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ANALYSIS OF PHYSIOLOGICAL AND MORPHO-AGRONOMIC TRAITS OF UPLAND COTTON UNDER DIFFERENT CONDITIONS OF WATER SUPPLY

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ABSTRACT

According to the authors, upland cotton lines adapted to water deficit by changing the total water content and transpiration rate in the leaves of the plants, with varying degrease and varying degrees of increase in water retention in the leaves. It was found that the trait of transpiration rate is the most influential sign of water deficiency among the studied traits. It was found that the content of chlorophyll a, chlorophyll b and carotenoids in leaves of upland cotton line plants decreases in different degrees in water deficit compared to optimal water supply. The amount of proline amino acid was found to increase in different degrees. Plant productivity was reduced in upland cotton lines under water deficit compared to control (optimal water regime). Relatively high productivity and durability under these stress conditions were recorded in L-22, L-11, L-15 and L-7 lines. It was found that the water retention capacity of leaves degreases with the increase of transpiration rate in the upland cotton lines against the condition of different water supply. It was found that there is a positive correlation between the increase in the water retention property of leaves and the increase in plant productivity in water deficit condition.

INTRODUCTION

Drought is one of the most serious environmental stresses limiting crop productivity in most regions of the world, especially in warm and dry areas (Porudad and Beg, 2003). Water deficit stress is one of the strongest factors affecting productivity and it is considered a major threat to productivity crop production. Drought (water deficit) tolerance of crops is animportant trait related to productivity. In order to improve this feature, it is required to carry out relevant fundamental changes in selection work (Maleki *et al*., 2013; Nabiev *et.al*. 2022).

As you know, cotton is linens mainly for fiber. Today, Uzbekistan ranks 6th in world in terms of the area of cotton cultivation, but it ranks one of the last in terms of the yield of cultivated fiber (Axmedov *et. al*., 2018). The main goal of cotton breeders is creating varieties with high yield and fiber quality characteristics (Waleed, Yehia and Essam El-Hashash, 2022).

In 2019, approximately 386 million hectares of cotton were planted around the world, the average yield per hectare was 21.4 tons/ha, and the total yield was 82.6 million tons. In 2019, the area occupied by *G.barbadense* L. and *G.hirsutum* L. cotton varieties in Egypt was 100.000 hectares, and the yield was 30.5 ton/ha (FAOSTAT, 2021).

About 90% of the world's cotton production is obtained from the upland cotton of the *G.hirsutum* L. species, while 3% of the fiber obtained from the Egyptian cotton varieties of the *G.barbadense* L species belongs to Egypt (Fang *et. al*., 2017). Cotton ginning, processing, textile industries, etc. are a major source of employment for millions of people and constitute a significant share of the Gross domestic product of many countries such as Uzbekistan, Greece, India, China and Pakistan (Imran *et. al*., 2016).

Some scientists emphasize that cotton is a drought-resistant crop. However, as a result of drought, as in other crops, a significant decrease in productivity is observed in cotton. Lack of water has a significant negative effect on the morpho-physiological traits and productivity of cotton (Jayalalitha *et.al*., 2015). Currently, in the researches on thecreation of varieties resistant to water deficit, the resistance properties of cotton to drought, high temperature, insects, pests and diseases are studied in connection with morpho-economic and physiological characters. For effective selection of drought resistant cultivars, genetic differentiation management through various morpho-economic traits has been implemented (Latif *et.al*., 2015).

Water deficit resistant genotypes reduce water loss by reducing leaf area and stomatal opening. Morphological and physiological traits considered to be the most effective criteria for identifying high-yielding genotypes under drought conditions include cell membrane stability index, chlorophyll a and relative water content (Mustafavi *et.al*., 2016).

In field conditions, there is a correlation between the decrease of the amount of water in the leaves under the influence of water deficit and the increase in the leaf stomata. However, no correlation was found between these indicators under conditions of optimal water supply. Thus, it was noted that under conditions of optimal water supply, the opening of leaf stomata is not considered a positive condition et low water concentration in the cotton genotype (Baloch *et. al*., 2015; Nabiev *et.al*. 2022).

According to a number of scientists, there is a positive relationship between cotton productivity, fiber yield, number of bolls, boll weight, fiber yield and seed weight (Latif *et.al.*, 2015; Jarwar *et.al.*, 2019). Batao *et al.* (2016) found positive heterosis in yield, boll weigh and boll number in cotton. Imran *et al.* (2016) found that h^2 was equal to unity for fiber length, less than 1.0 for output and microneurium, and line lineage fibers had h^2=0.61 for fiber hardness, h^2=0.65 for density fiber and for fiber softness it turned out to be h^2=072.

Correlation is a statistical method that shows the degree to which a pair of variables are related to each other. Genotypic and phenotypic correlations are natural genetic factors that determine the degree of correlation between yield and traits related to yield (Ali Karademir *et.al.*, 2009). Because of this. It is very important to determine the correlation levels of different traits before starting any selection program for the development of agricultural crops. When the correlation of cotton traits was studied, it was found that the genes involved in maintaining a high water balance and cell membrane stability in the leaves are genetically related to the genes controlling the number bolls, fiber length and maturity. The conducted genetic analysis showed that if the effect of the gene is stable under moisture-deficient conditions and the selected plants have the same useful properties, it is effective to identify valuable forms in their next generation (Batao *et.al.*, 2016; Nabiev et.al. 2022).

