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Application of Water Saving Irrigation Technology in Cotton Cultivation

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ABSTRACT: The article presents use water-saving irrigation technology, including of drip irrigation on the growth, development and yield of cotton in the conditions of slightly saline, light and medium loamy soils of the Bukhara region and the results of experiments on the study. The effectiveness was proven in experimental fields when the soil moisture before irrigation was maintained at 70-80-65 % compared to the marginal field humidity (MFMC) during irrigation using the method of drip irrigation of cotton. When watering cotton using drip irrigation technology with soil moisture of 70-80-65 % compared to MFMC, compared with the furrow irrigation method during the irrigation season on soils with a light mechanical content of 1692-2067 m^3/ha and on soils with an average mechanical content of 1325-1660 m^3/ha. the amount of river water was economical. According to the results of the economic analysis, in the 2nd variant of drip irrigation (70-80-65 % compared to the MFMC), a conditional profit was revealed compared to variant 1 (furrow irrigation) by 6836 thousand Uzbek soums (1 USD=1100 Uzbek soums) and the level of profitability is 17.2 % higher.

KEY WORDS: Uzbekistan, Bukhara, cotton, water-saving, drip irrigation, light soil, medium soil, marginal field moisture capacity (MFMC), irrigation rate, seasonal irrigation rate, yield, productivity, efficiency.

I.INTRODUCTION

The most important and urgent task in the country is the use of water-saving technologies in obtaining high and high-quality crops, especially cotton, in the conditions of shortage of irrigation water. The President and the government of our country pay great attention to this issue.

On July 10, 2020, the Concept of Water Resources Development of the Republic of Uzbekistan for 2020-2030 was developed. According to the Concept of Water Resources Development of the Republic of Uzbekistan for 2020-2030, the areas where water-saving technologies have been introduced will be 2 million hectares. ha, including drip irrigation technology 600 thousand ha. 35-40 % (3.5-4 billion m^3) of water saving per year is estimated at 298 thousand ha. areas that are out of use can be redeveloped [1, 8, 9].

According to analytical estimates, 1.1 billion out of 7.5 billion people in the world today suffer from water shortages. By 2025, the number of people living in water shortages is expected to exceed 3 billion and make up 40 percent of the population. That is why the attention to the widespread use of drip irrigation systems around the world is growing from year to year. In particular, great achievements have been made in the use of water-saving irrigation technology in Israel, Cyprus, the United States, Italy, Australia and Germany. The fact that Uzbekistan is the sixth largest producer of cotton in the world and the fifth largest exporter of cotton shows that the use of economical irrigation technology, including drip irrigation, is one of the most important aspects of cotton cultivation [6, 9, 14, 17].

Taking into account the above, currently in the Republic in 2020-2030, one of the main issues is the sustainable water supply of the population and all sectors of the economy, the improvement of the reclamation state of irrigated lands, the widespread introduction of the principles and mechanisms of the market and digital technologies in the water sector, ensuring the reliable operation of water facilities and increasing the efficiency of land and water resources use [1].

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II. THE DEGREE OF STUDY OF THE PROBLEM

Research studies on the improvement of methods of economical irrigation of crops in developed countries of the world have doubled the seasonal consumption of water during drip irrigation of cotton and crops of its complex (United States Department of Agriculture, USA), increased plant development of soil feed elements during drip irrigation (Univosity of Cordoba, Spain), accelerated biochemical processes on the plant during the activation of irrigated waters (St. Petersburg State Scientific Center named after Kirov, Russia), developed a technology for the use of nitrogen fertilizers for drip irrigation (State Scientific Center of Israel), studied the influence of mineral fertilizers on the reclamation state of soils in the drip irrigation system (Central Institute for Cotton Research, India), economical technologies have been developed for irrigation of new and promising cotton varieties, irrigation through flexible pipes, discrete irrigation, drip and rain irrigation [4, 5, 7].

