Influence of Nanopolymer Preparations Based on Chitosan Bombyx Mori on the Germination of Seeds of Wheat Varieties

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Abstract. In recent years, the introduction of nanotechnologies for use in grain growing has been widely spread. The effect of nanopolymer preparations based on chitosan on the laboratory germination of various wheat varieties Krasnodar-99, Oksuv, Dustlik, Semurug, Tezpishar and Istiklol-6 was carried out at the Research Institute of Breeding, Seed Production and Agricultural Technology of Cotton Growing in 2018-2020. The best indicators of laboratory germination had seeds treated with nanopreparations Nanoascorbatchitosan 0.5% (4:1), Polymer-metal complex Cu2+:Ag 8:2 and Nanochitosan 0.5% (90 kDa), which had a higher germination rate than the control and the Daltebu standard for all studied varieties of various origin. The influence of nanopreparations on the length of the aboveground and underground parts of seedlings of wheat varieties Krasnodar-99 and Grom was also studied under phytotron conditions on the 7th day, where the measurements of nanopolymer preparations in the Krasnodar-99 variety exceeded the control in the aerial part by 9.8-15.3mm, and underground at 11.3-17.5mm and standard at 4.9-9.4mm; 8.2-14.4mm, respectively. The same picture was observed in the Grom variety.
Keywords: seeds, variety, nanopreparations, growth, development, plant, wheat, encapsulation, germination energy, germination.

1 Introduction

Today, the introduction of nanotechnologies for use in agriculture, especially in cereals, is widely spread in the world. The deepening of research work aimed at studying the effect of nanotechnology on increasing the yield of grain crops is of great scientific and practical importance [1-3], especially when using digital technologies [4-7] and legal regimes of their use [8-11].

Scientists in many countries of the world in the USA, Japan, India, China, Vietnam, Germany, Russia and Uzbekistan are conducting research to study the effect of nanopreparations on the sowing quality of seeds, growth, development and yield to increase

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crop yields. The ongoing research to study the effect of nanopolymer preparations based on chitosan on seeds, plants and products is one of the urgent problems [12-16].

It has now been established that plants for their growth and development can use the surface energy coming from outside the nanoparticles, including that obtained by seeds during presowing treatment, and nanoparticles can have a prolonging effect at the cellular level [17-18].

Two polar effects of the impact of iron solutions depending on its form and concentration were revealed: phytotoxic and the effect of stimulating the germination of seeds of Triticum aestivum L. Iron sulfates (II) and (III) inhibit the development of the plant organism, reducing the germination of seeds and their morphometric parameters. At the same time, iron nanoforms stimulate the processes of seed germination, which resulted in an increase in morphometric parameters and germination compared to the control variant. It is noted that Fe3O4 magnetite nanoparticles have a greater stimulating effect compared to Fe nanoiron particles [19].

Long-term research results made it possible to opt for chitosan, a polyfunctional polymer that is widely used in foreign agricultural practice and obtained from crab shell [20]. Chitosan is a polymer derived from chitin, which is the second biopolymer in nature after cellulose. Chitosan is known for its unique features of biodegradability, biocompatibility and non-toxicity [21, 22]. In Uzbekistan, natural silk production waste in the form of silkworm pupae is a source of chitin and chitosan [23].

Solubility in aqueous media of chitosan and its derivatives opened up new possibilities for creating unique polymer systems used in agriculture. Chitosan samples have fungicidal [24], virucidal [25], bactericidal [26], growth-regulatory [23] properties.

In addition, some studies have shown that chitosan has a positive effect on seed germination and can accelerate the chlorophyll and soluble protein content of Hulless Barley L. increase the salt tolerance of seeds and seedlings of wheat [27, 28].

Chitosan nanocleaners are widely used in agriculture, especially for plant protection, due to their size dependent quality, high surface to volume ratio and unique optical properties [29, 30, 31]. They have the ability to increase chlorophyll content and nutrient uptake by plants, the effect of chitosan nanopure on germination, seedling growth, and wheat yield [32, 33], chitosan nanopure can promote growth at lower concentration than chitosan. The researchers came to the following conclusion that chitosan nanopure can be used as new nanodrugs to stimulate wheat growth and reduce the use of agricultural fertilizers [34].

