Application of under-film drip irrigation for high yield yields in saline soils and global warming

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Abstract. The use of water- and resource-saving technologies for the cultivation of cotton on saline soils in the context of global warming is considered. In the studies, drip irrigation was used under the film, without a film through a row and furrow irrigation. In the control, 3000 m^3/ha of water was used for leaching, 4200 m^3/ha for vegetation, productivity - 40 c/ha, for vegetation for 1c crop - 105.0 m^3/ha of water. With drip irrigation without a film and under a film, it was watered 21 times, the water consumption was respectively: 3770-3465-m^3/ha, and with salt washing - 2400-2200m^3/ha, the yield was 53-64 centners/ha. To obtain 1 centner of yield during the growing season, 71.13-54.40 m3/ha of water was consumed, compared to the control, less by 33.86-50.86 m^3/ha. For growing 1s. harvest, spending 71.13-54.14 m^3/ha of water, 13-24 centners/ha of yield increase was obtained, water savings for cotton is 1.48-1.94 times lower than the control. Scientifically substantiated, saving water, resources, eliminating excessive consumption of nutrients due to the accumulation of CO_2 under the film, pH neutralization and soil desalination, successful completion of biochemical processes, improved absorption of phosphorus by the plant and the absence of fusarium, verticillium wilt.

1 Introduction

Uzbekistan is located in the center of the Eurasian continent in the Aral Sea basin. In the republic, semi-deserts and deserts, including the largest desert in Central Asia - Kyzylkum, occupy more than 70% of the territory. In recent years, the total population of states is more than 35 million people, of which about 49% live in regions prone to drought [1-7].

As a result, one of the world's largest environmental disasters is the drying up of the Aral Sea. Over 60% of the coastal areas of Central Asia have become practically unsuitable for use for agriculture and other activities. At the same time, 75 million tons of salt are annually distributed to other parts of Central Asia and beyond [1-7].

This, in turn, accelerates the processes of salinization and desertification in the countries of Central Asia as a whole. Especially on the lands of the Aral Sea region on the territory of

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Uzbekistan, where, in addition, a new Aralkum desert was formed in the northeast and the south of the region with an area of 5.5 million hectares [1-7].

In the Republic, out of 20.2 million hectares of agricultural land, only 20.7% are irrigated. Over the past 15 years, the share of irrigated land per capita has decreased by 24% - from 0.23 ha to 0.16 ha. According to forecasts, by 2050 the area of irrigated land may be reduced by another 20-25%.

On September 16, a videoconference was held under the chairmanship of the President of the Republic of Uzbekistan Shavkat Mirziyoyev on measures to introduce saving technologies and implement public-private partnership projects in the water sector. It says that every year the issue of water shortage is becoming more and more acute. Over the past 10 years, the volume of water resources in Uzbekistan, for example, has decreased by 12 percent, and this year - by 15 percent compared to last year. For irrigation of 2.5 million hectares of land, 8 billion kilowatt-hours of electricity and 2.4 trillion soums of budget funds are spent annually. An average of 800,000 soums is spent from the budget to supply water with pumps per hectare of land. As a result of furrow irrigation, about 5-6 billion cubic meters or 20 percent of water is lost in the fields every year [1-7].

In the lower reaches of the Amudarya River (on the territory of the Khorezm, Bukhara regions and the Republic of Karakalpakstan), 91% of irrigated lands are classified by varying degrees of soil salinity, desertification and degradation of agricultural ecosystems are observed [1-7].

Water is the most abundant substance on Earth. However, 97% of the water is not suitable for human use. Of the 3%, two-thirds of drinking water is trapped in glaciers around the poles. Only 1% of all water in the world is available for human consumption. Thanks to the natural cycle in nature, water is endlessly renewed. Lack of access to clean water, hygiene and sanitation not only affects the standard of living of the population, but also undermines the health of people regardless of the country of residence. According to the UN, by 2050, water scarcity will be a major problem for more than 5.5 billion people worldwide [3].

