Water-Saving Irrigation Technology as a Way of using Water Resources Sustainably in the Khorezm Oasis

Mukhamadkhan Khamidov, Bakhtiyar Matyakubov, Kasimbek Isabaev

***Abstract*: Agricultural water is a limiting resource in many semi-arid countries of the world due to low precipitation and high evapotranspiration. Installation of water-saving technologies has been implemented in many parts of the world to use water more sustainably. The use of water-saving irrigation technology for cotton-grain crop rotation has not been adequately studied in the Khorezm region of Uzbekistan. This study provides insights into such technology used on irrigated meadow-alluvial soils of the Khorezm region with a groundwater level of 2-3 m. On the basis of the irrigation regime, experimental work was carried out in the cotton field to determine the sustainability of irrigation technology. In addition, it was determined the duration of irrigation and the soil moisture pattern along the length of the furrows with a field moisture capacity of the soil 70-80-60%.**

The results indicate that regardless of the soil physical properties (light, medium and heavy), applying irrigation for cotton using counter furrows showed the highest yield of raw cotton, i.e. 4.1-4.2 ton/ha, which is 1.1-1.2 ton/ha more compared to traditional furrow irrigation. Moreover, under variable-jet furrow irrigation the yields of raw cotton was amounted at 4-4.1 ton/ha, which is about 0.9-1 ton/ha more compared to traditional method of irrigation. At the same time, about 16-18% of irrigation water was conserved.

***Keywords*: Cotton irrigation, drainage infrastructure, field moisture capacity, Uzbekistan.**

I. INTRODUCTION

All over the world, including the Republic of Uzbekistan today, one of the ten global problems of the 21st century is the shortage of fresh water. Over the past 60 years, the consumption of drinking water on our planet has increased 8 times. By the middle of the century, many countries will be forced to import water. Water is a rather limited resource. World agriculture uses 2.8 thousand km^3 of fresh water per year. This represents 70% of the world's fresh water consumption, which is 7 times more than the water used in world industry.

At present, irrigation water is an important key factor in geopolitics, and at the same time, one of the causes of global tension and conflict situations. Almost all the water in agriculture is used for irrigation. About 40% of world food and 60% of grain crops are produced on irrigated lands [1].

Unattended and non-regulation use of water resources leads to their global shortage. Problems in the distribution and supply of water for crops exist even in developed countries.

The search for new sources of water resources requires a large investment to service water management systems. The increase in the price of each cubic meter of water causes problems in the water supply to developing countries. If modern models of water use and water consumption will remain the same, then with an increase in population, water scarcity will increase.

In order to achieve high and sustainable yields on irrigated land, it is important to ensure timely supply of a sufficient amount of moisture required for cotton. As a result of maintaining a favorable water-nutrient, air, salt and thermal regimes, through the use of science-based water-saving technologies, you can get a high and stable yield of agricultural crops.

II. MATERIALS AND METHODS

The effects of irrigation regime, technology and irrigation technology in irrigated agriculture, taking into account the water and physical properties of the soil, as well as nutritional regimes on the growth, development, yield and quality of cotton fiber in the Republic of Uzbekistan, have been studied by many scientists, such as: S.N.Rijov, V.E.Eremenko, M.P.Pednis, Kh.A.Akhmedov, S.A. Gildiev, N.T.Laktaev, N.F.Bespalov, F.M.Rakhimbaev, K.M. Mirzazhonov, G.A.Bezborodov, B.F. Kambarov, R.K.Ikramov, Sh.N.Nurmatov, M.Kh. Khamidov, B.S.Mambetnazarov, A.Isashov, K.T.Isabaev, A.S.Shamsiev, B.Sh. Matyakubov, A.G.Bezborodov and others [2,3,4,5,6,7,8,9]. Currently in the country, given the scarcity of water resources, research on the development and use of science-based irrigation regimes of cotton and water-saving irrigation technologies, due to the need to optimize and improve the efficiency of water use in a changing water use system, crop rotations, including cotton and winter wheat is a priority.

The object of the research is the method of irrigation technology of medium-fiber cotton variety “Khorezm-127” on meadow-alluvial, different mechanical composition of soils in the Khorezm region, under the water table is 1.0-2.0 m and salinity is 1-3 g / l.

Revised Manuscript Received on December 05, 2019.

