Justification of methods for regulation the salt regime of irrigated soils in Uzbekistan under current conditions

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Abstract. Foreign approaches to maintaining a favorable salt regime of soils are analyzed. On the basis of experimental studies, a change in the water-physical properties of the soil during deep loosening and an increase in salt leaching during leaching and vegetation irrigation using the Biosolvent preparation were established. Based on the analysis of the leaching results, the optimal technologies and norms for leaching saline soils have been established.

1 Introduction

In modern conditions, soil salinization is common in an area of 45% of the irrigated lands of Uzbekistan and in ½ of the territory groundwater is at a depth of 2 m. According to the Ministry of Water Resources of the Republic of Uzbekistan, the volume of water allocated annually for flushing saline irrigated lands exceeds 25% of the annual water intake.

With a close location of groundwater, it is impossible to carry out high-quality washing of highly and moderately saline soils. The reasons for this are:

- Insufficient free capacity of the aeration zone to fill it with water that dissolves salts.
- Insufficient drainage of the field, for the diversion of water and the supply of a displacing portion of water.
- The need to conserve water.

In Western approaches, soil desalination is recommended to be carried out during the growing season, due to the additional volume (leaching fraction) of water in excess of the needs of plants, which is intended for salt leaching. The leaching fraction is determined by formulas based on the balance and taking into account the "planned" crop losses depending on the water quality, salt tolerance of the crop.

At the same time, this approach does not take into account: 1) - the position of groundwater, which limit the gravitational movement of moisture from top to bottom, and 2) - filtration and other properties of soils (depending on the composition of the soil profile in terms of mechanical composition and soil density). As is known, with a close location of groundwater, the creation of a leaching irrigation regime is difficult. [11].

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When irrigating along furrows, which is mainly used in Uzbekistan, it is difficult to ensure a uniform leaching irrigation regime, due to the uneven distribution of water along the length of the field (according to the law of gravity). Although, due to the infiltration of water into the soil, a leaching irrigation regime is inevitably created during furrow irrigation, the lack of water accounting, field leveling, maintenance, and accounting and control of a given leaching fraction for managing the salt regime of the soil is impossible in practice. In addition, it is also impossible to plan a leaching irrigation regime in the conditions of Uzbekistan, with mass irrigation of crops during the growing season and an acute shortage of water in dry years, since this will require the allocation of additional volumes of limited water to land users.

In the absence of water accounting and field leveling, maintaining and controlling a given leaching fraction to control the salt regime of the soil during furrow irrigation is unrealistic, although a leaching irrigation regime is inevitably created due to water infiltration into the soil. Nevertheless, planning a leaching irrigation regime in the conditions of Uzbekistan, with mass irrigation of crops during the growing season and an acute shortage of water in low water, is impossible, since this will require additional volumes of limited water.

In domestic approaches to leaching, the task was to desalinate highly saline soils by capital leaching to the degree of non-saline soils. These leachings were carried out against the background of a well-constructed drainage, reinforcing it with temporary drains. In scientific studies of capital leaching, agro-reclamation methods were also used to enhance the leaching of salts (the introduction of soil-acidifying components: lignin, manure, plant residues from cotton, with preliminary deep loosening of the soil). The leaching was carried out on newly developed lands not occupied by crops, with the supply of large volumes of water (up to 15–20 thousand m3/ha and more). At the same time, the effectiveness of the annual leaching of irrigated fields by farmers, the so-called operational leaching, has not been studied enough.

This article evaluates the effectiveness of experimental leaching as a technology used in Uzbekistan (by checks and furrows), as well as using methods to improve the physical and chemical properties of soils that enhance the leaching of salts. In addition, the authors' proposals on improving the methods of managing the salt regime of soils from an ecological and economic point of view are given.

2 Materials and methods

Literary and analytical review of foreign and domestic published works on the topic, processing the results of our own field studies of leaching: by checks and furrows; using deep loosening and using bioorganic ameliorants. Analytical evaluation of the results of the review and statistical processing of experimental data. Calculations of salt leaching efficiency indicators (specific water consumption for reducing soil salinity by 1 dS/m and salt recovery indicators) and water consumption for leaching under various soil and reclamation conditions and technologies based on experiments in Uzbekistan.