MATERIALS AND METHODS

The recent research proceeded during 2023 at the Institute of Genetics and experimental biology, Academy of sciences of the republic of Uzbekistan, located in the district Zangiota, Tashkent, Uzbekistan (with an altitude of 398 masl). The climate exhibited sharp fluctuations, with high temperatures in summer (June, July and August) and a sharp drop in air temperature in winter (December and January). Sunny days prevailed for 175-185 days non-cold days for 200-210 days. It rains fall, winter and spring, with the air dry in the summer. The soils of the experimental field were low in humus, typically gray, an d moderately sandy according to the granulometric composition. The terrain is slightly sloping, not saline, and naturally damaged by whitish (*verticillium*) silt. The bulk density of the soil measured 1.32-1.33 g/cm^2, with a limited field moisture capacity (LFMC) of 22%. Groundwaters go deep (8 m and more) (Matniyazova *et.al.*, 2022; Muminov *et.al.*, 2023; Nabiev *et.al.* 2022).

The study took place on cotton line under two water regimes (non-stress and stressed conditions). In optimum and controlled water regimes, the cotton genotypes received irrigation four times (scheme 1:2:1) during the vegetative and flowering stages, using 4800-5000 m^3/ha water. However, under stress conditions, only two irrigations (scheme 1:1:0) were applied to the genotypes, with the total volume of water used for irrigatio n at 2800-3000 m^3/ha. In the stressed environment, the cotton genotypes were irrigated once during the seedling and once at the flowering stage, artificially creating water scarcity (modeled drought). A group of parental cotton cultivars belonging to the species *Gossypium hirsutum* L. and their line underwent study (Shavqiev *et.al.*, 2021; Nabiev *et.al.* 2022).

The following new lines of upland cotton were used as research objects: L-1 (L-SA x Dior) x (*G.hirsutum* L. x *G.tomentosum*); L-2 (Navbakhor-2 x L-SA) x (*G.hirsutum* x *G.tomentosum*); L-3 (C-9082 x 3B) x (*G.hirsutum* L. x *G.arboreum*); L-7 (C-9082 x 4B); L-11 (Barxat); L-15 (Navbakhor-2); L-16 (C-9082 x C-9080); L-20 (Navbakhor-2 x AN-16) x (Ishonch x C-9082); L-21 (L-1849) and L-22 (Navbakhor-2 x C-9082).

In our study, the total amount of water in the leaves, the rate of transpiration in the leaves, the water holding properties of the leaves, the relative surface density of the leaves, the amount of chloroplast pigments, and the amount of proline amino acid were determined from the physiological and biochemical characteristics of upland cotton leaf samples in the budding and flowering and budding period.

The major agronomic traits, cotton weight in one boll, plant productivity, fiber index and output were studied.

Extraction and determination of pigment concentration: This experiment determined the amount of pigments in the leaves from the soybean plant samples 3-4 leaves, calculating from the glineth point. Fifty milligrams of each leaf sample, placed in a test tube, gained homogenization in 5 ml of 95% ethyl alcohol solution (Lichtenthaler and Wellburn, 1983). The homogenate underwent centrifugation at a speed of 5000 rpm for 12 min. The amounts of chlorophyll a and b carotenoids in the resulting extract attained determination by an Agilent Cary 60 UV-Vis spectrophotometer at 664, 649 and 470 nm. Based on these indicators, calculating the amounts of chlorophyll a and b and carotenoids in soybean leaves used the following equations (Nayek *et al.*, 2014):

Ch-a=13.36A664 – 5.19 A649

Ch-b=27.43A649 – 8.12 A664

C x+c=(1000A470 – 2.13Ca – 97.63Cb)/209

Statistical analysis: Data analysis was performed using Stat View (SAS Institute Inc., Cary, NC, USA) with one-way ANOVA followed by a Fisher PLSD post hoc test ($P<0.05$ and $P<0.01$)

RESULTS

In scientific sources (fiziologiya xlopchatnika,1977; Nabiev *et.al.* 2022) it is shown that the total amount of water in leaves is 70-80% of the wet weight of the leaf under conditions of optimal water supply.

The total water content in plant leaves is one of the most important physiological parameters of water exchange, and the study of this characteristic in upland fiber cotton lines is important for the development of drought resistant varieties of upland fiber co tton.

In the group of upland fiber cotton lines under optimal water supply conditions, the highest total water content in plant leaves was 78.4% in line T-7, and the lowest values were recorded in lines T-16 and T-1, respectively 75.2% and 75.95 (Table 1).