Mukhamadkhan Khamidov, Department of Irrigation and Melioration, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME), Tashkent, Uzbekistan. Email: khamidov_m@mail.ru

Bakhtiyar Matyakubov, Department of Irrigation and Melioration, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME), Tashkent, Uzbekistan. Email: bmatyakubov@inbox.ru

Kasimbek Isabaev*, Department of Irrigation and Melioration, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME), Tashkent, Uzbekistan. Email: ahmad.hamidov@gmail.com

When conducting research, analyzing the soil, observing cotton, measurements and analyzes were carried out based on the methods of the Institute of Cotton-growing "Methods of conducting field experiments", "Methods of irrigation techniques and technology" [10]. The reliability and accuracy of the obtained data were analyzed by the standard multi-factor method of B. A. Dospekhov [11], as well as using the mathematical statistical software SPSS (Statistical Package for Social Science), Statistica 7.0.

Scientific studies at the experimental plots were carried out to determine water-saving irrigation technologies that ensure optimal cotton irrigation regime [12].

To select an experimental field site, the method used by V.V.Shabanov [13] was analyzed, taking into account the natural and production conditions of the oasis, soil texture and location of the groundwater level. This method is characterized by a combination of both quantitative and qualitative characteristics of two natural systems for optimizing the experimental site: the microzone and microregion correspond to the main parameters of the experimental sites.

The main type (first testing) includes: the moisture content in the soil, water capacity, water permeability, soil texture, the amount of humus in the fertile layer (0-30 cm), the slope of the irrigated area. Second testing is the amount of cotton per 1 hectare, the amount of fertilizer supplied and soil growth.

Comparisons using the method recommended by Shabanov, the results obtained by the Pascal program were 0.567.

The suitability of the selected pilot fields for irrigated lands in the Khorezm oasis was 56.7%. Based on this, the experimental fields were chosen correctly.

Field experiments were conducted in 2013-2014 on the meadow-alluvial soils of farms "Bobo Omoniyoz" (light loam soils - experience 1 and medium loam soils - experience 2), "Abdulla" (heavy loams soils-experience 3) in the Yangibazar region of the Khorezm region in the following scheme shown in Table 1 [14, 15, 16].

Table 1: The scheme of conducting experiments on the study of irrigation technology

No.	Furrow irrigation technology on cotton	Pre-irrigation soil moisture, % of lowest humidity
1.	Production control	70-80-60
2.	Furrow irrigation with variable jet	
3.	Counter irrigation furrow	
4.	Alternate furrow irrigation	

In accordance with the recommendation of V.E. Eremenko [17], the elements of irrigation equipment were taken depending on the mechanical composition of the soil and the slope of the irrigated lands. The length of the furrow, as recommended for light loamy soils, is 80 m, on medium loamy soils, 100 m, and on heavy loamy soils, 120 m. The flow of water along the furrows is 0.60 l / s, 0.40 l / s and 0.20 l / s, respectively (in version 2, the water consumption in the furrow is halved after reaching the end of the furrow), the width between the furrows is 0.6, 0.9 and 0.9 m. The slope of the experimental plot is i = 0,00018-0,00020.

Based on the experimental schemes, field experiments were carried out in 4 variants and 4 repetitions. The size of the experimental field is: the furrow length Le = 80 m, the distance between the furrows was chosen based on the mechanical composition of the soil, a = 0.6 m (light soil), a = 0.9 m (medium and heavy soil). The number of rows is 8, 4 of which are calculated, other protective strips and the area of one variant with light loamy soil is 8 x 0.6 x 80 = 384 m^2, with a repetition area of 384 x 4 = 1536 m^2, the total area of the experimental plot is 1536 x 4 = 6144 m^2 (Fig. 1).

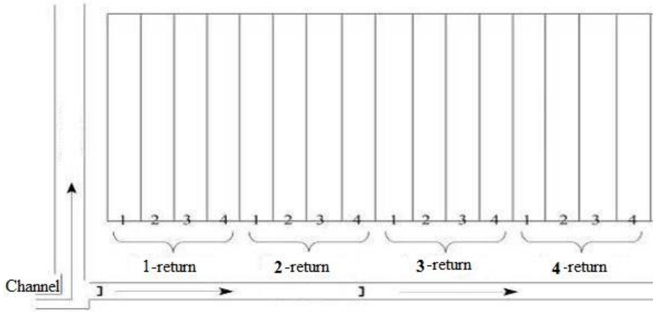

Figure 1. The scheme of the experimental plot

At the beginning of the growing season, the water-physical properties of the selected experimental site were determined.

