The expediency of using a plant protection system using the microbiological fungicide BisolbiSan, W in the cultivation of winter wheat in the Southern natural and agricultural zone of the Rostov region

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Abstract. The authors analyzed the biological effectiveness of the integrated plant protection system formed when the microbiological fungicide BisolbiSan, Zh was included in the classical protection scheme adopted in the farms of the Rostov region. The biological effectiveness of the integrated protection system, including the fungicide BisolbiSan, was analyzed, the impact of the studied protection system on the yield, the quality of the grain obtained, the phytosanitary condition of the crop during the growing season on winter wheat crops of the variety Nakhodka with the use of a plant protection system, including the fungicide BisolbiSan, Zh. The fungicide BisolbiSan, containing a culture of rhizospheric bacteria Bacillus subtilis strain H-13, suppresses the germination of spores and mycelium growth of phytopathogenic fungi due to the multilateral action of bacterial metabolites, without causing the formation of resistance in pathogens. It was found that the protection system used practically does not cause a decrease in grain quality — in terms of the average protein and gluten content, the grain at the experimental site even slightly exceeds the grain obtained from the control site by 16.88% and 27.8%. With the cost of winter wheat grain of 1100 rubles/kg, an increase in the yield in the experiment of 3.8 kg/ha in relation to control and the cost of an experimental protection system in the amount of 3,357 rubles/ha, revenue amounted to 823 rubles/ha.

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1 Introduction

Biologization and ecologization of plant protection, the introduction of integrated protection systems based on the preventive role of the use of entomophages, microbiological rodenticides and fungicides, microbiological destructors of stubble, microbiological fertilizers and fertilizers based on humic acids have been given special importance in recent years [1-3]. Carrying out measures to restrain the number of pests is assumed only taking into account the assessment of the physiological and phytosanitary condition of crops, the forecast of the development of harmful organisms and economic thresholds of harmfulness [4]. The greatest effectiveness in maintaining high yields and environmental safety is shown by the use of integrated systems aimed at obtaining well-developed plants, carrying out preventive treatments with biological products, destroying the wintering stock of harmful objects and pest breeding stations (weeds and others), as well as growing varieties resistant to pests and diseases, preserving and activating the activity of natural entomophages [5- 7].

The use of intensive crop cultivation technologies, in which the main emphasis is on chemicalization, without taking into account the actual phytosanitary situation on the land, the state of plant development, the number of harmful organisms and stages of their development, is associated with the depletion of natural soil fertility, degradation of useful soil microbiota, accumulation of harmful substances in the soil (residual amount of pesticides, nitrites and nitrates), the development of resistance to pesticides in pests, pathogens and weeds. And the expansion of the use of integrated systems, their maintenance for a number of years, contributes to the transition to organic farming, which ensures the highest quality of agricultural products [8-11].

The purpose of our work was to analyze the biological effectiveness of the integrated plant protection system formed when the microbiological fungicide BisolbiSan, Zh was included in the classical protection scheme adopted in the farms of the Rostov region [12]. As a result of the successful completion of the research work, in accordance with the terms of reference, the biological effectiveness of the integrated protection system, including the fungicide BisolbiSan, was analyzed, the impact of the studied protection system on the yield, the quality of the grain obtained, the phytosanitary condition of the crop during the growing season was assessed [13-14]. The object of the study is winter wheat crops of the Nakhodka variety using a plant protection system including the fungicide BisolbiSan, Zh [15].

2 Materials and methods

To determine the effectiveness of the use of drugs and their combinations in the cultivation of agricultural crops, the branch of the Federal State Budgetary Institution "Russian Agricultural Center" in the Rostov region conducted a field demonstration test of a plant protection system, including the fungicide BisolbiSan, Zh., produced by Bisolbi Plus LLC, containing a live culture of rhizosphere bacteria Bacillus subtilis strain H–13. The venue of the experiment is located on the territory of the FGBNU "ANC "Donskoy". The sites where the experiment was conducted are located in the Southern natural and agricultural zone. Winter wheat crops of the Nakhodka variety were studied. The type of soils on which the cultivation of the crop was carried out are ordinary chernozems, the granulometric composition of the soils is heavy loamy. The area of the control and experimental plots is 0.024 hectares each.

