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ACTIVITY OF THE MICROBIOCENOSE OF THE ROOT ZONE OF CORN PLANTS UNDER THE ACTION OF PLANT PROTECTION AGENTS

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ABSTRACT

The vast majority of modern chemical poisons solve the problem of diseases and pests on agricultural plants. However, their use causes deterioration of the ecological condition of agrocenoses. The biological activity of the soil of the root zone of corn was studied during the pre-sowing treatment of seeds with a complex of microorganisms No.1 + No.2. It was found that the use of a complex of microorganisms No. 1 + No. 2 reduced the number of micromycetes by 1.8–2.5 times. The level of antifungal activity increased 4–7 times compared to the control, and 1.5 times compared to the options where chemical preparations were used. Therefore, bioagents of complex No. 1 and No. 2, being introduced into the root zone of corn plants, initiate changes in the functioning of the microbiocenosis and protect plants during the growing season. We believe that the complex of microorganisms No. 1 and No. 2 is promising for further biotechnological developments.

Key words: carbon dioxide emission, biomass of microorganisms, antifungal activity, phytotoxicity, number of micromycetes, maize, biological products, microorganisms, biofungicide.

INTRODUCTION

The full-scale war in Ukraine showed that one of the most acute problems on Earth remains the provision of food to the population of the planet. One of the sources of functional food for mankind is corn [1, 2].
Obtaining the highest quality agricultural products with a high yield is the foundation of effective management. However, one of the obstacles to obtaining high-quality products is crop diseases, the pathogens of which are transmitted through the seed material or accumulate in the soil.
Pre-sowing treatment of seeds with protective and insecticidal protoxins has a significant advantage over the treatment of vegetative crops, as it is less time-consuming, economically economical and ecologically appropriate. Farmers believe that such an agro-practice is mandatory because corn suffers from a number of infectious diseases, and crop losses from diseases sometimes reach 10-20%.
Every year, during the cultivation of grain crops, the biological method of protection of agricultural crops becomes more and more popular. The biomethod is based on the use of living microorganisms and the products of their metabolism [3–6]. The effectiveness of biological preparations that include living microorganisms depends on the influence of abiotic factors (temperature, moisture, pH, etc.) [7–10].
Abiotic factors directly affect the agent microorganisms, exerting a stressful or stimulating effect on the introduced strain of microorganisms. Or they affect indirectly – by changing the number and physiological activity of other living organisms of the ecosystem.One of the determining factors for the successful introduction of microbial preparations into agroecosystems is the individual properties of active strains of microorganisms [11, 12].
It is believed that the most promising microbiological drugs are complex drugs created on the basis of two or more microorganisms [15, 16].
Scientists of the Institute of Agroecology and Nature Management of the National Academy of Sciences (Kyiv, Ukraine) have created 2 compositions of microorganisms that are considered promising.
The purpose of the study was to check the effect of the mixture of compositions No.1 + No.2 on the activity of the microbiocenosis of corn plants during the growing season.
Methods. In the experiments, corn hybrids *Khorol SV* (FAO 270) and *Vizyr* (FAO 350) were used. The area of experimental plots is 25.2 m^2, the seeding rate is 50,000 seed/ha.The repeatability of the field experiment is three times.
Agricultural machinery is generally accepted for the conditions of the Forest Steppe of Ukraine. Pre-sowing treatment of corn seeds was carried out with a mixture of chemical preparations and a complex of microorganisms No.1 + No.2.
Chemical preparation of Syngenta company (reference control): *Maxim XL* (fungicidal drug, active substance fludioxonil and metalaxyl-M) and *Cruiser* (insecticide, thiamethoxam).

Composition of microorganisms No.1 consisted of strains of *Paenibacillus polymyxa* 6M [13] and *Pseudomonas fluorescens* K-11 [14], collection of microorganisms of the Institute of Agroecology and Nature Management of the National Academy of Sciences (Kyiv, Ukraine), quantity – $3.2*10^9$ CFU/ml. The composition has a protective

effect, namely a high level of antagonistic properties against the pathogens of fungal diseases of cultivated plants. The rate of use of the composition is 0.5 l per 100 kg of seeds.

