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Research paper

Features of Applying Biological Preparations in the Technology of Potato Growing on Gray Forest Soils

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Abstract

The article offers an analysis of investigating some experimental potato plantations. Potato is a widespread agricultural crop, which is one of the main food and industrial crops in Russia. The complex conditions of the modern period necessitate the development of new technologies adapted to the modern conditions of land use. One of the most important problems of potato growing is the lack of knowledge of agro biological properties of modern cultivars and their response to the biological methods of potato growing. Identifying the most effective of them and the best ways to use them is an actual problem of modern agriculture.
The results of field experiments indicate that biological preparations (Albite and Biocomposite-Correct) have a multifunctional effect on potato plants. As a result of these studies, some positive data were obtained which showed the effect of the preparations on the onset of potato development phases and on the yield increase of potato test varieties. The maximum yield increase was formed during complex treatment of Gala cultivar potatoes with Biocomposite-Correct and was 2.52 t/ha as compared with the control variant, and the highest yield increase of Ryabinushka cultivar was achieved with the complex treatment with Albite and amounted to 2.12 t/ha.

Keywords: *potato, Ryazan oblast, cultivar, bio preparation, yield*

1.Introduction

Potato is a universal crop. A variety of forms of potato use is due to its valuable properties [1]. This crop can grow in different soil and climatic conditions [2, 3, 4]. Russia ranks third in the world in potato consumption - 25 million tons. The Russian Federation is the largest producer in the world, ranking second in area, third in bulk yield and one of the last places in terms of yield per unit.
Ryazan oblast has always been a traditional producer and supplier of food potatoes. The geographical position and agro-climatic conditions of Ryazan oblast have a huge potential for growing potatoes and make possible to obtain stable yields with high quality tubers [5, 1]. At the end of the last century, Ryazan oblast ranked third in the Russian Federation after Bryansk and Moscow oblasts in potatoes production, and this is not by chance. As raw materials, potatoes in the region were used by 17 distilleries, which produced 25 % of alcohol in Russia, and 4 starch-making factories. In addition, potatoes were used to feed the cattle. Currently, potato production in the oblast is small, so in 2018 the area under potato was 4.7 thousand hectares, with an average yield of 26.5 tons per hectare [5, 1].
The regional trend of potato production requires a decrease in the use of pesticides and increases interest in the use of biologically active substances [6, 7, 8]
Scientists have established that biological preparations have an active influence on the development of plants, the formation of their organs and quality parameters [9, 10, 11]. Therefore, they are beginning to be widely used in potato production. Comprehensive studies on the effects of biological preparations on agricultural crops, including potatoes, in the conditions of the Nonchernozem zone, have been extremely inadequate [12, 13, 14, 24].
Every year, the volumes and assortment of such preparations expand, so investigations aimed at testing them and putting them into production are an urgent task of science and production [15, 16, 1, 14, 25].

2.Materials and Methods.

The studies took place at agricultural enterprise “Verderevo” in Ryazan oblast in the period from 2015 to 2018.