On the plots (experimental and control) on 08/27/2020, ammophos 10:48 was introduced at a dose of 100 kg /ha. The fertilizer distributed over the surface of the field was embedded in the soil by cultivation. Sowing was carried out on 27.09.2020 with the

SS-11 "Alpha" seeder. The depth of seeding was 5 cm. Germination took place at air temperatures from 10 °C to 21 ° C.

A plant protection system based on the use of three chemical pesticides in tank mixtures (insecticide, fungicide, herbicide), liquid organomineral fertilizer and microbiological fungicide BisolbiSan, Zh. No treatments were carried out at the control site. A plant protection system based on the use of three chemical pesticides in tank mixtures (insecticide, fungicide, herbicide), liquid organomineral fertilizer and microbiological fungicide BisolbiSan, Zh. No treatments were carried out at the control site.

3 Results and Discussion

Pesticide treatments at the experimental site were carried out according to the approved scheme of the experiment (Table 1)

Table 1. The scheme of the treatments carried out

<table>
<tr><th>Date of processing</th><th>Culture phase</th><th>Working fluid consumption l/t, l/ha.</th><th>The applied drug</th><th>Consumptio n rate, l/t, l/ha, t/ha</th></tr>
<tr><td rowspan="4">24.09.2020</td><td rowspan="4">Seeds</td><td rowspan="4">10</td><td>Imidor Pro, CS</td><td>1,2</td></tr>
<tr><td>Benefit, ME</td><td>0,8</td></tr>
<tr><td>Biostim start</td><td>1,0</td></tr>
<tr><td>BisolbiSan, W</td><td>1,0</td></tr>
<tr><td rowspan="2">08.04.2021</td><td rowspan="2">Exit into the tube</td><td rowspan="2">200</td><td>Diva, SE</td><td>0,9</td></tr>
<tr><td>BisolbiSan, W</td><td>2,0</td></tr>
<tr><td>07.05.2021</td><td>The beginning of earing</td><td>200</td><td>BisolbiSan, W</td><td>2,0</td></tr>
</table>

Winter wheat treatments with preparations were carried out in three stages, consisting of pre-sowing seed treatment and two treatments of crops during the growing season.

Stage I. Pre-sowing seed treatment

The composition of the tank mixture for seed treatment included the following preparations: chemical insecticide Imidor Pro, CS in a dose of 1.2 l / t to protect seedlings from damage by larvae of bread beetle and cereal flies; chemical fungicide Benefit, ME in a dose of 0.8 l / t to protect germinating seeds and seedlings from pathogens of fusarium and helminthosporiosis root rot detected during phytopathological examination, seed mold (including alternarium seed infection), as well as to prevent infection with powdery mildew (in the early stages of development), snow mold, dusty and hard smut; liquid organomineral fertilizer Biostim brand Start at a dose of 1.0 l/t to stimulate seed germination and root system development; microbiological fungicide BisolbiSan, Zh in a dose of 1.0 l / t for the protection of germinating seeds and seedlings from pathogens of mold formation, fusarium and helminthosporiosis root rot detected during phytopathological examination, as well as to strengthen plant immunity, overcome the effects of chemical stress caused by chemical pesticides, increase germination and amity of seed germination, stimulate intensive growth and development of plants, increase plant resistance to autumn frosts.

Stage II. The first treatment during the growing season

Fig. 1. Carrying out the first processing of crops 08.04.2021

The first treatment of crops during the growing season was carried out on 08.04.2021 at an air temperature of 3 ° C in the phase of entering the culture tube. The composition of the tank mixture for wrapping included two drugs — herbicide Prima Donna, SE at a dose of 0.9 l / ha to protect against clogging of crops with dicotyledonous weeds in the early growth phases of the latter and microbiological fungicide BisolbiSan, W at a dose of 2.0 l / ha to enhance immunity and resistance of plants to leaf diseases such as powdery mildew, septoria, pyrenophorosis and to overcome the effects of chemical stress caused by herbicide, stimulation intensive growth and development of plants, increasing the resistance of plants to morning spring frosts and lack of moisture.

Stage III. The second treatment during the growing season

Fig. 2. Carrying out the second processing of crops 07.05.2021

The second treatment of crops was carried out on 07.05.2021 at an air temperature of 14 ° C during the earing phase of the crop. The treatment was carried out with the microbiological fungicide BisolbiSan, Zh at a dose of 2.0 l/ha to strengthen the immunity and resistance of plants to leaf diseases (such as powdery mildew, septoria, pyrenophorosis), stimulate intensive growth and development of plants, increase plant resistance to moisture deficiency, increase yield.

