Effect of “Bist” and “Bist-M” biopreparations on quality and productivity of wheat and cotton yields in agro-ecological zones of Uzbekistan

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Abstract. Significant emphasis is placed on the development and application of biopreparations harnessed from beneficial bacteria, which exhibit advantageous traits for plants. A multitude of experiments have substantiated that the concurrent utilization of biopreparations in conjunction with mineral fertilizers opens avenues to cultivate high-quality agricultural produce. Researchers across diverse regions have demonstrated that not only can plant productivity be augmented through this approach, but also the attainment of superior, environmentally-friendly yields is feasible, stemming from an exploration of the intricate interplay between plants and microorganisms. This growing body of scientific evidence underscores the potential of leveraging the symbiotic relationship between plants and beneficial microorganisms. This synergy holds the promise of enhancing agricultural output while championing the production of products that meet stringent ecological standards. As such, the collaborative influence of biopreparations and traditional agricultural practices stands as a noteworthy avenue for fostering sustainable and quality-driven agricultural endeavors.
Keywords. Microbe, biopreparation, strain, bacteria, salinity, drought, pesticide.

1 Introduction

In recent years, in order to ensure the effectiveness of mineral fertilizers, recommendations have been developed on the use of their nanoparticles. Taking into account the damage caused by mineral fertilizers and chemical pesticides, systematic work has been started in developed countries to reduce their amount as much as possible and to replace them with biotechnology products [1]. Ensuring environmental protection, as well as growing ecologically clean products, increasing soil fertility, at least leaving this indicator unchanged, is defined as the main task facing agriculture today [2]. For this purpose, scientific and practical researches are being carried out on the saturation of the soil with bacteria that can provide biological nitrogen and phosphorus.

Lack of moisture or drought is one of the common stress factors for plants [3]. The lack of moisture in the soil dehydrates the plant tissue, disrupts the hormonal status, respiration

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and photosynthesis, and finally leads to a number of negative conditions and secondary effects, including oxidative stress, nutrient deficiency, and in most cases, the plant dies [4]. When plants are inoculated with associative bacteria, many of these adverse conditions can be mitigated or even completely eliminated [5]. It is of great scientific and practical importance to create and use microbiological tools based on associative rhizobacteria that increase the productivity of agricultural plants, improve the ecological condition of the soil, and serve to grow ecologically clean products [6]. Although biopreparations "Bist" and "Bist-M" have exactly this feature, the question of their use is lagging behind the requirements of the times [7]. The reason for this is that we do not have enough knowledge about the ecology of the microorganisms that form the basis of these preparations and the role of agroecological factors that determine the effective functioning of the plant-bacterial association [8].

It is known from scientific sources that the number of populations of microorganisms is a factor determining their activity and status in the biocenosis [9]. The specificity of the reactions of different types and varieties of plants to bacteriization is related to the preservation or loss of associative bonds that make a particular plant with bacteria. In addition to the soil-climatic conditions of the microbial populations artificially introduced from outside, the interactions between the indigenous microorganisms living in this soil and the newly introduced microorganisms have a great impact on the productivity of the inoculated plants [10]. Despite this, there have been no studies that could reveal the effect of agroecological factors on the interaction of associative rhizobacteria with plants. Taking this into account, we conducted experimental tests on soils of different agro-ecological conditions of Khorezm region, Uzbekistan.

2 Materials and methods

In total, 2 liters per seed per 1 hectare of land with biopreparation, 5 liters of sap water and 5 liters of suspension during the growing season of the plant, yield increased by 7-12 centners, germination of seedlings was accelerated by 3-4 days; it was observed that the bolls were prevented, the cotton bolls became larger, the quality of the harvest improved, and in the case of grain, the plant leaves became larger, the amount of gluten increased, the photosynthesis process improved, and as a result, the yield increased.

These indicators show that the use of biopreparations is effective at a time when it is increasingly difficult to carry out agricultural work in the conditions of the Khorezm region, and it increases the urgency of creating biotechnologies in accordance with these soil-climatic conditions. Taking this into consideration, in the scientific laboratory of the Department of Microbiology and Biotechnology of UzMU, research was conducted to create the "Bist-M" biopreparation, which can work effectively even in salinity and dehydration conditions, by modifying the "Bist" biopreparation. It is known that "Bist" biopreparation is based on Pseudomonas putuda Pp-1 bacterium, it is gram-negative and does not form spores, which means it is resistant to stress conditions (high salinity and dehydration). If this biopreparation is enriched with a spore-forming bacterium that has a positive effect on plants , it has been confirmed in laboratory experiments that the above-mentioned shortcomings can be avoided. The meaning and essence of the new proposal is that under favorable agro-climatic conditions, both microorganisms can work well in harmony with each other, but when the non-spore-forming bacteria dies, the spore-forming bacteria can protect itself and the agro-climatic conditions are favorable. by changing its direction, it returns to the vegetative state and continues its interaction with the plant.

