The Influence of *Chlorella Vulgaris* on the Productivity of Photosynthesis in Saline Soils and “Afghan Heat”

Dilorom Burieva[1], *Mahbuba* Ikramova[2], *Elbek* Jalolov[1], *Shokhista* Mirzaeva[1,*], *Bahtiyor* Rakhmatov[2], *Mekhriddin* Kuldoshev[3]

[1]Bukhara State Universities, Bukhara, Uzbekistan
[2]Research Institute of Selection, Seed Production and Cultivation of Agrotechnology of Cotton of the Bukhara Scientific Experimental Station, Bukhara, Uzbekistan
[3]Bukhara State Pedagogical Institute, Bukhara, Uzbekistan

Abstract. The study conducted at the experimental farm of the Research Institute of Selection, Seed Production, and Agrotechnology of Cotton (Bukhara Scientific Experimental Station) examined the effects of Chlorella vulgaris suspension on the Bukhara-10 cotton variety under extreme Bukhara conditions (“Afghan heat,” saline, and desert-arid zones). Among four tested methods, the fourth option, which involved a combined application of Chlorella vulgaris suspension, showed the best results. This treatment increased the number of cotton bolls by 4 pcs per bush, capsule weight by 1.0 g, and yield by 12 c/ha compared to the control. The soil pH decreased from 8.1 to 7.5, indicating improved soil conditions. The positive effect of Chlorella vulgaris is attributed to its rich composition of phosphorus, nitrogen, calcium, potassium, iron, zinc, and over 40 amino acids, which enhance nutrient absorption and balance soil salinity. As a result, plant growth improved through better nutrient distribution, photosynthetic activity, and accumulation of dry matter. The treatment increased photosynthetic surface area to 55.2 thousand m²/ha, dry mass to 275 g/bush, boll number to 16 pcs/bush, and photosynthesis productivity to 10.9 g/m²/day, which was 20.8 thousand m²/ha higher than the control.

1 Introduction

It is known that at present the world population is growing very quickly, geometrically. According to the concept adopted by the Food and Agriculture Organization of the United Nations (FAO): “All people should have enough food to meet their nutritional needs and personal preferences and to lead an active and healthy lifestyle, economic and social opportunities to have safe and nutritious food in the country - food security is ensured.” [1]. Agriculture is one of the industries that provide the entire population with products - food, clothing and other goods. Today in the world there are 1 billion hectares of arid and saline lands, which make up 25-30%. Of the 300 million hectares of irrigated land, 45 million hectares of land are subject to salinization. Of these, highly saline soils are formed on 62 million hectares. Due to the negative impact of salinization, drought on the productivity and quality of the crop in most countries growing agricultural crops, in the context of global climate change and growing water shortage, scientists around the world need to combat and prevent soil drought and salinization, extensive scientific research is being conducted in certain scientific areas [1,2].

Multifactorial studies are important in the scientific areas of improving the technology of arid, saline lands, optimizing the water-salt balance. Restoring soil fertility and obtaining high and high-quality yields of agricultural crops with the widespread use of biological (universally acting living organic fertilizers such as Chlorella vulgaris) and melioration measures [1].

The problem of producing especially environmentally friendly and safe agricultural products has become generally recognized. The strategy for the development of high technologies adopted in the Republic of Uzbekistan opens up prospects for the creation of environmentally friendly industries, food products, biologically active substances, the development of effective technologies for environmental protection, and the development of the agricultural sector. In this regard, the choice of the research topic is very relevant and promising. Suspension (Chlorella vulgaris) is based on the decision to use both progressive biotechnologies to identify its unique properties.

Recently, various plant growth stimulants and plant bio additives have been widely used in agriculture. Such special compounds are also called bio regulators, phytohormones, but they all pursue one goal - activation and regulation of vital processes in plant cells, adaptation to unfavourable environmental conditions and protection from various fungal, bacterial and viral diseases by increasing the immunity of agricultural crops [3-5].