The aim of the research is to study the response of potato cultivars to biological preparations and to improve methods for increasing potatoes yield.
The soil is dark gray forest, heavy loam. The soil pH was on average 5.6–5.9 during 4 years of investigations. With such parameters, the reaction of the soil solution is considered weakly acidic. The content of humus in the soil ranged from 3.1 to 4.0 %. The soil with such parameters is considered medium humus and medium fertile. The content of mobile forms of phosphorus is low (156-164 mg/kg) and the mobile forms of potassium are increased (235–244 mg/kg).
The influence of biological preparations Albite and Biocomposite-Correct on the productivity and quality of potatoes was considered.
The objects of investigations were potato cultivars Gala, Ryabinushka, Zabava, Fritella, and biopreparation Albite with a consumption rate of 0.1 l / t with a working fluid consumption of 10 l / t and 50 g / ha for non-root application with a working liquid consumption of 400 l / ha and biological preparation “Biocomposite-Correct” for tubers treatment before planting at a rate of 2.0 l / t, with a working fluid consumption of 30 l / t and 3.0 l / ha for non-root application with a working fluid consumption of 400 l / ha.
The experience included the following variants (Table 2):
1. Without any biological preparations (control);
2. Treating potato tubers with a solution of biological preparation Albite before planting (with a consumption rate of 0.1 l / t with a working fluid consumption of 10 l / t);
3. Spraying vegetative potato plants with Albite in the phase of budding with an interval of 15 days (with a consumption rate of 0.1 l / t, a working fluid consumption of 50 g / ha for non-root application, with a working liquid consumption of 400 l / ha);
4. Complex treatment with biological preparation Albite (treatment of tubers + spraying in the budding phase and 15 days later);
5. Without the use of biological preparations (control);
6. Treating potato tubers with a solution of biological preparation Biocomposite-correct before planting (with a consumption rate of 2.0 l / t, with working fluid consumption of 30 l / t).
7. Spraying vegetative potato plants with a solution of biopreparation Biocomposite-Correct in the phase of budding with an interval of 15 days (with a consumption rate of 3.0 l / ha, with a working fluid consumption of 400 l / ha);
8. Complex treatment with biopreparation Biocomposite-correct (tubers treatment + spraying in the budding phase and in 15 days).
The fore crop was winter wheat. The seed time was the second decade of May. The planter was CH-4-B, the tubers seeding depth was 10-12 cm, the row width was 70 cm and the planting rate was 4.2 t / ha. The replication was fourfold.
Cultivar Gala refers to mid-early ones in terms of ripening, it is a table variety. Cultivar Ryabinushka refers to mid-season varieties. Cultivar Zabava is a quickly ripening potato variety for table use. Cultivar Fritella is a mid-season variety for table use.
The studied cultivars are resistant to the causative agent of potato cancer, golden potato cyst nematode. They are moderately susceptible to potato late blight pathogen and resistant to wrinkled and streak mosaic and leaf roll disease.
Agrotechnical activities. The fore crop is winter wheat. Agrotechnics: stubble peeling to a depth of 10-12 cm, autumn plowing (MTZ-1221 + PLN-4-35) to a depth of 25-27 cm, early spring harrowing (MTZ-1221 + BZSS-1.0) in two tracks to a depth of 3 -4 cm, cultivation (MTZ-1221 + KPS-4) to a depth of 12-14 cm and pre-sowing cultivation (MTZ-1221 + KPS-4) to a depth of 8-10 cm, ridge tillage (MTZ-1221 + KOH-2, 8), preparation of tubers, planting (MTZ-1221 + CH-4-B) at a depth of 10-12 cm, 1st intercultivation (MTZ-1221 + KPH-4.2) at a depth of 3-4 cm, 2-nd intercultivation (MTZ-1221 + KPH-4,2) to a depth of 3-4 cm, hilling (MTZ-1221 + KOH-2,8) to a depth of 15-20 cm and plant protection. To combat weeds before the beginning of potato sprouting (the third decade of May) herbicide Zenkor of continuous action (1.4 kg / ha) was applied, double treatment with the Karate Zeon insecticide (0.1 l / ha) was used against pests during mass colonization by the larvae of the Colorado potato beetle. Sprayer OBT-1 in the unit with tractor MTZ-1221 was used for spraying and MTZ-1221 + KIR-1.5 was used for haulm mowing.
All agrotechnical techniques were carried out as close as possible to the optimal time.

3.Results and Discussion.

