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MANAGEMENT OF PHYSIOLOGICAL INDICATORS AND PRODUCTIVITY OF UPLAND COTTON (*GOSSYPIUM HIRSUTUM* L.) BASED ON CONVOLUTION NEURAL NETWORK

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SUMMARY

This research describes positive effects of the combined use of stimulant + insecticide + fungicide in improving phytosanitary conditions of the cotton field. The upland cotton (*Gossypium hirsutum* L.) crop acquired proper nourishment with robust stems, numerous leaves, and enhanced photosynthesis productivity and resulted in the highest seed cotton yield with better fiber quality. By analyzing the cotton leaf surface area, fine fiber cultivar Marvarid provided 4,375,200 cm^2/ha, followed by medium fiber cultivar Bukhara-8 with 4,262,700 cm^2/ha, using the combination of stimulant + insecticide + fungicide. By analyzing the seed cotton yield, the fine-fiber cultivar Marvarid resulted in 11.3 t/ha (35.0%) higher than the standard variant, followed by the medium-fiber cultivar Bukhara-8 with 10.6 t/ha (33.7%).

Keywords: Upland cotton (*G. hirsutum* L.), cultivars, diseases, pests, convolution neural network, fungicides, insecticides, seed cotton yield

Key findings: The use of stimulant + insecticide + fungicide in cotton (*G. hirsutum* L.) improved the phytosanitary conditions of the cotton field, with the crop properly nourished, having strong stems, numerous leaves, and photosynthesis productivity.

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INTRODUCTION

The cotton (*Gossypium hirsutum* L.) crop is primarily susceptible to insect pests and diseases and can quickly become infected. Therefore, it is necessary to maintain proper pest and disease control measures; otherwise, the expected optimum seed cotton yield would be unsuccessful. Cotton boll pests are one of the most damaging factors in cotton cultivation in Uzbekistan. The complex technology of cotton cultivation has not reached development in accordance with crop biological characteristics and advanced agrotechnology to combat diseases and pests, which are causing a considerable decrease in productivity and economic efficiency. Moreover, climate change and global warming adversely affect cotton crop production and food security worldwide (Jia *et al*., 2022; Farooq *et al*., 2022).

Upland cotton (*G. hirsutum* L.) is the most important fiber crop species, providing raw material to the textile industry worldwide. However, its production has become unstable over the years due to climate change-induced biotic stresses, such as insect pests, diseases, and weeds, as well as abiotic stresses, including drought, salinity, heat, and cold (Ahmed *et al.,* 2024). However, the development of Pima cotton (*G. barbadense L.*) cultivars resistant to adverse environmental factors produced a high-quality fibrous product compared with the upland cotton, also grown mainly in cotton fields (Amanov *et al*., 2020; Avliyoqulov and Durdiev*,* 2021; Chorshanbiev *et al.,* 2021).

Despite the cotton crop's economic worth, its cultivation faces numerous challenges, i.e., abiotic and biotic stresses, such as drought, heat, salinity, weed competition, diseases, and insect pest infestation during its life cycle (Verma *et al.,* 2024). The insect pests cause significant losses in crop yield and also disrupt agroecosystems worldwide, negatively affecting productivity and eventually farm income. Globally, insect pests incur almost 38% yield losses in different crops (Cerda *et al.,* 2017).

Global environmental changes are leading to an increased effect of various pests and diseases on different crops. The pests' negative impact on global agriculture reaches an estimated USD 1.4 trillion, which is around 5% of the global gross domestic product. Thus, ensuring food safety in agriculture and improving crop protection from pests has become one of the vital issues (Kimsanbaev *et al*., 2023). Enhancing crop protection from various pests and increasing their ecological safety is currently one of the most crucial national economic, social, and environmental problems. Therefore, the said issue is particularly vital in connection with the mass reproduction and increased aggressiveness of the relatively few most harmful species of arthropods and phytopathogens. These species gained classification as overly dominant against the background of a general decrease in the biological diversity of agroecosystems (Pavlyushin *et al.,* 2005).

