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The expediency of using an integrated plant protection system and organomineral fertilizers in the conditions of the Southern natural and economic zone

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Abstract. The authors of the article conducted research and comparative analysis of the impact of the branch's products FGBI "Rosselkhoznadzor" in the Rostov region fertilizers Vostok EM–1, containing live cultures of effective microorganisms (photosynthetic and lactic acid bacteria, yeast, actinomycetes, fermenting fungi); organo-mineral fertilizer based on humic acids Humate +7 grade C2 liquid concentrate, organo-mineral fertilizer based on humic acids Green-Organic Gum–1; o study the effect of the microbiological fungicide Metabacterin produced by Inagro LLC, a joint venture based on live cultures of bacteria Methylobacterium extorquens NVD BKM B-2879 D + Bacillus subtilis VKPM B-2918 IPM-215 and validamycin Streptomyces hygroscopicus subsp. limoneus VKPM AC-1966 to increase seed germination, enhance growth and shaping processes, reduce the development of septoria, increase immunity to diseases and adverse environmental factors, increase yields, improve grain quality. he research was conducted on the basis of the Federal State Budgetary Budgetary Institution "ANTS "Donskoy". The area of the control and experimental plots is 0.024 hectares each. The soil type is ordinary chernozems. The agricultural crop on which the studied preparations were used is winter wheat variety - Volnitsa. Pre-sowing seed treatment with a mixture of chemical pesticides was carried out at the control sites. Pre-sowing seed treatment with a mixture of the studied preparations was carried out at the experimental sites.

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1 Introduction

A comparison of current indicators of the phytosanitary situation with long-term data on the phenology, abundance and distribution of harmful objects makes it possible to predict the timing of their appearance and the nature of the harm caused, which, in turn, provides grounds for planning effective measures to protect cultivated crops [1, 2, 3,4]. The nature of weather conditions is also important, which determines the ratio and duration of the phases of development of crops and harmful objects [5, 6, 7, 8] and therefore the intensity of the impact of factors harmful to the condition of crops, which determines the onset of the economic threshold of harmfulness (EPV) and the choice of plant protection methods [9, 10, 11, 12].

Ongoing research and comparative analysis of the impact of the branch's products FGBI "Rosselkhoznadzor" in the Rostov region fertilizers Vostok EM–1, containing live cultures of effective microorganisms (photosynthetic and lactic acid bacteria, yeast, actinomycetes, fermenting fungi); organo-mineral fertilizer based on humic acids Humate +7 grade C2 liquid concentrate; organo-mineral fertilizer based on humic acids Green-Organic Gum–1; to study the effect of the microbiological fungicide Metabacterin produced by Inagro LLC, a joint venture based on live cultures of bacteria Methylobacterium extorquens NVD BKM B-2879 D + Bacillus subtilis VKPM B-2918 IPM-215 and validamycin Streptomyces hygroscopicus subsp. limoneus VKPM AC-1966 and their effect on increasing seed germination, strengthening growth and shaping processes, reducing the development of septoria, increasing immunity to diseases and adverse environmental factors, increasing yields and improving grain quality [13, 14, 15].

2 Materials and methods

Conducting a demonstration experiment with the use of microbiological fertilizer Vostok EM–1.

In both plots, ammophos grade NP 12:52 was introduced at a dose of 100 kg/ha during sowing. Tillage: plowing, cultivation.

Seed treatment before sowing was carried out with three preparations: Biostim Start growth regulator at a dose of 0.5 l/t, Heraclion fungicide, CS at a dose of 1.2 l /t to protect seeds and seedlings from hard and dusty smut, helminthosporiasis and fusarium root rot, seed mold, septoria, alternaria seed infection and snow mold, Bombard insecticide, CS at a dose of 1.2 l/t to protect seedlings from damage by larvae of bread beetle and cereal flies.

The sowing date is 07.11.2022.

The seeding rate is 210 kg/ha.

The date of emergence is 11/18/2022.

Germination: control — 87%, experimental site — 97%.

