

Effect of Chitosan Nanopreparations on Grain Yield of Soybean Varieties

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Abstract This study investigated the effects of chitosan-based preparations, including nanocitosan and nanoascorbat-chitosan, on the average three-year grain yield of wheat varieties Nafis, Sevinch, and Selekt-302. Results showed that for the Nafis variety, yields increased by 5.6% (31.9 c/ha), 16.5% (35.2 c/ha), and 15.2% (34.8 c/ha) compared to the control (30.2 c/ha) when treated with chitosan, nanocitosan, and nanoascorbat-chitosan, respectively. For the Sevinch variety, yields improved by 6.1% (32.9 c/ha), 18.7% (36.8 c/ha), and 19.3% (37.0 c/ha) compared to the control (31.0 c/ha). The imported Selekt-302 variety, with a control yield of 23.1 c/ha, exhibited increases of 3.5% (23.9 c/ha), 16.4% (26.9 c/ha), and 17.3% (27.1 c/ha) for the same treatments. These findings confirm the potential of chitosan nanopreparations to significantly enhance grain yield, especially in local varieties, although soil fertility played a critical role in determining outcomes.

Keywords Chitosan, Nanocitosan, Preparation, Encapsulation, Soybean, Leguminous crops, Seeds, Yield

1. Introduction

Nowadays, in soybean-producing countries around the world, providing the population with environmentally friendly protein products, improving soil fertility, and enhancing exports are of great importance [1].

One of the main tasks of the food industry is to obtain safe, environmentally friendly, and high-yield soybean varieties, as well as to ensure food security and meet the demand for quality food [3].

As we know, an important aspect of growing agricultural crops is related to productivity. The productivity of agricultural crops varies depending on the genetic characteristics of the variety, the influence of biotic and abiotic factors of the environment, the applied mineral fertilizers and the influence of properly organized agrotechnical measures. Based on the current ecological situation, the use of stimulants has been introduced to obtain abundant harvests from cultivated crops. We have used biostimulants from natural sources to obtain eco-friendly bountiful yield from soybean plant and achieved the expected good results [2].

It is known from the literature that scientists have emphasized that optimal agrotechnical measures and the use of nitrogen strains and the use of various stimulants have a positive effect on increasing the yield of soybean varieties,

and that good results can be obtained depending on the soil-climatic conditions and the characteristics of the variety [2].

The good implementation of symbiotic activity in the soybean plant, that is, the plant's sufficient absorption of free biological nitrogen in the atmosphere, causes high productivity. For this, of course, there must be nitrogen-fixing nodule bacteria in the soil. If not, seeds are sown by treating rhizotorphin or nitrogen strains before planting. When rhizotorphin is used, the yield increases to 15-20% [7,8].

When analyzing the yield obtained from the experiments conducted by T.Y. Rajabov and B.S. Kamilov, it was found that the highest grain yield was achieved in the upper layer of the soil of the experimental field at 65-60% moisture, irrigation was conducted three times throughout the growing period, resulting in a yield of 26.7 quintals per hectare. The lowest soybean yield was obtained when the experiment was irrigated twice during the growing period, resulting in a grain yield of 18.9 quintals per hectare [9].

According to A. Muminov and Z. Yakubov, to obtain a high-quality yield from soybean cultivation, it is necessary to apply 70-75 kg of nitrogen, 90 kg of phosphorus, and 60 kg of potassium fertilizers per hectare. The first application of nitrogen fertilizers should be carried out until the pod formation stage, where 30-35 kg/ha of nitrogen should be applied using a cultivator to a depth of 12-14 cm. The second application of nitrogen fertilizers should be done during the flowering stage, with 40 kg/ha applied to a depth of 16-18 cm, which is recommended for optimal results [10].

2. Research Object and Methods

In our research, we used nanopreparations based on Bombyx mori chitosan isolated from the cocoons of the local mulberry silkworm by the staff of the Institute of Polymer Chemistry and Physics of the Academy of Sciences of the Republic of Uzbekistan as a biostimulant that helps the growth and development of soybean plants and obtaining a high ecological yield.

Nafis, Sevinch and foreign **Selekta-302** mid-ripe soybean varieties created in local conditions were selected, soybean seeds were treated with a 0.5% solution of nanochitosan preparations before planting, and phenological and biometric monitoring studies were carried out.

