

Ways to reduce pesticide load in production technologies for cultivating agricultural crops

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Abstract. The article presents the results of field studies of the use of the universal growth stimulator "Plantarel" in technologies for cultivating winter wheat, sunflower, grain corn and soybeans. Schemes for using the growth stimulant are presented, as well as the results of economic efficiency. Evaluation indicators of studies have established the effectiveness of the drug. The increase in crop yields was: winter wheat - by 15.1%, sunflower - by 5.2%, corn for grain - by 7.1%, soybean - by 9.3%.

1 Introduction

To achieve sustainable and environmentally friendly agriculture, more and more attention is being paid to the development of biological methods of plant protection. Biological preparations are living organisms or their products that can effectively combat pathogens and plant pests without harming the environment and human health [1-2].

The use of biological protection agents can reduce soil and water pollution with chemicals, reduce the risk of resistance in pests, as well as the pesticide load on agrocenoses. Moreover, the use of biological products helps improve soil quality, improve plant growth and development [3-5].

The importance of biologization of agriculture is to give it energy-resource-saving and sustainable development. The development and justification of biologization techniques to increase the productivity and environmental friendliness of agricultural crops is an urgent task of modern agriculture.

Thus, the transition to biological methods of plant protection is a key step towards sustainable agriculture, which will contribute to the preservation of the environment and human health, as well as provide high yields of products with improved characteristics [6-8].

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2 Materials and methods

As part of experimental studies, the innovative drug "Plantarel" was tested on various crops, such as winter wheat, sunflower, grain corn and soybeans. The experiments were carried out at the production site of the validation site of the Novokubansk branch of the Federal State Budgetary Institution "Rosinformagrotech" (KubNIITiM).

The validation site is located in the Novokubansky district of the Krasnodar Territory, in the flat zone. The climate of this region belongs to the temperate continental type, characterized by unstable moisture. Rainfall varies from 600 to 630 mm per year and is uneven. The annual sum of temperatures above 10 °C is 3400 degrees.

The main type of soil that predominates in the fields of the validation site is ordinary low-humus, heavy-duty, light-clay soil. This means that the soil is characterized by a high content of fertile substances and good structure.

The studies were carried out to evaluate the effectiveness of the use of the growth stimulator "Plantarel" in the conditions of this region and on various crops. The experimental results allow us to draw conclusions about the effective use of this drug in plant protection and increasing productivity.

Plantarel, BP [9] (complete with a working solution stabilizer (2.0 ml for every 100.0 ml "Plantarel") - a universal growth stimulator based on silver with fungicidal properties. Active ingredient, mg/l: colloidal silver - 500 , polyhexamethylene biguanide hydrochloride – 500.

The growth stimulator is intended for pre-sowing treatment of seeds and treatment of vegetative plants of agricultural crops, and promotes the growth of plant resistance to abiotic stress factors (frost, drought, herbicide pit), as well as strengthening the resistance of plants to factors of biogenic nature - the effects of phytopathogenic microorganisms (fungi and bacteria). Enhances the effect of systemic fungicides while reducing hectare norms. It has a powerful elicitor effect with stimulation of nonspecific plant immunity, a high level of quality of agricultural products, regardless of climatic conditions or type of crop. Activates the development of a powerful root system, and also increases the yield of agricultural crops.

In the experimental studies, we used seeds zoned for the central zone of the Krasnodar Territory: the mid-ripening variety of winter soft wheat "Gomer" and the early-ripening corn hybrid "Krasnodarsky 194 MV" (selections of the Federal State Budgetary Scientific Institution "NTsZ named after P.P. Lukyanenko"), the early-ripening sunflower hybrid LG 50480 from LG company and the mid-early, highly productive oilseed soybean variety SK Veda (Soy Complex LLC).

For each of these crops, experimental plots were established within one field. At the same time, all recommendations for the cultivation of these field crops were taken into account and followed. Recommendations included soil preparation, selection of varieties and hybrids, optimal sowing time, correct and reasonable use of fertilizers and protective agents, as well as effective methods of weed and pest control (Table 1) and in compliance with the basic rules and requirements for field experience B.A. Dosphehova [10].

Table 1. Preparations used in the treatment of seeds and crops of agricultural crops.