Table 1/Total water content (%) and transpiration rate (mg H_2O/1 g.wet leaf x 1 hour) in leaves of upland fiber cotton plants under different water su pply conditions,

Lines	total amount of water in leaves,%			transpiration rate (mg H_2O/1 g.wet leaf x 1 hour)		
	NK	DC	LA,%	NK	DC	LA,%
L-1	75.9	73.4	-3.3	233.86	149.79	-35.9
L-2	77.2	71.5	-7.4	232.48	84.98	-63.4
L-3	77.3	73.3	-5.2	239.88	74.47	-69.0
L-7	78.4	71.9	-8.3	306.69	137.38	-55.2
L-11	77.8	74.5	-4.2	261.26	132.16	-49.4
L-15	76.5	73.9	-3.4	227.42	124.51	-45.3
L-16	75.2	73.2	-2.7	217.39	95.12	-56.2
L-20	76.4	72.7	-4.8	303.57	123.38	-59.4
L-21	76.7	72.5	-5.5	259.25	106.46	-58.9
L-22	77.9	73.2	-6.0	232.32	104.51	-55.0
LCD_{05}	0.7	0.5		7.68	8.19	

Explanation: NK – normal condition (optimal water regime), DC – drought condition (water deficit regime), LA – levels of adaptation, LCD – the least significant difference

Under conditions of water deficiency, the highest total water content in leaves was 74.5% in line T-11, and the lowest index were found in lines T-2 and T-7, 71.5% and 71.9%.

In general, in our studies on the total water content of plant leaves, the range of variability of this trait in the upland fiber cotton lines 75.2 – 77.9% in the optimal water regime and 71.5 – 74.5% in the water deficit, that is lack of moisture in the soil slightly increased the range of variability if this trait.Among the lines of upland fiber cotton studied in our study, the most strong are T-7 and T-2 (LA = -8.3% and LA = -7.4%, respectively), T-16, T-1 and T-15 lines showed a relatively weak sensitivity (respectively LA = 2.7% ; LA = -3.3% and LA =3.4%).

The study of rate of transpiration in the leaves of upland fiber cotton lines shoved that the transpiration rate in the leaves of the plants of the L-7 and L-20 lines under conditions of optimal water supply is higher that than in other lines (306.69 mg and 303.57 mg, respectively), and the lowest transpiration rate was in the L-16 line was 217.39 mg (Table 1).

The highest rates of transpiration rate in plant leaves under water deficit conditions were in L-1, L-7 and L-11 lines, respectively 149.79 mg, 137.38 and 132.16 mg, while the lowest lines were in L-3 and L-1 lines, respectively 74.47 and 84.98 mg.

In general, the range of variation in leaf transpiration rate was 217.39-306.69 mg under optimal water supply conditions and 74.47-149.79 mg under water deficit conditions in upland fiber cotton lines studied in our experiment, that is, water stress conditions led to a decrease in the extent of variability of this trait. The strongest sensitivity to water deficit according to the sing of transpiration rate in leaves belonged to the L-3 and L-2 lines, respectively LA=-690% and 63.4%. the weakest sensitivity was recorded in the (LA=-35.9%).

Among the new lines of upland fiber cotton under optimal conditions, relatively high water retention properties of plant leaves were recorded in L-22 and L-2 lines, the average index of this trait was 30.1% and 30.5%, respectively, and the lowest water retention property of leaves was in the L-20 and L-7 lines, which were 42.1% and 40.6%, respectively (Table 2).

L-3, L-22 and L-2 lines belong to the high water retention property of plant leaves in the conditions of lack of water in the soil, and the index of this trait was 19.1%, 19.5% and 19.7%, respectively. Compared to other genotypes, low water retention property of leaves was noted in L-1 line (27.7%).

In general, the water retention property of the leaves was 30.1-42.1% in the condition of optimal water supply and 19.1-27.7% in the condition of water deficit in the upland fiber cotton lines studied in our experiment, that is, water stress caused a reduction in the range of variation of this trait. The analysis of the levies of adaptation (LA) indicator shows the strong sensitivity of L-7, L-20 and L-3 lines to water deficit (LA=-44.1%, LA=-43.5% and 40.9%), and the L-1 line showed weak sensitivity (LA=-13.2%).

Table 2. Water retention properties (%, after 4 hours) and specific surface density of the leaf (mg/10 cm^2) of the leaves of upland fiber cotton plants under different water supply conditions.

Lines	Water retention property,%			specific surface density of the leaf, mg/10sm^2		
	NK	DC	LA,%	NK	DC	LA,%
L-1	31.9	27.7	-13.2	74.57	65.05	-12.8
L-2	30.5	19.7	-35.4	77.96	72.61	-6.9
L-3	32.3	19.1	-40.9	78.55	72.53	-7.7
L-7	40.6	22.7	-44.1	78.64	78.39	-0.3
L-11	32.9	23.1	-29.8	76.18	74.99	-1.6
L-15	33.2	21.4	-35,5	80.42	81.11	+0.9
L-16	31.8	23.7	-25.5	77.28	65.99	-14.6
L-20	42.1	23.8	-43.5	94.14	83.48	-11.3
L-21	35.3	21.8	-38.2	75.84	79.07	+4.3
L-22	30.1	19.5	-35.2	79.66	85.27	+7.0
LCD_{05}	1.1	1.3		4.17	5.03	

In the conditions of optimal water supply, the highest relative surfa ce density of plant leaves was in the L-20 line (94.14 mg), and the lowest indexes were in the L-1 and L-21 lines, respectively 74.57 mg and 75.54 mg.