Biocomposite-correct is a suspension in the culture fluid of a consortium of highly effective strains of different types of bacteria, including those not previously used in agricultural microbiological preparations. The preparation contains living bacteria and products of their metabolism.
"Biocomposite-correct" contains new, first used strains of bacteria. The microorganisms that make up the preparation have a wide spectrum of action: phytoprotective, growth-promoting, destructive, antagonistic, nitrogen-fixing and phosphate-mobilizing properties. Strains-producers of the preparation are non-pathogenic, harmless to humans and animals. They are not toxic, allergic and toxicogenic. Hazard class - 4 (low hazard substance).
The successful combination of all the properties of the preparation of this class makes it promising for use in crop production [17, 18, 19, 23]. However, up to the present moment, there have not been any field tests of preparation Biocomposite-Correct when growing potatoes in the conditions of Ryazan oblast.
In the last decade, the most common of similar preparations is Albite. He has become the de facto standard of his class in plant growing.
Biological preparation Albite is a real example of Russian scientists' elaborations competitive with the best analogues in the country and abroad. Unlike most analogues, Albite does not have a direct stimulating effect on growth, but increases the natural immunity and stress resistance of plants, thereby increasing yield.
The active ingredient of Albite is a natural biopolymer, poly-beta-hydroxybutyric acid from soil bacteria Bacillus megaterium. In the natural environment, these bacteria live on roots of plants, stimulate their growth, protect against diseases and adverse environmental conditions. The preparation also contains substances that stabilize and enhance the effect of the main active ingredient: magnesium sulphate, potassium phosphate, potassium nitrate, urea and spruce extract. Albite does not contain any living microorganisms, but only the active substance of them, which makes the preparation more stable and less susceptible to environmental conditions.
The meteorological conditions of the growing season over the years of experiments: 2015, 2016, 2017 were characterized by normal moistening and increased temperature conditions (HTI - 1.0). They were relatively favorable for growth, development and formation of high yields of tubers. 2018 is a year with insufficient moisture for potatoes, especially during the critical period of moisture consumption - the phase of tuber initiation (HTI - 0.8).
The period from planting to the emergence of potato seedlings in the years of experiments was 22–24 days. The phenological phases timing depended on weather and the influence of biological preparations, the use of which, has contributed to the acceleration of the emergence of seedlings for 2-4 days compared with the control variant. Subsequent phases of development also came earlier. The tested potato cultivars were responsive to the use of these preparations during complex treatment.
The effect of the preparation is manifested in stimulating seed germination, as well as in enhancing the growth of the vegetative mass and the leaf surface of plants [20, 6, 7].
As a result of the investigations, the effect of Albite and Biocomposite-correct on the increase in the share of the marketable yield of potatoes of the tested cultivars was determined.
The treatment of tubers with Albite before planting increased the yield of Gala cultivar by 0.2 t / ha, Ryabinushka cultivar by 0.9 t / ha, Zabava cultivar by 1 t / ha and Fritella cultivar by 1.3 t / ha. Spraying in the phase of budding and in 15 days increased the yield of Gala cultivar by 0.5 t / ha, Ryabinushka cultivar by 0.8 t / ha,

Zabava cultivar by 1.3 t / ha and Fritella cultivar by 1.9 t / ha. The complex treatment increased the yield of Gala cultivar by 1.7 t / ha, Ryabinushka cultivar by 1.6 t / ha, Zabava cultivar by 1.5 t / ha and Fritella cultivar by 2.1 t / ha (Table 1).

Table1 – Crop structure and potato yield, average for 2015-2018

Cultivar, Factor A	Preparation, Factor B	Variant of treatment, Factor C	Mass of tubers from 1 plant, g	Number of tubers from 1 plant, pcs	Mass of 1 tuber, g	Yield, t / ha
Gala	Albite	Control	439.8	7.1	61.4	19.4
		Tubers treatment	448.0	8.0	55.3	19.7
		Treatment in budding phase and in 15 days	458.0	8.2	55.5	19.9
		Complex treatment	476.2	8.8	53.5	21.1
	Biocomposite-correct	Control	447.8	7.3	60.8	19.6
		Tubers treatment	461.9	8.4	55.5	20.5
		Treatment in budding phase and in 15 days	476.6	9.0	53.2	20.7
		Complex treatment	495.2	9.4	53.2	21.6
Ryabinushka	Albite	Control	472.6	7.6	61.8	20.8
		Tubers treatment	491.9	8.2	59.6	21.7
		Treatment in budding phase and in 15 days	490.2	8.4	57.7	21.6
		Complex treatment	510.6	9.2	55.6	22.4
	Biocomposite-correct	Control	474.1	7.5	62.5	20.5
		Tubers treatment	506.5	8.4	60.1	21.6
		Treatment in budding phase and in 15 days	504.1	8.5	58.7	22.4
		Complex treatment	525.7	9.8	54.6	22.5
Zabava	Albite	Control	462.1	7.1	65.1	20.4
		Tubers treatment	485.1	7.9	61.2	21.4
		Treatment in budding phase and in 15 days	491.7	8.2	60.4	21.7
		Complex treatment	495.0	8.8	56.4	21.9
	Biocomposite-correct	Control	449.3	7.3	61.5	19.7
		Tubers treatment	465.0	8.5	54.7	20.3
		Treatment in budding phase and in 15 days	482.4	8.8	54.8	21.0
		Complex treatment	513.8	10.0	51.9	22.6
Fritella	Albite	Control	498.4	8.3	60.3	22.0
		Tubers treatment	529.5	9.1	58.7	23.3
		Treatment in budding phase and in 15 days	537.8	9.5	57.2	23.9
		Complex treatment	547.4	10.5	52.2	24.1
	Biocomposite-correct	Control	521.1	8.5	61.7	23.1
		Tubers treatment	552.9	9.5	59.2	24.2
		Treatment in budding phase and in 15 days	556.8	9.6	58.4	24.8
		Complex treatment	569.0	10.2	59.0	25.2
HCP_{05}(ABCinteraction) yield, t/ha 2015 – 1.99; 2016 – 1.85; 2017 – 2.03; 2018 – 3.05						

