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ASSESSMENT OF PHYSIOLOGICAL AND YIELD-RELATED RESPONSES OF UPLAND COTTON (GOSSYPIUM HIRSUTUM L.) UNDER DROUGHT STRESS CONDITIONS

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Abstract

This research examined the physiological and yield responses of 18 advanced upland cotton (*Gossypium hirsutum* L.) lines together with the cultivar Namangan-77 under contrasting water regimes. Significant genotypic variation was detected for total water content, transpiration rate, and yield components in both optimal and drought-stressed environments. Lines L-1, L-24, and L-29 showed reduced susceptibility to water deficit based on physiological and agronomic performance, indicating their potential use in breeding for drought tolerance. Lines L-2, L-11, and L-24 produced heavier seeds under well-watered conditions, though drought markedly decreased seed weight and fiber yield in most genotypes. Overall, the study provides practical implications for developing cotton varieties with improved drought adaptation and stable yield potential.

Keywords: Upland cotton (*Gossypium hirsutum* L.), water regimes, drought conditions, physiological traits, chlorophyll, carotenoids, morpho-agronomic traits.

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INTRODUCTION

Upland cotton (*Gossypium hirsutum* L.) is the most important fiber crop that providing raw material to the textile industry worldwide. However, its production has been unstable over the years due to climate change induced biotic stresses such as insects, diseases, and weeds, as well as abiotic stresses including drought, salinity, heat, and cold (Ahmed *et al*., 2024). Drought stress is an inevitable factor that disturbs the crops production by altering various morphological, physiological, biochemical, and molecular functions. Breeding for drought tolerance earnestly needs complete knowledge of the molecular factors controlling stress-responsive pathways. Generally, the crop plants respond to drought stress by adopting four different mechanisms: avoidance, escape, tolerance, and recovery. Traditional plant-breeding tools have been employed to enhance the cotton plants tolerance, however, the complexity of drought tolerance has limited the use of these conventional breeding methods (Rasheed *et al*., 2023). Climate change and global warming adversely affect the crops production and food security (Jia *et al*., 2022; Farooq *et al*., 2022). Abiotic stress factors are the considerable hazards to the crop production, leading to 73% reduction in cotton production worldwide (Mahmood *et al.,* 2019, 2020). Abiotic stresses such as cold, drought, salt, waterlogging, heavy metals, and other environmental factors have also threatened plant growth and development. However, the drought and salt stresses are causing more than 45% yield losses globally. With the continuous increase in global greenhouse gas emissions, the arid and semi-arid areas will spread by more than 50% by the end of this century (Liao and Hou, 2020).

Cotton is an economically important crop cultivated under various climates around the globe (Noreen *et al*., 2020). Water is a major component of plants and is necessary for plant nutrient transport, chemical and enzymatic reactions, cell expansion and transpiration (Meshram *et al*., 2022). According to past studies, there was a positive association among the seed cotton yield, fiber yield, number of bolls, boll weight, fiber yield and seed weight (Waleed *et al*., 2022).

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MATERIALS AND METHODS

Experimental site and genetic material

The recent research was conducted during 2023-2025 at the Institute of Genetics and Experimental Biology, Academy of Sciences, Tashkent, Uzbekistan (with an altitude of 398 masl). The climate exhibited sharp fluctuations, with high temperature 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 and non-cold days for 200-210 days. The rainfall was observed in the fall, winter, and spring, with the air dry in the summer. The experimental field soil was low in humus, typically gray, and moderately sandy according to the granulometric composition. The terrain is slightly sloping, not saline, and naturally damaged by whitish (verticillus) silt. The measured soil bulk density was 1.32–1.33 g/cm^3, with a limited field moisture capacity (LFMC) of 22%. Groundwaters go deep (8 m and more) (Matniyazova *et al.,* 2022).

The study comprising evaluation and response of the 18 cotton (*G. hirsutum* L.) advanced lines and cultivar Namangan-77 in terms of physiological and yield-related traits under water 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 irrigation at 2800-3000 m^3/ha. Under water stressed environment, the cotton genotypes were irrigated once during the seedling and once at the flowering stage, to artificially develop the water scarcity (modeled drought).