Stimulants are used in all regional farms, in Agro clusters, and farms. However, none of the stimulants is

* Corresponding author: diloromburiyeva237@gmail.com

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universally effective against all adversities, in addition, the specified "environmental safety" is only apparent.
"Environmental safety" means that the drug is completely decomposed in the natural environment, without accumulating anywhere. "Safety for people and animals" does not mean that precautions should not be taken [3].
The production of high-quality, early-ripening goods from agricultural crops and growing tolerance to a variety of unfavorable environmental circumstances are two global issues. Environmentally friendly living organic fertilizers, such Chlorella vulgaris, are particularly useful in resolving these issues.
Ecologically sustainable organic fertilizers Chlorella vulgaris improves soil quality, lowers pH and salinity in the soil environment, controls plant growth and development, boosts photosynthesis productivity, yield, and quality, and increases plant resistance to stress and immunity to a variety of natural diseases [5–14].
One such live organic fertilizer that is safe for the environment and has a more thorough impact on plants and soil than other compositions is suspensions of Chlorella vulgaris. It boosts immunity, protects plants from bacterial and fungal infections, and controls the action of endogenous phytohormones in plants, which ensures growth and development, leaf canopy, dry mass, and photosynthetic productivity [3-7].
The causes of drought, increased salinity, decreased fertility, soil degradation and compaction, violation of melioration, improper use of crop rotation, ongoing disruption of crop nutrition, and climate change must all be studied in order to determine how to use the Chlorella vulgaris suspension and at what rates on a scientific basis.
Identifying the negative aspects of such changes, finding ways to eliminate them, developing new, resource-saving, environmentally friendly, inexpensive, safe, living organ fertilizers such as Chlorella vulgaris, their practical application and developing innovative agro-nutrition technologies on a scientific basis remain one of the most important problems of our time. One of the most significant issues of our day is recognizing the drawbacks of such changes, figuring out how to mitigate them, creating new, resource-efficient, eco-friendly, affordable, and safe living organ fertilizers like Chlorella vulgaris, putting them into practice, and creating cutting-edge agronutrition technologies based on sound science. To address this issue, the Research Institute of Agricultural Sciences and Agriculture, Bukhara experimental stations employed Chlorella vulgaris suspensions in cotton using a variety of techniques and times. In 2023–2024, they investigated the effects of these suspensions on salinity, drought, soil fertility, structure and growth, photosynthesis development and productivity, and cotton fiber yield and quality. As a result, using natural, eco-friendly live microalgae that are abundant in macro- and microelements, amino acids, and other vital components is imperative right now. Chlorella vulgaris is one such organism. In this context, it is necessary to demonstrate how Chlorella vulgaris suspensions impact salinity, "Afghan wind heat," water deficits, soil fertility, cotton photosynthesis productivity, yield, and fiber quality through a field experiment, various analyses, and observations in order to conduct a scientific study on the costs and methods of applying suspensions of Chlorella vulgaris to cotton varieties Bukhara-10, saline soils, and "afghan heat."

2 Literature

Chlorella vulgaris is a unique single-celled green organism with properties that have attracted the attention of space programs, especially after Japanese scientists made significant progress in studying it [9].
Many years of scientific research and evidence of the usefulness of chlorella have led to the fact that microalgae has become widespread throughout the world. Scientists have proven that just 20 kilograms of chlorella can provide one person with oxygen, but chlorella has other amazing properties. It has a rich nutrient content, can reproduce quickly, contains a high level of protein and fat, surpassing wheat [9].
World scientists have identified more than 650 valuable components that successfully combine and maintain an optimal balance in the structure of plankton cells. These include:
• vitamins of almost all types and groups;
• trace elements (potassium, calcium, magnesium, copper, iron, etc.);
• Proteins consisting of 40 amino acids (glutamic and aspartic acids, glycine, leucine, etc.);
• phytohormones (steroids);
• natural antibiotic (chlorellin), effective against pathogenic microflora;
• biologically active substances (auxins, gibberellins, cytokinin's, phenolic compounds).
Auxins contribute to the formation of a powerful root system and improve the flow of nutrients through it. Gibberellins are responsible for regulating the processes of flowering and fruiting. Cytokinin's coordinate the development of shoots, branches and buds.
Rare elements contained in the chlorella suspension completely provide the correct ratio of substances for the perfect direction of the entire plant development cycle.
The composition of chlorella contains active components of natural growth regulators that act as catalysts at any stage of all plant life processes. The product provides nutrition to the plant throughout its entire life cycle. Chlorella is effective when soaking seeds before planting and at the initial stage of germination, increasing their level almost 2 times and reducing the period of root formation [5].
The preparation stimulates the survival of plants in unfavourable environmental conditions (drought, temperature changes). Chlorella suspension:
• improves the appearance of plants;
• enhances the decorativeness of flowers;
• revives wilted flowers;
• Increases yields and improves the taste of vegetables and fruits.
Features of soil enrichment.
Organic matter produced during photosynthesis makes up over 95% of a plant organism's dry biomass.

Consequently, the absorption activity of plants may be objectively reflected as a change in their dry mass. The net productivity of photosynthesis (NPP) is one of the metrics used to describe the production process of plants. In scientific studies, this measure is frequently employed to assess plants' photosynthetic output [3-5].