3 Results and discussion

Just such a bacterium was identified as *Bacillus subtilis* , and a special, inexpensive nutrient medium for its growth was invented and protected by a patent (IAP 20180376). It has been proven in the experiments that the biopreparation "Bist-M" created in this way can be used together with the usual farming methods and other chemical means. "Bist" before planting seeds of Tanya variety of winter wheat in moderately saline soils of Khorezm region (solid residue 0.5-1.0%; chlorine content 0.05-0.1%; sulfate ion 0.3-0.4%) and "Bist-M" biopreparations, the results obtained against the background of mineral fertilizers are shown in Table 1.

It was observed that winter wheat was damaged in the process of coming out of winter, affected by unfavorable climatic conditions (sudden temperature changes, dusty wind, etc.), and even died. At that time, it was observed that the resistance of the plant to adverse factors depends on its general physiological state (Table 1).

Table 1. Winter wheat "Tanya" variety seeds treated with "Bist" and "Bist-M" biopreparations, indicators of plant emergence from winter ("Shukhrat-Nadir" and "Qalandar Yakhshibaev" farms, 2020), %.

Options	**During the collection phase of the plant (number of plants per sq. meter)**	**Plant emergence from winter (number of plants per sq. meter)**	**Plant emergence rate from winter**
Control	397	361	90.9
Seed treatment with "Bist".	401	387	96.5
Seed treatment with "Bist-M".	407	395	97.2
Seed treatment with vitawax FF (3 L per 1 seed).	385	353	91.8
$N_{30}P_{30}+N_{30}$ in early spring	388	361	93.1
Seed treatment with "Bist". $+N_{30}+P_{30}+N_{30}$ in early spring	420	406	96.7
Seed treatment with "Bist-M" $+N_{30}+P_{30}+N_{30}$ in early spring	417	412	97.2
Seed treatment with vitawax $+N_{30}+P_{30}+N_{30}$ in early spring	380	373	98.1

More than 90% of the total amount of plants that have come out of the winter. The total amount of wheat planted with "Bist" and "Bist-M" biopreparations was not significantly different from each other in non-fertilized and fertilized fields, and 96.5 and 96.7% in "Bist", respectively; In the biopreparation "Bist-M" it was 97.2 and 97.9%. Under the influence of biopreparations, it was observed that the yield of wheat and the amount of gluten in its content also changed in a positive direction (Table 2).

Table 2. Effect of biopreparations "Bist" and "Bist-M" on the yield of wheat and the amount of gluten in it ("Sukhrat-Nadir" and "Qalandar Yakhasbaev" farms and "Zimnitsa" and "Durdona" varieties 2020).

Options	Productivity, q/ha	Additional crop		Raw gluten content, %
		q/ha	%	
Control	17.0	-	-	26.0
"Bist" (2 L/1 ton of seeds + 5 L during the period of tuberization)	18.7	1.7	10.0	26.8
"Bist-M" (2 L/ton of seeds + 5 L during tuberization)	19.0	2.0	11.7	26.9

It was found that the amount of nitrogen in plants sprouted from seeds treated with biopreparations increased by almost 2 times compared to the control, and this indicator is equal to the plant growing in the field where nitrogen mineral fertilizer was used. Similar results were obtained when determining the amount of potassium in the plant.

Yields increased in all experiments. The increase in the yield of wheat planted by seed treatment with "Bist-M" biopreparation was achieved when phosphorus-potassium, nitrogen-phosphorus-potassium fertilizers were used together.

An increase in the yield of the winter wheat variety "Asr" was observed in all variants of our experiments. Positive results were observed when using biopreparations ("Bist" and "Bist-M"), together with phosphorus-potassium, nitrogen-phosphorus-potassium fertilizers. The highest results were obtained in the variant "Bist-M" + $N_{60}P_{45}K_{60}$ with the biopreparations "Bist" and "Bist-M" when using different doses of nitrogen-phosphorus-potassium fertilizers in different doses, the weight of 1000 pieces of wheat, compared to the control 0 It was found that 8-1.2 g increased.

The number of plants in a certain area and their branching capabilities play a key role in the formation of productivity. In this case, the plant's supply of mineral nutrients is a determining factor. A number of biometric indicators characterizing the state of winter wheat were determined: branching coefficient, plant height, number of leaves in the branching phase and ear formation period are among them (Table 3).

Table 3. Biometric indicators of winter wheat variety Andijan-2 during branching.

