The importance of field research in efficient water use in Kashkadarya region

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Abstract. The article presents long-term data on the efficient use of water in the Kashkadarya region, as well as their analytical indicators. Agricultural crops, including cotton, require a certain level of moisture in the active layer during the development phases. Natural rainfall is insufficient for optimal soil moisture in cotton cultivation. Therefore, there is a need to artificially moisten the active layer of the soil. There are many forms and methods of artificial soil moistening. At a time when water resources are scarce, the application of new water-saving irrigation technologies is of great importance. At the same time, water-saving technologies have been introduced to 1.3 million (30%) of the 4.3 million irrigated areas in the Republic of Uzbekistan. Out of this, drip irrigation is used on 475 thousand hectares, sprinkler irrigation on 49 thousand hectares, discrete irrigation on 29 thousand hectares, flexible pipe on 45 thousand hectares, film on 27 thousand hectares, and laser leveling on 674 thousand hectares. Based on this, it is stated that 22% of the total area of Kashkadarya region is being used for research on the use of water-saving irrigation technology, and as a result, up to 40% of irrigation water has been saved. According to the results of the research, it is possible to obtain a large and high-quality cotton yield by maintaining the limit field moisture capacity (MFWC) of the soil at 70-75-60 percent before irrigation from under the soil of cotton. In the conditions of experimental field soils with medium mechanical composition, the length of the sprinkler (60-250 m.), the distance between the sprinklers (1.25-1.50 m.) was used. It has been proven that irrigation water planning should be managed based on water evaporation. The average monthly amount of evaporation in Kashkadarya region was 5.16 mm, and the highest evaporation was observed in June and July, and the average annual precipitation was 111.4 mm. It was mentioned that 80 percent of the time of the year falls on the autumn-winter seasons.

Keywords. Kashkadarya, precipitation, arid region, soil with medium mechanical composition, water scarcity, subsoil irrigation.

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1 Introduction

In the world, global changes in air temperature are expected to affect the growth and development of agricultural crops, including cotton, because cotton requires a certain temperature and humidity to produce sufficient quantity and quality of fibers. Expected temperature increases and more frequent extreme weather events could harm global production. These extreme weather conditions can adversely affect the growth and yield and quality indicators of cotton [1].

The fact that the republic, including the Kashkadarya region, experiences a water deficit from year to year, indicates the need for effective and rational use of available water resources in the cultivation of agricultural crops. The introduction of water-saving technologies is of great importance in providing water taking into account the needs of agricultural crops [2, 3].

At the republic level, consistent measures are being taken to fundamentally reform the mechanisms of water resources use, to ensure their rational and efficient use, to support and encourage the introduction of water-saving technologies in economic sectors, as well as to improve the reclamation of irrigated lands. Based on this, there is a need to increase the use of water-saving technologies in agriculture and to intensify measures aimed at effective use of water resources [4].

The government has developed a state program to ensure the delivery of every drop of water to the farmer's field without waste [5], and favorable conditions have been created for the development of irrigation and the improvement of land reclamation and the wide use of drip irrigation technologies in the cultivation of raw cotton [6]. At the same time, the President of the Republic of Uzbekistan developed measures to expand the mechanisms for encouraging the introduction of water-saving technologies in agriculture [7].

In recent years, the introduction of water-saving irrigation technologies has been significantly expanding in the republic, including in the Kashkadarya region, the main reason for which is the attention of water users to water and the correct use of water.

According to the Republic of Uzbekistan, in 2023, drip irrigation was applied to 473.5 thousand hectares, sprinkler irrigation to 44.7 thousand hectares, discrete irrigation to 18 thousand hectares, laser leveling to 569 thousand hectares, and other water-saving technologies to 133.9 thousand hectares [8].

It is known that Kashkadarya region is one of the leading regions in the Republic of Uzbekistan in terms of water supply volume to meet the demand of agricultural crops. Based on this, it seems important to dwell on the work carried out in connection with the introduction of water-saving technologies in the districts of Kashkadarya region, as well as to conduct research (table 1) [2].

