FACTORS TO PREVENT LAND SALINATION THROUGH THE APPLICATION OF INTEGRATED WATER, RESOURCE-SAVING AGROBIOTECHNOLOGIES

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АННОТАЦИЯ

В статьи приводятся данные в засоленных, засушливых климатах и на высоких (42-53^{0}C) глобальных потеплениях применению опресняющие (углекислота образующие полезной модели, Биосольвент 12 кг/га) и водо- и ресурсосберегающие (капельное орошение под пленкой) технологии комплексно, получению возможности высокого (55,2-70 ц/га) урожая хлопка. Экономия поливных вод в 2 раза, минеральное удобрение на 50% и засоленности-56,6% и снижение pH щелочная среда в зависимости от степени засоленности от 9 до 7,6-7,3. Исследовались 3 вар.1. Бороздовой полив; 2. Биосольвенть+ Капельное орошение укладка шлангов через ряд; 3. Углекислота образующая полезная модель+ Биосольвенть+ капельное орошение под пленки, укладка шлангов через ряд. Высокий урожай был получен на 2-3 вар-55,2-65 ц/га. Добавка урожая на 20,2-30,0ц/га выше контрольного.

Ключевые слова: Засоленная почва**,** Глобальное потепление, Нехватки воды, Капельное орошение под пленкой, «Углекислота образующие полезной модели», Урожайность.

ABSTRACT

The article presents data in saline, arid climates and high (42-53^{0}C) global warming, the use of desalination (carbon dioxide forming utility model, Biosolvent 12 kg/ha) and water- and resource-saving (drip irrigation under film) technologies in a complex, obtaining the possibility of a high (55.2-70 c/ha) cotton yield. Saving irrigation water by 2 times, mineral fertilizer by 50% and salinity by 56.6% and lowering the pH of the alkaline environment, depending on the degree of salinity, from 9 to 7.6-7.3. Were studied 3 variant: 1. Furrow irrigation; 2. Biosolvent + Drip irrigation laying hoses through the row; 3. Carbon dioxide forming utility model + Biosolvent + drip irrigation under films, laying hoses through a row. A high yield was obtained at 2-3 var-55.2-65 c/ha. Yield addition is 20.2-30.0 centners/ha higher than the control one.

Keywords: Salt soil, Global warming, Water shortages, Drip irrigation under film, “Carbon dioxide forming utility model”, Yield

INTRODUCTION

The President of the Republic of Uzbekistan Sh. Mirziyoyev approved the movement strategies in 2020 on February 18 “The first step out of ten to implement the “Strategy for the Development of Agriculture in Uzbekistan for 2020-2030”.

The Strategy provides information that in the Republic of 20.2 million hectares of agricultural land, only 20.7% is irrigated. Over the past 15 years, the share of irrigated land per capita has decreased by 24% - from 0.23 ha to 0.16 ha. According to forecasts, by 2050 the area of irrigated land may decrease by another 20-25% [1].

Tran’s boundary watercourses form about 80% of the republic’s water resources. 70% of irrigation networks do not have anti-filtration cover - water is lost during transportation to the fields. Most of the pumping stations have been in operation for over 30-40 years and need to be reconstructed or overhauled. Drip irrigation was introduced only (until 2020) by 1.7% [1].

In our region, the issue of water shortage is becoming more and more acute every year. For example, over the past 10 years, the volume of water resources in Uzbekistan has decreased by 12%, and in 2021 - by 15% compared to last year [1].

The level of electricity and water consumption in the cultivation of cotton and grain crops is also high. In particular, 2.4 trillion soums of budgetary funds and 8 billion kilowatt-hours of electricity are spent annually to ensure the operation of over 5,000 pumps for irrigation of 2.5 million hectares of land. From the budget, an average of 800,000 soums is spent on pumping water for 1 hectare of land. Because of furrow irrigation, about 5-6 billion m3 or 20% of water is spent on the fields every year [1].

According to the forecast of the World Resources Institute, by 2040, with the preservation of traditional irrigation methods, Uzbekistan will be one of the 33 countries with the greatest water deficit [1].

