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Influence of Cotton Irrigation with Drainage Water on the Soil Reclamation Regime

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Abstract. The article presents the results of a study of the influence of land reclamation regime due to cotton irrigation, biological reduction of the salinity of collector-drainage waters using aquatic plants to create additional water sources, irrigate crops, and obtain sustainable results yields in conditions of water shortage. Experience increased mineralization of drainage water in the small ponds. From water plants, such as Lemna minor, Azolla caroliniana and Eichhornia crassipes. When analyzing the salt regime of the soil, the content of chlorine ions in the control variant with direct irrigation with drainage water at the end of the growing season was 0.034%. With the method of reduced mineralization using aquatic plants, the content of chlorine ions in the soil was 0.025-0.029 %. It is less salt build-up. The yield of cotton was 31.9 c/ha in the control variant and more than the control 7.9-8.4 c/ha in other experiment variants.

INTRODUCTION

Today, 6-7 million hectares of land around the world become unusable every year. Forty percent of irrigated land is saline to varying degrees. Land reclamation is deteriorating by 16% due to depletion of soil nutrients, salinization and pollution, and by 3-5% due to compaction, subsidence and swamping [1]. In irrigated lands located in arid regions with different natural and economic conditions, it is important to maintain their sustainable reclamation status through the widespread use of irrigation reclamation measures in times of growing water shortages [2,3].

Scientists worldwide are researching certain priority areas to prevent water shortages, improve land reclamation, create additional sources of water for irrigation [4]. It is important to increase the effectiveness of bio-ameliorative measures to improve the reclamation of saline areas, achieve sustainable yields of agricultural crops in times of water scarcity, save water resources for saline leaching, and increase the efficiency of water irrigation water, to use biotechnologies to improve land reclamation. [5, 6].

The search for new water sources in Central Asia is one of the important tasks where water shortages are acutely felt. Therefore, expanding access to collector-drainage, groundwater and wastewater in agriculture helps prevent the negative consequences of water scarcity [7, 8].

There are 24.3198 km^3 of irrigation groundwater reserves under irrigated lands in Uzbekistan. From nix 0-1.0 g/l, mineralized water consists of 0.6234 km^3, 1-3.0 g/l - 15.93 km^3, 3-5.0 g/l 4.4 km^3, 5-10 g/l mineralized water is 2.8 km^3 and irrigation groundwater with a mineralization of 10-20 g/l - 0.6 km^3. The total volume of irrigation groundwater is 24.3 km3 of reserves, which can be used as an additional source of irrigation water and fill the shortage of irrigation water [9, 10].

The quality of drainage water depends on natural-economic, hydrogeological, soil-reclamation and water-economic conditions and on the ability to be characterized by the following indicators: generally accepted values; the amount of sodium ion; chloride ion content; the amount of sole magnesium; depends on the chemical composition of salts dissolved in water [11].

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Extensive research has been conducted on the use of mineralized collector-drainage water in irrigated agriculture. In some experiments, negative effects on soil and plant growth were observed when irrigating using collector-drainage water, while in some experiments, high results were observed [12, 13, 14].

The efficiency of using saline collector-drainage water for irrigation depends mainly on the biological properties of crops, water-physical properties of the soil, plant resistance to salts, drainage of the territory and the composition of salts in the water. Irrigation with mineralized water in the republic is carried out depending on the level of the water supply of the year. Irrigation with mineralized water in arid areas depends on the level of water supply in the year [15,16, 17].

In the conditions of the Syrdarya and Bukhara regions of the Republic of Uzbekistan, more than 6.0 million m^3 of water with mineralization of 1.39 g/l (chlorine - 0.16 g/l) is used for the cultivation of about 5000 hectares of land per year. More than 4.0 million m3 of irrigation water in the Bukhara region with a salinity of 1.0–3.0 g/l irrigate about 3000 hectares per year. More than 1000 hectares of land are irrigated with vertical drainage, the salinity of which is 0.5-1.14 g/l [17].

The study aims to develop scientific and practical recommendations for irrigating cotton with improved quality drainage water, reducing the mineralization of collector-drainage water biologically to reduce the negative effects of water scarcity in arid areas and saline soils, improve land reclamation.