While the total area of water-saving irrigation technologies used in Kashkadarya region until 2024 is 90,022 thousand hectares, the fact that it is 22% of the total irrigated land area of the region and that it will increase year by year in the future is a sign of efficient and rational use of water. Irrigation water is provided by pumps to meet the water demand of agricultural crops. 75 percent of the water entering the region is taken from the neighboring country of Turkmenistan through the “Amu Darya” basin from 7 lifting pumping stations on the Karshi main channel, 5 percent through the “Zarafshan” river, and the remaining 20 percent from the “Kashkadarya” river and its tributaries [2].

Eighty percent of the water is pumped and the cost of delivering 1 cubic meter of water from the Amudarya basin to the field is the most expensive for the Republic. The region has 14 reservoirs with a water collection capacity of 2.5 billion cubic meters, 1386 irrigation and reclamation wells, and 69 pumping stations. There are a total of 256 main and inter-farm canals with a length of 2476 km in water management, which are of great importance in the implementation of irrigation [2].

The length of on-farm canals financed by the cluster and farmers is 20.4 thousand km, of which 6.2 thousand km are part of the channel irrigation networks. 514.1 thousand hectares of irrigated areas in the region require 5.2 billion cubic meters of water annually. Taking into account the water shortage in water sources and the operation of several lifting pumps, a limit of 4.8 billion cubic meters of water was allocated and used in 2023 [2]. Out of 514,114 hectares of irrigated areas in the region, 293,959 hectares are non-saline, 220,155 hectares are saline (of which 176,540 hectares are weakly, 34,866 mediums and 8,749 hectares are strongly saline) [2].

Table 1. Information on the introduction of water-saving technologies in Kashkadarya region (01.01.2024), hectares.

Areas	**Agricultural fields**	**Common area where water-saving technologies are implemented**	**%**	**Drip irrigation technology**	**Sprinkler irrigation technology**	**Discrete irrigation system**	**Irrigation through flexible pipes**	**Irrigation by laying a polyethylene film on the irrigated fields**	**Laser leveling of lands**
Guzor	31068	5369	17	2448	147		400	150	2224
Dehkanabad	1868	186	10	186					
Karshi	40352	8752	22	3059	15		560	220	4898
Karshi city	111	24	21	24					
Kasan	61007	7962	13	3043	588		500	550	3281
Kamashi	27785	8176	29	4864	242		490	180	2400
Kitob	8235	3086	37	2053	221		680	132	
Mirishkor	55788	7954	14	3539	110		620	160	3526
Muborak	31562	5138	16	2602	820		200		1516
Nishon	52137	13432	26	1526	634	600	780	500	9392
Kasbi	44518	7767	17	1349	56		180	320	5862
Chirakchi	11880	7713	65	5591	92		660	222	1148
Kukdala	10671	3052	29	682	80		560	420	1310
Shahrisabz	17425	4234	24	2105			520	143	1466
Yakkabog	21367	7176	34	4939	26		520	160	1531
Kashkadarya region	415774	90,022	22	38,01	3,031	600	6,670	3,157	38,55

Source: "Information received from Amu-Kashkadarya Irrigation Systems Basin Department.

As mentioned above, at a time when water shortage is observed from year to year, scientific recommendations and conclusions should be taken into account to implement scientifically based agrotechnical measures in the cultivation of raw cotton and to introduce water-saving technologies in irrigation, in particular:

- achieving effective use of available water resources;
- observance of scientifically based agrotechnical rules for introduction of drip irrigation technology developed taking into account soil - climate and other conditions;
- design, construction and use of modern water-saving technologies in crop irrigation is of great importance.

The irrigated agricultural lands of the region are characterized by average (64%) productivity. The average score of soil fertility is 51% [9].

Today, rational use of existing water resources, introduction of scientifically based, resource-efficient, improved agro-technologies of crop care is one of the most urgent tasks of today.