The amount of dry matter in grams collected by one m^2 of leaf surface in a single day is known as the net productivity of photosynthesis.

For various plant species, this indicator's value ranges from 1 to 50 g/m^2 day.

Phosphorus improves plant cells' capacity to hold onto water, increasing their tolerance to dry spells and freezing temperatures. The application of chlorella suspension enhances the dry weight, leaf canopy, photosynthesis, fruiting, soil structure, and the amount of sugars and proteins in agricultural crops' fruits.

In light of the aforementioned literary facts, we may deduce that the following must be used in dry, salty, and extremely hot climates in order to produce a high and high-quality yield of agricultural crops: Chlorella vulgaris suspension in liquid form readily enters plant cells and fills them with beneficial components. It is a living organism that prevents nitrogen, potassium, manganese and other useful elements from being washed out of the soil. Improves the structure of the soil:

- interacts with its substances;
- enriches it with organic components;
- activates the vital activity of soil flora (microorganisms, worms);
- increases the amount of humus;
- increases the enzymatic tone of the soil and the effectiveness of fertilizers;
- cleanses the soil of harmful decomposition products [12-13];
- reduces moisture consumption during irrigation.

3 Research methods

In order to determine NPK and humus, experimental tests were carried out using the techniques used by the Research Institute of Selection, Seed Production, and Cultivation of Cotton Agrotechnology. Soil samples were taken in the 0–30 and 30–50 cm soil layers, prior to application, and at the conclusion of the vegetation period using the I.V. Tyurin method. Phosphorus and nitrogen were measured using the I.M. Maltsev and L.N. Gritsenko technique. Using an ion metric instrument, nitrate forms of nitrogen are detected.

B.P. Machigin's mobile phosphorus and a flame photometer's exchangeable potassium. The productivity of photosynthesis was assessed using the Nichiporovich and Tretyakov (2000) method, and the amount of gross and mobile forms of humus and nutrients (NPK) in the experimental field's soil was averaged by sampling for each variant from the 0-30, 30-50 cm soil layer "Methodology of field and vegetation and agrochemical experiments with cotton" [14].According to the research of E. Dzhalolova [4], it was established that 1 ml of chlorella suspension grown in the conditions of the Bukhara region contains 10 million chlorella cells. Accordingly, for soaking seeds with "Chlorella vulgaris" (in a ratio of 1:2) with 5 liters of chlorella suspension (in a warm solution, at 25 °C), 8-12 kg of seeds can be soaked. Per hectare, 25 kg of naked cotton seeds are required, which will require 10.0 liters of chlorella suspension, soaking it for 12-14 hours before sowing. Depending on the soil's mechanical makeup and moisture content, the seeds soaked in chlorella suspension are taken out of the container two hours before to sowing, spread out on a sheet of paper to dry, and then planted in a seeder to a depth of four to five centimeters. The experimental design states that the aboveground organs of cotton in the phases of 2-4 true leaves, budding, and mass flowering-fruiting the day before sunset are fed by spraying the vegetative organs of cotton plants with a suspension of Chlorella vulgaris. Depending on the amount of plant mass, the working solution with chlorella will correspond to different amounts of water. For example, for spraying foliar feeding in the phase of 2-4 leaves per weight of aboveground organs of cotton on an area of 50 m^2, 1 liter of chlorella mixed with 10 liters of water is taken. In the budding phase, 1 liter of chlorella suspension mixed with 20 liters of clean water is applied to plants on an area of 50 m^2, taking into account the increase in the mass of cotton organs. During the flowering and fruiting period, a working solution is prepared by mixing 1 liter of chlorella suspension with 30 liters to 50 liters of water and treated with the working solution.

When feeding the roots of cotton with a suspension of chlorella by drip irrigation, per hectare, pour 20.0 liters of chlorella into the available containers in the drip installation for feeding nutrients, carefully monitor the growth and development of cotton constantly.

Depending on climate change or various stress conditions and diseases are strongly expressed, as well as the lag in growth and the number of fruit elements, it can be watered with chlorella more often. When stress conditions are insignificant and then after 2-3 watering's once can be used. In this regard, it is necessary to constantly monitor and analyze the morphogenetic and physiological processes of the plant in the phases of its growth and development.

Samples were taken from each variant's experimental plots at the start and end of the growing season, that is, from the first to the fifth of each month. Dry biomass and the area of the leaf canopy were measured during this time period to ascertain the productivity of photosynthesis.