The objectives of the study are:

- To determine the effect of aquatic plants of Little Ryaska (Lemna minor), Azolla (Azolla caroliniana) and Eichhornia (Eichhornia crassipes) on the mineralization of drainage water in small ponds in the field;
- to determine the effect of irrigation with improved drainage water on the reclamation regime of irrigated lands - changes in the level and mineralization of groundwater and salt accumulation in the soil;
- The effect of irrigation with improved drainage water on cotton yield and the quality of cotton fiber.

The object of the study was meadow alluvial, saline soils of medium mechanical composition, mineralized collector-drainage waters of various degrees, salt-absorbing ameliorant plants Little Ryaska (Lemna minor), Azolla (Azolla caroliniana) and Eichhornia (Eichhornia crassipes) and cotton of Bukhara-102 variety. In this research object was applied an irrigation technology with improved drainage.

The subject of the study was the reduction of mineralization of collector-drainage water in the arid and saline soils of the Bukhara oasis with the help of aquatic plants Little Ryaska (Lemna minor), Azolla (Azolla caroliniana) and Eichhornia (Eichhornia crassipes). The subject of the study is to determine the effect of changes in mineralization and salt accumulation in the soil.

METHODS

The methods are field, laboratory research and phenological observations on cotton breeding, growing seeds of agricultural technologies Research Institute "methods of conducting field experiments" (UzPITI 2007) [18], the international DIN and ZALF standard of agricultural technologies Research Institute of agricultural technologies. Also, the water-physical properties of soils, agrochemical indicators and the number of salts in the soil were carried out following the "Methodology for studying the agrochemical, agrophysical and microbiological properties of irrigated cotton areas" [19] mathematical and statistical analysis of the accuracy and reliability of the data obtained was carried out based on B.A.Dospekhov "Methods of conducting field experiments" and a computer program using a linear regression model and correlation methods.

RESULTS AND DISCUSSION

Research has been carried out on cotton irrigation by biological reduction of the mineralization of collector-drainage waters using aquatic plants Lemna minor, Azolla caroliniana and Eichhornia crassipes. Scientific research was carried out in the fields of farms of the Kagan district of the Bukhara region according to the following system: Variant 1, (control) - direct irrigation of collector-drainage water; variant 2 - irrigation with drainage waters of which biological purified by a water plant Lemna minor; variant 3 - irrigation with drainage waters of which biological purified by a water plant *Azolla caroliniana*; variant 4 - irrigation with drainage waters of which biological purified by a water plant *Eichhornia crassipes*.

In the course of the study, when cultivating cotton of the "Bukhara-102" variety due to irrigation, reducing the mineralization of collector-drainage waters by biological methods on the reclamation regime of the soil: salt composition of the soil, the level and mineralization of groundwater, and the yield of cotton.

In the study of norms and duration of polyvin variants rasschityvalis according to the formula S.N. Ryjova ot zavisimosti urovnya vlajnosti pochvы [20]. The amount of water supplied to the field is determined by pumping units installed in the pool and measured by the water meter "Chipoletti VCh-75".

The cotton was irrigated 5 times according to the 1-3-1 system, at 70-75-65 % relative humidity of the soil moisture capacity before irrigation. Irrigation rates averaged 736-1210 m^3/ha, seasonal - 4201-4596 m^3/ha. The watering duration is 14-22 hours, the interval between waterings is 16-25 days.

The average annual location of groundwater in scientific research was 1.92-2.56 meters. The period of the closest groundwater level to the surface is July-August, and the lowest period is November-December. The amplitude of groundwater changes during the year was 0.41-0.53 meters (figure 1).