The Republic of Uzbekistan is located in the center of the Eurasian continent in the Aral Sea basin. Semi-deserts and deserts, including the largest desert in Central Asia - Kyzylkum, occupy more than 70% of the republic's territory. The total population of Uzbekistan is about 35 million people, of which about 49% live in regions prone to drought [2].

One of the world's largest environmental disasters is the drying up of the Aral Sea; over 60% of the coastal areas of Central Asia have become practically unsuitable for use for agriculture and other activities. At the same time, 75 million tons of salt are annually distributed to other parts of Central Asia and beyond. This, in turn, accelerates the processes of salinization and desertification in the Central Asian countries as a whole, especially in the lands of the Aral Sea region on the territory of Uzbekistan, where, in addition, a new Aralkum desert was formed in the northeast and south of the region with an area of 5.5 million hectares [2].

According to Saparov A. There are more than 20 types of causes of land degradation and desertification. These are physical, chemical, biological causes, climate change, wind and water erosion, anthropogenic factors, pollution with household waste, radioactive substances and oil residues. At present, 76% of the total land area is degraded in Kazakhstan to varying degrees. The lands of the Aral Sea region are considered the most degraded. Formed salt and dust flows spread over an area of 25 million hectares, thereby polluting the soil. This leads to loss of fertility. It takes 200-250 years to restore 1 cm of fertile soil naturally. Therefore, all ongoing soil restoration operations should be optimal. It is required to take the necessary and immediate measures to restore the soil, taking into account the recommendations of scientists. The support of the state in these matters is also required [5].

In the lower reaches of the Amudarya River (on the territory of the Khorezm region and the Republic of Karakalpakstan, including the Bukhara region), about 91% of irrigated lands are classified by varying degrees of soil salinity, desertification and degradation of agro ecosystems are observed [2].

According to geobotanical studies, data are given that on 5.3 million hectares of pastures in the Aral Sea region, it was shown that 2.4 million hectares of degraded land. Because of the research, proposals were developed for the restoration of these territories [2].

Population growth, the development of industrial and agricultural production determines the increase in water consumption and water disposal, depletion and pollution of water resources. There are also causes of land degradation and desertification, these are physical, chemical, biological, climate change, wind and water erosion, anthropogenic factors, pollution with household waste, radioactive substances and oil residues, etc. [1-5;6-10; 11-16].

Combating soil salinization, melioration and revival of agricultural ecosystems, mitigation and adaptation to climate change through innovative approaches and technologies, the introduction of the so-called "climate-smart agriculture" and the integration of all this through the national "Agricultural Development Strategy until 2030" - are our top priorities for the long term[1-5;6-10;11-16].

To solve these most important environmental problems, scientists and specialists of the Republic of Uzbekistan were given the task of turning unsuitable soils into suitable ones through the use of desalination and water- and resource-saving new innovative technologies. Revive the agricultural ecosystem, save twice as much irrigation water, get 50% more yield, and reduce salinity, pH of the alkaline environment of soils by 40-56.6%, respectively, and pH from nine to 7.6-7.3.

On September 23, 2020, President of the Republic of Uzbekistan Sh. M. Mirziyoyev, speaking at the 75th session of the UN General Assembly, proposed, “to adopt a Special Resolution of the UN General Assembly on declaring the Aral Sea region a zone of environmental innovation and technology. And the day of adoption of this important document should be declared the International Day for the Protection and Restoration of Ecological Systems” [4].

Any plant cell for normal functioning must be saturated with water. The higher the air temperature, the lower its humidity, the more water evaporates from the above-ground organs, especially leaves, the roots do not have time to replenish the water that decreases in the tissues, there is a water deficit and temporary, and in dry hot summer conditions, often long or stable wilting of plants. Water deficit can also occur with sufficient soil moisture in conditions of low or high temperature and dry air, with strong dry winds [6; 7].

One of the effective methods of dosed irrigation on saline soils is drip irrigation.

