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Research Article

Morpho-physiological and yield contributing traits of cotton varieties with different tolerance to water deficit

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Abstract

Climate change and rising temperatures caused water deficits due to lesser and irregular rainfalls, leading to lower production of crops. Morpho-physiological and yield contributing traits of Upland (*G. hirsutim* L.) cotton varieties grown under optimal water supply (control) and water deficit (experimental) conditions are presented in the article, total chlorophyll, chlorophyll "a", chlorophyll "b", carotenoids, the amounts of proline, malonyldialdehyde, yield per plant, cotton weight per boll, the number of seeds per boll and the number of bolls per plant and the results of their correlation analysis are presented. Under water deficit conditions, there is a strong positive correlation between the carotenoids in plant leaves and the number of bolls per plant, a strong negative correlation between the number of carotenoids and malonyldialdehyde, a strong negative correlation between malonyldialdehyde in plant leaves and the number of bolls per plant, a strong positive correlation between plant productivity and the number of bolls per plant was found to exist. It has been determined that the varieties of Ishonch and Navbahor-2 are more resistant to water deficit than C-6524 and Tashkent-6 in traits of physiological-biochemical and yield attributes.

Keywords: *G. hirsutum* L., cotton, water deficit, varieties, physiology, morphology.

Introduction

Globally, increasing water and energy demand is expected to reach 6.9 trillion cubic meters by 2030, exceeding 40% of the available water supplies. The global climate changes observed in the world cause an increase in air temperature in the biosphere, and hot winds caused by a sharp decrease in relative humidity in the summer months cause atmospheric and soil dryness. In the present era, when the water problem is serious, the creation and implementation of water-saving agro-technologies, including the creation of cotton varieties resistant to soil and atmospheric drought and with a high coefficient of efficient use of water, water are considered the most urgent tasks of the world's cotton industry. Scientific research is being carried out to combine traditional genetic selection methods with physiological research to create modern varieties of cotton, which is one of the main agricultural crops in the world. In this regard, in addition to the medium-fibre cotton varieties that dominate the cotton area, using cotton gene pool sources with high-fibre technological indicators and resistance to environmental stress factors, determining the reactions of cultivated cotton species to water scarcity in terms of morpho-biological characteristics of varieties, lines, and hybrids, and distinguishing resistant genotypes, special attention is paid to the development of drought-resistant genotypes. The cotton plant is a valuable technical crop cultivated in many regions of the world. This plant is also an industrial crop grown in developed and developing countries (Imran *et al.,* 2011).

Cotton varieties of the medium-fiber G. *hirsutum* L. type are grown as the main field crop in 77 countries around the world, covering approximately 32.0 million hectares and growing in a variety of soil and climate conditions. The worldwide cotton trade is approximately 20.0 billion US dollars per year (Saranga *et al.,* 2001). In the cotton sector, cotton ginning and processing plants, the textile industry, etc. are the main source of employment for millions of people and constitute a significant share of the gross domestic product of many countries such as Uzbekistan, Australia, Greece, India, China, and Pakistan (https://kun.uz., 2022; worldbank.org., 2020). Uzbekistan ranks fifth in the world in terms of cotton production and fourth in the export of cotton raw materials, so it is among the largest cotton-growing countries in the world. About 93 percent of the country's cotton fields are planted with medium-fibre cotton varieties (worldbank.org., 2020; www.trendingtopmost.com., 2021). Like other countries, Uzbekistan is facing severe drought problems due to a lack of irrigation water.

The main problem in the decline of cotton productivity is related to the lack of irrigation water. Therefore, the creation of new varieties that can withstand the conditions of water scarcity is one of the most urgent tasks facing cotton science. Current global climate change will exacerbate water scarcity in the future. Given that these changes will continue in the near future, water scarcity is becoming a serious obstacle to crop production worldwide. In this situation, the need to create varieties resistant to water deficit increases (Longenberger *et al.,* 2006).

According to data, the global average temperature is expected to increase by 2 °C to 4 °C, and precipitation will decrease by 30%, which will have a strong negative impact on productivity and water resources in 2050 (Khalikova *et al.,* 2009). Thus, drought is a major challenge for food security, which indicates the need to develop agricultural crop varieties that perform well under conditions of water scarcity (Ben-Asher *et al.,* 2007; Almeselmani *et al.*, 2015).

