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# The effectiveness of the use of biological preparations in the production of potatoes

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## Abstract

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The use of biological preparations in the protection of agricultural plants from diseases is of great importance. This issue is especially relevant in the production of potatoes. The development of new science-based plant protection technologies should combine the effectiveness of protective measures and the interests of human health safety, as well as the absence of damage to the environment. In modern agricultural production promising preparations based on various subspecies of spore-forming bacteria are widely used together with traditional chemical plant protection products. The aim of the study was to determine the effectiveness of the use of biological preparations of Kartofin (based on the *Bacillus subtilis* strain I5-12/23) and BisolbiSan, (based on the *Bacillus subtilis* strain h-13) according to the following indicators: – germination of tubers, plant growth and development, prevalence and development of diseases on plants, crop weight and its marketability. Records and observations were carried out according to the generally accepted methods described in the following manuals: "Methodology of held trial"; " Methodological guidelines for conducting registration tests of agrochemicals and plant growth regulators" . Educational and methodological guidelines for conducting research in agronomy". The results of the studies showed that pre-planting treatment of seed tubers with Kartofin and BisolbiSan biologics had a positive effect on the germination of potato tubers, increasing it by 6.3 – 8.7% compared to the control. Under field conditions they showed high biological effectiveness against pathogens of fungal diseases of potatoes: late blight, Rhizoctonia blight (from 37.5% to 100%). Accounting for the total yield showed that the highest yield indicators were noted on the variant with the use of the biological preparation BisolbiSan – 38.4 t/ha (20.5% higher than the control variant).

*Keywords:* biofungicide; Kartofin (*Bacillus subtilis* I5-12/23); BisolbiSan (*Bacillus subtilis* H-13); organic farmin'; productivity; protection from diseases

## Introduction

Over the last few decades, consumer demand for healthier food focused on environmentally sustainable agricultural systems have both promoted a rapid expansion of organic farming (Järvan et al., 2009) . Potato (*Solanum tuberosum* L.) represents a major food crop in many countries where the demand for organic productsis gradually increasing (Maggio et al., 2008).

In addition to traditional mineral fertilizers and pesticides, modern potato growing technologies also include the use of new-generation organic preparations (Gazdanova et al., 2020; Gerieva et al., 2019) This optimizes nutrition, stimulates the growth and development of plants, increases resistance to harmful environmental factors and a number of pathogens, contributes to increasing potato yields and environmental safety of agrocenosis (Azizbekyan, 2012; Azizbekyan et al., 2012; Novikova, 2013; Gerieva et al., 2020; Shapoval et al., 2017; Likhnenko et al., 2020).The use of

microbes-antagonists in the protection of potatoes from phytopathogens has a long history (Satarova et al., 2009; Revina et al., 2011; Zaitseva et al., 2014). The most effective and widely used means of combating diseases are preparations based on gram-positive spore-forming bacteria of the Bacilliaceae family. They have the ability to secrete antibiotics that suppress competing phytopathogens, enhance the fixation of atmospheric nitrogen by plants, and dissolve mineral compounds of the soil that are difficult for plants to access (Chebotar et al., 2009; Chetverikov et al., 2011).

When combined with agricultural practices biofungicides are important elements of organic farming (Uromova et al., 1985). The high physiological and bactericidal activity of many biological products is expressed in low concentrations of 5-50 mg/ha with no harmful effects on the soil and the environment (Zakharenko et al., 2008; Van Mansvelt et al., 2015; Basiev et al., 2017; Gaizatulin et al., 2019).

The aim of our research was to determine the effect of preplanting treatment of tubers and spraying of potato plants with biological preparations Kartofin and BisolbiSan on growth, development, productivity and protection against diseases of potato plants.

## Materials and Methods

Experience in the study of biofungicides was laid in the conditions of the foothill zone of the North Caucasus, at the experimental base of the SKNIIGPSKH VSC RAS in Mikhailovskoye village in 2018-2020.The experiment was carried out in accordance with the standard methods described in the following manuals: "Methodology of held trial" (Dospekhov, 1985), " Educational and methodological guidelines for conducting research in agronomy" (Adinyaev, 2013).