Drip irrigation is the most efficient irrigation method in agriculture. Positive results obtained in a short time have contributed to the rapid spread of drip irrigation in many countries of the world, especially on soils prone to salinity and water shortages. They are characterized by the presence of a permanent pressurized distribution network, allowing continuous or frequent irrigation, precisely matching the water demand of the cultivated crops.

Unlike other methods, drip irrigation is based on the flow of water in small doses to the root zone of plants; the amount and frequency of water supply are regulated in accordance with the needs of the plants.

Water comes to all plants in the same amount.

This makes it possible to maintain an optimal water-physical regime in the root zone (especially in the critical phases of their development), which creates conditions for obtaining high yields.

This effect is more pronounced in arid climates, but in more humid areas, drip irrigation can significantly improve the quality of products.

Drip irrigation is applicable where other irrigation methods cannot be used or are inefficient:

- On soils prone to salinity;
- When used for irrigation of water with a high content of water-soluble salts;
- In areas with prolonged droughts and constant strong winds;
- With difficult terrain and a large slope of the site (up to 45 degrees or more);
- In the presence of sources with a limited amount of water;
- On soils with low capacity and very low or high hygroscopicity.

With drip irrigation, only a limited part of the soil surface is moistened, without surface runoff or water filtration into the deep layers of the soil. This makes it possible to maintain the humidity of the root layer during the entire growing season at an optimal level, without significant fluctuations, which are characteristic of all other irrigation methods. With drip irrigation, soil moisture is carried out by capillary action. Due to this, the optimal water-physical properties of the soil are preserved and moisture losses due to surface runoff and infiltration into the depth are eliminated, toxic salts do not rise above the ground [8-14].

Israel is a world leader in the rationalization and conservation of water resources in agriculture.

Low rainfall and high water prices have forced Israeli populations to look for technological solutions to this problem, such as innovative irrigation methods and water recycling.

Drip irrigation systems are widely used in Israel. The main batteries are also supplied in drops. This approach requires adherence to a clear technological process. A special cultivation system has been developed for each crop. There are no trifles here - everything is important: the correct installation of equipment, observing the distances between the pipes and the length of the rows.

The yield is affected by the cross section of the pipes, the speed of the aqueous solution, the working pressure in the hoses, so it is so important not to deviate from the technology in order to meet the irrigation standards. In addition, only filtered water is used for irrigation. Shafdan is the most famous Israeli facility that provides water to farms.

Shafdan purifies wastewater from the Gush Dan agglomeration, filters it and sends it to the local sandy aquifer. This water compensates for the lack of rainfall and minimizes drought damage and salinity in the area.

According to the author [15] in 2015, about 1.15 billion cubic meters of water were used in agriculture. 60 % of water for agriculture in Israel is used undrinkable such as treated sewage, salt water. In addition, in terms of the use of such water, the country is among the world leaders [15].

To obtain a normal crop yield in arid and saline soils, it is necessary to create a moderate water-physical regime in the root zone. Due to the high transpiration coefficient of such lands, there are shortages of CO_2 and H_2O [8-9].

For the formation of carbonic acid in the soil, CO_2 and H_2O are needed. CO_2 is found in abundance in the exhaust gas of tractors; during operation, when the internal engine burns, CO_2 is released and volatilizes uselessly [8-9].

Proper use of CO_2 and H_2CO_3 in arid and saline zones can solve problems with salinity and phosphorus uptake by plants and save water resources [8-9].

According to electronic resource data [15-16] from arid and saline uneven soils, you can get a good and high-quality crop in various crops, if you follow the instructions and requirements. Due to the use of drip irrigation systems lead to the advantage of:

1. The amount of flushing, fertilizer and nutrient waste is reduced by local irrigation.
2. With proper design, implementation and management, its irrigation efficiency is high.
3. No need to level the truss and applicable in steep terrain.
4. It is easy to apply on agricultural land with irregular shape.
5. Non potable recycled water can be used with confidence.
6. Moisturizing is provided in the root area.
7. Soil type is less important when determining irrigation time.
8. During the irrigation period, it decreases.
9. Soil erosion is decreasing.
10. Weed growth is reduced.
11. The amount of spray and the distribution of water in the nozzles are very uniform and controllable.
12. Labor cost is lower than other irrigation methods.
13. Watering volume can be adjusted with valves and drippers.
14. When using fertilizers with a drip system, fertilizer losses are minimized.
15. As the grass stays dry, the chance of plant disease is reduced.
16. Because the drip irrigation system requires low pressure compared to other irrigation methods, energy consumption is also lower [15-16].