In the first experimental plot, the bulk soil mass at the beginning of the growing season in a layer of 0-50 cm (light loam) is (on average for three years) 1.29 g / cm^3 in a layer of 0-70 cm: 1.31 g / cm^3, and in a meter layer 1.30 g / cm^3. As a result of agrotechnical measures for growing cotton, by the end of the growing season, the bulk soil mass increased. The greatest compaction of the soil was in production control: in the 0–100 cm layer it was –0.05 g / cm^3; the smallest soil compaction was observed in 3 and 4 variants - 0.02 g / cm^3.

In the second experimental plot, the bulk soil mass at the beginning of the growing season in the 0-50 cm layer (middle loam) is 1.35 g / cm^3 in the 0-70 cm layer: 1.37 g / cm^3, in the 0-100 cm layer: 1.35 g / cm^3. As a result of agrotechnical measures for growing cotton, by the end of the growing season, the bulk soil mass increased. The soil compaction in the production control was: in a layer of 0-100 cm amounted to - 0.04 g / cm^3; the smallest soil compaction was observed in the 3rd variant and amounted to 0.02 g / cm^3.

In the third experimental plot, the bulk soil mass at the beginning of the growing season in the 0-50 cm layer (heavy loam) is 1.43 g / cm^3, in the 0-70 cm layer, 1.42 g / cm^3 and in the 0-100 cm layer 1.39 g / cm^3. As a result of agricultural activities carried out during the growing season, the bulk soil mass in all variants of the experimental plot increased. Soil compaction in production control was: in a layer of 0–100 cm amounted to - 0.03 g / cm^3; the smallest soil compaction was observed in version 3 and amounted to 0.01 g / cm^3.

The maximum field moisture capacity of the soil was: in the 0-50 layer: 19.25% (experiment 1), - 20.06% (experiment 2), and 21.55% (experiment 3); in the 0-70 cm layer: -19.34% (experiment 1) - 20.26% (experiment 2) and 21.83% (experiment 3); in the 0-100 cm layer: -19.35% (experiment 1) - 20.43% (experiment 2) and 22.17% (experiment 3) by weight.

Retrieval Number: B6718129219/2019©BEIESP
DOI: 10.35940/ijitee.B6718.129219

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

The water permeability of the soil stabilized after three hours, it amounted to 110-162 m^3 per hectare. In all experimental plots, water permeability was relatively low, since the soil section was layered.

On the experimental plot 1 showed that the water permeability of the soil at the beginning of the growing season was 1469 m^3 or 0.408 mm / min, at the end of the growing season were: option 1: 1186 m^3 or 0.329 mm / min; option 2: 1211 m^3 or 0.336 mm / min; option 3: 1315 m^3 or 0.365 mm / min; option 4: 1238 m^3 or 0.344 mm / min.

On experimental plot 2 showed that the water permeability of the soil at the beginning of the growing season was 1235 m^3 or 0.343 mm / min, and by the end of the growing season: option 1: 1072 m^3 or 0.298 mm / min; option 2: 1118 m^3 or 0.311 mm / min; option 3: 1155 m^3 or 0.321 mm / min; option 4: 1132 m^3 or 0.314 mm / min.

On experimental plot 3 showed that the water permeability of the soil at the beginning of the growing season was 818 m^3 or 0.227 mm / min, and at the end of the growing season: option 1: 681 m^3 or 0.189 mm / min; option 2: 730 m^3 or 0.203 mm / min; option 3: 741 m^3 or 0.206 mm / min; option 4: 736 m^3 or 0.204 mm / min. Such patterns were in all experiments and variants.

From the point of view, the initial water permeability of soils according to V.A. Kovda [18] was satisfactory, and according to S.V.Astanov [19] from medium to weak.

The irrigated mounds were calculated based on the soil moisture deficit [20,21,22].

III. RESULTS AND DISCUSSION

In field studies, the deviation of the actual soil moisture from the target was ± 2.0 % of MMC (lowest humidity). During production control (option 1), the actual soil moisture before cotton irrigation in the years of research was 50.6-57.0 % of MMC.