Insect pests are one of the most damaging factors in cotton production. More than 210 pests have reached their identification that damage cotton crops in Uzbekistan. Cotton bollworm is one that develops and damages cotton crops from germination to harvest. As a result, severe effects on plant growth and development caused plant leaves to curl and fall off, ultimately reducing sharply the seed cotton yield. Therefore, if timely measures are unsuccessful to combat them, it can reduce the seed cotton yield by 30%–50%, and in some cases, even lead to the complete loss of young seedlings (Alimuhamedov and Khojaev, 1991; Jumaev, 2017; Anorbaev and Sulaymonov, 2013). More than 20 types of insect pests have a system distribution, and if not controlled in time, the raw cotton yield losses may exceed 1.1 million tons per year. Therefore, it is necessary to pay special attention to the various types of insects that especially damage the generative elements of cotton crops during flowering and maturity. This pest infection also disrupts metabolic processes in plant tissues, which can develop during the ripening period of fiber and during storage, leading to its destruction and unsuitability for textile purposes (Ochilov *et al.,* 2009).

Additionally, cotton plants are susceptible to various phytopathogens, including cotton leaf curl virus, leaf mosaic virus, and other viral diseases characterized by the formation of leathery leaves. Recently, using modern molecular approaches, identifying several viruses damaging cotton crops in Uzbekistan, including the cotton leaf curl virus, was successful (Kadirova *et al*., 2024; Makhmudov *et al.,* 2025). In accordance with the Decree of the President of the Republic of Uzbekistan No. PF-6079 dated October 5, 2020, "On approval of the ‘Digital Uzbekistan–2030’strategy and measures for its effective implementation" and the Resolution No. PQ-4699 dated April 28, 2020, "On measures to increase the efficiency of the implementation of the digital economy and expand the public administration system," the use of digital and geoinformation technologies in agriculture and water management is a requirement of the time (Decision PQ-170 and 179, Decree PF-5853). Data analysis comprising the effect of chemical preparations studied in experiments on cotton yield revealed the combined use of biostimulants and insecticides against pests and fungicides against various diseases in cotton cultivation remarkably boosted seed cotton yield.

MATERIALS AND METHODS

Experimental site and procedure

The cotton field experiment, conducted in 2023, took place at the Kashkadarya Scientific Experimental Station, Scientific Research Institute of Cotton Breeding, Seed and Cultivation Agrotechnologies, Kasbi District, Kashkadarya Region, Uzbekistan. It sought to study the effect of chemical agents on the seed cotton yield and fiber quality parameters of cotton cultivars Bukhara-8 and Marvarid. These cultivars are both resistant to diseases and pests. The experimental soil area is an irrigated and medium loam, according to its mechanical composition, with light gray soil at a depth of 3–4 m. Field experiments used five variants and four replications based on the structure explained in Table 1. In the experiment, each subplot has a length of 10 m, a width of 4.8 m, and a surface of 48 m^2, with a calculated area of 36 m^2 and all plots systematically placed in one layer. Testing insecticides against insect pests, fungicides against diseases, and growth stimulants in the experiment continued in the cotton field.

The study applied stimulants, insecticides, and fungicides separately and together to the medium-fiber cultivar Bukhara-8 and fine-fiber cultivar Marvarid, with their effects on diseases and pests studied after (Figures 1 and 2).

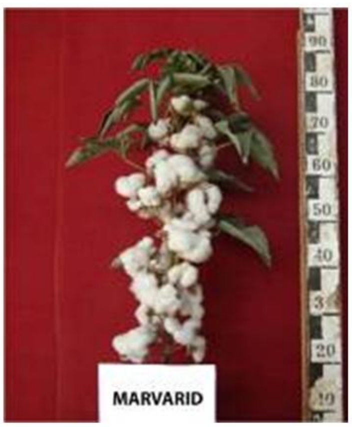
The first treatment served as the control (standard/check) and received no application. In the second treatment, the growth stimulator Tandem, as applied, had a rate of 0.5 L/ha. In the third treatment, the provision of insecticide Indoxamectin had a rate of 0.7 L/ha. The fourth treatment

Table 1. Agrotechnological processes carried out in the cotton cultivars, Bukhara-8 and Marvarid.