3 Results

The results of the review, as noted above, in the international theory of soil salt regulation, the fundamental concept is the method of reducing soil salinity during the growing season, for a specific crop, according to the principle of leaching irrigation regime (LR-leaching requirement LF - leaching fraction), taking into account the salinity of the water used for irrigation (Figure 1) [1]. In this case, drainage must be provided [3-7]. In the same sources, for successful washing of the soil from salts, the importance of the rate of water infiltration into the soil is mentioned, which should not be too small or too high. Also, as an option, the possibility of washing the soil with precipitation [7, 8] and the feasibility of special soil loosening to enhance infiltration were mentioned.

It is noted in [8] that “there are several shortcomings in the LR concept, as suggested using stationary analysis. The LR concept is based on achieving maximum output. The maximum yield may not be economically optimal. This is especially true when only salt water is available and the potential maximum yield is not possible.” Advances in irrigation technology, such as micro-irrigation and sprinkler systems, allow irrigation with very low leach fraction (LF) values. However, irrigation with low leaching fractions can lead to soil salinization, resulting in reduced crop yields. In the age of computerization, transition state models do not calculate LR directly. Instead, models are modeled for a series of seasonal irrigations, from which the lowest flow rate is selected to support maximum yield.

The influence of groundwater and provision of drainage is considered in the study [9], which the authors performed on the basis of a qualitative and quantitative analysis and statistical processing of stochastic (expert) data related to the causes and consequences of salinity in irrigated soils. Using a diagram showing the relationship between the consequences of problems and their causes, the following list of risks has been compiled:

- The effect of rising groundwater levels on the increase in soil salinity.
- Influence of the irrigation system on soil salinity.
- Effect of poor drainage system on soil salinity.

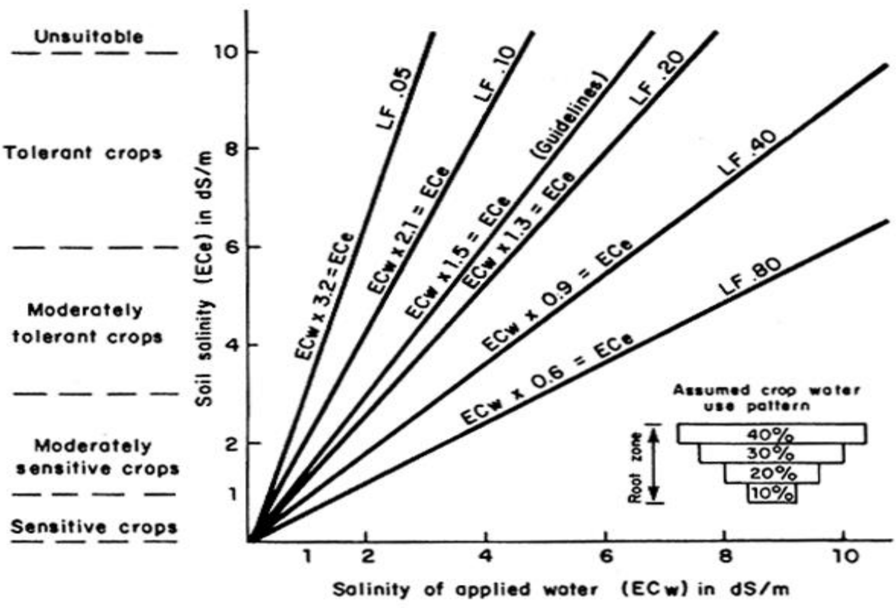

Fig. 1. Effect of applied water salinity (EC_w) upon root zone soil salinity (EC_e) at various leaching fractions (LF) [1].

After analyzing the expected risk value (EV), the following impact of risks on the efficiency of water use (Eu) was revealed [2]:

- When the groundwater level drops to 25% and 50% of the critical level, soil salinity will decrease by 60.8-67%, respectively, which will lead to a decrease in water consumption for soil leaching and an increase in water efficiency by 60.8-67%.

- When using the drip irrigation system as a modern irrigation system, soil salinity will increase by 27.6-69%. This will lead to an increase in the amount of water spent on soil leaching and a decrease in water efficiency by 27.6 - 69%.
- If a poor drainage system is applied, soil salinity will increase by 37.2 - 41.6%, then the volume of water for leaching the soil will increase and the water use efficiency will decrease by 22.32 - 25%.

