

The effect of using biologically active substances on the initial growth indicators of potato tubers

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Abstract. Studies to identify the effectiveness of using preparations based on biologically active substances. Potato varieties Goryanka and Nart 1 and the following preparations were studied as objects: Polydon iodine, Fulvigrain Stimulus Pro, Zircon and BisolbiSan liquid, Succinic acid. Analysis of the data obtained during the research shows that potato tubers' treatment before planting with preparations based on biologically active substances contributed to an increase in the rate of tubers' germination. In the experimental options with application of Fulvigrain Stimul Pro at a dose of 3.0 l/t and BisolbiSan – 10 ml/t, an increase in the sprouts' weight relative to the control option by 34.2% and 26.4% was noted; root weight increased by 20.8% and 21.6%, respectively. The use of Succinic acid at a concentration of 10 g/l led to an increase in the bud number by 32.4%, the weight of sprouts and roots - by 36.8% and 27.1%, respectively. Pre-planting tubers' treatment with preparations based on biologically active substances led to an increase in the rate of seedlings' emergence in the Goryanka variety by 11.1 – 27.1%, in the Nart 1 variety - by 10.1 - 21.2%.

1 Introduction

Potatoes are cultivated in almost all regions of the country on an industrial basis. The share of the TOP 5 regions (2020) accounts for 37.3% of all crops, the share of the TOP 10 regions - 51.9%, the share of the TOP 20 – 68.7%. Bryansk, Tula, Nizhny Novgorod, Moscow, Sverdlovsk, and Tyumen regions can be distinguished among the key growing regions/ Astrakhan and Rostov regions, Krasnodar and Stavropol Territories, Kabardino-Balkarian Republic are leading in the market according to the offer of early potatoes [1].

In 20 regions of the Russian Federation, the volume of industrial potato harvesting exceeds the mark of 100 thousand tons, in the 21st region the indicators are at the levels of 50 to 99 thousand tons, in 22 regions - from 10 to 49 thousand tons. In other growing regions (17 regions), production is at levels not exceeding 10 thousand tons [1].

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According to Rosstat, in recent years there has been a reduction in the size of potato cultivation areas in 2020 and 2021. In 2019, the area was 305.3 thousand hectares, in 2020 it decreased to 282.7 thousand hectares. In 2021, it was expected that given the high level of potato prices, the area would somewhat expand in relation to 2020. In fact, the area decreased - largely due to the late onset of spring - and amounted to 274.0 thousand hectares. This is the lowest value since 2008 [1].

In addition to the decrease in acreage, there was also a decrease in potato harvest volumes in 2020 and 2021. In 2019, they amounted to 7,564.9 thousand tons; in 2020 they decreased to 6,811.1 thousand tons; according to AB-Center estimates, in 2021 they will be at around 6,200 thousand tons [1].

The decrease in the harvest volume in 2021 was not only due to the reduction of areas, but also due to a slight decrease in yields. In addition, according to market participants, the quality of the harvest itself has somewhat deteriorated. In addition to reduced harvest, this also affected the supply volume of potatoes of medium and high quality characteristics [4].

For the Kabardino-Balkarian Republic, abiotic factors are among the limiting factors for obtaining high potato yields. In this regard, there is a need to develop methods for increasing the yield and quality indicators of potato tubers [6].

Special importance is given to the use of biologically active substances in potato cultivation to increase the yield of cultivated varieties and to control the potential productivity inherent in them. As of today, the issues related to the use of biologically active substances in potato cultivation in the conditions of the Kabardino-Balkarian Republic have not been practically studied, the effectiveness of their use has not been established [5].

In this regard, research related to the development of new and improvement of existing potato growing technologies, the use of preparations (Polydon iodine, Fulvigrain Stimul Pro, Zircon, BisolbiSan liquid, Succinic acid) allowing to reveal and maximize the genetically inherent potential of potato varieties, are relevant and have applied nature to obtain stable yields with high technological properties.

The aim of the study was to establish the effect of preparations based on biologically active substances (Polydon iodine, Fulvigrain Stimul Pro, Zircon, BisolbiSan liquid, Succinic acid) on potato plantings when grown on mountain leached chernozems in the conditions of the mountainous zone of the Kabardino-Balkarian Republic.

To achieve this goal, the following tasks were solved:

- research of preparations for pre-planting tubers' treatment: Polydon iodine (POLYDON Agro LLC), Fulvigrain Stimul Pro (ASCA TRADE LLP (UK), Zircon and BisolbiSan liquid (Bisolbi-Inter LLC), Succinic acid (ORTON LLC);

- establishment of Succinic acid preparation effect at the initial stages during tubers' germination;

- identification of pre-planting treatment of tubers and plants with preparations based on biologically active substances for growth, development, yield and quality indicators of zoned potato varieties' tubers [2, 12, 13].