The indications required to compute the NPF were identified in the lab:

- using the formula S = PS1n/P1, where S is the total area of one plant's leaves, cm2; S1 is the area of one cut, cm2; P is the total weight of one bush's leaves, g; P1 is the weight of cuts, g; and n is the number of cuts, the area of the leaf canopy was calculated using the "cutting" method on ten cotton plants from a plot on two non-adjacent plots based on the phases of plant development. The area of leaves per 1 ha was computed when the plant density per 1 ha was established;
- An average sample of crushed plants was taken in order to calculate the mass of dry matter. Samples weighing 50 g each were obtained from each variety in

two repetitions, fixed, and dried to constant weight in a drying chamber at 105°C.

Using the formula X = A x 100/B, where A is the dry weight (sample after drying), g; and B is the wet weight (sample before drying), g; the dry matter weight was calculated.

- The Kidd, West, and Briggs formula was utilized to determine the net productivity of photosynthesis:

NPP, or net productivity of photosynthesis, is equal to (B2 - B1) / (L1 + L2) times 0.5 x n. where B1 and B2 represent the dry biomass of cotton at the start and finish of the accounting period, in grams; B2-B1 represents the dry weight growth over n days, in grams; L1 and L2 represent the leaf areas at the start and finish of the period, in meters squared; 0.5× (L1 + L2) represents the average leaf area over the experiment, in meters squared;

Day count in the accounting period (n).

In the experimental versions, samples were collected in three replicates, which are most typical for a particular stage of growth. These replicates included 50 plants with 2-4 true leaves and three plants throughout the vegetation maturation period. All fallen and dried leaves, shoots, roots, and fruiting components were included in the samples. After being gently removed from the earth, the cotton roots were cleaned with water. After all of the chosen cotton organs were moved to the lab and sealed in polyethylene bags, the moist weight was promptly measured.

At the start and finish of vegetation, the wet and dry weight of different plant sections was measured from each variety of the chosen test plants. Plants from each duplicate were broken down into their component parts (leaves, stems, roots, fruit components, and raw cotton) and weighed for this purpose. Dead and yellowed leaves were distinguished from one another. A field journal contained the results.

The whole plot area's yield was physically gathered using the weighing method. The oil content of the seeds was ascertained using the petroleum ether extraction method on a Soxhlet apparatus, while the fiber quality was assessed at the regional "Sifat" laboratory.

"A method for carrying out field research." The yield data were dispersed and examined using B. Dospekhov's "Methodology of field experiment" approach.

The rows are separated by 90 cm. Each allotment has a 150 m^2 space. Groundwater is 2 meters below the surface. The soil has a medium weight mechanical composition. The yearly application of mineral fertilizers in the following dosages was the control variant: N-250 kg/ha, P-175 kg/ha, and K-120 kg/hectare. Additionally, the yearly rates of mineral fertilizer application were lowered by 50% in the investigated versions. A drip irrigation system was used for all varieties. Four variations in all were examined. Three iterations of the experiment were conducted.

The distribution of experimental variants by repetitions on the field was carried out using the randomization method.

The purpose is to investigate the effects of the best dosages and treatment techniques for "Chlorella vulgaris" on the medium-fiber cotton variety "Bukhara-10" in harsh circumstances. To determine how the harsh circumstances of the Bukhara oasis affect seed germination, plant growth and development, fruit shedding, photosynthetic productivity, yield and quality of fiber and seeds, and the effects of soil fertility, environmental pH, salinity, and "Afghan wind heat."

4 Object and subject of research

The cotton cultivars "Bukhara-10" and the application of ecologically friendly, living organic fertilizer "Chlorella vulgaris" by drip irrigation were the subjects of the study. In the experiment, suspensions of microalgae “Chlorella vulgaris” were used at various times and in various ways during the vegetation of cotton, i.e. steeping naked seeds (25 kg/ha) on a suspension of “Chlorella vulgaris” 10 l. 20 l/ha of "Chlorella vulgaris" was applied in a variety of ways during the cotton vegetative phase (when 2-4 true leaves, budding, mass blooming, and fruiting appeared). The methods and rates of application are given in table 1.

Table 1 Experimental scheme.

