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EFFECTIVENESS OF THE USE OF MICROBIAL PREPARATIONS AFTER CULTURE OF SHORT-TERM ROTATION IN THE SOUTHERN STEPPE

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Formulation of the problem. Modern conditions of agrarian production require measures that provide the most realistic level of productivity of crops, high quality products while reducing the costs of their cultivation. One of the most effective ways of increasing the intensity of agriculture can be the use of modern biological means of reproduction of soil fertility and increase of crop yields [1, 2].

A powerful factor in increasing the productivity of agroecosystems is the activation of microbial-plant interactions. In this connection, arose a need for the use of techniques aimed at increasing the number and activity of agronomically valuable microorganisms in the root zone of plants. To this end, ecologically safe complex of microbial preparations are developed and involved in the system of necessary agrotechnical measures [3, 4]. Practical interest in biological products is not only due to their effectiveness, but also to the fact that they are based on microorganisms isolated from natural biocenoses that do not pollute the environment.

The use of biologic preparations based on effective microorganisms is an integral aspect of modern agriculture. They optimize the nutrition of plants, stimulate growth and development, promote the productivity of crops [5, 6].

Microorganisms are one of the main factors of the soil forming process, nutrition of plants and phytosanitary state of the soil. Therefore, the use of modern microbial preparations should be aimed at the restoration of soil fertility, productivity and ecological safety of agriculture. It is especially important to determine the role of microorganisms and the use of microbial preparations in conditions of minimized soil cultivation, which has significantly expanded in recent years. [7]. Under its application, the upper (0–10 cm) layer of soil in the summer months in the steppe zone dry up and nutrient elements of mineral fertilizers are absorbed slowly. Therefore, it is necessary to find out which microbial preparations are most effective and adapted for such conditions. So far, such studies in the Southern Steppe have not been carried out.

The purpose of research. The increase of biological activity of the soil by optimizing the use of modern microbial preparations that contribute to improving the nitrogen and phosphate nutrition of plants under natural moisture conditions for the use with minimized soil cultivation.

Materials and methods of research. The laying of experiments and their carrying out was carried out according to generally accepted methods in agriculture and methodical instructions. [8–11]. The research

was carried out in a six-way crop rotation in a stationary two-factor experiment, which consisted of the following scheme: Factor A – soil cultivation system: 1. Plowing; 2. Polished deep cultivation; 3. Polished silage cultivation. Factor B – microbial preparations: 1. Control (without bacteria); 2. Nitrogen fixing bacteria; 3. Phosphate-bubbling bacteria. In 2011–2013, the following microbial preparations were used on sunflower seeds: 1. Diazophyte – microbiological agent – nitrogen fixing bacterium *Rhizobium radiobacter* 204; 2. Polymixobacterine – based on the growth-stimulating bacteria *Paenibacillus polimyxa KB.* On the crops of spring barley (2011–2013) the following preparations were used: 1. Microhumine – nitrogen fixing bacteria; 2. Phosphophetrain – phosphate membrane bacteria. In 2013–2015, on the winter wheat crops, the following microbial preparations were used for seed treatment: 1. Diazophyte – based on nitrogen fixing bacteria *Rhizobium radiobacter 204*; 2. Polymixobacterine – based on the growth-stimulating bacteria *Paenibacillus polimyxa KB*;

The research was conducted on the research field of the Institute of Irrigated Agriculture of the National Academy of Sciences of Ukraine. The soil of the experimental field is dark chestnut medium soured with a content of humus in the plowable layer of 2,2%. The field moisture content of the one-meter layer of soil is 22,4%, the moisture content of the wilting is 9,5%. In order to evaluate the effectiveness of these preparations, the determination of mobile forms of nitrogen and phosphorus, as well as the number of major groups of microorganisms in an arable layer of soil (0–30 cm) was conducted in the analytical laboratory of the Ias, which was certified in the State Enterprise "Kherson – standardmetrology."