The mass of 1 tuber on the same variants of Gala decreased by 6.1 g, 5.9 g and 7.9 g respectively. The mass of 1 tuber of Ryabinushka decreased by 2.2 g, 4.1 g and 6.2 g. The mass of 1 tuber of Zabava decreased by 3.9 g, 4.7 g and 8.7 g, and that of Fritella decreased by 1.6 g, 3.1 g and 8.1 g.

The number of tubers from one plant in similar variants of Gala cultivar increased by 1.1 pcs., 1.2 pcs. and 1.8 pcs. respectively; Ryabinushka cultivar - by 0.6 pcs., 0.8 pcs. and 1.6 pcs.; Zabava cultivar - by 0.8 pcs., 0.9 pcs. and 1.7 pcs.; Fritella cultivar - by 0.8 pcs., 1.2 pcs. and 2.2 pcs.

The mass of tubers from 1 plant of Gala increased by 9 grams, 18.2 grams and 36.4 grams; that of Ryabinushka increased by 19.3 g, 17.6 g and 38 g respectively; that of Zabava increased by 23 g, 29.6 g and 32.9 g; that of Fritella increased by 31.1 g, 39.4 g and 49 g.

Biocomposite-correct in creased the yield of Gala cultivar on these variants by 0.9 t / ha, 1.1 t / ha and 2.0 t / ha respectively; the yield of Ryabinushka by 1.1t / ha, 1.9t / ha and 2.0 t / ha; theyieldofZabava by 0.6 t / ha, 1.3 t / ha and 2.9t / ha; the yield of Fritella by 1.1t / ha, 1.7 t / ha and 2.1 t / ha.

Themassof1 tuber of Gala decreased by 5.3 g, 7.6gand 7.6 g; that of Ryabinushka decreased by 2.4 g, 3.8 g and 7.9 g; that of Zabava decreased by 6.8 g, 6.7 g and 9.6 g; that of Fritella decreased by 2.5 g, 3.3 g and 2.7 g.

The number of tubers from one plant in similar variants of Gala increased by 1.1 pcs., 1.7 pcs. and 2.1 pcs.; that of Ryabinushka - by 0.9 pcs., 1.0 pcs. and 2.3 pcs. respectively; that of Zabava - by 1.2 pcs, 1.5 pcs and 2.7 pcs. and that of Fritella - by 1.0 pcs., 1.1 pcs. and 1.7 pcs.

The mass of tubers from 1 plant of Gala increased by 14.1 g, 28.8 g and 47.4 g, respectively; that of Ryabinushka - by 32.4 g, 30 g and 51.6 g; that of Zabava - by 15.7 g, 33.1 g and 64.5 g and that of Fritella - by 31.8 g, 35.7 g and 47.9 g.

Cultivars for industrial processing for food purposes should contain at least 22 % of dry matter and no more than 0.4 % of reducing sugars [21, 22, 26], have non-darkening pulp and give small waste when cleaning tubers. Potatoes weighing 80-120 grams and 5-6.5 cm in the largest transverse dimension are most suitable for pro-

cessing. It should be noted that in the investigations all potato cultivars fulfilled the requirements for industrial processing on dry matter and other quality parameters (Fig. 1).