The rational and efficient use of water resources in the face of current global climate change and growing water scarcity is essential. On the relevance of drip irrigation technology, the effectiveness of the irrigation method and its importance in the technology of water-saving irrigation when growing cotton in agricultural irrigated fields [9].

By drip irrigation of crops V.A.Dukhovniy, M.G.Khorst, Yu.G.Sheinkin, A.V.Novikova, M.A.Pinkhasov, S.N.Ryzhov, M.P.Mednis, Kh.A.Akhmedov, F.M.Sattarov, F.M.Rakhimboev, N.F.Bespalov, R.M.Ikramov, K.M.Mirzazhanov, G.A.Bezborodov, F.A.Baraev, B.S.Serikbaev, A.T.Salokhiddinov, M.Kh.Khamidov, B.Sh.Matyakubov, I.E.Makhmudov, R.A.Murodov, Sh.H.Rakhimov, A.S.Shamsiev, A.H.Karimov, S.A.Nerozin, B.F.Kambarov, A.Usmanov, B.Kamilov, B.Mallaev, T.Palvanov, E.Cholpankulov, R.Lubar, U.Norkulov, A.G.Sherov, S.A.Mamatov, Yu.Esanbekov, G.V.Stulina and M.Sarimsakov are covered in detail in the studies [8, 9, 12, 13].

Along with this, as a result of the research carried out by the scientists listed above, certain scientific results were achieved. However, changing and intensifying the farming system, year-round use of land and water resources, and increasing water shortages require the improvement of innovative water-saving methods and technologies for irrigation of crops. In this matter, the research work of the Bukhara region on the use of drip irrigation in watering cotton in light and medium sand, weak brackish soils has not been sufficiently studied.

Purpose of the study In the Bukhara region, with a groundwater level of 2.0-2.5 m, groundwater mineralization of 2.0-3.0 grams/liter, poorly salted, according to the mechanical content of light and medium-loamy soils, they will develop an optimal irrigation regime for the technology of drip irrigation of cotton and a scientific justification for the effectiveness of this technology.

III. RESEARCH METHODS

In order to mitigate water scarcity and establish rational use of available water resources at the water table of 2.0-2.5 m, with mineralization of 2.0-3.0 grams/liter. Bukhara region, improving the optimal irrigation regime for the technology of drip irrigation of cotton in low salinity conditions, in terms of the mechanical composition of light and medium soils and in 2020-2022, field research was carried out on the scientific justification of the effectiveness of this technology.

The focus of the field research was on the economical use of water, and the determination of water utilization efficiency using drip irrigation technology was aimed at improving the elements of field equipment.

The scientific significance of the results of field research work lies in the optimal norms of irrigation and drip irrigation as well as the calculation of irrigation timing was carried out on the basis of new approaches, that is, using the FAO SROPWAT program [15, 16].

The research uses methods of soil analysis, observation, measurement and cotton analysis “Methods of field experiments”, as well as FAO. The multivalued method of B.A.Dospekhov, generalized accuracy and reliability of the obtained data, as well as methods of constructing mathematical models and their numerical calculus were used [2, 3].

Research studies to study the effectiveness of drip irrigation of cotton in the conditions of slightly salty soils of the Bukhara region were carried out in two experimental fields. The soils of the Shofirkan district of the Bukhara region are light, the soils of the Vobkent district are medium soils, the depth of groundwater is 2-2.5 m, the mineralization of groundwater is 2-3 gr/l. Scientific research works were carried out through the experimental system mentioned in table 1.

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Table 1. Experimental system

№ variants	Soil moisture before irrigation, % of MFMC	Irrigation method	Irrigation rate, m^3 / ha
1.	Production control	Furrow irrigation method	Actual measurements
2.	70-80-65 % of MFMC	Drip irrigation	50-70-50 cm. on moisture deficit
3.	80-80-65 % of MFMC	Drip irrigation	

Note: Field experiments were performed in 4 replicates. 70-80-65% (before flowering of cotton: from flowering to ripening: percentage of moisture retention after ripening, relative to the limit humidity) [3, 8].

