PAPER • **OPEN ACCESS**

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To cite this article: V I Cherniavskih *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **901** 012058

NEW MICROBIOLOGICAL PREPARATIONS FOR SOIL CONSERVATION AGRICULTURE

V I Cherniavskih[1,2,3], I V Pravdin[4], E V Dumacheva[1,2,3], Tsugkiev[5], V.B. Tsugkieva[5]

[1]All-Russian Research Institute of Phytopathology, 5 Ownership, Institute St., r.p. Big Vyazemy, Odintsovo district, Moscow region, 143050, Russia
[2]Federal Williams Research Center of Forage Production & Agroecology, 1 building, Scientific town, Lobnya, Moscow region, 141055, Russia
[3]Belgorod State University, 85, Pobedy St., Belgorod, 308015, Russia
[4]Scientific and Technical Center for Biological Technologies in Agriculture (NTC“BIO”), 2, Dokuchaeva St., Shebekino, Belgorod region, Russia
[5]Gorsky State Agrarian University, 37, Kirov St., Vladikavkaz, North Ossetia-Alania, 362040, Russia

E-mail: cherniavskih@mail.ru

Abstract. In the system of soil-saving technologies, comparative tests of the effectiveness of the use of various biological products based on consortia of microorganisms, fungal cultures in the field were conducted, and their effectiveness was evaluated. We used the preparations "Nurse Mycorrhiza" (Russia), MycoCrop ® (Germany), a new drug of the "Biogor" series developed by the Scientific and Technical Center for Biological Technologies in Agriculture (NTC"BIO") (Russia). The effectiveness of seed treatment with biological preparations is shown. Plants of spring wheat of the Darya variety, the seeds of which were treated with the preparation "Biogor", had friendly aligned shoots, formed a better-developed root system, which later resulted in a significant increase in yield. The results of the dispersion analysis showed that the difference between the processing options is significant, and the processing by the "Biogor" consortium has a positive effect on the formation of grains in the ear, their mass, the mass of 1000 seeds, as well as on the yield of spring wheat in general. The use of a new preparation of the "Biogor" series, developed in LLC "STC "BIO" and containing a consortium of beneficial microorganisms, is promising for spring wheat: the weight of 1000 seeds increases by 13.5 %, the yield significantly increases by 12.5 %.
Keywords: soil-saving technologies, productivity, spring wheat, microbiological fertilizer, technology of use, Scientific and Technical Center for Biological Technologies in Agriculture (NTC“BIO”).

1. Introduction
The biologization of agriculture and the development of the system of organic agriculture, which is currently aimed at by the world community, provides for the creation of safety mechanisms that will protect both plants and soil in the event of increased anthropogenic pressure [1-4].

An important direction is biological reclamation using highly effective cultures of microorganisms - antagonists of soil phytopathogens that increase the suppressiveness of soils. Previous studies of the team of authors have developed theoretical provisions and practical recommendations for improving the fertility of eroded soils, maintaining the productivity of eroded soils in the development of soil protection, biological and recultivation systems of landscape agriculture, including the use of microbiological preparations [5-8].

The potential of plant-microbial interaction in agrocenoses is actively studied by scientists, both in Russia and abroad [9-14].

The effectiveness of mycorrhizal preparations on various cultures has been proven. In particular, it is shown that the symbiosis with mycorrhizal fungi increases the resistance of spring wheat to unfavorable soil and climatic conditions, as well as its productivity, and improves the physical indicators of grain quality. The use of bacterial-mycorrhizal complexes makes it possible to increase the efficiency of the functioning of plant-microbial symbioses and associations, the culture of agriculture and reduce the pesticide load on the environment [15, 16].

The aim of the work is to evaluate the effect of various preparations based on effective microbiological compositions and mycorrhizal fungi on the productivity of spring wheat.

