Growth stimulator Lariksin in the cultivation of buckwheat in the southern agricultural zone of the Amur Region, Russia

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Abstract. This article presents the findings of a study on the effect of the growth stimulant Lariksin on the buckwheat varieties Amur Local and Devyatka. The treatment regimens included pre-sowing seed treatment, foliar spraying during the budding phase, and a combined treatment (seed treatment + vegetative spraying). The study established that the variant involving the combined application of Lariksin yielded the best results. Plants in this treatment group developed greater height and a higher number of lateral branches, which consequently enhanced individual plant productivity and ultimately determined the overall yield. Across both varieties, plant height in the experimental variants exceeded the control by an average of 5 to 22 cm, while the number of lateral branches was 1.5 to 2 times higher. The number of grains per plant in the experimental variants exceeded the control by 13-23%, and the grain weight per plant was 15-21% higher. With the combined use of Lariksin, the yield reached 17.4 dt/ha for the Amur Local variety and 24.3 dt/ha for Devyatka, compared to 12.2 and 14.6 dt/ha in their respective control groups, representing an increase of up to 40% over the control. Furthermore, the combined application of Lariksin produced higher quality grain, with grain size exceeding the control by an average of 10-15%, and a reduction in filminess coupled with an increase in kernel yield by 1.5-2.5%.

1 Introduction

Buckwheat is recognized as one of the most significant cereal crops globally. Groats produced from its grain are highly valued for their exceptional nutritional, organoleptic, and dietary properties. As the primary product derived from buckwheat, it plays a strategically important role in ensuring national food security [1-3].

The nutritional composition of buckwheat includes approximately 10% protein, up to 3% lipids, and 60–80% carbohydrates, primarily in the form of starch. It is also a rich source of essential minerals, including iron, calcium, phosphorus, and copper, as well as other trace elements vital for human health. The protein fraction of buckwheat consists predominantly of globulins and albumins, which contribute to its high biological value. Although lipids constitute about 80% unsaturated fatty acids, buckwheat exhibits good storage stability due to the predominance of palmitic and oleic acids, both of which are resistant to oxidative

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deterioration. Furthermore, buckwheat is an important dietary source of B vitamins, including thiamine (B1), riboflavin (B2), and niacin (PP), as well as rutin (vitamin P), all of which play essential roles in human physiological processes.

Waste from grain cleaning and sorting, cereal production waste (bran, shriveled grain, flour dust), buckwheat straw and chaff are very effectively used as feed for farm animals and birds. Pigs and young cattle are especially willing to eat.

Buckwheat as a honey crop contributes to the development of beekeeping in the region of cultivation. Buckwheat honey is a special type of marketable honey with unique beneficial properties. The main component in the composition of honey are carbohydrates, represented mainly by glucose and fructose. Honey contains amino acids, proteins and enzymes. Buckwheat honey, in comparison with other honeys, has a high content of the macronutrient sodium and trace elements of iron, zinc and copper [4-6].

The role of buckwheat is also indispensable in agrotechnical terms. It grows quickly, shade the soil well, suppresses weeds, and therefore serves as a good predecessor for many crops. Buckwheat has an important biological property; it is able to assimilate sparingly soluble phosphorus compounds from the soil, which are inaccessible to most agricultural crops, converting them into a water-soluble, easily accessible form for plants [7].

Buckwheat green manure is one of the easily accessible, but little used reserves for a comprehensive and effective increase in soil fertility. Buckwheat is able to absorb well phosphorus and potassium from sparingly soluble compounds and carry them into the arable horizon. The yield of green mass of buckwheat can reach 200 c/ha, when it is plowed, physical, chemical and biological processes in the soil are activated, and the agrophysical properties of the soil are improved. A number of studies indicate a significant increase in the yield of subsequent crops [7].

Despite all the value, buckwheat most often occupies a secondary position compared to other field crops and is cultivated according to the residual principle. The main way to increase its production at present is a significant increase in productivity. This can be done through the use of means of intensifying agricultural production.

Intensive crop cultivation technologies are designed to enable the full realization of the genetic potential of plants, thereby ensuring high yields and superior product quality. In global agricultural practice, the primary strategies for increasing crop productivity involve the application of mineral fertilizers and plant protection chemicals. However, these approaches require substantial energy and material inputs and are not always environmentally sustainable. An alternative to the use of synthetic agrochemicals is the application of growth stimulants of biological origin. Modern bio-based preparations exert a dual effect on seeds and vegetative plants: they stimulate growth and development while also providing protective functions against pathogenic microflora and adverse environmental conditions. An important criterion in evaluating the resulting harvest is product quality. Biologically derived growth stimulants do not accumulate in the final product and are characterized by short degradation periods. These properties render their use both effective and safe in crop production, particularly in the cultivation of buckwheat intended for food purposes [8, 10].