When using water-saving irrigation technology, the following is achieved:

- compliance of cotton irrigation with water requirements;
- water is supplied directly to the layer where the cotton root system develops;
- low amount of water evaporated from the soil;
- restriction of the development of weeds;
- that the water supplied for irrigation is supplied uniformly along the length of the cotton and does not soak into the soil;
- not to throw water from the field into the field, etc.

For this purpose, it is of great importance to provide optimal moisture in the cotton layer in the field, to create a balance of water-food-salt-air when necessary for cotton, using a water-saving irrigation method in field conditions.

High cotton yield and water productivity can be achieved by providing optimal cotton irrigation and nutrition.

2 Materials and methods

Scientific research works were carried out in the conditions of medium mechanical composition soils of Kashkadarya region. It was decided to carry out research on the basis of the following system (Table 2).

Field, laboratory research and phenological observations were carried out based on the methods adopted in Uzbek Scientific Research Institute of Cotton Breeding and Seed Production (URICBSP) "Methods of conducting field experiments" [10], Research Institute of Irrigation and Water Problems on determining elements of irrigation techniques [10].

The introduction of elements of irrigation technology in the experimental system was as follows: the length of the sprinkler (60-250 m.), the distance between the sprinklers (1.25-1.50 m.) and the duration of irrigation in relation to the soil moisture before irrigation marginal field wet capacity (MFWC) was determined during the study.

Table 2. Experience system.

Options	Irrigation technology	Pre-irrigation soil moisture relative to MFWC, %	Elements of irrigation technique		
			The length of the pipe, m	Depth of settlement, m	Comparative water consumption, l/s
1	Traditional irrigation method				
2	Soil watering from below	70-70-60	0.1-2.0	0.4-0.6	0.05-0.25
3	Soil watering from below	70-75-60	0.1-2.0	0.4-0.6	0.05-0.25
4	Soil watering from below	75-75-60	0.1-2.0	0.4-0.6	0.05-0.25

Soil moisture before irrigation was determined based on scientific recommendations for the application of irrigation technologies for Kashkadarya region in relation to MFWC [12].

A spatial image of the location of the experimental field site in Kashkadarya region is presented in figure 1.

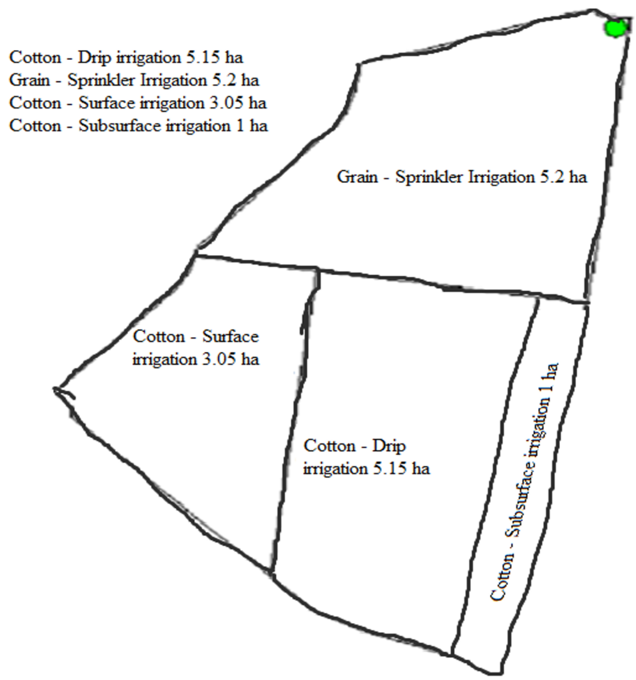

Fig. 1. Location of experimental field in Kashkadarya region.

The experimental site is located at the experimental site of the Kashkadarya branch of the "Research Institute of Cereals and Leguminous Crops" in the Karshi district of the Kashkadarya region. Pale gray soils are considered. The highest limit of the area where pale gray soils are spread is 300-600 meters above sea level [8].