2. Methods and materials

Scientific and practical research was conducted by scientists of Belgorod State University together with the Scientific and Technical Center for Biological Technologies in Agriculture (NTC "BIO") with the participation of the leading federal research centers of the Russian Academy of Sciences: Williams Research Center for Forage Production and Agroecology, All-Russian Research Institute of Phytopathology.

In the research laboratory of NTC "BIO", after a series of experiments, the technology of obtaining mycelium on a grain-perlite nutrient substrate was developed, which provide better growth of mycelium with a good processability of this mixture in the enzymatic process, on special microbiological compositions. For the preparation of the drug, the original method of production of microbiological cultures, mycorrhiza and soluble salts of trace elements, developed by NTC "BIO " scientists, was used.

The developed drug belongs to the well-known "Biogor" series in Russia and abroad. The complex product contains four mandatory blocks:

1 - mycorrhiza;

2 - a pool of effective microorganisms whose metabolic products affect plant roots and mycorrhizal hyphae, activating their growth simultaneously;

3 - the nutrient substrate (carrier) contains a finely dispersed organic product (starch, bran, corn extract, molasses, beet pulp), a dispersed mineral product (perlite, vermiculite, chalk, gypsum). The nutrient substrate is pasteurized and fermented in a solid-phase manner by a special pool of microorganisms;

4 - inductors of micro-formation.

The composition and technology of the new drug are at the stage of patenting.

On the basis of IE "Mavrodin S.A." (Belgorod region) in the system of soil-saving technologies, field experiments were conducted on the cultivation of spring wheat of the Darya variety using new microbiological preparations, and the effectiveness of the proposed microbiological consortia in the system of soil-harvesting agriculture was evaluated.

The methodological and theoretical basis of the research project is the provisions of the following approaches and concepts:

- methodological approaches developed in the course of research to improve the productivity of eroded soils [17,18];
- methods of microbiological research [19];
- methods of statistical processing and analysis of variance [20].

The repetition of the experience is 8-fold. The area of the accounting plot is 1.0 m2.

The plots are two-row, the width of the row spacing is 25 cm.

Four preparations were used for the treatment of spring wheat seeds:

option 1 - control-without processing;

Option 2-the preparation "Nurse mycorrhiza" (Russia, LLC NVP "BashInkom", contains mycelium and forms of the fungus of the genus Glomus, colonized root fragments, peat);

option 3-preparation MycoCrop ® (Germany, contains fungi Glomus proliferum, G. intraradice, G. etunicatum, G. mosseae carrier-clay granules;

Option 4-preparation of the "Biogor" series (Russia, a new mycorrhizal-microbial preparation developed by NTC "BIO").

Grain processing (inoculation) was carried out each preparation was carried out in accordance with the recommendations set out in the instructions for their use.

Treatment with the new preparation of the "Biogor" series was carried out during the sowing process: through separate cans in the seeder, by pre-mixing the grain with the inoculant when loading the seeder.

To assess the structure of the crop, sheaves were selected from test sites with an area of 1 m^2 in four-fold repetition on each plot in all repetitions of the experiment.

We evaluated: the number of fruit-bearing stems, sp.*(m) $^{-2}$; the number of grains in 1 ear, pcs.; the weight of grains from 1 ear, g; the weight of 1000 seeds, g; the biological yield of spring wheat, g*(m) $^{-2}$.Harvesting was carried out by hand. The mass of 1000 seeds was determined by weighing air-dry seeds and calculating the mass of dry matter, based on the mass of 1000 air-dry seeds and their humidity.

3. Results and discussion

The new drug NTC " BIO "of the" Biogor " series is an innovative approach to the formation of ideal relationships of microorganisms, fungi and plants. A special feature of this product is the combination in one preparation of a mycorrhizal fungus, bacteria, each of which plays an important role in the growth and development of the plant, as well as vitamins.

Table 1 shows the results of laboratory and field experiments conducted in the system of soil-saving crop rotation on spring wheat.

