Innovative technologies in the effective use of water resources

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Abstract. Global warming in the arid region is currently exacerbating water scarcity. The use of groundwater for crop irrigation is one of the major problems in the world. In this context, the use of rivers and ponds with varying degrees of mineralization is especially important for the irrigation of crops. About 300 km³/year of collector-drainage water (CDW) is formed in the world, which causes great damage to the economy and nature of all countries of the world. In this regard, one of the important tasks is the development of measures for the reuse of collector-drainage water for irrigation, the first demineralization, and disinfection, or their use in combination with river water. To solve these problems, a neutron-active analysis of the composition of the soil and trace elements were studied, as well as the dynamics of the distribution of water in the active soil layer to determine the patterns of water absorption in active soil during irrigation based on a new innovative method of nuclear physics and irrigation of cotton plantations with the addition of drainage water and as a result of which, there was provided the efficiency of water use and increase the productivity.

1. Introduction

In world practice, the use of groundwater for irrigation is widespread, and farms mainly use groundwater for irrigation of their land. At the same time, the government does not require high costs, since farmers independently use the wells at their own expense. In India, 66% of irrigated land is irrigated by a well. Groundwater is the only source of irrigation in Saudi Arabia and Lebanon. In Italy, tens of thousands of hectares of irrigated land are irrigated by saline groundwater. In the USA, especially on the Atlantic coast, rivers and ponds with varying degrees of mineralization are used to irrigate vegetables and other crops. When they are irrigated with these waters, salts in arable lands are increased and subsequently, the number of salts after a significant amount of precipitation or leaching is decreased. Studies on the use of low salinity irrigation for various crops in the Mediterranean, USA, Australia, India and Pakistan have shown that for irrigation of vegetables and melons, alfalfa, rice, grains and other crops, water with high salinity can be successfully used, i.e. 5 g/l. Experiments on the effect of salt irrigation on the reclamation state of non-saline lands in Tunisia have shown that up to 5 g/l of irrigation water can be used on sandy soils and sometimes even higher and on heavy soils, the salt concentration in irrigation water is 2-2 g 5 g/l [1, 2, 6, 17, 18, 19, 20].

The usual practice of using saline water for irrigation and salinization in Central Asian states that it is desirable to use a collector-drainage stream under certain conditions of land reclamation, with light and medium permeability on well-drained soils at 3-3.5 g/l well. It has been shown that collector-drainage flows can be effectively used without mixing with any of the mineralized channels up to 1 liter. Only in this case, it is necessary to observe the irrigation flushing regime, that is, the total amount of irrigation water in the field should be 5-10% higher than the total evaporation [1, 3].
In the case of mineralization of the drainage stream, which exceeds 3-4 g/l, water should be used by mixing river water with the following formula:

\[
M_{ir} \cdot C_{ir} + M_{di} \cdot C_{di} = M_{ca} (C_{ir} + C_{di})
\]

Where: \(M_{ir}\), \(M_{di}\), and \(M_{ca}\) are irrigation (ditches), mineralization of ditches and mixed waters, g/l; \(C_{ir}\) and \(C_{di}\) are consumptions of irrigation and drainage water, m\(^3\)/s.

The equation of the water-salt balance of the irrigated territory with the air zone was suggested by S.F. Averyanov [3, 19]

\[
\Delta W_a = Or + A + (1 - \alpha) F - C - ET \pm q \ m^3/ha
\]

Here: \(\Delta W_a\) is the change in moisture reserves from groundwater to the surface; \(A\) is the amount of water supplied from the irrigated internal network to the irrigated area; \(C\) is the field discharges; \(\pm q\) is groundwater supply by groundwater (+) or groundwater recharge (-) due to the flow of water for irrigation under it; \(F\) is filtering channels. Coefficient shows the percentage of channel filtration from groundwater filtration \(Fi/c\), and (1a) shows the percentage of soil moisture \(Fi/c\); \(A\) (or \(O_r\)) is precipitation; \(ET\) is Bulk evaporation and transpiration [4, 5, 7, 15].

The salt balance of the air zone is calculated by the following equation:

\[
\Delta C_a = C_{ir} + C_{os} \cdot A + C_f \cdot (1 - \alpha) F + C_{dr} + q \cdot C_{cc}
\]

Here: \(\Delta C_a\) is the change in salt reserves in the air zone for the reporting period, t/ha; \(C_{ir}\) is the mineralization of irrigation water, g/l; \(C_{os}\) is the wastewater mineralization, g/l; Mineralization of filtered water \(C_f\) is the mineralization, g/l; Mineralization \((\pm q)\) of water exchange between the aeration zone and groundwater, g/l.