Table 1. Scheme of experience

№ processing	The development phase	Events	
		Control	Experience
1	Seeds before sowing 07.11.2022	Seed treatment with a tank mixture of preparations: Heraklion, KS (1.2 l/t) Bombard, CS (1.2 l/t) Biostim Start (0.5 l/t)	Seed treatment with a tank mixture of preparations: Heraklion, KS (1.2 l/t) Bombard, CS (1.2 l/t) Biostim Start (0.5 l/t) Vostok EM–1 (0.1 l/t)
2	Tillering 27.04.2023	–	Spraying of crops with Vostok EM–1 fertilizer (0.6 l/ha)

3	Flag sheet 15.05.2023	–	Spraying of crops with Vostok EM–1 fertilizer (0.6 l/ha)

Conducting a demonstration experiment using the organomineral fertilizer Humate +7 grade C 2 liquid concentrate.

In both plots, ammophos grade NP 12:52 was introduced at a dose of 100 kg/ha during sowing. Tillage: plowing, cultivation.

Seed treatment before sowing was carried out with three preparations: Biostim Start growth regulator at a dose of 0.5 l/t, Heraclion fungicide, CS at a dose of 1.2 l /t to protect seeds and seedlings from hard and dusty smut, helminthosporiasis and fusarium root rot, seed mold, septoria, alternaria seed infection and snow mold, Bombard insecticide, CS at a dose of 1.2 l/t to protect seedlings from damage by larvae of bread beetle and cereal flies.

The sowing date is 07.11.2022.

The seeding rate is 210 kg/ha.

The date of emergence is 11/18/2022.

Germination: control — 87%, experimental site — 95%.

Table 2. Scheme of experience

№ processing	The development phase	Events	
		Control	Experience
1	Seeds before sowing 07.11.2022	Seed treatment with a tank mixture of preparations: Heraklion, KS (1.2 l/t) Bombard, CS (1.2 l/t) Biostim Start (0.5 l/t)	Seed treatment with a tank mixture of preparations: Heraklion, KS (1.2 l/t) Bombard, CS (1.2 l/t) Biostim Start (0.5 l/t) Humate +7 (1 l/t)
2	Tillering 27.04.2023	–	Spraying of crops with Humate +7 fertilizer (1 l/ha)
3	Flag sheet 15.05.2023	–	Spraying of crops with Humate +7 fertilizer (1 l/ha)

Conducting a demonstration experiment with the use of organo-mineral fertilizer Green-Organica Gum–1.

In both plots, ammophos grade NP 12:52 was introduced at a dose of 100 kg/ha during sowing. Tillage: plowing, cultivation.

Seed treatment before sowing was carried out with three preparations: Biostim Start growth regulator at a dose of 0.5 l/t, Heraclion fungicide, CS at a dose of 1.2 l /t to protect seeds and seedlings from hard and dusty smut, helminthosporiasis and fusarium root rot, seed mold, septoria, alternaria seed infection and snow mold, Bombard insecticide, CS at a dose of 1.2 l/t to protect seedlings from damage by larvae of bread beetle and cereal flies.

The sowing date is 07.11.2022.

The seeding rate is 210 kg/ha.

The date of emergence is 11/18/2022.

Germination: control — 87%, experimental site — 92%.

Table 3. Scheme of experience

№ processing	The development phase	Events	
		Control	Experience
1	Seeds before sowing 07.11.2022	Seed treatment with a tank mixture of preparations: Heraklion, KS (1.2 l/t) Bombard, CS (1.2 l/t) Biostim Start (0.5 l/t)	Seed treatment with a tank mixture of preparations: Heraklion, KS (1.2 l/t) Bombard, CS (1.2 l/t) Biostim Start (0.5 l/t) Green Organic Gum–1 (1 l/t)
2	Tillering 27.04.2023	–	Spraying of crops with Green-Organic Gum–1 fertilizer (1 l/ha)
3	Flag sheet 15.05.2023	–	Spraying of crops with Green-Organic Gum–1 fertilizer (1 l/ha)

Conducting a demonstration experiment using the microbiological fungicide Metabacterin, SP.