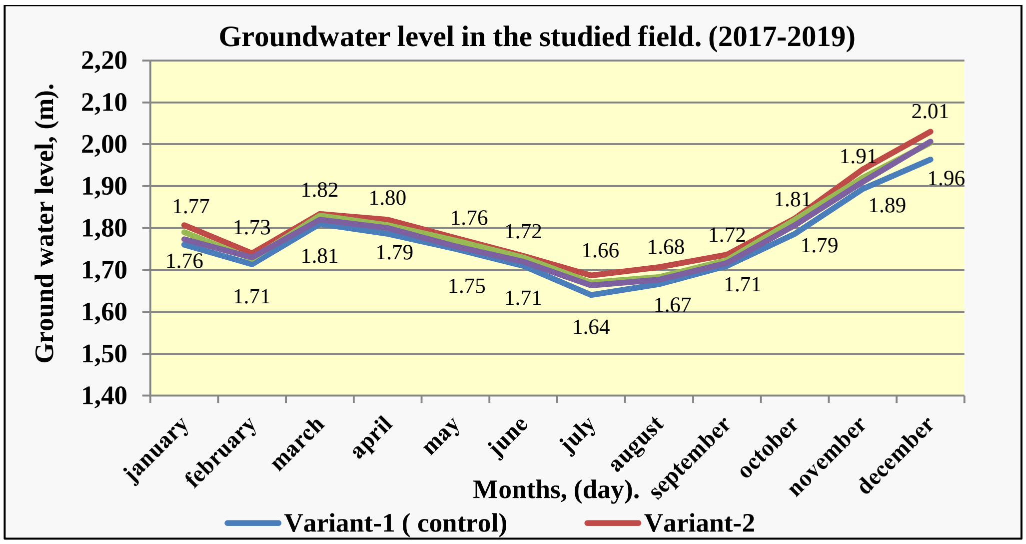

FIGURE 1. Dynamics of the groundwater level in the field of research

The degree of groundwater mineralization is continuously related to the amount and mineral composition of irrigation water supplied to irrigated areas and groundwater level. When the degree of groundwater mineralization is high and close to the surface, the amount of salt accumulates in the active layer, where the roots are scattered, which leads to re-salinization of the soil. The irrigation regime for agricultural crops on irrigated lands significantly affects the degree of soil salinity and groundwater mineralization. The level of groundwater mineralization in the experimental plot was determined once every ten days during the growing and new growing periods. Groundwater samples were taken from observation wells installed in the experimental field, dry residue and other salts were determined using water absorption analysis in laboratory conditions. (figure 2, 3).

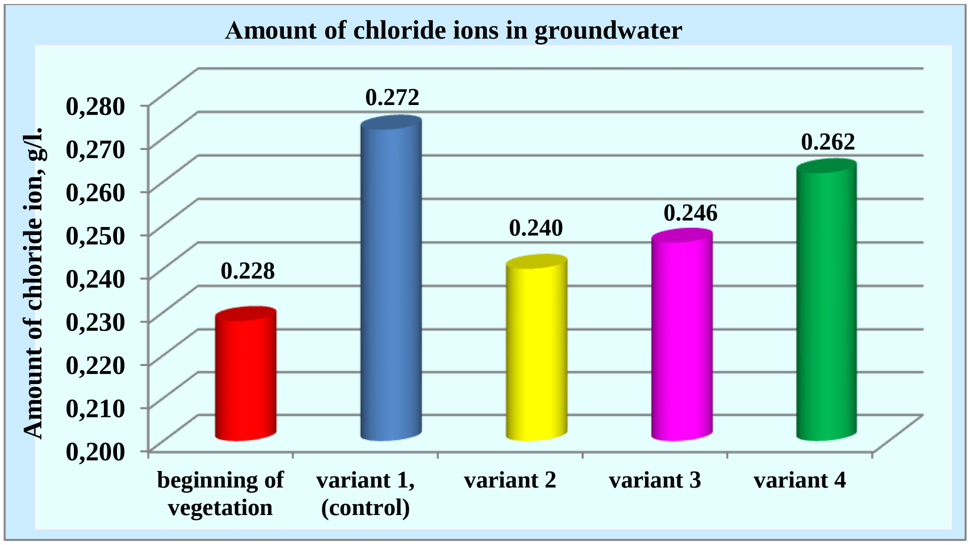

FIGURE 2. Changes in the number of chlorine ions in groundwater.