Water deficit is one of the factors that negatively affect the growth and development of plants and, in turn, productivity. Depletion of water resources absorbed by plant roots, as well as the large amount of energy spent on water absorption, directly affect cotton productivity in irrigated agriculture. Therefore, the study of the drought tolerance of the plant is one of the main issues for farmers in the field of cotton cultivation, as well as in many other fields of agricultural crops (Talskikh *et al.,* 2009; Howard *et al.,* 2001).

Some scientists argue that cotton is a drought-resistant crop. However, as a result of the drought, cotton, like other crops, has experienced a significant reduction in yield. Lack of water has a significant negative effect on the morpho-physiological characteristics and productivity of cotton (Pace *et al.,* 1999; Patil *et al.,* 2011). Some researchers have noted that a large genetic variation occurs in cotton under water shortage and high-temperature conditions and that this variation is maintained by genetic factors (Khaidarova *and* Samiev.,1993; Shavkiev *et al.,* 2019).

Currently, the characteristics of cotton resistance to drought, high temperatures, insects, pests, and diseases are being studied in conjunction with morpho-economic and physiological characteristics in the research on the creation of water deficit varieties (Khamdullaev *et al.,* 2021). For the effective selection of drought-resistant cultivars, management of genetic differentiation through various morpho-economic characteristics has been implemented (Nabiev *et al.*, 2020; Shavkiev *et al.,* 2020).

Water deficit is a factor that has a strong negative effect on the physiological mechanisms of cotton. Prolonged periods of drought can be fatal to the cotton plant. The highest level of water demand occurs during the flowering period, while this demand is relatively low during the early and late flowering stages. The loss of crop elements caused by permanent drought also results in a significant loss of productivity (Makamov *et al.,* 2022). The evolution of drought-resistant structures is important for understanding the diverse array of phenotypic traits studied under drought. Molecular biologists have developed transgenic approaches to identify drought-tolerance genes (Sanaev *et al.,* 2021).

As a response to water deficit conditions, at first, in very early periods, a sharp change in the direction of slowing down the process of the enlargement of the leaf plate was noted in the plant, but it is noted that the process of photosynthesis does not change significantly. Due to the slowing down of the process of enlargement of the leaf plate surface, the level of consumption of carbohydrates and energy in the process of metabolism in the tissues of the plant organism decreases, and it is estimated that the saved energy and nutrients can be directed to the root system.

Thus, it was noted that the root system of the plant is less sensitive to the effects of drought when compared to the growth and development of the aboveground parts (Shavkiev *et al.,* 2017).

It has been studied that the morpho-physiological characteristics of the plant in water deficit can be evaluated by the water-holding properties of the leaf, the leaf surface, the permeability of the leaf mouth, the size of the leaf mouth, and other indicators (Ashiralieva *et al.,* 2023). Relative water content has been reported to be the most important measure of water status in plants (Rakhimova *et al.,* 2023). A specific relationship between relative water content and seed cotton yield has been identified under drought conditions (Chorshanbiev *et al.,* 2023). Water deficit-resistant genotypes reduce water loss by reducing leaf area and stomatal opening. Morphological and physiological traits considered the most effective criteria for identifying high-yielding genotypes under drought conditions include cell membrane stability index, chlorophyll "a," and relative water content (Matniyazova *et al.,* 2023; Saidigani *et al.,* 2022). (Kar *et al.,* 2005) tested five cotton hybrids for yield under water-stress conditions. Their findings indicate that this stress factor negatively affected the yield of all five stressed hybrids at the flowering stage, which was found to be more sensitive to drought than the vegetative stage of cotton. Kumari *et al.,* (2005) studied the water deficit tolerance of 20 cotton cultivars. Among the 20 tested cultivars, it was concluded that three cultivars were resistant to water deficits based on the fact that they retained a high level of water content in the leaves, produced more bolls and biomass, and produced more cotton. (Bajwa *and* Vories., 2006) studied the sensitivity of cotton genotypes to different irrigation regimes and noted that water deficits have a significant negative effect on the quality indicators of cotton fibre, especially during the period of fibre development, when the length of the fibre decreases and the formation process slows down under the influence of drought.