In both plots, ammophos grade NP 12:52 was introduced at a dose of 100 kg/ha during sowing. Tillage: plowing, cultivation.

Seed treatment before sowing was carried out with three preparations: Biostim Start growth regulator at a dose of 0.5 l/t, Heraclion fungicide, CS at a dose of 1.2 l /t to protect seeds and seedlings from hard and dusty smut, helminthosporiasis and fusarium root rot, seed mold, septoria, alternaria seed infection and snow mold, Bombard insecticide, CS at a dose of 1.2 l/t to protect seedlings from damage by larvae of bread beetle and cereal flies.

The sowing date is 07.11.2022.

The seeding rate is 210 kg/ha.

The date of emergence is 11/18/2022.

Germination: control — 87%, experimental site — 98%.

Table 4. Scheme of experience

№ processing	The development phase	Events	
		Control	Experience
1	Seeds before sowing 07.11.2022	Seed treatment with a tank mixture of preparations: Heraklion, KS (1.2 l/t) Bombard, CS (1.2 l/t) Biostim Start (0.5 l/t)	Seed treatment with a tank mixture of preparations: Heraklion, KS (1.2 l/t) Bombard, CS (1.2 l/t) Biostim Start (0.5 l/t)
2	Tillering 27.04.2023	–	Spraying of crops with the fungicide Metabacterin, SP (9 g/ha)
3	Flag sheet 15.05.2023	–	Spraying of crops with the fungicide Metabacterin, SP (9 g/ha)

3 Results

Conducting a demonstration experiment with the use of microbiological fertilizer Vostok EM–1.

At the experimental and control sites during the tillering phase in spring, a similar degree of infection of winter wheat with septoria and root rot was revealed. By the phase of the flag leaf, infection with septoria reached its maximum. At the control site, the prevalence of septoria was 100% (development — 20%, exceeding the economic threshold of harmfulness (EPV) of 15%), at the experimental site, the prevalence of septoria was 58% (development — 5.8%, not exceeding EPV). After treatments with microbiological fertilizer to the phase of milk ripeness at the experimental site, the development of septoria decreased by 7 times, reaching 0.2%, whereas at the control it remained almost at the same level, slightly decreasing to 20% due to the onset of the culture phase unfavorable for the development of the disease.

Table 5. Results of a phytosanitary survey of winter wheat conducted to identify infectious diseases

Date of examination	The culture phase	Region	Disease	Distribution (P), %	Develop-ment (R), %
27.04.2023	Tillering	Control	Septoria	40	2,2
			Root rot	2	0,3
		Experience	Septoria	17	1,7
			Root rot	2	0,2
04.05.2023	Exit into the tube	Control	Septoria	65	13,0
			Root rot	3	0,2
		Experience	Septoria	19	1,9
			Root rot	2	0,2
15.05.2023	Flag sheet	Control	Septoria	100	20,0
			Root rot	3	0,2
		Experience	Septoria	58	5,8
			Root rot	2	0,2
20.06.2023	Milk ripeness	Control	Septoria	80	20,0
			Root rot	3	0,1
		Experience	Septoria	15	0,8
			Root rot	2	0,2

Table 6. Results of determining the quality of winter wheat grain

Option	Content			Grain size, g/l
	protein, %	gluten, %	starch, %	
Control	12,46	21,3	66,8	784
Experience	12,74	21,8	66,3	781

Table 7. Yield of winter wheat

Indicator	Control	Experience
Number of productive stems, pcs./m2	314	334
The number of grains in an ear, pieces	33	34
Weight of 1000 grains, g	42,5	51,7
Yield, kg/ha	5100	5880
Yield increase, kg/ha	–	780

Conducting a demonstration experiment using the organomineral fertilizer Humate +7 grade C 2 liquid concentrate.

