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Issue Article

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COTTON PEST CONTROL AND COTTON YIELD IMPROVEMENT USING CONVOLUTIONAL NEURAL NETWORK

***Abstract**: This article presents data on the observation of plant development periods during cotton cultivation and the study of changes in its condition, timely assessment, analysis of the biology of pests and diseases of cotton, as well as the impact of the comprehensive use of various biostimulants on growth and yield. In cotton cultivation, the development periods of diseases and pests were determined, and the combined use of insecticides, fungicides against diseases, and biostimulants against them was 10.6 centners per hectare or 33.7% higher for the medium-fiber "Buxoro-8" variety and 11.3 centners per hectare or 35.0% higher for the fine-fibered variety "Marvarid".*

***Key words**: Convolutional neural network, cotton, disease, pest, fungicide, insecticide, yield, fiber quality.*

***Language**: English*

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Introduction

Nowadays, chemical preparations are mainly used in the fight against pests and insects of agricultural crops, and such chemical means are highly effective in the fight against pests.

Cotton is one of the main strategic crops of our country. In recent years, as a result of implementing radical reforms in the republic's agriculture, problems such as gradually increasing cotton yields have been resolved, and processes of further strengthening are continuing. Cotton belongs to the category of plants that are susceptible to insects and diseases and can quickly show signs of damage. Therefore, it is necessary to apply measures to combat pests and diseases; otherwise, the expected cotton yield will not be achieved.

G.barbadense L is the youngest, plastic species and originated from South America [6]. Globally, 9% of the total cultivated area under cotton is allocated to varieties of the species *Gossypium barbadense* L. However, Pima's fine fiber made up only 3% of world cotton production, they are considered commercial varieties that produce high quality fiber. Pima are mainly grown in the western and northwestern regions of the United States and also in large areas of China [12]. Uzbekistan is one of the countries in the world that has adopted the cultivation of fine-fiber cotton. The republic in the cultivation of fine-fiber varieties occupied the second place after Egypt [8].

In Uzbekistan, the greatest threats to cotton are the turnip moth (Agrotis segetum Den. Et Schiff), cotton bollworm (Helicoverpa armigera Hbn.), spider mite (Tetranychus urticae Koch.), various species of aphids (Aphididae), and plant bugs (Miridae). More than 20 species of pests have a nested distribution. If not controlled, the loss of cotton raw material yield could exceed 1.1 million tons per year, according to Ochilov et al. [10].

Improving the system for protecting crops from pests to increase their environmental safety is currently one of the most important national economic, social, and environmental problems. This problem is of particular importance in connection with the mass reproduction and increased aggressiveness of a relatively small number of the most harmful species of arthropods and phytopathogens, which are classified as over-dominant against the background of a general decrease in the biodiversity of agroecosystems, according to Pavlyushin et al. [11].

Particular attention should be paid to insect species that damage the generative organs of cotton during flowering and ripening periods. In this case, metabolic processes in plant tissues are disrupted, fiber development can also be affected during maturation, and during storage, this leads to its destruction and unsuitability for textile purposes [10].

Cotton pests are considered one of the most damaging factors in cotton cultivation. More than 210 pests that cause damage to cotton have been identified in Uzbekistan. One of them is aphids, which develop on cotton and cause damage from the time true leaves appear until the harvest. As a result, the plant stops growing and developing, leaves wither and fall off, and ultimately, productivity sharply decreases. If timely measures to combat aphids are not taken, they can reduce cotton yield by 30-50%, and in some cases, lead to the complete loss of young seedlings [3;4]. If timely measures to combat aphids are not taken, they can reduce cotton yield by 30-50%, and in some cases, lead to the complete loss of young seedlings [3].

In accordance with the Decree of the President of the Republic of Uzbekistan dated October 5, 2020 No. UP-6079 "On Approving the Strategy 'Digital Uzbekistan - 2030' and Measures for its Effective Implementation" and the Resolution No. PQ-4699 dated April 28, 2020 "On Measures for the Wide Introduction of the Digital Economy and E-Government," as well as to increase the effectiveness of digital and geoinformation technologies in agriculture and water management, the Cabinet of Ministers' strategy includes important tasks for developing "Smart Agriculture" technologies, implementing digital and geoinformation technologies in agricultural land use, developing and monitoring digital technologies for water resource management and use through the application of modern computer technologies, and advancing scientific and technical activities [1;2].