Light gray soils in the area of the experimental field are mainly developed in loess. According to the opinion of most geologists, the origin of Central Asian loess is related to water and mainly consists of products of alluvial-proluvial deposits. Light-colored gray soils are located in the plains, with a very low humus content (0.81 %), high carbonate, medium and light clays. It is insufficiently supplied with mobile phosphorus and exchangeable potassium. The flatness of the zone of pale gray soils is very convenient for irrigation [9].

The irrigated light gray soils in the experimental plot area have been irrigated and farmed for more than 35 years. The soils are medium in terms of mechanical composition, the depth of low salinity seepage water is 2.0-2.5 meters, low mineralization (2.5-3.0 g/l).

Soils of the field experiment mstudy orthological signsIt was conducted according to the method of V.V.Dokuchaev [6] and the analytical results were conducted in the "Soil Science and Agrochemistry" laboratory of the Kashkadarya branch of the "Research Institute of Cereals and Legumes" (tables 3-6).

Table 4 presents the results of the analysis of the volumetric mass of the soil of the experimental area. According to analytical data, the volumetric mass of irrigated light gray soils varies along the soil profile. Since the plowed layer 0-28 cm thick is porous, the density is also low - 1.29 g/cm^3. Subsoil is significantly denser, its size is 1.34 g/cm^3. There is no significant change in the volumetric mass of soils in the lower layers.

Table 3. Historically irrigated light gray soils (01.03.2024).

Layer information		Morphological structure
Designation	**Thickness, cm**	
A_a	0-28	The arable layer is pale brown, dry, with high porosity, weakly compacted in the lower part, the mechanical composition is heavy sand, invertebrates are rare, the soil contains rotted plant residues and cultivated plants, weed roots are widespread.
A_{al}	29-42	The arable layer is light brown, hard, poorly moistened, compacted, large-pored, heavy sand with a mechanical structure, plant remains are not found, but the roots of cultivated plants and weeds are found. Density, moisture and color change to the next layer.
B	43-87	Compared to the previous layer, it is pale yellow, has rust spots, soft, unconsolidated, wet, mechanical composition is sandy, plant and weed remains are not found, but cultivated plants and weed roots are found. The density and color change to the next layer.
B_1	88-104	Compared to the previous layer, there are darker brown, rust and gray spots, the mechanical composition is light sand, it is noticeable that the moisture level has increased, small plant veins are found, the porosity is low, the color changes to the next layer.
B_2	105-126	Compared to the previous layer, it is dark gray in color, there are rust and gray spots, the middle sand is wet, not compacted, soft, porous, there are small traces of plant roots, the color changes to the next layer.
V_0	127-180	It is dark gray in color, with rust and gray spots, very low porosity, weakly compacted, moderately wetted, mechanical composition and color change to the next layer.
V_1	181-208	Dark brown, white, brown, rust and gray mottled, compacted, strongly wetted, clay, non-porous, carbonated, moisture changes to the next layer.

Table 4. Experimental field soilsphysical properties.

Layer depth, cm	Bulk density, g/cm^3	Relative mass, g/cm^3	Porosity, %
0-28	1.29	2.71	51.0
29-42	1.34	2.73	44.6
43-87	1.28	2.72	49.2
88-104	1.27	2.72	49.0
105-126	1.28	2.71	46.7
127-180	1.33	2.72	44.5
181-208	1.34	2.73	42.9

The specific mass of the soil depends on the mineral and chemical composition, and 2.71 g/cm^3 was observed in the 0-28 cm layer, while in the soils of the experimental area, the mass of the soil was almost the same along the profile.

In the soils of the experimental area, the porosity was observed to change in the range of 44.6-51.0% along the profile. The arable layer with a relatively small volumetric mass of the soil is considered porous, and its indicator is 51.0%, and in the denser subsoil layer it is 44.6%.

NaCl, Na_2SO_4, which is easily soluble in water, causes soil salinity, $NaNCO_3$, Na_2CO_3, Na_2SO_4, $CaCl_2$, $MgSO_4$, $MgCl_2$ salt determination is of great practical importance.