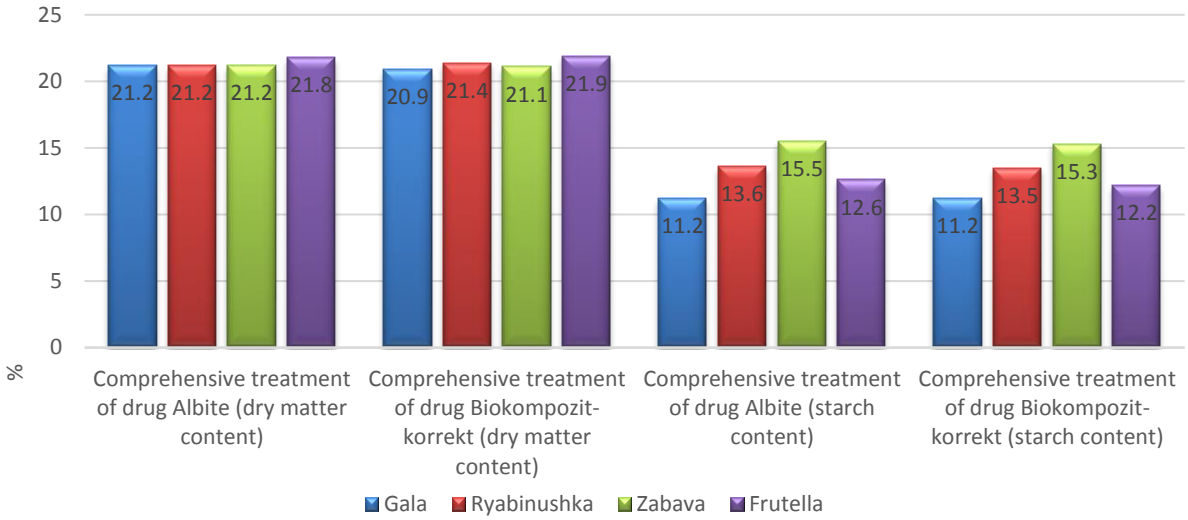

Figure 1. The effect of the use of Albite and Biocomposite preparationsthe correct content of starch and dry matter in potato tubers varieties Gala, Ryabinushka, Zabava, Fritella on average for 2015-2018.

The qualitative composition of tubers and biochemical processes under the same conditions of production and storage are grading factors of potatoes. So, for example, the dry matter content of potatoes has not changed much (21.2-21.8 %) of the potato cultivar, within the limit of error. We note a higher starch content in Zabava cultivar (15.3-15.5 %) than in other experimental cultivars.

4.Conclusion.

Thus, a positive effect from the use of biological preparations to increase the yield of tubers was revealed. When using Albite, the greatest increase of potato yield was formed during complex treatment of Fritella cultivar, and that was 2.1 t / ha compared to the control variant, and the highest yield increase when using preparation Biocomposite-Correct was formed during complex treatment of Zabava cultivar, and that was equal to 2.9 t / ha.

Despite the increase in yield, the mass of 1 tuber in all treatment options with the used preparations decreased. The maximum decrease in the use of Albite was noted in Zabava cultivar with complex treatment. When using Biocomposite-correct for Zabava cultivar the maximum weight loss was also noted during complex treatment.

The maximum number of tubers from one plant was observed in Fritella cultivar - 2.2 pcs. (complex treatment with Albite) and in Zabava cultivar - 2.7 pcs. (complex treatment with Biocomposite-correct).

The greatest increase in the mass of tubers from one plant was observed in Ryabinushka cultivar with complex treatment with Biocomposite-correct (by 51.6 g).

This indicates a different reaction of these cultivars to this factor due to their biological characteristics, and creates prerequisites for expanding their use in potato phytocenosis.

All potato cultivars in the experiments met the requirements for industrial processing on dry matter and other quality parameters. The dry matter content of potato cultivars remained relatively constant, 21.2-21.8 %. Zabava cultivar had higher starch content (15.3-15.5 %).

Thus, the use of biological preparations in potato growing is a promising technique that makes possible to increase the yield of the crop.

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