	Experimental variants	**Methods and rates of application of suspension “*Chlorella vulgaris*”**			
		soaking of seeds	**in appearance of 2-4 true**	**leaves in budding**	**in flowering-fruit formation**
1	Control	0.0	0.0	0.0	0.0
2	Pre-sowing soak with warm suspension “*Chlorella vulgaris*”	25 kg/ha of bare seeds + 10 l/ha (warm solution)	0.0	0.0	0.0
3	Soaking seeds + spraying with suspension “*Chlorella vulgaris*” of vegetative organs of cotton	25 kg/ha of bare seeds + 10 l/ha (warm solution)	20 l/ha “*Chlorella vulgaris*”	20 l/ha “*Chlorella vulgaris*”	20 l/ha “*Chlorella vulgaris*”
4	Soaking seeds + spraying with suspension “*Chlorella vulgaris*” + its application through drip irrigation	25 kg/ha of bare seeds + 10 l/ha (warm solution)	“*Chlorella vulgaris*” 20+20 l/ha	“*Chlorella vulgaris*” 20+20 l/ha	“*Chlorella vulgaris*” 20+20 l/ha

5 Results and discussion

The total and mobile forms of nutrients in this field in the spring by soil layers (0-30; 30-50 cm) by experiment variations (1-2-3-4) were analyzed using the data in Table 3. nitrogen—11.2–11 mg/kg (control); 12.4–11.9 mg/kg (4 var); humus—1.069–1.010%; 1.080–1.042 percent; 1.095–1.053 percent; 1.110–1.073 percent by fall, these markers (1-4 var.) were as follows: potassium (175-170 mg/kg; 187-178 mg/kg); phosphorus (20.8-19.6 mg/kg); and 22.7-20.7 mg/kg. 1.039-0.980% of the total mobile forms; humus-0.953-0.890% Figures such as 4.0-3.7 mg/kg, 5.1-4.7 mg/kg, phosphorus-13.3-13.0 mg/kg, 18.3-14.0 mg/kg, potassium-175-170 mg/kg, and 187-178 mg/kg show that the experimental field's soil is nutrient-rich.

Table 2 lists the soil's agrochemical properties both before and after "Chlorella vulgaris" was added.

Laers of soil, cm	Total humus content, expressed as %		General forms,%		Mobile forms, mg/kg					
			N	P	N-NO_3		P_2O_5		K_2O	
	Spring	autumn	autumn	autumn	Spring	autumn	Spring	Autumn	Spring	Autumn
Bukhara-10										
0-30	1.069	0.953	0.082	0.153	11.2	4.0	20.8	13.3	185	175
30-50	1.010	0.890	0.078	0.145	11.0	3.7	19.6	13.0	181	170
0-30	1.080	0.975	0.093	0.154	11.3	4.2	21.5	14.5	187	176
30-50	1.042	0.899	0.089	0.147	11.1	4.0	19.8	13.9	182	170
0-30	1.095	0.990	0.098	0.168	11.5	4.5	21.7	17.3	189	178
30-50	1.053	0.940	0.089	0.159	11.3	4.2	20.3	13.7	185	172
0-30	1.110	1.039	0.109	0.168	12.4	5.1	22.7	18.3	194	187
30-50	1.073	0.980	0.099	0.159	11.9	4.7	20.7	14.0	187	178

By the end of the cotton plant vegetation, organic fertilizer "Chlorella vulgaris" was being applied in varying amounts and according to the experimental choices, based to the summary of the fall soil data on the quantity of mobile forms of N K. The presence of a suspension of "Chlorella vulgaris" chlorophyll, phosphorus, potassium, zinc, iron, calcium, CO_2, and 40 amino acids, among other elements, is one of the primary causes of this. It enhances the distribution of nutrients in plants and in saline soils (neutralizing the pH of the soil environment). Because phosphorus is gradually supplied throughout plant vegetation, there is an increase in crop elements because plants are better at absorbing phosphorus, potassium, and nitrogen than they are with mineral fertilizers. The distribution of these elements depends on the leaf surface, accumulation of dry matter, and accumulation of the crop's fruit elements in a single plant. Despite the fact that the plant absorbs varied amounts of humus and transportable forms of nutrients, "Chlorella vulgaris" was employed differently in the experimental versions.