The amount of dry residue in the 0-28 cm soil layer of the experimental field soils did not exceed 0.84%, chlorine ions were 0.200%, and sulfate ions were 0.040% (Table 5).

Table 5. Chemical composition of experimental site soils.

Layer depth, cm	Dry residue	General alkalinity	C1-	SO4-	Salinity level
0-28	0.084	0.033			Unsalted
		0.520	0.200	0.040	
29-42	0.080	0.038	0.006	0.027	Unsalted
		0.620	0.150	0.070	
43-87	0.284	0.015	0.009	0.142	Unsalted
		0.250	0.350	2,210	
88-104	0.327	0.019	0.070	0.171	Not lightly salted
		0.310	1,930	3,520	
105-126	1.313	0.012	0.062	0.469	Moderately unsalted
		0.200	1,470	10.50	
127-180	1.315	0.015	0.054	0.541	Moderately unsalted
		0.250	1,450	12.32	
181-208	1.345	0.013	0.058	0.612	Moderately unsalted
		0.210	1.82	13.70	

Note: % in figure, mg-eq in denominator.

The soils of the experimental area were moderately supplied with humus. The amount of humus in the arable layer of soils is 0.81% and gradually decreases towards the bottom. Accordingly, it was observed that humus was equal to 0.68% in a half-meter layer.

The total nitrogen content in the arable layer of the soil of the experimental area is 0.078%, and it varies in the range of 0.027-0.061% in the lower layers of the soil profile. The nitrogen reserve in half a meter layer of soil is 4.91 t/ha (Table 6).

Table 6. Nutrient content in pale gray soils.

Layer depth, cm	Total, %				Active, mg/kg	
	Hummus	N	P_2O_5	K_2O	P_2O_5	K_2O
0-28	0.81	0.078	0.180	2.51	30.0	380.0
29-42	0.68	0.061	0.100	2.40	24.5	365.1
43-87	0.21	0.016	0.300	2.20	13.0	300.0
88-104	0.25	0.019	0.320	2.10	14.4	220.5
105-126	0.41	0.036	0.051	2.00	14.7	180.0
127-180	0.36	0.032	0.042	1.80	13.0	150.1
181-208	0.30	0.027	0.034	1.75	9.0	100.0

Total phosphorus was 0.180% and potassium was 2.51%. Mobile phosphorus, the main source of plant nutrition (30.0 mg/kg) and potassium (380.0 mg/kg) tested soils were moderately supplied. The amount of phosphorus and potassium decreased uniformly downwards along the soil profile.

The experimental site is located at an altitude of 340 meters above sea level, at 33.31^o north latitude, 65.53^o east longitude, in the middle part of the Kashkadarya river. A flat slope occupies the eastern-northern part of the experimental area [8, 9].

The plains are quite long and have a general length towards the south. Plains are the most important element of the surface in relief. It stretches to 450-550 meters on the sides, the slope is 1-2^o, in some places it is 4-5^o. As a result of weathering and washing of rocks, the relief of the researched area was formed, plains were formed. There is a network of water discharges on the plains. Natural drainage of the area is weak [8].

Kashkadarya region is located in the southwestern part of the Republic, and its northern and western sides are surrounded by mountains. That's why the Karshi steppe (Mubarak, Mirishkor, Kasbi, Kasan, Karshi and Nishon districts) located in the territory of Kashkadarya region receives cold air from the north, and a strongly heated air mass from Karakum from the west. This situation, in turn, creates a severe continental climate.

Precipitation is very low, 40-140 mm in the growing season, 104-394 mm in autumn, winter and spring. Evaporation of moisture is 1110-1580 mm during the growing season, 394-402 mm during the off-season. As a result, moisture deficit is observed.