Under water deficit conditions, the highest indexes of specific surface density of leaves were in L-22 and L-20 lines, 85.27 mg and 83.48 mg, respectively, and the lowest values were in L-1 and L-16 lines, respectively 65.05 mg and 65.99 mg. in general, the range of variation in terms of specific surface density of leaves in upland fiber cotton lines studied in our experiment was 74.57-94.14 mg under optimal water conditions, and 65.05-85.27 mg under water deficit conditions, and no significant difference was noted. The analysis of the levels of the adaptation (LA) showed that water deficit has a strong effect on the L-16 line (LA=-14.6%) in terms of the relative surface density of leaves. On the contrary, it showed a weak effect on L-1, L-15 and L-11 lines (LA=-0.3%; LA=+0.9% and LA=-1.6%).

In our research, the amount of chlorophyll “a”, chlorophyll “b”, carotenoids and proline amino acid in the leaves during the flowering period of upland fiber cotton plants under different water regime conditions was studied.

Under conditions of optimal water supply, the highest index of chlorophyll “a” content was found in the L-7 line (3.01±0.03 mg/g), and the lowest index was found in the L-2 line (2.48±0.01 mg/g) (Table 3).

Table 3. The amount of chlorophyll “a”, “b” and carotenoids in the leaves of upland fiber cotton lines under conditions of different water supply, mg/g.

Lines	amount of chlorophyll "a", mg/g			amount of chlorophyll "b", mg/g			amount of carotenoids, mg/g		
	NK	DC	LA,%	NK	DC	LA,%	NK	DC	LA,%
L-1	2.56 ±0.05	2.31 ±0.04	-9.8	0.98±0.01	0.91±0.03	-7.14	1.85±0.06	1.70±0.01	-8.11

L-2	2.48 ±0.01	2.26 ±0.01	-8.9	1.00±0.02	0.96±0.05	-4.00	1.78±0.01	1.66±0.03	-6.74
L-7	3.01 ±0.03	2.77 ±0.02	-8.0	1.10±0.01	1.05±0.01	-4.54	1.83±0.01	1.78±0.02	-2.73

In the conditions of water deficit, the content of chlorophyll "a" in the leaves decreased in different degrees in the lines of upland fiber cotton studied in our study. Against the condition of this stress, the highest index of the amount of chlorophyll "a" in plant leaves was determined in the L-7 line (2.77±0.02 mg), and the lowest index in the L-2 line (2.26±0.01 mg/g). According to the indicators of the levels of adaptation (LA) for this character, it was found that the amount of chlorophyll "a" decreased by 8.0%-9.8% in the water shortage in comparison to the optimal water regime in the upland fiber cotton lines.

The amount of chlorophyll "b" in leaves was determined during the gross flowering period of upland fiber cotton plants under different water regime conditions. In this case, under conditions. In this case, under conditions of optimal water supply, the highest indicat or of the amount of chlorophyll "b" in the leaves was in the L-7 line (1.10±0.01 mg/g), and the lowest indicator was in the L-1 line (0.98±0.01 mg/g) (Table 3).

It was found that the amount of chlorophyll "b" in the leav es of the plants of the medium-fiber cotton lines studied in our experiment was reduced to a different extent in conditions of water deficit compared to the control, i.e., the conditions of optimal water supply. Against the condition of this abiotic stress, the highest indicator of the sign was recorded in the L-7 line (1.05±0.01 mg/g), and the lowest indicator was recorded L-1 line (0.91±0.03 mg/g). the levels of adaptation (LA) showed that the content of chlorophyll "b" in the leaves of upland fiber cotton lines decreased from 4.00% to 7.14% under water deficit compared to optimal water supply conditions.

In our experiments, we also studied the sign of carotenoid content in the leaves of plants of upland fiber lines in different water regimes. Under conditions of optimal water supply, the highest index of carotenoid content in leaves was recorded in the L-7 line (1.83±0.01 mg/g), and the lowest index was recorded in the L-2 line (1.78±0.01 mg/g).

The amount of carotenoids in leaves decreased to different extents in upland fiber cotton lines in our experiment under water deficit compared to optimal water regime. In these adverse environmental conditions, the highest level of carotenoid content in was found in L-7 line (1.78±0.02 mg/g), and the lowest level in L-2 line (1.66±0.03 mg/g).

According to the analysis of the levels of adaptation (LA), it was noted that the amount of carotenoids in the leaves of upland fiber cotton lines decreased from 2.73% to 8.11 in water deficit compared to the conditions of optimal water supply.

The content of the amino acid proline in plant leaves increased to different extents under water deficit compared to optimal water supply conditions during the flowering period of upland fiber cotton lines. Under conditions of optimal water supply, the amount of proline is the highest in the L-7 line (63.0±0.81 mg/g), and relatively low in the L-1 and L-2 lines (respectively 49.0±0.75 mg/g and 44.2±1.00 mg/g).

It was found that proline content was the highest in the L-7 (85.1±1.01 mg/g), and relatively low in the L-1 and L-2 lines (57.3±0.61 mg/g and 50.7±0.66 mg/g, respectively). In terms of the amount of proline amino acid, the highest variability in the conditions of water deficit compared to the optimal supply with water was found in the L-7 line (LA=+35.07%), and relatively low variability was found in the L-1 and L-2 lines (respectively, LA=+16.90% and LA=+14.02%).

The analysis of our results in terms of plant productivity, which is the most important of the major agronomic traits of cotton, that is the weight of raw cotton per plant, shoved that the highest productivity among the lines of upland fiber cotton studied in our research was in the L-7 line (101.06 g) under conditions of optimal water supply and the low productivity was in the L-3 line and was 82.23 g (Table 4).