Soil moisture before irrigation in the variants of irrigation of cotton on furrows with a variable stream, counter watering and irrigation through furrows varied depending on the periods of growth and development of cotton: actual soil moisture before flowering: 68.0-68.5%, flowering 78, 0-78.8% and 58.1-58.4 (3 options) during the ripening period.

At the experimental site 1, four irrigations of cotton were carried out according to the scheme 1-2-1, irrigation norms 1175-1241 m^3 / ha and irrigation rate - 4898 m^3 / ha. The irrigation period was 26-30 days. Cotton yield was 3.07 t / ha.

When irrigating cotton on variable furrow furrows (option 2), six irrigations were carried out according to the scheme 1-4-1, irrigation rates of 426-806 m^3 / ha and irrigation rate of 3611 m^3 / ha. The irrigation period was 18-25 days. Cotton yield was 3.38 t / ha, which is 0.31 t / ha more than in the control. The irrigation rate was less by 1287 m^3 / ha compared to the control.

When irrigating cotton on the opposite furrows (option 3), six irrigations were carried out according to the scheme 1-4-1, irrigation norms 432-804 m^3 / ha and irrigation norms 3587 m^3 / ha. The irrigation period was 14-20 days. Cotton yield was 4.19 t / ha, which is 1.12 t / ha more than in the control. The irrigation rate was less by 1311 m^3 / ha compared to the control.

When irrigating cotton through furrows (option 4), six irrigations were carried out according to the scheme 1-4-1, irrigation norms 430-809 m^3 / ha and irrigation rate 3625 m^3 / ha. The irrigation period was 17-23 days. Cotton yield was 3.68 t / ha, which is 0.61 t / ha more than in the control. The irrigation rate was less by 1292 m^3 / ha compared to the control. Such results were obtained in other experiments.

In the experiments, the effect of cotton irrigation technologies on the salt regime of the soils of the experimental plots was studied. During the years of research in the fourth experimental plot in the active soil layer (0–100 cm) of the control variant, at the beginning of the growing season, the amount of chlorine ions was 0.010%, and by the end of the growing season 0.0128–0.0130%, the amount of dry residue was 0.268–0.279 %, by the end of the growing season 0.326–0.339%, the seasonal salt accumulation coefficient for chlorine ion was 1.28–1.30, and for the dry residue 1.22.

In the 2nd variant, where cotton irrigation was carried out on furrows with a variable water flow rate, by the end of the growing season, the coefficient of seasonal salt accumulation by chlorine ion was 1.21–1.22, and by dry residue 1.16–1.20.

In the 3rd variant, where cotton irrigation was carried out using oncoming furrows, the seasonal salt accumulation coefficient in the 0–100 cm layer was 1.19–1.21 for chlorine ions and 1.17–1.19 for the dense residue. Compared to production control, the seasonal salinity coefficient is lower: by chlorine ion by 0.07–0.11; by the tight residue by 0.03–0.05.

In option 4, when cotton is irrigated through furrows, the seasonal salt accumulation coefficient in the 0-100 cm layer is 1.23–1.24 for the chlorine ion and 1.22 for the solid residue, which is respectively less by 0.05–0.06 and by 0.01 than in production control.

Such patterns on the influence of the irrigation regime and the technology of irrigation of cotton on the salt regime of soils were obtained in other experiments.

Ensuring a favorable reclamation regime of irrigated lands by maintaining pre-irrigation soil moisture at a level of 70-80-60% and uniform moistening of the soil along the entire length of the furrows helped to reduce the restoration of soil salinization by the end of the growing season, which are line with the findings of other researchers [23,24,25].

In experiment 1, when irrigating cotton along furrows with variable water consumption (option 2) on light loamy soils, the time of jetting (qb = 0.6 l / s) until the end of the furrow was 1.3 hours, and the duration of soil humidification, with a reduced flow rate twice (qb = 0.3 l / s) with an irrigation rate of 600 m^3 / ha, it was 2.1 hours. The duration of watering was 3.4 hours. The plot of soil moistening along the length of the furrows during cotton irrigation along variable-speed furrows is shown in Figure 1.

