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THE EFFICIENCY OF BIOMELIORATION OF SALINE SOILS IN CONDITIONS OF A SHORTAGE OF WATER RESOURCES

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ABSTRACT

The article presents the research results on the impact of global climate change on Uzbekistan, increasing water scarcity, reclamation of irrigated lands, increasing soil salinity, reducing their negative effects, including the effectiveness of biological land reclamation. In the case of Syrdarya region, where climate change and water scarcity have a significant impact and irrigated lands are prone to complete salinization, biomeliorant plants after winter wheat – White corn (*Sorghum Moench*) and Mung (*Vigna radiata*) are affected by salinity and nutrient regimes. As a result of research to determine the norms and timing of soil salinity leaching in areas where biomeliorant plants are grown: saline leaching standarts in the experimental areas are 3278 - 3800 m^3 / ha in the average saline winter wheat, 2380 (white corn) and 2500 (mung) m^3/ ha in the replanted area, in the highly saline area was found to be 4507 - 4731 m^3 / ha, 3000 (white corn) and 3340 (mung) m^3 / ha, respectively, according to the above crop. Saline leaching at the above rate provided complete leaching of soil salts from the 1.0 m layer and reduced chlorine ion content to 0.01-0.02%, saving 25-30% of water compared to accepted saline leaching standards.

Keywords: Climate change; water scarcity; plants; biomelioration; saline soils; water-physical properties of soil; water conservation; leaching; leaching rate; irrigation rate; yield; salt regime; reclamation; efficiency.

INTRODUCTION

The problem of global climate change is on the agenda of mankind, with not only the average annual temperature rise on the planet, but also changes in the entire geosystem, the rise of the world's oceans, melting ice and permanent glaciers, increasing uneven rainfall, changing river flow regimes and climate instability. other changes involved.

Due to global warming, the melting of glaciers in mountainous areas and their reduction in volume may reduce river flow by 25-30% in the next 20 years, especially in the Amudarya and partly in the Syrdarya and Zarafshan, causing severe problems in the region. the amount can be increased by 1.5 times.

Observations of the temperature dynamics regime in Uzbekistan over the past 50 years have shown that the maximum temperature growth rate was 0.22°C per year, and the minimum -0.36°C. On this basis, after 20 years, the average annual temperature in the northern part of the republic will increase by 2-3°C, and in the southern part by 1°C. Climate change will lead to 10-15% evaporation of water from water surfaces and 10-20% more water consumption due to increased plant transpiration and irrigation standards. This leads to an average 18% increase in non-renewable water consumption, which will undoubtedly complicate the further growth of agricultural production [1,2,3].

As a result of global climate change, the area of glaciers in Central Asia has shrunk by about 30 % over the last 50-60 years. It is estimated that the volume of glaciers decreases by 50 percent when the temperature rises to 20°C and by 78 % when heated to 40 ^{o}C. According to estimates, by 2050, water resources in the Syrdarya basin are expected to decrease by 5%, and in the Amudarya basin - by 15%. The total water deficit in Uzbekistan in the period up to 2015 was more than 3 billion cubic meters by 2030, it may reach 7 billion cubic meters, and by 2050 - 15 billion cubic meters [4,5].

The territory of the republic has its own soil and climatic conditions, and as a result of lack of natural drainage, high level of groundwater mineralization, a number of areas are "primary salinity". At the same time, as a result of irrational use of water resources and the negative impact of other anthropogenic factors, "secondary salinization" of lands was observed in some areas, 45.3% of irrigated land was saline to varying degrees, of which 31.1% was weak, 12.2% moderate and 2% strongly salted. In 24.4 percent of the area, the groundwater level is 2 m and above [4,6,7,8]. Today, to improve the reclamation of irrigated lands in the country, the total length is 142.9 thousand km, including 106.2 thousand km of open and 36.7 thousand km of closed horizontal collector-drainage network, as well as 172 reclamation pumping stations, 3,897 vertical drainage wells. used. The creation and application of effective technologies to improve the reclamation and sustainability of irrigated lands, to help increase soil fertility, to reduce and prevent soil salinity are among the pressing issues.

LITERATURE REVIEW

The reason for the salinization of irrigated lands in Central Asian countries is excessive irrigation and inefficient operation of ditches. While the drainage system reduces irrigation water consumption by lowering the groundwater level, on the other hand, they add saline water to the water in the irrigation system, degrading their quality [9,10].

In strongly saline and arid soils, it was recommended to sow white corn (sorgo), millet, nut, rapeseed, and sorghum after winter wheat [11]. Studies in the cultivation of moss and other legumes with minimal tillage between rows of cotton and corn in saline soils have yielded high results [12].

When studying the effect of repeated sowing of white corn on the salt and moisture regime of the soil in the saline lands of Bukhara region, the amount of salt in 1 m layer of soil increased from 0.036% chlorine ion at the beginning of the growing season to 0.031% at the end of the growing season Decreased to 0.022%. Soil moisture was 11.6–12.0% at the beginning of the growing season in the variant planted with white oats, and increased to 14.9–16.8% at the end of the growing season [13].