Growth stimulants (growth regulators) are preparations based on various natural plant materials. Their use helps to increase seed germination, productivity, disease resistance and, ultimately, obtaining products that meet high quality criteria, and, above all, ensure a balanced development of vegetative and reproductive organs in plants. One of the effective growth and development stimulants currently produced is the biological drug Lariksin.

Lariksin is a natural stimulator (regulator) of plant growth and development; inducer of immunity to various diseases; stimulator of development of vegetative and reproductive organs. Produced in the form of an aqueous emulsion. Larixin is used for pre-sowing treatment of seeds, planting material (consumption rate of the drug is 50-250 ml/t), for spraying plants during the growing season (30-100 ml/ha). Lariksin is non-phytotoxic and

does not contain chemical impurities, therefore it is recommended for farms producing environmentally friendly products. Lariksin has a complex positive effect on plants. When it is applied, seed germination is accelerated and their germination capacity increases; accelerates the growth of the root system; frost resistance and drought resistance increase; fungal and bacterial morbidity of plants decreases; the terms of ripening and the onset of biological and technical ripeness are reduced; productivity increases; the quality of the products obtained improves. Upon entering the plant, the agent activates genes responsible for defense mechanisms and stress tolerance. Consequently, the plant endogenously produces compounds that mediate the interactions between environmental stimuli and the expression of specific genes or gene complexes.

The active ingredient of Larixin is a natural bioflavanoid - dihydroquercetin (dihydroquercetin DHQ), obtained from Siberian larch (Larix sibirica). Dihydroquercetin, in international practice, better known as taxifolin (Taxifolin), refers to antioxidants of natural origin, or bioflavonoids. The chemical formula is C15H12O7. Dihydroquercetin is a powder from white to white-cream in color, with a slight taste of woody bitterness, sparingly soluble in water and has a wide spectrum of action. Dihydroquercetin, in addition to agriculture, is used in the food, pharmaceutical, and cosmetic industries.

The Amur Region is unique in its natural resources. Many valuable tree species grow here, including Siberian larch (Larix sibirica). Based on the availability of natural raw materials, the Amur Region has established its own production of dihydroquercetin, including the growth stimulator Lariksin. This is done by the company Ametis, which is located in the regional center, in the city of Blagoveshchensk.

The purpose of scientific research was to establish the effect of the growth stimulator Lariksin on the productivity of buckwheat plants and the quality of the grain obtained. Conducting these studies determined that buckwheat is an important product for providing food to the population, and it is important to increase local production than to deliver cereals from the center of the country. In the structure of sown areas of the region, buckwheat is of no small importance, the area under crops of this crop has fluctuated in recent years, within the range of 5-7 thousand hectares. During the cultivation of buckwheat, common problems arise, which consist in the defeat of plants by diseases, pests; in unfavorable years, plants suffer from stress due to fluctuations in external natural factors. Negative actions or the consequences of these actions can be smoothed out by the highly effective growth stimulator Lariksin. The availability of the drug, the presence of its own, local production also contributed to the implementation of the indicated studies.

2 Materials and methods

Field and laboratory studies on the effect of Larixin growth stimulant on buckwheat were conducted at the Far Eastern State Agrarian University, which is located in the southern agricultural zone of the Amur region, in 2016-2018.The soil and climatic conditions of the Amur region are highly favorable for the cultivation of buckwheat. The warm period of the year is usually characterized as predominantly warm with sufficient precipitation. In some years, an unstable temperature regime is noted, with a sharp fluctuation in the amount of precipitation, when soil drought is replaced by excessive and prolonged waterlogging. During the years of research, agrometeorological conditions for field work were quite favorable.

