments (188.76x107g^{-1}soil). Higher number of total microorganisms leads to more intensive biochemical reactions, which affect significantly the processes of mineralization and synthesis of organic matter in the soil. Applying fertilizer in quantities of 750 kg ha^{-1} in both variants of experiment resulted with larger total number of microorganisms. In the variant without EMW treatment (246.33x107g^{-1}soil) increase in total number was 72.17%, compared to the control (143.07x107g^{-1}soil). In the variant with EMW treatment (315.43x107g^{-1}soil) increase was 39.37%, compared to the control (226.33x107g^{-1}soil) (Table 2).

Ammonifiers are heterotrophic microorganisms, their enzymes are involved in the complete decomposition of nitrogen to nitrogen compounds. Dynamics of microorganisms number from this group was small, both with and without EMW treatment. In the variant without the use of EMW the number of this microbial group in the average was 78.50x104g^{-1}soil, and with EMW treatments the number was 79.70x107g^{-1}soil.

Table 2: The number of microorganisms in the rhizosphere soil with application of electromagnetic waves (EMW) on soybean seeds

Variants	Azotobacter		The total number of microorganisms		Ammonifiers	
	10^2	I.N.	10^7	I.N.	10^4	I.N.
Control+ EMW	3.27	100	226.33	100	54.50	100
Fertilization 1+EMW	8.50	259.94	315.43	139.37	85.27	156.45
Fertilization 2+EMW	10.73	328.13	209.90	92.74	99.33	182.25
Average	7.50	229.36	250.55	116.05	79.70	146.23

Number of Azotobacter depends on ecological conditions, agricultural technology and quantity of plant exudates. In addition to atmospheric nitrogen fixation, these microorganisms have the ability to produce plant growth physiologically active substances. Based on the results, significantly higher number of this group of microorganisms was found in variants without the application of EMW and in the control (89.10x102g^{-1} soil) (Table 1). In this variant, with fertilization amount of 1300 kg ha^{-1}, number of microorganisms was not determined. Decrease in number of this group of microorganisms can be influenced by presence of large quantities of nitrogen compounds in the soil. In average, smaller number of this group of microorganisms was found in the variant with application of EMW (7.50x102g^{-1}soil), than without EMW treatment (40.22x102g^{-1}soil). The yield (Table 3) was higher in variants with the application of EMW (3052.17 kg ha^{-1}). The increase in yield was 4.27% and for 125.09 kg ha^{-1}, which is the level of statistical significance of p>0.01 in relation to the variant without the application of EMW (2927.08 kg ha^{-1}).

Table 3: The height of soybean yield in variants in the experiment (kg ha^{-1})

Variants (A)	Fertilization (B)	AxB	Average (A)
Without the use of electromagnetic waves	Control	2878.00	2927.08
	Fertilization 1	2925.25	
	Fertilization 2	2978.00	
With the use of electromagnetic waves	Control + EMW	3060.25	3052.17
	Fertilization 1 + EMW	3063.25	
	Fertilization 2 + EMW	3033.00	
Average (B)	Control + EMW	2969.12	
	Fertilization 1 + EMW	2944.25	
	Fertilization 2 + EMW	3005.50	
Average yield		2972.79	

LSD	A	B	AxB
5%	19.59	27.11	38.34
1%	35.96	38.00	53.74

Conclusion

Based on the obtained results it can be concluded that the dynamics of the number of microorganisms in the rhizosphere depended on the amounts of fertilizer and the application of EMT. Applying fertilizer in quantities of 750 kg ha^{-1} the highest total number of microorganisms was determined in both variants of experiment, without the use of EMW and with the application of EMW. The total number of microorganisms was significantly higher (250.55x107g^{-1}soil) than in the variant without the EMW seed treatments (188.76x107g^{-1}soil). Determined number of ammonifiers on average was not with significant differences, while the number of Azotobacter with ETW treatment was significantly lower (7.50x102g^{-1}soil), than without EMW treatment (40.22x102g^{-1}soil). According to the results, it can be said that probably a competitive ratio occurred of total number of microorganisms and Azotobacter. Yield was in correlation with the results of the biological value of soil parameters. Yields was higher by 4.27% in the variant with the application of EMW (3052.17 kg ha^{-1}). The highest yield was in variant with the fertilization of 750 kg ha^{-1} and with the application of EMW (3063.25 kg ha^{-1}) .

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Značaj primjene organskih inputa i elektromagnetnih valova u proizvodnji soje

Sažetak

U funkciji očuvanja elemenata životne sredine potrebno je raznim metodama podržavati prirodne cikluse kao i organizme koji u njima sudjeluju. Cilj rada bio je utvrditi biogenost tla u proizvodnji soje primjenom organskih gnojiva, smjese korisnih mikroorganizama i tretmana sjemena elektromagnetnim valovima EMT (frenkvencije 15 Hz ekspozicije 30 minuta). U osiguranju potrebnih hraniva korišten je granulirani živinski stajnjak i smjesa korisnih grupa mikroorganizama (mliječno kiselinske bakterije, kvasci, gljive i aktinomicete). U tijeku istraživanja praćeni su osnovni parametri biogenosti tla kao i visina prinosa. Na osnovu dobivenih rezultata utvrđeno je u prosjeku značajno veći prinos soje (3052.17 kg ha^{-1}) u varijanti sa primjenom EMT (4.27%), nego bez primjene EMT (2927.08 kg ha^{-1}). Također, utvrđen je značajno veći broj ukupnih mikroorganizama u tlu, brojnost azotobaktera bila je manja, a amonifikatora ujednačena. Najveća dinamika broja ispitivanih grupa mikroorganizama u obje varijante pokusa bile su pri gnojidbi sa 750 kg ha^{-1}. Rezultati ispitivanih parametara biogenosti tla bili su kompatibilni sa visinom prinosa soje.

Ključne riječi: mikroorganizmi, elektromagnetni valovi, soja, prinos