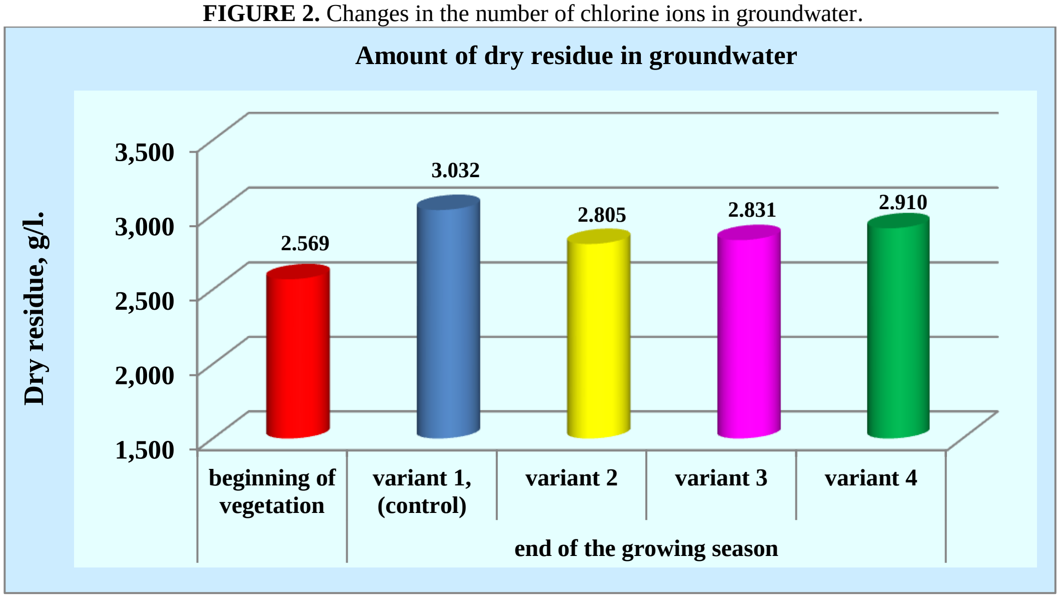

FIGURE 3. Change in the amount of dry residue in the composition of groundwater, irrigation of cotton with drainage waters

In the studies, a high degree of groundwater mineralization was observed in a field directly irrigated with drainage water. When analyzing changes in the content of dry residue and chlorine in groundwater in 2017, at the beginning of the growing season, the dry residue content was 2.612 g/l of the period, and the content of chlorine ions was 0.235 g/l. At the end of the growing season, the control variant with direct irrigation from the drainage, the amount of dry residue in the groundwater increased to 3.084 g/l, and the chlorine content increased to 0.276 g/l. In variant 2, cotton irrigation by biological reduction of drainage water salinity using the aquatic plant Lemna minor, the dry residue content in groundwater increased to 0.240 g/l and amounted to 2.852 g/l. Accordingly, the amount of chlorine ion increased to 0.013 g/l compared to the result obtained at the beginning of the growing season and amounted to 0.248 g/l. This showed less chloride ion accumulation of 0.028 g/l and solids of 0.232 g/l compared to the control.

In the course of the study, the influence of seasonal accumulation of salts in the soil during cotton irrigation was analyzed by reducing the mineralization of collector-drainage waters using water plants. During the study, the number of salts in the soil was determined at the beginning and end of the growing season, before and after each watering. The observations, the amount of dry residue, chloride ion, sulfate ion and hydrocarbonate in the soil was determined. (figure 4, 5).