The amount of fresh water use will double under the influence of salinity, resulting in a 28% decrease in water use efficiency. An increase in water stress for sensitive crops due to NaCl salts results in a yield reduction of 40.5-71.9%, resulting in a decrease in water use efficiency of 32.4-57.52%. The value of such studies is very high, however, experimental studies make it possible to refine innovative technologies for combating soil salinization, suitable for specific conditions, necessary for practice.

In the theory and practice of combating salinization of irrigated lands in Uzbekistan, in the previous period and at present, the most recognized method is the flushing of saline soils by checks during the non-vegetation period.

In the present study, a comparison was made of the influence of conditions and leaching technology on the intensity of salt leaching from the soil (salt recovery of soils). According to experimental data, washing of saline soils carried out in various soil and reclamation conditions, using various technologies, including the use of measures that enhance leaching (Table 1).

Table 1 presents the results of changes in the ECE indicators during experimental leaching of saline lands in various soil and reclamation conditions, using various technologies. Such as: leaching by checks, leaching along furrows, leaching with precipitation the background of loosening, leaching the use of Biosolvent. The characteristics of the washing areas are as follows:

- Medium loamy, dense soils drained by an open collector, experiment-1.
- Light loamy soils with good infiltration and sufficiently high water supply, experience 2 and 3.
- Medium loamy soils with "dry drainage", experiment-4.
- The same, with the use of Biosolvent before pouring water into the checks, experiment-5.
- Desalination of initially dense soils by precipitation after preliminary deep loosening, experiment-6.
- The same, with the use of Biosolvent, experiment-7.
- Layered medium-density soils, with a close occurrence of groundwater and poor outflow, experience-8.

Table 1 shows data on the specific water consumption per unit of salinity reduction - 1 dS/m. When flushing in checks, with provided drainage, on denser soils (experiment-1), higher specific water consumption was revealed than in other options (1036 m^3/ha per 1 dS/m). Increased specific water consumption was also noted in the variant of flushing along the furrows, with a high flushing rate (experiment-3) - 1048 m^3/ha per 1 dS/m. The lowest specific water consumption (254 and 295 m^3/ha per 1 dS/m) was obtained in experiments 6 and 7, apparently due to the high initial soil salinity and increased soil salinity, both by loosening and Biosolvent.

The intensity of salt leaching from the soil is expressed by the indicators of soil salinity in the formula of V.R. Volobuev [12]. The author of the formula recommends to determine the salt recovery parameters experimentally. Actual salt recovery rates were determined using experimental data from different washing experiments (Table 1) and compared to evaluate the effectiveness of each technology and washing conditions.

$$M_{LE} = 10000 * \alpha * \lg(S_h/S_o) \quad (1)$$

Where: M_{LE} – leaching rate, m^3/ha; Sin – salt content in the soil layer in need of washing, in% of the soil mass; Sadd – permissible salt content in this layer, in% of the soil mass; α – soil leaching coefficient, established according to the data of pilot production leaching.

The obtained indicators α were used to compare the potential (required) water consumption (norm of leaching) for soil desalinization up to 2 dS/m (Table 1).

Table 1. Evaluation of the leaching efficiency according to the experimental data.