The accuracy of the yield obtained on the basis of experimental options and repetitions is carried out by the dispersion method of B.A. Dospekhov. Productivity data was statistically analyzed in the "Methodology for Field Experiments" style. The statistical analysis of the accuracy of the obtained data was carried out using the Microsoft Excel program according to the method of dispersion

analysis based on the manual of B.D. Dospekhov [3].

Soybean cultivation practices are generally accepted for the region. Phenological observations were conducted four times for all experimental variants. The beginning of the plant development stage was considered to have started when 15% of the soybean plants reached the phase, and the full phase was considered to have been reached when 75% of the plants had entered the stage [13].

During the vegetation period of the plants, phenological observations and biometric measurements were carried out, including calculations of seedling density and the number of plants left for harvesting; measurement of plant height; determination of the dynamics of leaf surface formation; and identification of the dynamics of dry matter accumulation [12].

3. Research Results and Its Discussion

As a result of our three-year research, it was clear that chitosan biopolymers used as biostimulants had a positive effect on the high productivity of soybean plants.

Table 1. The effect of chitosan nanopreparations on the yield of soybean varieties, c/ha (average for 2021-2023)

№	Experience options	Nafis			Sevinch			Selekta-302		
		c/ha	addition		c/ha	addition		c/ha	addition	
			c/ha	%		c/ha	%		c/ha	%
1	Control	30,2			31,0			23,1		
2	Chitosan	31,9	1,7	5,6	32,5	1,5	4,8	23,9	0,9	3,9
3	Nanochitosan	35,2	5	16,5	36,3	5,3	17,1	26,9	3,8	16,4
4	Nanoascorbate chitosan	34,8	4,6	15,2	36,9	5,9	19,0	27,2	4,1	17,7

According to our results, when analyzing the average three-year yield of the local Nafis variety taken as a sample, the control variant yielded 30.2 c/ha. However, when the chitosan preparation was applied, the yield increased to 31.9 c/ha, resulting in an additional yield of 1.7 c/ha compared to the control variant. In the variant treated with nanocitosan, the yield was 35.2 c/ha, which corresponds to an additional increase of 5.0 c/ha. Meanwhile, in the variant treated with nanoascorbate-chitosan, the yield reached 34.8 c/ha, allowing for an additional yield of 4.6 c/ha.

In the experiment, the average three-year yield of the promising Sevinch variety in the control variant was 31.0 c/ha. In the variant treated with the chitosan preparation, the yield increased to 32.9 c/ha, resulting in an additional 1.9 c/ha compared to the control. In the variant treated with nanocitosan, the yield was 36.8 c/ha, which corresponds to an additional yield of 5.8 c/ha. Meanwhile, in the variant treated with nanoascorbate-chitosan, the yield reached 37.0 c/ha, resulting in an additional increase of 6.0 c/ha.

When analyzing the yield of the imported Selekta-302 variety, the control variant, in which no preparations were applied, recorded an average three-year yield of 23.1 c/ha. In the variant treated with the chitosan preparation, the yield increased to 23.9 c/ha, indicating an additional yield of 0.8 c/ha compared to the control. In the variant treated with

nanocitosan, the yield was recorded at 26.9 c/ha, which corresponds to an additional 3.8 c/ha. Finally, in the variant treated with nanoascorbate-chitosan, the yield reached 27.1 c/ha, resulting in an additional increase of 4.0 c/ha.

In conclusion, the study revealed the potential for increasing yield through the use of chitosan nanopreparations. When the chitosan preparation was applied to the Nafis variety, the yield was higher by 5.6% compared to the control. The application of nanocitosan resulted in a yield increase of 16.5%, while the use of nanoascorbate-chitosan led to a 15.2% increase. Although theoretically a greater result was expected, the fertility of the soil played a significant role. When the soil fertility is sufficient, the excess nutrients promote the development of the plant's vegetative organs, which may lead to less development of the generative organs.

The promising Sevinch variety, when treated with chitosan preparation, showed an average yield increase of 6.1% compared to the control. In variants treated with nanocitosan, the yield increased by 18.7%, while those treated with nanoascorbate-chitosan achieved the highest yield increase of 19.3%. In comparison to the Nafis variety, a yield increase of 2-3% was observed.

When analyzing the change in grain yield among the studied varieties, the foreign Selekta-302 variety exhibited lower yield indicators compared to the control. However, it

can be noted that with the influence of chitosan nanopreparations, the yield of this variety increased by 16.4-17.3%. This demonstrates the effectiveness of chitosan preparations in enhancing yield across different varieties.

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