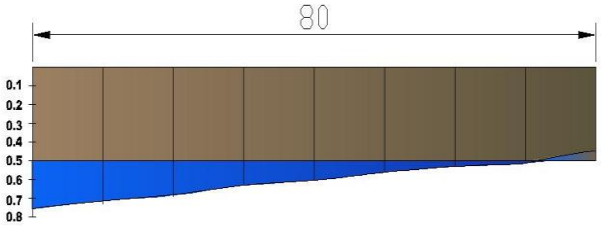

Figure 1. The plot of soil moistening along the length of the furrows during the irrigation of cotton along the furrows with a variable stream (option 2).

When cotton was watered along counter furrows (option 3), when water was supplied along the furrow slope, the jetting time (qb = 0.6 l / s) until the end of the furrow was 1.25 hours, irrigation duration at a rate of 589 m^3 / ha was 2.25 hour (Fig.2).

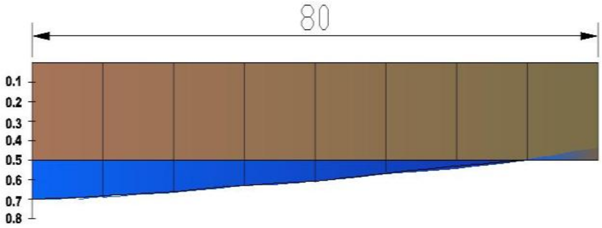

Figure 2. The plot of soil moistening along the length of the furrows (water supply on the slope of the furrow) during cotton irrigation along the opposite furrows (option 3).

When water was supplied against the slope of the furrow, in this embodiment, the jetting time (qb = 0.6 l / s) was 1.52 hours before the end of the furrow, and the irrigation duration at a rate of 589 m^3 / ha was 3.12 hours. Diagrams of soil moistening along the length of the furrows during cotton irrigation along the counter furrows are shown in Figure 3.

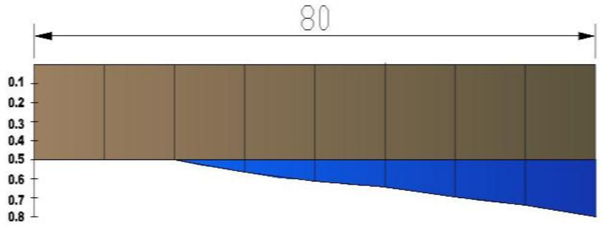

Figure 3. Plot of soil moistening along the length of the furrows (water supply against the furrow slope) when cotton is watered along the opposite furrows (option 3).

When cotton was watered through furrows (variant 4), the jet lag time (qb = 0.6 l / s) until the end of the furrow was 1.4 hours, and the irrigation duration at a rate of 600 m^3 / ha was 2.9 hours. The plot of soil moistening along the length of the furrows during cotton irrigation through the furrows is shown in Figure 4.

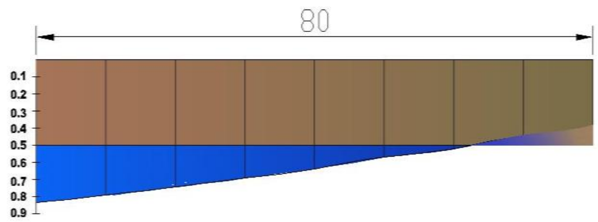

Figure 4. The plot of soil moistening along the length of the furrows during the irrigation of cotton through the furrows (option 4).

Such results on the effect of irrigation mode and cotton irrigation technology on the uniformity of soil moistening along furrows were obtained in other experiments (medium-coarse and heavy loamy mechanical compositions of the soil).

According to the results of research on the use of water-saving technologies, it can be concluded that the most effective irrigation technologies in all experiments are cotton irrigation along counter furrows and irrigation along variable jet furrows. During the years of research with these irrigation technologies, the productivity of 1 m^3 of water was 630-860 m^3 / t, which is 740-880 m^3 / t less than in the control.

Based on the results of field studies, the effective use of water is achieved through the use of counter watering and irrigation with an alternating stream along the furrows. Using these technologies, evaporation of water from the field will be reduced and a normal distribution of water along the furrow will be ensured.

Depending on soil condition for irrigation. The depth of the furrow for irrigation of cotton is 18 cm, between rows 60 cm and 20-22 cm between rows 90 cm.

When distributing irrigation norms along the furrow length using water-saving irrigation technology, the uniform distribution coefficient was 0.76-0.82, and the water use coefficient was 0.79-0.87. Water at the end of the furrows reached in 1.3-1.7 hours. Depending on the mechanical composition of the soil and the elements of the irrigation technique, 5.3 - 11.1 hours were used to ensure that the calculated soil layer was completely moistened. Water filtration during irrigation is 17-28%.