The aim of the study is the use of desalination and water- and resource-saving factors in a complex, lowering the degree of salinity, pH of the soil environment, mineral fertilizers, fuels and lubricants and labor, increasing the assimilable form of phosphorus by the plant, and reducing the amount of leaching and irrigated water, restoring fertility, increasing yields and quality of crops, in conditions of phosphates saline lands and arid zones.

Object of study: saline soil, desalination factors, "Carbon dioxide forming a useful model" drip irrigation under the film, Bukhara-8 cotton.

Materials and methods of research

The experiments were carried out according to the methodology "Methodology for conducting field experiments" adopted in Scientific Research Institute for Seed Breeding and Agricultural Texnology of Cotton Growing [17; 18], "Methodology of agrochemical, agro physical and microbiological studies of field cotton areas" [19].

Table 1. Location of experimental options in the field plots

Experience Options	Repetition and Tiering		
1 Furrow irrigation (control)	1 tier, 1 repetition tier length 50м, each option consists of 12 rows	2 tier, 2 repetition tier length 50м, each option consists of 12 rows	3 tier, 3 repetition tier length 50m, each option consists of 12 rows
2 Biosolvent + Drip irrigation laying hoses across the row	1 tier, 1 repetition tier length 50м, each option consists of 12 rows	2 tier, 2 repetition tier length 50м, each option consists of 12 rows	3 tier, 3 repetition tier length 50m, each option consists of 12 rows
3 Bio solvent + "Carbonic acid-forming utility model" + drip irrigation under the film, laying hoses through the row	1 tier, 1 repetition tier length 50m, each option consists of 12 rows	2 tier, 2 repetition tier length 50м, each option consists of 12 rows	3 tier, 3 repetition tier length 50m, each option consists of 12 rows

Irrigation water counts were calculated using the Ryzhov method [20]. These yield results were depressively analyzed by the method of B.A. Dospekhov, "Methodology of field experience" [21].

The soils are saline and phosphates. The depth of groundwater is 2.0-2.5 m above sea level. Three options were studied in the experiment, 3 times repeated, each option was located on 1-2-3 tiers according to agility. The length of the tier (plot) was 50 m. Each variant consists of 12 rows (the total number of rows in each variant was 36 rows). Row spacing 60 cm. Each option consists of (60cm x12 row x 50m x 3p =) 1080m^2. The total area is = 3240m^2. All agro technical measures on the experimental plots were carried out according to the plan developed by the experimental farm.

A test to study the effectiveness of desalination, water and resource-saving technologies in a comprehensive manner was carried out in 2021-2022 with scientists at the Research Institute of Breeding, Seed Production and Cultivation of Cotton Agro technology at the Bukhara Scientific Experimental Station. During the leaching period, Bio solvent was poured in doses of 12 kg/ha and leaching was carried out. The soil was cultivated using a "carbon dioxide-forming utility model" during the plowing period and during cultivation in order to reduce salinity, wash and irrigation water and improve the pH of the environment and restore, increase soil fertility, and obtain a high-quality raw cotton crop. Table 1 shows the scheme of the experiment.

RESULTS AND DISCUSSION

Usually, in the Central Asian countries, especially in arid, saline soils, to obtain a high yield from agricultural crops, surface-furrow irrigation of crops is used (80-90% of the area). Due to poor mechanization and imperfect irrigation technology, labor productivity and irrigation quality are very low.