In the conditions of water deficit, relatively high indicators of plant productivity were recorded in L-22, L-11, L-15 and L-7 lines (respectively 76.23 g, 69.75g, 66.34 g and 65.50 g), and the lowest indicator was recorded in L-3 and was 52.77 g. Our research was devoted to the drought resistance of medium-fiber cotton lines L-22 (Navbakhor-2 x C-9082), L-11 (Barxat), L-15 (Navbakhor-2) and L-7 (C-9082 x4B) with relatively high plant productivity under conditions of water deficiency indicates that they can be used as starting material for resistance selection. In general, the range of variation in plant productivity was 82.23-101.06 g in conditions of optimal water supply and 52.77-76.23 g in the conditions of water shortage in upland fiber cotton lines studied in our experiment. This suggests that water stress slightly increased the range of variation in plant productivity. It should be noted that in optimal agrotechnical conditions, including optimal water supply, it is difficult to distinguish between plants, while water scarcity allows to distinguish the genotypes of a variety or a range population. According to the level of adaptation (LA), it was found that the strong sensitivity to water deficit in terms of plant productivity is in the L-16 line (LA=-38.5%), and the weak sensitivity is in the L-22, L-15 and L-11 lines (LA=-15.5%, LA=-20.9% and LA=-22.5%).

Table 4. plant productivity (g/plant) and cotton weight (g) in one boll, in upland fiber cotton lines under conditions of different water supply.

Lines	Plant productivity, g/plant			cotton weight (g) in one boll		
	NK	DC	LA,%	NK	DC	LA,%
L-1	86.19	56.08	-34.9	4.9	4.6	-6.1
L-2	85.44	57.50	-32.7	4.8	4.5	-6.3
L-3	82.23	52.77	-35.8	4.6	4.2	-8.7
L-7	101.06	65.50	-35.2	5.1	4.3	-15.7
L-11	90.03	69.75	-22.5	5.0	4.4	-12.0
L-15	83.87	66.34	-20.9	4.8	4.6	-4.2
L-16	91.28	56.13	-38.5	4.7	4.4	-6.4
L-20	85.04	58.58	-31.1	5.0	4.5	-10.0
L-21	87.93	57.68	-34.4	5.0	4.3	-14.0

L-22	90.23	76.23	-15.5	4.5	4.4	-2.2
LCD_{05}	4.18	5.07		0.3	0.2	

Cotton weight per boll is one of the important components of plant productivity. The results of our study of this character are presented in Table 4.

According to the results of this table, in conditions of optimal water supply, the highest indicator of the weight of cotton in boll compared to other lines was in the L-7 (5.1 g), and the low indicators were in the L-22, L-3 and L-16 lines (respectively 4.5 g, 4.6 g and 4.7 g). In the conditions of lack of water in the soil, the relatively high indicators of the weight of cotton in the boll are in the lines L-1, L-15, L-2 and L-20 (respectively, 4.6 g, 4.6 g, 4.5g and 4.5 g), and the lowest value was recorded in the L-3 line (4.2 g).

The analysis of the level of adaptation (LA) indicators, according to the weight of cotton in one boll, shoved a strong sensitivity to water deficit in the L-7 and L-21 lines (LA=-15.7% and LA=-14.0%), and the weakest sensitivity was found in the L-22 line (LA=-2.2%).

Table 5 shows our results for the yield of fiber, the main product of cotton. In the conditions of optimal water supply, the highest indicator of the sign was in the L-11 line (40.7±0.8%), and the lowest indicator was recorded in the L-1 (35.9%), in the L-7 line was 36.5±1.9%, and in other lines it was in the range of 37.2-39.1%.

Table 5. Fiber output (%), fiber index (g) and weight of 1000 seeds (g) in upland fiber cotton lines under conditions of different water supply.

Lines	fiber output, %			fiber index, g.			weight of 1000 seeds, g		
	NK	DC	LA,%	NK	DC	LA,%	NK	DC	LA,%
L-1	35.9±0.9	33.1±0.3	-7.8	7.2±0.3	6.4±0.1	-11.1	110.7	109.9	-0.7
L-2	37.6±1.7	35.0±1.4	-6.9	7.7±0.4	7.1±0.4	-7.8	112.3	110.1	-1.9
L-3	39.1±0.9	37.1±0.6	-5.1	8.1±0.5	6.8±0.3	-16.1	105.9	105.4	-0.5
L-7	36.5±1.9	35.6±0.3	-2.5	7.5±0.9	6.1±0.8	-18.7	111.7	102.1	-8.6
L-11	40.7±0.8	38.2±1.5	-6.1	9.0±1.2	7.3±1.0	-18.9	124.0	116.8	-5.8
L-16	38.8±0.3	37.2±0.2	-4.1	6.1±0.5	5.8±0.7	-4.9	99.1	95.2	-3.9
L-20	37.8±1.4	36.1±1.2	-4.5	6.3±0.8	5.5±0.5	-12.7	115.8	106.1	-8.4
L-21	38.0±0.4	37.0±0.8	-2.6	7.4±1.0	7.7±0.3	+4.1	118.6	112.7	-4.9
L-22	37.2±1.2	36.6±0.3	-1.6	7.1±0.3	6.2±0.2	-12.7	109.0	104.8	-3.9
LCD_{05}	0.5	0.4		0.4	0.6		2.5	2.2	

Under water deficit, fiber output was reduced to varying extents in all cotton lines studied in our study compared to the control. In this case, the highest indicator remained in the L-11 line (38.2%), and the lowest indicator was recorded in the L-1 line (33.1%), as in the optimal water regime.