In the production control was the coefficient of performance was 0.72-0.93, while the counter irrigation of the furrow was 0.87-0.93. This was 0.15 - 0.17 more than production control.

In production control, on average over the years of research on experiments, profitability of 28.6-30.8 percent, the maximum conditional net income from 1 ha was obtained in options 2 and 3, where cotton irrigation was carried out on counter furrows and on furrows with a variable stream. Profitability is 34.6–35.1% when watering cotton over variable furrows, and profitability is 38.4–40.9% when cotton is irrigated with counter furrows, which is 6.0–10.1% more than in production control.

IV. CONCLUSION

The following conclusions can be drawn from the study:

1. In the Khorezm region of the total irrigated area of 265.4 thousand ha, 77.6 percent, i.e. 206.0 thousand ha lands are meadow-alluvial soils, 31.1% light in terms of mechanical composition, 51.0% medium and 17.9% heavy loamy soils. In the region, the area with a groundwater level of 1.0–2.0 m is 58.5% (155.3 thousand ha), the area with mineralization of 1-3 g / l –75.3% (199.8 thousand ha) Calculations of the representativeness of the soil-hydrological conditions of the sites in which the field experiments were carried out showed 56.7% compliance with the natural conditions of the Khorezm region.

2. The water-physical properties of the soils of the experimental plots vary depending on the preparation of the field for sowing, sowing, agrotechnical measures, irrigation technologies and irrigation norms.

In all experiments, the bulk soil mass increased towards the end of the growing season. The smallest compaction of 0.01-0.02 g / cm^3 was noted, where the over-irrigation soil moisture was maintained at the level of 70-80-60%.

3. While maintaining the pre-irrigated soil moisture at the level of 70-80-60% and the application of irrigation technology on the counter furrows, favorable conditions are provided for the growth, development and yield of cotton

- on light loamy soils, cotton yield was 4.19 t / ha and the irrigation rate was 3594 m^3 / ha, which is 1304 m^3 / ha less than production control;

- on medium loamy soils, cotton yield was 4.27 t / ha and the irrigation rate was 3073 m^3 / ha, which is 1934 m^3 / ha less than production control;

- on heavy loamy soils, cotton yield was 4.16 t / ha and the irrigation rate was 2702 m^3 / ha, which is 1964 m^3 / ha less than production control.

4. While maintaining soil irrigation soil moisture at a level of 70-80-60% and applying irrigation technology along variable stream furrows, favorable conditions for growth, development and yield of cotton are also provided:

- on light loamy soils, cotton yield was 4.03 t / ha and the irrigation rate was 3,611 m^3 / ha, which is 1,287 m^3 / ha less than production control;

- on medium loamy soils, cotton yield was 4.13 t / ha and the irrigation rate was 3083 m^3 / ha, which is 1925 m^3 / ha less than production control;

- on heavy loamy soils, the cotton yield was 4.08 t / ha and the irrigation rate was 2738 m^3 / ha, which is 1914 m^3 / ha less than production control.

5. As a water-saving irrigation technology, providing optimal irrigation regime for cotton, with a slope of the field of 0.00015-0.00020, the following are recommended:

-watered cotton on counter furrows, with elements of irrigation technology depending on the mechanical composition of the soil: the furrow length is 80 m (light loamy soil), 100 m (medium loamy soil), 120 m (heavy loamy soil) and furrow consumption, respectively, 0.6; 0.4; 0.2 l / s;

-Irrigating cotton on variable-furrow furrows with elements of irrigation equipment depending on soil texture: furrow length 80 m (light loamy soil), 100 m (medium loamy soil), 120 m (heavy loamy soil) and furrow consumption, respectively, 0.6; 0.4; 0.2 l / s, which are halved after the jet reaches the end of the furrow.

6. In experimental plots, high economic efficiency indicators over years of research were obtained with a pre-irrigation soil moisture regime of 70-80-60%, technology for irrigation of cotton on counter furrows and irrigation of cotton on furrows with variable spray (profitability 34.6-40.9 %).