The well-known great artist Leonardo da Vinci said this about the price of fresh water: “Water was given the magical power to become the juice of life on Earth. But we begin to appreciate Water not before the well dries up [8].

Based on this phrase of the great artist, one can think that how should we protect one of the most important and valuable resources of the planet - fresh water? How to make sure that farmers are not only interested in the proceeds from the crop, but the legacy that they leave to their descendants? How should we preserve and increase the freshwater resources of the planet. Especially considering the fact that even today the problem of shortage and pollution of fresh water is in the first place. In the agricultural sector of the leading countries, and every year it becomes more and more relevant for the agricultural crop irrigation industries [7-21].

In recent years, in the conditions of the Bukhara region, more frequent exposure to extreme temperatures (42-53 ^{0}C) and prolonged hot winds (garmsil) have a serious negative impact on the growth and development of all types of crops. This situation leads to excess water consumption by plant cells due to the excess of the transpiration coefficient in plants.

The annual increase in global temperature, the increase in saline land, the daily decrease in drinking water supplies and the geometric increase in the number of people require that every drop of fresh water be carefully spent and used efficiently. In such cases, it requires the effective use of water- and resource-saving, advanced innovative technologies in growing high and high-quality crop yields is a requirement of the time.

Now, without the use of water-saving technologies, the ability to maintain the amount of fresh water at a certain level is decreasing day by day.

One of the most effective methods of metered irrigation on saline soils is drip irrigation. Drip irrigation is characterized by the presence of a permanent pressurized distribution network, allowing continuous or frequent irrigation, precisely matching the water demand of the cotton crop.

Unlike furrow, it is based on the flow of water in small doses to the root zone of plants; the amount and frequency of water supply are regulated in accordance with the needs of plants. Water flows to all cotton plants evenly and in the same amount. This allows you to maintain an optimal water-physical regime in the root zone, especially during the critical phases of their development (during the budding period, flowering and the formation of cotton bolls), which creates conditions for high yields. This effect is more pronounced in dry climates.

One such water- and resource-saving technology is the method of laying hoses under the black film of drip irrigation along with the planting of cottonseeds.

2 Methods

An experimental experiment on the study of the use of drip irrigation under a film and without films through a row was carried out in 2021-2022. Scientists of the Scientific Research Institute for Seed Breeding and Agricultural Texnology of Cotton Growing, Bukhara Scientific Experimental Station, in the farms of the Bukhara agricultural cluster, Bukhara region, in arid, hot climates and saline soils on cotton varieties Bukhara-8. The experimental experiment consists of 3 variants. 1-variant furrow irrigation (control), 2-variant drip irrigation with black film, laying hoses through a row (tested variant). 3-Variant of non-film drip irrigation, laying hoses through a row (tested variant). The soil is meadow-alluvial, moderately saline. The occurrence of groundwater is located at 2.0 m above sea level. Each variant (plot) consists of eight rows, row spacing is 60 cm, and row length is 120 m. Accounting area -100 m^2. The repetition of the experiment is 3-fold. The total area according to the variants of the experiment was 8640 m^2. Experienced options are located in one tier. The layout of the experiment scheme by fields is shown in Table 1.

Table 1. Scheme of experiment location by fields.

1 repetition			**2 repetition**			**3 repetition**			The length of each plot is 120m
Each option for 8 rows			**Each option for 8 rows**			**Each option for 8 rows**			
(Control) Furrow irrigation	Drip irrigation with black film across the row	Drip non-film irrigation through the row	(Control) Furrow irrigation	Drip irrigation with black film across the row	Drip non-film irrigation through the row	(Control) Furrow irrigation	Drip irrigation with black film across the row	Drip non-film irrigation through the row	

Irrigation of cotton was carried out in three ways: a) furrow irrigation; c) drip irrigation under the films through a row. Drip irrigation without film through the row.