Research results. In southern Ukraine, agriculture is under difficult conditions of insufficient moisture. Here the evaporation from the fields exceeds the amount of moisture from the rains. The only natural source of water entering the field is atmospheric precipitation, which largely characterizes the conditions of the water regime of the soil under certain crops. Under such conditions, microbiological processes are often very depressed.

In the years of research the conditions of soil moisture storage were different, which influenced the intensity of microbiological processes – 2013 was very dry, when at the beginning of barley sowing in the meter layer contained only 5,3–21,7 mm of productive moisture, and under sunflower 41,5–77,1 mm. Close to it was 2014, in which the moisture reserves were 40,1–41,7 mm and 61,2–71,6 mm, respectively. 2013 was average, and 2015 – wet.

Observations in sunflower crops on the total number of microorganisms that are detected on soil agar indicate that the seed treatment with Diazophyte contributed to an increase in the number of microorganisms in this group at the beginning of its vegetation by 13,5–29,4% compared to the untreated variant and in the small fieldless cultivation was by 10,9–21,4% higher compared to deep work. The treatment of sunflower seed with this preparation increased the number of oligonitrophilic microorganisms at the beginning of the vegetation compared to the controlled variant at 9,7–15,1% irrespective of the cultivation of soil, and at the end of the vegetation the largest number was plowed.

The use of the Diazophyte preparation increased the number of ammonium microorganisms in comparison with the controlled throughout the vegetation period by 5,0–25,0%, especially in the conditions of non-field small-scale cultivation of soil, and the amount of nitrification microorganisms by 2,5–20,0% compared with the control variant, on the contrary, for deep soil treatments.

The use of Polymixobacterin did not significantly affect the number of microorganisms that were tested throughout the entire vegetation. It is only at its beginning that it is possible to mark an increase of them under plowing conditions by 14,0–18,3%.

Changing the biological regime of the soil during the application of the Diazophyte preparation contributed to the increase in nitrate nitrogen content since the beginning of sunflower growing by 8,8–16,1% compared with the control, and most – for deep soil treatments. Also the content of mobile phosphorus is increased by 9,4–26,8%.

The treatment of the seeds of barley with the Microhumin preparation contributed to an increase in the total number of microorganisms in the first half of the vegetation by 2,0–23,3% compared with the control, especially in the field without deep cultivation of soil – by 23,3%. The number of oligonitrophilic microorganisms also exceeded the control variant by 9,5–21,2% and it was the largest under plowing conditions.

However, the use of this preparation also contributed to the increase in the number of ammonium microorganisms in the second half of its vegetation by 6,4–36,3% compared with control and the advantage was in the small fieldless treatment of soil. The number of nitrification microorganisms under the influence of the preparation of Mikrohumin in the beginning of the growing of barley increased only under plowing conditions by 12,3%. It has not changed for other cultivating systems.

Seed treatment with microbial preparation Phosphaenterin had no advantages in the total number of microorganisms compared to control, but contributed to an increase in the number of ammonium microorganisms in the soil in the middle of the vegetation by 21,9–32,2%.

The increase in the number of individual groups of microorganisms in the soil with the use of the Microhumin preparation on the crops of spring barley helped to improve the nitrogen supply of plants. So the content of nitrates already at the beginning of the vegetation exceeded the control variant by 20,0–56,9% and the largest was in the fieldless ways of cultivating the soil. This preparation did not affect the content of mobile phosphorus.

The processing of winter wheat seeds by Diazophyte contributed to an increase in the total number of microorganisms and the greatest increase in their growth – 22,2–26,5% occurred in small, non-field cultivation of soil. Similarly, the number of oligonitrophilic microorganisms varied and the greatest increase in their number was observed also in the conditions of shallow non-field cultivation of soil – by 17,5–18,5%.

The use of Diazophyte for the treatment of wheat seed almost did not affect the number of ammonium

microorganisms in deep soil treatments, and under untreated cultivation their number is increased by 25,6%. Also, the number of nitrification microorganisms increased, especially in conditions of shallow non-field cultivation – by 28,2%.