Plant phase	Option No. 1 (control)	Option No. 2 (experiment)
Winter wheat		
seed treatment	Oplot Trio (0.6 l/ha)	Oplot Trio (0.6 l/ha) +Plantarel, BP (0.2 l/ha)
tillering	Pint, MD (0.15 l/ha) + Zim 500, KS (0.5 l/ha) + Litmus (0.2 l/ha)	Pint, MD (0.15 l/ha) +Plantarel, BP (0.2 l/ha)
the beginning of the exit into the tube	Shaman, CE (0.7 l/ha) +Title Duo, KKR (0.32 l/ha) +Litmus (0.2 l/ha)	Shaman, CE (0.7 l/ha) +Plantarel, BP (0.2 l/ha)
heading	Title Duo, KKR (0.32 l/ha) + Kinfos, KE (0.3 l/ha) + Assistant (0.12 l/ha) + Karbamid (7.0 kg/ha)	
Sunflower		
after sowing	Brig, KS (2.0 l/ha) + Acetal Pro, CE (2.0 l/ha)	
5-6 leaves	Ultramag Boron (1.0 l/ha) +Kinfos, CE (0.25 l/ha)	Ultramag Boron (1.0 l/ha) +Kinfos, CE (0.25 l/ha) +Plantarel, BP (0.2 l/ha)
Corn for grain		
3-4 sheets	Modern, KE (0.5 l/ha)	
5-7 leaves	Ultramag Boron (1.0 l/ha) +Ultramag SuperZinc-700 (1.0 l/ha)	Ultramag Boron (1.0 l/ha) +Ultramag SuperZinc-700 (1.0 l/ha) + Plantarel, VR (0.2 l/ha)
Soybeans		
seed treatment	Nitrofors (0.5 l/t) + Oplot, VSK (0.5 l/t)	Nitroforce (0.5 l/t) +Plantarel, BP (0.2 l/ha)
1-3 sheets	Geyser, KKR (2.6 l/ha) +Concept, MD (0.6 l/ha)	Geyser, KKR (2.6 l/ha) +Concept, MD (0.6 l/ha) +Plantarel, BP (0.2 l/ha)
budding	Shaman, CE (0.6 l/ha) +Assistant, F (0.2 l/ha) +Ultramag Boron (1 l/ha)	Shaman, CE (0.6 l/ha) +Assistant, F (0.2 l/ha) +Ultramag Boron (1 l/ha) +Plantarel, BP (0.2 l/ha)

The treatment schemes for cultivated plants in the experimental variants differed from those generally accepted on the farm:

- Before sowing, to treat the seeds of winter wheat, in an experimental version, the drug “Plantarel” was added to the tank mixture; in the phases of tillering and the beginning of emergence into the tube, the fungicides “Zim 500”, “Titul Duo” and the water acidity regulator “Litmus” were replaced with the growth stimulator “Plantarel”.
- In experimental crops of sunflower and corn for grain, the drug “Plantarel” was added to the tank mixture for foliar treatments in the phase of 5-7 leaves of the crop.
- In the tank mixture for treating soybean seeds, in the experimental version, the seed treater “Oplot” was replaced with the growth stimulator “Plantarel”; in experimental soybean crops, leaf treatments were completely different in the phase from 1 to 3 true trifoliolate leaves; in the control variant, treatments were carried out with a mixture of herbicides “Geyser” and “Concept”; in the budding phase of plants in control crops, treatments were carried out with a mixture of preparations: insecticide “Shaman”, microfertilizer “Ultramag Boron” and the organosilicone superwetting agent “Assistant”, and in the experimental ones the drug “Plantarel” was added to the tank mixture to these drugs.

3 Results

Analysis of indicators for the use of the biological growth stimulator "Plantarel" when growing winter wheat, sunflower, corn for grain and soybeans allowed us to obtain the following results:

- For winter wheat, grain yield increased by 6.86 c/ha (52.28 c/ha), relative to the yield obtained in the variant with crop treatment adopted on the farm (45.42 c/ha), while an increase in ear length was observed up to 8.4 cm and the grain size of the ear is on average 5 grains. In the experimental version, the weight of 1000 grains was 36.92 g, which is 2.41 g higher than in the control version.
- For sunflower, the seed yield was 40.28 c/ha, which is 2 c/ha higher than in the control option - 38.28 c/ha, while there was an increase in plant height relative to the control option by 18.21 cm, diameter baskets in sunflower plants by 3.3 cm and the weight of seeds from 1 basket by 6.46 g. The weight of 1000 seeds was 68.94 g, which exceeded the control variant by 9.4 g.
- For corn, grain yield increased by 3.32 c/ha and amounted to 50.18 c/ha, while plant height increased by 23.44 cm, cob diameter by 0.41 cm, average grain weight from 1 cob to 25 .26 g and the length of the cob was 15.82 cm, which is 2.82 cm higher than in the control variant. The weight of 1000 grains was 269.16 g, which exceeded the control variant by 23.99 g.
- For soybeans, grain yield increased by 1.6 c/ha (18.75 c/ha), relative to the yield obtained in the variant with crop treatment adopted on the farm (17.15 c/ha), while there was an increase in the number of beans by per plant per 0.2 pcs. and the number of grains on one plant by 1.6 pcs. The weight of 1000 grains in both options was 156 g. The additional profit obtained by replacing the preparations in comparison with the economic scheme for processing crops amounted to 4241 rubles/ha.

The results of the economic efficiency of using the biological product "Plantarel" are given: on winter wheat, sunflower (Table 2), corn for grain, soybeans (Table 3).

Table 2. The effectiveness of using the drug "Plantarel" on winter wheat and sunflower.

Indicators	The value of the indicator by culture			
	winter wheat		sunflower	
	No. 1 (control)	No. 2 (Plantarel)	No. 1 (control)	No. 2 (Plantarel)
Productivity, c/ha	45.42	52.28	38.28	40.28
Profit, rub./ha	18 915	27 568	56 530	60 590
Cost reduction, rub./ha	-	153	-	-
Additional costs, rub./ha	-	-	-	334
Additional profit received, rub./ha	-	8653	-	4060

Table 3. Efficiency of using the drug "Plantarel" on corn for grain, soybeans.

Indicators	The value of the indicator by culture			
	corn for grain		soybeans	
	No. 1 (control)	No. 2 (Plantarel)	No. 1 (control)	No. 2 (Plantarel)
Productivity, c/ha	46.86	50.18	17.15	18.75
Profit, rub./ha	31 468	35 444	23 367	27 608
Additional costs, rub./ha	-	334	-	688
Additional profit received, rub./ha	-	3976	-	4241

After analyzing the results of economic research, the following conclusions can be drawn:

- The use of a biological growth stimulator on agricultural crops had a significant impact on the increase in yield: winter wheat - by 15.1%, sunflower - by 5.2%, corn for grain - by 7.1% and soybean - by 9.3%.
- The increase in yield led to an increase in additional profit: for winter wheat – by 8653 rubles/ha, for sunflower – by 4060 rubles/ha; for corn for grain – by 3976 rubles/ha; for soybeans – by 4241 rubles/ha.
- Additional profit exceeds the cost of purchasing the drug on sunflower - 12.2 times, on corn for grain - 11.9 times, on soybeans - 6.2 times.

4 Discussion

Based on the results of studies of production technologies for cultivating main crops with biological methods of plant protection and reduced pesticide load, it was established that:

- Partial replacement of drugs or the addition of the growth stimulant “Plantarel” to crop cultivation technology contributed to an increase in the yield of winter wheat, sunflower, grain corn and soybeans.
- Profit increased for all crops: on winter wheat by 8,653 rubles/ha, on sunflower – by 4,060 rubles/ha, on corn for grain by 3,976 rubles/ha, on soybeans by 4241 rub./ha.
- Biometric characteristics and general condition of plants of the studied crops have improved.

5 Conclusion

The results obtained indicate significant positive changes that were observed in the cultivation of all four crops.

Firstly, the use of a biological growth stimulant led to an increase in the yield of each of these crops. Winter wheat produced higher quality grains, sunflower and corn had a higher weight of seeds and grains, and soybeans had improved yields compared to the control option without the use of a stimulant.

Secondly, the use of a biological growth stimulator made it possible to reduce the influence of agrochemicals on cultivated plants, contributed to more active plant growth, and accelerated their development phases. This reduced the risk of crop losses associated with unfavorable weather conditions or plant diseases.

Thirdly, the use of a growth stimulant led to the resistance of cultivated plants to diseases and pests, since the stimulant activated their own defense mechanisms. The plants were also better able to adapt to unfavorable conditions such as drought and low soil nutrients.

In general, the study of the use of the biological growth stimulator "Plantarel" in the cultivation of winter wheat, sunflower, grain corn and soybeans confirms its high efficiency.

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