The scientific novelty of the research is that when growing potato varieties Goryanka and Nart in the conditions of a mountainous zone on mountain leached chernozems, the effectiveness of using the following preparations has been established: Polydon iodine, Fulvigrain Stimul Pro, Zircon and BisolbiSan liquid, Succinic acid.

A list of preparations based on biologically active substances for the treatment of potato tubers has been identified; they allow to maximize the potential of varieties at the initial stages of potato plant growth. The influence of Succinic acid preparation on the intensity degree of potato tubers' germination processes has been studied.

2 Materials and methods

The experimental part of the experiments was carried out on the territory of the Kabardino-Balkarian State Agrarian University and the Institute of Agriculture of the KBSC RAS at the experimental site of LLC AP "Belokamenskoye" for three years (2019-2021).

The objects of research were potatoes of the zoned varieties Goryanka and Nart (elite reproduction) included in the State Register and recommended for the North Caucasus (6) region and the Kabardino-Balkarian Republic since 2002 [6, 7, 8].

The following preparations served as research objects: Fulvigrain Stimul Pro, Polydon® Iodine, Zircon solution, BisolbiSan liquid, Succinic acid root treatment.

In the course of laboratory studies, the effect of preparations based on biologically active substances and Succinic acid preparation on the intensity of the processes associated with potato tubers' germination was studied [3, 9, 15].

Potato tubers of the Nart 1 variety weighing 60-80 g were used as experimental objects. Germination was carried out in boxes; peat was the substrate for tubers' germination, humidity was maintained at the level of 70-75% [14]. The planting density was 25 tubers, the depth of sowing tubers - 6-7 cm.

The experiment consisted of the following options for potato tubers' pre-planting treatment:

1. Control (water);
2. Polydon iodine (150 ml/l; 300 ml/l and 450 ml/l);
3. Fulvigrain Stimul Pro (1.5 l/t; 3.0 l/t and 4.5 l/t);
4. Zircon (1 ml/t; 5 ml/t and 10 ml/t);
5. BisolbiSan liquid (1 ml/t; 2 ml/t and 3 ml/t);
6. Succinic acid (5 g/l; 10 g/l; 15 g/l).

The consumption of biologically active substances' working solution was 10 liters per 1 ton of potato tubers. The experiments were laid in 4-fold repetition. The number of emerged buds was calculated, 10 days after tubers' germination; the weight of sprouts and roots of potato tuber seedlings was determined after 30 days.

The placement of plots in the experiment was randomized; the repetition was 4-fold, the area of the plot was 50 sq.m.

The data on crop accounting and other biometric indicators were processed by the method of variance analysis using STATISTICA + Excel to calculate LSD 05.

Predecessor - cropped fallow. The technology of potato cultivation was the one generally accepted for this growing area [11].

In the course of the study, records and phenological observations, photosynthetic potential (PP), net photosynthesis productivity (NPP), plot crop accounting by the method of continuous harvesting, structural analysis of the resulting crop were carried out [11].

The economic efficiency of potato cultivation was considered according to potato prices as of 2019-2021 [10].

The content of ADS%, starch, vitamin C, and nitrates was carried out at the FSBI Kabardino-Balkarian Agrochemical Service Station.

3 Results and discussion

A laboratory experiment was conducted to study the effect of the preparations Polydon iodine, Fulvigrain Stimul Pro, Zircon, BisolbiSan and the effect of the phytohormone-based preparation Succinic acid on the initial growth of potato tubers (Table 1).

Table 1. The effect of preparations based on biologically active substances and "Succinic acid" preparation on potato tubers' emergence (average for 2019 - 2021)

Option	Doses	Number of buds per tuber, pcs.	%, relative to the control option
Control option	-	6.30	100.0
Polydon iodine	150 ml/t	6.47	102.7
	300 ml/t	6.47	102.7
	450 ml/t	6.27	99.5
Fulvigrain Stimul Pro	1.5 l/t	6.98	110.8
	3.0 l/t	7.09	112.6
	4.5 l/t	6.77	107.6
Zircon	1 ml/t	6.36	101.1
	5 ml/t	6.36	101.1
	10 ml/t	6.77	107.6
BisolbiSan	1 ml/t	6.07	96.3
	2 ml/t	6.87	109.2
	3 ml/t	6.78	104.3
Succinic acid	10 g/l	8.40	133.4

The data analysis in Table 1 shows that the use of the preparations studied in the experiment for processing potato tubers led to an increase in the processes of initial growth in potato tubers.

The number of emerged buds in potato tubers on the 10th day on average for 2 experimental years exceeded the control option with Fulvigrain Stimul Pro treatment in concentrations – 3.0 ml/t by 12.7%; with Zircon – 5 ml/t by 1.1%; with BisolbiSan - 2 ml/t by 9.2%.

The largest number of emerged buds per tuber was recorded on the option with Succinic acid – 10 g/l, the increase relative to the control option amounted to 33.4%.

The data analysis showed that the greatest effect was obtained in terms of buds' emerging in potato tubers on the option of potato tubers' pre-planting treatment with the preparation "Succinic acid".