In the cultivation of cotton varieties in our republic, it is a pressing issue to develop a convolutional neural network that monitors cotton development, which will serve to increase economic efficiency by observing the periods of cotton growth and development under the influence of natural and anthropogenic factors, studying and assessing changes in its condition, studying the biology of pests and diseases, controlling the phytosanitary state of crops, phenological, age-related and territorial distribution of harmful organism populations, as well as developing scientific foundations for control measures.

Conditions and methods for experimments

In order to study the effects of applied chemical agents on the yield and technological quality indicators of “Buxoro-8” and “Marvarid” cotton varieties, field experiments were conducted in 2023 at the Kashkadarya Scientific and Experimental Station of the "Scientific Research Institute of Cotton Breeding, Seed Production and Cultivation Agrotechnologies." The soils of this region are classified as long-irrigated, cultivated, medium loamy, light gray soils with a groundwater level at 3-4 meters depth.

The characteristics of the “Buxoro-8” variety: The plant height of “Buxoro-8” variety is 90-120 cm, with low susceptibility to lodging. The first fruiting branches appear at the 5th to 7th nodes. A single boll weighs 9-11 g, while 1000 seeds weigh 125-130 g. The fiber belongs to type IV, with a fiber yield of 35-36%, fiber length of 33-34 mm, and fiber strength of 4.4-4.6 g.f. The metric count is 6020, with a relative breaking strength of 28.0-29.0 g.f./tex and a micronaire of 4.3-4.5. This variety was developed by A.M. Battalov and colleagues. It is a medium-maturing variety with an average growing season of 118-130 days and was added to the State Register in 2007.

The characteristics of the “Marvarid” variety: Plant height: 90-100 cm. Growth period: 117-120 days. Weight of raw cotton per plant: 50.0 g. Weight of raw cotton per boll: 3.5-4.0 g.Weight of 1000 seeds: 115-120 g. Fiber yield: 35-36%. The fiber is staple type, 38 mm in length. Fiber index: 6.6 g. Industrial fiber type: I. Micronaire: 3.8-4.0. Authors: Nabiev S.M., Narimanov A.A., and others. This G. barbadense L. species belongs to the Institute of Genetics and Experimental Plant Biology of the Academy of Sciences of the Republic of Uzbekistan.

Field experiments were conducted with 5 variants and 4 replications according to the structure in Table 1. Each plot in the experiment had a length of 10 meters, a width of 4.8 meters, and a total area of 48 square meters, with a calculated area of 36 square meters. The plots were systematically arranged in a single tier.

In the experiments, Biostimulators, insecticides, and fungicides were applied separately and in combination to the medium-staple cotton variety “Buxoro-8” and the fine-staple variety “Marvarid” and their effects on diseases and pests were studied. The first variant was the control (st) with no treatment. In the second variant, Biostimulator “Tandem” was applied at a rate of 0.5 liters per hectare. In the third variant, the insecticide “Indoxamectin” was administered at a rate of 0.7 l/ha. In the fourth variant, the fungicide “Zerox” was applied at a rate of 1.5 liters per hectare. In the fifth variant, chemical preparations were combined as follows: Biostimulator (Tandem - 0.5 l/ha) + Insecticide (Indoxamectin - 0.7 l/ha) + Fungicide (Zerox - 1.5 l/ha).

Results and discussion

The growth and development of plants are among the most crucial processes in their life cycle and depend on the plant species, variety, cultivation conditions, and applied technological measures. Consequently, the growth and development of cotton are closely tied to the soil and climatic conditions of the area where it is cultivated, as well as the agrotechnological practices employed.

Analysis of the results from phenological observations and biometric measurements conducted during the vegetation period of cotton plants in the experimental field revealed that the applied had a significant impact on plant growth and development.

It was observed that cotton growth was significantly accelerated at the beginning of the budding and flowering phases (June 1 and July 1) of the growing season. However, this process later slowed down due to an increase in leaf area, dry mass of plants, and yield components.