Depending on the yield gained, the investigations have demonstrated that in all forms, their amount declines in layers from spring to autumn (see table 2).
Using the cylindrical approach, soil samples were obtained from the arable and subarable soil layers every 10–40 cm before to sowing and at the conclusion of the growing season. The bulk density was then calculated. The bulk masses were computed in order to ascertain the agrophysical characteristics of the soil in the spring and fall. These data are presented in table 3. Prior to the use of "Chlorella vulgaris," the soil density in the subarable layer was 1.3390-1.4469 g/sm^3; 1.5247 g/sm^3; and in the spring, the soil density was 1.3447-1.4585 g/cm^3; (0-40 sm) 1.5359 g/sm^3; in the autumn, the control variant by layers was 1.3427-1.4568 g/sm^3; 1.5390 g/sm^3; (4-var); and in the second variant of seed soaking (10 l/ha) was 1.3410-1.4545 g/sm^3; 1.5390 g/sm^3; in the autumn, the soil density was 1.3390-1.4469 g/sm^3; 1.5247 g/sm^3; (3 options).Thus, studies have shown that in comparison with furrow irrigation and the control option, which were used in various methods of chlorella suspension in the arable and under arable (0-30-40 sm) layers, the soil density by autumn decreased to 0.0143-0.0169 g/cm^3; 0.0122-0.0112 g/sm^3; 0.0040-0.0049 g/sm^3 compared to options used in various ways "Chlorella vulgaris" in options 4-3-2.
One of the main reasons for this situation is the limited access of equipment to cotton fields, and the second reason is that chlorella contains very rich nutritional components for improving soil fertility and favorable occurrence of biochemical processes in the soil, as well as neutralization of the pH of the environment depending on the methods of application and the consumption rate of the chlorella used.

Table 3 Effect of the suspension "Chlorella vulgaris" on the agrophysical properties of soils by experimental variants..

Soil layer, sm	Volumetric weight, gr/cm3, (before sowing, in spring, before setting up the experiment, watered using the furrow method).	Volumetric weight by experiment variants at the end of vegetation (in autumn), gr/cm3			
		Drip irrigation			
		1 var	2 var	3var	4 var
0-10	1.3447	1.3427	1.3410	1.3390	1.3362
10-20	1.4426	1.4416	1.4400	1.4300	1.4211
20-30	1.5882	1.5862	1.5826	1.5718	1.5688
0-30sm	1.4585	1.4568	1.4545	1.4469	1.4442
30-40	1.7682	1.7670	1.7600	1.7580	1.7500

0-40	1.5359	1.5344	1.5310	1.5247	1.5190

Chlorella vulgaris suspension (10 l/ha) was applied pre-sowing to the cotton variety "Bukhara-10" in order to affect seed germination under field circumstances.

Under the circumstances of this year, seed germination started on the fifth day from the date of sowing. The percentage of germination was 13.2% higher in the test variations than in the control variants, and the field germination rates for the test and control variants were, respectively, 78.3 and 91.5%.

Notably, root rot and gummosis were essentially nonexistent on the cotton variety "Bukhara-10," which received a suspension of Chlorella vulgaris at a rate of 10 l/ha. However, precipitation caused a variety of issues throughout the planting time. Cotton seeds were guaranteed to germinate more quickly and healthily than the control variety thanks to the presence of 40 distinct amino acids, zinc and potassium, calcium, phytohormones, chlorellin (which is effective against pathogenic microflora), and biologically active substances like phenolic compounds, gibberellins, cytokines, and auxins. To put it another way, these microelements and amino acids improve resilience to a variety of stressors, enabling consistent cotton seed germination in cold, wet, and salty conditions. The most crucial elements in raising plant photosynthetic production are agro-technical measures like heat, light, water-air standards, timing techniques for the application of chlorella, organic fertilizers, plant density, minting, and other agro-measures. The way that cotton tissues and cells receive water and nutrients is intimately connected to all physiological and biochemical activities that take place inside the plant organism. Plant germination and quality will be good if this process is done correctly. Cotton's water and nutrient supply, shoot count, and germination timing are all intimately correlated with the productivity of photosynthesis, respiration intensity, metabolism, water evaporation, and other associated activities. The method by which cotton's photosynthetic apparatus develops is intricate. The processes of genuine leaf growth and new leaf creation dominate cotton's early growth and development, whereas the processes of dying off are linked to enhanced movement of plastic materials to the reproductive organs in later stages [13–14]. The formation of leaf canopy and dry mass, which act as a structural and energetic component that guarantees plants' survival, coincides with the accumulation and storage of energy during photosynthesis [9–14].

Crops with the ideal leaf area and dry mass can produce the highest yields of cotton; it is crucial that these parameters rise rapidly to their maximum value and remain there for a considerable amount of time without experiencing a sudden drop by the end of ripening, while absorbing as much solar radiation as possible [7–10]. Growing conditions have a significant impact on the degree of actual development of the dry mass and, consequently, the factors of photosynthetic activity limiting productivity in crops that have the potential to form a very large leaf surface, such as cotton, cereals, and other agricultural crops [2–7]. Insufficient growth of the leaf surface and dry mass, as well as low productivity of its work on poor, arid, salt soils, are the primary factors limiting plant productivity if moisture and nutrition supplies are inadequate.