In the strongly saline soils of the Syrdarya region, the effect of licorice on soil salts was studied, and it was found that chlorine ions decreased from 0.101-0.210% to 0.014-0.066% over 10 years [14].

In the saline soils of Syrdarya region, alfalfa + wheat, triticale + hay peas were sown as a phytomeliorant in the fall, before early spring plowing, a green mass of 40 c/ha was obtained and the soil was kept up to 5% excess moisture, no salt accumulation in the soil. A total of 2000 m^3 / ha of water is saved. When wheat was sown in a mixture with alfalfa in the spring, a green mass yield of 60 c/ha was obtained from wheat and straw alfalfa, and the saline leaching rate was reduced to 4000 m3 / ha, which had a positive effect on the soil salt regime [15]. During the short rotation sowing, when sugar beet was planted after sugar beet, from the beginning to the end of the growing season, the salts in the soil decreased by 2 times (0.321% in spring, 0.151% in autumn) [16].

In his scientific research on improving the reclamation of soils in the lower reaches of the Amudarya and desalination of saline soils by phytomelioration, he selected the golden variety *Portulaca oleracea* in the saline areas of Khorezm region, as well as *halophyte* (AL), *Alopecia* (TH), *Alopecia* (TH GG), *Alhagi pseudalhagi*, *Karelinia caspia* (KC) and *Chenopodium album* (CA) were planted and its salinity assimilation was assessed: *Portulaca oleracea* plant has the ability to absorb up to 20% of topsoil salts in saline soils and can be used in food and livestock; The *Chenopodium album* halophyte plant, typical of the Khorezm region, can be recommended to the region as a plant that is widely saline-absorbing and highly biomass-producing; The *Chenopodium album* halophyte plant can also be widely used in the pharmaceutical industry; *Apocynum lancifolium* and *Karelinia caspia* halophyte plants can be used as saline assimilation and fodder bases for livestock; Abundant and high-quality crops of cotton, wheat, corn and other crops can be obtained after phytomelioration by placing the studied plants in the crop rotation system [17].

Under the influence of natural factors, an increase in the area of saline lands is predicted. So, under the influence of natural factors, slightly saline territories in 2050 will amount to 52.3-55.9%, and by 2100 they will decrease to 49.4-54.5%. Moderately saline areas will amount to 31.2-33.4% in 2050, and by 2100 they will increase to 32.4-34.6%, and highly saline areas will amount to 12.9-14.3% in 2050, and by 2100 they will increase to 13.1-16% [18].

METHODS

Field, laboratory research and phenological observations “Methods of field experiments” of the Research Institute of Cotton Breeding, Seed Production and Agrotechnology (UzPITI, 2007) performed on the basis of the accepted social research methodology. The accuracy and reliability of the obtained data were analyzed mathematically and statistically using the generally accepted multivariate method of BA Dospekhov and the computer program SPSS (Statistical Package for Social Science).

Field experiments were performed in the following system (Table 1).

The experiments were carried out in the conditions of medium-salinity of light gray, medium-salinity, weakly gypsum medium and strongly saline soils of "Hayot Joy" and "Qiz Uchgan" farms in Khavast district of Syrdarya region.

Botanical description of biomeliorant plants: 4 cultivars of *Sorghum* Moench (pers) of white corn: fodder, technical, food-grown white corn - S. Vulganell Pers, Kokand white corn - S. Cernum Host, Gaolyan (Japan white corn) - S.chinensi, grass from water grown as a fodder crop - S.Sudanensi is widespread. The root is a poplar root that grows 2 meters deep into the soil and spreads up to 90 cm around. The length of the stem is 2.5-3.5 meters in tropical countries, it reaches 6-7 meters. The grains are peeled and unpeeled, round, oval, white-brown, yellow-

Table 1. Experimental scheme for studying the effect of White Corn and Mung as biomeliorant on soil reclamation and saline leaching regime

Options	Name of the event	
1	Plowed after autumn wheat, the crop is not planted (control).	The soil is washed with saline until the chlorine content reaches 0.01%
2	As a phyto-ameliorant crop after winter wheat - White corn (*Sorghum Moench*) are planted.	The soil is washed with saline until the chlorine content reaches 0.01%
3	After winter wheat is planted as a phyto-ameliorant crop - Mung (*Vigna radiata*).	The soil is washed with saline until the chlorine content reaches 0.01%

brown. The weight of 1000 grains is 25-40 g. Each stalk contains 1,600 to 3,500 grains. White corn is the driest plant, with a transpiration coefficient of close to 200, making it one of the most heat-resistant cereals. White corn seeds germinate well at soil temperature 120S-140S. Air temperature can also rise at 35-400S. A useful temperature sum of 2250-25000S is required from sowing to ripening. Because the roots penetrate deep into the soil, they use the moisture available in the soil and are not demanding to moisture.