In observations conducted on the experimental field on June 1, the height of the main stem of the medium-fiber “Buxoro-8” variety in the control variant was 21 cm, with the application of the “Tandem” Biostimulator at a rate of 0.5 l/ha - 20 cm, with the application of the “Indoxamectin” insecticide at a rate of 0.7 l/ha - 19 cm, with the application of the “Zerox” fungicide at a rate of 1.5 l/ha - 22 cm, and with the combined use of the Biostimulator + Insecticide + Fungicide - 19 cm. For the fine-fiber variety “Marvarid”, in the control variant, it was 17 cm, with the application of the “Tandem” Biostimulator at a rate of 0.5 l/ha - 18 cm, with the application of the “Indoxamectin” insecticide at a rate of 0.7 l/ha - 18 cm, with the application of the “Zerox” fungicide at a rate of 1.5 l/ha - 19 cm, with the combined use of the Biostimulator + Insecticide + Fungicide - 20 cm. No significant differences were found between the variants.

Observations conducted on July 1 showed that the plant height of the medium-fiber “Buxoro-8” variety in the control variant was 32 cm, with the application of the “Tandem” Biostimulator at 0.5 l/ha - 36 cm, with the application of the “Indoxamectin” insecticide at 0.7 l/ha - 35 cm, with the application of the “Zerox” fungicide at 1.5 l/ha - 36 cm, and with the combined use of the Biostimulator + Insecticide + Fungicide - 42 cm. For the fine-fiber variety “Marvarid”, in the control variant, it was 31 cm, with the application of the “Tandem” Biostimulator at a rate of 0.5 l/ha - 35 cm, with the application of the “Indoxamectin” insecticide at a rate of 0.7 l/ha - 35 cm, with the application of the “Zerox” fungicide at a rate of 1.5 l/ha - 33 cm, in the variant with the combined use of the Biostimulator + Insecticide + Fungicide - 38 cm. It was noted that in the experimental variants where pesticides were applied, plants were 3-10 cm taller for the medium-fiber “Buxoro-8” variety and 2-7 cm taller for the fine-fiber “Marvarid” variety compared to the control variant.

The aforementioned pattern was observed when analyzing the growth dynamics of the main stem of cotton on August 1. The plant height of the medium-fiber “Buxoro-8” variety was 70 cm in the control variant, 78 cm with the use of the “Tandem” Biostimulator at 0.5 l/ha, 76 cm with the use of the “Indoxamectin” insecticide at 0.7 l/ha, 77 cm with the application of the “Zerox” fungicide at 1.5 l/ha, and 82 cm with the combined use of the Biostimulator + Insecticide + Fungicide. For the fine-fiber variety “Marvarid”, in the control variant, it was 68 cm, with the application of the “Tandem” Biostimulator at a rate of 0.5 l/ha - 77 cm, with the application of the “Indoxamectin” insecticide at a rate of 0.7 l/ha - 74 cm, with the application of the “Zerox” fungicide at a rate of 1.5 l/ha - 76 cm, in the variant with the combined use of the Biostimulator + Insecticide + Fungicide, it was 81 cm. It was noted that in the experimental variants where pesticides were applied, plants were 6-12 cm taller for the medium-fiber “Buxoro-8” variety and 6-13 cm taller for the fine-fiber “Marvarid” variety compared to the control variant.

When analyzing the growth dynamics of the main stem of cotton on September 1, the plant height of the medium-fiber “Buxoro-8” variety in the control variant was 83 cm. With the application of the “Tandem” Biostimulator at a rate of 0.5 l/ha, it reached 98 cm; with the “Indoxamectin” insecticide at 0.7 l/ha, 97 cm; with the “Zerox” fungicide at 1.5 l/ha, 96 cm; and with the combined use of Biostimulator + Insecticide + Fungicide, it reached 112 cm. For the fine-fiber “Marvarid” variety, the control variant was 79 cm. With the “Tandem” Biostimulator at 0.5 l/ha, it reached 95 cm; with the “Indoxamectin” insecticide at 0.7 l/ha, 95 cm; with the “Zerox” fungicide at 1.5 l/ha, 94 cm; and in the variant with the combined use of Biostimulator + Insecticide + Fungicide, 97 cm. It was noted that in the experimental variants where pesticides were applied, the plants were 8-29 cm taller than the control variant for the medium-fiber “Buxoro-8” variety, and 16-21 cm taller for the fine-fiber “Marvarid” variety (Figure 1.).