REFERENCES

1. Atajanov A.U., Matyakubov B.Sh. “Improvement of technology, providing uniform wetting of the root zone of the soil irrigated along furrows” // International Scientific and Practical Conference “Water for Sustainable Development of Central Asia”, March 23-24, 2018, Dushanba, Republic of Tajikistan, pp. 227-240. (In Russian).
2. Akhmedov Kh.A. “Irrigation of Khorezm” // Tashkent: Uzbekistan, 1965. - p. 76. (In Russian).
3. Bezborodov A.G. “The method of calculating the elements of the irrigation technique on furrows with a constant jet for the conditions of gray-meadow new-algal soils of the Hungry Steppe” // Dep. TsBNTI State Concern “Vodstroy” 767.- Moscow, 1992. -p. 9. (In Russian).
4. Bezborodov G.A. and others. “Efficient methods of feeding of water-saving technologies of cotton-and-mineral fertilizers” // PSUEAITI Collection of materials of the international scientifically-practical conference “Selection, seeding and current trends of agrotechnology”, 2016. Section II. - p. 111-115. (In Uzbek).
5. Bespalov N.F., Rijov S.N. “Water consumption and irrigation of cotton on hydromorphic soils” // Tashkent: Bulletin of agricultural science, 1973. № 2, pp. 1-8. (In Russian).
6. Matyakubov B.Sh. “Efficient use of water in the Khorezm Oasis”// International journal of innovations in engineering research and technology [IJIERT], ISSN: 2394-3696, VOLUME 5, ISSUE 11, Nov.-2018., p. 44-49. (In English).
7. Matyakubov B.Sh. “The Role of Sustainable Technology in Efficient Use of Irrigation Water” // Khorezm Academy of Science. - Khiva, , 2019-1.– p. 77-79. (In Uzbek).
8. Kambarov B.F., Tsoi OG, Kurbonov Z.M. “Methods of irrigation technique and technology” // Irrigation regime and monitoring technique // Taroz, 2002, pp. 82 -88. (In Russian).
9. Shamsiev A. “Recycling technologies for cotton gardening” // Journal of Agriculture of Uzbekistan, ISSN 2181-502X, Tashkent 2015 - № 9, p. 42. (In Uzbek).
10. Methods of field experiments with cotton under irrigation // Publisher 5 th, Tashkent, 1981, pp. 89-134. (In Russian).
11. Dospehov B.A. “Methods of field experience (the basics of static processing of research results)” // Moscow: Agropromizdat, 1985, 415 pp. (In Russian).
12. Matyakubov B.Sh. “Water productivity in the lower reaches of the Amudarya” // The deepening of the integration of education, science and production in agriculture of Uzbekistan. Reports of the international scientific-practical conference April 23-25, 2003, Tashkent 2003. Tashkent Agrarian University. pp. 153-155. (In Uzbek).
13. Shabanov V.V, Markin V. N. “Monitoring of water supply facilities in the Soviet Union” // Moscow 2016., RGAU-MSXA, - p. 154. (In Russian).
14. Isabaev K.T., Khamidov M.Kh., Aliyeva D. “Irrigating the crops and yield” //Tashkent, “Mekhnat”.1991. p.104. (In Uzbek).
15. Raximbaev F.M, Bespalov N.F, Khamidov M.Kh., Isabaev K.T, Aliyeva D. “Features of crop irrigation in the Lower Amudarya” // Tashkent, Publisher “Fan.”, Academy of Sciences of the Republic of Uzbekistan. 1992. p. 164. (In Russian).
16. Khamidov M.Kh., Matyakubov B.Sh. “Irrigation of agricultural crops in the Khorezm Oasis” // Journal of Agrarian Science, № 6, Moscow 2001, pp. 18-20 (ISSN 0869-8155). (In Russian).
17. Eremenko V.E. “Irrigation regime and cotton irrigation technique” // Tashkent: AN Uz.SSR. 1957. - p. 402. (In Russian).
18. Kovda V.A. “Fundamentals of the doctrine of soils” // Publishing Nauka, - No. 2. Moscow, 1973. - p. 29-47 (In Russian).
19. Kostyakov A.N. “Fundamentals of land reclamation” // Moscow: Selkhozgiz, 1960, - p. 621. (In Russian).
20. Nazarov R. “Fertilizing cotton on intensive technology” // Journal of Agriculture of Uzbekistan, ISSN 2181-502X, Tashkent, 2014. № 4, p. 9. (In Uzbek).
21. Rijov S.N. “Optimum soil moisture in cotton culture” // Soviet cotton, 1940. № 6. (In Russian).
22. http://www.cawater-info.net/int_org/icid/index.htm
23. Balla, D.; Omar, M.; Maassen, S.; Hamidov, A.; Khamidov, M. (2014) Efficiency of duckweed (Lemnaceae) for the desalination and treatment of agricultural drainage water in detention reservoirs. In Lothar Mueller et al. (Eds.): Novel measurement and assessment tools for monitoring and management of land and water resources in agricultural landscapes of Central Asia. Leibniz Centre for Agricultural Landscape Research (ZALF). Dordrecht: Springer, pp.423–440.
24. Jurayev, U.; Balla, D.; Khamidov, M.; Hamidov, A. (2016) Improvement of drainage water quality through biological methods: A case study in the Bukhara region of Uzbekistan. European Science Review 9–10, 162–167. DOI: 10.20534/ESR-16-9.10-162-167.
25. Khamidov, M.; Nazaraliev, D.; Hamidov, A. (2009) Soil protection and anti-erosion techniques for cotton irrigation. International Journal of Geology 3 (1), 17–19.