Cultivars and variants	Variants of Trial
Bukhara-8	
1	Control (standard/check)
2	Stimulator (Tandem - 0.5 l/ha)
3	Insecticide (Indoxamectin - 0.7 l/ha)
4	Fungicide (Zerox - 1.5 l/ha)
5	Stimulator (Tandem - 0.5 l/ha) + Insecticide (Indoxamectin - 0.7 l/ha) + Fungicide (Zerox - 1.5 l/ha)
Marvarid	
1	Control (standard/check)
2	Stimulator (Tandem - 0.5 l/ha)
3	Insecticide (Indoxamectin - 0.7 l/ha)
4	Fungicide (Zerox - 1.5 l/ha)
5	Stimulator (Tandem - 0.5 l/ha) + Insecticide (Indoxamectin - 0.7 l/ha) + Fungicide (Zerox - 1.5 l/ha)

Plant height: 90–120 cm, lodging resistant.
Growing period: 120–125 days
The first fruit branches appear in 5–7 nodes.
Boll weight: 9.0–11.0 g
1000-seed weight: 125–130 g
Fiber belongs to type: IV
Fiber output: 35.0%–36.0%
Fiber length: 33–34 mm
Micronaire: - 4.3–4.5
Developed by A.M. Battalov and others. The variety is mid-ripening, which was included in the State Register in 2007.

Figure 1. Medium fiber cotton cultivar Bukhara-8.



Plant height: 90–100 cm,
A branching type 0, growing period: 117–120 days,
The number of branches in the main stem: 22, between branches: 4.0 sm,
Cotton weight in one boll: 3.5–4.0 g,
Weight of 1000 seeds: 115–120 g,
Fiber output: 35%–36 %,
Fiber index: 6.6 g,
Fiber length: 38 mm,
Productivity per plant: 56.0 g and higher,
Micronaire: 3.8–4.0,
Strength: 48.8.
Developed by N.E. Chorshanbiev and others. The cultivar is fast-ripening, which was included in the State Register in 2018.

Figure 2. Fine fiber cotton cultivar Marvarid.

comprised the fungicide Zerox applied at 1.5 L/ha. The fifth and final treatment included the chemical preparations applied in combination: Stimulator (Tandem–0.5 L/ha) + Insecticide (Indoxamectin–0.7 L/ha) + Fungicide (Zerox–1.5 L/ha) (Table 1).

During the growing season of agricultural crops, the ability of plants to accumulate dry matter is one of the key indicators determining photosynthetic productivity and overall yield performance. Evaluating the effect of treatments on cotton leaf photosynthetic activity comprised the measurement of photosynthetic productivity. Photosynthetic productivity refers to the amount of dry matter (in grams) produced per day per 1 m² of leaf surface area.

Statistical analysis

The net productivity of photosynthesis determination used the formula of Nichiporovich (1966), as follows.

$$F_{n.prod.} = (M_2 - M_1) / T - L$$

Where M_1 and M_2 were the dry mass of the plant at the beginning and end of the calculated period, and this difference represents the increase in dry matter over time T, and L is the leaf area (average value).

All the recorded data on various traits underwent the analysis of variance (Dospekhov, 1985). The reliability of differences between the treatment means used Fisher's criterion (F), total mistake of experiment $S\bar{x}$, and error of the mean S_d, with the means compared with $LSD_{0.05}$.

The total error of the experiment formula is

$$S\bar{x} = S/\sqrt{n}$$

Where
$S\bar{x}$ is the total error (standard error of the mean);
S is the standard deviation of the sample; and
n is the number of observations.

$LSD_{0.05}$ means the least significant difference at the 5% significance level (95% confidence).

$$LSD_{0.05} = t_{0.05} \times S_d$$

Where
$t_{0.05}$ is the critical value from the t-table at the 5% level (depending on degrees of freedom), and S_d is the standard error of the difference between means.

RESULTS AND DISCUSSION

Chemical control of cotton diseases and pests in our country has its advantages. First, it is important for producing high-quality and massive cotton yields, preventing environmental pollution, and preserving human health (Khodjaev, 1994; Makhmudov *et al*., 2026). The duration of the development phases of cotton and the growing season vary. These depend on temperature, soil and air humidity, biological characteristics of the variety, the number of leaves on the plant, photosynthetic productivity, and the phytosanitary status of the field (Pardaev *et al.*, 2023).

Leaf surface role in plant development

The leaf surface area is greatly vital in plant growth and development and seed cotton yield. In cotton, the fabrication of larger and well-formed leaves enhances the production of carbohydrates, which serve as the main energy source and structural material for plant growth, flowering, and boll formation. The leaf assimilation in surface formation incurs influences from various factors, including plant nutrition, high-level technological measures, and the water and air regime of the soil. The selection of high-yielding varieties and the implementation of high-level agrotechnical measures, including optimal planting density, timely measures, and control of pests and diseases, also have a strong influence on the development of the leaf surface. In fact, the leaf is the most physiologically active organ of the plant. This is where photosynthesis, transpiration, respiration, and the synthesis of organic compounds occur. The efficiency and scale of these processes largely determine plant yield. Therefore, managing the factors that affect leaf surface formation is a key means of maximizing cotton productivity. After all, the leaf is the most active organ of the plant, where all the physiological processes happen.