Such differences in plant height and growth are primarily attributed to the amount of biomass produced by crops under the influence of pesticides used against pests and diseases. Analysis of the differences in cotton main stem growth showed that in field experiments with the use of pesticides, the plant height was highest in the variant with the combined application of Biostimulator + Insecticide + Fungicide. This is due to the effect of Biostimulators, insecticides, and fungicides on the phytosanitary condition of cotton and its nutrient regime.

Thus, the application of Biostimulators, insecticides, and fungicides positively influenced both the phytosanitary state of cotton and its growth, with the plant height being 8-29 cm higher for the medium-fiber “Buxoro-8” variety and 16-21 cm higher for the fine-fiber “Marvarid” variety compared to the control variant.

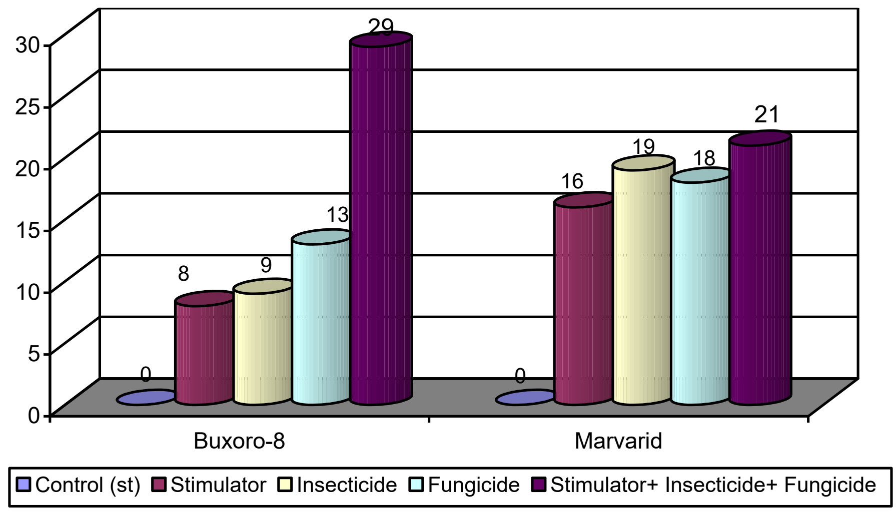

Figure 1. Difference in cotton stem height compared to the control variant 01.IX, (in centimetre).

According to the research, cotton develops rapidly in the first and second ten-day periods of May and June. From the last ten days of June, the weather conditions changed, and extremely hot days began. During the flowering-boll ripening phase of cotton, under the influence of the dry, hot climate in the region, cracks appeared in the bud sutures, and the shedding of green, vigorous buds was observed in the morning. In the following days, the shedding of flowers and buds intensified [6;7].

The use of pesticides in cotton cultivation has a positive effect, resulting in an increase in its productivity. Under these conditions, the yield of cultivated crops increases, and the quality of the product improves.

Analysis of the data obtained to determine the influence of the chemical preparations studied in the experiment on cotton yield showed that the combined use of bioBiostimulators and insecticides against pests, and fungicides against diseases in cotton cultivation positively influenced the increase in yield (Table 1).

In the third harvest of the medium-fiber “Buxoro-8” variety, the yield was 7.9 centners per hectare in the control variant, 7.6 centners per hectare with the application of the “Tandem” Biostimulator at 0.5 l/ha, 8.5 centners per hectare with the application of the “Indoxamectin” insecticide at 0.7 l/ha, 8.9 centners per hectare with the application of the “Zerox” fungicide at 1.5 l/ha, and 5.7 centners per hectare in the variant with the combined use of the Biostimulator + Insecticide + Fungicide. The fine-fiber variety “Marvarid” in the control variant yielded 8.1 centners per hectare, with the application of the “Tandem” Biostimulator at 0.5 l/ha - 7.6 centners per hectare, with the use of the “Indoxamectin” insecticide at 0.7 l/ha - 8.7 centners per hectare, with the application of the “Zerox” fungicide at 1.5 l/ha - 9.1 centners per hectare, and with the combined use of the Biostimulator + Insecticide + Fungicide - 5.6 centners per hectare.