The area of the experimental plots was 25 $m^2$ (100 plants), in four-fold repetition. Spraying of planting tubers with the studied preparations was carried out based on the calculation of the flow rate of the working fluid (a mixture of water and the preparation) 10 liters per ton of tubers. Spraying during the growing season of potatoes based on the consumption of working fluid was 350-400 liters per hectare of area. In the research one used the potato variety Udacha. Early ripening, cancer-resistant potatoes (*Synchytrium endobioticum* pathogen), golden potato nematode (*Globodera rostochiensis*), medium-resistant to late blight (*Phytophthora infestans* Mont. de Bary) tops and tubers.

The soil of the experimental field is leached chernozem, underlain by gravel. Predecessor: annual herbs. Tillage: disking followed by under-winter plowing (November), cultivation of plowing in two tracks, pre-planting ridge tillage (March). Planting potatoes with the introduction of mineral fertilizers at the rate of $N_{45}P_{45}K_{90}$. Plant care: inter-row cultivation, plant hilling; chemical spraying of plants against pests with Actara insecticide (active ingredient – Thiamethoxam) consumption rate: 60 g/ha. Harvesting potatoes by hand.

Description of biofungicides by manufacturers:

Kartofin (*Bacillus subtilis* I5-12/23) – biological preparation, has a high fungistatic effect, protects potato plants from r Rhizoctonia blight, early blight and late blight in the field, also protects new crop tubers from dry rot during storage.

BisolbiSan (*Bacillus subtilis H-13*) – biological contact fungicide, protects against a wide range of pathogens of fungal and bacterial diseases, has a protective, regulatory effect on the plant. Increases the germination rate and the vigor of seed sprouting. Induces plant immunity to bacterial and fungal diseases.

The experiments were carried out according to the scheme presented in Table 1.

The studied biofungicides were used at the concentrations recommended by the manufacturers

Meteorological indicators: The foothill zone of the North Caucasus is relatively humid, moderately hot, with a hydrothermal coefficient of 1.5. The average annual precipitation is 630-670 mm.

## Results and Discussion

Accounting for the emergence of potato seedlings showed that pre-planting treatment of seed tubers with biologics had a positive effect on germination, increasing it by 6.3% and 8.7%. compared to the control. Thus, the treatment of potato tubers of Udacha variety with the potato biological product germination on 16, 23 and 30 day was 53.8; 82.1 and

**Table 1. Scheme of the experiment on the testing of Kartofin and BisolbiSan in the held trial**

| Preparation | Treatment of tubers before planting | The duration of use of the preparation, the rate of consumption of the preparation of vegetative plants | | | |
|---|---|---|---|---|---|
| | | Spraying in full seedlings stage | Spraying in closing the tops in rows stage | Spraying in budding stage | Spraying in end of blooming stage |
| Control | No treatment | | | | |
| Kartofin | 3 g/t (10 l/t) | 5 g/ha,(400 l/ha) | 5g/l, (400 l/ha) | 5 g/l, (400 l/ha) | 5 g/ha,(400 l/ha) |
| BisolbiSan | 2 l/t (10 l/t) | 2l/ ha,(400 l/ha) | 2 l/ha, (400 l/ha) | 2 l/ha, (400 l/ha) | 2 l/ha, 400 l/ha |

*Note:* 3g/t – consumption of preparation per ton of tubers, (10 l/t) – consumption of working fluid per ton of tubers

95.3% of plants, and in the control 28.8; 59.8 and 72.1% of plants (Table 2). The results of the second and third checkings of germination dynamics confirmed the results of the first checkings.

Due to the fact that the potato flowering time is a very important stage in individual development, since it is at this time that the formation of the number of tubers and stems is completed, during this period there were observed the greatest mass of the tops and the leaf surface index and were measured biometric indicators. According to them, it is possible to predict the yield value, which is an integral factor of all processes (growth, physiological and biochemical) occurring in potato plants.

From the data given in Table 3 it follows that the use of BisolbiSan did not affect the number of main stems significantly, the number of tubers in the seedbed compared to the control. However, it contributed to an increase in the height of the potato plant by 6.9 cm. The biological preparation of Kartofin has an effect on the height of plants, the number of main stems, and a stimulating effect on the yield of potatoes.

Weather conditions in 2020 contributed to the significant development of late blight on potato plants. According to the results of the analysis there was noted the inhibitory effect of the biological preparation Kartofin and BisolbiSan on the causative agent of this disease. A decrease in the prevalence was observed with the use of both biologics, but a higher effect was obtained with the use of Kartofin, the decrease in the prevalence of the disease reached 15.2%, and with BisolbiSan – 10.9%. The highest biological effectiveness of both biologics was noted in relation to the initial stage of development of the fungus *Phytophthora infestans* Mont. de Bary, spores are formed at high humidity on the mycelium located on the stem near the ground surface, which was widespread in the agrometeorological conditions of 2020. The effectiveness of biologics thus significantly reduced the stock of pathogen infection in the soil. By mid-July the prevalence of the disease in the variants with biologics reached 20.2-21.4%, in the control – 42.5% (Table 4).

