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Studying Stimulant and Fungicidal Properties of Preparation "Argitos Agro" against Powdery Mildew in Greenhouse Conditions

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ABSTRACT

"Argitos Agro" is a plant growth stimulant with fungicidal effect and when disinfecting cucumber seeds and applying during the growing season, it does not have a significant effect on the development of powdery mildew disease.

The preparation, indeed, has a stimulating effect on the germination of cucumber seeds, the growth of seedlings and plants, accelerates flowering, increases the yield and improves its quality indicators.

Introduction

Currently, a lot of attention to the implementation of high technologies, including in agriculture, is paid all over the world (Singh, et al., 2017; Duhan, et al., 2017).

Recently, growth stimulant with fungicidal properties, namely preparation Argitos Agro produced by the scientific production enterprise "Nanosphere" of the Russian Federation has been registered in our Republic, the basis of which is the use of an ionic solution of nanosilver.

The preparation is intended for stimulating the growth and metabolism of plants, disinfection of soil, seeds and planting material (bulbs, tubers, roots), as well as prevention and immediate control of a number of diseases.

The stimulating effect of the preparation on the plant is due to the fact that colloidal nanosilver ions reduce its sensitivity to ethylene by suppressing ethylene receptors. As a result, premature aging of plants is inhibited and yield increases. In addition, colloidal silver ions increase the concentration of endogenous auxins in plant tissues at the expense of suppressing the activity of enzymes carrying out their oxidation, as a result of which a powerful root system is formed, thereby promoting growth and development of plants (Sharma, et al., 2012; Aung, et al., 2021).

Involvement of such a preparation in organic agriculture is very necessary, because in our deep conviction, the development of the greenhouse economy in our Republic should go mainly in the direction of the production of organic vegetables, fruits and greens from now on.

Based on the above stated, the aim of this work was to study the effect of the preparation Argitos Agro on the germination of cucumber seeds grown in greenhouse conditions, on plant growth, development, yield and quality indicators of fruits, as well as to study the potential role of the preparation in powdery mildew disease management.

Materials and methods

The experiments were carried out in the greenhouse economy of Darakert community at Masis region.

Before sowing, part of the seeds was kept for 10 hours in a 0.5 % solution of the preparation "Argitos Agro", some other part was treated in a 1.0 % solution of the preparation, and another part was left untreated.

The seeds were sown in plastic cups, and in order to stimulate the germination process, they were covered with a polyethylene film, making ventilation from time to time. In the initial period, cups were kept at $+(26\text{-}27)^0$, which was then gradually lowered: during the day: $+(20\text{-}22)^0$, at night: $+(15\text{-}17)^0$.

As soon as the first sprouts of the seeds appeared, the polyethylene film was removed.

Seedlings were planted one month after sowing, 2.5 plants per square meter. In order to stop the further growth of the plants and regulate the yield, the ends of the main stem of the 90-day-old plants were cut off.

During the vegetation period, the plants (including the control) were fed 3 times a week after planting, with the help of the drip system, with fertilizers intended for growing cucumbers. The first feeding was done one week after planting the seedlings (20 g urea, 10 g potassium sulfate, 10 g super-phosphate per 10 L of water), the second one – during mass flowering (30 g urea, 20 g potassium sulfate and 40 g super-phosphate per 10 L of water), the third one – during fruiting (20 g nitro-phosphate, 20 g potassium sulfate and 1 liter of manure infusion per 10 L of water). It should be also noted that during the preparation of the soil, it was enriched with bio-humus.

During the vegetation period, the plants were also sprayed twice with preparation "Argitos Agro". The first spraying was done one week after planting the seedlings, the second - 15 days after the first spraying. That is, as recommended by the instructions for the use of the preparation for cucumbers.

