Scientific substantiation of technology of efficient use of water resources in irrigation of cotton

A. T. Butayarov*, and *A. A.* Nazarov

Termez State University, Termez, Uzbekistan

Abstract. Today, due to global climate change, the demand for irrigation water is growing in every part of the world, so the rational use of available water resources requires the management of water resources through water-saving technologies. It is necessary to analyze data on the rational management and efficient use of limited water resources in the country, to continuously increase the efficiency of water resources in the field, to expand the use of water-saving irrigation technologies and their application in production, and to eliminate excess water loss.

1 Introduction

The rapid growth of the world's population and the growing demand for food, the sharp increase in demand for water for agricultural products, and the rational use of water resources for irrigation of agricultural crops are of particular importance [1, 2]. In this regard, one of the most important issues in the cultivation of agricultural crops is an innovative irrigation regime and the improvement of cost-effective irrigation techniques and technologies [3]. To date, with the rational use of water resources in the cultivation of cotton, which has become one of the key issues in the sustainable economic development of the Republic, the development of science-based innovative irrigation procedures for key agricultural crops and identification of modern irrigation technologies and irrigation techniques; At the level of public policy, several programs are being implemented to address the above problems[4]. PP-4919 of the President of the Republic of Uzbekistan, dated December 11, 2020, "On measures to accelerate the introduction of water-saving technologies in agriculture", and No. PP-5005 of February 24, 2021, Adopting the resolution "On approval of the Strategy for 2023" proves this. It is no exaggeration to say that it aims to increase water use efficiency. To rationally and economically use water resources, to further improve the reclamation of irrigated lands, to increase the yield of agricultural crops, especially cotton, on this basis to ensure the sustainable operation of agricultural production . Several measures are being taken to introduce an effective system of state support for producers of raw cotton using drip irrigation technologies in cotton growing, the mechanism of incentives for enterprises producing drip irrigation systems and their components is being improved [1]. It is important to form a scientific-practical and methodological basis for the use of drip irrigation technologies, taking into account the soil-

*Corresponding author: atbutayarov@gmail.com

climatic and other conditions of the territory of the Republic.

To plan the need for water in agricultural crops in Surkhandarya region for the irrigation of agricultural crops from October 1, 2020, to April 1, 2021, i.e., an average of 970 million m^3 of water was used for the non-irrigation season, from April 1 to October 1, 2021. the limited amount of water was 3577,6 million m^3 of water allocated to the plan, and in practice, we can see that 4223,4 million m^3 more water was consumed or 118% more water was used than planned. An average of 47 hectares of land was irrigated with 1 m^3/sec of water supplied [5]. With the given water limit, 53,017 hectares of cotton fields planted for the 2021 harvest were irrigated on 53,517 hectares, and cotton grown for the 2021 harvest was irrigated an average of 6 times or 430042 hectares. In addition, water was supplied to more than 727,000 hectares of farmland and other irrigation works (Fig.1).

As of December 25, 2021, 433,2 million m^3 of water was stored in 5 existing reservoirs in the region, which is 44,83 million m^3 more than in 2020. In particular: 154,22 million m^3 in the South-Surkhan Reservoir, 60.21 million m^3 in the Topolang Reservoir, 132,93 million m^3 in the Uchqizil Reservoir, 78.36 million m^3 in the Oktepa Reservoir, The Degrez reservoir has a capacity of 7.49 million m^3 [8].

In the Surkhandarya region, it is planned to introduce water-saving technologies on 4,045 hectares in 2021, and in practice, 4,273 hectares, or 106% of the current plan [13]. Drip irrigation technologies were introduced on 2,075 hectares of cotton fields, 2010 hectares of orchards, and 188 hectares of other crops [7].