The comparative study of the upland cotton advanced lines and cultivar Namangan-77 in terms of physiological and yield-related traits was conducted under optimum and water stress conditions. The genetic variability in cotton genotypes and inheritance in various traits, depending upon two water regimes, were determined. All the parameters' data recording was succeeded on 30 plants in each cotton genotype and then averaged. In cotton genotypes, identification of essential physiological indicators of water metabolism was carried out with the

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following methods: For total water content in the leaves, the formula according to Tretyakov *et al*. (1990) was used, and the transpiration rate was measured according to Ivanov *et al*. (1950). The yield-related traits i.e., boll weight, 1000-seed weight, and seed cotton yield per plant, were also recorded per the standard procedure in all the cotton genotypes. The determined levels of cotton lines adaptation to water deficit conditions employed the method according to Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Water content in plant leaves

In cotton genotype plant leaves, the total water content is one of the most important physiological indicators of plant water exchange. According to the results, 18 cotton advanced lines and cultivar Namangan-77 showed considerable differences in the total water content across various water regimes (Table 1). The Variant 1 (control group, with optimal water supply) showed that the total water content in the leaves ranged from 75.4% (line L-20) to 79.1% (line L-3). The cotton seeds obtained with optimal water supply conditions and planted in Variant 2 under water deficit conditions, the total water content in leaves decreased for all the cotton lines. Under water deficit conditions, the water content ranged from 67.8% (L-28) to 71.8% (L-26), and the lines L-20 and L-17 showed considerable genotypic response to water deficit condition, exhibiting reduction of 10.9% and 9.2%, respectively. Conversely, the cotton lines L-20, L-2, L-21, L-23, and L-22 showed relatively weak sensitivity to water deficit conditions, and the water reduction was ranging from 3.9% to 5.7%.

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Table 1. Total water content and transpiration rate in leaves of advanced cotton lines.

Line number	Total water content in leaves (%)			Transpiration rate (mg H_2O/1 g.wet leaf x 1 hour)		
	Variant 1	Variant 2	Variant 3	Variant 1	Variant 2	Variant 3
L-20	75.4	71.5	70.6	248.86	211.2	174.36
L-16	78.7	70.8	71.4	162.55	149.00	154.65
L-1	78.5	70.5	70.3	279.67	173.73	190.33
L-2	76.3	71.7	70.7	220.47	183.28	85.5
L-21	75.9	71.2	69.4	255.25	203.25	120.95
L-15	76.8	68.9	69.1	217.1	177.33	165.92
L-3	79.1	70.8	69.6	241.59	147.19	175.09
L-11	78.6	70.5	69.7	234.24	157.28	139.07
L-22	76.0	70.3	70.7	282.12	239.01	258.39
L-23	76.0	71.2	73.6	341.33	317.59	299.48
L-24	78.5	71.4	75.6	344.89	233.16	301.76
L-29	77.3	71.0	69.4	277.73	273.74	191.91
L-26	78.1	71.8	69.2	300.51	217.33	164.02
L-27	78.6	70.5	68.8	312.93	187.55	125.12
L-30	77.5	68.3	70.5	279.48	227.32	160.45
L-31	75.9	69.8	70.6	284.04	221.04	231.33
L-32	76.2	69.0	68.7	296.45	238.92	136.74
L-28	78.7	67.8	70.7	286.22	276.23	137.17
Namangan-77	79.4	70.9	70.4	297.51	247.10	188.45
LSD_{05}	0.5	0.4	0.4	10.14	8.43	9.27

In Variant 3, when the cotton seeds were obtained under water deficit conditions and planted under the same stress, total water content in leaves decreased similarly as like in Variant 2. However, cotton lines L-24 and L-23 displayed relatively higher leaf water content (75.6% and 73.6%, respectively), whereas L-32 and L-27 showed the lowest leaf water content (68.7% and 68.8%, respectively). The cotton L-27, L-3, L-11, and L-26 lines showed considerable sensitivity to water deficit conditions, and leaf water reduction was 8.9% to 9.8%

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in total leaf water content. In contrast, cotton lines L-23, L-24, and L-20 exhibited weaker sensitivity, and the leaf water decrease was ranging from 2.4% to 4.8%.
Under drought conditions (Variant 2 and Variant 3), the observed reduction in leaf water content was consistent with the past studies on cotton. According to Khamdullaev *et al*. (2021), water stress significantly reduced the leaf turgor pressure and water content, leading to decreased metabolic processes and plant growth. In present findings, some of the cotton lines (L-20, L-2, and L-23) exhibited weaker sensitivity to water deficit conditions align with the study carried out by Nabiev *et al*. (2020), who found that specific cotton genotypes with efficient water retention mechanism were less affected by drought stress conditions. This indicates that these cotton genotypes could be valuable in breeding programs focused on drought tolerance.