AUTHORS PROFILE

Prof. Mukhamadkhan Khamidov has been working at the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME) in Uzbekistan since 1979. His background is hydraulic engineering. He received his PhD from the Uzbek Research Institute for Cotton Growing (SoyuzNIHI) in 1985 on "Irrigation regimes of cotton, alfalfa and maize on heavy loamy soils of the Khorezm oasis". Moreover, he successfully defended his doctoral dissertation in 1993 on "Scientific foundations for improving water use on the irrigated lands of the Khorezm oasis" and was awarded the academic title Professor. Prof. Khamidov worked as a Dean of Hydromelioration faculty at TIIAME during 1996–2010. He served as the director of Bukhara branch of TIIAME during 2010–2013. Last but not least, he was the Rector of TIIAME during 2013–2017. Since 2017 he works at the Department of Irrigation and Melioration at TIIAME, conducting research and lecturing the students on irrigation and drainage related studies. Under his direct supervision, more than 20 PhD and Doctor of Sciences (DSc) students successfully defended their dissertations. Based on his scientific works, Prof. Khamidov has published more than 150 scientific works. More than 20 of his works have been published internationally (e.g. in the USA, Germany, Portugal, Austria, Greece, Russia, Ukraine, Kazakhstan and Moldova).

Noteworthy to mention that Prof. Khamidov was awarded the "Shukhrat" medal in the Republic of Uzbekistan and the honorary title of "Honored Worker of Science" in the Republic of Karakalpakistan for his active contributions to the field of agriculture and water resources. He was also awarded the Gold Medal in Science by the International Organization for Economic Cooperation and Development (OECD).

Currently, Prof. Khamidov is the chairman of the scientific seminar at the Specialized Council for awarding a PhD at TIIAME as well as a member of the Specialized Councils for awarding a DSc at TIIAME and SoyuzNIHI.

Prof. Bakhtiyar Matyakubov has been working at the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (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 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 90 scientific and methodological works, including 1 monograph, 1 patent in water management, 2 textbooks and 1 study guide. He led the defense of 1 PhD student, 12 Masters and 65 Undergraduate students.

He also serves as an Agronomy consultant at the AgroMart.Uz portal. Since January 2017 he advises over 8,000 farmers in Uzbekistan.

Dr. Kasimbek Isabaev has been working at the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME), Uzbekistan since 1980. His background is hydraulic engineering. During 1980–1983, Dr. Isabaev was a PhD student at the Uzbek Research Institute for Cotton Growing (SoyuzNIHI). At the end of his studies, he successfully defended his PhD thesis on "Water consumption and irrigation regime of agricultural crops in meadow soils of Khorezm oasis". He also worked as the dean of Hydromelioration faculty during 2010–2012. Since 2012 he is an assistant professor at the Department of Irrigation and Melioration.

Dr. Isabaev's research interests include improvement of crop irrigation regimes, water-saving equipment and irrigation technology, and optimization of reclamation regimes of irrigated lands in the arid zone. Under his leadership, 8 Master students defended their theses. He has also prepared and published about 100 scientific and methodological works, including 3 textbooks. More than 9 of his works have been published abroad (e.g. in Poland, India, Russia, and Kazakhstan).