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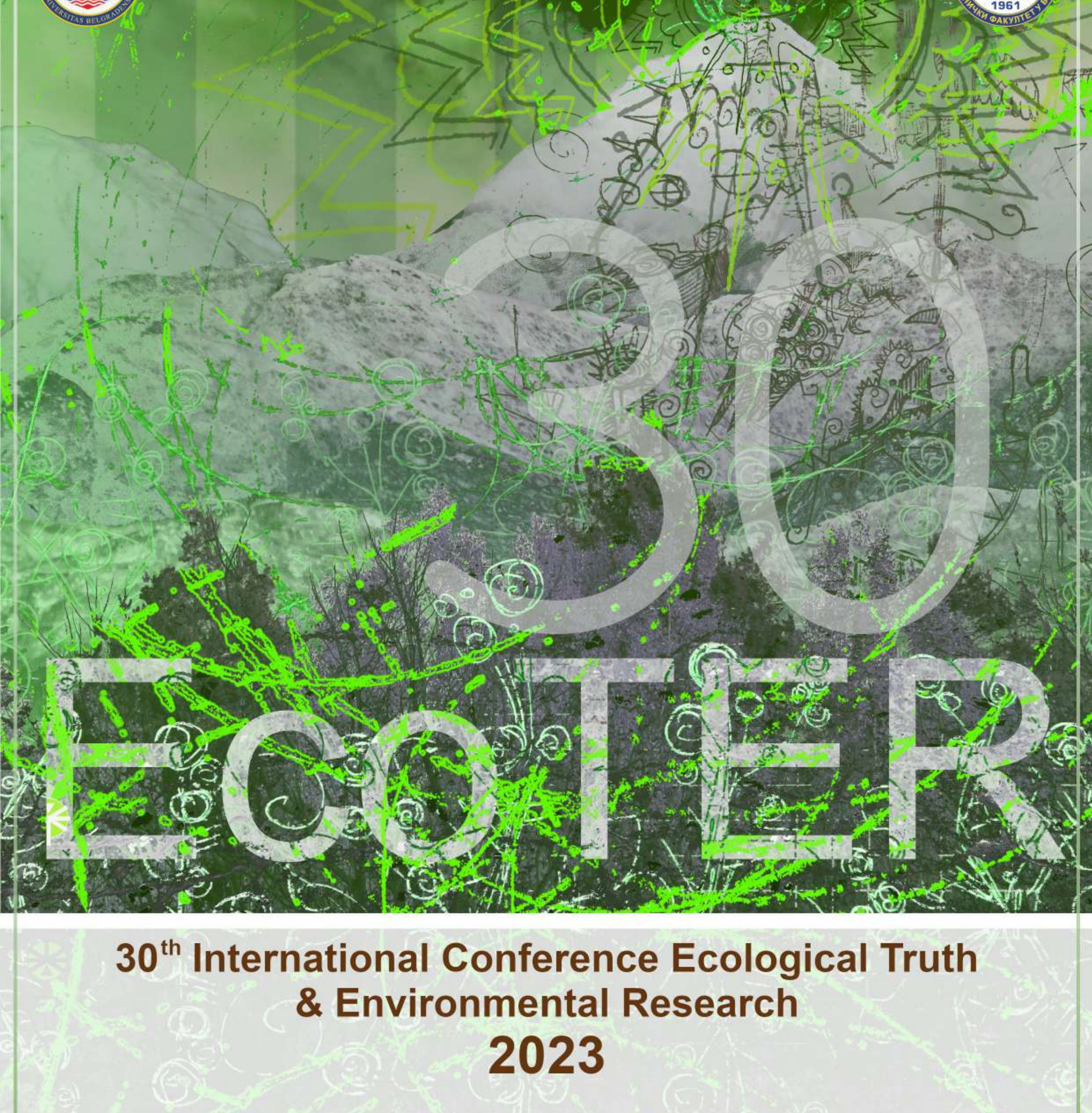

30th International Conference Ecological Truth & Environmental Research 2023

Proceedings

Editor
Prof. Dr Snežana Šerbula

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30 EcoTER

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INFLUENCE OF EFFECTIVE MICROORGANISMS ON THE BASIC PARAMETERS OF SOIL BIOGENICITY IN THE PRODUCTION OF WHEAT AND CORN