In the Republic of Uzbekistan, for the first time, the role of polymers in the creation and application of polymer formulations of chemical means of protection and increasing crop yields was revealed in the works of Rashidova S.Sh. with students [35-37].

2 Materials and methods

Seeds of wheat varieties of various origin Krasnodar-99, Oksuv, Dustlik, Semurug, Tezpishar, Istiklol-6 and Grom served as the starting material. Wheat seeds were treated with nanopolymer preparations Polymer-metal complex Cu2+:Ag 7:3, Polymer-metal complex Cu2+:Ag 8:2, Nanochitosan 0.5% (90 kDa), Nanoascorbatchitosan 0.5% (4:1), the Daltebu disinfectant served as a reference and as a control seeds without treatment. The laboratory germination of wheat seeds on the 3rd and 7th days in a thermostat at a temperature of +20 0C and the length of the aboveground and underground parts of the seedlings on the 7th day were studied. The experiments were carried out in the laboratory of biochemistry and plant physiology of the Research Institute of Selection, Seed Production and Agricultural Technology of Cotton Growing for three years. O'zDSt 2823: 2014 Seeds of agricultural crops varietal sowing qualities. Specifications. Statistical processing of the results obtained during the research was carried out according to B. A. Dospekhov (1985).

3 Results and discussion

One of the topical tasks in research is to study the effect of nanopreparations on laboratory germination, morphophysiological indicators and their behavior when interacting with biological materials and influence on metabolic processes in plants. In obtaining high and guaranteed wheat yields, an important place is given to the use of promising technologies for the preparation of sowing seeds, which provide for the use of a wide range of environmentally friendly plant protection products.

Tables 1-2 and Figure-1 show the effect of nanopolymer preparations on the germination of seeds of wheat varieties. The data given in the tables show that the seeds of all wheat varieties treated with nanopreparations showed germination results higher than the control and standard. Thus, in table 1, wheat seeds of the Krasnodar-99 variety treated with Nanoascorbatchitosan, Polymermetal complex Cu2+:Ag 8:2, Nanochitosan, had a germination rate from 97.5 to 98.2% and were ahead of the control by 3.3 + 4.0%, and the standard Daltebu by 1.9-2.6%. Similar results were obtained during the treatment of wheat seeds of the Oksuv variety.

Table 1. Determination of laboratory germination of seeds of wheat varieties Krasnodar -99 and Oksuv

№	Options	Germination,%					
		for 3 days	for 7 days	± to control	for 3 days	for 7 days	±to control
		Variety Krasnodar -99			Sort Oksuv		
1	Control	90,7±0,6	94,2±0,4	0	90,7±0,5	95,2±0,2	0
2	Daltabu (reference)	92,0±0,3	95,6±0,5	+1,4	92,0±0,2	97,5±0,4	+2,3
4	Nanochitosan	94,5±0,3	97,5±0,5	+3,3	93,0±0,1	97,2±0,3	+2,0
5	Polymermetal complex Cu^{2+}:Ag 7:3	92,3±0,2	96,0±0,1	+1,8	91,2±0,4	96,7±0,3	+1,5
6	Polymermetal complex Cu^{2+}:Ag 8:2	94,2±0,4	97,7±0,5	+3,5	92,5±0,2	97,7±0,4	+2,5
7	Nanoascorbathytosan	93,0±0,1	98,2±0,4	+4,0	91,0±0,2	98,5±0,2	+3,3

HCP_{05}=1,88% HCP_{05}=1,96%

Figure-1 shows the determination of the germination of wheat seeds sown in the rainfed conditions of the Gallyaaral experimental station. Both varieties Tezpishar and Istiklol-6 had the best result for seeds treated with Nanoascorbatchitosan and Nanochitosan, which had a germination rate higher than the control by 3.2-4.3% and 2.0-2.5%, respectively. And the variant Polymer-metal complex Cu2+:Ag 8:2 also outperformed the control by 1.5-2.6%. For all three preparations, the germination energy and seed germination were higher on average by 1.4-3.5% than the Daltebu standard.