Borehole fresh water was used for irrigation. Experimental options for repetitions were arranged according to the randomization method.

The study was carried out according to the methodology adopted in the Scientific Research Institute for Seed Breeding and Agricultural Texnology of Cotton Growing "Methodology for conducting field studies" [22, 23]. The calculation of water was calculated according to the formula of S N Ryzhov [24]. These yield results were dispersion analyzed according to the method of B Dospekhov "Methodology of the field experiment" [25].

The purpose of the study is to study the effect of the effectiveness of the use of drip irrigation under film and without films through a row and to identify water savings on cotton varieties "Bukhara-8" in moderately saline soils and arid climates of the Bukhara region of the Republic of Uzbekistan.

3 Results and discussion

Taking into account the above literature data, in order to save and increase the freshwater resources of the planet, scientists from the Research Institute for Water and Water Resources of the Bukhara Scientific Research Institute of Water Research conducted research work on saving water and resources on the Bukhara-8 cotton plant in hot, dry climates and saline soils.

Analyzing, the two-year data on the study of water and resource-saving technologies of cotton on a scientific basis was determined as follows: The entire drip irrigation equipment (Tanks, filter device, mineral fertilizer distribution device, underground pipes and above-ground irrigation hoses) per 1 ha, amounted to 2.5 thousand dollars. After washing the salts, in all variants of the experiment, 70% of phosphorus and potassium fertilizers were applied in pre-sowing tillage, nitrogen and the rest (30%) of macro and micro fertilizers under the soil were applied through drip irrigation water. Sowing of cotton seeds was carried out on April 12. The density of standing cotton was 125-130 thousand. bushes per hectare. During the growing season, cotton of the Bukhara-8 variety was watered through a row 21 times in the 2-3 variant. In the control variant, it was watered by the furrow method 4 times with a norm (1100-1100-1200-800m^3/ha) and water calculations were carried out with Chippoletti devices. On each variant during the growing season, all planned records were made on 4-5 rows of 8 rows. During the growing season, phenological observations were made, soil moisture, water consumption, pH of the environment, soil salinity, and water consumption were determined to obtain 1 centner of yield.

Table 2 shows data on the growth and development of cotton varieties Bukhara-8.

Analyzing table 2 on cotton growth and development, during the first and last growing seasons. It was found that the growth and development phases were improved and accelerated in the no-film drip irrigation and black-film drip irrigation through-row hose laying compared to the (furrow) control option.

The height of plants, the number of sympodial branches, the number of mature bolls, of which open, total and vegetative water consumption at the end of the growing season (September 1) according to the experimental options. Respectively, were: 100-125-120cm; 16-19-18pcs/bush; 7-12-10pcs/bush; 3.5-10-7pcs/bush; 7200-5660-6150 m^3/ha; 4200-3465-3770 m^3/ha, which is respectively higher than the control one by: 25-20cm; 3-2 pcs/bush; 5-3pcs/bush; 6.5-3.5pcs/bush; saving water by 1540-1050m^3/ha; 735-430 m^3/ha.

It should be noted that in the years under study (2021-2022), especially in 2022, the air temperature was very hot and long (from 42 to 53^{0}C) with dry, hot winds (the duration of stressful days lasted almost 60-70 days). Of course, under such unfavorable conditions, since the soil is saline and the depth of groundwater is close, it goes without saying that, due to an increase in the transpiration coefficient, the accumulation of harmful salts rises to the topsoil and has a negative impact on the growth and development of crops.