According to Nichiporovich (1966), to obtain the highest yields from cultivated plants, the leaf area should be at least 40,000–60,000 m^2 per hectare. The total area of plant leaves has a vital role in the formation process of crop yield. It is typical that the total area of leaves, net productivity of photosynthesis, and the level of productivity appeared as closely associated with each other (Allanazarov, 2015; Matniyazova *et al.,* 2024). The lack of sufficient plant leaves and leaf surface area leads to incomplete absorption of solar radiation (Sanakulov and Hamedov, 2007).

The presented experiment studied the effect of chemical preparations on the plant leaf formation and leaf surface area and the amount of dry matter accumulated in cotton plants per the different variants during the cotton's main development phases. Although the leaf number and leaf surface area of plants are the genetic characteristics of each cultivar, by using the stimulant + insecticide + fungicides in the experiment, the variants emerged with varied values for these traits (Table 2). According to experimental results,

Table 2. Photosynthetic activity in cotton cultivars Bukhara-8 and Marvarid under different variants.

Cultivars and variants	Variants details	Leaf surface area (million cm^2/ha)	Photosynthetic potential (thousand m^2 day/ha)	Net productivity of photosynthesis (g/m^2)	Dry matter accumulation (g/m^2)
Bukhara-8					
1	Control (standard/check)	3,685,400	99.82	2.25	4085
2	Stimulator (Tandem)	3,954,600	119.31	2.37	4539
3	Insecticide (Indoxamectin)	3,945,700	118.65	2.35	4422
4	Fungicide (Zerox)	4,010,300	121.18	2.36	4413
5	Stimulator (Tandem) + Insecticide (Indoxamectin) + Fungicide (Zerox)	4,262,700	128.84	2.42	4691
Marvarid					
1	Control (standard/check)	3,745,500	101.14	2.31	4234
2	Stimulator (Tandem)	4,010,200	123.41	2.43	4669
3	Insecticide (Indoxamectin)	3,925,400	121.69	2.41	4652
4	Fungicide (Zerox)	3,987,500	122.52	2.40	4636
5	Stimulator (Tandem) + Insecticide (Indoxamectin) + Fungicide (Zerox)	4,375,200	131.38	2.49	4911

reckless use of insecticides not only increases production costs, but it also negatively affects the phytosanitary status of agrocenoses and the environment. The degree of leaf damage also serves as a criterion for determining the economic threshold (Tashbekov *et al.,* 2012).

The results revealed the lowest number of leaves and the smallest assimilation surface area produced by the control variants in cotton cultivars Bukhara-8 and Marvarid. According to the leaf surface area, in the medium-fiber cultivar Bukhara-8, the control variant provided a leaf area of 3,685,400 cm^2/ha. The stimulator Tandem (3,954,600 cm^2/ha), insecticide Indoxamectin (3,945,700 cm^2/ha), fungicide Zerox (4,010,300 cm^2/ha), and the combined use of stimulant + insecticide + fungicide emerged with the highest leaf surface area (4,262,700 cm^2/ha). In the fine-fiber cotton cultivar Marvarid, in the control option, the leaf surface area was 3,745,500 cm^2/ha; using stimulator Tandem gave 4,010,200 cm^2/ha, and with insecticide Indoxamectin, it was 3,925,400 cm^2/ha. Using fungicide Zerox provided 3,987,000 cm^2/ha, while in the case of the combined use of stimulant + insecticide + fungicide, the leaf surface area was the maximum (4,375,200 cm^2/ha).

By analyzing the photosynthetic potential of the medium-fiber cotton cultivar Bukhara-8, the said value was 998,200 m^2 day/ha in the control variant, 119,310 m^2 day/ha with the stimulator Tandem, and 118,650 m^2 day/ha with insecticide Indoxamectin. For the fungicide Zerox, it was 121,180 cm^2/ha. Meanwhile, in the combined use of stimulant + insecticide + fungicide, the photosynthetic potential was the highest at 128,840 m^2 day/ha. In the fine-fiber cotton cultivar Marvarid with the control variant, the photosynthetic potential was 101,140 m^2 day/ha; in the stimulator Tandem, it was 123,410 m^2 day/ha; with the insecticide Indoxamectin, it was 121,690 m^2 day/ha; and in the fungicide Zerox, it was 122,520 m^2 day/ha. The integration of stimulant + insecticide + fungicide was notable with the highest photosynthetic potential (131,380 m^2 day/ha) (Table 2).