According to the coefficient of elasticity (LA), the strongest sensitivity to water deficit in terms of fiber output was in the L-1 and L-2 lines (LA=7.8% and LA=6.9%), and the weakest sensitivity was in the L-22 line (LA=-1.6%).

The fiber index, i.e., the weight of fiber in 100 seeds, was the highest in the L-11 line (9.0 g) under the optimal water regime, and lowest in the L-16 and L-20 lines (6.1 g and 6.3 g, respectively) was noted.

Water deficit resulted in varying degrees of decrease in fiber index in all lines of upland fiber cotton studied in our experiment. Against the condition of this stress, the relatively high indicators of the sign were in the L-21, L-11 and L-1 lines, 7.7 g, 7.3 g and 7.1 g, respectively, and the lowest indicator were in the lines L-20 and L-16 and amounted to 5.5 g and 5.8 g, respectively.

According to the analysis of the level of adaptation (LA), the strongest sensitivity to water deficit according to the fiber index sign was in L-11 and L-7 lines (LA=18.9% and -18.7%, respectively), the weakest sensitivity was in the L-21 and L-16 lines (LA=+4.1% and LA=-4.9%, respectively).

In the medium-fiber cotton lines studied in our research, the highest indicator of the weight of 1000 seeds against the condition of the optimal water regime was recorded in the L-11 line, which was 124.0 g, and the lowest value was in the L-16 line, which was 99.1 g (Table 5).

Soil water deficiency resulted in varying degrees of 1000 seed weight reduction in many medium staple cotton lines in our experiment. At the same time, a relatively high indicator of this indicator of indicator was recorded in the L-11 line, since it was against the condition of an optimal water regime, amounted to 116.8 g. It was found that the lowest indicator was in the L-16 line (95.2 g) as in the control variant.

According to the analysis of the level of adaptation (LA), strong sensitivity to water deficiency by weight of 1000 seeds was observed on lines L-7 and L-20 (LA=-8.6% and LA=-8.4%, respectively), weak sensitivity was noted in the L-1, L-3 and L-2 lines (LA=-0.7%, LA=-0.5% and LA=-2.0%, respectively).

In the reporting year, the relationship between the studied physiological parameters was established in new lines of medium fiber cotton obtained as the object of study. According to the analysis, in the group of new lines of medium-fiber cotton studied in our study conditions of optimal water supply, the correlation of the total water content in the leaves (TWCL) with the transpiration rate (TR) is moderately positive (r=0.41), while the water-holding capacity of the leaf (WHCL) is weak negative (r=-0.13), relative surface density of leaves (RSDL), and with dry weight and leaf area of 3rd leaf was insignificant (respectively r=-0.06, r=-0.12 and r=-0.08).

There is a strong negative correlation between TR and WHCL (r=-0.95), a moderate positive correlation with RSDL and a moderate negative correlation with dry weight and leaf area of 3rd leaf (r=-0.38 and r=-0.66). our data showed that high transpiration rates are closely related to water-holding capacity of leaves.

The WHCL trait had a moderate negative correlation with RSDL and leaf area of 3rd leaf (r=-0.66 and r=-0.59, respectively) and a weak negative correlation (r=-0.26) with dry weight of 3rd leaf. The RSDL trait had a moderate negative correlation correlated with 3rd leaf area (r=-0.40), whereas with dry weight of 3rd leaf this correlation was not significant (r=-0.05). dry weight of leaf had a high positive correlation (r=0.87) with its area.

Under conditions of water deficiency, the correlation betwee n the TWCL trait and TR is weakly positive (r=0.23), moderately negative with WHCL (r=-0.28) and weakly negative with RSDL and the 3rd leaf area (r=-0.18 and r=-0.07, respectively), and the dry weight of the 3rd leaf was strong positive (r=0.85). TR trait had a strong negative correlation (r=-0.80) with WHCL, while the correlation with RSDL, dry weight and area of 3rd leaf were not significant (respectively, r=0.01, r=-0.02 and r=-0.02).

WHCL had a moderately positive (r=0.45) correlation with RSDL, a weak negative (r=-0.25) correlation with dry weight of 3rd leaf, and an insignificant correlation (r=-0.02) with area of 3rd leaf. RSDL trait showed moderate positive (r=0.36) correlation with dry weight of 3rd leaf and insignificant (r=-0.04) correlation with dry weight of 3rd leaf. Correlation between dry weight of 3rd leaf and its area was insignificant (r=0.06).

Under conditions of optimal water supply, the plant productivity trait in upland fiber cotton lines had a moderate positive correlation with TWCL and TR (from r=0.40), and a weak negative correlation with RSDL, dry weight and area of 3rd leaf (respectively, r=-0.19, r=-0.32 and r=-0.22). Under these optimal conditions, the increase in plant productivity shoved a positive correlation (r=0.35) with the decrease in water of leaves.