The results of the phytopathological examination of seeds carried out before sowing showed a total infection rate of 32%. Infection with fusarium was 3%, helminthosporiosis - 2%, which indicated the likelihood of the development of fusarium and helminthosporiosis root rot on crops. Infection with mainly saprophytic fungi - alternaria and mold fungi was mainly 18% and 9%.

In all areas, crops developed normally. The phytosanitary condition before wintering was good, there were no diseases. The number of winter wheat plants that reached the tillering phase by 10/23/2020 was 64 per 1 running meter at the control site, and 67 specimens at the experimental site.

By 01.11.2020, the height of winter wheat plants on both control and experimental plots averaged 19.5 cm.

The height of winter wheat plants at the control site in the tillering phase on 03/19/2021 was 27-32 cm, in the tube exit phase 08.04.2021 - 40-44 cm, at the beginning of the earing phase 07.05.2021 - 47-62 cm.

The height of winter wheat plants at the experimental site in the tillering phase on 19.03.2021 was 27-32 cm, in the tube exit phase on 08.04.2021 was 40-44 cm, at the beginning of the earing phase on 07.05.2021 - 56-68 cm.

Phytosanitary surveys of crops in order to determine the effectiveness of the tested protection system were carried out 23.10.2020, 01.11.2020, 19.03.2021, 08.04.2021, 07.05.2021, 29.05.2021 (Table 2, Table 3).

Table 2. Results of phytosanitary monitoring at test sites

Date of the survey	Culture phase	Region	Disease	Distribution %	Development, %
19.03.2020	End of tillering	Control	Septoria	9	0,5
			Root rot	12	1,5
		Experience	Septoria	7	0,4
			Root rot	3	0,1
08.04.2020	Exit into the tube	Control	Septoria	20	2,0
			Root rot	15	1,5
		Experience	Septoria	13	1,3
			Root rot	3	0,1
17.04.2020	Flag sheet	Control	Septoria	14	1,4
			Root rot	15	0,7
		Experience	Septoria	5	0,3
			Root rot	3	0,2
07.05.2020	The beginning of earing	Control	Septoria	5	0,3
			Root rot	15	0,3
		Experience	Septoria	2	0,1
			Root rot	3	0,1
29.05.2020	Waxy ripeness	Control	Septoria	0	0
			Root rot	13	0,2
		Experience	Septoria	0	0
			Root rot	2	0,1

Infection with root rot and septoria was manifested both on the experimental plot and on the control one. At the experimental site, the development and spread of diseases was lower than at the control site. Weed vegetation was not observed on the crops. The pests common piavica and thrips were noted with insignificant numbers.

Table 3. Results of phytosanitary monitoring at test sites

Date of the survey	Culture phase	Region	Pest	Number, copies/plant
19.03.2021	End of tillering	Control	–	0
		Experience	–	0
08.04.2021	Exit into the tube	Control	Piavica	2
		Experience	Piavica	2
17.04.2021	Flag sheet	Control	Piavica	3
			Thrips	1
		Experience	Piavica	2
			Thrips	1
07.05.2021	The beginning of earing	Control	Piavica	0
			Thrips	3
		Experience	Piavica	0
			Thrips	3
29.05.2021	Waxy ripeness	Control	Piavica	0
			Thrips	0
		Experience	Piavica	0
			Thrips	0

Fig. 3. Winter wheat at the control site on 03/19/2021

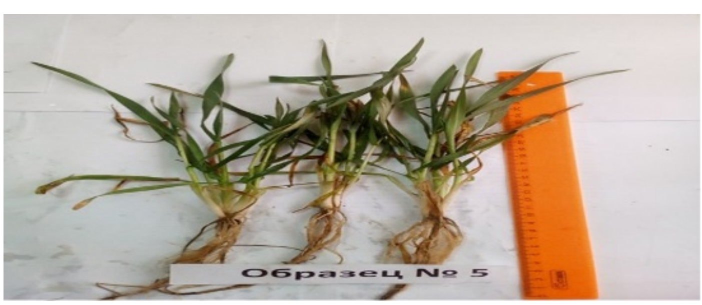

Fig. 4. Winter wheat at the experimental site on 03/19/2021

Fig. 5. Winter wheat at the control site 08.04.2021

Fig. 6. Winter wheat at the experimental site 08.04.2021

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Fig. 7. Winter wheat at the control site 07.05.2021