Photosynthetic productivity

The net photosynthetic productivity is one of the most important indicators determining the biological yield of crop plants. On average, the net photosynthetic productivity varies within the range of 0–20 g/m^2 in nature. Under unfavorable conditions, when respiration predominates over photosynthesis, the index was 0, and when growing crops under

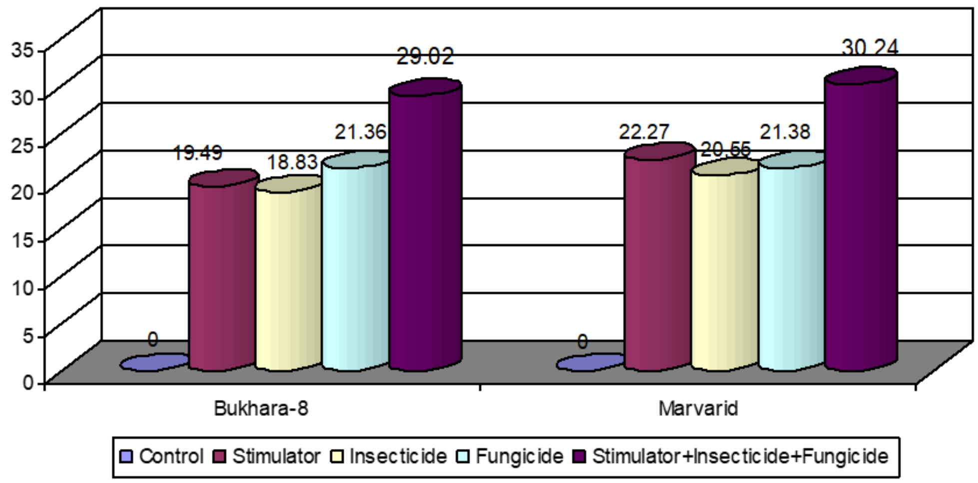


Figure 3. Photosynthetic potential of cotton cultivars Bukhara-8 and Marvarid with different variants (thousand m^2 day/ha).

favorable conditions, the net productivity of photosynthesis was high (Gold *et al.,* 2008).

The analysis of net photosynthesis productivity in the medium-fiber cotton cultivar Bukhara-8 disclosed the control variant with a value of 2.25 g/m^2, the stimulator Tandem (2.37 g/m^2), the insecticide Indoxamectin (2.35 g/m^2), and the fungicide Zerox (2.36 g/m^2). The combined use of stimulant + insecticide + fungicide achieved the highest net photosynthesis productivity (2.42 g/m^2). In the fine-fiber cotton cultivar Marvarid, the net photosynthesis productivity value was 2.31 g/m^2 in the control variant, 2.43 g/m^2 in the stimulator Tandem, 2.41 g/m^2 in insecticide Indoxamectin, and 2.40 g/m^2 in the fungicide Zerox. Meanwhile, the combination of stimulant + insecticide + fungicide provided the highest net photosynthesis productivity (2.49 g/m^2).

These study results gained validation in the works of Boquet and Coco (2002). The effect of leaf surface on the growth and development phases of the plant, as determined, expressed leaf surface and its photosynthetic activity with a positive influence on the subsequent stages of growth. Consequently, it played an important role in obtaining high yields.

By studying the difference in photosynthetic potential of the different variants in comparison with the control in the medium-fiber cotton cultivar Bukhara-8, diverse outcomes arose. The stimulator Tandem emerged with the value of 19,490 m^2 day/ha, insecticide Indoxamectin (18,830 m^2 day/ha), fungicide Zerox (21,360 m^2 day/ha), and the combination of stimulant + insecticide + fungicide gave the highest photosynthetic potential (29,020 m^2 day/ha) (Figure 3). By analyzing the fine-fiber cotton cultivar Marvarid for photosynthetic potential, the stimulator Tandem provided the value of 22,270 m^2 day/ha, insecticide Indoxamectin (20,550 m^2 day/ha), and fungicide Zerox (21,380 m^2 day/ha). The combination of stimulator + insecticide + fungicide resulted in the photosynthetic potential of 30,240 m^2 day/ha, which was significantly higher than all other variants.