Leaching experiments	**Actual norm of leaching, m^3/ha**	**S start**	**S end**	**Difference start-end**	**Specific water consumption, m^3/ha per 1 dS/m**	**Salt recovery index, α**	**Estimated leaching rate (m^3/ha) for soil desalination up to 2 dS/m**	
							Total	**Difference cost-fact**
Experience 1. Soils are medium loamy. Ground water 2.5 m, leaching by checks 50x50 m (layer 60 cm, n=12*), well-functioning drainage, density up to 1.70 g/cm^3 [13]	4426	8.3	4.0	4.3	1036	1.39	5155	729
Experiment 2. Soils - light loams with sandy loam, ground water=2.0 m, leaching by checks 20x40 (n=7), provided drainage [13]	6000	9.9	1.7	8.2	733	0.78	3793	-2207
Experiment 3. The same, furrow leaching, 200 m (n=14) [13]	4000	5.4	1.5	3.9	1048	0.72	2174	-1826
Experience 4. Homogeneous light and medium loamy soils, ground water 2.0 m, leaching by checks 20x20 (layer 70 cm, n=5) [15]	2000	8.3	6	2.3	828	1.42	6143	4143
Experience 5. The same, but with soil treatment with the Biosolvent preparation (n=5)	2000	8.5	5.5	3	726	1.06	4663	2663
Experience 6. Desalinization of a layer of 0-30 cm of medium and light loamy soils with the help of precipitation against the background of deep loosening, (n=5), the initial density of the upper layer is up to 1.7 g/cm^3 [18]	3020	15.7	7.6	8.1	254	0.96	not def.	not def.
Experience 7. The same, but with soil treatment with the Biosolvent preparation (n=5)	3020	11.9	5.3	6.6	295	0.86	not def.	not def.
Experience 8. Khorezm, soils: light and medium loamy and light clay, ground water < 1 m, leaching by checks (layer 70 cm, n=20), density 1.52 g/cm^3, low infiltration [17].	2522	8.8	5.6	3.2	788	1.28	5765	3243

*Experiments 1-7 were conducted in the Syrdarya region of Uzbekistan

The salt yield indicators given in the table characterize the leaching of salts under specific conditions: mechanical composition, groundwater depth, drainage, water supply, initial and final soil salinity. From the data given in the table it follows that the highest salt recovery rate is 1.42, and the lowest is 0.72. The table also shows that (with the exception of experiments 2 and 3, carried out on soils that are light loamy in texture), when washing soils in checks, to reduce soil salinity from 8-9 dS/m to 2 dS/m, it will require from 5.2 to 6.1 thousand m^3/ha of water. These are quite large, by today's standards, volumes, especially in dry years.

The calculation of the required leaching rates for soil desalination from the upper limit of the average degree of salinity to non-saline (using the actual salt yield calculated from the experimental data for ECe, dense residue and chloride ion) showed that the use of the Biosolvent ameliorant, which enhances the leaching of salts (analogue of the drug Spersal), reduces the need for leaching.

In this case, the possible reduction in water volumes will be: for the ECe, - 1.5 thousand m^3/ha (from 6.0 to 4.5 thousand m^3/ha), for the dense residue - by 3.1 thousand m^3/ha (from 5.3 to 2.2 thousand m^3/ha), and for chloride ion by 3.3 thousand m^3/ha (from 4.6 to 1.3 thousand m^3/ha).

These values show the volumes of water that can be saved as much as possible with average salinity and the desire to desalinate the soil as much as possible. Taking into account the fact that for cotton crops, the reduction of soil salinity by leaching to 2 dS/m is not necessary, the use of this preparation to enhance the leaching of salts will solve the problem of soil desalinization in conditions of water deficiency. (According to the experiments of the authors, it has been clarified that the threshold of salt tolerance of cotton in the Syrdarya region is 4 dS/m, and the equation for crop losses due to soil salinity: $y = -0.062x + 1.174$ $R^2 = 0.831$) [14].

From the data in Table 1, it can be seen that the studied methods for increasing the leaching of salts: the use of Biosolvent and deep loosening of the soil are effective. They are described in more detail in the sources [15, 16, 18].

With comparable data of initial salinity and water supply (experiment 1, 4 and experiment-8), the required water consumption for soil desalination up to 2 dS/m in the Syrdarya region and in Khorezm is very close and is, respectively, according to the experiments: 5.2, 6, 1 thousand m^3/ha and 5.8 thousand m^3/ha.

4 Discussion

From the review of the above foreign sources, it follows that the approach to leaching, based on the normalized regulation of the salt regime of the root zone of plants during the growing season (based on the salt tolerance of the crop, real evapotranspiration, salinity of irrigation water and a given drainage flow) is difficult to implement so far in Uzbekistan, in case of mass application of furrow irrigation. With a gradual transition to water-saving, controlled systems, this is not excluded, since in modern conditions their modeling and online control is developing, as noted in work [8].