Plant productivity trait in fiber cotton lines under water deficit conditions shoved a weak positive correlation (r=0.25, and r=0.30, respectively) with TWCL and TR. Under these abiotic stress conditions, the correlation of plant productivity with RSDL, dry weight and area of 3rd leaf was statistically insignificant (respectively, r=-0.06 and r=-0.05). A weak but positive correlation (r=0.20) was noted between the increase in plant productivity in water deficit and the increase in water-holding capacity in leaves.

DISCUSSION

The lack of moisture in the soil causes various morpho-physiological and biochemical adaptatioans in plants, which subsequently inhibit glineth, reduce photosynthesis, reduce the permeability of leaf stomata and transpiration, reduce the amount of chlorophyll and lead to changes in proteomics (Wijewardana *et. al.*, 2017; Matniyazova *et. al.*, 2023). In our results, compared to the conditions of optimal water supply, the content of chlorophyll "a", chlorophyll :b: and carptenoids in the leaves of plants of upland fiber cotton lines decreased in different degrees, and the content of proline amino acid increased in different degrees in water deficit.

Ali Karademir *et al.* (2009) evaluated twenty cotton genotypes under water stress conditions.

Significant differences were found between genotypes in leaf chlorophyll content, boll weight, seed index, plant height and fiber output. Correlation of chlorophyll content with yield (r=0.23*) and fiber output (r=0.32**) was noted. Leaf chlorophyll content directly affected plant height, number of monopodial branches, fiber output, weight of 1000 seeds and yield. Such results indicate that chlorophyll content in leaves can be used as one of the effective factors for increasing yield under water deficit conditions.

Based on the study of 100 cotton samples, Javed *et al.* (2017) determined that there is a positive genotypic and phenotypic correlation of cotton yield with plant height, boll number and boll weight. Gulhane and Wadikar (2017) found that boll weight and number in 38 genotypes of *G. arboretum* L. an *G. hirsutum* L. had a reliable positive correlation with yield. In our results, it was found that the water holding capacity of leaves decreases with the increase of transpiration rate in the upland fiber cotton lines against the condition of different water supply. It was found that there is a positive correlation (r=0.20) between the increase in the water holding capacity of leaves and the increase in plant productivity in water deficit.

CONCLUSION

Medium-fiber cotton lines adapted to water deficit with variation in the general direction, with varying degrees of reductions in total leaf water content and transpiration rates, and varying degrees of increases in leaf water holding capacity. It was found that the transpiration rate sign is the most influential sigh of water deficit among the studied signs.

It was found that the total amount of water in the leaves i n water deficit condition was the highest (74.5% and 73.9%) in L-15 and L-11 lines, and L-16, L-1 and L-15 lines are resistant to water deficit.

It was found that the L-1 line is the most resistant to water deficit (LA=-35.9% in terms of the rate of transpiration in plant leaves, and the high indicator of the genotype against the condition of water stress does not always show its stability according to the studied character in different water regimes.

It was found that the water holding capacity of leaves in water deficit condition is the highest in L-3, L-22 and L-2 lines, while L-1, L-16 and L-11 lines showed the least sensitivity to the stress factor.

Under water deficit, the relative surface density of leaves slightly decreased compared to the control only in L-16 and L-20 lines, and no reliable difference was detected in the other lines.

Plant productivity decreased from 15.5% to 38.5% compared to control (optimal water regime) in upland fiber cotton lines under water deficit. Relatively high productivity and resistance under these stress conditions were recorded in L-22, L-11, L-15 and L-7 lines, which were 76.2g, 69.8g, 66.3 g, respectively. These lines can be used as starting material in the selection of upland fiber cotton for drought tolerance. In the L-7 line, plant productivity was 65.5 g, and the level of adaptation showed a low index (LA=-35.2) due to very high productivity (101.1 g) in the optimal water regime.

Cotton weight in one boll and fiber output decreased to varying degrees during water deficit in upland fiber cotton lines. In this case, the yield of fiber in L-11, L-16 and L-3 lines was 37.1-38.2%.

Conflict of Interest: The Authors declare that there is no conflict of interest

Authors' Contribution Statements: HM, SN and RA executed the field research, GE, NM few laboratory and analyses, whereas HM and SN conceived the idea and supervised the work.

