Universal Journal of Agricultural Research 9(1): 6-12, 2021 http://www.hrpub.org
DOI: 10.13189/ujar.2021.090102

Analysis of an Experiment Carried Out on the Lines and Varieties of Fine Fiber Cotton

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Received July 6, 2020; Revised September 2, 2020; Accepted January 20, 2021

Cite This Paper in the following Citation Styles

(a): *[1] Nurali Chorshanbiev Esanpulatovich, Surayyo Burieva Zayliyevna, Erkinjon Khazratkulov Shodmonovich , "Analysis of an Experiment Carried Out on the Lines and Varieties of Fine Fiber Cotton," Universal Journal of Agricultural Research, Vol. 9, No. 1, pp. 6 - 12, 2021. DOI: 10.13189/ujar.2021.090102.*

(b): *Nurali Chorshanbiev Esanpulatovich, Surayyo Burieva Zayliyevna, Erkinjon Khazratkulov Shodmonovich (2021). Analysis of an Experiment Carried Out on the Lines and Varieties of Fine Fiber Cotton. Universal Journal of Agricultural Research, 9(1), 6 - 12. DOI: 10.13189/ujar.2021.090102.*

Abstract This paper highlights the results of conducted research on the issues of physiological and morphological features of new lines of fine-fiber cotton such as Gossypium barbadense L. L-2006, L-167, L-5440, L-5445, L-1, L-10, L-663, L-450, and varieties like Marvarid, Surkhan-14 and Termez-31 in different conditions of water regime. In fact, in comparing optimal water supply and modeling drought with studying the lines and varieties of fine fiber cotton depending on individual genotype reaction in different levels indicated decreasing water content and intensity of transpiration in the leaves. Moreover, the water deficiency and improving the water holding capacity and density surface of the leaves are considered as physiological and morphological characteristics which contribute to the adaptation of cotton to water deficiency in drought conditions. Besides, lysimetric experiment was carried out with new lines and varieties of fine fiber cotton at the institute of Genetics and Experimental Plan Biology at the Academy of Sciences in Uzbekistan. According to the analysis, the water supply indicated the plants were determined simultaneously in both backgrounds, when the pre-irrigation soil moisture at an optimal water supply background was 70-72% of the water content (field moisture capacity), and according to the background of a simulated drought, it was 48 -50% from the water supply. As a result, water content and intensity of transpiration in the lines and varieties of fine fiber cotton were widely indicated in the below-mentioned tables and diagrams as well as broadly discussed in the conclusion of the research work.

Keywords Varieties of Fine Fiber, Psychological and Morphological Characteristics, Drought Conditions, the Water Holding Capacity, Experiment

1. Introduction

In the Decree of the President of the Republic of Uzbekistan dated February 7, 2017 PD-4947, research work on the creation and introduction of new breeding varieties of crops resistant to diseases and pests adapted to local soil, climatic and natural conditions is outlined as one of the urgent tasks [1]. For the development of cotton production in our republic, new cotton varieties being created, in addition to high yields and high fiber quality, must withstand abiotic stresses and endure drought.

A number of functional systems have been formed in the plant body that can withstand oxidative stress. In particular, various enzymes present in the cells of plant tissue reduce the level of formation of reactive oxygen species and, in turn, are involved in increasing the plant's resistance to adverse environmental conditions [2].
Additionally, low concentrations of photosynthetic pigments and reduced photosynthetic potential limit plant

productivity. The chlorophyll content in the leaf is one of the important parameters from a physiological point of view. Shakeel Ahmad Anjum, Xiao-yu Xie1, Long-chang Wang, Muhammad Farrukh Saleem, Chen Man and Wang Lei (2011) stated that under conditions of water deficiency, loss of chlorophyll level can be caused by the destruction of mask cells in plants [3]. Besides, Abdel Hafiz Adam Dahab, Bahaeldeen Babiker Mohamed, Tayyab Husnain and Muhammad Saed (2012) stated in their experiments note that lack of water can have a negative effect on plant development, which will lead to a decrease in plant productivity by 50% [2]. At present, some scientists are carrying out a lot of experiments on the issues of creating new varieties of fine fiber cotton and looking for some key components to adapt them in drought conditions. Cotton-growing, which is one of the main agricultural branches of the republic, is based mainly on artificial irrigation and requires regular irrigation with higher degree than other cops. For the cultivation of cotton on a hectare field in our country is spending more than twice the water, compared with some countries [6].