Transpiration rate in plant leaves

The transpiration rate is another crucial physiological indicator, which was also measured under different water supply conditions. Under Variant 1 (with optimal water conditions), the cotton lines L-24, L-23, L-27, and T-26 exhibited the highest transpiration rates, ranging from 344.89 mg to 300.51 mg. However, the lowest transpiration rate was observed in the line L-16 (162.55 mg). When the cotton seeds were planted under water deficit conditions in Variant 2, the highest transpiration rates were observed in cotton lines L-23 (317.59 mg), L-28 (276.23 mg), and L-29 (273.74 mg). Lines T-3 and T-16 exhibited the lowest transpiration rates (147.19 mg and 149.00 mg). Water deficit conditions generally reduced the transpiration rate across all the cotton lines, and the genotype L-27 showed the highest sensitivity (-40.1%), while cotton line L-29 enunciated the weakest (-1.4%).
In Variant 3, where seeds were obtained under water deficit conditions and planted under the same conditions again, the transpiration rate decreased for all the cotton lines compared to Variant 1. The highest transpiration rates were observed in cotton lines L-24 (301.76 mg), L-23 (299.48 mg), and L-22 (258.39 mg), while the lowest rates were found in L-2 (85.50 mg) and L-32 (136.74 mg).

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In this variant, lines L-2, L-27, L-26, and L-32 exhibited the considerable sensitivity to water deficit conditions, with the reduction in transpiration rates was ranging from -53.9% to -61.2%. The cotton lines L-16 and L-22 were observed with weaker sensitivity (-4.9% and -8.4%, respectively).

In the present study under water deficit conditions, the decrease in transpiration rate was a well-documented physiological response of the cotton plants to drought stress. During limited water supply, plants mostly close their stomata to conserve water, result in reduced transpiration rate. reported that cotton plants under water deficit conditions had lower transpiration rates, and considered as a protective mechanism to minimize the water loss. The present results further revealed that cotton lines L-27 and L-29 were found as the most sensitive genotypes to the water deficit conditions, showing a drastic reduction in transpiration rate. Lambers and Oliveira (2019) findings revealed that some cotton varieties had a higher degree of sensitivity to drought conditions, which negatively affected the plants physiological processes.

Seed cotton yield

The analysis of seed cotton yield showed that water supply during seed formation had a significant effect on the genotypes seed cotton yield. Under Variant 1, the highest seed cotton yield was recorded in cotton lines L-2, L-20, L-1, and L-3, ranging from 77.50 g to 78.26 g per plant (Table 2.). However, the lowest seed cotton yield per plant was observed in the line L-11 and cultivar Namangan-77 (62.50 g and 62.51 g, respectively). In Variant 2, the cotton seeds obtained under optimal water conditions, and planted under water deficit conditions, revealed the highest seed cotton yield in lines L-1 (64.03 g), L-16 (63.08 g), and L-15 (60.39 g). However, the lowest seed cotton yield was recorded in the cultivar Namangan-77 (39.68 g), and lines L-26 (39.73 g), L-30 (41.30 g), and L-32 (42.15 g), respectively. Considerable sensitivity to water deficit conditions was observed in the cotton lines L-32, L-30, L-26, and L-24, where the plant productivity decreased by 36.5% to 38.5% as compared to

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Table 2. Effect of stress conditions on plant productivity and 1000-seed weight in advanced cotton lines.