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Abstract

In modern directions of food production, it is necessary to apply measures that would reduce the possibility of soil degradation. The aim of the work was to determine the influence of effective microorganisms on the basic parameters of soil biogenicity in the production of wheat and corn. The experiment with wheat was carried out in 2019 and the experiment with maize in 2017. Agroecological conditions in 2019 were optimal for wheat production. In 2017, unfavorable agrometeorological conditions for maize production were recorded. In both experiments, the microbiological preparation EM Aktiv with effective microorganisms was used. With wheat, it was applied twice foliarly with 6 l ha^{-1}. In the case of maize, EM Aktiv was introduced into the soil before sowing at 20 l ha^{-1} and foliarly applied twice at 6 l ha^{-1}. The rhizosphere soil was analyzed. The total number of microorganisms and the abundance of Azotobacter in wheat were determined. In the case of corn, the total number of microorganisms and the number of ammonifiers were determined. In both experiments, an increase in the number of tested groups of microorganisms was found. The percentage increase in abundance depended on the genotype of wheat and corn. Based on the results, it was concluded that the application of effective microorganisms is necessary and that in sustainable food production systems it should be a mandatory measure to preserve the basic resources for food production.

Keywords: Microorganisms, wheat, corn, soil, biogenicity.

INTRODUCTION

In the era of satisfying food needs, the negative impact of agricultural production on the ecosystem is increasing. Inputs in agricultural production in the form of fertilizers, pesticides and agricultural mechanization have increased, which has led to higher yields, but also increased air, water, soil pollution and loss of biodiversity. Greenhouse gases from agriculture contribute to climate change. According to Tian *et al.* [1] in anthropogenic warming with greenhouse gases, nitrogen oxides from agriculture contribute 8%. The application of intensive agrotechnical measures most often leads to disruption of physical, chemical and biological properties. Intensive application of chemical inputs leads to soil contamination with heavy metals, radionuclides, and a decrease in the biodiversity of the soil microbiome. Soil pollution is estimated to contribute to more than 500,000 premature deaths worldwide each year [2], the largest percentage through food. With the development of sustainable systems of agricultural production (integral and organic), it is necessary to introduce methods that favor processes in accordance with the bio-geo-ecosystem into food production technology. The central place in these systems belongs to microorganisms. In agricultural production, in addition to bacteria that promote plant health (PHPR, Plant Health Promoting Rhizobacteria) or bacteria that promote nodulation (NPR, Nodule Promoting Rhizobacteria) [3,4], preparations with effective microorganisms (EM) are introduced.

Effective microorganisms are mixed cultures of beneficial microorganisms isolated from nature that can be used as inoculants to increase the yield of cultivated plants and the microbial diversity of the soil ecosystem. They consist mainly of photosynthesizing bacteria, lactic acid bacteria, yeasts, actinomycetes and fermenting fungi. When introduced into the soil, they participate in improving the structure, increasing the water capacity and fertility of the soil [5]. Chan *et al.* [6] found that the presence or absence of these beneficial microorganisms in any soil system accurately distinguishes "living" from "dead soil". Vals and Lorenzo [7] determined that the regular application of effective microorganisms can reduce the use of chemical fertilizers and pesticides, which results in a reduction of environmental pollution. Dourado [8] showed that the application of EM and its metabolites can reduce the population of phytopathogenic fungi *Fusarium sp.* on corn seeds from 21–67%. Iriti *et al.* [9] suggest that the use of EM can improve photosynthetic efficiency and thereby increase yields.

Large amounts of mineral fertilizers are used in the intensive production of basic agricultural crops. The constant use of mineral fertilizers leads to a decrease in soil fertility, a decrease in the biodiversity of soil microbes, leaching of nitrate nitrogen and eutrophication of waters. Wheat and corn occupy significant areas of the world, because they are the most common in human nutrition. Considering the large production of organic matter and yields of wheat and corn grains, large amounts of nitrogen are necessary. In intensive production, which is the most common form of production, complex mineral and nitrogen fertilizers are mainly applied.

Due to the current public concern about the side effects of agrochemicals, there is a growing interest in improving the understanding of the activities of microbial interactions among rhizosphere microbes and how they can be effectively used to benefit agriculture and the environment [10,11].

The aim of the work was to show the advantages of using effective microorganisms to change the abundance of the most important groups of microorganisms in the rhizosphere of different genotypes of wheat and maize.