The objects of the study were buckwheat varieties Amur local and Devyatka. The scheme of the experiment included 4 variants: control (treatment with water); seed treatment before sowing with Lariksin; treatment of plants for vegetation with the drug Lariksin; seed treatment before sowing with Lariksin + during vegetation with Lariksin. The dose of the drug was 100 ml/t or 100 ml/ha. The flow rate of the working solution is 300 l/ha. The

experiment was conducted in 4-fold repetition. The reference area of the experimental plot was 20 m^2,

Agrotechnics is generally accepted and recommended for buckwheat by the farming system of the Amur region. The soil of the plot is meadow chernozem-like medium-thick, the reaction of the medium is slightly acidic, the average content of phosphorus and potassium. Pre-sowing tillage consisted of early spring harrowing and two cultivations with harrowing, the last cultivation was carried out immediately before sowing. Sowing was carried out in the third decade of May, with a selective seeder SS-1.2. Sowing method - ordinary, with row spacing of 15 cm. Seeding rate - 4.5 million germinating grains per hectare. In the variants with seed treatment, the seeds were sprayed with an aqueous solution of Lariksin a day before sowing, with natural drying. Vegetation treatment with the preparation was carried out in the phase of inflorescence formation, using a Zhuk-12 manual sprayer. Control - treated with water. To combat weeds during the growing season, manual weeding was carried out. During the growing season, phenological observations were made. In the phase of 75% grain ripeness, sheaf material was selected for further laboratory analysis. Harvesting and accounting of buckwheat crops were carried out by plots, in a separate way, using the Terrion selection combine.

When conducting field and laboratory studies, we used the method of field experiment B.A. Dospekhov, 2013; the method of state variety testing of crops, 2021 (Figure 1). Quality indices of grain were determined in accordance with the requirements of generally accepted methods and GOSTs: GOST ISO 520-2014 "Cereals and legumes. Determination of the weight of 1000 grains", GOST 10843-76 "Grain. Method for determination of filminess".

Fig. 1. General view of the field experiment, phase of the beginning of budding, (05.07.2017).

For a long time, one variety of buckwheat, Amur local, has been cultivated almost throughout the region. The variety was created by the method of multiple mass selection. Registered at the Amur breeding station, zoned in the Amur region since 1939. The variety is unpretentious, early ripening, ripens in 65-75 days. Variety of alat. The type of growth is determinant. Filminess 24.5%, uniformity 60.5%, cereal yield 68.5%, protein content 15.5%. The variety is resistant to lodging and drought. The average yield in the region is 5.0-10.0 c/ha. The grain is not large, the weight of 1000 grains is 25-28 g, which is not attractive from the point of view of processing into cereals.

The buckwheat variety Devyatka [10] was included in the State Register of Breeding Achievements of the Russian Federation in 2004 and recommended for cultivation in the Far East region. Variety of alat. The type of growth is determinant. Medium-ripening variety, the growing season is 83-95 days. It is characterized by friendly flowering and maturation. Resistance to lodging and shedding is high. It has increased resistance to early spring cold, high temperatures and drought. The variety is high yielding. The average yield in the tolerance regions is 17.8 c/ha, the maximum yield of 49.7 c/ha was obtained in 2003 in the Krasnoyarsk Territory. Technological and culinary qualities are high. The variety is large-fruited, the weight of 1000 grains is 30-36 g. Filminess is 20.9%, evenness is 52.4%, cereal yield is 75.5%, kernel yield is 68.1%, grain size is 82.2%. It is included in the list of valuable varieties in terms of quality.

The yield value is the result of a number of physiological processes, and one of the main indicators is the productivity of one plant. The productivity of a buckwheat plant is the sum of the average plant height, the number of branches per plant, the average number of grains per plant, the average grain weight per plant, and the weight of 1000 grains. Previous studies conducted by the author indicate that the buckwheat of the studied varieties responds quite well to the applied means of intensification.

3 Results

The productivity of buckwheat varieties Amurskaya local and Devyatka with various methods of using the growth stimulator Lariksin is presented in tables 1 and 2.

Table 1. Productivity of buckwheat variety Amur local when treating seeds and vegetative plants with growth stimulator Larixin

Variant	Average height of the plant, cm	Number of lateral branches, pcs.	Number of grains per plant, pcs	Weight of grains per plant, g	Yield, c/ha	Deviation of yield from control, c/ha
Control	95	2	54	1.41	12.2	–
Sowing with seeds treated with Larixin	105	3	65	1.54	13.7	1.5
Pure seed sowing + Larixin treatment of plants during vegetation	102	4	67	1.67	14.5	2.3
Sowing with Larixin-treated seeds + Larixin treatment of plants during vegetation	117	4	80	1.83	17.4	5.2
LSD_{05}						2.1

The study revealed that, for the buckwheat variety Amur local, the most effective treatment was the combined application of the growth stimulant Lariksin. Plants in this treatment group developed greater height and an increased number of lateral branches, which directly enhanced individual plant productivity and, consequently, determined the final yield. In the Amur local variety, plant height in the experimental variants exceeded the control by 7 to 22 cm, representing an increase of 6.8-18.8%. The number of lateral branches was 1.5 to 2 times higher than in the control. The number of grains per plant in the experimental variants surpassed the control by 11 to 26 grains, or 16.9-32.5%. Grain weight per plant was 0.13-0.42 g higher than in the control, corresponding to an increase of 8.4-22.9%. A

statistically significant yield increase was observed only in the variant involving the combined application of the growth stimulant, where the yield advantage over the control reached 5.2 dt/ha, or 42.6%.