At the experimental and control sites, in the tillering phase in spring, a similar degree of infection of winter wheat with septoria and root rot was revealed. By the phase of the flag leaf, infection with septoria reached its maximum. At the control site, the prevalence of septoria was 100% (development — 20%, exceeding the EPV of 15%), at the experimental site, the prevalence of septoria was 64% (development — 6.4%, not exceeding the EPV). After organo-mineral fertilizer treatments to the phase of milk ripeness in the experimental site, the development of septoria decreased by 7 times, reaching 0.9%, whereas in the control it remained almost at the same level, slightly decreasing to 20% due to the onset of the culture phase unfavorable for the development of the disease.

Table 8. The results of a phytosanitary survey of winter wheat conducted to identify infectious diseases

Date of examination	The culture phase	Region	Disease	Distribution (P), %	Development (R), %
27.04.2023	Tillering	Control	Septoria	40	2,2
			Root rot	2	0,3
		Experience	Septoria	21	2,1
			Root rot	2	0,2
04.05.2023	Exit into the tube	Control	Septoria	65	13,0
			Root rot	3	0,2
		Experience	Septoria	24	2,4
			Root rot	2	0,2
15.05.2023	Flag sheet	Control	Septoria	100	20,0
			Root rot	3	0,2
		Experience	Septoria	64	6,4
			Root rot	2	0,2
20.06.2023	Milk ripeness	Control	Septoria	80	20,0
			Root rot	3	0,1
		Experience	Septoria	17	0,9
			Root rot	2	0,2

Table 9. Results of determining the quality of winter wheat grain

Option	Content			Grain size, g/l
	protein, %	gluten, %	starch, %	
Control	12,46	21,3	66,8	784
Experience	12,89	22,1	66,2	784

Table 10. Yield of winter wheat

Indicator	Control	Experience
Number of productive stems, pcs./m2	314	333
The number of grains in an ear, pieces	33	34
Weight of 1000 grains, g	42,5	51,8
Yield, kg/ha	5100	5870
Yield increase, kg/ha	–	770

4 Discussion of the results

Conducting a demonstration experiment with the use of organo-mineral fertilizer Green-Organica Gum–1.

At the experimental and control sites, in the tillering phase in spring, a similar degree of infection of winter wheat with septoria and root rot was revealed. By the phase of the flag leaf, infection with septoria reached its maximum. At the control site, the prevalence of septoria was 100% (development — 20%, exceeding the EPV of 15%), at the experimental site, the prevalence of septoria was 76% (development — 7.6%, not exceeding the EPV). After organo-mineral fertilizer treatments to the phase of milk ripeness in the experimental site, the development of septoria decreased by 3 times, reaching 2.5%, whereas in the control it remained almost at the same level, slightly decreasing to 20% due to the onset of the culture phase unfavorable for the development of the disease.

Table 11. The **results** of a phytosanitary survey of winter wheat conducted to identify infectious diseases

Date of examination	The culture phase	Region	Disease	Distribution (P), %	Development (R), %
27.04.2023	Tillering	Control	Septoria	40	2,2
			Root rot	2	0,3
		Experience	Septoria	28	2,8
			Root rot	2	0,2
04.05.2023	Exit into the tube	Control	Septoria	65	13,0
			Root rot	3	0,2
		Experience	Septoria	37	3,7
			Root rot	2	0,2
15.05.2023	Flag sheet	Control	Septoria	100	20,0
			Root rot	3	0,2
		Experience	Septoria	76	7,6
			Root rot	2	0,2
20.06.2023	Milk ripeness	Control	Septoria	80	20,0
			Root rot	3	0,1
		Experience	Septoria	25	2,5
			Root rot	2	0,2

Table 12. Results of determining the quality of winter wheat grai

Option	Content			Grain size, g/l
	protein, %	gluten, %	starch, %	
Control	12,46	21,3	66,8	778
Experience	12,49	20,7	66,7	784

Table 13. Yield of winter wheat

Indicator	Control	Experience
Number of productive stems, pcs./m2	314	326
The number of grains in an ear, pieces	33	34
Weight of 1000 grains, g	42,5	49,8
Yield, kg/ha	5100	5530
Yield increase, kg/ha	–	430

Conducting a demonstration experiment using the microbiological fungicide Metabacterin, SP.