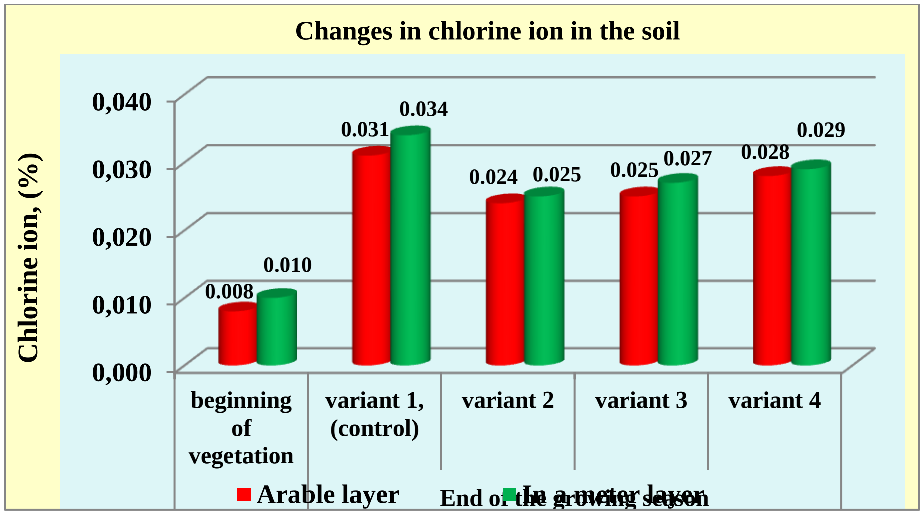

FIGURE 4. Change in the number of chloride ions in the soil of the experimental field.

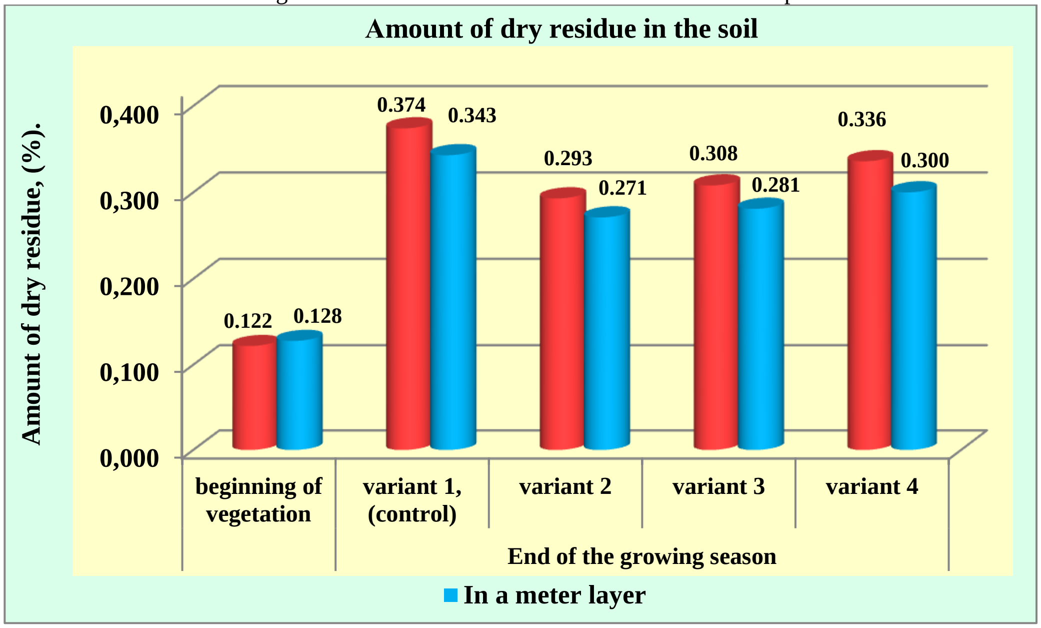

FIGURE 5. Change in the amount of dry residue in the soil of the experimental site.

At the beginning of the growing season, in the upper soil layer (0-40 cm), the amount of chlorine was 0.008 %, the amount of HCO_3 was 0.031 %, and the amount of SO_4 was 0.056 %, the amount of dry residue was 0.122 %; in the 0-100 cm layer, the amount of these salts was 0.010, respectively; 0.034; 0.051 and 0.128 %, respectively. At the end of the growing season in a cotton field, all salts in the soil were increased. In the variant-1 of experiments with direct irrigation of collector-drainage water, the amount of chloride ion in the soil layer increased by 0.023 % compared to the beginning of the growing season and amounted to 0.031 %, in 0-100 cm, the layer increased by 0.024 % and amounted to 0.034%. The amount of dry residue in the upper soil layer increased by 0.250 % and amounted to 0.374 %, and in the 1-meter layer increased by 0.215 % and amounted to 0.343 %. In variant 2, irrigation of cotton with a biological decrease in the mineralization of collector-drainage waters using the aquatic plant Lemna minor, by the end of the growing season, the chlorine content in the stratum layer increased by 0.016 %, and in the 0-100 cm layer by 0.015 % and amounted to 0.024 and 0.025 %. This indicates that the chlorine ion content was less than 0.007 and 0.009 %, respectively, compared to the control. The amount of dry matter increased relative to the beginning of the growing season by 0.169; 0.143 % and amounted to 0.293 and 0.271%, respectively.