Plant height, cm				Branching coefficient				Number of leaves, pcs			
1	2	3	4	1	2	3	4	1	2	3	4
No fertilizer (control)											
17.5	18.3	18.7	18.0	3.1	3.7	3.9	3.6	5.5	8.1	8.6	8.2
$N_{30}P_{30}+N_{30}$ (in early spring)											

21.3	22.4	23.8	22.3	3.2	3.6	4.0	3.9	8.0	8.5	9.1	8.5
$N_{30}P_{60}+N_{60}$ (in early spring)											
21.9	23.1	24.2	22.6	2.7	2.7	2.9	3.6	7.2	7.6	8.2	7.6
$N_{30}P_{30}K_{30}+N_{30}$(in early spring $+N_{20}$ in the tuber phase $+N_{20}$ in the spike phase)											
19.2	24.1	24.6	22.7	2.8	2.6	2.8	2.7	6.3	6.9	7.4	6.8
$N_{30}P_{60}K_{60}+N_{60}$(in early spring + N_{40} in the tuber phase + N_{40} in the spike phase)											
21.1	26.6	26.8	22.7	2.8	3.1	3.2	2.9	7.8	7.2	7.8	7.2
Note : *Control - 1; "Bist" - 2; "Bist-M" - 3; Vitavaks 200 FF - 4*											

It was observed that the height of winter wheat in the branching phase depends on the amount of mineral fertilizers applied to the soil and treatment with biopreparations and vitavaks before seeding. If we evaluate the effect of pre-sowing treatment of wheat seeds with biopreparations, we can see that both biopreparations had a stronger effect than the chemical preparation vitavaks in different variants.

In the non-fertilized version, biopreparations "Bist" and "Bist-M" led to a higher growth by 0.3-0.7 cm compared to vitavaks, and in fields fertilized in different amounts and at different times, the development of wheat compared to the version treated with vitavaks was 0.1 cm to 3.9 cm higher can be seen.

Although the coefficient of branching varied from 2.7 to 4.0 depending on the options, it showed that it is somewhat difficult to explain the method of seed treatment in connection with different doses of mineral fertilizers. A similar situation can be observed when analyzing the number of leaves that appear on a winter wheat plant.

Different varieties of winter wheat reach their maximum height during the spike formation phase. In 2017, in Koshkopir, Yangariq, Khiva and Bogot regions of Khorezm region, this indicator was found to be from 62.5 cm to 75.6 cm. it was observed that it also fell.

Even in the year with such severe weather, it was observed that the yield harvested from the fields planted with biopreparations was slightly higher than that of the control (the difference was 1.2-1.5 q/ha). According to the data of 2017, it was observed that the coefficient of productive formation was 0.9-1.1, and this indicator depends on the mineral nutrition of the plant and the treatment of the seed with biopreparations and chemical agents, and it was found that the number of wheat in one spike was from 13 to 16 (Table 4).

Table 4. Biometric indicators of winter wheat in the ear formation phase.

Plant height, cm						**Productive branching coefficient**					
1	2	3	4	5	6	1	2	3	4	5	6
No fertilizer (control)											
43.2	44.6	58.1	49.1	61.1	44.4	1.1	1.2	1.3	1.2	1.4	1.2

$N_{30}P_{30}+N_{30}$ (in early spring)											
57.1	54.3	59.3	60.1	65.3	5.37	1.2	1.5	1.5	1.5	1.6	1.5
$N_{30}P_{60}+N_{60}$ (in early spring)											
58.3	55.1	59.5	60.1	62.7	54.4	1.3	1.4	1.5	1.5	1.5	1.3
$N_{30}P_{30}+N_{30}$ in early spring + N_{20} in the spike phase											
59.3	60.3	60.7	61.3	65.0	55.0	1.2	1.5	1.4	1.5	1.6	1.3
$N_{30}P_{60}+N_{60}$ in early spring + $N_{40}N_{30}P_{60}K_{60}+N_{60}$ (in early spring + N_{40})											
59.5	60.4	60.9	61.5	65.3	55.0	1.3	1.4	1.5	1.5	1.6	1.3
$N_{30}P_{30}K_{30}+N_{30}$ in early spring + N_{20} in tuberization + N_{20} in spike phase											
59.4	60.3	60.7	61.5	65.8	54.9	54.9	1.2	1.3	1.5	1.6	1.3
$N_{30}P_{60}K_{60}+N_{60}$ in early spring + N_{40} (in the tuber phase + N_{40} in the spike phases)											
59.7	60.5	60.8	61.6	66.1	55.1	55.1	1.3	1.4	1.5	1.6	1.3
Note: Control - 1; "Bist" - 2; "Bist" in the phases of tuberization and spike - 3; "Bist-M" - 4; "Bist-M" in the phases of tuberization and spike - 5; vitavaks 200 FF - 6											

The productivity of winter wheat is formed under the influence of a number of factors. It is known that by affecting the nutrition, water and air regime of the plant, its productivity can be increased. Based on this, it is possible to improve plant nutrition and air circulation in the soil through the correct use of mineral fertilizers and biopreparations. In the experiments, it was observed that the use of biopreparations during the vegetation period of the plant softens the soil and improves its physical condition.