Table 2. Effect of drip irrigation on the growth and development of cotton.

months	May				September				
Experience options	**Growth height, cm**	**Number of sympodia, pcs.**	**Buds, pcs.**	**Height, plants, cm**	**Number of sympodia, pcs.**	**Number of bolls, pcs.**	**Of them disclosed, pcs.**	**total water consumption,m^3/ha**	**Vegetation irri gation, m^3/ha**
Furrow irriga tion (control)	22	3	-	100	16	7	3.5	7200	4200
Drip irrigation with a film, laying hoses along a row	33	6	5	125	19	12	10	5660	3465
Drip irrigation without film, laying hoses lengthwise in a row	31	6	3	120	18	10	7	6150	3770

Despite such stressful conditions, where drip irrigation with black film and no film was used laying hoses through the row, the first irrigation was started when the soil Limiting field moisture capacity (LFMC) was 65% in all variants, and the remaining irrigations, depending on the variant and soil (LFMC), were watered differently. In the control variant, they watered (according to the scheme 1-2-1) 4 times (the soil LFMC) 65-75-65%). On each irrigation, the average water consumption was 1050 m^3/ha, and on the 2nd-3rd variant, it was watered 21 times during the growing season, i.e. on each irrigation, the average water consumption was respectively: 165.0-179.53 m^3/ha.

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Among the options studied, the best irrigation technique and water savings was drip irrigation with black films laying hoses across the row (2nd option). In this variant, total water savings compared to furrow irrigation were higher by 1540 m^3/ha. In option 3, total water saving is 1050 m^3/ha.

Table 3 shows the data on the consumption of total and vegetation water in a cotton field to obtain 1 center of the crop.

Table 3. Consumption of total and vegetation water in a cotton field to obtain one center of cotton harvest (2022 data).

Experience options	Salt washing, m^3/ha		vegetative watering,		Total water consumption, m^3/ha		Prod uctivi ty c/ha	Water con sumption, per 1center of crop, m^3/ha
	1500	1100-1200	once		Flush ing	Vege tatio n wate ring		
	once							
Furrow irriga tion (control)	2	2	4	-	3000	4200	40	105.0
Drip irriga tion with a film, laying hoses along a row	-	2		21	2200	3465	64	54.14
Drip irrigation without film, laying hoses lengthwise in a row	-	2		21	2400	3770	53	71.13

The data in Table 3 shows that, spending 7200m^3/ha of total water on the control (furrow irrigation) variant, 40 c/ha of raw cotton yield was obtained. To obtain one center of the crop, the vegetative water consumption (4200m^3:40c =) is 105m^3/ha. In variant 2-3, these indicators were correspondingly less (water consumption) by 5660-6150 m^3/ha; 54.14-71.13m^3/ha, which received 24-13 centers/ha more yield addition compared to the control.

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4 Conclusions

Thus, in two-year studies of studies, it can be concluded that among those studied, the best option turned out to be (2-option), i.e. drip irrigation with black film laying hoses across the row.

On the second option, despite very hot, windy and dry weather conditions, favorable conditions were provided for the growth and development of cotton due to covering with black films and laying drip hoses under the films.

During the growing season, thanks to the drip device in dissolved form, the introduced organ mineral and various composite fertilizers are evenly distributed through the root systems throughout all organs of the cotton plant. Therefore, all the various compositions introduced are much better absorbed in comparison with the control and evenly distribute macro and microelements on the plant, due to the formation of favorable conditions, the accumulation of fruit elements has increased by 2 times.

In addition, due to drip irrigation under the shelters of laying hoses with black films, water condensation, the transpiration coefficient decreased significantly; CO_2 interaction with water formed H_2CO_3.

Thanks to H_2CO_3, the soil pH neutralization process improves, and in saline soils, phosphorus fertilizers in H_2CO_3 are better dissolved and the soil is desalinated, harmful salts for plants turn into harmless, additional fertilizer.

In the second and third variants, the taproots of cotton, due to the provision of normal moisture, uniform distribution of organomineral and microelements, turn into fibrous, i.e. they were in the arable, fertile soil layer. Due to the creation of favorable soil conditions, Verticella and Fusarium wilt were absent, the yield increased by 1.5-2 and the water consumption decreased by 1.94-1.48 times.

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