Operative and reasonable use of irrigation water in the environment of the Republic of Karakalpakstan

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Abstract. The article presents scientific research, including complex water-saving measures when irrigating crops for the conditions of the Republic of Karakalpakstan. On the irrigated territory of the farm, a demonstration site has been created in the complex, where various types of resource-saving technologies for irrigation and leaching of saline lands are tested and implemented. Taking into account the characteristics of this region, various types of irrigation of agricultural crops were tested at the scientific site, including the equipment and technology of furrow irrigation and irrigation with drip irrigation systems. When using various technologies, significant water savings were obtained compared to traditional irrigation, including: - the rate of land leaching was 2700 m^3/ha, which is 850 m^3/ha lower or 25% lower than the average value of the experimental indicators of previously carried out leaching; - the irrigation rate when using the drip irrigation system was 2793 m^3/ha, while saving water resources by 35-44% than the rate with traditional irrigation. Based on the results obtained, recommendations for the introduction of irrigation technologies for the conditions of the Republic of Karakalpakstan were formed.

1 Introduction

Water conservation today is the main principle of the transition to integrated water resources management and the basis for rational water use. The main objectives of water conservation are: saving irrigation water, increasing the efficiency of use of irrigation water, improving the productivity of water and land use, etc.

The use of water-saving technologies helps save water resources, improve soil fertility and is carried out in the following main areas:

- Reduction of water supply intensity.
- Improving the quality of irrigation by increasing the uniformity of moisture.
- Formation of a favorable habitat for plants.

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- Taking into account the physiological characteristics of plants when developing and choosing irrigation methods.
- Creation of a closed water cycle.
- Improving the quality and reuse of drainage and waste water.

In all studies of drip irrigation systems (DIS), water savings range from 40 to 60% compared to furrow irrigation. Water savings are achieved by eliminating water losses due to deep filtration and filtration that forms soil subsidence during furrow irrigation with water discharge at the end of the field.

The worsening water management situation determines the real need for the accelerated implementation of the transfer of irrigated agriculture to highly developed, effective resource-saving technology and irrigation techniques. This scientific and technical problem, which is of great economic importance, is especially relevant for the Republic of Karakalpakstan, where, despite the centuries-old history of irrigated agriculture, resource-saving irrigation technologies are still poorly developed. In this regard, the main attention in this work is on the problems of introducing new resource-saving technologies.

A huge amount of ongoing research on irrigation techniques and technologies requires generalization, testing and implementation in agricultural use on the basis of an experimental site in the field. Field agricultural experience - research carried out in the field allows you to conduct research as close as possible to production conditions and draw reliable conclusions and make recommendations for the widespread use of one or another tested technology. The main objective of the field experiment is to establish differences between the experimental options, quantify the effect of various factors, conditions or methods of influencing the plant yield and its quality; in this particular case, the results of studies of the influence of a particular irrigation technology on the growth, development and formation of the cotton crop and Before conclusions and recommendations for production (if any can be proposed) can be drawn, they must be tested under comparative field experience. All this makes field experience the main, most important method of research in agricultural production.

2 Materials and methods

Field research was carried out within the territory of the farm. Parameter measurements were carried out on the basis of geodesy techniques (theodolite and leveling measurements) when determining the parameters of irrigation and reclamation areas, indicators of soil differences using soil research methods, and when determining the degree of salinity, the express method of electrical conductometry was adopted.

a b

Fig. 1. Shandor (a), SANIIRI tray (Yartsev) (b). All these structures were used to record the flow of water for irrigation.

The determination of water flows supplied for irrigation of agricultural crops was carried out using the generally accepted hydrometric method; in particular, all irrigation canals of the experimental site were equipped with control structures. Shandor measuring 0.40 x 0.50 and a SANIIRI tray (Yartsev) for which the incoming water was recorded (Figure 1).

3 Results and Discussion

Object of research: The results of the above studies were obtained on an experimental plot on the basis of a farm located in the Kegeyli region of the Republic of Karakalpakstan.

Main part: In irrigation practice, there are three methods of irrigation: surface, sprinkling and drip (subsoil). Each of these methods has its own advantages and disadvantages. The main and promising method of irrigation, despite all its shortcomings, for the conditions of the Republic of Karakalpakstan still remains surface irrigation. In recent years, numerous works have been carried out to rationalize and study the possibilities of its effective use.

The tense water management situation in recent years in the lower reaches of the Amudarya River, expressed in the lack of water resources for irrigation of agricultural crops, forces us to consider the acceptability of using subsoil and drip irrigation, where there is an acute shortage of water (even on the basis of weakly mineralized groundwater).

At the established experimental production site, cotton variety S-4727 was sown, an obsolete cotton variety (the variety was bred in 1950, zoned in 1961), but nevertheless it recommended itself well in production conditions, both in terms of salt tolerance and good fiber quality.

When conducting research at the pilot plant, three resource-saving technologies of furrow irrigation and drip irrigation of cotton were tested.