At the experimental and control sites, in the tillering phase in spring, a similar degree of infection of winter wheat with septoria and root rot was revealed. By the phase of the flag leaf, infection with septoria reached its maximum. At the control site, the prevalence of septoria was 100% (development — 20%, exceeding the EPV of 15%), at the experimental site, the prevalence of septoria was 43% (development — 4.3%, not exceeding the EPV). After treatments with the fungicide Metabacterin, the development of septoria decreased 9 times by the phase of milk ripeness in the experimental site, reaching 0.5%, whereas in the control it remained almost at the same level, slightly decreasing to 20% due to the onset of the culture phase unfavorable for the development of the disease.

Table 14. The results of a phytosanitary survey of winter wheat conducted to identify infectious diseases

Date of examination	The culture phase	Region	Disease	Distribution (P), %%	Development (R), %
27.04.2023	Tillering	Control	Septoria	40	2,2
			Root rot	2	0,3
		Experience	Septoria	24	2,4
			Root rot	2	0,2
04.05.2023	Exit into the tube	Control	Septoria	65	13,0
			Root rot	3	0,2
		Experience	Septoria	30	3,0
			Root rot	2	0,2
15.05.2023	Flag sheet	Control	Septoria	100	20,0
			Root rot	3	0,2
		Experience	Septoria	43	4,3
			Root rot	2	0,2
20.06.2023	Milk ripeness	Control	Septoria	80	20,0
			Root rot	3	0,1
		Experience	Septoria	9	0,5
			Root rot	2	0,1

Table 15. Results of determining the quality of winter wheat grain

Option	Content			Grain size, g/l
	protein, %	gluten, %	starch, %	
Control	12,46	21,3	66,8	784
Experience	13,07	23,7	66,1	792

Table 16. Yield of winter wheat

Indicator	Control	Experience
Number of productive stems, pcs./m2	314	337
The number of grains in an ear, pieces	33	34
Weight of 1000 grains, g	42,5	52,0
Yield, kg/ha	5100	5960
Yield increase, kg/ha	–	860

5 Conclusions

The combined use of Vostok EM–1 fertilizer with chemical pesticides had a positive effect on increasing seed germination, plant growth, the number of grains in an ear, the mass of 1000 grains, which, together with the successful overcoming of the negative effects of pesticide stress and infection with pathogens, contributed to an increase in yield, as well as the content of protein and gluten in the grain. The increase in yield in the experiment was 7.8 c/ ha, which is 15.3% of the yield obtained in the control.

The combined use of organic mineral fertilizer Humate +7 grade C2 liquid concentrate with chemical pesticides positively affected the increase in seed germination, plant growth, the number of grains in the ear, the mass of 1000 grains, which, together with the successful overcoming of the negative effects of pesticide stress and infection with pathogens, contributed to an increase in yield, as well as the content of protein and gluten in the grain. The increase in yield in the experiment was 7.7 c / ha, which is 15.1% of the yield obtained in the control.

The combined use of organic mineral fertilizer Humate +7 grade C2 liquid concentrate with chemical pesticides positively affected the increase in seed germination, plant growth, the number of grains in the ear, the mass of 1000 grains, which, together with the successful overcoming of the negative effects of pesticide stress and infection with pathogens, contributed to an increase in yield, as well as the content of protein and gluten in the grain. The increase in yield in the experiment was 4.3 c / ha, which is 8.4% of the yield obtained in the control.

The use of the fungicide Metabacterin, SP caused a decrease in the development of septoria, an increase in plant growth, the number of grains in the ear, the mass of 1000 grains, which contributed to an increase in yield, as well as the content of protein and gluten in the grain. The increase in yield in the experiment was 8.6 c / ha, which is 16.9% of the yield obtained in the control.

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