Table 2. The productivity of buckwheat variety Devyatka when treating seeds and vegetative plants with a growth stimulator Larixin

Variant	Average height of the plant, cm	Number of lateral branches, pcs.	Number of grains per plant, pcs	Weight of grains per plant, g	Yield, c/ha	Deviation of yield from control, c/ha
Control	110	2	69	2.79	14.6	–
Sowing with seeds treated with Larixin	122	3	75	3.25	17.7	3.1
Pure seed sowing + Larixin treatment of plants during vegetation	115	3	79	3.39	18.6	4.0
Sowing with Larixin-treated seeds + Larixin treatment of plants during vegetation	131	5	86	4.13	24.3	9.7
LSD_{05}						2.9

For the Devyatka variety, the most favorable outcome was likewise observed in the variant with the combined application of Lariksin. Plant height in the experimental treatments exceeded the control by 5 to 21 cm, corresponding to an increase of 4.3-16.0%. The number of lateral branches was 1.7 to 2.2 times greater than in the control group. The number of grains per plant in the experimental variants surpassed the control by 6 to 17 grains, or 8.0-19.8%. Grain weight per plant was 0.5-1.3 g higher than in the control, representing an increase of 14.2-32.4%. Under the combined application of Lariksin, the yield of the Devyatka variety reached 24.3 dt/ha, compared to 14.6 dt/ha in the control, resulting in an increase of 9.7 dt/ha, or 40%.

When evaluating the physical indicators of the quality of buckwheat grain, its fineness was determined, according to the mass of 1000 grains, grain filminess and kernel yield (Table 3).

Table 3. Physical indicators of grain quality of buckwheat varieties when treating seeds and vegetative plants with growth stimulator Larixin

Variant	Amur local			Devyatka		
	weight of 1000 grains, g	filmness, %	yield of kernel, %	weight of 1000 grains, g	filmness, %	yield of kernel, %
Control	23.1	25.3	74.7	30.1	21.9	73.1
Sowing seeds treated with Larixin	23.7	24.3	75.7	31.9	21.4	74.6
Sowing pure seeds + treatment of plants with Larixin during vegetation	24.3	23.8	76.2	33.0	21.1	74.9
Sowing with Larixin-treated seeds + Larixin treatment of plants during vegetation	25.5	23.1	76.9	34.8	20.3	75.7

4 Discussion

Under favorable development conditions, and the use of a growth stimulator contributes to this, the grain is formed larger and more complete. Large, well poured grain has an optimal ratio of all components. When processing such grain, the yield of benign products increases and the grain is rated higher.

Table 3 shows that the use of the drug Lariksin in the pre-sowing treatment of seeds with spraying of vegetative plants had a positive effect on grain formation, the grain was obtained larger and more complete. The mass of 1000 grains of the Amur local variety in the variant with the complex use of the drug is 2.4 g or 10.4% higher than in the control variant. The same trend was noted on the Devyatka variety. The grain size, in the variant with the complex use of the drug, exceeds the control variant by 4.7 g or 15.6%.

Filminess is of great importance as an indicator of quality in buckwheat, which affects the yield of cereals (kernel). The higher the filminess, the lower the content of the kernel in the grain, and, consequently, the lower the yield of cereals. Grain with a high film content is of less value as a forage. This grain contains a lot of fiber, the digestibility coefficient of which is low. The content of films in buckwheat grain averages 17-26% and depends on the type, variety, region and growing conditions of the culture. Studies have established that with the complex use of the drug, the grain obtained is more fulfilled, respectively, the content of films decreases. The yield of buckwheat kernel grain variety Amurskaya local increases in the experimental variants from 1.0 to 2.2% in relation to control, in the variety Devyatka the increase is 1.5-2.6%, relative to the variant without treatments.

5 Conclusion

Thus, the conducted studies indicate the feasibility of using the growth stimulator Lariksin in buckwheat crops in order to increase plant productivity and improve the quality of the resulting grain.

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