In the experiments of (Kuchkarov *et al.,* 2009), the main stem length was shortened to 60-80 cm and the number of crop branches was reduced to 6-12 pieces in cotton plants under conditions of water deficit, crop element shedding and preservation up to 30%, and boll weight was 0-8 g. It was found that the length of fibre decreased by 0.5–4.0 mm, and the vegetation period was also shortened. In the last stage of the flowering period in cotton plants, under the influence of a water deficit, the development of the bolls formed in the late periods slows down, the length of the fibre is shortened, the strength of the fibre’s resistance to mechanical impact decreases, and the degree of shedding of the existing bolls increases. Especially during the first 16–20 days after the flowering period in the plant, the length of the fibre is greatly affected by the lack of water. In the period 3–4 days before the opening of the pods in the plant, that is, in the 25–30 days of the development of the pods, the water deficit has a significant negative effect on the strength of the resistance to mechanical impact of the fibre (Shavkiev *et al.,* 2021).

It was observed that the number of joints forming flower buds in the plant bush is drastically reduced due to the drought that occurs during the period before the flowering period of the plant. It is also noted that water shortage causes an imbalance of phytohormones in the buds and pods of the cotton plant, which, in turn, decreases the yield (Shavkiev *et al.,* 2021). Optimizing the morphology, physiology, and metabolic processes of plant organs and cells is required to increase the productivity of agricultural crops. However, this approach can often reduce the plant's tolerance to water deficits. Different mechanisms of resistance and adaptation to water deficits have been formed in plants. In many cases, a water deficit reduces plant growth, leaf area development, and duration (Shavkiev *et al.,* 2021; Shavkiev *et al.,* 2019).

Plant stem height, root length, their biomass; chlorophyll and proline content; photosynthetic rate; and drought response genes are reliable indicators of plant response to water stress (Shavkiev J *et al.,* 2020). Drought has been found to cause late flowering in cotton, delayed boll formation, reduced fibre number in bolls, and increased fibre softness in bolls (Shavkiev *et al.,* 2019).

(Holliyev., 2009) discovered that when cotton varieties are given enough water, the activation of physiological and biochemical processes in their bodies occurs. However, the amount of water in the soil being higher or lower than the optimal level has a negative effect on the passage of the above processes, particularly in cases of water deficit, and the low amount leads to the premature opening of the cysts. The purpose of the experiment is to study the comparative analysis of physiological and morpho-economic characteristics of upland cotton varieties with different resistance to water deficit and the correlation between the characteristics.

Material and methods

Plant material and growing conditions

Field experiments were carried out in the experimental field of the regional experimental base of the Institute of Genetics and Experimental Plant Biology Academy of Sciences of Uzbekistan, located in Zangi-ota district, Tashkent region, in 2015-2021. This land is located 0.5 km north-east of the city of Tashkent, at $41^{0}20$ north latitude, $69^{0}18$ east longitude, on the upper route of the Chirchik river, at an altitude of 398 meters above sea level. The soil of the experimental field is low in humus, typical gray soil, according to the mechanical composition, the soil is moderately sandy. The terrain is slightly sloping, non-saline, weakly damaged by verticillium wilt. Groundwater is deep (7-8 m). The climate is highly variable, summer (June, July, August) is characterized by high heat, and winter (especially December and January) is characterized by a sharp drop in air temperature. Sunny days are 175-185 days, and the frost-free period is 200-210 days. Precipitation occurs in autumn, winter and spring, while summer is dry. This requires artificial irrigation of cotton (Shavkiev *et al.,* 2019; 2020).

The agrotechnical activities in the experimental areas were carried out in the order accepted in the experimental farm of the Institute of Genetics and Plant Experimental Biology: in the fall, the land areas were cleared from the stalks and ploughed to a depth of 35 cm. In the spring, with moderate air and soil temperature, fertilization was carried out in order to preserve moisture in the soil and destroy growing weeds. The seeds of the experimental and control options are divided into 2 backgrounds, which differ in terms of water regime, i.e., the background of optimal water supply (1-2-1 irrigation scheme, the total volume of water used when calculating with seed water is 4800-5000 m^3/ha), the background of water deficit (irrigation scheme 1-1-0, the total amount of water used when calculated with seed water was 2800-3100 m^3/ha) planted (Khamidov *and* Matyakubov., 2018). In this case, the modeled drought, that is, the background of water deficit, was created at the expense of reducing the number of irrigations during the period of gross flowering of plant vegetation and not carrying out irrigation after flowering. Agrotechnical measures were carried out the same in both backgrounds (Shavkiev *et al.,* 2019). Mineral fertilizers were given before planting by feeding 3 times during the growing season (1st feeding at the beginning of tillering, 2^{nd} at mass tillering, 3^{rd} at flowering). The annual rate of mineral fertilizers was 250 kg/ha of N_2, 180 kg/ha of P_2 and 115 kg/ha of K.