Ordinary irrigation - furrow irrigation is used everywhere in the production conditions of the Republic of Karakalpakstan. At the same time, depending on the slope of the terrain, watering is carried out on one side and the main disadvantages are: high labor costs, long duration of watering time, large volume of vertical filtration, with low water flow rates in the furrow (up to 0.4-0.5 l/s), which ultimately leads to excessive consumption of irrigation water and an increase in groundwater levels.

Irrigation through a furrow can be successfully used both separately and in combination with counter irrigation. This option gives the expected results on soils of medium and light texture. When irrigating through a furrow, a slight slope close to the ground surface is allowed (0.0003 - 0.0005) and water is supplied through the furrow.

When using irrigation through a furrow, soil aeration improves throughout the growing season and thereby reduces the amount of inter-row tillage and allows you to get a high yield with minimal water consumption.

Counter irrigation combined with concentrated water supply. In this case, watering is carried out from both sides through one side temporary sprinklers (temporary sprinklers are cut using a ditch digger, and one side of the roller is developed manually to supply water along the furrows). Water is supplied simultaneously from both sides. At the same time, the furrow length and watering time are reduced by 1.5 - 2.0 times. A prerequisite for this is good planning with a zero slope.

Irrigation using anti-filtration film - the main conditions for the use of this technology are the use of technology on sandy soil, and also preferably on lands with deep groundwater levels. The use of this technology helps retain soil moisture for a long period, and the film coating also prevents the growth of weeds in the furrows. This irrigation technology can be combined with the above irrigation technologies.

Drip irrigation is an irrigation method in which an amount of water is delivered to the soil layer where the main root system of the plant develops while maintaining crops. With drip irrigation, it is possible to water at rates of 300-400 m^3/ha, taking into account the type of crop, water consumption, irrigation rate, duration and frequency of irrigation, and stages of crop development. There is no excess moisture in the active soil layer. With this method of irrigation, the efficiency of the irrigation method is increased due to the fact that mineral fertilizers are supplied dissolved in the soil along with water using a special device for applying fertilizers. With drip irrigation, you can constantly provide the plant with water and nutrients depending on its needs. As a result of supplying water saturated with mineral fertilizers to crops throughout the entire irrigation period through a drip irrigation system, it is possible to ensure an acceptable (optimal) water-nutrient regime in the subsoil layer. As a result, the crop is not stressed in terms of nutrients and water requirements during development stages, the crops are provided with water and nutrients, and the resources used when watering the crop are not wasted.

Groundwater level monitoring

During the experiment, an observation well was installed at the experimental site and systematic observations were made of changes in the groundwater level at the experimental site, where various furrow irrigation technologies were tested. Data on groundwater levels are given in Table. 1.

Table 1. Average monthly groundwater level according to the operating level for the observation period.

No. sampling point	**IX**	**X**	**XI**	**XII**	**miner g/l**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**miner g/l**
	2021					**2022**								
1	259	211	273	285	3.810	329	246	329	181	189	266	279	309	3.920

The current year 2022, just like the previous year 2021, was low in water, autumn-winter leaching of the soil was not carried out on the farm, spring leaching was also carried out at low rates in connection with this, as can be seen from the data in the Table. 1, the groundwater level was quite low, below the 200 cm mark, even after irrigation, the groundwater level rarely rose above the 150 cm mark.

Taking this into account, it can be argued that groundwater practically did not participate in the water consumption of cotton at the pilot plant, since if groundwater lies at a depth of 2-2.5 m, its contribution to the water regime of root-inhabited horizons is small.

The mineralization of groundwater in the experimental area is quite high and ranges from 2.7 g/l to 3.9 g/l.

The groundwater level was low enough from the surface of the earth and could not have a sufficient negative effect on plants, and also did not contribute to secondary salinization of the soil.

Monitoring soil moisture changes.

When solving certain engineering, reclamation (irrigation and drainage) and agrotechnical measures, the assessment of natural soil moisture resources is of utmost importance. Especially in the process of crop formation, the main role is played by maintaining optimal moisture in the root layer of the soil.

For the selected area in 2022, humidity sampling points were established for each option, according to which systematic observations were made of the nature of humidity changes, both in depth and in area. Soil moisture was normal only in the month of May, however, on other dates in all irrigation options, drying of the soil was observed on the top layer, which is associated with the lack of water for irrigation and an extreme increase in air

temperature from late June to early August, which could not but affect on soil moisture, especially the top layer up to 40 - 60 cm layer.

Cotton is considered a relatively drought-resistant plant. Cotton responds very well to irrigation, and yields increase sharply. The year 2023 was an average year during the growing season; the first watering of cotton began in early July.

The maximum value of the irrigation norm according to option IV turned out to be equal to 3045.0 m^3/ha, the smallest according to option II is 2332.0 m^3/ha, however, the frequency of irrigation increases here, since watering is carried out through one furrow; watering is carried out with small irrigation norms, so there is a need to supply additional water supply.