Plants' dry matter

The ability of plants to accumulate dry matter during the growing period is one of the most valuable indicators that determine their overall photosynthetic efficiency and total productivity. In cotton plants, the structure and functional activity of leaves play a decisive role in determining photosynthetic efficiency. Studying the purposes of the effect of cotton leaf on photosynthesis activity helped determine photosynthesis productivity. Cotton is a light-loving plant; hence, photosynthesis activity is most active in full sunlight. The size of the leaf surface, chlorophyll content, anatomical features, and physiological condition affect the intensity of photosynthesis. It is common that the measurement of photosynthetic productivity is the amount of dry matter produced per day per m^2 of leaf surface in grams. Thus, evaluating photosynthetic productivity provides a quantitative basis for assessing crop efficiency.

According to Sharipov and Ikromova (2009), one of the indicators determining seed cotton yield is the amount of dry matter in the plants. In cotton plants, the dry matter accumulation was slow during the growth period, from seed germination to heading. However, it enhances after heading. The dry matter increase in plants depends on the periods of growth and development. The variant with the combined use of stimulant + insecticide + fungicide revealed considerably enhanced productivity of photosynthesis with a lot of dry matter accumulated in the plants.

The dry matter accumulation's analysis in the medium-fiber cotton cultivar Bukhara-8 indicated the control variant with the value of 4085 g/m^2, the stimulator Tandem (4539 g/m^2), the insecticide Indoxamectin (4422 g/m^2), and the fungicide Zerox (4413 g/m^2). For the combined use of stimulant + insecticide + fungicide, it gave the highest dry matter accumulation (4691 g/m^2). In the fine-fiber cotton cultivar Marvarid, the dry matter accumulation was 4234 g/m^2 in the control variant, in the stimulator Tandem (4669 g/m^2), the insecticide Indoxamectin (4652 g/m^2), and the fungicide Zerox (4636 g/m^2). The combined use of stimulant + insecticide + fungicide revealed the highest dry matter accumulation (4911 g/m^2) (Table 2).

The results of our study confirmed the findings obtained by Ikramova and Atoyiva (2019) in the conditions of saline and heavy soil of the Bukhara Region. In this case, when applying Zerox to the aboveground organs of cotton in the growing phases, the opening percentage of bolls was 74.8%, and the total yield was 41.5 t/ha.

Thus, with the combined application of stimulant + insecticide + fungicide in cotton fields, the phytosanitary condition of the field improves, nourishing the cotton plants properly with robust stems, numerous leaves, and increased photosynthesis productivity. This results in the highest seed cotton yield with better fiber quality.

Cultivar productivity

The productivity of cotton varieties is a complex trait determined by several components, including the number of bolls per plant, boll weight, seed weight, and the rate of maturation. In addition to traditional approaches for increasing productivity—such as selection and improvements in cultivation technology—the effective utilization of positive genotype × environment interactions in the future requires an in-depth understanding of the biological characteristics of varieties and their sensitivity to specific growing conditions (Nabiev, 2020; Nabiev *et al*., 2020). The number of bolls and boll weight are particularly important factors in achieving high productivity in fine-fiber cotton varieties (Chorshanbiev *et al*., 2025).

By analyzing the seed cotton yield in the medium-fiber cotton cultivar Bukhara-8, the control variant recorded a 31.5 t/ha yield, 36.3 t/ha in the variant with stimulator Tandem, and 35.9 t/ha in the insecticide Indoxamectin. A 35.7 t/ha yield occurred in the fungicide Zerox, and in the combination of stimulant + insecticide + fungicide, the highest seed cotton yield of 42.1 t/ha resulted. In the fine-fiber Marvarid cultivar, the seed cotton was 32.3 t/ha in the control, 37.8 t/ha in the stimulator Tandem, 36.5 t/ha in the insecticide Indoxamectin, and 36.2 t/ha in the fungicide Zerox. Meanwhile, the highest yield of 43.6 t/ha was evident in the combined use of stimulant + insecticide + fungicide (Table 3). The results of our research were also consistent with the findings by Herve (1994) in his studies, namely, the use of stimulants in low and acceptable doses is environmentally beneficial and highly effective in producing clean agricultural products. He also noted that

Table 3. Seed cotton yield in cotton cultivars Bukhara-8 and Marvarid with different variants.