The coefficient of utilization of photosynthetic active radiation, leaf area, dry mass, and net productivity of photosynthesis are the primary measures of cotton's photosynthetic activity. A variety of factors, including the growing season, growing weather, plant density, and the availability of nutrients (such as bio humus and different kinds of unicellular green microalgae like "Chlorella vulgaris"), influence the size of the cotton leaf area, which is composed of the leaf area of individual bushes [5-8]; [12-14]. Research has shown that a plant that has less intensive photosynthesis, but uses a higher percentage of assimilates to form leaves and forms a larger assimilation surface, can be more effective. Thus, it is crucial to use agricultural techniques to get the ideal leaf area and dry mass of plants in the shortest amount of time.

Numerous studies show that yield and quality rise when the assimilation area of leaves increases. There is a limit to the beneficial connection between these two processes, though, where a broad leaf surface diminishes the intensity of photosynthesis owing to mutual shade, increasing the unproductive portion of the crop and decreasing yield.

According to our research, variations in leaf area across varieties are just now starting to show up when "Chlorella vulgaris" is applied in various ways, at different times, and at varying rates during the budding phase of cotton growth.

In versions 1 and 4, the leaf area during the budding phase ranges between 34.4 and 55.20 thousand m^2/ha. Additionally, "Chlorella vulgaris" was sprayed in different methods in variants 2-3-4, which range from 45.00 to 45.70 to 55.20 thousand m^2/ha.

When used in variations 3–4, the propensity to expand the assimilation surface of the leaves is particularly evident at the beginning of the phase (creation of 2-4 true leaflets). It appears that the effects of "Chlorella vulgaris" are just now starting to manifest [4]. A single production process is based on the development and photosynthesis of cotton, and the accumulation of biomass per unit of continuous leaf canopy during a specific time period is the primary measure of a plant's photosynthetic productivity [8–13].

The net productivity of photosynthesis (NPP), which describes the activity of the assimilative surface of leaves during the growing season, plays a key role in the development of agricultural production. To this end, a great deal of research has been done on the productivity of photosynthesis under different soil and climate conditions in order to determine the elements that both increase and restrict the productivity of agricultural crops.

Our research's findings indicate that, on average, over the years of study in the cotton flowering-fruiting phase, the net productivity of photosynthesis changed from 9.1 to 10.9 g/m2 day, based on the dosages and techniques of chlorella suspension. In the mass flowering-fruiting period, photosynthetic productivity varied between 9.5

and 10.9 g/m2 day, whereas in the control version, it was 9.1 g/m2 day. This led to a 0.4-0.5-1.8 g/m2 day increase in the NPP.

Data on the productivity of photosynthesis for the experimental variants are given in table 4.

Table 4 The effect of the suspension "Chlorella vulgaris" on the productivity of photosynthesis.

№	Variants, doses and methods of their application, l/ha	2-4 genuine leaves develop on the dry material, g (B1)	Dry mass throughout the ripening stage, g (B2)	Growth in dry mass over a 90-day span (B2-B1)	leaf surface, m^2 (on average per plant)		NPF, g/m^2 day
					At the beginning of the growing season (Ls_1)	At the end of the growing season (Ls_2)	
1	Control	1.3	144	142.7	0.00430	0.3440	9.1
2	Pre-sowing soak with warm suspension "*Chlorella vulgaris*"	1.6	196	194.4	0.00438	0.4500	9.5
3	Soaking seeds + spraying with suspension "*Chlorella vulgaris*" of vegetative organs of cotton	1.6	200	198.4	0.004400	0.4570	9.6
4	Soaking seeds + spraying with suspension "*Chlorella vulgaris*" + its application through drip irrigation	1.6	275	273.4	0.005000	0.5520	10.9
	(least significant difference) Lsd_{005}, g/m^2						**0.14**
	(least significant difference) $Lsd_{005,\%}$						**4.7 %**

Several writers have discovered that the NPP falls as crop leaf area rises. But there are also different viewpoints. Our research findings indicate that there was no discernible drop in photosynthetic output as leaf area increased. This can be explained by the fact that cotton crops had an ideal maximum leaf area of 55.20 thousand m^2/ha during the ripening period. According to A.A. Nichiporovich [9], cotton crops have a larger leaf area than wheat, which has a maximum of 40–50,000 m^2/ha. The leaves are shadowed and photosynthetic production falls if the leaf area exceeds this threshold. Additionally, the leaves are not shadowed and the intensity of photosynthesis does not diminish if the density of plant standing and agrotechnology are normal.