Furthermore, we carried out lysimetric experiment of the issues of physiological and morphological features of new lines of fine-fiber cotton such as Gossypium. barbadense L. -L-2006, L-167, L-5440, L-5445, L-1, L-10, L-663, L-450, and varieties like Marvarid, Surkhan-14 and Termez-31 in different conditions of water regime. We have made qualitative analysis , having collected data, and according to the analysis, the water supply indicated the plants were determined simultaneously in both backgrounds, when the pre-irrigation soil moisture at an optimal water supply background was 70-72% of the water content (field moisture capacity), and according to the background of a simulated drought, it was 48 -50% from the water supply. Moreover, comparing optimal water supply and modeling drought with studying lines and varieties of fine fiber cotton, it found out the parameters of improving the water-holding capacity and density surface of the leaves and intensity of transpiration in the leaves. As a result, the findings were indicated in the below-mentioned tables and diagrams.

2. Literature Review

Cotton is an important source of the country which provides raw materials for textile, food, chemical, and other industries. One of the main cotton productions is fiber. K.P. Dhamayanthi and K. Subashree [4] carried out investigations on the identification of valuable-economic traits in varieties of species of Gossypium barbadense L. Kausar Nawas Shah et al (2010) established those traits of fiber that are formed under heredity and environment [5].

In the world market, the countries with a high yield of cotton fiber are the USA, Egypt, Israel, Australia, and Uzbekistan, whereas countries with a low yield of cotton fiber are the states of Asia, Africa, Oceania, Europe, and South America [7]. According to statement of Abdurakhmonov [8], the main goal of the world breeding programs for cotton is to increase productivity and improve fiber quality [11]. In the world market of cotton, fine-fiber cotton, i.e. varieties of Gossypium barbadense L. are estimated to be 1.5–2 or more times more expensive than fiber of medium-fiber. With one ton of fine fiber, 1.3-2.0 times more and more expensive fabric is obtained than with one-ton medium-fiber varieties of the species Gossypium hirsutum L. [9]. Gossypium barbadense L is the youngest, plastic species and originated from South America [10]. Globally, 9% of the total cultivated area under cotton is allocated to varieties of the species Gossypium barbadense L.

In the past these species were mainly sown on the shores of the islands and plains of the United States and were famous under the name of Sea Island. Besides, cotton land covered the Nile Valley of Egypt and began to be grown in the country [11].

However, Pima's fine fiber made up only 3% of world cotton production, they are considered commercial varieties that produce high quality fiber. Pima are mainly grown in the western and northwestern regions of the United States and also in large areas of China [12]. In 2012, 94% of the total sown of Pima was in the San Joaquin Valley of California, and Arizona, New Mexico and Texas [13].

Uzbekistan is one of the countries in the world that has adopted the cultivation of fine-fiber cotton. The republic in the cultivation of fine-fiber varieties occupied the second place after Egypt [14].

With limited water resources and the noticeable impact of global climate change on agriculture require the development and implementation of water-saving agricultural technologies. One of such agricultural technologies is the creation of drought-resistant varieties of agricultural crops, including fine-fiber cotton, the cultivation of which were in the southern regions of the republic in recent years has received special attention from the government of the country. The large-scale basic and applied research has been conducted on fine-fiber cotton by scientists (R.G. Percy, [15]; A.G. Abdel-Hafez et al. [16]; Gamal I. A. Mohamed et al. [17] and others [18] who studied economically valuable traits, inheritance, and variability in fine fiber cotton. Abdullaev A. A. [19] also carried out a research on the molecular labeling of fiber features and resistance to fusarium mobility, associative mapping and linkage disequilibrium mapping in germoplasma Gossypium barbadense L. Moreover, scientists in the field of agriculture (A. I. Avtonomov, A. A. Avtonomov, Yu. P. Khutornoy, M. I. Iksanov, A.P. Tyaminov, Vad. A. Avtonomov, Vik. A. Avtonomov and O. Kh. Kimsanboev) made a contribution to creating many fine-fiber varieties such as S-6029, S-6030, S-6032, S-6037, S-6040, S-6042, Karshi-8, Karshi-9, Surkhon-2, 3, 5, 7, 9, 14, 16, 18, 100, 101, 102, 103 of cotton [20].