The change in the number of microorganisms under the influence of the Diazophyte preparation on winter wheat crops has contributed to an increase in the content of nitrates at the beginning of its vegetation by 14,2–98,0%. in comparison with the control variant. In this case, in the first half of the growing season of wheat, the most excess over the control was the field-free cultivation, and at the end of the growing season under plowing conditions.

Improvement of the nutrient regime of the soil when using the Diazophyte preparation increased the yield of winter wheat grain by 0,38–0,45 t / ha, depending on the method and depth of soil cultivation under its predecessor (Table 1). The largest increase was the increase in the application of plowing to a depth of 23–25 cm – 0,45 t / ha.

Improvement of the nitrogen regime of the soil during the use of microbial preparations led to the formation and somewhat higher level of spring barley harvest. Growth of its crop from the use of microbial preparation Microhumin was the highest – 0,21 t / ha for shallow free-field cultivation of soil, and the smallest 0,13 t / ha – with polished deep soil treatment.

Table 1. Productivity of crops under crop rotation depending on soil cultivation and microbial preparations, t / ha (average over three years)

Soil cultivating option (factor A)	Winter wheat			Spring barley			Sunflower		
	* Microbial preparations (factor B)								
	1	2	3	1	2	3	1	2	3
Plowing	4,25	4,70	4,37	1,87	2,01	1,90	2,37	2,65	2,50
Polished deep cultivation	3,96	4,34	4,10	1,73	1,86	1,76	2,24	2,31	2,26
Polished silage cultivation	3,57	3,97	3,66	1,42	1,63	1,55	1,96	2,09	2,08

Notes: 1 – контроль;
2 – preparations of nitrogen-fixative bacteria;
3 – preparations of phosphate-mobilizing bacteria.
HIP $_{05}$ of partial differences A 0,30 0,23 0,17
B 0,36 0,27 0,21

The processing of sunflower seeds with Diazophyte helps to improve the nitrogen regime of the soil, which contributed to the increase in its yield by 0,07–2,87 t / ha and the highest it was in the version with application of plowing. An appreciable increase was the increase in sunflower crop from the use of the preparation and with the background of shallow, polished silage cultivation of soil – 0,17 t / ha.

The calculation of the effectiveness of the application of microbial preparations for pre-sowing cultivation of seeds showed that the most profitable it is during the use of nitrogen-fixing bacteria as agents and amounted up to 436,62–1803,62 uah / ha depending on the culture and cultivation of the soil. Preparations of phosphate-mobilizing bacteria in arid conditions are much less effective.

Conclusions. In arid conditions of the southern Steppe on the farms it is necessary to use the microbial preparation Diazophyte as a deep and shallow cultivation of the soil under the predecessor to improve the nutritional conditions of the soil and increase the yield of winter wheat. Wheat seeds need to be processed by phosphate-mobilizing bacteria Polymycobacterium only under conditions of a polished silage cultivation of soil for the predecessor.

When sowing spring barley, its seeds should be treated with a microbial preparation of nitrogen-fixing bacteria Microhumin. It is most effective with minimized soil cultivation. Application of microbial preparation of phosphate membrane bacteria Phosphaenterin in acutely arid conditions of spring in the region does not provide a stable positive effect.

In sunflower crops, seeds must be treated with a microbial preparation Diazophyte under conditions of deep plowing under it, or a shallow, untreated cultivation. The preparation Polymixobacterin can be used only under conditions of plowing under sunflow.

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ПОРІВНЯЛЬНА ХАРАКТЕРИСТИКА ЕКОЛОГО-МЕЛІОРАТИВНИХ ПОКАЗНИКІВ ІНГУЛЕЦЬКОЇ ТА ДНІПРОВСЬКОЇ ЗРОШУВАЛЬНОЇ ВОДИ ІЗ ЗАСТОСУВАННЯМ МЕТОДУ КЛАСТЕРНОГО АНАЛІЗУ

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Постановка проблеми. Як відкрита система, ґрунт є динамічним і знаходиться в постійній взаємодії з атмосферою, гідросферою, біосферою та літосферою. Залежно від інтенсивності, з якою ці чинники діють, ґрунт може представляти диференційовані характеристики, які визначають свої