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**BIOLOGICAL EFFICACY OF FUNGICIDES AGAINST POWDERY
MILDEW DISEASE OF WHEAT**

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Abstract: This article presents the biological efficacy of biological preparations used against powdery mildew in wheat crops; the research was conducted at the "Temirqadam Ilhomov Sanjarbek" farm in the Kibray district of the Tashkent region during 2023–2025. The preparations used against powdery mildew demonstrated varying levels of efficacy. In the control variant (untreated), the disease prevalence was 68.4%, while the disease development rate was 39.7%.

According to the test results, biological efficacy ranging from 64.5% to 82.3% was recorded when Mildown (2.0% SC) and Bactivipe (2.0% SC) were applied at rates of 1.0–2.0 L/ha.

Keywords: Wheat, powdery mildew, biological efficacy, Mildown, Bactivipe, fungicide.

Introduction. The expansion of intensive and energy-efficient technologies has enabled farmers to achieve high yields of winter wheat grain—ranging from 7 to 9 tons per hectare. At the same time, the need to reduce the use of chemical protectants—and replace them with biological products—has become a critical and urgent issue, driven by the goal of obtaining eco-friendly produce and lessening the pesticide load on the



agrocenosis. Studying the mechanisms underlying the protective action of beneficial microorganisms against plant diseases serves as the theoretical foundation for developing new biofungicides and introducing them into production.

Wheat ranks first among agricultural crops in terms of both cultivated area and overall importance. Wheat grain contains protein (ranging from 10–12% to 20–25% in cultivated varieties, and up to 25–30% in wild species), starch (60–64%), fats (2%), vitamins, enzymes, and minerals. The grain, bran, and other by-products serve as valuable animal feed and raw materials for the compound feed industry. Wheat straw is used for fodder, animal bedding, and construction material, while the stalks are utilized in the manufacture of paper, cardboard, and packaging materials, as well as for weaving baskets and hats. The green biomass is fed to livestock and also used for silage production. Wheat grain is used to produce various grades of flour, groats, alcohol, starch, and other products. Amidst current global climate change, powdery mildew poses a challenge to increasing the yield of wheat—a staple grain crop essential for food security. Key priorities include improving integrated control systems against powdery mildew, enhancing plant disease resistance, and utilizing protective agents that are harmless to beneficial microorganisms [13].

Powdery mildew is a major disease affecting cereal crops; its causative agents include *Blumeria graminis* f.sp. tritici (on wheat and triticale), *Blumeria graminis* f.sp. hordei (on barley), *Blumeria graminis* f.sp. avenae (on oats), and *Blumeria graminis* f.sp. secalis (on rye). While all cereal crops are susceptible to powdery mildew, the pathogen exists in distinct forms that specifically infect particular crops.

Symptoms of powdery mildew appear as a flour-like coating on leaves, stems, and spikes, though the leaves are most frequently affected. Typically, white pustules emerge, forming a mass of spores that gives the infection its characteristic floury appearance. As the fungal mycelium grows, it darkens to gray or brown. At the end of the season, cleistothecia—containing spore sacs—form as black dots on the infected plant parts [4, 5].



Wheat powdery mildew is a disease of economic importance across all wheat-growing regions, particularly in areas with cool and temperate climates. Several biotic constraints hinder global wheat production; among the most damaging are the rusts and powdery mildew. The pathogen causing powdery mildew is *Blumeria graminis* (DC.) Speer f.sp. tritici Em. Marchal (Bgt) (syn. *Erysiphe graminis* (DC.) f.sp. tritici), which ranks fourth in terms of harmfulness, following the three types of rust. These fungi develop exclusively on living plant tissues. It remains a serious disease that damages crops and impedes grain production worldwide [8, 10, 11].