Fig. 8. Winter wheat at the experimental site 07.05.2021

Fig. 9. Crops in the control area in the ripening phase

Fig. 10. Crops at the experimental site in the ripening phase

Table 4. Results of determining yield and profitability

№ n/a	Option	Yield, c/ha	Grain moisture, %	Content	
				squirrel, %	gluten, %
1	Control	39,8	5,6	16,88	27,80
2	Experience	43,6	5,5	17,41	28,80

Fig. 11. Harvesting of winter wheat 12.07.2021

4 Conclusions

The results of the study provide the basis for a number of conclusions about the effectiveness of the use of the studied plant protection system in the agro-climatic conditions of the Southern natural and agricultural zone of the Rostov region.

Pre-sowing seed treatment with the microbiological fungicide BisolbiSan, in addition to protecting seeds and seedlings from the harmful activity of root rot pathogens and seed mold, had an impact on increasing field germination, activating growth and shaping processes, increasing the resistance of seedlings to adverse factors such as pest damage, frost, lack of moisture, as well as stress caused by the use of chemical pesticides, stimulating seed germination and root system development against the background of the protective action of chemical protectants - insecticide Imidor Pro, CS and fungicide Benefit, ME. This made it possible to obtain healthy developed seedlings that quickly reached the stage of tillering before wintering.

The treatment of crops in the phase of entering the tube and in the phase of earing the culture with the microbiological fungicide BisolbiSan, had a beneficial effect on increasing resistance to adverse environmental factors, improving the phytosanitary condition and grain quality, increasing yields.

It should be noted the positive effect of the studied protection system on the improvement of plant development, which allowed overcoming the adverse consequences of the appearance of root rot and septoria.

Over time, in the control area, the proportion of the spread and development of these diseases gradually increased throughout all phases of wheat development up to the "earing" phase. The magnitude of the spread of root rot in the control area increased from 12% to 15%, while in the experimental area the spread and development of the disease stopped at the level of 3%. By the onset of the flag leaf phase, the spread of septoria at the experimental site was 5%, which is 3 times lower than in the control.

It was found that the protection system used practically does not cause a decrease in grain quality — in terms of the average protein and gluten content, the grain at the experimental site (17.41% and 28.8%, respectively) even slightly exceeds the grain obtained from the control site (16.88% and 27.8%, respectively).

When the cost of winter wheat grain is 1100 rubles/kg, the yield increase in the experiment is 3.8 kg/ha in relation to the control (Table. 5) and the cost of an experimental protection system in the amount of 3,357 rubles/ha, revenue amounted to 823 rubles/ha.

Table 5. Profitability of the experimental plant protection scheme

№ n/a	Option	Yield at natural grain moisture, c/ha	The cost of the crop excluding costs, RUB/ha	The cost of the crop, including costs, RUB/ha
1	Control	39,8	43 780	43 780
2	Experience	43,6	47 960	44 603

It is worth noting that if the optimal crop rotation is observed and the results of phytopathological examination of the seed material are used, it is possible to optimize the classical protection scheme by adding biologics of Bisolbi Plus LLC in order to reduce costs during pre-sowing etching.

The fungicide BisolbiSan, containing a culture of rhizospheric bacteria Bacillus subtilis strain H-13, suppresses the germination of spores and mycelium growth of phytopathogenic fungi due to the multilateral effects of bacterial metabolites (lytic enzymes and antibiotics), without causing the formation of resistance in pathogens. Strengthens the immunity and resistance of plants, stimulating the production of phenolic compounds and phytoalexins. Relieves chemical stress caused by pesticides, increases germination and friendly germination of seeds, stimulates intensive growth and development of plants, increases plant resistance to stresses caused by infection with pathogens, damage by pests, frost and lack of moisture. At the same time, the drug is not phytotoxic in recommended doses and is compatible in tank mixtures with chemical fungicides, insecticides, herbicides and fertilizers, it is not dangerous for fish, earthworms and wild fauna. It is especially important that the use of an integrated preventive protection system based on the use of a combination and alternation of traditional chemicals with biological products contributes to the maintenance of natural soil fertility, reduces the pesticide load of agricultural land, prevents the threat of environmental pollution, makes it possible to obtain an environmentally friendly crop that does not contain a residual amount of pesticides. Expanding the use of integrated systems, maintaining them for a number of years, contributes to the transition to organic farming, which ensures the highest quality of agricultural products.

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