At present, an acute environmental problem in the country – deficiency of irrigation water and creating drought-resistant varieties of fine-fiber cotton requires a broad research to find the physiological parameters of plant water metabolism in conjunction with the morphological characteristics of the leaf in different conditions of water deficiency.

3. Research Methods

Lysimetric experiment was carried out at the Institute of Genetics and Experimental Plant Biology at the Academy of Sciences in Uzbekistan. The soil was typically unsalted. As the objectives of research were new lines of fine-fiber cotton; — L-167, L-663, L-2006, L-5440, L-5445, L-450; use in hybridization of the thin-fiber ruderal subspecies ssp. vitifolium - L-1 and L-10, as well as varieties such as Surkhon-14, Termiz-31 and Marvarid, conducted by the scientists at the institute. Additionally, lines of fine-fiber and varieties of cotton were sown shortly in the experiment of lysimeter on two backgrounds of water regime: water supply and drought lands. Lines and varieties according to each background of the water regime were sown in three randomized repetitions, 10 plants in each repetition. Schema of sowing is 60 x25 x1.

The water supply indicated the plants were determined simultaneously in both backgrounds, when the pre-irrigation soil moisture at an optimal water supply background was 70-72% of the water content (field moisture capacity), and according to the background of a simulated drought, it was 48 -50% from the water supply.

Physiological parameters were determined according to the total water content in the leaves — according to M.D. Kushnirenko [21]; the intensity of leaf transpiration according to A.A. Ivanov [22]; water holding capacity of leaves - according to N.N. Tretyakov [23]. The collected data were statistically analyzed with the method of B.A. Armor [24] and ANOVA models. Adaptability of coefficient (Cad.) was calculated by the formula S.A. Ebarhart [25].

4. Findings and Discussion

According to the analysis collected from the data indicated the water content of plant leaves ranged from 77.8% (L-2006) to 80.5% (Termez-31). In modeling drought, a research on the lines of fine-fiber and varieties of cotton, the trait indicated decreasing point - from 1.9% in the Termez-31 variety to 8.8% in the L-1 line. With a deficit of soil moisture, the greatest amount of water was observed in plants of the Termez-31-78.6% variety, and leaves of the L-1 line contained the least amount of water - 70.2% (Table 1).

Table 1. Water content in the leaves such as lines and varieties of fine-fiber cotton in optimal water availability and modeling the drought:

№	Lines and varieties	Water content in the leaves %		Cad %	Difference %
		OWS	MD		
1	L-167	78,53±0,44	74,60±0,05	-5,0	3,9
2	L-663	79,33±0,06	71,33±0,56	-10,1	8,0
3	Surxan-14	78,23±0,26	74,23±0,17	-5,1	4,0
4	L-2006	77,83±0,41	74,76±0,60	-3,9	3,1
5	L-5440	79,43±0,08	73,26±0,03	-7,8	6,2
6	L-10	79,33±0,26	73,16±0,37	-7,8	6,2
7	L-1	78,96±0,51	70,2±0,63	-11,1	8,8
8	Termiz-31	80,50±0,10	78,6±0,43	-2,4	1,9
9	L-5445	79,03±0,20	73,33±0,44	-7,2	5,7
10	L-450	79,30±0,05	75,73±0,18	-4,5	3,6
11	Marvarid	79,30±0,51	73,30±0,30	-7,7	6,0

Note: OWS-optimal water supply; MD-modeling drought

The intensity of transpiration in the leaves; in optimal water regime, the transpiration rate proceeded most intensively in the leaves at the early ripening Marvarid and medium contained 356.77 mg H_2O / 1 gram of raw leaf x 1 hour. Lowest indicators in comparing late ripen lines as L-10 and L-2006, consequently, 149.04 mg H_2O / 1 gram of raw sheet x 1 hour and 156.56 mg H_2O / 1 gram of raw sheet x 1 hour (Table 2).