**Table 2. The effect of potato biologics treatments on the dynamics of seedlings, % (average for 2019-2020)**

| Experiment options | Luck | | | | | |
|---|---|---|---|---|---|---|
| | 16th day | % to control | 23rd day | % to control | 30th day | % to control |
| 1. Control | 28.8 | – | 59.8 | – | 72.1 | – |
| 2. BisolbiSan | 37.9 | 131.9 | 71.0 | 134.2 | 98.0 | 135.9 |
| 3. Kartofin | 47.1 | 163.5 | 80.3 | 118.7 | 95.0 | 131.7 |

*planting of potatoes on April 25-30, when the soil warms up to 18-22°C

**Table 3. The effect of biologics on the biometric indicators of potatoes (average for 2019-2020)**

| Experiment options | Number of main stems | | Plant height | | Number of tubers (1 plant) | | Weight of tubers (1 plant) | | Weight of the tops (1 plant) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | pcs | % to control | cm | % to control | pcs. | % to control | g | % to control | g | % to control |
| 1.Control | 6.6 | 100.0 | 54.0 | 100.0 | 15.2 | 100 | 365.0 | 100.0 | 401.0 | 100.0 |
| 2.BisolbiSan | 6.6 | 100.0 | 60.9 | 112.7 | 15.7 | 103.2 | 372.2 | 108.1 | 420.0 | 104.7 |
| 3.Kartofin | 7.0 | 106.0 | 73.1 | 135.3 | 17.5 | 115.1 | 428.3 | 117.3 | 384.5 | 95.8 |

**Table 4. The effect of biofungicides on the spread and development of late blight on potato plants, % (2020)**

| Experiment options | 29.06 | | 15.07 | | 30.07 | |
|---|---|---|---|---|---|---|
| | P | R | P | R | P | R |
| Control | 17.3 | 4.1 | 42.5 | 18.1 | 58.0 | 19.3 |
| BisolbiSan | 13.2 | 0.2 | 21.4 | 9.7 | 47.1 | 13.3 |
| Kartofin | 0.8 | 0.0 | 20.2 | 1.5 | 42.8 | 11.0 |

*Note:* P – degree of extension, %; R – degree of development, %

**Table 5. The effect of the use of biologics on the productivity of potato plants (average for 2018-2020)**

| Experiment options | Yield of crops | | Fractional composition, % | | |
|---|---|---|---|---|---|
| | t/ha | % to control | 30-60 mm | > 60 mm | < 30 mm |
| 1 | 23.4 | - | 55.3 | 39.5 | 5.2 |
| 2 | 28.2 | 116.0 | 51.7 | 41.7 | 6.6 |
| 3 | 27.9 | 114.8 | 53.8 | 40.0 | 6.2 |

Accounting for the total yield in the held trial showed that with Udacha variety, all the studied biological products have a positive effect on the yield indicators compared to the control. The highest indicators were noted in the variant using the BisolbiSan biological product – 38.4 t/ha, while in the control the indicator was 33.4 t/ha (an increase in control – 5 t/ha) as it is shown in the Table 5.

## Conclusion

The use of biological preparations of Kartofin (*B. subtilis*-I5-12/23), BisolbiSan (*Bacillus subtilis* h-13) in the conditions of the foothill zone of the North Caucasus had a positive effect on the germination of potato tubers, increasing it compared to the control by 6.3; and 8.7%.

The biological effectiveness of Kartofin (*B. subtilis*-I 5-12/23) and BisolbiSan (*Bacillus subtilis* h-13) against pathogens of fungal diseases of potatoes, in particular against Phytophthora infestans Mont.de Bary, has been proven. The decrease in the prevalence of late blight with the use of Kartofin reached 15.2%, and with BisolbiSan -10.9%.

Taking into account the total yield in the field experiment showed that all the studied biological products on the Luck variety have a positive effect on productivity indicators compared to the control. The highest yield indicators were noted in the variant using BisolbiSan biopreparation-38.4 t/ha, higher than the control variant by 20.5%.

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