The total water balance of the irrigated area according to S.F. Averyanov:

\[
\Delta W = B + \bar{P} + \bar{P} + O_r - C - ET - O - D
\]

where: \(\Delta W\) is the total change in water resources within the irrigation zone; \(B\) is the irrigation; \(\bar{P}\) - drain flow; \(\bar{P}\) - a stream of earthworms; \(O\) is precipitation; \(B\) is the total discharge of water; \(ET\) is the total volume of evaporation and transpiration; \(O\) is groundwater flow outside the array.

2. Methods

The study of the macro and microelement composition in the soil and the dynamics of the distribution of water in the active soil water during the collection and drainage of water from an experimental site in Syrdarya region as solution methods were used “Neutron-activation analysis” and “Spectrometric measuring” [8, 9, 10, 11, 12].

3. Results and discussion

Research work was carried out on Shuruzak Nurli Kelajak farm Sayxhunabad district of Syrdarya region. The total irrigated area of the farm is 122 ha, of which 54 are cereal and 65 are cotton. The Sh-4 irrigation network is used as a source of water, its mineralization is 1.2 g / l, and the groundwater level is 1.5-3 m. Taking into consideration the geographical location of the farm and the lack of irrigation water in canals, Sh-4 water is used for irrigation. Depending on the season, the average salinity of water ranges from 1 g/l to 1.6 g/l. The main areas of the economy are saline soils with slightly saline soils and the mechanical composition of excavated and underground sediments. The size of the experimental field is 50x200 m, i.e. 1 ha. Experimental studies of the patterns of absorption of CSR in the active soil were carried out to assess the impact and consequences of collector-drainage water (mineralization 3 g/l) on weak and moderately saline soils in the experimental areas.
The experimental zone is typical for all considered zones. The methods by V. Shabanov and E. P. Rudachenko for the comparison of areas by criteria were used.

\[ P = P_1 \cdot P_2 \cdot P_3 \cdot P_4 \cdot [1 - (1 - P_5)] \cdot [1 - (1 - P_6)] \cdot [1 - (1 - P_7)] \cdot [1 - (1 - P_8)] \]

Here: \( P_1 \cdot P_2 \cdot P_3 \cdot P_4 \cdot P_5 \cdot P_6 \cdot P_7 \cdot P_8 \) are filtration coefficients, soil weight, water permeability, minimum moisture content, layer thickness; the amount of humus in the soil, the amount of salt, signs of groundwater level.

The probability of using the experimental results in Syrdarya region is:

\[ P = 0.97 \times 0.96 \times 0.75 \times 0.82 \times [1 - (1 - 0.94) \times (1 - 0.80)] \times [1 - (1 - 0.81) \times (1 - 0.94)] = 0.69 \]

The survey results show that 69% of the Syrdarya region can be used.

\[ FP = F_{gen} \times P = 284000 \times 0.69 = 195960 \text{ ha;} \]

Where: \( F_{gen} \) is the total irrigated area, ha

Field experiments to improve the technique and technology of cotton crop rotation were carried out at Shuzuzak Nurli Kelajak farm of Saykhunabad district of the Syrdarya region. The water consumption for furrows was 0.6 - 1 l/s, and the length of the furrows was 150-200 m. Watering was carried out with a furrow length of 150, 160, 170, 200 m, and a water flow rate of 0.6, 0.8, 1.0 l/hour. When the furrow width was 0.9 m, the furrow depth was 18-20 cm. Watering was carried out on the basis of a continuous and variable flow of water.

**Table 1. Technique and technology for cotton yield irrigation**

| Tilt | Face/Row spacing | Tape length | Water consumption l/s | Watering rate m³/ha | Humidity coefficient evenly | Hunter on sealers business fertile | Hunter on sealers business business |
|------|------------------|-------------|-----------------------|---------------------|--------------------------|-----------------------------------|-----------------------------------|
|      | 1                | 2           | 3                     | 4                   | 5                        | 6                                 | 7                                 |
|      | 0.003            | 0.9         | 150                   | 0.6                 | 800                      | 0.64                             | 0.7-1.3                           |
|      | 0.003            | 0.9         | 160                   | 0.6                 | 800                      | 0.65                             | 0.7-1.4                           |
|      | 0.0035           | 0.9         | 170                   | 0.8                 | 900                      | 0.62                             | 0.9-1.4                           |
|      | 0.004            | 0.9         | 200                   | 1.0                 | 800                      | 0.60                             | 1.0-1.5                           |
|      | 0.003            | 0.9         | 150                   | 1.0/0.6             | 800                      | 0.89                             | 1.2-1.6                           |
|      | 0.003            | 0.9         | 160                   | 1.0/0.6             | 800                      | 0.85                             | 1.4-1.8                           |
|      | 0.0035           | 0.9         | 170                   | 1.0/0.6             | 900                      | 0.83                             | 1.3-1.8                           |
|      | 0.004            | 0.9         | 200                   | 1.0/0.8             | 800                      | 0.79                             | 1.4-1.7                           |