Line number	Plant productivity (g)			1000-seed weight (g)		
	Variant 1	Variant 2	Variant 3	Variant 1	Variant 2	Variant 3
L-20	78.17	55.80	55.40	113.3	93.0	90.5
L-16	73.78	63.08	54.73	98.4	86.5	85.8
L-1	77.86	64.03	56.88	111.9	104.8	99.8
L-2	78.26	50.54	49.80	124.1	103.4	102.3
L-21	74.70	58.72	48.30	104.9	98.4	95.4
L-15	76.41	60.39	42.94	106.6	97.9	101.2
L-3	77.50	59.96	53.70	110.4	89.8	90.7
L-11	62.51	46.14	46.25	119.3	101.6	90.2
L-22	72.09	53.54	49.34	104.2	95.5	92.7
L-23	66.33	45.93	41.55	103.6	95.5	97.9
L-24	68.80	43.70	39.83	121.0	102.0	107.0
L-29	65.97	52.08	50.47	109.3	101.2	98.9
L-26	63.51	39.73	53.86	106.2	95.0	95.9
L-27	65.38	44.00	54.33	110.2	92.4	98.7
L-30	66.28	41.30	49.00	108.9	95.6	97.1
L-31	72.76	48.10	49.47	112.5	88.5	97.4
L-32	68.49	42.15	50.92	109.2	89.5	92.3
L-28	70.42	46.11	55.33	106.0	89.2	98.3
Namangan-77	62.50	39.68	48.08	106.6	92.7	91.5
LSD_{05}	4.61	5.13	4.92	3.1	2.9	2.7

Variant 1. However, the weak sensitivity was noted in cotton lines L-16, T-1, T-15, T-29, and T-21, in which the productivity decrease was ranging from 14.5% to 21.4%.

In Variant 3, where the cotton seeds were obtained under water stress conditions and planted under the same stress, the highest seed cotton yield was observed in lines L-1 (56.88 g), L-20 (55.40 g), and L-28 (55.33 g). However, the lowest seed cotton yield was obtained in lines T-24 (39.83 g), L-23 (41.55 g), and L-15 (42.94 g). The remarkable decrease in productivity was observed in lines L-15 (-28.9%) and L-21 (-17.7%) as compared to Variant 2. However, some lines, such as L-26,

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L-27, L-32, and cultivar Namangan-77, showed higher productivity in Variant 3 compared to Variant 2. Seed cotton yield based on the yield related traits, is one of the most sensitive traits to water deficit conditions. The cotton lines L-1 and L-2 exhibited the highest seed cotton yield under optimal conditions, and the present results were in a greater analogy with the past research as highlighted that seed cotton yield was significantly influenced by water availability during seed formation in upland cotton genotypes (Shavkiev *et al*., 2022). The reduction in seed cotton yield under water deficit variants, particularly in cotton lines L-32, L-30, and L-26, supports the conclusions of earlier studies that indicated that severe drought stress conditions during seed formation stage leads to significant yield loss.

100-seed weight

The 100-seed weight is a crucial trait in cotton breeding as it correlates with seed yield and quality. The results revealed that under optimal water conditions (variant 1), the cotton lines L-2, L-24, and L-11 exhibited the heaviest seeds, with 100-seed weight of 12.41 g, 12.10 g, and 11.93 g, respectively. However, under water deficit conditions (variant 2 and variant 3), the 100-seed weight was significantly decreased, and the line L-31 showed the significant decrease (21.3%). Interestingly, some cotton lines, like L-21 and L-1, were less affected by the water deficit conditions, showing a minimal decrease in 100-seed weight (6.2% and 6.3%, respectively). The results suggested that certain cotton genotypes may have a considerable tolerance to water deficit conditions that help maintain seed quality. Moreover, the reduction in 100-seed weight under drought conditions (Variant 2 and Variant 3) was consistent with the past findings which enunciated that water deficit conditions leads to a reduction in seed size due to reduced cell division and expansion (Jaleel *et al.,* 2009).

Fiber yield

Fiber yield is a key economic trait in cotton cultivation, and in cotton genotypes the said trait was also affected by water deficit conditions. In the optimal water

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regime, the fiber yield ranged from 37.2% (T-28) to 41.0% (in other cotton lines), and the cultivar Namangan-77 was being close to the leading genotype L-2 with fiber yield of 39.4% (Table3). Under water deficit conditions (variant 2), the fiber yield enhanced in nine cotton lines, decreased in seven lines, and remained unchanged in two genotypes. In variant 3, the fiber yield decreased in 12 lines compared to variant 2, indicating the cumulative stress of water shortage over two years. However, in cotton lines like L-24, L-26, and cultivar Namangan-77, the fiber yield was relatively stable, suggesting potential resilience in these genotypes. The results underline the variability across different cotton lines for fiber yield in response to drought stress conditions, and some cotton lines showed more stability under drought conditions.

Table 3. Effect of stress conditions on fiber length and fiber output in advanced cotton lines.