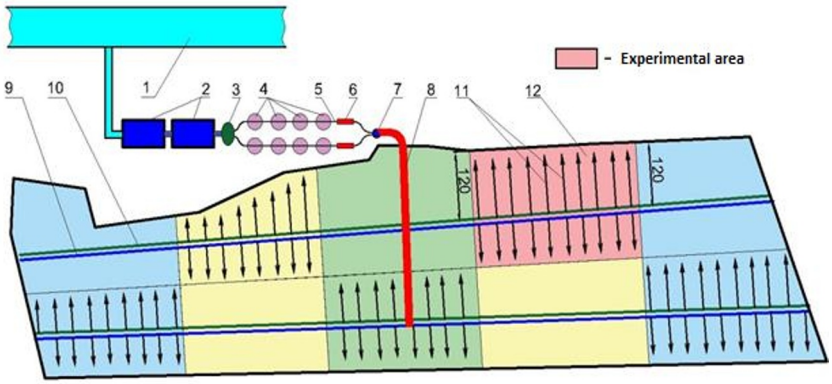


Fig. 1. Schematic view of a drip irrigation system on a field test site: 1 is Amu-zang main channel; 1a is distribution main channel; 2 is catchment pool; 3 is electric pump; 4 is sand filters; 5 is a pipe connecting the sand filter to the mesh filter; 6 is different filters; 7 is latch; 7a is manometer 8 is main pipe; 9 is distribution pipe; 10 is small distribution pipe; 11 is drop hose; 12 is field experimental areas.

2 Research methodology

Drip irrigation technologies were used by 3 entities on 2075 hectares of cotton fields, including Denov Oltin Yerlari farm in Denov district on 1970 hectares, Surkhan Sifat Tekstil LLC in Jarqurghon district on 60 hectares, and Nurmat Khojakulov farm in Shurchi district on 45 hectares. It was introduced [2].

Table 1. Weather forecast of Termez meteorological station of Surkhandarya region for 2021

Termez metostation data - 2021								
Pointer	1	2	3	4	5	6	7	8
	January	February	March	April	May	June	July	August
Air temperature, C	6.2	8.9	18.0	19.4	24.5	30.9	33.2	29.2
Relative humidity, %	66	63	59	53	51	38	37	41
Insufficient humidity, mm	4.2	5.0	10	12.9	17.2	29.6	34.3	25.5
Precipitation, mm	8.8	22.6	15.8	12.9	29.4	-	-	-

Continuation of table № 1.

Termez metostation data - 2021						
Pointer	9	10	11	12	13	14
	September	October	November	December	Average annual	Total annual
Air temperature, C	24.4	16.7	10.1	8.6	19.1	230.1
Relative humidity, %	45	53	69	71	53.8	646
Insufficient humidity, mm	18.6	11.0	4.3	5.0	14.8	177.6
Precipitation, mm	-	14.0	18.5	24.9	10.7	128.4

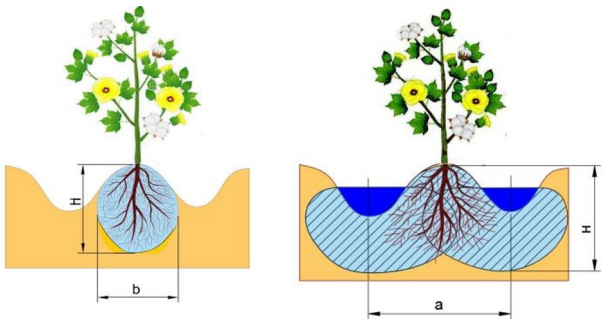
Introduction of water-saving technologies in 2020 Total drip irrigation technologies on 4515,5 hectares, including 2930,8 hectares of cotton, 1065,5 hectares of gardens, 345,2 hectares of vineyards, 74 hectares of other crops and 100 hectares of vegetable fields developed on [11]. The field cluster of the Denau branch cluster of Surkhan Sifat Tekstil LLC in Jarqurghon district was tested to determine the irrigation regime, irrigation regime, irrigation norms, and irrigation periodicity by using a drip irrigation system on 60 hectares of Sultan cotton variety in Jarqurghon massif [4-10].

3 Results and Discussion

The scope of work in this area, organizational and economic mechanisms are indicated. In particular, the task is to introduce drip irrigation systems on 25,000 hectares of land in the country by 2020, 45,6 thousand hectares in the country, and 34,0 thousand hectares in the country by flexible pipes [6]. The task is to install drip irrigation on 65,6 thousand hectares and to introduce irrigation systems on 56,0 thousand hectares through flexible pipes. It is known that drip irrigation, in general, is carried out based on the State Program for introducing water-saving irrigation technologies. Without denying the need to manage water consumption in cultivation, using water-saving methods and technologies in the fields to reduce water consumption from the soil surface, i.e., to use economical methods of irrigation, Surkhandarya region In the cultivation of high-quality cotton in 2021, drip irrigation technologies were widely used. According to the results of research conducted in the experimental field controls of the Surkhandarya region in 2020-2021, cotton was irrigated 6 times according to the scheme 1-5-0 during the growing season under production control, using the 1st (control) variant of the experiment. Due to large irrigation standards