The variation of irrigation of cotton with river water (mineralization – 1.2 g/l) with a catchment and drainage (mineralization – 3 g/l) was made in 4 options:
Option 1 is the lowest moisture capacity contains a 1: 4 dilution in 70% (1 strain of water, water of the 4th river, mineralization – 1: 4 = 3 g/l + 4.8 g/l = 7.8: 5 = 1.56 g / l);

Option 2 is the lowest moisture capacity contains a 1: 3 dilution in 70% (1 strain of water, 3 – river water 1.65 g/l);

Option 3 is the lowest moisture capacity contains a 1: 2 dilution in 70% (1 water for drinking, 2 water for the river 1.8 g/l).

Option 4 is the lowest moisture capacity contains a 1: 1 dilution in 70% (1 water from the strain, 1 water from the river, 2.1 g / l).

| Options                  | Registration Results | \( \sum \) | \( \chi_{gen} \) | \( \alpha \) ± | Household average, t / ha |
|--------------------------|----------------------|----------|-----------------|------------|--------------------------|
| (permanent stream) 4     | 25.61                | 26.43    | 27.14           | 25.64      | 105.82                   |
| (temporary stream)       | 31.84                | 30.76    | 30.81           | 31.12      | 124.53                   |

The results of the experimental work on the dynamics of water erosion in the active soil layer using the irrigated irrigation method are shown in Figure 1. Curve 1 is water distribution in the soil from 02-04 June 2017, curve 2 is water distribution in the soil from July 17-20, 2017 years, and curve 3 is the distribution of water in the soil from August 1, 2017.

As can be seen from Figure 1, the dynamics of the distribution of water in the active soil layer at different times, when using conventional irrigation methods were significantly different. In the case of using collector-drainage water and freshwater, the distribution of water in the active soil layer is as follows: 40% water at a depth of 0-20 cm, 30% water at a depth of 20-40 cm, 20% at a depth of 60-60 cm, 60- at a depth of 90 cm, 10% of water absorption was detected.

The amount of water absorbed in the soil correlated with the concentrations of copper and an aqueous solution of copper crystals used for irrigation by measuring gamma spectra after irradiation of soil samples in neutron flux. In experiments, copper gamma lines with energies \( E = 511 \text{ keV} \) and \( E = 1039 \text{ keV} \) were used as analytical signals. The copper concentration in the soil samples was determined by the intensity of gamma radiation due to known formulas. In experiments, the
concentration of copper in soil samples is proportional to the amount of water absorbed in the soil. This allowed us to study the patterns of absorption of aqueous solutions in soils using existing irrigation methods [12, 13, 14, 15].

4. Conclusions
1. When using saline soils on saline soils with a salinity of 3 g/l, option 1 - Lowest moisture capacity contains a 1: 4 dilution of 70% (1st drain, river water, salinity-1: 4 = 3 g/l) + 4, 8 g/l = 7.8: 5 = 1.56 g/l) is the most effective varnish, and in field experiments, it was shown that it is possible to increase the efficiency of water use in agriculture without affecting the environment of the region. The study showed that the salinity of the experimental plots did not increase with the seasonal use of mineral fertilizers of GLC, that is, they remained weak.
2. A stream of water was supplied in an alternating stream to ensure uniform water humidification. Experimental options were most effective for variable flow furrow irrigation. In this case, the uniform moisture yield was 0.89 for irrigation with a length of 150 fathoms with a slope of 0.003 and 1.0/0.6 in the range of 0.9 m, which led to a water-saving of 567 m3/ha compared to control and cotton yield relative to control option it was higher to 4.68 c/ha.
3. The dynamics of the distribution of water in the active soil layer at different times, when applying the irrigated method was significantly different. When using collector drainage water with fresh water, the distribution of water in the active soil layer is as follows: 40% water at a depth of 0-20 cm, 30% water at 20-40 cm, 20% at a depth of 60-90 cm 10% of water absorption was found.

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