Soil Protection and Anti-Erosion Techniques for Cotton Irrigation

Mukhamadkhan Khamidov[1], Dilshod Nazaraliev[2], Ahmad Hamidov[3]

Abstract
In the Republic of Uzbekistan, irrigation erosion is one of the most commonly occurring problems adversely affecting agricultural productivity. This environmentally dangerous phenomenon is spread for over 660 thousand hectares in the country. In order to prevent the negative effects of irrigation, it has been developed an anti-erosion technique for cotton irrigation on eroded soils. A zigzag furrow irrigation technique was seen as the most productive and efficient way to prevent soil erosion and subsequently, increase the production. The results reveal that using zigzag furrow irrigation practices, the yield of cotton reached to 3.35 tons/ha, about 0.6 ton/ha more than the traditional straight furrow irrigation. Furthermore, this technique significantly contributed to the improvement of agro-physical properties of the soil in the experimental stations of the Uzbek Research Institute of Cotton Growing.

Keywords
Anti-erosion techniques, zigzag furrow irrigation, conventional (straight) furrow irrigation, cotton growing.

I. Introduction

IT is known that water and land resources in the republic of Uzbekistan are limited. Therefore, the only way to increase the biomass of cotton or other potential crops in the nation is through the increase of productive capacity of each hectare of land (Gussak et al., 1963).

In the complex of measures aimed at rational use and improvement of irrigated lands, the most important role plays to combat irrigation-soil erosion, because the introduction of crop irrigation by furrows in the foothills of the republic vast spread of irrigation erosion could be observed (Besedin et al., 1978).

In the country, this kind of erosion affects crops in the area of more than 660 thousand hectares. It is environmentally dangerous phenomenon commonly occurring in Tashkent, Samarkand, Kashkadarya, Surkhandarya, Andijan, Namangan, Djizzakh and partly Fergana region of Uzbekistan, which annually loss their fertile soils and also cotton yield by about 15-30% (Mirzadjanov, 1971). As can be observed, the flushing of soils containing high toxic chemicals in it pollutes the environment (Geldiyev, 1966). In this regard, the development of measures to combat irrigation-soil erosion, rehabilitation and improvement of soil fertility is of great economic and ecological importance.

The main purpose of this research is to develop anti-erosion elements of technology in furrow irrigation of cotton fields on eroded soils.

II. Materials and Methods

Experiments on these specific tasks were conducted at the Central Experiment Base of Uzbek Research Institute of Cotton Growing as follows:

1st option - conventional (straight) furrow irrigation with the depth of 10-12 cm, with sliced hillers (control);

2nd option - furrow with the depth of 10-12 cm with transverse ridges (5 ridges per 1 linear meter), sliced with special instrument, party placed on the cultivator KHU-4 instead of hillers.

The slope of the ground surface is 0.01, the sort of cotton is Okdarya-6, and the volume of water flow into each furrow is 0.15 l/sec.

Observations, descriptions, and the field experiments carried out in accordance with the «methodology of field and vegetation experiments with cotton» (UzRICG, 1981).

III. Results and Discussions

Results of theoretical and field experiments on the development of sustainable irrigation regimes, irrigation techniques and technologies of cotton, as well as anti-erosion control measures in the foothill lands, composed of typical *serozems*, allow us to state the following points:

- soils in piloted production units - typical irrigated *serozems*, middle eroded, texture particles - medium loamy. In the arable layers, the nutrient contents were: humus - 0.83%, mobile phosphorus – 19.5 mg/kg of soil, nitrated nitrogen - 9.5 mg/kg of soil, and the exchange potassium - 227 mg/kg of soil. The results reveal that the contents of humus and nitrogen substances are very low in the experiment area. In the meantime, the content of phosphorous is considered to be moderately sufficient, and the content of potassium looks to be rich;

- long cultivation of cotton on the same irrigated area to some extent affects the water-physical properties of the soil. Thus, the bulk density by the end of the experiment has

[1] Professor, Director of Bukhara Branch of Tashkent Institute of Irrigation and Melioration, Uzbekistan; e-mail: khamidov_m@mail.ru
[2] Dr., Head of Hydrology and Hydro-geology Department, Tashkent Institute of Irrigation and Melioration, Uzbekistan; e-mail: dnazaraliev@bk.ru
[3] PhD student, Faculty of Agriculture and Horticulture, Humboldt University of Berlin, Germany; e-mail: ahmad.hamidov@agrar.hu-berlin.de

increased by 0.002 g/cm^3, and the permeability of the soil decreased by 0.04 mm/min;

Influence of shape and depth of furrows on the speed of irrigation water in furrows, m/sec. (volume of flow - 0.15 l/s, length of furrows - 100 m, depth of furrows - 10-12 cm) is given in Table 1.