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REFERENCES

- Ali-Karademir, C., Karademir, E., Ekinci, R., and Gencer O. 2009. Correlations and Path Coefficient Analysis Between Leaf Chlorophyll Content Yield and Yield Components in Cotton (*G. hirsutum* L.) under Drought Stress Conditions. Bot. Hort. Agrobot. Cluj. 37:241-244.
- Axmedov, J. X. and Choriyeva, X. 2018. Ingichka tolali g'o'zaning afzalliklari. Qishloq xo'jaligi jurnali. – Toshkent. 9:31.
- Baloch, M.J., Sial, P., Qurat-ul-ain, B., Arain, T., andArain, M.A. 2015. Assessment of heterotic effects in F_1 hybrids of cotton (*Gossypium hirsutum* L.). Pak. J. Agri. Agril. Egg. Vet. Sci. 31:193-202.
- Batao, L. Y., Shi, J., Gong, L., Liu, J and Shang, A.H. 2016. Genetic effects and heterosis of yield and yield component traits based on *Gossypium barbadense* chromosome segment substitution lines in two *Gossypium hirsutum* L. backgrounds. PLoS ONE. 11:1-14.
- Fang, L., Wang, Q., Hu Y. et. Al. 2017. Genomic analyses in cotton identify signatures of selection and loci associated with fiber quality and yield traits. Nat.Genet. 49:1089-98.
- FAOSTAT. 2021. Food and agriculture organization of the United Nations. FAO Statistics Division. Rome, Italy.
- B.A.Rubina. 1977. Fiziologiya xlopchatnika. pod red. Chl.-korr. VASXNIL. Moskva "Kolos". pp.70-87.
- Gulhane, A. and Wadikar, M.S. 2017. Correlation analysis of cotton derived through introgressive hybridization. Bioinfolet A Quarterly Journal of Life Sciences 14:64-66.
- Imran, M., Kamaran, S., Khan, T.M., Muneer, M.A., Rashid, M.A., Munir, M.Z. and Azhar, F. 2016. Genetic analysis of fiber quality parameter under water stress in upland cotton

(*Gossypium hirsutum* L.). J. Agri. And Envi. Sci. 5:134-139.

- Jarwar, A.H., Wang, X., Iqbal, M., Sarfraz, Z., Wang, L., Qifeng, M.A., Shuli, F. 2019. Genetic divergence on the basis of principal component, correlation and cluster analysis of yield and quality traits in cotton cultivars. Pakistan Journal of Botany 51:1143-1148.
- Javed, M., Hussain, S., and Baber, M. 2017. Assessment of genetic diversity of cotton genotypes for various economic traits against cotton leaf curl disease (CLCuD). Genetics and Molecular Research 16:1-12.
- Jayalalitha, K., Rani, A.Y., Kumari, S.R. and Rani, P. 2015. Effect of water stress on morphological physiological parameters and seed cotton yield of Bt-cotton (*Gossypium hirsutum* L.) hybrids. Int. J. Food. Agri. Vet Sci. 5:99-112.
- Latif, A., Bilal, M., Hussain, S.B., and Ahmad, F. 2015. Estimation of genetic divergence association direct and indirect effects of yield with other attributes in cotton (*Gossypium hirsutum* L.) using biplot correlation and path coefficient analysis. Tropical Plant Res. 2:120-126.
- Lichtenthaler, H. K, Wellburn, A. R. 1983. Determinations of total carotenoids and chlorophylls a and b of leaf extracts in different solvents. J. Bioc hem. Soc. Trans. 11:591-592.
- Maleki, A., Naderi, R., Naseri, A., Fathi, A., Bahamin, S and Maleki, R. 2013. Physiological Performance of Soybean Cultivars under Drought Stress. Bull. Env. Pharmacol. Life Sci. 2:38-44.
- Matniyazova, H., Nabiev, S., Azimov, A., Shavkiev, J. 2022. Genetic variability and anheritance of physiological and yield traits in upland cotton unde r diverse water regimes. SABRAO J. Breed. Genet. 54:976-992.
- Matniyazova, H., Nabiev, S., Kholikova, M., Mavlonova, G., 2023. Physiological and biochemical parameters of soybean genotypes under diverse water regimes. SABRAO J. Breed Genet. 55:1094-1108.
- Muminov K., Amanov B., Buranov A., Tursunova., Umirova L. 2023. Analysis of yield and fiber quality traits in intraspecific hybrids of cotton. J. SABRAO Breed Genet. 55:453-462.
- Mustafavi, S.H., Hatami-Maleki, F.S. and Nasiri, Y. H. 2016. Effect of water stress on some quantitative and qualitative traits of valerian (*Valeriana Officinalis* L.). J. Plants Bulletin UASVM Horticulture 73:1-8.
- Nabiev S, Azimov A, Shavqiev J, Matniyazova H, Yuldashov U. 2022. Indicators of physiological characteristics of the lines in soybean under optimal and deficit irrigation conditions. Journal Universum 1:92-97.
- Nayek, S., Choudhury, I.H., Jaishee, N., Roy S. 2014. Spectrophotometric analysis of chlorophylls and carotenoids from commonly glinen ferm species by using various extracting solvents. Res. J. Chem. Sci. 4:63-69.
- Porudad, S.S., Beg, A., Safflower. 2003. Asuitable oil seed for dryland areas of Iran. In: proceeding of 7 th international conference on dev elopment of drylands. Sep. pp.14-17.
- Shavkiev, J., Azimov, A., Nabiev, S., Khamdullaev, S., Amanov, B. Kholikova, M. Matniyazova, H. and Yuldashov, U. 2021.Comparative performance and genetic attributes of upland cotton genotypes for yield-related traits under optimal and deficit irrigation conditions. SAB RAO Journal of Breeding and Genetics 53:157-171.
- Waleed, M.B. Yehia and Essam, F. El-Hashash. 2022. Estimates of genetic parameters for cotton yield, its components, and fiber quality traits based on line x tester mating design and principal component analysis. Egyptian Journal of Agricultural Research 100:302-315.
- Wijewardana, C., Henry, W.B., Reddy, K.R. 2017. Evaluation of drought tolerant maize germplazm to induced drought stress. Miss Acad Sci. 62:316-329