In the studies, the greatest accumulation of salts in the soil was observed in the control variant, which was directly irrigated with collector-drainage water, and the smallest accumulation of salts was observed in option 2, irrigation of cotton varieties Bukhara-102, reducing the mineralization of the collector-drainage water using the aquatic plant Lemna minor. This, in turn, is explained by the addition of salts from collector-drainage waters to the soil during irrigation.

Influence of irrigation with different water quality on the yield and quality of cotton. In the course of research on the control variant with direct irrigation of collector-drainage water, the average cotton yield over the years was 31.9 - 32.0 c/ha.

In variant 2, cotton irrigation biological reduction of collector-drainage water mineralization using water plants Lemna minor, the cotton yield was 39.5-40.5 c/ha, higher than the control 7.9-8.4 c/ha. In variant 3 of the study, the yield was 38.6 - 38.9 c/ha. The yield of cotton in this variant was 6.7-7.0 c/ha higher than in control. In the experiments, the cotton yield was 33.9-34.5 c/ha in the 4th variant of cotton irrigation with biologically reduced mineralization of collector-drainage water using the aquatic plant Eichhornia crassipes which is 1.9-2.4 c/ha higher than in control. (1- table).

TABLE 1. Influence of irrigation of different water quality on cotton yield, (c/ha)

Variant mode	**Repetition**			**Average annual**
	I	II	III	
	2017-2019 years			
1	32.0	31.9	31.9	31.9
2	40.1	40.5	39.5	40.0
3	38.9	38.6	38.9	38.8
4	34.5	33.9	33.9	34.1

Result of irrigation of cotton varieties "Bukhara-102" of different water quality in the control variant, the fiber length was 31.2-31.6 mm. The microneira index was 3.8-4.0; the fiber content was 1.8-2.0, the relative tensile strength was 24.8-25.4 gc/tex, the oily seed was 18.6-20.2 %. Variant 2, biologically reduced mineralization of collector-drainage waters when using the aquatic plant Lemna minor, fiber length 33.1-33.3 mm, more than 1.8-1.9 mm control and microneir index was 4.1-4.3. The fiber density was 2.0-2.3 g, and the tensile strength was 26.2-26.9 gc/tex. The oily seed was 20.4-21.8 %, which is 1.6-1.8 % higher than the control.

CONCLUSIONS

As a result of watering cotton varieties Bukhara-102 by reducing the mineralization of collector-drainage waters with the help of aquatic plants, the following conclusions were drawn:

1. It was found that the number of chloride ions in the drainage water decreased by 25 %, and the amount of dry residue by 27.7% when growing Lemna minor algae in drainage water with a salinity of 3-5 g/l.
2. When analyzing soil salinity, the content of chlorine ions was 0.034% in the control variant with direct irrigation with collector-drainage water, in the variant, the mineralization of collector-drainage water was reduced by a biological method using the aquatic plant Lemna minor, chlorine ions were 0.025%, less than 0.009% was accumulated than in control.
3. In the control variant, the increase in the pressure of the collector-drainage water, the average yield of the crop was 31.9 s/ha, and in variant 2, the crop yield was 7.9-8.4 s/ha, which is more than the control variant. 40.2 s/ha.
4. When studying the effect of cotton fiber "Bukhara-102" on the quality of cotton fiber as a result of irrigation with waters of different quality, the best results were observed with a biological decrease in the mineralization of cotton collector-drainage waters using the aquatic plant Lemna minor. The fiber length was 33.1–33.3 mm, which is 1.8–1.9 mm more than the control variant, and the microneur index was 4.1–4.3. In addition, the fiber content was 2.0-2.3 g, and the relative tensile strength was 26.2-26.9 gc/tex. The seed yield was 20.4-21.8 %, which is 1.6-1.8 % higher than the control.

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