MATERIALS AND METHODS

In the conducted research, the impact of effective microorganisms applied with the preparation EM Aktiv (trade name) on the total number of microorganisms, the abundance of *Azotobacter* and ammonifiers in the rhizosphere soil of cultivated plants was determined. Standard microbiological methods, a series of dilutions on agar plates, determined the basic parameters of biogenicity of the rhizosphere soil of cultivated plants. Microorganisms in the rhizosphere form complex communities, which are strongly influenced by products from plant roots and which have a great influence on the promotion of plant growth and soil fertility.

In 2019, an experiment with different wheat genotypes (Ratarica and Pobeda domestic selection, Nogal and Apache French selection) was conducted at the location of Padinske Skele. The plants were sown at a density of 500 plants per m^2. For the planned grain yield, the plants are provided with 129 N, 60 P_2O and 60 K_2O kg·ha^{-1}. In the phenological phase of flowering, EM Aktiv was applied twice in the amount of 6 l·ha^{-1}. In the phenological phase of pouring wheat grains, the rhizosphere soil was sampled.

In 2017, at the Šabac location, there was an experimental trial with different genotypes of corn where treatment with EM aktiv was applied. The plants were provided with 160 kg·ha^{-1} of nitrogen before sowing. Also, 20 l·ha^{-1} of EM Aktiv was introduced into the soil and during the growing season it was applied foliarly (2 x 6 l·ha^{-1}, in the phenological stages of development of 5–7 leaves and after 15 days). Rhizosphere soil was sampled in the phenological phase of intensive vegetative growth.

Given that agroecological factors are decisive for stable production, temperatures and precipitation in the vegetation were measured during the experiment. In 2019, agroecological factors were favorable for wheat production. The average temperature was within the optimum range of 10.9°C, the amount of precipitation was 537.3 mm, with a relatively good distribution. In 2017, the average temperature determined was 18.3°C, which is within the optimal range. The total amount of precipitation was 360.3 mm, which is below optimal needs. In addition, an unfavorable distribution of precipitation in the vegetation was determined Figure 1.

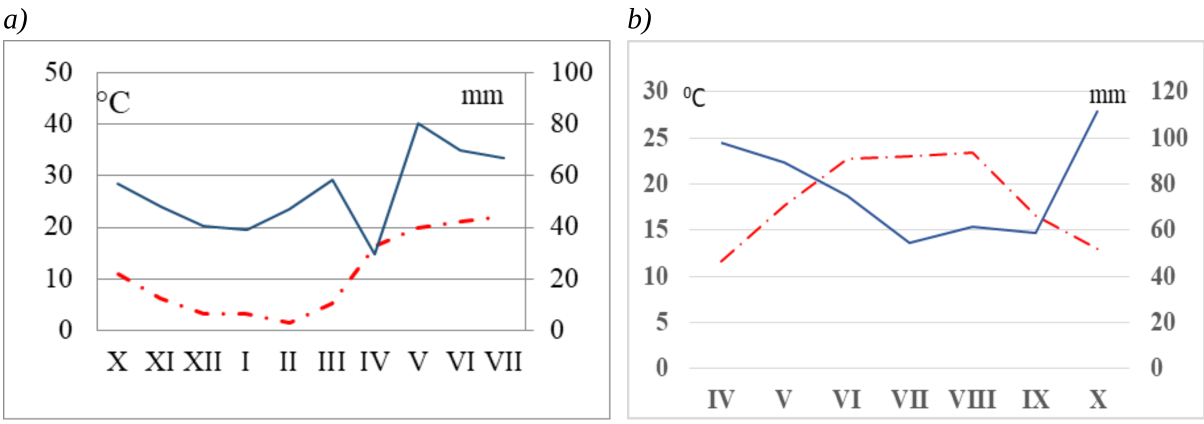

Figure 1 *Average air temperature (^{0}C) and sum precipitation (mm) in vegetation a) in 2019 year-wheat, b)-in 2017. year -corn*

RESULTS AND DISCUSSION

The level of soil fertility depends on the abundance and activity of different groups of microorganisms as indicators that define changes in soil quality. Given the fact that conditions in the rhizosphere are very dynamic (as a result of the day/ night cycles of photosynthesis and assimilation, and the dynamic growth of roots), thus, plant-associated microbial communities are highly variable in space and time. Research into the dynamics of changes in certain groups of microorganisms in the soil is a good indicator of changes. Changes in soil microbial balance can serve as an "early warning" for negative and positive changes in soil conditions long before they could be detected by classical chemical methods. Today, many studies are devoted to the composition of the microbial community in the soil from the aspect of its preservation [12,13].