Table 1. Formation of productivity elements and yield of spring wheat depending on the use of microbial consortia

Experience option	The number of productive stems, sp.*(m)$^{-2}$	The number of grains in the ear, PCs.	The mass of the grains in the ear, g	The weight of 1000 seeds, g	crop productivity, g*(m)$^{-2}$
1- control	189.1	45.0	1.60	26.6	400.4
2 – «Nurse mycorrhiza »	194.0	45.5	1.60	26.6	411.9
3 – MycoCrop®	199.6	59.0	1.75	29.1	465.0
4 – «Biogor»	202.1	62.6	1.81	30.2	488.2
SSD_{05}	16.9	13.6	0.15	2.6	31.2

On average, there was a tendency to increase the number of productive stems under the influence of treatment with various biological products by 2.6-6.9 %.

The number of grains in the ear under the influence of treatment with various biological products increased by 1.1-39.1 %. The maximum indicator was in the variant with the treatment of seeds before sowing with a new preparation of the "Biogor" series.

There was a tendency to increase the weight of grains in the ear under the influence of treatment with biological products only in variants 3 and 4 – by 9.4 and 13.1%, respectively.

The mass index of 1000 seeds is one of the key and genetically determined factors in the formation of the final yield of agricultural plants.

On average, according to the experiment, there was a tendency to increase the weight of 1000 seeds under the influence of treatment with various biological products only in variants 3 and 4 – by 9.4 and 13.5%, respectively. The maximum indicator was in the variant with the treatment of seeds before sowing with the new preparation "Biogor".

The yield of spring wheat tended to increase in all variants of the experiment. In the second variant, the difference was insignificant 1-1.71 %. In the third variant, the yield was higher than the control by 8.3%, in the fourth-by 12.5 %.

The results of the variance analysis of the number of productive stems of spring wheat depending on the use of the studied mycorrhizal consortia are given in table 2.

Table 2. Results of the dispersion analysis of the number of productive stems of spring wheat

Source of variation	D	n-1	s^2	F_f	$F_{st\ 0.05}$	h^2_x
General	8742.4	31	-	-	-	100
Repetitions	1757.8	7	-	-	-	20.1
Options	1451.7	3	483.9	1.8	3.1	16.6
Random	5532.9	21	263.5	-	-	63.3

Note. *D is the sum of the squared deviations (deviant); s2 is the dispersion; n-1 is the number of degrees of freedom; h2x - force of influence on the effective attribute.*

The strength of the influence of factors on the resulting attribute varies in a row: the number of repetitions → the number of options → random factors.

It is shown that the value of this indicator is significantly influenced by random factors. It is important to take into account that, despite the tendency to increase the number of productive stems under the influence of treatment with a complex of microorganisms, in the experiment F is actually less than F is theoretical, which rejects the null hypothesis and indicates that the difference between the variants is unreliable.

The results of the dispersion analysis of the number of grains in an ear of spring wheat, depending on the use of the studied mycorrhizal consortia, are shown in Table 3.

Table 3. Results of the dispersion analysis of the number of grains in an ear of spring wheat

Source of variation	D	n-1	s^2	F_f	$F_{st\ 0.05}$	h^2_x
General	6202.9	31	-	-	-	100
Repetition	656.2	7	-	-	-	10.6
Options	1991.1	3	663.7	3.9	3.1	32.1
Random	3555.7	21	169.3	-	-	57.3

Note. *D is the sum of the squared deviations (deviant); s2 is the dispersion; n-1 is the number of degrees of freedom; h2x - force of influence on the effective attribute.*

The strength of the influence of factors on the resulting attribute varies in a row: the number of repetitions → the number of options → random factors.

For the studied indicator, F is actually greater than F than the theoretical one, which does not reject the null hypothesis and indicates that the difference between the variants is reliable, and the treatment of microorganisms by consortia has a positive effect on the manifestation of the "Number of grains in the ear" trait.

The results of the dispersion analysis of the mass of grains in an ear of spring wheat, depending on the use of the consortia of the studied microorganisms, are shown in Table 4.

