The effectiveness of using the growth regulators of a new generation in the production of garlic winter planting material

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Abstract. The use of quality planting material is an important factor for the production of agricultural products, because it allows to realize the biological potential of the cultivated plant to a greater extent, to obtain a high-quality crop. Garlic is an exclusively vegetatively propagated crop. Due to the low breeding rate, garlic is difficult to reproduce in a short time in volumes that would fully meet the demand for planting material. In this regard, a large number of imported, often poor-quality planting material of this culture comes to the domestic market. Therefore, the issue of providing a domestic manufacturer with a quality planting material is acute. We have established the effectiveness of contemporary growth regulators in the planting of garlic. The article discusses the issues of increasing the economic efficiency of the production of winter garlic planting material using the growth regulators of the last generation. The article shows the high efficiency of using the composition of silicon organic growth regulators, including Boratran, Krezacin, and Asyak, in a concentration of 0.015% in winter garlic plantings, which allows to increase the yield of bulbs by 2 t / ha. The economic efficiency of using the preplant treatment of clove and plants during the growing season with growth regulators allows to obtain additional profit, amounting to 178 thousand rubles per hectare.

1. Introduction

Garlic is an important culture in the human diet. It is used to prevent the development of cancer and diseases of the cardiovascular system [1], [3], [4]. The medical intake rate of garlic is 3-4 kg / year per person. According to FAOSTAT (2017), garlic production in Russia is at the level of 260 thousand tons, while the need for this crop in the country is about 430 thousand tons annually. The agro-industrial complex of the country is not able to meet the demand of the population and industry in this culture in full; therefore, the imported products enter the Russian market. China is the world’s largest garlic importer. In China, more than 20 million tons of garlic are grown annually, which is about 79% of the world production (Table 1) [1], [2], [3].
Studies were conducted in the Department of Biotechnology and Innovation Projects of the All-Russian Research Institute of Vegetable Growing – Branch of the Federal Scientific Center for Vegetable Growing (Moscow Region, Ramensky District, Vereya Village) in open ground conditions (Table 2).

### Table 1. Main countries producing garlic [9].

| Country | Production, t | Sown area, ha | Productivity, t / ha | The share of world production, % |
|---------|--------------|---------------|----------------------|----------------------------------|
| China   | 22,216,965   | 820,101       | 27.1                 | 78.9                             |
| India   | 1,693,000    | 321,000       | 5.8                  | 6.0                              |
| Egypt   | 274,668      | 12,607        | 21.8                 | 1.0                              |
| Russia  | 258,455      | 27,445        | 9.4                  | 0.9                              |
| Bangladesh | 425,401   | 66,259        | 6.4                  | 1.5                              |
| USA     | 232,000      | 13,360        | 17.4                 | 0.8                              |
| Ukraine | 185,830      | 21,500        | 8.6                  | 0.6                              |
| Brazil  | 120,897      | 10,588        | 11.4                 | 0.4                              |
| World   | 28,160,584   | 1,577,780     | 17.8                 |                                  |

In Russia, the production of garlic is limited by the lack of quality seed and planting material. In the State Register of Breeding Achievements, 74 varieties of winter garlic are registered [5], but most of them “exist only on paper,” and the high-quality domestic planting material cannot be purchased in an amount sufficient for industrial production. Because of this, the market of this culture is filled with imported low-quality products. The seed propagation method is absent in varieties of garlic sown, listed in the state register of the Russian Federation, in connection with which its reproduction is carried out by vegetative means, namely cloves, single-clove bulbils, aerial bulbils. The main method of reproduction of garlic is cloves. In total, 5-9 cloves usually form in winter garlic bulbils. Those cloves weighing at least 3-5 g are suitable for landing. A high yield of bulbils can be guaranteed to be obtained from such chives for the next year, subject to agrotechnical requirements. However, not all cloves in the bulbil meet this condition, some cloves have a smaller mass, some can be fused; therefore, the reproduction rate of cloves remains very low. To overcome this limiting factor, aerial bulbils can be used. From 40 to 300 aerial bulbs formed in the inflorescences of garlic planting. In this case, the more bulbils formed in the inflorescence, the smaller the mass of one bulbil. When using aerial bulbils weighing less than 0.1 g, the process of obtaining multi-chives bulbils is often three years. The traditional cultivation of garlic from aerial bulbils is as follows:

- Aerial bulbils \(\rightarrow\) Small single-clove bulbils \(\rightarrow\) Large single-clove bulbils \(\rightarrow\) Bulbils divided into cloves

The production of garlic according to this scheme hinders the filling of the market with planting material of this culture [3]. Therefore, the use of contemporary growth regulators (aimed at increasing the mass of aerial and single-clove bulbils), which are accompanied by an increase in yields and a reduction in the period of obtaining multi-clove bulbils and aerial bulbils for one year, is a relevant and promising direction of research.