In the Western approach, there are a lot of assumptions and simplifications; salt diffusion processes are not taken into account. Also, the initial (initial) salinization of the soil is not always accurately taken into account, and the final one is calculated according to an empirical formula, through the concentration of salts in the water used, expressed in terms of electrical conductivity (ECw). Also, unfortunately, it does not take into account the depth of groundwater, which affects leaching, reducing infiltration, creating an obstacle to the outflow of wash water "backwater" when located close to the surface.

With a large number of published theoretical, logical approaches and formulas, experimental data confirming the described hypotheses and regularities are clearly insufficient, especially taking into account the diversity of soils of their genesis, properties, etc.

It is known that the soil has a solid phase, and the denser and heavier it is to the mechanical composition, the more complex the processes of salt movement occurring in it. It is also known that the movement of salts in the soil is described by two processes: 1-gravitational leaching of salts from large pores, when moisture moves down; 2-diffuse movement of salts from the solid phase of the soil, towards the side with the lowest salt concentration.

Some foreign scientists note the shortcomings of this approach for the implementation of soil desalinization in practice using a normalized leaching regime (LF - leaching fraction). The reasons for this are: uneven soil and other conditions of the irrigated area (in terms of mechanical composition, degree of salinity, infiltration, etc.); evenness of the field will affect the leaching share; the need for knowledge of all soil parameters, as well as water salinity for irrigation. Irrigation technology greatly influences the implementation of such flushing. For example, when irrigating along the furrows, there is uneven soil moistening along the length of the field, and, accordingly, the leaching fraction cannot be provided evenly (Figure 2) [5, 10].

The leaching share is also difficult to normalize with the basin irrigation method, due to the difficulty in accounting for water by the farmer and the management of small volumes of water.

Only with drip irrigation and sprinkling (controlled irrigation systems) is it possible to create a uniform provision of the flushing regime along the length of the field. 98% of irrigation in Uzbekistan is furrow irrigation, which most often does not ensure the uniformity of moistening and salinization of the soil profile. The results of field studies have shown that when irrigating a plot of low-slope lands, along the furrows, the lower part of the field has, by autumn, a higher degree of soil salinity (Figure 3) [17].

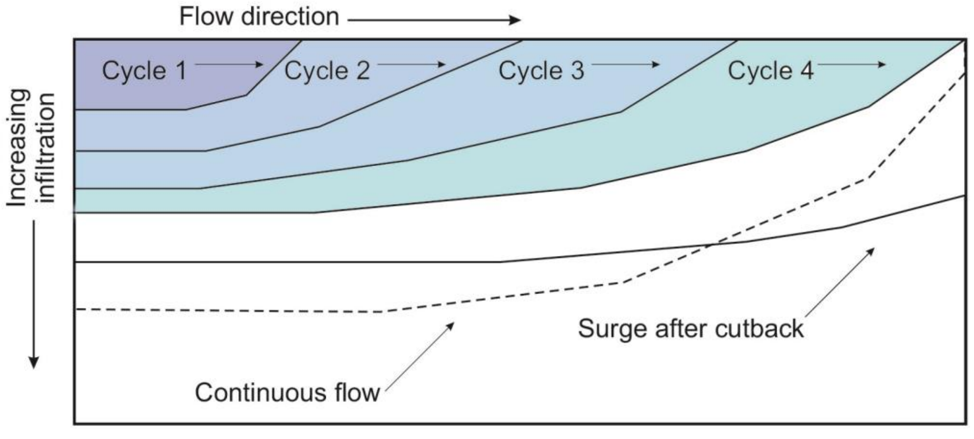

Fig. 2. Infiltration losses in furrow irrigation [5, 10].