Table 4. Results of the dispersion analysis of the grain mass in the ear of spring wheat

Source of variation	D	n-1	s^2	F_f	$F_{st\ 0.05}$	h^2_x
General	0.83	31	-	-	-	100
Repetition	0.09	7	-	-	-	10.2
Options	0.29	3	0.09	4.6	3.1	35.4
Random	0.45	21	0.02	-	-	54.4

Note. *D is the sum of the squared deviations (deviant); s^2 – the dispersion; n-1 is the number of degrees of freedom; h^2x – force of influence on the effective attribute.*

The strength of the influence of factors on the resulting attribute varies in a row: the number of repetitions → the number of options → random factors.

For the studied indicator F, the actual value is greater than the theoretical value, which does not reject the null hypothesis and indicates that the difference between the variants is reliable, and the treatment of microorganisms by consortia has a positive effect on the manifestation of the "Grain mass in the ear" trait.

The results of the dispersion analysis of the mass of 1,000 seeds in an ear of spring wheat, depending on the use of the studied mycorrhizal consortia, are shown in Table 5.

Table 5. Results of the dispersion analysis of the mass of 1000 spring wheat seeds

Source of variation	D	n-1	s^2	F_f	$F_{st\ 0.05}$	h^2_x
General	231.5	31	-	-	-	100
Repetition	23.7	7	-	-	-	10.2
Options	81.6	3	27.2	4.5	3.1	35.2
Random	126.2	21	6.0	-	-	54.5

Note. *D is the sum of the squared deviations (deviant); s^2 – the dispersion; n-1 is the number of degrees of freedom; h^2x – force of influence on the effective attribute.*

The strength of the influence of factors on the resulting attribute varies in a row: the number of repetitions → the number of options → random factors.

For the studied indicator F, the actual value is greater than the theoretical value, which does not reject the null hypothesis and indicates that the difference between the variants is reliable, and the treatment of microorganisms by consortia has a positive effect on the manifestation of the "Weight of 1000 seeds" trait.

The results of the variance analysis of the yield of spring wheat depending on the use of the studied mycorrhizal consortia are shown in Table 6.

Table 6. Results of the dispersion analysis of spring wheat yield

Source of variation	D	n-1	s^2	F_f	$F_{st\ 0.05}$	h^2_x
General	40951.9	31	-	-	-	100
Repetition	5291.9	7	-	-	-	12.9
Options	16954.6	3	5651.5	6.3	3.1	41.4
Random	18705.4	21	890.7	-	-	45.7

Note. *D is the sum of the squared deviations (deviant); s^2 – the dispersion; n-1 is the number of degrees of freedom; h^2x – force of influence on the effective attribute.*

The strength of the influence of factors on the resulting attribute varies in a row: the number of repetitions → the number of options → random factors.

For the studied indicator F, the actual value is greater than the theoretical value, which does not reject the null hypothesis and indicates that the difference between the variants is reliable, and the treatment of the proven microbial consortium has a positive effect on the manifestation of the "Spring wheat yield" trait.

4. Conclusion

1. Spring wheat plants treated with a new preparation of the "Biogor" series had friendly aligned shoots, formed a better developed root system, which later resulted in a significant increase in yield.
2. The results of the dispersion analysis showed that the difference between the processing options is significant, and the processing by the "Biogor" consortium has a positive effect on the formation of grains in the ear, their mass, the mass of 1000 seeds, as well as on the yield of spring wheat in general.
3. The use of a new preparation of the "Biogor" series, developed in NTC " BIO " and containing a consortium of beneficial microorganisms, is promising for spring wheat: the weight of 1000 seeds increases by 13.5 %, the yield significantly increases by 12.5 %.

Acknowledgments
The research was carried out within the framework of the project of the Belgorod Scientific and Educational Center of the World Level «Innovative Solutions in Agro-Industrial Complex».

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