In experiments selected during scientific research, soil humidity and water-physical properties of soils in the soil layer are determined on the basis of methods in laboratory and field conditions.
On the experimental field, where the drip irrigation method was applied, soil moisture 60 cm., On the field, where the furrow irrigation method was applied, 100 cm. Soil moisture was constantly monitored from a depth.
When determining the time for watering cotton, soil moisture was detected using thermostat-weight and tensiometers. In the phases of cotton development, its demand for water was studied, optimal variants for irrigation of the crop with furrow and drip irrigation methods were tested.

IV. RESEARCH RESULTS

Favorable wet conditions and favorable reclamation conditions for the growth and development of cotton on experimental fields are created when the soil moisture obtained during cotton irrigation using drip irrigation technology is kept at 70-80-65 %. During growing season with application of drip irrigation technology during cotton irrigation works:
- on soils of light mechanical component 18 times, with norms of irrigation 174.7-218.4 m^3/ha and norms of seasonal irrigation 3283 m^3/ha;
- 15 times on soils of medium mechanical composition, 223.4-261.3 m^3/ha with irrigation standards and 3491 m^3/ha with seasonal irrigation standards.
When watering cotton using drip irrigation technology with soil moisture of 70-80-65 % compared to MFMC, compared with the furrow irrigation method during the irrigation season on soils with a light mechanical content of 1692-2067 m^3/ha and on soils with an average mechanical content of 1325-1660 m^3/ha. the amount of river water was economical.
For the growth, development and collection of high cotton yields at experimental sites, variant 2 with soil humidity obtained during irrigation through the technology of drip irrigation of rye is acceptable, with 70-80-65 % compared to the MFMC:
- cotton yield on soils of light mechanical component 4.35 t/ha;
- yield on soils of medium mechanical composition was 4.23 t/ha. and cotton yields were higher compared to furrow irrigation at 1.12 t/ha and 0,90 t/ha, respectively.
Water consumption (evapotranspiration) of cotton over the past experimental years is calculated by various calculation methods - according to empirical formulas (table 2), all calculation methods for determining evapotranspiration are based on climatic data. The best operational method is the effectiveness of the FAO program. The level of clarity of this program is very high, very simple and modern, does not require much time and hard work. The Cropwat program presented by FAO meets the time requirements and is of great importance for planning the supply of water on demand to the water of crops [10, 11].

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Table 2. Seasonal irrigation rates of cotton determined in different methods

Years of experience	Variants	Penman-Monteith	Blaney-Criddle	N.I. Ivanov	S.M. Alpatev	Field experience results
2020	1	7012	6374	7582	5341	6045
	2	4845	4326	5178	3661	4163
	3	4991	4472	5346	3754	4275
2021	1	7096	6353	7601	5338	6061
	2	4863	4345	5198	3651	4145
	3	4970	4450	5323	3739	4245
2022	1	7048	6310	7550	5302	6020
	2	4915	4400	5265	3697	4198
	3	5023	4496	5380	3778	4290

All agro-technical measures used, including irrigation and harvesting costs, were considered in determining the cost-effectiveness of cotton tillage and drip irrigation technologies. Based on the yield obtained from cotton, the conditional net profit and the degree of profitability were calculated. The cost of irrigation technology used in the calculation of economic efficiency was considered.

Table 3.Economic efficiency of irrigation in different irrigation technologies of cotton

№	Indicators	Unit of measurement	Furrow irrigation method (1-variant)		Drip irrigation method (2-variant)		Drip irrigation method (3-variant)	
			for one hectare	Total	for one hectare	Total	for one hectare	Total
1.	Crop area	ha	1	19	1	19	1	19
2.	The harvest	ton / ha	3.23	3.23	4.35	4.35	4.26	4.26
3.	Gross harvest	ton	3.23	61.37	4.35	82.65	4.26	80.94
4.	Total costs	thousand soums	20521	390566	24912	474001	24766	470545
5.	Total income	thousand soums	32381	615234	43609	828566	42707	811433
6.	Net profit	thousand soums	11860	224668	18696	354566	17941	340879
7.	Profitability	%	57.8	57.8	75.0	75.0	72.0	72.0