Experiments were performed as follows:

1. Seeds were not disinfected and the plants were not sprayed with a stimulant during vegetation (Control);
2. The seeds were not disinfected and the plants were sprayed twice with a 1.0 % colloidal silver solution during the vegetation period;
3. Seeds were disinfected with a 0.5 % solution of colloidal silver and the plants were sprayed twice with a 1.0 % solution of colloidal silver;
4. Seeds were disinfected with a 1.0 % solution of colloidal silver and the plants were sprayed twice with a 1.0 % solution of colloidal silver.

Observations related to the plants infection degree by powdery mildew were carried out with the methods accepted in phytopathology (Shamray and Glushenko, 2006).

Biometric observations of plants were made using the accepted methods (Bukharova, 2021).

The qualitative indicators of the fruits were determined with the methods accepted for biochemical analysis (Yermakov, et al., 1987). Dry matter in fruits was determined by drying the samples in a thermostat at 100-105 ^{0}C until constant weight was reached. Total acidity was determined by the titration method, ascorbic acid (vitamin *C*) - by Murre's method, and sugars - by the Bertrand's method.

Statistical analysis: *The data for yield were analyzed by applying Anova Single Factor Test at 95% confidence level for 4 replicates.*

Results and discussions

Observations made during the vegetation period showed that no signs of powdery mildew or any other disease appeared on cucumber plants within 50 days after germination. Later, only signs of the powdery mildew disease began to appear on the leaves of the plants that gradually became stronger and more widespread, and more intensively in the control version (Table 1).

Table 1. Effect of Argitos Agro on the development of powdery mildew disease in cucumber plants*

Variants	Infection rate, %		
	Days after seed treatment		
	50	70	90
Untreated seeds and plants (Control)	0.0	5.2	12.2
The seeds were not disinfected but the plants were sprayed with a 1.0 % stimulant solution during the vegetation	0.0	4.4	11.0
The seeds were disinfected with a 0.5 % solution of the stimulant and the plants were sprayed with a 1.0 % solution during the vegetation	0.0	3.5	7.4
The seeds were disinfected with a 1.0 % solution of the stimulant and the plants were sprayed with a 1.0 % solution during the vegetation period	0.0	3.0	6.4

*Composed by the authors.

Table 2. Biometric data of cucumber plants*

Variants	Flowering after sowing, day	Germination after sowing, days	Seedling length before planting, cm	Length of the main stem, cm		
				50	70	90
Untreated seeds and plants (Control)	49	4	18	65	110	182
The seeds were not disinfected but sprayed with a 1.0 % stimulant solution during the vegetation	47	4	18	70	115	186
The seeds were disinfected with a 0.5 % solution of the stimulant and sprayed with a 1.0 % solution during the vegetation	45	3	20	74	122	192
The seeds were disinfected with a 1.0 % solution of the stimulant and sprayed with a 1.0 % solution during the vegetation	45	3	22	78	128	200

*Composed by the authors.

Table 1 clearly shows that the preparation Argitos Agro inhibits the development of the disease to some extent. During the vegetation the seeds were not disinfected with the preparation, but after repeated sprayings with the stimulant, the infection rate on the leaves of 70-day-old plants was 0.8 % lower than in the plants of the control variant. Within the same period, the spread of the disease in the disinfected and sprayed versions decreases by 1.7-2.2 %. A similar pattern is also observed after 90 days. In the specified period, the intensity of the disease on the leaves of plants compared to the control decreases by 1.2 % in the non-disinfected and sprayed version, and by 4.8-5.8 % – in the disinfected and sprayed versions.

In order to prevent the further spread of the powdery mildew on the cucumber plants, they were completely sprayed twice with Bayleton.The obtained data prove that even the disinfection of the seeds and repeated application of Argitos Agro during the vegetation does not have a significant effect on the development of powdery mildew disease.

The ineffectiveness of the stimulant is also mentioned in the literature on wheat (Lin and Xing, 2007) and in the informative summary of the preparation application. It is also noted that the effectiveness of the preparation against a number of diseases (bacterial burn, stem rust, reddish-gray spotting, root rot, powdery mildew) of different crops is high.