Line number	Fiber length (mm)			Fiber output (%)		
	Variant 1	Variant 2	Variant 3	Variant 1	Variant 2	Variant 3
L-20	33.1	30.8	30.8	40.5	40.4	40.1
L-16	33.0	29.3	30.9	37.4	37.7	40.8
L-1	32.9	30.6	29.9	38.0	39.5	38.5
L-2	33.2	29.6	30.2	39.4	37.9	39.5
L-21	32.9	29.2	29.3	38.1	39.8	38.9
L-15	33.1	30.3	29.8	39.2	39.2	35.9
L-3	32.8	29.7	30.3	38.3	43.2	40.2
L-11	33.1	30.2	31.0	38.9	37.0	38.1
L-22	32.9	30.2	30.2	41.0	38.3	37.6
L-23	32.9	30.4	31.1	38.7	37.9	38.3
L-24	33.3	29.9	30.7	37.8	39.1	38.9
L-29	32.5	30.5	31.0	40.4	38.6	37.5
L-26	32.9	30.7	30.7	38.2	40.9	38.3
L-27	32.8	29.6	30.0	40.8	40.2	38.3
L-30	32.7	30.7	30.7	38.5	36.1	36.3
L-31	32.9	30.5	30.1	38.5	40.4	38.8
L-32	33.1	30.1	30.2	38.3	40.3	39.2
L-28	32.8	29.5	30.1	37.2	38.4	37.1
Namangan-77	32.7	29.4	30.3	39.4	41.6	39.6
LSD_{05}	0.5	0.4	0.4	1.1	1.2	1.0

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Fiber length

Fiber length is a vital quality parameter in cotton production. Under optimal conditions (variant 1), fiber length ranged from 32.7 to 33.3 mm. Under water deficit conditions (variant 2), fiber length decreased by 2.0-3.7 mm, and the greater reduction observed in lines L-16, L-21, and L-2. In Variant 3, the fiber length further decreased in lines L-21 and L-15, and the reduction was 3.6 mm and 3.3 mm, respectively. Interestingly, the cotton lines L-16 and L-22 showed an increase in fiber length in Variant 3. The results suggested that prior exposure to water stress may trigger adaptive responses that improve the fiber quality in the subsequent year of study.

The effects of water deficit conditions on fiber yield and fiber length observed in the present study were consistent with the past studies on cotton under drought stress conditions. Water stress generally reduces the fiber yield and fiber quality in upland cotton genotypes. However, in the present study, some genotypes like L-24, L-26, and Namangan-77 exhibited stable fiber yields under drought stress, suggesting that these lines have some level of drought resilience, and the same was also reported by Khamdullaev *et al*. (2021) in upland cotton. The increase in fiber length of some cotton lines L-16 and L-22 in Variant 3, despite previous drought exposure, was an interesting finding and has been observed also in previous studies. Results suggested that previous exposure to water stress conditions could trigger adaptive mechanism that improve the fiber quality in subsequent growth cycles (Matniyazova *et al* 2024).

CONCLUSIONS

The present study identified the specific cotton genotypes for improving seed cotton yield under drought stress conditions. The cotton lines L-2, L-24, and L-11 produced the heaviest seeds under optimal water conditions, however, the seed weight decreased across all the cotton lines under drought stress conditions. Fiber yield responses to water deficit conditions were variable, and some cotton lines showed increased seed cotton yield under stress conditions. The findings suggest that cotton lines L-1, L-16, and L-24 were effective candidates for selection in breeding drought-tolerant cotton varieties. Overall, this research provides valuable insights for future selection and breeding programs aimed at enhancing cotton productivity with better fiber quality under water stress conditions.

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REFERENCES
1. Ahmed AI, Khan AI, Negm MAM, Iqbal R, Azhar MT, Khan SH, Rana IA (2024). Enhancing cotton resilience to challenging climates through genetic modifcations. *J. Cotton Res.* 7: 10 https://doi.org/10.1186/s42397-024-00171-4
2. Eberhart SA, Russell WA (1966). Stability parameters for comparing parameters. *Crop Sci.* 6: 36-40
3. Farooq MS, Uzaiir M, Raza A, Habib M, Xu Y, Yousuf M, Yang SH, Ramzan KM (2022). Uncovering the research gaps to alleviate the negative impacts of climate change on food security: A review. Front. Plant Sci. *13:* 927535.
4. Jaleel CA, Manivannan P, Wahid A, Farooq M, Al-Juburi HJ, Somasundaram R, & Panneerselvam R (2009). Drought stress in plants: A review on morphological characteristics and pigments composition. *Int. J. Agric. Biol.*11(1):100–105.
5. Jia Q, Li M, Dou X (2022). Climate change affects crop production potential in semi-arid regions: A case study in Dingxi, Northwest China, in Recent 30 Years. Sustainability *14:* 3578.