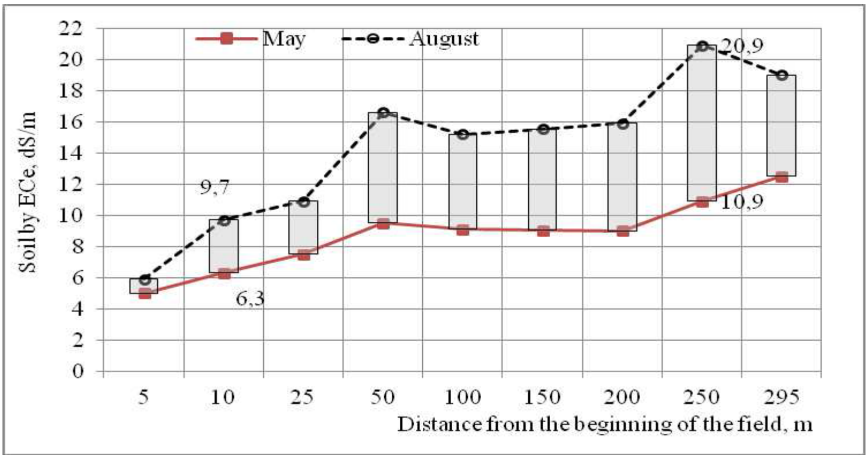

Fig. 3. Changes in soil salinity along the length of the field in a layer of 0-60 cm during the growing season of cotton in the Khorezm region [17].

Regarding leaching's used in the practice of land desalination in Uzbekistan. In previous studies of the authors [13], it was found that "It is impossible to desalinate the soil to lower levels (non-saline soils 0.02% chlorine, 2 dS/m) by leaching, with a norm of up to 6.0 thousand m^3/ha, if you do not provide the site with additional drainage. Therefore, when growing such salt-tolerant crops as cotton and wheat, it is sufficient to reduce soil salinity by leaching to 3 dS/m. The next task is the normal regulation of soil moisture by irrigation, to maintain this level of salinity, preventing it from increasing. As is known, on saline soils, it is necessary to water the plants more often to maintain the permissible concentration of soil solution (no more than 8 g/l after watering) and soil moisture pressure (osmotic + matrix, no more than 4 atm.)."

The authors studied the influence of methods that enhance the leaching of salts by influencing the physical and chemical properties of soils. This is a deep loosening of the soil, which increases the infiltration of water into the soil, as well as the use of the local bioorganic preparation Biosolvent (an analogue of the foreign preparation Spersal), which has an acidic environment.

The results of the analysis of experimental data on flushing and the calculations performed on their basis (Table 1) made it possible to reveal the following.

When washing initially strongly saline soils (9-10 dS/m) by checks, with a water supply of 2.0-2.5 thousand m^3/ha (experiments 4 and 8), soil desalination below 5 dS/m was not achieved. When applying 4.4 thousand m^3/ha (Experiment 1), medium loamy soils were desalinated to 4 dS/m. With water supply of 6.0 thousand m^3/ha, light loamy and sandy loamy soils of Experiment 2 were completely desalinated (1.7 dS/m). In three cases (experiments 2, 4 and 8), the specific water consumption for reducing soil salinity by 1 dS/m was 750-800 m^3/ha, and in Experiment 1 - 1036 m^3/ha. With a smaller volume of water used (by 2.4–3.0 times, in experiments 4 and 8, compared with experiment 2), the leaching of salts was also 2.6–3.6 times less (E4 -2.3 dS/m; E8 -3.2 dS/m; E2 - 8.2 dS/m; E1-4.3 dS/m). The costs of labor and funds for the preparation of lands for flushing by checks, in all the experiments considered, were the same. Conclusion: preparation of land for leaching with a layer of water according to checks is not advisable if water cannot be supplied in a volume of more than 2.0 thousand m^3/ha.

Comparison of leaching of soils with an average degree of salinity (5-7 dS/m), with a norm of about 4 thousand m^3/ha for checks (medium loam, experiment 1) and furrows (light loam and sandy loam, experiment 3), showed that the efficiency of leaching soils of light texture along furrows is 1.5 times higher.

At the same time, in both variants, the specific water consumption exceeded 1 thousand m^3/ha per 1 dS/m (Tables Experiment-1 and Experiment-3). The conclusion is that it makes no sense to wash the soils of light texture with an average degree of salinity by checks.

Table 1 also presents the results of experiments on the desalinization of abandoned lands by precipitation during preliminary loosening of the soil up to 70 cm, which enhances infiltration (and salt release) of soils (experiments 5 and 6) [18]. Experiments have established that the volume of water that entered the field (more than 3 thousand m^3/ha, in the form of precipitation), ensured effective soil desalinization in a layer of 0-30 cm (from 16 to 8 dS/m), with the cost of funds only for deep loosening soils, without leaching saline lands using another technology (experiment 5). At the same time, the specific water consumption for reducing soil salinity by 1 dS/m was 250–300 m^3/ha. The desalination of abandoned lands by precipitation has advantages from the point of view of soil ecology, since during sprinkling, the effect of water on changing the structure and compaction of the soil is less than when washing with a layer of water by checks.