Having compared the data collected from the optimal background water with conditions of insufficient water availability, the transpiration rate decreased to different levels in all conducted lines and kinds of fine-fiber cotton (from 12.6% in Termez-31 to 43.9% and 42.2% in Marvarid and L-553 line). According to water deficiency, the highest leaf transpiration rate was observed in the Marvarid plants —200.26 mg H_2O / 1 gram of raw leaf x 1 hour, whereas in the ripening L-10 and L- lines In 2006, as well as in the L-663 line, as it indicated the lowest and amounted to 106.45 mg, 109.19 mg and 111.03 mg H_2O / 1 gram of raw leaf x 1 hour, respectively.

In improving water content in the leaves indicated the amount of water that evaporates within two hours from its initial content. Therefore, high values mean a low water-holding capacity of leaves, and low, on the contrary, a high water-holding capacity. In conditions of optimal water supply, the low water content in the leaves was Marvarid in which 38.5% of the total content evaporated from the leaves of plants within two hours. High levels of water-holding capacity in the leaves were found in lines L-10 and L-5445, consequently, 21.1% and 23.7% (Table 3).

On conditions of soil moisture deficit in all studied lines and varieties of fine-fiber cotton increased the water-holding capacity of plant leaves to different levels. Moreover, in lines such as L-663, L-10, L-1, L-2006, L-5440 and L -5445 within two hours, only evaporated 11.8-14.7% of water from its initial content.

Table 2. Intensity of transpiration in the leaves and varieties of fine-fiber cotton in optimal water supply and modeling the drought

№	Lines and varieties	Intensity of transportation, мгH_2O/1г in the leaves x 1 hour		Cad. %	difference, %
		OWS	MD		
1	L-167	245,3±9,0	147,5±1,3	-39,9	97,8
2	L-663	192,1±3,7	111,0±0,4	-42,2	81,1
3	Surkhan -14	263,3±4,0	176,5±4,9	-33,0	86,8
4	L-2006	156,6±3,5	109,2±1,2	-30,3	47,4
5	L-5440	200,2±2,2	134,5±1,7	-32,8	65,7
6	L-10	149,0±0,3	106,5±3,1	-28,5	42,5
7	L-1	224,1±0,5	161,2±2,6	-28,1	62,9
8	Termiz-31	213,7±0,6	186,7±2,5	-12,6	27,0
9	L-5445	181,3±2,3	126,6±2,2	-30,2	54,7
10	L-450	230,3±0,5	179,0±1,2	-22,3	51,3
11	Marvarid	356,8±5,1	200,3±5,5	-44,0	156,8

Note: OW-optimal water supply; MD-modeling the drought.

Table 3. The water –holding capacity of leaves in lines and varieties of fine-cotton fiber on conditions of optimal water supply and modeling the drought

№	Lines and varieties	Water –holding capacity of the leaves %		Cad %	Difference %
		OWS	MD		
1	L-167	27,50±1,15	18,56±0,08	-32,5	8,9
2	L-663	27,1±0,23	11,8±0,95	-56,5	15,3
3	Surkhan-14	29,30±0,85	15,56±1,18	-46,9	13,7
4	L-2006	25,76±0,26	13,73±0,90	-46,7	12,0
5	L-5440	24,53±0,80	14,30±0,40	-41,7	10,2
6	L-10	21,10±1,23	12,20±0,79	-42,2	8,9
7	L-1	27,8±1,10	13,36±1,21	-51,9	14,4
8	Termiz-31	28,86±1,18	21,8±0,11	-24,5	7,1
9	L-5445	23,73±0,66	14,66±1,08	-38,2	9,1
10	L-450	28,56±1,08	22,56±0,49	-21,0	6,0
11	Marvarid	38,53±0,75	18,93±1,02	-50,9	19,6

Note: OWS-optimal water supply; MD-modeling the drought

While Termez-31 and L-450 line showed the lowest level transpiration, average value was 21.8% and 22.6%, accordingly. Features in Surkhan-14 and Marvarid were 15.6% and 18.9%, in (Table 3).