Cultivars and variants	Variants details	Harvesting times			Total yield (t/ha)	Compared to control (±)	Compared to control (%)
		1	2	3			
Bukhara-8							
1	Control (standard/check)	15.4	8.2	7.9	31.5	-	-
2	Stimulator (Tandem)	18.5	10.2	7.6	36.3	4.8	15.2
3	Insecticide (Indoxamectin)	17.6	9.8	8.5	35.9	4.4	14.0
4	Fungicide (Zerox)	17.5	9.3	8.9	35.7	4.2	13.3
5	Stimulator (Tandem) + Insecticide (Indoxamectin) + Fungicide (Zerox)	22.3	4.1	5.7	42.1	10.6	33.7
	Sx				0.04		
	$LSD_{0.05}$				0.43		
Marvarid							
1	Control (standard/check)	15.8	8.4	8.1	32.3	-	-
2	Stimulator (Tandem)	19.5	10.7	7.6	37.8	5.5	17.0
3	Insecticide (Indoxamectin)	17.9	0.0	8.7	36.5	4.2	13.0
4	Fungicide (Zerox)	17.7	9.4	9.1	36.2	3.9	12.1
5	Stimulator (Tandem) + Insecticide (Indoxamectin) + Fungicide (Zerox)	23.3	4.7	5.6	43.6	11.3	35.0
	Sx				0.03		
	$LSD_{0.05}$				0.38		

stimulants affect the metabolic process and control the synthesis of enzymes and hormones; most of these substances accelerate physiological processes in living organisms and achieve high productivity.

By comparing the seed cotton yield of different variants with the control, the medium-fiber cotton cultivar Bukhara-8 showed an increase of 4.8 t/ha (15.2%) with the stimulator Tandem and 4.4 t/ha (14.0%) with the insecticide Indoxamectin. It was 4.2 t/ha (13.3%) with the fungicide Zerox and 10.6 t/ha (33.7%) by using a combination of stimulator + insecticide + fungicide. In the fine-fiber cotton cultivar Marvarid, the stimulator Tandem showed an increase of 5.5 t/ha (17.0%), the insecticide Indoxamectin with 4.2 t/ha (13.0%), and the fungicide Zerox with 3.9 t/ha (12.1%). As for the combined use of stimulant + insecticide + fungicide, it signified an increase of 11.3 t/ha (35.0%) versus the control variant (Table 3).

Thus, the integrated use of stimulant + insecticide + fungicide in cotton fields improves the phytosanitary conditions of the field. Cotton crops acquire proper nourishment, providing with robust stems, many leaves, and increased photosynthesis productivity, resulting in the highest seed cotton yield and better fiber quality. By analyzing the leaf surface area, the medium-fiber cotton cultivar Bukhara-8 was remarkably with 4,262,700 cm^2/ha with the combined application of stimulant + insecticide + fungicide. In the fine-fiber cotton cultivar Marvarid, the combined application of stimulant + insecticide + fungicide resulted in the leaf surface area of 4,375,200 cm^2/ha. With the combined application of stimulant + insecticide + fungicide, the seed cotton yield was 10.6 t/ha (33.7%) higher in the medium-fiber cotton cultivar Bukhara-8 and 11.3 t/ha (35.0%) higher in the fine-fiber cotton cultivar Marvarid than the control. The findings of Chorshanbiev *et al*. (2025) also confirmed that plants in cotton fields treated with stimulants + insecticides + fungicides together not only grow and develop optimally, but also grow relatively strong and healthy. The stems become thick, which emphasizes the possibility of forming generative elements of the cotton.

CONCLUSIONS

Such complex treatment not only improved the phytosanitary conditions of the field by effectively cleaning the pest population and combating fungal diseases. It also created more favorable conditions for plant growth and development. Moreover, the number and size of leaves increased significantly, which led to a boost in the photosynthetically active surface area. This, in turn, increased the rate of photosynthesis and improved the accumulation of assimilations necessary for growth and reproductive development. This manifested in a more uniform plant development, better formation of bolls, and reduced shedding of reproductive structures. Thus, the complex use of stimulants, insecticides, and fungicides to obtain elevated and high-quality cotton yields in field conditions can be a favorable and effective agrotechnical measure.

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