It was observed that the use of "Bist" and "Bist-M" biopreparations can increase the yield of winter wheat from 2 to 6 centners per hectare. In particular, it was found that feeding the soil in the order of N30 P30 and N60 in early spring gave the best results (Table 5).

Table 5. Effect of mineral fertilizers and biopreparations on the yield of winter wheat.

Options	**control**	**Bist**	**Bist-M**	**Bist in tubercle**	**Bist-M is in progress**	**Bist-M is on the rise**	**Bist-M is on the rise**	**Vitavox**
Without fertilizer	17.1	19.3	20.9	18.7	20.1	17.3	18.6	19.2

N30P30+N30 in spring	20.1	22.3	24.1	24.7	25.3	23.0	25.0	22.7
N30P30+N60 in spring	24.5	26.3	28.7	29.1	30.1	29.7	30.2	23.8
N30P60+N60 in spring	24.3	26.1	28.8	28.9	29.9	28.9	29.7	23.5

It is known that the quality of winter wheat depends on the genetic characteristics of the plant and growing conditions. In the experiments, it became clear that increasing the amount of mineral fertilizers by the amount indicated in the above tables had a positive effect on the quality of the wheat crop.

Although no significant difference was observed in the experiments conducted under different options, it was noticed that additional treatment with nitrogen fertilizers during the spike phase of the plant led to better results. No changes were detected in the amount of phosphorus and potassium in winter wheat grain, the amount of crude gluten was 18-19%, but the amount of nitrogen and phosphorus in straw of winter wheat planted with biopreparations was found to be lower than in the control. It was found that the plants sprouted from the seeds planted by treatment with "Bist" biopreparation also affect the amount of nutrients in the soil (Table 6).

Table 6. Ontogeny of winter wheat planted with "Bist": changes in the 0-30 layers of soil (mg) and the amount of mobile nutrients (kg).

Plant growth phase	**$N\text{-}NO_3$**		**P_2O_5**		**K_2O**	
	control	**Bist**	**control**	**Bist**	**control**	**Bist**
Formation phase	2.3	8.5	120	110	611	620
The spike phase	1.7	0.8	145	155	750	740
Seed ripe phase	1.5	1.2	155	160	720	710

It was observed that treatment with "Bist" had a positive effect on nitrogen accumulation in the 0-30 cm layer of the soil in early spring, but it did not affect the accumulation of mobile phosphorus, and it led to an increase of mobile potassium, albeit slightly (Table 6).

It is observed that the amount of mobile nitrogen decreased during the earing phase, the amount of mobile phosphorus remained almost unchanged, the amount of mobile potassium increased, and when the seed was fully ripened, the changes in the above options became uniform. It was found that it had a positive effect in the autumn period. The amount of plants that emerged from the winter was 90.9%. It was observed that the coefficient of productive branching and the number of spikes changed depending on the dose of mineral fertilizers and "Bist" treatment. It was found that productivity increased by 2-6 q/ha. Below is the effect of biopreparation "Bist" on the quality of wheat grain in the conditions of Khorezm region soils (Table 7).

Table 7. Effect of biopreparation "Bist" on the quality of wheat grain in the conditions of Khorezm soils.

Options	**Grain type, g**		**Transparency**		**Weight of 1000 grains**		**Amount of gluten**	
	1 *)	**2 *)**	**1 *)**	**2 *)**	**1 *)**	**2 *)**	**1 *)**	**2 *)**
Durdona variety								
Control	718 ± 2.0	713 ± 4.0	72	69	40.6 ± 0.5	40.1 ± 0.5	21.0 ± 1.3	20.3 ± 1.5
Bist	740 ± 2.5	736 ± 2.2	81	77	44.1 ± 0.7	43.9 ± 0.6	23.6 ± 0.7	28.7 ± 0.6

4 Conclusions

Biopreparations "Bist" and "Bist-M" increase the number of microorganisms useful for plants in the soil, regardless of the ecological condition of saline soils (washed and not washed). The effect of "Bist" and "Bist-M" biopreparations on the number of micromycetes and denitrifiers depended on the ecological condition of the soil, and it was observed that it passed faster in washed soils than in unwashed ones.

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