Specific surface density of leaf indicates leaf thickness. In optimal water supply, Marvarid, L-663 and Surkhon-14 showed highest, relevant to 63.27 mg; 61.15 mg and 60.72 mg / 10 cm^2, but the thinnest leaf was varieties of Termez-31 - 42.46 mg / 10 cm^2.

In modeling drought, we found that the leaves of studied lines of fine fiber cotton and varieties were widened in comparison with varieties, i.e. optimal water supply (from 6.9% for L-663 to 26.6% and 26.0% for L-167 and Termez-31). Varieties like Marvarid and Surkhan-14 did not show any significant reaction to different conditions of water supply.

In optimal water supply, 3rd leaf was largest of L-1, L-2006 and L-10 (in accordance with 162,6 sm2; 158,3 sm2 and 157,9sm2), L-5440 and Marvarid indicated the lowest relevant to 108,8sm2 and 019,2sm2).

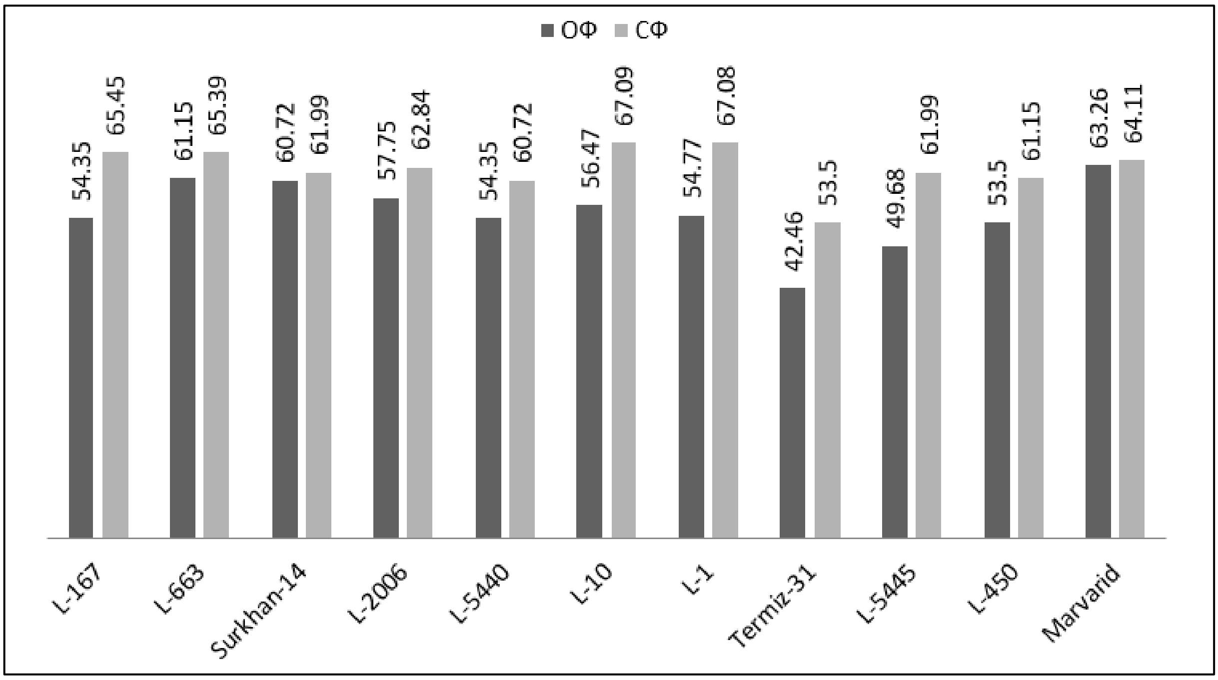

Diagram 1. (ОФ) OWS-optimal water supply; (СФ) MD-modeling the drought, *lines and varieties of fine fiber cotton*