The composition of microorganisms No.2 consisted of strains of *Bacillus thuringiensis* 2729 and *Streptomyces spp*, collection of microorganisms of the Institute of Agroecology and Nature Management of the National Academy of Sciences (Kyiv, Ukraine), quantity – $4.7*10^9$ CFU/ml. The composition of microorganisms has a contact and systemic effect, which allows controlling a wide range of pests. The rate of use is 1.25 liters per 100 kg of seeds.
Research options:
1.Control (corn seeds were treated with sterile water);
2.pre-sowing treatment of seeds with a mixture of Maxim XL + Cruiser drugs;
3. pre-sowing treatment of seeds with a complex of compositions No.1 + No.2;

Soil samples were taken from the root zone of corn in the panicle shedding phase. The number of micromycetes in the root zone was determined by the method of sowing limiting dilutions. The carbon content of microbial biomass in the soil was determined by the rehydration method, and the intensity of carbon dioxide emission was determined by the Shtatnov method. Phytotoxicity of the soil of the root zone of corn was determined according to the method of Grodzinsky in the modification of Mochalov and Sherstoboev [17]. The antifungal activity of the soil of the root zone of corn was determined by measuring the zone of inhibition of the growth of test cultures of Fusarium Link., collection of the Institute of Agroecology and Nature Management of the National Academy of Sciences [18]. Statistical processing of experimental results was performed in the Statistica 6.0 program.
Results and discussion. The content of microbial biomass, carbon dioxide emissions, phytotoxicity, and the number of micromycetes were determined in the studied agroecosystems (Table 1). The study of the effect of pre-sowing treatment of corn seeds with chemical preparations (Maxim XL+ Cruiser) and a mixture of compositions No. 1 + No. 2 on the biological activity of the soil of the root zone of plants, testified to significant changes in the functioning of the microbiocenosis of the root zone of corn plants.
The use of chemical preparations suppresses the development of micromycetes in the soil by 2.4–3.3 times compared to the control. However, the treatment of corn seeds with a mixture of compositions No.1 and No.2 was not inferior to chemical preparations in terms of effectiveness and contributed to a decrease in the number of micromycetes by 1.8–2.2 times. Thus, the protective function of the complex of compositions No.1 and No.2 was manifested in the inhibition of the development of microscopic fungi during the growing season of corn plants, which in turn testifies to the successful colonization of the root zone of corn plants by microorganisms-agents of compositions No.1 and No.2.
It was established that the content of the biomass of microorganisms depended on the means of pre-sowing treatment with the help of the type of hybrid and the year of study. An active increase in the content of microbial biomass was noted in the variants with the use of a complex of compositions No.1 and No.2 with its gradual decrease until the end of the corn growing season, which develops due to the attenuation of vital processes in the microbiocenosis at the base of the root zone of corn plants. Biomass content in the soil of the root zone of plants under the condition of seed inoculation of the complex of compositions No.1 and No.2 was 281–305 μg C/g of soil, which is 39–47 μg C/g of soil less than in the control plot. Maxim XL+Kruizer seed treatment reduced the microbial biomass by 27–32.5 %, depending on the corn hybrid. The highest level of carbon dioxide emission in the soil of the root zone of corn plants was noted for the research option where a complex of compositions No.1 and No.2 was used. It was found that the use of a complex of compositions No.1 and No.2 contributed to an increase in CO_2 release by 5.4–10.8 % relative to the control and options with chemical seed poisoning.
In turn, the indicator of soil carbon dioxide emission decreased by 13–18.8 % under the action of chemical preparations relative to the control, which indicates a decrease in the intensity of microbiocenosis processes in the root zone of corn plants.

Table 1. Biological activity of the soil of the root zone of corn

Options	The number of micromycetes, 10^3 of CFU/g of soil	Emission of carbon dioxide, mg CO_2/kg soil per day	Biomass, μg C/g of soil	Phytotoxicity, %
Khorol SV (FAO 270)				
Control (sterile water)	67.4±8.1	42.51±3.8	352±28,2	14.2
Maxim XL+Cruise	28.6±2.3	36.93±2.2	256±16,0	5.4
Composition of microorganisms No.1+No.2	36.8±4.3	44.79±2.5	305±22.0	10.5
Vizyr (FAO 350)				
Control (sterile water)	73.6±7.4	38.14±2.7	320±27.5	15.8
Maxim XL+Cruise	22.5±3.4	30.97±1.9	216±16.5	6.3

Composition of microorganisms No.1+No.2	32.9±3.2	42.25±3.4	281±21.8	9.1

It is appropriate to note that the soil of the root zone of corn plants in the phase of panicle shedding did not have phytotoxic properties, which proves the absence of accumulation of spores of phytopathogenic fungi and bacteria in the soil. The phytotoxicity indicator correlates with the number of micromycetes of the studied agrocenosis (Table 1).