As the object of research, the varieties of cotton G. *hirsutum* L. resistant to water deficit and Navbakhor-2 of different genetic origin and the varieties Tashkent-6 and S-6524 resistant to water deficit were used. Under optimal water supply and water deficit under field conditions, during the flowering period of plants, chlorophyll "a", chlorophyll "b", total chlorophyll, carotenoid content (Lichtenthaler *and* Wellburn., 1983), biochemical indicators - malonyldialdehyde in plant leaves (Dhindsa *et al.,* 1981), and proline amino acid amount was determined (Bates *et al.,* 1973).

Among economic characters - plant productivity, the number of bolls per plant, weight of cotton per boll, the number of seeds per boll, fibre yield, fibre length, and weight of 1000 seeds were determined by generally accepted methods (*Methods of conducting field experiments*., 2007).

Statistical analysis

A dispersion analysis of the characteristics of cotton cultivars and hybrids was carried out (Steel *et al.,*1997). The reliability of differences between genotypes for each character was Fisher's criterion (F), the common error of the experiment (SD), the error of the difference of the means (SE) and the smallest reliable difference ($P \leq 0.05$*, $P \leq 0.01$** and $P \leq 0.001$* **) levels were determined.

Results

In the experiment, the amount of proline amino acid in the leaves of cotton plants was studied. Proline content increased to different extents in all studied cultivars under water deficit conditions compared to optimal water supply conditions. In conditions of optimal water supply, the amount of proline was the highest in the S-6524 variety (68.1 µg/g) and the lowest in the Navbahor-2 variety (39.5 µg/g). Under conditions of water stress, it was found that the proline content was the highest (75.2 µg/g) in the Ishanch variety and the lowest (69.4 µg/g) in the Tashkent-6 variety (Table 1). In scientific sources, it is noted that the amount of proline in drought-tolerant plants increases under water deficit conditions compared to non-tolerant plants (Bozorov *et al.*,2016). This situation was also confirmed in our experiment, and it was found that in conditions of water deficit, more proline amino acid is synthesized in the leaves of the Ishanch and Navbahor-2 varieties compared to the S-6524 and Tashkent-6 varieties.

The dispersion analysis of our results showed reliable differences in the amounts of chlorophyll "a," chlorophyll "b," total chlorophyll, and carotenoids in the leaves of the plants of the varieties of Ishanch, Navbahor-2, S-6524, and Tashkent-6 under different water regime conditions (Table 1). In this case, under conditions of optimal water supply, the highest index of total chlorophyll was recorded in the S-6524 variety (2.3 mg/g), and the lowest amount was recorded in the Ishanch variety (2.0 mg/g). In the conditions of water deficit, the lowest total chlorophyll value was found in the Tashkent-6 variety (1.8 mg/g), and the highest values were found in the Ishanch and Navbahor-2 varieties (2.2 mg/g and 2.2 mg/g, respectively). In conditions of water deficit, the indicators of total chlorophyll content were found to be close to each other in the cotton varieties Ishanch and Navbahor-2, but decreased in the cotton varieties S-6524 and Tashkent-6. In the conditions of optimal water supply, the highest amount of chlorophyll "a" was recorded in the Navbahor-2 variety (1.57 mg/g), and the lowest amount was recorded in the Ishanch variety (1.34 mg/g). Under conditions of water deficit, the lowest indicator of the amount of chlorophyll "a" was in the Tashkent-6 variety (1.31 mg/g), and the highest indicators were in the Ishanch and Navbahor-2 varieties (1.61 mg/g and 1.69 mg/g, respectively). The amount of chlorophyll "a" increased in the conditions of water deficit compared to the conditions of optimal water supply in the cotton varieties "Ishonch" and "Navbahor-2," while it decreased in the cotton varieties "C-6524" and "Tashkent-6."