Modern American Journal of Biological and Environmental Sciences
ISSN (E): 3067-7920
Volume 01, Issue 07, October, 2025
Website: usajournals.org

6. Khamdullaev S, Nabiev S, Azimov S, Shavkiev S, Yuldashov U (2021). Combining ability of yield and yield components in upland cotton (*G. hirsutum* L.) genotypes under normal and water-deficit conditions. *Plant Cell Biotechnol. Mol. Biol.* 22(35&36): 176-186.
7. Lambers H, Oliveira RS (2019). Plant Water Relations, Plant Physiological Ecology. Springer International Publishing, *Cham.* pp. 187-263.
8. Liao H, Hou Z (2020). Effects of saline alkali stress on growth and ion group content distribution of different cotton varieties. *Xinjiang Agric. Sci.* 57: 219–232.
9. Mahmood T, Khalid S, Abdullah M, Ahmed Z, Shah MKN, Ghafoor ADX (2019). Insights into drought stress signaling in plants and the molecular genetic basis of cotton drought tolerance. Cells: *9:* 105.
10. Mahmood T, Khalid S, Abdullah M, Ahmed Z, Shah MKN, Ghafoor A, Du X. (2020). Insights into drought stress signaling in plants and the molecular genetic basis of cotton drought tolerance. *Cells* 9(1): 105. https://doi.org/10.3390/cells9010105
11. Matniyazova H, Nabiev S, Azimov A, Shavkiev J (2022). Genetic variability and inheritance of physiological and yield traits in upland cotton under diverse water regimes. *SABRAO J. Breed. Genet.* 54(5): 976-992
12. Matniyazova H, Nabiyev S, Ergasheva G, Mamadaliyeva N, Egamberdiyev R (2024). Analysis of physiological and morpho-agronomic traits of upland cotton under different conditions of water supply. *The Bioscan. Int. Q. J. Life Sci.*19(2): S2: 265-271. https://doi.org/10.63001/tbs.2024.v19.i02.S2. Pp265-271
13. Meshram JH, Singh SB, Raghavendra KP, Waghmare VN (2022). Drought stress tolerance in cotton: Progress and perspectives. In: *Clim. Change Crop Stress, Acad. Press.* pp. 135–169
14. Nabiev CM, Usmanov RM, Khamdullaev Sh A, Shavkiev J Sh. Study of physiological indicators of the water balance of plants and morphological signs of leaf of fine-fiber varieties in different irrigation regimes. *J. Biol. Uzbekistan.2020*; 1:51-58

Modern American Journal of Biological and Environmental Sciences
ISSN (E): 3067-7920
Volume 01, Issue 07, October, 2025
Website: usajournals.org

15. Noreen S, Ahmad S, Fatima Z, Zakir L, Iqbal P, Nahar K, Hasanuzzaman M (2020). Abiotic stresses mediated changes in morpho-physiology of cotton plant. In: Ahmad S, Hasanuzzaman M (eds.): Cotton Production and Uses. Singapore, Springer: pp. 341–366
16. Rasheed A, Zhao L, Raza A, Mahmood A, Xing H, Lv X, Saeed H, Alqahtani FM, Hashem M, Hassan MU (2023). Role of molecular breeding tools in enhancing the breeding of drought-resilient cotton genotypes: An updated review. *Water* 15: 1377. https://doi.org/10.3390/15071377
17. Shavkiev J, Nabiev S, Azimov A, Chorshanbiev N, Nurmetov KH (2022). Pima cotton (*Gossypium barbadense* L.) lines assessment for drought tolerance in Uzbekistan. *SABRAO J. Breed. Genet*. 54(3): 524-536. http://doi.org/10.54910/sabrao2022.54.3.6
18. Waleed MB, Yehia EF, El-Hashash (2022).Estimates of genetic parameters for cotton yield, itscomponents, and fiber quality traits based on line xtester mating design and principal component analysis. *Egypt. J. Agric. Res.* 100: 302-315.