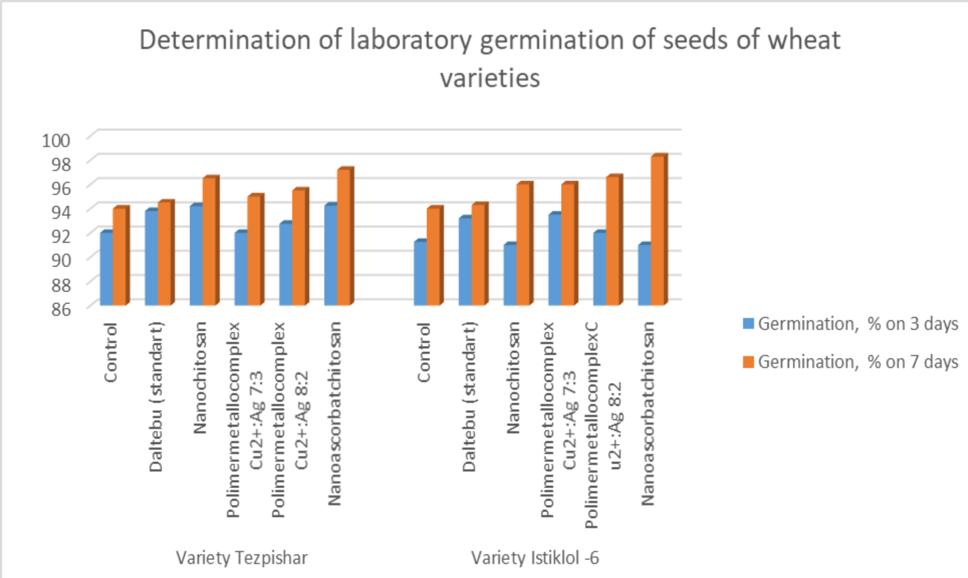

Fig. 1. Determination of laboratory germination of seeds of wheat varieties

In the irrigated zone of the Gallyaaral experimental station, two wheat varieties Dustlik and Semurug were sown. Seeds of the Dustlik variety treated with Nanoascorbatchitosan had the highest seed germination of 98.0%, which is 4.0% higher than the control and the Daltebu standard by 3.5%. Also, high rates were observed in the options Polymermetal complex Cu^{2+}:Ag 8:2 97,2% and Nanochitosan 95.2% (Table 2).

For Semurug variety, high laboratory seed germination was found in nanopolymer preparations Nanoascorbatchitosan and Polymermetal complex Cu^{2+}:Ag 8:2 respectively 99.0% and 98.25%, which exceeded the control by 3.5-4.25% and the standard by 3.05-3.80%. In other variants, the seeds encapsulated with nanopreparations had the germination capacity of the seeds at the level of the Daltebu chemical disinfectant.

The conducted studies allow us to conclude that Bombyx mori chitosan-based nanopolymer preparations are non-toxic, do not pollute the ecosystem, and have a positive effect on increasing the laboratory germination of wheat seeds. Nanopreparations Nanoascorbatchitosan, Polymermetal complex Cu^{2+}:Ag 8:2 and Nanochitosan can be recommended for seed treatment by encapsulation.

Table 2. Determination of laboratory germination of seeds of wheat varieties Dustlik and Semurug

№	Options	Germination , %					
		for 3 days	for 7 days	± to control	for 3 days	for 7 days	± to control
Variety Dustlik					Variety Semurug		
1	Control	91,2±0,4	94,0±0,4	0	92,25±0,2	94,75±0,4	0
2	Daltabu (reference)	91,5±0,2	94,5±0,5	+0,5	91,5±0,2	95,2±0,2	+0,45
4	Nanochitosan	92,0±0,3	95,2±0,3	+1,2	91,75±0,4	95,25±0,2	+0,5
5	Polymermetal complex Cu^{2+}:Ag 7:3	93,6±0,4	94,7±0,2	+0,7	88,75±0,2	95,75±0,3	+1,0