According to the analysis of the experience, the most economical option was irrigation through a furrow, however, one of the disadvantages of this technology can be considered an increase in the frequency of irrigation. This technology can be recommended for the first irrigation of cotton, when the plants do not need a large amount of water; then it can be combined with other irrigation options, be it counter-forced irrigation or irrigation with an anti-filtration film.

After all the technical preparations were completed, watering of cotton began at the pilot plant with a drip irrigation system. With each irrigation, water was supplied to the fields in several cycles depending on the needs of the plants. So the first test watering was carried out in three cycles on 06/30, 07/05. and 07.07. 23 years the norm is 394 m^3/ha. The second watering started on July 11. with a rate of 551 m^3/ha, during the third irrigation the number of water supply cycles was increased and the supply rate was accordingly increased to 1061 m^3/ha, the increase in cycles and water supply rates is explained by the abnormally high air temperature during this period of time, when the air temperature warmed up to 43 – 45^0C, which provoked an increase in the share of evaporation from the soil surface. The fourth and all subsequent irrigations, there were 7 in total, were carried out in a standard mode with rates ranging from 249 to 415 m^3/ha. In total, 2793 m^3/ha were supplied to the pilot plant with drip irrigation during the growing season. According to the results of research in 2023, the following advantages of drip irrigation were identified: only the root part of the cotton plant is moistened; water losses due to cotton transpiration are reduced; the concentration of cotton irrigation on the irrigated plot is eliminated; There are no water losses due to vertical discharge and good reclamation conditions are maintained.

4 Conclusion

- Water savings when using various options of furrow irrigation relative to the control option amounted to 179 m^3/ha in option I, 713 in option II, and 150 m^3/ha in option III. Can be seen that the most economical option was irrigation through a furrow, however, one of the disadvantages of this technology can be considered an increase in the frequency of irrigation. This technology can be recommended for the first irrigation of cotton, when the plants do not need a large amount of water; then it can be combined with other irrigation options, be it counter-forced irrigation or irrigation with an anti-filtration film.
- With drip irrigation, in comparison with traditional irrigation technology, the following savings in water resources have been identified, according to the irrigation regime according to NPO “Cotton”, with traditional cotton irrigation technology, a norm of 5000 m^3/ha is required (VII hydromodular region), i.e. According to the results of studies with drip irrigation, savings of about 44% of water resources were obtained; according to Sredazgiprovodkhlopok, the irrigation rate of cotton is 4300 m^3/ha, respectively, saving water resources of about 35%. It follows from this that with proper

operation of the drip irrigation system in production conditions, it is possible to achieve savings in water resources of the order of 25 - 30%.

Cotton yield according to monitoring results.

Harvesting and accounting for crops require special attention and accuracy, since yield during an experiment is the main criterion for assessing the conduct of a particular study. As has already been mentioned above, due to technical reasons, drip irrigation on the site was not possible; watering was carried out in the usual way along furrows; therefore, the data presented here can serve for a comparative analysis of next year's research.

The date of the first harvest on the experimental field has not yet been carried out; therefore, the calculated biological yield was determined on the experimental plot. The yield calculation was carried out in the same way as in experiments with furrow irrigation technologies.

As can be seen from the data in table. 2, the highest yield is expected from field No. 1, field No. 2 is in second place in terms of productivity, field No. 3 is expected to have the smallest yield, this can be explained by the fact that the soil of this field is the most saline

References

1. N.F. Bespalov, N.I. Mallabaev, Hydromodular zoning and irrigation regime for agricultural crops in the Khorezm region. Abstract. report scientific conf., NPO Soyuzkhlopok, Tashkent, 13-15 (1985)
2. B.A. Dospehov, "Methodology of field experience" (Agropromizdat, Moscow, 1985)
3. N.T. Laktaev, Watering cotton (Kolos, Moscow, 1978)
4. V.M., Legostaev M.P. Mednis, Irrigation regime and hydromodular zoning in the Uzbek SSR. Abstract. report Rep. scientific conf., NPO Soyuzkhlopok, Tashkent, 16-19 (1971)
5. Sagit Kurbanbaev, Zakir Turlibaev, Technical justification of the application of double regulation of ground water level (sub-irrigation) in the conditions of the Republic of Karakalpakstan, International Scientific Conference "Construction Mechanics, Hydraulics and Water Resources Engineering" (CONMECHYDRO-2021) Tashkent, Uzbekistan, April 1-3, 2021 E3S Web of Conferences, **264**, 04024 (2021) https://doi.org/10.1051/e3sconf/ 202126404024
6. Sagit Kurbanbaev, Zakir Turlibaev, Rashid Baymuratov, Effective and rational use of irrigation water in the conditions of the Republic of Karakalpakstan International Scientific Conference "Construction Mechanics, Hydraulics and Water Resources Engineering" (CONMECHYDRO-2021) Tashkent, Uzbekistan, April 1-3, 2021 E3S Web of Conferences, **264**, 04023 (2021) https://doi.org/10.1051/e3sconf/202126404023