In the last 30-40 years, the drying up of the Aral Sea has led to the devastating effects of climate change and global warming. In addition, the improper conduct of agro technical measures for agricultural crops, the excessive use of irrigation water, and the violation of crop rotation of soils have led to deterioration in the structure and fertility of the soil. Due to the lack of irrigation water and the increase in air temperature, the transpiration coefficient increased, and groundwater rose. As a result, the amount of soluble, harmful ions for plants increased in the arable layers of the soil.

Illustrative data are given in Table 2. Analyzing the data in Table 2 on the accumulation of harmful soluble ions for plants in the arable (0-30 cm) soil layer, it indicates that furrow irrigation (control) at the beginning of the experiment (2021) at the end of the growing season of plants of toxic salts (chlorine and sulphate ions) accumulated 13.750 mg/kg of soil. Where complex factors were used (2-3 var.), these indicators were respectively: 8.957-7.861 mg / kg. Due to the complex use of desalination and water-saving factors, the accumulation of harmful salts decreased by 2-3 options, respectively, by 4.793-5.889 mg/kg of soil or by percentage by 53.5-74.91%

These figures indicate that as a result of the integrated use of desalination, water and resource saving factors, due to the "Utility Model" and under-film drip irrigation, evaporation from the soil surface decreases several times, in the soil layer, moisture and dissolved mineral fertilizers spread to the roots plants evenly, due to this it positively affects its pH of the environment, and leads to a decrease in the amount of harmful salts for the plant.

As a result, due to the neutralization reaction in the soil, the assimilation of phosphate fertilizers by the plant improves, harmful salts turn into harmless acidic ones, that is, an additional source of nutrients for the plant is formed, and, as a result, a favorable environment is created for its growth and development, increasing productivity and quality agricultural products.

Compared to furrow irrigation (7800m^3/ha), less irrigation water was consumed compared to the tested (2-3) options by 3300-3800m^3/ha. These indicators prove that the technologies we use are the most efficient and acceptable for growing crops.

In addition, using mineral fertilizers (N-250-P-175-K-125 kg/ha in pure form) on furrow irrigation, the yield of raw cotton in saline and arid climates was -35 q/ha. At 40-50% less spending mineral fertilizers, a crop of 55.2-65 centers / ha was obtained.

Based on the study of two-year results, it can be said that, despite very hot weather conditions and long-term (harmsils), with the complex use of desalination, water and resource-saving factors (Bio solvent 12 kg/ha was used for leaching. During plowing and "Carbon dioxide forming useful model") on saline and arid soils of cotton Bukhara-8, with under-film drip irrigation, irrigation water savings reached 1.73- two times.

Table 2. Influences on the yield of cotton with the use of desalination and water- and resource-saving factors

	Experience Options	Vegetative irrigatio m3/ha	Total water consumptio m3/ha	The amount of harmful soluble ions		Yield, c/ha	± Difference to contro c/ha	Water consumption, t obtain 1 quintal of yiel m3/ha
				Cl^- + SO_4^{2-}	Cl^- + SO_4^{2-}			
				2021 (beginning)	2022 (end)			
				0-30cm soil layers				
	Furrow irrigation (control)	4800	7800	13.750	11.720	35,0	0,0	222,857
	Biosolvent + Drip irrigation laying hoses across the row	2500	4500	8.957	7.194	55,2	+20,2	81,521
	Biosolvent + "Carbonic acid-forming utility model" + drip irrigation under the film, laying hoses through the row	2000	4000	7.861	6.773	65,0	+30,0	61,538

Reduced fuel and lubricants by 45-50%, the amount of harmful salts 56.6%, due to the neutralization of the alkaline environment, soil pH decreased from 9 (in autumn before leaching in the control variant) to (tested variant, the use of desalination and water-saving factors) 7.7-7.3 and the yield increased by 2.0 times.

This ensured the production of 5.52-6.5 t/ha of raw cotton. With the complex use of drip irrigation under the film and desalination factors together, it allows to increase the yield of cotton in comparison with traditional irrigation by two times. Reduce water consumption (222.857: 61.538 =) up to 3.62 times to obtain 1 quintal of raw cotton yield.