The high demand for irrigation water during the growth and development of crops can be seen from the analysis of data from meteorological stations, during these periods the demand for water is greatly increased. During this period, the water demand of crops is met only by artificial irrigation. Due to the low water volume of the Kashkadarya river, water is collected in Chimkurgan, Pachkamar, Hisarak and other reservoirs in order to collect water in autumn, winter and spring. The resulting reserve water is used during the growth and development of repeated crops. However, the accumulated water reserves provide a zone of typical gray soils of the region. Therefore, the Talimarjan reservoir is filled with Amudarya water through the Karshi main channel, and crops are irrigated in the summer. Crops in the light gray soil region of the region are mainly irrigated using the waters of the Karshi main canal and the Talimarjon reservoir.

The cultivated areas of the region can be divided into three agricultural regions depending on the type and composition of soils (gray typical, light gray, barren and barren soils), climatic conditions and the amount of precipitation falling from the atmosphere during the year.

The first region includes Kitab, Shakhrisabz, Yakkabag districts and the upper parts of Chirakchi and Kamashinsky districts. In this region, the relative humidity is up to 18%, and the maximum daily temperature is 3-4 degrees lower than in other districts, and the total useful temperature is 285-461 degrees. The average annual precipitation is 400 mm and above [2].

The second area includes areas of light gray soils of Guzor, Kamashi, Karshi, Kasan and Kasbi, Nishan districts. In this area, the air temperature is 2-3 degrees higher than the first area, the relative humidity is slightly lower, the amount of evaporation is 190 mm higher, and the humidity deficit is 270 mm. Annual rainfall does not exceed 200-300 mm. When the relative humidity in the air is sharply reduced, strong garmsel winds blow [2].

The third region includes the barren soils of Mirishkor and Mubarak districts, as well as Kasbi, Nishon, and Kasan districts.These lands are characterized by unfavorable weather conditions. Annual rainfall in this area reaches only 150-250 mm. Therefore, it is necessary to increase the standards of one-time irrigation of crops in this area by 200-250 m^3 compared to the first area [6].

The total land area of Kashkadarya region is 2856.8 thousand hectares, the area of agricultural land is 2413.5 thousand hectares, cultivated areas are 679.3 thousand hectares, of which 422.0 thousand hectares are irrigated, and dry land is 257.3 thousand hectares. The main irrigated soils of the region include irrigated barren, pale gray, typical gray and barren meadow, meadow alluvial soils that have been exploited for different periods of time [2, 3, 4].

Medium loam (40.35%), light loam (26.58%) and heavy loam (23.04%) soils are common in the province, and they make up about 90% of the total irrigated areas. Soils with such a mechanical composition have good agronomic properties in terms of natural fertility and a number of chemical, physical and water-physical properties [2].

The irrigated land area of Kashkadarya region consists of typical gray soils, light gray soils, meadow and gray-meadow soils, barren and barren soils, meadow soils of the desert region (Table 7).

Table 7. Types of soils of Kashkadarya region.

№	The main soil types	As a percentage of the area, %	
		General	Irrigated lands
1.	Light-brown-meadow-desert high mountain	2.8	
2.	Brown soils located in the middle of the mountain	14.2	-
3.	Dark gray soils	8.8	-
4.	Typical gray soils	23.1	15.3
5.	Pale gray soils	19.2	22.6
6.	Meadow and gray-meadow soils	3.8	22.8
7.	Barren soils	12.4	17.1
8.	Desert sandy soils	2.2	2
9.	Meadow soils of the desert region	1.6	18.2
10	Gray brown soils	6.1	2.0
11	Salty soil	1.6	-
12	Sands and others	4.2	-
	Total	**100**	**100**

About 70% of the region's irrigated soils are saline to varying degrees, the districts with strong salinity include Guzor, Karshi, Chirakchi, and the districts of Kasan, Nishon, Yakkabog with average indicators. It is important to apply measures aimed at preventing salinity in order to increase soil fertility.

The risk of wind erosion is high in Nishan, Mirishkor, and Dehkanabad districts of the province, because the soil of most of their areas is light sand and loam. 10% of the region's soils are moderately, 88% weakly eroded by irrigation. Irrigation erosion observed as a result of irrigation is widespread in the soils of Dehkanabad, Kamashi, Mubarak, Chirakchi and makes up 20-40% of the total land area.