The antifungal activity of the soil of the root zone of corn was determined by inhibition of the development of the test culture and the zone of mycelium lysis around the soil lumps. It was established that the antifungal activity of the soil of the root zone of corn (Fig. 1) depended on both the cultivated hybrid and the weather conditions of the research. However, the general trend regarding the influence of the complex compositions of microorganisms No.1+No.2 and chemical preparations on this indicator remained unchanged.

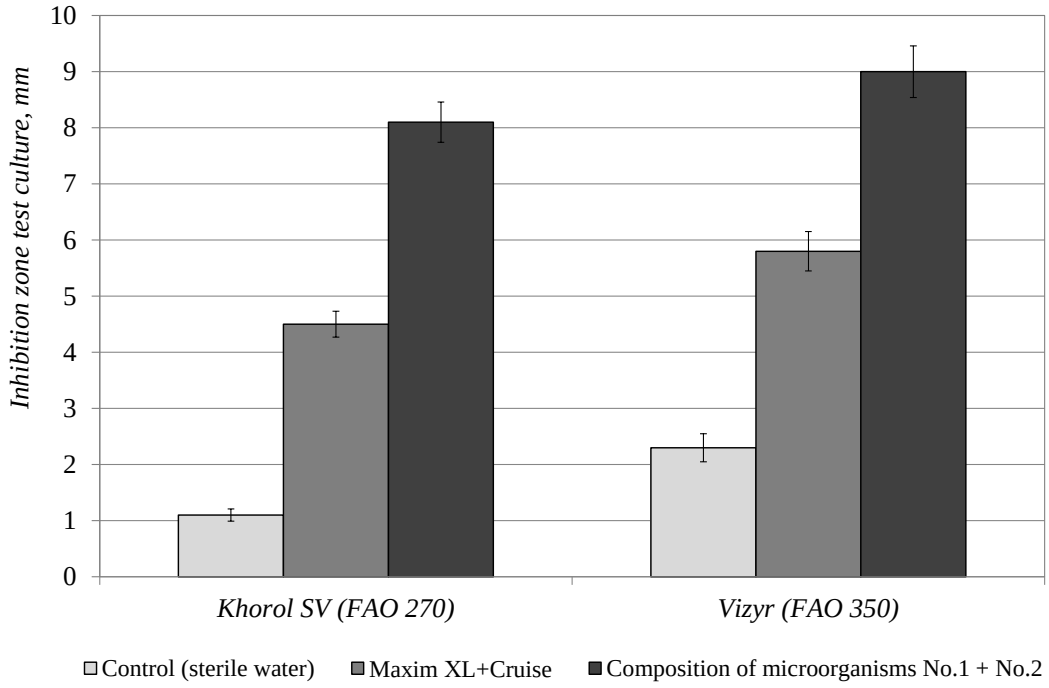

Figure 1. Antifungal activity of the soil of the root zone of corn when using a complex of compositions of microorganisms No.1+No.2 and chemical preparations

In the control variant, the antifungal activity was at a low level, the zones of phytopathogen growth inhibition ranged from 1.1 to 2.3 mm. The use of a complex of microorganisms No.1 + No.2 helped to increase the antifungal activity of the soil, the inhibition zone of the test culture was 8.1–9 mm. It should be noted that when using the complex of microorganisms No.1 + No.2, an increase in antifungal activity and a decrease in the number of micromycetes were noted. This suppression of the micromycete link of the microbiocenosis of the root zone of corn can be explained by the antagonistic properties of the agents of composition No. 1 in relation to phytopathogens. including causative agents of root rot of corn plants at various stages of ontogenesis. So, in the conditions of field research, it has been proven that bioagents of the complex of biocompositions No.1 + No.2, being introduced into the root zone of corn plants, initiate positive changes in the microbiocenosis of the soil.

CONCLUSIONS

It was established that the pre-sowing treatment of corn seeds with a mixture of compositions of microorganisms No.1 and No. helps to reduce the number of micromycetes by 1.8-2.2 times. However, the level of biological activity of the soil and the intensive flow of all microbiological processes remain at a high level, which is evidenced by the high level of indicators. It was found that the use of a mixture of compositions of microorganisms No.1 and No.2 increased the level of antifungal activity more than 4–7 times compared to the control and more than 1.5 times compared to the options where chemical preparations were used.

Thus, the complex of compositions of microorganisms No.1 and No.2 is a promising basis for the creation of a complex biological preparation with fungicidal and insecticidal properties. The complex of compositions of microorganisms No.1 and No.2 is recommended to be used by agricultural producers as one of the modern agricultural methods of ecologically safe farming, which will ensure biological control of the development of plant diseases during the entire period of their growth, as well as during the storage period of agricultural products and seeds.

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