In salty and dry regions, it is essential to establish favorable conditions that maximize the potential capabilities of the photosynthetic activity of plants in the agrocenosis in order to produce high and high-quality cotton harvests. Because of the creation of new and increased amounts of old structural elements, many authors [4–10] view the growth and development of plants as a process of organismal differentiation that has a significant impact on the distribution, redistribution, and utilization of organic substances produced during photosynthesis and metabolism. Additionally, the absorption of water and mineral salts is utilized for reserve deposits, organ and tissue surface formation, and tissue regeneration.

The growth of cotton encapsulates and crowns a variety of different plant life processes, expressing to some degree the equilibrium of the production and breakdown of chemicals inside the organism as it interacts with its surroundings. The primary cause of plant growth and biological production is photosynthetic activity, which creates organic materials. As a result, cotton development, formative, organ-forming, and a rise in dry mass start mostly after the leaf's photosynthetic system is formed and the photosynthesis process is put into action.

As an organ of photosynthesis, the leaf is where primary products are formed, metabolized, and transported to storage organs [7–12].

In the flowering-fruit formation phase, more intensive growth and a significant increase in the assimilation surface of the leaves was observed for all variants and ranged from -45.00-45.70 to 55.20 thousand m^2/ha, and in the control variant - 34.40 thousand m^2/ha

The assimilation surface of the leaves increased significantly during the flowering-fruit formation period, ranging from -45.00 to 45.70 to 55.20 thousand m2/ha for all variations and 34.40 thousand m2/ha for the control version. After reviewing our research, we discovered that, when applied to the fourth variant, the leaf surface, dry mass, and photosynthesis productivity at the end of the cotton growing season were, respectively, 55.20 thousand m^2/ha; 275 g; 10.9 g/m^2 day. These values were 20.8 thousand m2/ha; 131 g; 1.8 g/m^2 day higher than the control (34.40 thousand m^2/ha). 100 trial bolls were chosen from all varieties, and their average weight was measured in order to ascertain the impact of the "Chlorella vulgaris" suspension on the weight of a single boll and the yield of cotton varieties Bukhara-10 when the suspension was used prior to each harvest. The average weight of one boll in the cotton variety Bukhara-10, which was subjected to a suspension of "Chlorella vulgaris" (3–4 var), was as follows, per the findings of the analysis:

The yield for two harvests using different methods of applying the "Chlorella vulgaris" suspension was 8.2-8.4 g; compared to the control (37.1 c/ha; 8.0 g), it was 45.1-47.5 c/ha, which is higher by 8.0-10.4 c/ha; 0.2-0.4 g. The best indicators for fiber yield were observed in the Bukhara-10 cotton variety when using the Chlorella vulgaris suspension (3-4 var.); fiber quality was 36.5-37 mm; fiber yield was 38.7-39.5%; in the control variants, respectively, it was: 35.5 mm; 38.1% in relation to the control there was a high indicator of 1.0 -1.5 mm; 0.6-1.4%;

6 Conclusion

The following findings may be drawn from the research that was done:
- it is advisable to use chlorella suspension as a bio stimulator of plant growth. Soaking seeds, spraying plants in the vegetation phase, as well as introducing through drip irrigation have a complex positive effect on agrochemical and agrophysical properties and contribute to increasing soil fertility;
- The complex use of chlorella suspension allows abandoning the use of chemicals in many areas of agriculture and ensuring the production of environmentally friendly food products while increasing the profitability of farms and preserving nature;
- the complex use of chlorella suspension for irrigation allows to reduce water consumption due to the ability to retain moisture and structure the soil environment, and therefore, save water resources and their rational use in arid areas.

Thus, from the above studies it can be concluded that one of the main reasons in the suspension of "Chlorella vulgaris" which contains very valuable components: the presence of phosphorus, nitrogen, calcium, potassium, iron, zinc and 40 amino acids, which improves the distribution of nutrients in plants, as well as in saline soils by neutralizing the pH environment and as a result of the gradual flow of phosphorus into all plant organs during the growing season of cotton, which leads to an increase in fruit elements due to better assimilation of phosphorus by the plant than that of mineral fertilizers, their distribution depending on the leaf surface, accumulation of dry matter and accumulation of crop elements in one plant and the productivity of photosynthesis were, respectively: 55.20 thousand m^2/ha; 275 g/bush; 16 pcs/per bush; and 10.9 g/m^2 day; which is higher than the control by 20.8 thousand m^2/ha; 131 g/per bush; 4 pcs/per bush; 1.8 g/m^2 day.

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