6	Polymermetal complex Cu^{2+}:Ag 8:2	93,0±0,5	97,2±0,4	+2,7	91,5±0,1	98,25±0,4	+3,5
7	Nanoascorbathytosan	94,2±0,4	98,0±0,2	+4,0	92,0±0,1	99,0±0,2	+4,25

HCP_{05}=2,04% HCP_{05}=1,92%

Under the conditions of a phytotron, studies were carried out on the effect of nanopolymer preparations on the length of the aboveground and underground parts of seedlings of wheat varieties Krasnodar-99 and Grom. Aboveground and underground parts of seedlings of wheat varieties were determined on the 7th day. The data obtained are shown in Table 3.

Measurements of the length of seedlings of seeds of the wheat variety Krasnodar-99 showed that the treatment of seeds with Nanoascorbatchitosan nanopreparation turned out to be 62.9 mm along the aerial part, 151.4 mm along the underground part, which exceeds the control by 32.1% and 8.0%. For the option Polymermetal complex Cu^{2+}:Ag 8:2 the indicators were 53.3 mm and 157.6 mm, respectively. Measurements on the aboveground and underground parts of the seedlings of all plants, the seeds of which were treated with nanopreparations, exceeded the control and the Daltebu standard. The same picture was observed in the measurements of the aboveground and underground parts of the Grom wheat variety. According to the measurements of the above-ground and underground parts, the highest rates were for the Nanoascorbatchitosan variant of 64.0 mm and 146.3 mm, respectively.

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Table 3. The length of root roots and seedlings from seeds of wheat varieties Krasnodar-99 and Grom when interacting with nanopolymer preparations on the 7th day

№	Variety Krasnodar -99							Variety Thunder					
	Option	Above-ground part, mm	G	V	Underground part, mm	G	V	Above-ground part, mm	G	V	Underground part, mm	G	V
1.	Control	47,6±0,4	1,5	2,4	140,1±0,3	1,0	0,7	56,5±0,3	1,1	2,0	129,9±0,4	1,1	0,8
2.	Daltabu (reference)	53,5±0,3	1,1	2,0	143,2±0,4	1,2	0,9	59,1±0,2	0,9	1,5	133,1±0,3	1,0	0,9
4.	Polymermetal complex Cu^{2+}: Ag 7:3	59,1±0,4	1,3	2,2	149,3±0,3	0,9	0,6	62,3±0,4	1,2	2,2	137,8±0,2	0,7	0,5
5.	Polymermetal complex Cu^{2+}: Ag 8:2	53,3±0,4	1,15	1,8	157,6±0,2	0,6	0,4	61,9±0,3	0,8	1,5	138,6±0,5	1,5	1,1
6.	Nanoascorbathytosan	62,9±0,3	0,9	1,5	151,4±0,3	0,9	0,6	64,0±0,2	0,8	1,4	146,3±0,2	0,7	0,5
7.	Nanochitosan	58,4±0,3	0,9	1,6	151,7±0,9	2,9	1,9	60,1±0,3	0,9	1,6	139,8±0,3	0,9	0,6

From the results obtained, it can be said that nanopolymer preparations have a more active effect on the aboveground and underground parts of wheat seedlings than the Daltebu dressing agent.

4 Conclusion

The study of laboratory germination of seeds of wheat varieties of various origins Krasnodar-99, Oksuv, Dustlik, Semrug, Tezpishar, Istiklol-6 led to the conclusion that nanopolymer preparations based on chitosan Cu^{2+}: Ag 8:2 and Nanochitosan 0.5% (90 kDa) have a positive effect on the germination energy and germination of wheat seeds;

- it was found that nanopolymer preparations Nanoascorbatchitosan 0.5% (4:1), Polymer metal complex Cu^{2+}:Ag 7:3, Polymermetal complex Cu^{2+}:Ag 8:2 have high biological activity, which allows at the first stage of germination to increase the length of the aboveground and underground parts of wheat seedlings.

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