The research results suggest that the use of Succinic acid and biologically active substances leads to an increase in growth processes, acceleration of the breakdown of spare nutrients in tubers and their entry to the dormant buds.

The results of the conducted studies show that the use of preparations based on biologically active substances and Succinic acid contributed to the formation of the greatest weight of sprouts and roots of tuber seedlings of varieties studied in the experiment on the 30th day (Table 2).

Table 2. The effect of preparations based on biologically active substances and "Succinic acid" preparation on the weight of sprouts and roots of potato tubers of the Nart 1 variety (average for 2019-2021)

Option	Doses	Weight of sprouts and roots, g	%, to control
Control option	-	23,90	100,0
		7,39	100,0
Polydon iodine	150 ml/t	26,08	104,90
		8,28	112,04
		27,51	115,10
	300 ml/t	7,98	107,98
		26,18	109,54
	450 ml/t	7,30	98,78

Fulvigrain Stimul Pro	1.5 l/t	$\frac{29,83}{7,78}$	$\frac{124,81}{105,28}$
	3.0 l/t	$\frac{31,82}{8,82}$	$\frac{134,18}{119,35}$
	4.5 l/t	$\frac{32,07}{8,50}$	$\frac{134,18}{115,02}$
Zircon	1 ml/t	$\frac{23,87}{8,21}$	$\frac{99,87}{111,09}$
	5 ml/t	$\frac{29,34}{8,26}$	$\frac{122,76}{111,77}$
	10 ml/t	$\frac{24,41}{8,43}$	$\frac{102,13}{114,07}$
BisolbiSan	1 ml/t	$\frac{24,22}{8,36}$	$\frac{101,34}{113,12}$
	2 ml/t	$\frac{25,49}{8,30}$	$\frac{106,65}{112,31}$
	3 ml/t	$\frac{29,94}{8,87}$	$\frac{125,27}{120,03}$
Succinic acid	10 g/l	$\frac{32,44}{9,21}$	$\frac{135,73}{124,63}$

Note: *the numerator is the weight of the sprouts, the denominator is the root weight

The greatest weight of potato tuber sprouts relative to the control option was noted on options with the use of the following preparations: Polydon iodine 300 ml/t – by 15.1%, Fulvigrain Stimul Pro 3.0 l/t and 4.5 l/t – by 31.8% and 32.0%; Zircon 5 ml/t – by 29.3%; BisolbiSan – 3 ml/t – by 25.3% and "Succinic acid" at a dose of 10 l/g – by 35.7%.

The largest root weight when using biologically active substances was established on the experimental options using the following preparations: Polydon iodine – 150 ml/ t – 12%, Fulvigrain Stimul Pro – 3 l/ t and 4.5 l/ t – 19.3% and 15%, respectively, on the option with the use of BisolbiSan – 3 ml/t – 21%. The use of Zircon increased the root weight by 11.1-14.1%. The use of Succinic acid in a dose of 10 g/l increased the root weight relative to the control option by 24.6%.

Thus, the treatment of potato tubers before sowing with biologically active substances, their germination in a solution of Succinic acid have a positive effect on buds' emerging processes and increasing growth processes, which will contribute to the emergence of uniform shoots, more intensive growth, and development of potato plants in the initial vegetation periods in the conditions of industrial crops.

4 Conclusions

1. In the course of the conducted studies, it was found that among the preparations studied in the experiment, the preparations Zircon (tubers 5 ml/t + plants 10 ml/l) and BisolbiSan (tubers 2 ml/t + plants 10 ml/l) have the greatest influence on the growth and development of plants studied in the experiment of potato varieties Goryanka and Nart 11). The use of these preparations has a significant impact on the processes occurring at the initial stages, formation of a more developed leaf-stem mass, intensifying photosynthetic processes, increasing the number of stems and tubers from one bush, increasing productivity and improving the quality of potatoes.

2. Pre-planting potato tubers' treatment with preparations based on biologically active substances contributed to an increase in the rate of tubers' germination. In the experimental options where Fulvigrain Stimul Pro was used at a dose of 3.0 l/t and BisolbiSan – 10 ml/t, there was an increase in the sprout weight relative to the control option by 34.2% and 26.4%;

the root weight increased by 20.8% and 21.6%, respectively. The use of Succinic acid at a concentration of 10 g/l led to an increase in the bud number by 32.4%, the weight of sprouts and roots - by 36.8% and 27.1%, respectively.

3. Pre-planting tubers' treatment with preparations based on biologically active substances led to an increase in the seedlings' emergence rate in the Goryanka variety by 11.1–27.1%, in the Nart 1 variety – by 10.1 - 21.2%. The value of the plant height indicator in the options of combined use increased by 9.7-31.6%. The tallest plants were formed in the Goryanka variety on the experimental options with the use of Zircon preparations, in the Nart 1 variety – BisolbiSan.

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