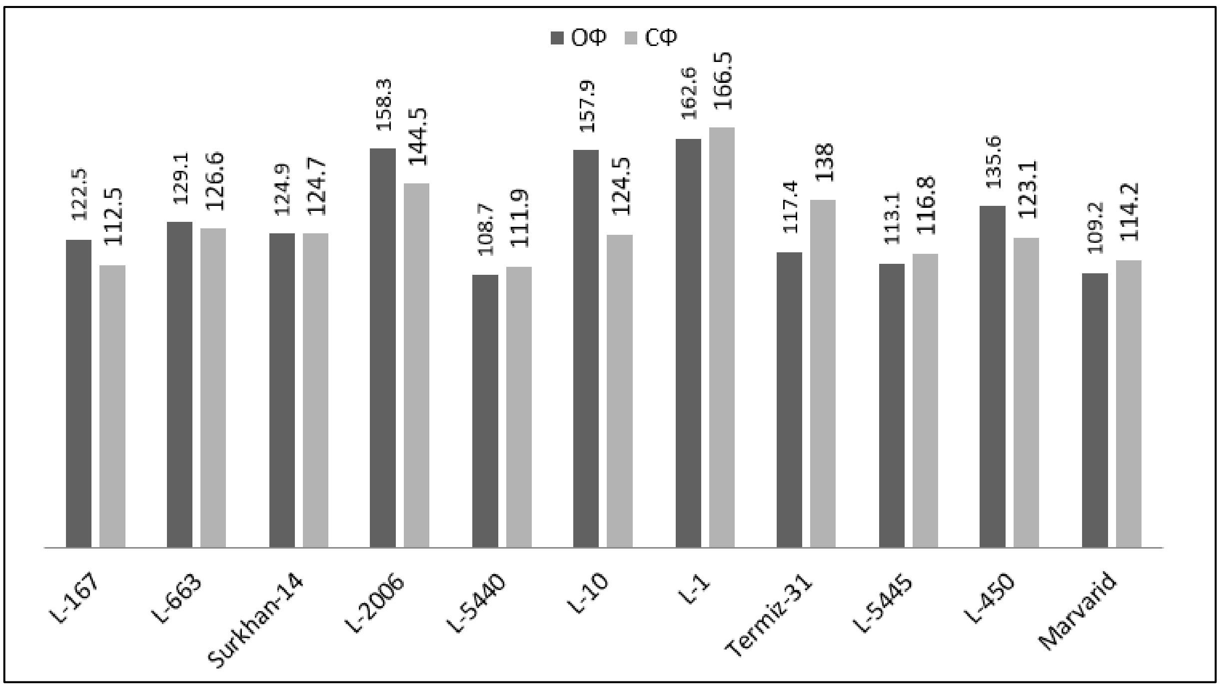

Diagram 2. (ОФ) OWS-optimal water supply; (СФ) MD-modeling the drought, *lines and varieties of fine fiber cotton*

We have found most deficit of water in L-1(166.5 cm^2) but L-5440 and L-167 differed from 3d line with lowest width, in accordance with 111.9 cm^2 and 112.5 cm^2. In comparing optimal water supply, and soil moisture deficiency with the features of lines L-10, L-450, L-2006 and L-167, relatively contained 21.1%, 9.2%, 8.7% and 8, 2%, whereas it increased 17.6%in Termez-31. Additionally, varieties and lines of fine fiber cotton according to the width of 3rd leaf showed stability in different conditions of water availability.

5. Conclusions

1. Soil moisture deficiency in research of lines and varieties of fine fiber cotton in the flourishing phase depending on individual genotype reaction in different levels decreases water content and transpiration in the leaves and improves water-holding capacity.
2. Water deficiency in the lines and varieties of fine fiber cotton decreases surface thickness of leaves and width, but the 3rd leaf indicated physiological properties in the above-mentioned tables and diagrams, which showed transportation in the leaves and denying water deficiency. In such case, lines (L-10, L-450, L-2006) increased width of 3rd leaf and variety Termiz-31 decreased, other genotypes showed stability in different conditions of water availability.
3. Decreasing water content and intensity of transpiration in the leaves increases water-holding capacity and density surface of leaf is considered as a morpho-physiologic adaptation of lines and varieties of fine-fiber cotton to the conditions of water deficiency in the soil.
4. Water deficiency in the lines such as L-10, L-1, L-2006, L-5440, and also L-663 in the longer growing season, had high water-holding capacity in the leaves in the flourishing phase, which indicates the possibilities of their use in genetic-selection research according to the selection of fine-fiber cotton in drought conditions.

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