In the cotton varieties studied in our research, it was found that the amount of chlorophyll "b" in the leaves of plants decreased to a different extent under water deficit conditions compared to the optimal water regime. Against the background of control, i.e. under conditions of optimal water supply, the highest indicator of chlorophyll "b" content was recorded in S-6524 variety (0.74 mg/g), and the lowest indicator was recorded in Navbahor-2 variety (0.54 mg/g). The lowest indicator of chlorophyll "b" content in water deficit was in the Tashkent-6 variety, 0.47 mg/g, and the highest indicator was in the "Ishanch" variety, 0.60 mg/g. The decrease in the amount of chlorophyll "a" and chlorophyll "b" in the conditions of water deficit may be caused by the inhibition of the oxidant in the photo-oxidation process by the free oxygen radical (Shavkiev *et al.,*2017; Rakhimova *et al.,*2023; Matniyazova *et al.,*2022; Nabiev *et al.,*2022). Compared to the control background, it was found that the amount of carotenoids in plant leaves increased in different degrees in the experimental background, i.e. in the water deficit. In the optimal water regime, the highest amount of carotenoids was recorded in the Navbahor-2 variety (0.34 mg/g), and the lowest amount was recorded in the Tashkent-6 variety (0.27 mg/g). Under water deficit conditions, the lowest carotenoid content was found in the Tashkent-6 variety, 0.31 mg/g, and the highest values were found in the Isfish and Navbahar-2 varieties, 0.40 mg/g and 0.41 mg/g, respectively. formed (Table 1). It was found that the amount of carotenoids in the leaves in the environment of water deficit is higher in the varieties S-6524 and Tashkent-6. In experiments, it was noted that the amount of chlorophyll and carotenoids in cotton genotypes decreased in an environment of low water supply, and the amount of chlorophyll and carotenoids increased by re-watering (Shavkiev *et al.,*2020).

According to the dispersion analysis of the results of our research, the varieties of cotton "Ishanch", "Navbahor-2", "S-6524" and "Tashkent-6" were reliably distinguished by the amount of malonyldialdehyde in plant leaves under different water regime conditions. The amount of malonyldialdehyde in the plants of the cotton cultivars studied in our experiment increased to a different extent in the water deficit compared to the conditions of optimal water supply. In the control and experimental backgrounds, the highest values of malonyldialdehyde content were found in the Tashkent-6 variety ($202{,}3*10^{-5}$ µmol/mg and $359{,}0*10^{-5}$ µmol/mg, respectively), and the lowest values were found in the Navbahor-2 variety (respectively $148{,}8*10^{-5}$ µmol/mg and $208{,}7*10^{-5}$ µmol/mg) were recorded (Table 1). In the conditions of water deficit, the amount of malonyldialdehyde in the cotton varieties of Ishanch and Navbahor-2 was lower than that of the cotton varieties S-6524 and Tashkent-6.

Discussion

In our experiment, the parameters of plant productivity were close to each other in the control, i.e. under conditions of optimal water supply, in the varieties Ishanch, Navbahor-2, S-6524 and Tashkent-6. In the conditions of water shortage, the productivity is high in the varieties "Ishanch" and "Navbakhor-2", respectively, on average 50.93 g. and 50.03 g. and in Tashkent-6 and S-6524 varieties it is low, respectively 34.77 g on average and was 35.46 g (Table 2). It was found that in Tashkent-6 and C-6524 cultivars, the cotton yield in the plant decreased sharply in the case of water deficiency compared to Ishanch and Navbakhor-2 cultivars.

In the conditions of optimal water supply, the weight of cotton in one boll was close to each other in the varieties of Ishanch, Navbahor-2, S-6524 and Tashkent-6. In the case of water shortage, the lowest indicators of the trait were in S-6524 and Tashkent-6 varieties (on average 4.46 g and 4.60 g, respectively), and the highest indicator was in Navbakhar-2 variety (5.53 g) (Table 2). It was found that the water deficit had a more negative effect on the indicators of this sign in the varieties Ishanch, S-6524 and Tashkent-6 compared to the Navbahor-2 variety.

In the control and experimental backgrounds, the lowest indicator of the number of seeds in one pod was determined in the S-6524 variety (28.21 pieces and 24.38 pieces, respectively). In the optimal water regime, the highest indicator of this indicator is in the Tashkent-6 variety, with an average of 30.63 pieces, in the case of water deficit, it was recorded in Navbahor-2 variety and it was 27.08 pieces on average. (Table 2). Soil drought caused a greater decrease in the number of seeds per boll in cultivars S-6524 and Tashkent-6 compared to Ishanch and Navbahar-2 cultivars.

Under the conditions of optimal water supply, the number of bolls per plant was close to each other in the cultivars Ishanch, Navbahor-2, S-6524 and Tashkent-6 (Table 2). The lowest indicator of the trait is water deficit.