(1070-1300 m^3/ha), the pre-irrigation moisture level in the intended layer of soil was moderately high; the crop was not irrigated during ripening, and the seasonal irrigation norms totaled 5960-6910 m^3/ha. The period between irrigations was 24-28 days [8]. In option 1 (control), with the use of drip irrigation, according to the analysis of the norms of irrigation periods, cotton varieties "Sultan" were irrigated 6 times in the order of 60-70-65% compared to ChDNS [9]. The irrigation interval is 24,26,28,25,23 days, and the average irrigation rate is 1138 m^3/ha per 1 hectare. During the season, 6830 m^3/ha of water was poured on 1 hectare.

Field experiments were conducted in the development of resource-saving technologies. According to the results of field experiments, 2,3,4- variants of options in the field experiment in 2019. Medium-pressure drip irrigation technologies were used. According to the analysis of the norms of irrigation times according to schemes 1-4-1 in options 2,3,4, "Sultan" cotton varieties were irrigated 6 times in the order of 70-75-65% compared to IFMC. The irrigation interval was 24,26,28,25,23 days, and the irrigation norm averaged 305 m^3/ha per 1 hectare. During the season, 1840 m^3/ha of water was poured on 1 hectare.

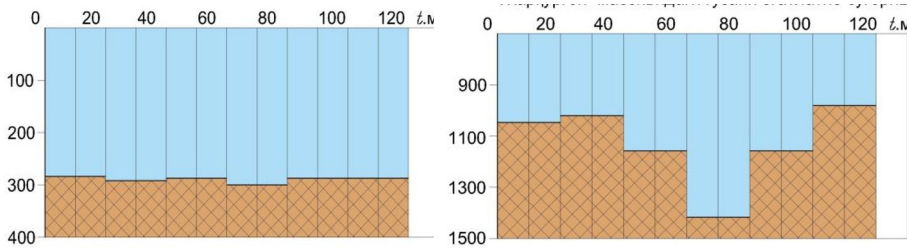


Humidification in drip irrigation

Humidity in irrigation

Fig. 2. Absorption of water in field.

In the process of drip irrigation, compared to drip irrigation, not only was water wasted, but we can see a significant increase in productivity compared to previous indicators of raw cotton. This means that the drip irrigation regime and the control option have reduced the water consumption by 50-55% compared to 6910 m^3/ha, or 3970 m^3/ha. In other words, the number of irrigations in the drip irrigation scheme did not increase, but the water consumption decreased by half.



Ipura in drip irrigation

Ipura in irrigated irrigation

Fig. 3. An overview of rate of wetting after irrigating cotton

Drip irrigation saves water by taking into account the following.
- compliance of the irrigation regime with the plant's demand for water.

- Lack of water evaporating from the soil.
- There are no weeds, so all water should be for crops only.
- water does not spread across the field and does not seep into the soil.
- No water is thrown into the dump.

Drip irrigation saves 30% to 75% of water compared to other irrigation methods. Consumption of labor and material resources is reduced. In drip irrigation, the field soil does not harden as water is supplied to the plant through hoses, resulting in no need for soil loosening (cultivation) and drainage. The uncultivated field is easily plowed at the end of the season. Since the fertilizer is applied with water, there is no need to use techniques for fertilization. As a result, cocktails and fuel lubricants are saved. In the field, divers do not need to carry a hoe and straighten the ditch, which means that manual labor in irrigation is sharply reduced.

Table 2. Order of irrigation of cotton in 2021 in the control and experimental fields of Surkhandarya region

№	Indicators	Control options						
		Number of irrigations						Seasonal irrigation norm is m^3/ha
		1	2	3	4	5	6	
Irrigation of cotton								
1	Soil moisture%	10.9	11.1	13.2	14.8	13.7	13.4	
2	Humidity relative to IFMC,%	62.8	66.7	71.5	69.8	57.5	54.6	
3	Irrigation periods	25.04	18.05	13.06	10.07	04.08	27.08	
4	Irrigation interval, days		24	26	28	25	23	
5	Irrigation duration, hours	17	17	18	19	18	17	
6	Irrigation norm, m^3/ha	1090	1070	1105	1300	1200	1145	**6910**

Continuation of table № 2.