3 Results and discussion

In the experiments, the moisture of the soil before watering is from the moisture determined in the system of experiments. It was maintained with a difference of around $\pm$ 2% [7, 8].

The results of changes in soil moisture before irrigation in the experimental field of Kashkadarya region according to Table 9, in the 1st control variant of the experiment, which was irrigated by the method of horizontal irrigation, during the period from germination to flowering of cotton, the moisture in the calculation layer was 16.40% compared to the weight of the soil and 74.14% compared to MFWC , was 14.69-14.98% relative to soil weight and 67.95-69.29% relative to MFWC during the period of flowering-bud bearing. In option 2, where the soil moisture before irrigation is 70-70-60% compared to MFWC, during the period from cotton germination to flowering, the soil moisture is 15.89% relative to soil weight and 71.84% compared to MFWC, during the period of flowering-budding. 15.50-15.56% by weight and 71.88-71.97% by weight; In option 3, during the period from cotton germination to flowering, the moisture content is 15.75% by soil weight and 71.20% by MFWC, and by 16.59-16.64% by soil weight and MFWC during the flowering-budding period. to 76.73-76.97%; In the 4th option, during the period from cotton germination to flowering, the moisture content is 16.17% by soil weight and 73.10% by MFWC, and by 16.46-16.90% by soil weight and MFWC during the flowering-budding period. It was equal to 74.41-76.40%. During the ripening period, irrigation was not required (Table 8).

Table 8. Changes in experimental field soil moisture as a function of irrigation method (in % relative to soil weight and MFWC).

Options	Irrigations			
	1		2	
	Growth phases of cotton			
	from germination to flowering		From flowering to fruiting	
	Relative to heavy soil, %	Regarding MFWC, %	Relative to heavy soil, %	Regarding MFWC, %
V-1	16.40	74.14	14.98	69.29
V-2	15.89	71.84	15.56	71.97
V-3	15.75	71.20	16.64	76,97
V-4	16,17	73.10	16.46	74.41
Options	Irrigations			
	3		4	
	Growth phases of cotton			
	From flowering to fruiting			
	Relative to heavy soil, %	Regarding MFWC, %	Relative to heavy soil, %	Regarding MFWC, %
V-1	14.87	68,79	14.69	67.95
V-2	15.50	71.69	15.54	71.88
V-3	16.62	76,87	16.59	76,73
V-4	16.66	75.30	16.90	76.40

The coordinates of the weather station “Karshi” in Kashkadarya region were determined (Altitude: 384 m.; Latitude: 38.86 °S; Longitude: 65.79 °W) and data on air temperature, relative humidity, precipitation, wind speed and duration of sunlight were obtained from the meteorological station. and analyzed [10].

Effective use of water is one of the most pressing tasks of today, while saving every drop of water, supplying water to the layer where the cotton root system is located is of great importance. Taking into account the existing water resources, the development of the design irrigation procedure for agricultural crops, including cotton, and the rational use and management of available water resources were evaluated using meteorological data in the cultivation and maintenance of agricultural crops and obtaining high-quality crops, i.e., in determining the criteria for water use. The change of all meteorological data by months was presented in a graphical way (figures 2-4).

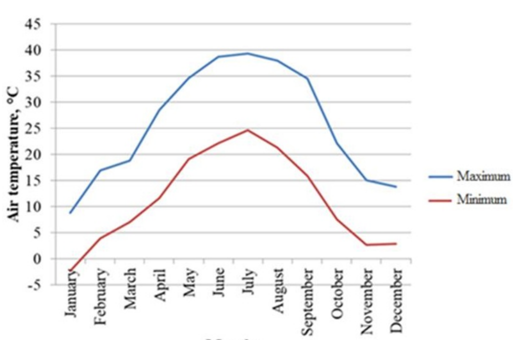

Fig. 2. Variation of air temperature by months.