When evaluating the salt recovery indicators (Table 1), calculated according to the Volobuev formula based on actual experimental data (volumes of water supply and data on changes in soil salinity), the following was revealed.

- On highly saline soils (experiment 1, 2, 4, 8), the salt recovery index in experiment 2 (light soils, high leaching rate) is lower than in other options (respectively 0.78, against 1.39 1.42 and 1.28). Comparison of calculated and actual leaching rates for soil desalination up to 2 dS/m showed that in experiment 2, 2.2 thousand m^3/ha was applied in excess, and in experiments 1, 4 and 8, it will be necessary to additionally apply 0.7; 4.1 and 3.2 thousand m^3/ha of water.
- When washing moderately saline soils, light mechanical composition along the furrows (E3), the salt recovery index, established by the experimental calculation method, is the lowest of all experiments (0.72). Accordingly, the leaching rate for soil desalination to 2 dS/m, calculated according to this indicator, amounted to 2.2 thousand m^3/ha. That is, in the experiment of 3 thousand m^3/ha, an excess amount of water was supplied in the amount of 1.8 thousand m^3/ha.
- Calculation of salt recovery indicators and required leaching rates for complete soil desalination made it possible to reveal the effectiveness of Biosolvent application in conventional leaching and loose soils. Under the influence of Biosolvent, in experiments 4 and 5, the salt recovery index decreases by 34%, and in experiments 6 and 7, by 12%. At the same time, in the conditions of the Mirzaabad district (leaching by checks experiment 4 and 5), the required leaching rate, when using the drug, for complete desalination of the soil according to ECe decreases by 1.5 thousand m^3/ha, according to the dense residue by 3,0 thousand m3/ha and for chlorine ion by 3,3 thousand m^3/ha.

The possibility of managing the salt regime of the soil during the growing season has been proven by experiments, the authors [14-16]. When spraying the surface of the furrows before the first irrigation of cotton with Biosolvent preparation, an increase in the leaching of salts down (settling) was established.

During pre-irrigation treatment of the surface of irrigation furrows with Biosolvent, when diluted with water in a ratio of 1:10, an increase in the leaching of salts from the root-inhabited soil layer (leaching effect from irrigation) is created. A significant decrease in salts in the layer of 0-70 cm and below was observed immediately after the first irrigation (Figure 2) [16]. Compared with the initial content, the percentage of ion leaching during the first irrigation, the variant with the use of the Biosolvent preparation, was higher than in the control: in terms of dense residue by 18% (29% with Biosolvent and 11% in the control); by chlorine ion by 7% (42% with Biosolvent and 25% in control); for calcium by 13% (25% and 12%, respectively). It was found that during furrow treatment, the leaching of potassium (K) from the soil during irrigation decreases three times: in the variant with Biosolvent, it was 7%, and in the control - 23%.

Figure 3 shows the dynamics of soil salinity during the growing season with conventional irrigation and with irrigation, with preliminary processing of the furrow surface. It can be seen from the figure that under the influence of the treatment of furrows with the preparation, during watering, the content of salts in the soil decreases, and also that this phenomenon is prolonged and persists until the end of the growing season.