Microorganisms, as the most numerous group of organisms in the soil, are under the direct influence of all substances introduced into the soil. Soil microorganisms participate in the degradation of organic and inorganic compounds, in the immobilization of heavy metals, in the biodegradation of slowly degradable compounds such as polycyclic aromatic compounds (PAH), as well as in processes related to the increase and quality of soil fertility. Their enzymatic activity, number, and diversity are bioindicators of the toxic effect of pollutants that reach the soil. Due to their specificities, they can be used as biosensors of soil toxicity [14]. Also, certain groups of microorganisms can be used in plant nutrition as a substitute or supplement for mineral fertilizers.

Based on the results of the experiment with wheat, it was determined that there is a significant influence of genotype and treatment with EM Table 1. In the rhizosphere of all tested wheat genotypes, there was an increase in the total number of microorganisms by 12.23% when treated with EM compared to the control. The PKB Ratarica variety had the best interaction relationship, and the Nogal variety had the weakest. The abundance of Azotobacter on average for all genotypes was increased by 9.14%. A decrease in the number of this group of bacteria was found in the Nogal variety, which indicates that there was probably no competitive relationship with the activity of other groups of microorganisms.

Table 1 *Total number of microorganisms (×·10^7 CFU·g^{-1} absolutely dry soil) and the number of Azotobacter (×·10^1 CFU·g^{-1} absolutely dry soil) in the rhizosphere of wheat*

Treatment (B)	**Total number of microorganisms**			***Number of Azotobacter***		
Genotype (A)	**Control**	**EM**	**Control =100 %**	**Control**	**EM**	**Control =100 %**
Ratarica	222.33	319.67	43.78	85.00	89.67	5.49
Pobeda	175.67	195.67	10.75	95.67	160.33	67.58
Nogal	259.67	255.67	15.64	320.67	312.67	-2.49
Apach	184.67	199.67	8.12	194.33	196.67	1.20
Average	**210.58**	**242.67**	**15.23**	**173.92**	**189.83**	**9.14**
	A**	B**	AxB**	A**	B**	AxB**
F test	0.00	0.03	0.00	0.00	0.00	0.00
LSD $_{0.05}$	12.39	16.69	33.39	6.66	5.05	10.10
LSD $_{0.01}$	16.61	22.87	45.75	8.93	6.92	13.84

In the experiment with corn, Table 2 shows the high significance of genotype and treatment on the total number of bacteria, while treatment with EM had a significant effect on the number of ammonifiers. The total number of microorganisms on average was higher by 23.52% when treated with EM, while the number of ammonifiers was higher by 14.86%. In the rhizosphere of hybrid ZP 548, the highest total number of microorganisms and ammonifiers was determined, so it can be said that it had the best interaction relationship with EM. The hybrid ZP 684 had the weakest interaction relationship. Given that a water deficit was determined in the period before rhizosphere soil sampling, it can be said that the application of EM can alleviate the stress of plants in unfavorable conditions for development.

Table 2 *Total number of microorganisms (× 10^7 CFU g^{-1} absolutely dry soil) and the number of ammonifiers (× 10^1 CFU g^{-1} absolutely dry soil) in the rhizosphere of maize*

Treatment (B)	**Total number of microorganisms**			***Number of ammonifiers***		
Genotype (A)	**Control**	**EM**	**Genotype (A)**	**Control**	**EM**	**Genotype (A)**
ZP 427	161.43	165.33	2.41	41.33	53.80	30.17
ZP 548	130.88	254.63	94.55	36.74	50.83	38.35
ZP 684	274.42	280.12	2.07	72.09	67.84	-5.89
Average	**188.91**	**233.36**	**23.52**	**50.05**	**57.49**	**14.86**
	A**	B**	AxB**	A	B**	AxB**
F test	0.00	0.38	0.00	0.10	0.00	0.00
LSD $_{0.05}$	9.53	10.19	24.57	7.66	5.53	9.58
LSD $_{0.01}$	13.36	11.83	32.61	10.74	7.34	12.72

CONCLUSION

The advantages of applying this form of plant production is that in this way the soil is enriched in organic matter, and the autochthonous microbial population is also activated, and oxidation-reduction processes in the soil are accelerated, which affects the yield and quality of cultivated plants.

Considering that microorganisms are effective only when they are provided with optimal conditions for physiological processes, often their effects are not clearly expressed. However, it can be said that microbial technologies are applicable for solving various agricultural and environmental problems with significant success in recent years, and such research should be continued.

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