S-6524 and Tashkent-6 varieties (9.8 pieces and 8.5 pieces, respectively), and the highest indicators were recorded in Ishanch and Navbahor-2 varieties (12.7 pieces and 12.5 pieces, respectively) (1- table). It was found that water deficit had a more negative effect on S-6524 and Tashkent-6 varieties compared to Ishanch and Navbahor-2 varieties in terms of the number of pods per plant. Data obtained by a number of researchers (Shavkiev *et al.,*2021; 2019; Makamov *et al.,* 2022) on the reduction of plant productivity, cotton weight in one boll, number of seeds and number of plant bolls in water deficit were also confirmed in our experiment.

The analysis of the results of our research in cotton varieties such as Ishanch, Navbakhor-2, C-6524 and Tashkent-6 showed that the levels of proline, carotenoids and malonyl dialdehyde in the leaves increased, chlorophyll "b", plant productivity, weight of cotton in one boll, one the number of seeds per boll and the number of bolls per plant showed a decrease.

In our experiment, we studied the correlation between the characteristics of the cotton varieties in the conditions of water deficit and optimal water supply. It was found that there is a reliable strong positive correlation (r=0.99) between proline content and chlorophyll "b" in plant leaves under water deficit conditions. Strong positive correlations (r=0.98; r=0.98; r=0.98 and r=1, respectively) between total chlorophyll in plant leaves and chlorophyll "a", carotenoids, plant productivity and number of bolls per plant under water deficit conditions and a negative strong correlation (r=-0.97) was noted between total chlorophyll and malonyl dialdehyde.

A strong positive correlation between chlorophyll a in plant leaves and carotenoid content, plant productivity and number of bolls per plant under water deficit conditions (r=0.98, r=0.96 and r=0.97, respectively), chlorophyll a and malonyl dialdehyde, a strong negative correlation (r=-0.99) was found.

A strong positive correlation (r=0.99) was observed between the number of carotenoids in plant leaves and the number of bolls per plant under water deficit conditions, and a negative strong correlation (r=-0.99) was noted between the number of carotenoids and malonyldialdehyde.

It was found that there is a strong negative correlation (r=-0.96) between malonyldialdehyde in plant leaves and the number of bolls per plant under water deficit conditions and a strong positive correlation (r=0.97) between plant productivity and the number of bolls per plant. It was found that there is a strong positive correlation (r=0.97) between proline content and chlorophyll "b" in plant leaves under conditions of optimal water supply (Table 3).

In conditions of optimal water supply, there is a negative strong correlation between chlorophyll "b" in plant leaves and cotton weight in one boll (r=-0.95), a negative strong correlation between carotenoid content in plant leaves and malonyldialdehyde (r=-0.95), in one boll A strong negative correlation (r=-0.99) was noted between cotton weight and the number of bolls per plant.

In Rajeshwari's experiments, 30 genotypes were selected to study water deficit tolerance. Three genotypes were found to have high yield potential for drought tolerance and rapid ripening photosynthesis was found to be associated with drought tolerance (Rajeshwari., 1995).

Conclusions

According to the results of the research, it was determined that the varieties of medium-fibre cotton, Ishanch and Navbahor-2, are more resistant to water deficit than S-6524 and Tashkent-6, in terms of physiological-biochemical and economic parameters. Under water deficit conditions, there is a strong positive correlation between the number of carotenoids in plant leaves and the number of bolls per plant, a strong negative correlation between the number of carotenoids and malonyldialdehyde, a strong negative correlation between malonyldialdehyde in plant leaves and the number of bolls per plant, a strong positive correlation between plant productivity and the number of bolls per plant was found to exist.

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Table 1. Physiological-biochemical indicators of cotton varieties "Ishonch", Navbahar-2, S-6524 and Tashkent-6 under the conditions of optimal water supply (control) and water deficit (experiment)