Also in 2.0-2.5, times reduce the cost of labor, fuel, machinery and equipment, mineral fertilizers and the amount of harmful salts, respectively: by 30-40-50-56.6%, restore soil fertility; due to the successful passage of neutralization processes and others, biochemical reactions create favorable conditions for the growth and development of cotton.

Due to the formation of CO_2 and H_2CO_3 on saline soils in the soil, hardly soluble, phosphates are converted into an assimilable form for plants.

A test to study the effectiveness of desalination, water and resource-saving technologies in a comprehensive manner was carried out in 2021-2022 with scientists at the Research Institute of Breeding, Seed Production and Cultivation of Cotton Agro technology at the Bukhara Scientific Experimental Station. During the leaching period, Bio solvent was poured in doses of 12 kg/ha and leaching was carried out. The soil was cultivated using a “carbon dioxide-forming utility model” during the plowing period and during cultivation in order to reduce salinity, wash and irrigation water and improve the pH of the environment and restore, increase soil fertility, and obtain a high -quality raw cotton crop.

Usually, in the Central Asian countries, especially in arid, saline soils, to obtain a high yield from agricultural crops, surface-furrow irrigation of crops is used (80-90% of the area). Due to poor mechanization and imperfect irrigation technology, labor productivity and irrigation quality are very low. In the last 30-40 years, the drying up of the Aral Sea has led to the devastating effects of climate change and global warming. In addition, the improper conduct of agro technical measures for crop agricultures, the excessive use of irrigation water, and the violation of crop rotation of soils have led to deterioration in the structure and fertility of the soil. Due to the lack of irrigation water and the increase in air temperature, the transpiration coefficient increased, and groundwater rose. As a result, the amount of soluble, harmful ions for plants increased in the arable layers of the soil.

In addition, since H_2CO_3 is a weak acid in chemical properties, and the soil is alkaline. Weak acids and strong bases interact very well with each other. As a result, all harmful soluble ions under the soil are converted into harmless salts during neutralization processes, i.e. into additional minerals for plants. By improving the pH of the soil environment, which we give through drip irrigation, various mineral, organic compositions and microelements, passing through the root system in an assimilated form, are evenly distributed throughout the plant organs. As a result, the formation of the best neutral environment in the soil increases the number of beneficial microorganisms, the accumulation of fruit elements, and dry matter, improves yield and quality. Ultimately, due to the creation of favorable conditions for plants, various fungal (fusarium and varicella wilt) and bacterial diseases disappear.

Due to the cover under the drip irrigation film and the laying of hoses through a row due to global warming (garmsil) and long-term high air temperatures from 42 to 53^{0}C), thanks to the shelter under the film, the evaporated water from the soil surface does not evaporate into the air, but condenses, remaining under film. Moisturizing on the surface layers of the soil, the evaporation of water decreases by several times. Due to the formation of moderate soil moisture, groundwater does not rise, and harmful salts for plants do not accumulate in the arable layers. As a result, secondary salinization is not observed. The soil is desalinated. The law of balance of nature is being restored.

CONCLUSIONS

Thus, as a result of two-year studies, it can be concluded that when using desalination and water- and resource-saving factors in a complex way, water consumption is reduced by 2 times compared to traditional irrigation;

- By reducing the water consumption from 2.73 to 3.62 times to obtain 1 center of the crop, and it is possible to obtain an increase in yield by 20.2-30.0 c/ha compared to the control;

- also 2.-2.5 times to reduce the cost of labor, fuel, machinery and equipment, mineral fertilizers and the amount of harmful salts, respectively: by 30-40-50-56.6%;

-pH of the medium decreases (in autumn in the control variant - before washing) from nine to 7.6-7.3 (tested variants)

- degraded soils turn into fertile, due to the successful passage of neutralization processes and other biochemical, redox reactions, favorable conditions are created for the growth and development of cotton. Increases the number of beneficial microorganisms;

- The balance of uniform distribution of macro and microelements in plant organs improves;

- The law of the balance of nature is being restored.

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