Note: 1 USD = 1100 Uzbek soums

On the economic side, it is analyzed that in the 2nd variant of drip irrigation (relative 70-80-65 % to MFMC) compared to the furrow irrigation, conditional profit increased by 6836 thousand Uzbek soums and profitability - by 17.2 %, compared to the 3rd variant of cotton drip irrigation (relative 80-80-65 % to MFMC), you can see an increase in conditional profit by 755 thousand Uzbek soums and profitability by 3 % (table 3) [18].

V. CONCLUSION

In the results of field studies of the Bukhara region, carried out in order to scientifically substantiate the effectiveness of the technology of drip irrigation of cotton in groundwater conditions of 2.0-2.5 m, mineralization of 2.0-3.0 gr/l, slightly salted, light and medium sand mechanical compositions, it was revealed:

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-when watering cotton using drip irrigation technology with soil moisture of 70-80-65 % compared to MFMC, compared with the furrow irrigation method during the irrigation season on soils with a light mechanical content of 1692-2067 m^3/ha and on soils with an average mechanical content of 1325-1660 m^3/ha. the amount of river water was economical.
-when irrigating cotton using drip irrigation technology, variant 2 with soil humidity of 70-80-65% is acceptable compared to MFMC: - cotton yield on soils of light mechanical component 4.35 t/ha; - yield on soils of medium mechanical composition was 4,23 t/ha. and cotton yields were higher compared to furrow irrigation 1.12 t/ha and 0.90 t/ha, respectively;
-in the 2nd variant of cotton drip irrigation (relative 70-80-65% to MFMC) compared to the furrow irrigation variant, conditional profit increased by 6836 thousand Uzbek soums and profitability by 17.2 %, conditional profit compared to the 3rd variant of drip irrigation (relative 80-80-65% to MFMC) - by 755 thousand Uzbek soums and we may see an increase in profitability by 3 percent;
-when determining the cotton watering mode, it is recommended to use the SROPWAT program according to the FAO method.

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AUTHOR’S BIOGRAPHY

Professor Matyakubov Bakhtiyar Shamuratovich has been working at the National Research University “Tashkent institute of irrigation and agricultural mechanization engineers” (NRU “TIIAME”) in Uzbekistan since 1988. His background is irrigation and drainage. During 1982-1987 Prof. Matyakubov graduated his University degree with honors from the Department of Irrigation and Melioration at TIIAME. He worked in the Department of Irrigation and Melioration during 1988-2019 as the head of a laboratory assistant, a graduate student, an assistant, associate professor, doctoral student and professor, as well as the dean of Hydromelioration faculty and the Department of Advanced Training at TIIAME. Prof. Matyakubov conducted field experiments in the

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Khorezm region in the field of cotton irrigation regime and introduction of water-saving irrigation technologies. On the basis of his research work he defended his doctoral dissertation (DSc) on the topic “Scientific and practical foundations of the effective use of water resources in irrigated agriculture: In the case of Khorezm oasis” and received a doctorate in agricultural sciences. He has published over 140 scientific and methodological works, including 1 monograph, 2 patent in water management, 5 textbooks and 1 study guide. He led the defense of 2 PhD student, 20 Masters and 86 Undergraduate students.

Nurov Dilmurod - Doctoral student (PhD) of the Bukhara Institute of Natural Resources Management at the National Research University “Tashkent institute of irrigation and agricultural mechanization engineers”. He is conducting scientific research on the topic “Effectiveness of drip irrigation technology of cotton in conditions of soils prone to salinity of Bukhara region”. To date, he has published more than 15 articles on his doctoral thesis. At the same time, he published 1 article in the international SCOPUS database. He is preparing to defend his PhD dissertation. based on the results of scientific research conducted in field conditions, while participating in international and national conferences with his lectures. He supervised the defense of 21 undergraduate students.