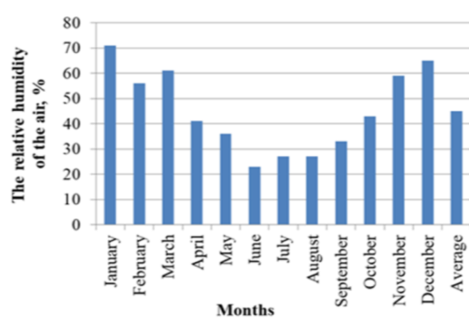

Fig. 3. Variation of relative air humidity by months.

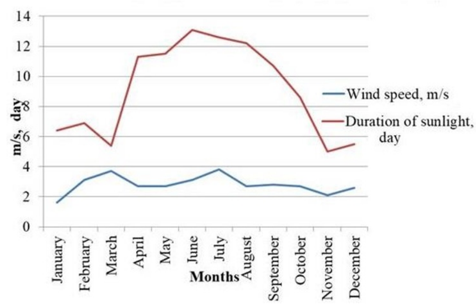

Fig. 4. Variation of wind speed and sunshine duration by months.

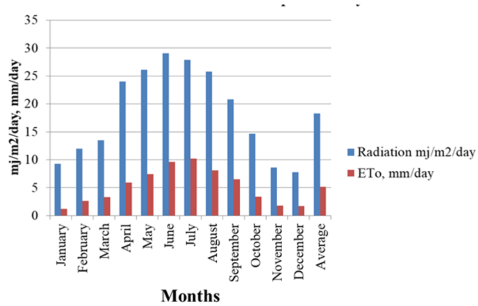

Fig. 5. Variation of radiation and evaporation by month.

Based on the obtained data, the amount of solar radiation and evaporation in the area of the experimental field was calculated using the Penman-Monteith formula.

Evaporation in the experimental field was determined based on the following formula [19].

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma * \left(\frac{900}{T + 273}\right) u_2 * (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

The months with the highest solar radiation are June and July. The total monthly amount of radiation is 29.1 and 27.9 MJ/m2/day, respectively. It was determined from the calculation books that the evaporation was high in these months, i.e. equal to 9.63 and 10.26 mm/day.

In June and July months (3.1-3.8 m/s), the wind speed is usually higher than in other months, and because it coincides with the flowering and ripening period of cotton, it was observed in these months that the water demand of cotton is high.

The average annual rainfall in Kashkadarya region is 111.4 mm. 80% of the rain falls in the autumn-winter seasons. 99.6% was observed in November-May. Agricultural crops are grown through irrigation, as rainfall during the season does not meet the demand of the crop at all.

For this purpose, the use of water-saving irrigation technologies for efficient use of water is of great importance. In Kashkadarya region, if we take into account the increase in the cost of water when raising irrigation water to a certain height, the value of each drop of water is high.

4 Conclusion

1. Research shows that water-saving irrigation technology allows saving up to 40 percent of water when irrigating 22 percent of agricultural crops.
2. In the Kashkadarya region, as a result of lifting irrigation water by 7 lifting pumping stations, given that the price of water is the most expensive for the republic, it is necessary to supply water in accordance with the demand of agricultural crops (it is advisable to use programs).
3. When irrigating cotton from under the soil, it was determined that the soil moisture before irrigation should be maintained at a level of 70-75-60 percent relative to the UPPV.
4. When irrigating cotton from under the soil in soils with an average mechanical composition, the length of the humidifier (60-250 m) and the distance between

humidifiers (1.25-1.50 m).

5. It is noted that the greatest solar radiation in the Kashkadarya region occurs in June and July. The amount of radiation is 29.1 and 27.9 MJ/m2/day, respectively.
6. The average monthly evaporation amount in the Kashkadarya region was 5.16 mm, and the highest evaporation was observed in June and July, i.e. it was equal to 9.63 and 10.26 mm/day.
7. Average annual precipitation in Kashkadarya region is 111.4 mm, 80% fall in the autumn-winter seasons.

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