Table 1. Influence of shape and depth of furrows on the speed of irrigation water in furrows, m/s

Replication	***Irrigation periods***			
	1st	***2nd***	***3rd***	***4th***
Conventional (straight) furrow irrigation				
I	0.26	0.25	0.27	0.26
II	0.27	0.25	0.26	0.26
III	0.27	0.28	0.27	0.28
Zigzag pattern for furrow irrigation (5 ridges per 1 linear meter, depth 10-12 cm)				
I	0.17	0.17	0.18	0.16
II	0.18	0.17	0.17	0.15
III	0.18	0.16	0.17	0.18

As can be seen, the highest speed irrigation system installed in the version where cotton is irrigated by conventional (straight) furrow. The water movement rate on a zigzag furrow is almost two times less than in a straight furrow. This provision modifies the processes of soil erosion (Figure 1).

Fig.1. A zigzag furrow irrigation in cotton field

The lower velocity of irrigation water on a zigzag furrows leads to a smaller volume of soil erosion and, consequently, removal of these nutrients. That, in turn, has beneficial effects on increasing crop yields (Table 2).

Table 2. Water leaching with drainage water during cotton irrigation, t/ha

Options	Irrigation periods					Total
	1st	2nd	3rd	4th	5th	
Conventional furrow	8.6	8.3	9.0	10.0	8.2	44.1
Zigzag furrow	5.9	5.0	6.2	6.6	-	23.7

The results of this investigation revealed that at the same steepness of the slope and magnitude of the stream, the loss of irrigation water and soil on the alignment, depending on the shape and depth of the furrow varies widely.

With four conventional furrow irrigation, an average norm for cotton irrigation was 6,496 m3/ha, while the volume of discharge reached 2,916 m3/ha, while at a zigzag pattern - 960 m3/ha.

In the liquid effluent, the content of N-NO3 is 7.77-8.22, N-NH4 -3.50-3.62, and P2O5 – 0.68-0.58 mg/liter. Thus, the zigzag type furrow irrigation keeps soil fertility in good condition and prevents land degradation, as compared with the usual - conventional furrow irrigation (Fig. 2)

Fig.2 Land degradation at the end of conventional (straight) furrow

IV. Conclusion

The highest yield of cotton at a relative minimum of soil erosion obtained by zigzag furrow – 3.35 tons/ha. This is 0.6 tons/ha more than the conventional furrow irrigation.

Thus, the zigzag furrow irrigation, as anti-erosion measurement, reduces the discharge of water and erosion processes, contributing to the growth and development of cotton.

In addition, the research results revealed that using zigzag furrow irrigation in cotton field significantly improved soil agro-physical properties: soil bulk density was reduced by 0.02-0.03 g/cm3 at the end of the experiment as compared to the initial sample, and soil-water permeability increased by 19,6%. It was also seen that about 1,371 m3 (or 20%) of water per hectare was conserved in zigzag furrow irrigation as compared to the traditional furrow irrigation practices.

The findings also show that during the zigzag irrigation practices, organic fertilizers were well absorbed by cotton leading to the improvement of soil fertility. Therefore, the growth and development of cotton was improved and about 8% of increase was observed as compared to control sample.

Acknowledgment

The authors indebted to the International Center for Agricultural Research in the Dry Areas (ICARDA) who provided financial support under the “use of micro-furrow irrigation on cotton field” project grant. Additional gratitude

goes to Sabirjan Isaev, head of laboratory department in Uzbek Research Institute of Cotton Growing, for his constant support during the field experiments and laboratory analysis.

REFERENCES

[1] S. A. Geldiyev, "Questions of land reclamation and irrigation in cotton-growing", Proceedings of Uzbek Research Institute of Cotton Growing. Edition 14, 1966, Tashkent, Uzbekistan.
[2] V. E. Eremenko, "Irrigation regime and irrigation techniques in cotton-growing", Publication: FAN (SCIENCE), 1973, Tashkent, Uzbekistan.
[3] P. N. Besedin, K. M. Mirzadjanov, K. P. Pagayans, "Soil erosion in irrigation and the ways to liquidate it", 1978, Tashkent, Uzbekistan.
[4] V. B. Gussak, Kh. M. Makhsudov, "Irrigation erosion in typical serozems and questions to combat them", Tr. NIIP AN UzSSR, Edition 3, 1963, Tashkent, Uzbekistan.
[5] K. M. Mirzadjanov, "Erosion prevention in irrigated lands", 1971, Tashkent, Uzbekistan.
[6] Uzbek Research Institute of Cotton Growing (UzRICG), "Methods of conducting field investigations with cotton", Proceedings, 1981, Tashkent, Uzbekistan.