№	Indicators	Control options						
		Number of irrigations						Seasonal irrigation norm is m^3/ha
		1	2	3	4	5	6	
Drip irrigation of cotton								
1	Soil moisture%	19.5	18.6	17.5	20.1	19.7	18.6	
2	Humidity relative to IFMC,%	67.3	69.7	69.8	71.3	73.7	70.7	
3	Irrigation periods	03.05	25.05	19.06	17.07	11.08	03.09	
4	Irrigation interval, days		24	26	28	25	23	
5	Irrigation duration, hours	10	12	11	12	11	12	
6	Irrigation norm, m^3/ha	300	310	305	310	305	310	**1840**

4 Conclusions

Irrigation of cotton in the experimental fields was carried out based on the system adopted in the scientific work program. In this case, the timing of irrigation and irrigation standards for the options was determined based on the soil's moisture level. In option 2, when determining the irrigation rate in the germination phase, soil moisture was determined at 0-50 sm, irrigation in the flowering-budding phase at 0-70 sm, and irrigation in the ripening and opening phase at 70 sm.

References

1. Serikbaev B. S., Baraev F. A., Gulomov S. B. Reliability of the system of drip irrigation. Journal Irrigation and Melioration. Vol. 4(10). pp.10-11. (2017).
2. Serikbaev B., and Butayarov A. Operational responsibility and operational reliability of cotton drip irrigation systems. In IOP Conference Series: Materials Science and Engineering, Vol. 883, p. 012037. (2020).
3. Khamidov M. K., Juraev U. A., Buriev X. B., Juraev A. K., Saksonov U. S., Sharifov F. K., and Isabaev K. T. Efficiency of drip irrigation technology of cotton in saline soils of Bukhara oasis. In IOP Conference Series: Earth and Environmental Science, Vol. 1138, p. 012007. (2023).
4. Khamidov M., and Khamraev K. Water-saving irrigation technologies for cotton in the conditions of global climate change and lack of water resources. In IOP Conference Series: Materials Science and Engineering, Vol. 883, No. 1, p. 012077. (2020).
5. Sherov A., Amanov B., Gadayev N., Tursunboev S., and Gafarova A. Basis of cotton irrigation cultures taking into current natural conditions and water resources (on natural conditions of the Republic of Uzbekistan). In IOP Conference Series: Materials Science and Engineering, Vol. 1030, No. 1, p. 012146. (2021).
6. Isaev S., Bekmirzaev G., Usmanov M., Malikov E., Tadjiev S., and Butayarov A. Provision of remote methods for estimating soil salinity on meliorated lands. In E3S Web of Conferences, Vol. 376. (2023).
7. Qodirov Z. Z., Oripov I. A., Tagiyev A., Shomurodova G., and Bobirova M. Water-saving irrigation technologies in soybean irrigation, effect of soybean on growth and development. European Journal of Interdisciplinary Research and Development, Vol.3, pp.79-84. (2022).
8. Wanjura D. F., Upchurch D. R., Mahan J. R., and Burke J. J. Cotton yield and applied water relationships under drip irrigation. Agric. Wat. Man., 55(3), pp. 217-237. (2002).
9. Kalfountzos D., Alexiou I., Kotsopoulos S., Zavakos G., and Vyrlas, P. Effect of subsurface drip irrigation on cotton plantations. Water resources management, Vol.21(8), 1341. (2007).
10. Mateos L., Berengena J., Orgaz F., Diz J., and Fereres E. A comparison between drip and furrow irrigation in cotton at two levels of water supply. Agricultural water management, Vol. 19(4), pp.313-324. (1991).
11. Basal H., Dagdelen N., Unay A., and Yilmaz E. Effects of deficit drip irrigation ratios on cotton (Gossypium hirsutum L.) yield and fibre quality. Journal of Agronomy and Crop Science, Vol. 195(1), pp. 19-29. (2009).
12. Bielorai H., Vaisman I., and Feigin A. Drip irrigation of cotton with treated municipal effluents: I. Yield response, Vol. 13(2), pp. 231-234. American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America. (1984).