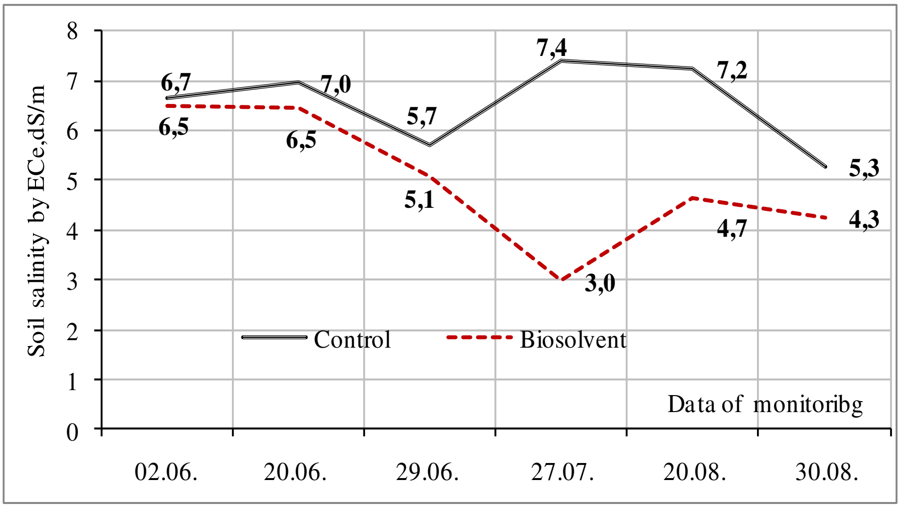

Fig. 4. Influence of furrow treatment with Biosolvent on the salt regime of the irrigated field in a layer of 0-70 cm.

Figures 4 show that the effects of salt leaching, achieved after the first irrigation, persist until the end of the growing season [16].

- The use of the Biosolvent preparation as an ameliorant of saline lands is a means for managing the water-salt regime of an irrigated field and allows (at relatively low financial costs) to save water during land leaching: 2000 m^3/ha - in the current year, and 1500 m3/ha, - in the next year, due to the prevention of seasonal accumulation of salts in the soil.
- The practical significance of the development lies in the fact that the use of this drug in the conditions of seasonal soil salinity in the fields is available to farmers.

Improving the efficiency of salt leaching also gives farmers a chance to save scarce water and get more cotton crops. As a result of improved conditions in the root zone of cotton, in the variant with Biosolvent, an increase in yield of 7.5 c/ha was obtained.

5 Conclusion

Under the conditions of furrow irrigation technology widely used in Uzbekistan, it is impossible to provide a leaching regime, with a given percentage of leaching fraction, evenly across the field. The approach proposed by foreign authors to the management of the salt regime of the soil of the root-inhabited soil layer, by regulating the leaching share to the needs of plants, can be applied in practice only with regulated (managed) control technologies and uniform distribution of water over the field: sprinkling, drip irrigation. Perhaps in the future, with the large-scale introduction of managed irrigation technologies, computer technologies will be used for regulation based on special programs operating in the online "smart irrigation and mudflow management" mode.

An analysis of experimental data on saline lands leaching by technologies under different conditions showed that the specific water consumption per unit of salinity (ECe, dS/m), as well as the salt recovery indicators according to the formula of V.R.Volobuev, vary widely. They depend: a) on the initial degree of salinity and filtration properties of the soil (including field drainage); b) from the supplied amount of water; c) from the technology of leaching and methods of enhancing leaching.

With equal degrees of initial soil salinity, the decrease in salinity (and, accordingly, water supply for complete soil desalination, - 2 dS / m), is affected by:

- The amount of water supplied for leaching.
- Mechanical composition and filtration properties of the soil.
- Leaching technology.
- The use of the preparation Biosolvent.

In conditions where leaching of saline lands by checks is possible and expedient (deep occurrence of groundwater, provision of outflow by drainage, a sufficient amount of water), it should be carried out.

Of all the analyzed leaching by checks, the most successful can be considered the leaching of medium loamy compacted soils with adequate drainage (Experiment 1). An almost adequate leaching rate of 4.4 thousand m^3/ha was applied and soil desalinization up to 4 dS/m was obtained. To achieve 2 dS/m, it is necessary to apply another 0.7 thousand m^3/ha of water, that is, a total of 5.1 thousand m^3/ha.

With a shortage of water (and the impossibility of supplying more than 2000 m^3/ha of water), flushing of highly saline soils of light and medium loamy soils, by checks, is not effective enough, especially in conditions of closely located groundwater (with unsecured outflow).

With an average and low degree of salinity of soils of light mechanical composition, it is advisable to carry out flushing along the furrows, with a norm of 2.0-2.5 thousand m^3/ha.

In the absence of drainage, it is possible to regulate the salt regime of soils only by the precipitation of salts during the period of moisture-charging and vegetation irrigation along the furrows, using methods to enhance salt leaching: preliminary deep loosening in the fall and spraying the soil with a salt leaching enhancer - Biosolvent before water supply. Research to substantiate the effectiveness of such a (year-round) technology for regulating the salt regime of soils continues.

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