Varieties of cotton Background		Proline (mkg/g)	Total chlorophyll (mg/g^{-1})	Chlorophyll a (mg/g^{-1})	chlorophyll b (mg/g^{-1})	Carotenoid (mg/g^{-1})	Malonyl dialdehyde (10^{-5} µmol/mg)
		M±SE	M±SE	M±SE	M±SE	M±SE	M±SE
Ishonch	full irrigated	55,1±0,2	2,0±0,02	1,34±0,02	0,69±0,01	0,33±0,02	172,3±0,3
	deficit irrigated	75,2±1,3	2,2±0,05	1,61±0,01	0,60±0,04	0,40±0,02	246,8±0,5
Navbakhor-2	full irrigated	39,4±1,1	2,1±0,05	1,57±0,04	0,54±0,01	0,34±0,02	148,8±0,5
	deficit irrigated	72,1±1,2	2,2±0,04	1,69±0,02	0,52±0,02	0,41±0,01	208,7±1,3
C-6524	full irrigated	68,1±1,2	2,3±0,06	1,52±0,04	0,74±0,03	0,32±0,01	170,5±0,5
	deficit irrigated	72,4±1,2	1,9±0,05	1,39±0,03	0,54±0,03	0,35±0,02	314,1±0,6
Tashkent-6	full irrigated	62,5±0,3	2,1±0,02	1,39±0,01	0,70±0,01	0,27±0,02	202,3±2,6
	deficit irrigated	69,4±1,1	1,8±0,02	1,31±0,02	0,47±0,03	0,31±0,01	359,0±2,8

Table 2. Morpho-yield indicators of cotton varieties "Ishonch", Navbahar-2, S-6524 and Tashkent-6 under the conditions of optimal water supply (control) and water deficit (experiment)

Varieties of cotton / Background		Plant productivity (g)	Weight of cotton in one boll (g)	Number of seeds in one boll (per)	The number of bolls on the plant (per)	Fiber length (mm)	Fiber output (%)
		M±SE	M±SE	M±SE	M±SE	M±SE	M±SE
Ishonch	full irrigated	70,73±4,66	5,70±0,14	28,51±0,46	15,8±1,3	33,07±0,25	37,35±0,65
	deficit irrigated	50,93±4,34	4,85±0,15	26,82±0,79	12,7±1,1	32,72±0,30	38,09±0,69
Navbakhor-2	full irrigated	71,02±5,47	5,94±0,14	29,63±0,54	14,3±1,0	33,57±0,20	39,10±0,49
	deficit irrigated	50,03±5,36	5,53±0,16	27,08±1,06	12,5±1,0	33,46±0,18	39,24±0,86
C-6524	full irrigated	78,42±5,44	5,62±0,18	28,21±0,89	16,3±1,0	32,90±0,24	38,21±0,64
	deficit irrigated	35,46±2,64	4,46±0,22	24,38±1,06	9,8±0,6	32,70±0,22	37,48±0,92
Tashkent-6	full irrigated	78,04±6,45	5,77±0,17	30,63±0,89	15,3±1,7	32,65±0,28	38,40±0,36
	deficit irrigated	34,77±4,05	4,60±0,14	26,31±0,74	8,5±1,0	32,02±0,30	37,76±0,90

Table 3. Correlation indicators between physiological-biochemical and morpho-yield traits of cotton varieties under conditions of water deficit (upper diagonal) and optimal water supply (lower diagonal)

	1	2	3	4	5	6	7	8	9	10
1		0,76	0,64	0,99***	0,76	-0,64	0,71	0,16	0,12	0,80
2	0,52		0,98*	0,68	0,98*	-0,97*	0,98*	0,76	0,62	1,00***
3	-0,36	0,60		0,56	0,98*	-0,99***	0,96*	0,85	0,63	0,97*
4	0,97*	0,37	-0,52		0,68	-0,56	0,63	0,05	0,05	0,73
5	-0,57	-0,043	0,44	-0,48		-0,99*	0,94	0,75	0,49	0,99*
6	0,68	-0,06	-0,67	0,66	-0,95*		-0,93	-0,85	-0,55	-0,96 *
7	0,82	0,72	0,04	0,68	0,71	0,64		0,77	0,73	0,97*
8	-0,90	-0,42	0,40	-0,95*	0,19	-0,41	-0,53		0,74	0,72
9	-0,22	-0,32	-0,08	-0,32	-0,67	0,47	0,16	0,60		0,56
10	0,88	0,42	-0,39	0,94	-0,16	0,37	0,50	-0,99 ***	-0,63	

Note: Confidence difference P ≤ 0.05* ; P≤ 0.01** ва P≤ 0.001..*** Proline -1, Total chlorophyll -2, Chlorophyll “a”-3, Chlorophyll “b” -4, Carotenoid-5, Malonyldialdehyde -6, Plant productivity-7, Weight of cotton in one boll-8, Number of seeds in one boll -9, Number of bolls per plant