Table 1. Cotton yield

№	Experimental options	Harvest			Total yield, c/ha	Compared to control, ±	Compared to control, %
		1	2	3			
Бухоро-8							
1	Control (standard)	15,4	8,2	7,9	31,5	-	-
2	BioBiostimulator	18,5	10,2	7,6	36,3	4,8	15,2
3	Insecticide	17,6	9,8	8,5	35,9	4,4	14,0
4	Fungicide	17,5	9,3	8,9	35,7	4,2	13,3
5	BioBiostimulator + Insecticide + Fungicide	22,3	4,1	5,7	42,1	10,6	33,7
6	Sx				0,04		
7	SPD_{05}				0,43		
Marvarid							

1	Control (standard)	15,8	8,4	8,1	32,3	-	-
2	BioBiostimulator	19,5	10,7	7,6	37,8	5,5	17,0
3	Insecticide	17,9	0,0	8,7	36,5	4,2	13,0
4	Fungicide	17,7	9,4	9,1	36,2	3,9	12,1
5	BioBiostimulator + Insecticide + Fungicide	23,3	4,7	5,6	43,6	11,3	35,0
6	Sx				0,03		
7	SPD_{05}				0,38		

In the experiment, the average cotton yield of the "Buxoro-8" variety was 31.5 centners per hectare in the control variant, 36.3 centners per hectare with the use of the "Tandem" Biostimulator at 0.5 l/ha, 35.9 centners per hectare with the use of the "Indoxamectin" insecticide at 0.7 l/ha, 35.7 centners per hectare with the application of the "Zerox" fungicide at 1.5 l/ha, and 42.1 centners per hectare in the variant with the combined use of the Biostimulator + Insecticide + Fungicide. For the fine-fiber variety "Marvarid", it was 32.3 centners per hectare in the control variant, 37.8 centners per hectare when using the "Tandem" Biostimulator at 0.5 l/ha, 36.5 centners per hectare when using the "Indoxamectin" insecticide at 0.7 l/ha, 36.2 centners per hectare when using the "Zerox" fungicide at 1.5 l/ha, and 43.6 centners per hectare in the variant with the combined use of the Biostimulator + Insecticide + Fungicide.

Compared to the control, the yield of medium-fiber cotton of the "Buxoro-8" variety was 4.8 centners per hectare or 15.2% higher when using the "Tandem" Biostimulator at a rate of 0.5 l/ha, 4.4 centners per hectare or 14.0% higher when using the "Indoxamectin" insecticide at a rate of 0.7 l/ha, 4.2 centners per hectare or 13.3% higher when using the "Zerox" fungicide at a rate of 1.5 l/ha, and 10.6 centners per hectare or 33.7% higher when using the Biostimulator + Insecticide + Fungicide combination. For the fine-fiber variety "Marvarid", the application of the "Tandem" Biostimulator at a rate of 0.5 l/ha resulted in an increase of 5.5 centners per hectare or 17.0%, the application of the "Indoxamectin" insecticide at a rate of 0.7 l/ha - 4.2 centners per hectare or 13.0%, the application of the "Zerox" fungicide at a rate of 1.5 l/ha - 3.9 centners per hectare or 12.1%, and the combined application of the Biostimulator + Insecticide + Fungicide - 11.3 centners per hectare or 35.0% higher.

Conclusion

In conclusion, when biostimulants, insecticides against pests, and fungicides against diseases were used together in cotton cultivation, the yield increased compared to the control: for the medium-fiber "Buxoro-8" variety by 10.6 centners per hectare or 33.7%, and for the fine-fiber "Marvarid" variety by 11.3 centners per hectare or 35.0%. In the Kashkadarya region, the combined application of biostimulants, insecticides against pests, and fungicides against diseases in cotton cultivation provides an additional yield of 10.6-11.3 centners per hectare.

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