Within the framework of this research, we studied silicon organic growth regulators (such as Energy M, Kufecin, Boratran, Krezacin, Asyak, Hermatanol, and Silacin) in various combinations. Registered in 2008, the drug “Energy M” is the most widely distributed and well-known of these regulators. This drug has shown its high efficacy on sunflower, root crops, cabbage, and other vegetable crops [6], [7]. The remaining drugs are the latest developments of the “Flora Si” LLC.

### 2. Materials and Method

Studies were conducted in the Department of Biotechnology and Innovation Projects of the All-Russian Research Institute of Vegetable Growing – Branch of the Federal Scientific Center for Vegetable Growing (Moscow Region, Ramensky District, Vereya Village) in open ground conditions (Table 2).
Studies have revealed a high efficiency of use of the composition, including Boratran, together with Krezacin and Asyak 0.015%; Silacin together with Krezacin and Asyak 0,015%; Silacin with Potassium chloride at a dose of 50 g / m²) 2 weeks after the first.

The cloves and plants of the garlic winter varieties “Gladiator” served as the material for research [8]. The study design included the triple treatment of plants with solutions of growth regulating substances. The following compositions were used in the experiment: Kufe together with Energy M 0.01%; Boratran together with Krezacin and Asyak 0.015%; Hermataranol together with Krezacin and Asyak 0.015%; Silacin together with Krezacin and Asyak 0,015%; Silacin with Asyak 0.015%. In the control variant, the plants were treated with water. The repetition of the experiment was 4-fold, the area of one plot is 1 m², the sowing of a private is the distance between the lines of 25 cm; 10 cm between plants in a row; and the length of a row is 1 m².

3. Results and Discussion

Studies have revealed a high efficiency of use of the composition, including Boratran, together with Krezacin and Asyak, used in a concentration of 0.015%. In this embodiment, the yield of bulbils was 1.58 kg / m², which is 14% higher than the control, and the average mass of the bulbils was 40.4 g, which was 12.5% higher than the control.

Table 3. The economic efficiency of the use of growth regulators of the new generation in the production of winter garlic planting material.

| Economic indicator | Standard technology | Using growth regulators | Deviation |
|--------------------|---------------------|-------------------------|-----------|
| Bulbil yield, t / ha | 13.8 | 15.8 | 2 |
| Bulbil sales price, rubles / kg | 200.0 | 200.0 | 0 |
| Gross income from bulbils selling, rubles | 2,760,000.0 | 3,160,000.0 | +400,000.0 |
| The cost of production, rubles, Including the following: | 1,128,800.0 | 1,350,800.0 | +230,000.0 |
| Preplant treatment and processing during the growing season of Boratran together with Krezacin and Asyak in a concentration of 0.015% | - | 60,000.0* | +60,000.0 |
| Production cost per ton of received bulbils, rub. | 44,457.4 | 42,627.3 | -1830.0 |
| Taxes (UAT, 6%) | 97,900.0 | 108,600.0 | +10,700.0 |
| Profit, rub. | 1,631,200.0 | 1,809,200.0 | 178,000.0 |
| Profitability, % | 144.5 | 133.9 | -10.6 |

* A regulator cost is 3000 rubles per 50 g.
Evaluation of the effectiveness of this technique showed that it allows one to get 15.8 t / g of garlic bulbils, which is 2 tons more compared to standard technology (Table 3). Thus, the use of growth regulators has led to higher production costs. However, a large profit from sales of products covered them. The use of Boratran in combination with Krezacin and Asyak in a concentration of 0.015% made it possible to increase profits by 178 thousand rubles / ha.

4. Conclusion
Pre-treatment of cloves and double treatment of garlic plants with a solution of growth regulators of a new generation, including Boratran, Krezacin, and Asyak in a concentration of 0.015%, allows to increase the yield of bulbils by 2 t / ha, and the weight of the bulbils grows up to 40 g, making it possible to get additional 178 thousand rubles / ha.

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