It has been determined that *Bacillus subtilis* confers resistance against the disease during the pre-germination stage of powdery mildew conidia. Additionally, the Gram-negative bacterium *Sphingomonas* can be utilized as a biological control agent to suppress the development of powdery mildew. Studies on biological control mechanisms indicate that yeast or its analogs can degrade plant antitoxins. Other research demonstrates that *Bacillus subtilis* can produce a lipopeptide substance (turin) capable of effectively inhibiting conidial germination. Through the further development of integrated, pollution-free prevention and control technologies, biological control—combined with measures such as planting at the optimal time and density, proper fertilization, timely irrigation, and strategies to reduce the source of powdery mildew—can mitigate the occurrence and spread of the disease [9, 12].

Materials and Methods. Researches were carried out on the basis of generally accepted methods in mycology and agricultural phytopathology. Types of fungi that cause powdery mildew in wheat fields and their bioecological characteristics N.M. Pidoplichko, M.K. Khokhryakov and others, from the classical methods of N.A. Naumov, M.K. Khokhryakov, G.I. Roskin, M.I. Dementeva [1,2,3,5,6] in the examination of plants affected by powdery mildew in wheat and barley. methodical manuals of Sh.T. Khojayev were used to determine the biological and economic effectiveness of fungicides against the disease. In data analysis, dispersion was analyzed according to the method of B.A. Dospekhov.



Results and Discussion. During 2023–2025, the biofungicides Mildown (2.0% suspension concentrate; *Bacillus subtilis* strain IPL/BS-09; titer 1×10^8 CFU/ml or CFU/g; application rate 1.0–2.0 L/ha), Bactivipe (2.0 suspension concentrate; *Pseudomonas fluorescens* strain IPL/PS-01; titer 1×10^8 CFU/ml; application rate 1.0–2.0 L/ha), and SPORAGIN (suspension concentrate; *Bacillus subtilis* strain AN 2004; titer 1×10^9 CFU/ml; application rate 1.0–2.0 L/ha) were tested against wheat powdery mildew at two different application rates (Table 1).

Table 1

Biological efficacy of biological fungicides used against wheat powdery mildew ("Temirqadam Ilhomov Sanjarbek" farm, Qibray district, Tashkent region, 2025)

№	Experimental variants	Application rate of the product, l/ha	Severity before Disease treatment,	Day 15			Day 30		
				Disease Incidence, %	Disease Severity, %	Biological efficiency, %	Disease Incidence, %	Disease Severity, %	Biological efficiency, %
1.	Control	-	7,6	68,4	39,7	-	90,5	64,5	-
2.	Mildown (2.0% suspension concentrate;	1,0	7,5	26,5	13,3	66,4	26,4	24,0	62,9
3.	<i>Bacillus subtilis</i> strain IPL/BS-09)	2,0	7,8	14,4	7,0	82,3	24,2	15,6	75,8
4.	Bactivipe (2.0 suspension concentrate,	1,0	7,2	28,6	14,1	64,5	26,8	25,3	60,7
5.	<i>Pseudomonas fluorescens</i> strain IPL/PS-01; titer 1×10^8 CFU/ml	2,0	6,9	19,4	9,7	75,6	25,2	17,6	72,7
6.	SPORAGIN (suspension concentrate, <i>Bacillus subtilis</i> strain AN 2004	2,0	7,4	12,5	8,0	79,8	22,3	15,7	75,6



EKF₀₅=

2,87

Regarding powdery mildew infection in winter wheat, the variant not treated with biological preparations showed a disease prevalence of 68.4–90.5% and a disease development intensity of 39.7–64.5%. In the studies, when the preparation Mildown (2.0% SC) was applied at a rate of 2.0 L/ha against wheat powdery mildew, disease development was 7.0% and disease prevalence was 14.4% after 15 days. As shown in the table, the highest biological efficacy was observed in winter wheat crops treated with Mildown (2.0 L/ha) and Bactivipe (2.0 L/ha), recording 82.3% and 75.6%, respectively.

Conclusion. Biological efficacy ranging from 64.5% to 82.3% was recorded when Mildown (2.0% SC) and Bactivipe (2.0% SC) were applied at rates of 1.0–2.0 L/ha to control powdery mildew in wheat. No adverse effects on wheat development—specifically, no phytotoxicity—were observed. The products are convenient to use and mix rapidly with water.

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