In order to clarify the stimulating effect of the preparation Argitos Agro, we performed biometric observations.

The data in Table 2 show that the preparation really has stimulating properties on the cucumber. Cucumber seeds disinfected with the stimulant germinate 1 day earlier than those that are not disinfected. The preparation stimulates the growth of seedlings and contributes to the earlier flowering of shoots. Moreover, before the planting, the length of the seedlings in the versions disinfected and double sprayed with the stimulant was 2-4 cm longer than in the control one. Compared to the latter, flowering of the plants begins 2-4 days earlier.

The stimulating effect of Argitos Agro on cucumber plants is manifested during the entire vegetation period. The length of the main stem of 90-day-old plants is 10-18 cm longer in the stimulant versions compared to the control. Even if the seeds are not disinfected and the stimulant is used during the vegetation, the length of the plants increases by 4 cm.

Table 3. Yield of cucumber as affected by the use of Argitos Agro preparation*

Variants	Yield (kg/m^2) LSD =1.09
Untreated seeds and plants (Control)	15.2±1.30
The seeds were not disinfected but plants were sprayed with a 1.0 % stimulant solution during the vegetation	17.2±1.46
The seeds were disinfected with a 0.5% solution of the stimulant and plants were sprayed with a 1.0% solution during the vegetation.	19.0±0.90
The seeds were disinfected with a 1.0 % solution of the stimulant and plants were sprayed with a 1.0 % solution during the vegetation.	19.0±0.61

*Composed by the authors.

Table 4. Effect of Argitos Agro stimulant on the main qualitative properties of cucumber*

Variants	Sugars, %			Organic acids, % (by malic acid)	C vitamin, mg%
	mono- sugars	succrose	Total		
Untreated seeds and plants (Control)	1.98	0.65	2.63	0.1	5.0
The seeds were not disinfected but plants were sprayed with a 1.0 % stimulant solution during the vegetation	2.41	0.55	2.96	0.1	7.3
The seeds were disinfected with a 0.5 % solution of the stimulant and plants were sprayed with a 1.0 % solution during the vegetation.	2.23	0.74	2.97	0.09	9.0
The seeds were disinfected with a 1.0 % solution of the stimulant and plants were sprayed with a 1.0 % solution during the vegetation.	2.37	0.67	3.04	0.1	10.0

*Composed by the authors.

A significant increase in yield is observed when the seeds are disinfected with the preparation and the plants are sprayed twice with the stimulant during the vegetation. In these cases, 3.8 kg of additional harvest is obtained from one square meter (Table 3).

The obtained data were analyzed by variance (Anova) with 95 % confidence level. The null hypothesis was rejected ($P<0.05$, $Fobs>Fcr$). A statistically significant difference between variants was found.

Biochemical analyzes performed by us have shown that the fruits of all variants, where Argitos Agro was used, stand out with better quality indicators (Table 4). Moreover, the total content of sugars in them is higher than in the control variant by 0.33-0.41 %, and the amount of vitamin *C* exceeds that of the control one even twice.

These results are confirmed upon the literature, where it is shown that some concentrations of silver nanoparticles have a pronounced phytostimulating effect on plants of rape, poplar and arabidopsis plants (Gusev, et al., 2013; Vance, et al., 2015). The mechanism of phytostimulation can be the suppression of silver nanoparticles in the activity of microflora pathogenic for plants, as well as the inclusion of silver in biochemical processes.

Conclusion

Summarizing the results of the research related to the effect of Argitos Agro on cucumbers, it can be concluded that the preparation, in the case of seed disinfection and its repeated application during the vegetation, does not have a significant effect on the development of the powdery mildew.

Whereas, the preparation really has a stimulating effect, promotes the germination of cucumber seeds, the growth of seedlings and plants, accelerates flowering and increases the harvest, while providing better quality fruits.

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