Mung (*Vigna radiata*) - Mung is light-loving, heat-loving, resistant to soil drought. The demand for moisture is moderate. For full germination, the seeds absorb around 120-150 percent of their weight. The temperature should be at least 12-15 degrees for the seeds to germinate. Yield is 20-24 c/ha when sown in April-May, taking into account soil climatic conditions, and 11.8-21.0 c/ha when sown as a secondary crop. Bacteria accumulate in the root of the moss and assimilate free nitrogen in the molecular state of the atmosphere, biologically 50-100 kg, sometimes 150 kg in the soil. leaves nitrogen around. The studied Marjon variety is a fast-ripening variety, ripening in 60-63 days after the first pods sprout. The full cooking time is 90-95 days. The pods are formed at the top of the stem (20-25 pieces). Grain yield is 25.5-28.0 c/ha. The weight of 1000 seeds is 82 g. The variety is intended for sowing under irrigated conditions.

RESULTS AND DISCUSSION

Experimental Field Soil and its Properties

The soil of the experimental areas is light gray meadow, medium and strongly saline, weakly gypsum, medium mechanical composition, groundwater depth of 1.70-2.5 m, mineralization rate 5-8 g / l. The experimental area is a ditch, with a collector on the north and northwest side, an open ditch on the south and southeast side, and a closed ditch between the two.

The volumetric weight of the soil in the average saline field of the experiments averaged 1.50–1.54 g / cm^3 in the 1 m layer, and 1.56–1.58 g ⁄ cm^3 in the strongly saline area. Data on soil density show that due to the thickness and relative abundance of the gypsum layer in the strongly saline area, the soil of this experimental area is more compacted than the average saline experimental area.

When analyzing the water permeability of the soil, the average salinity was 29.2–29.8 mm/min for an average of 6 hours in the experimental area, and 25.5–26.7 mm / min in the strongly saline experimental area. According to the data obtained, the water permeability of the soil in both experimental areas is unsatisfactory, and the water supplied for irrigation and saline washing is characterized by slow filtration into the soil.

The limited moisture capacity of the soil was 22.7% in the average 1 m layer in the average salinity experimental area and 23.5% in the strongly saline area. These data were used as a basis for determining saline wash standards.

Humus, total nitrogen, phosphorus and potassium in the soil of the experimental area and their mobile forms were determined at the beginning of the study. The amount of humus in the average salinity area was 0.686% in the topsoil, 0.414% under the topsoil, and 0.523% in the topsoil and 0.368% under the topsoil. The lack of humus in the experimental fields is related to the salinity levels of the soil and the very low content of organic matter in the soil, including plant residues. Experimental field soils are poorly supplied with mobile forms of nutrients, including nitrogen and phosphorus (nitrogen 2.7–3.4 mg / kg, phosphorus 11.4–14.34 mg / kg), but are highly supplied with exchangeable potassium (plowing) 369.0-376.4 mg / kg in the stratum, 345.0-311.0 mg / kg in the subgrade). The abundance of potassium in the soil is related to salinity, and in saline soils potassium is always abundant.

Repeated crops after winter wheat are white corn and moss irrigation regimes. Corn, sown as a secondary crop after winter wheat, was irrigated 4 times during the season (June-October). Of these, the first irrigation was carried out after the planting of corn to obtain a completely flat seed, with an irrigation rate of 737-803 m3 / ha. The remaining 3 irrigations were carried out during the growing season of corn. Irrigation norms in the average salinity experimental area are 750-970 m^3 / ha, seasonal irrigation norms are 3201-3590 m3 / ha, irrigation norms in the strongly saline area are 850-1070 m^3 / ha, and seasonal irrigation norms are 3680-4380 m^3 / ha. e. Irrigations were carried out from July to the end of August, the interval between irrigations was 20-30 days.

Moss sown as a repeat crop after winter wheat was irrigated at a rate of 600-960 m^3 / ha to obtain a full flat crop. In the average salinity experimental area, 3 irrigations were carried out with irrigation norms of 750-1000 m^3 / ha, while the seasonal irrigation norm was 3378-3590 m^3 / ha. In the heavily saline area, the moss was irrigated 4 times with 880-900 m^3 / ha irrigation norms and the seasonal irrigation norm was 3680-4380 m^3 / ha. Irrigations were carried out from July to early September, the interval between irrigations was 18-21 days. The given irrigation numbers, norms, and timings ensured the full maturation of the corn and showed its effect on the water-salt regimes of the soil (Table 2).

Depending on the amount of salts in the soil, the type of salinity and the mechanical composition of the soil, as well as the specific climatic characteristics of the area, saline leaching criteria were determined. The salinity was measured using a Chipoletti water meter. In calculating the norm of saline leaching was calculated according to the following formula of VR Volobuev for one meter of soil layer, taking into account the water-physical properties of the soil and the amount of salts [5]:

$$N = 10000*\lg*[Si/Sadm]\alpha \quad (m^3/ha).$$

Here: α – free salt transfer coefficient, Si , Sadm the amount of salts in the soil before saline leaching and, in% of weight.

Based on the soil moisture and the amount of accumulated salts formed as a result of seasonal irrigation in the areas planted with repeated biomeliorant crops, the theoretically required saline leaching norms were determined. At the same time, in the cultivation of winter wheat, the maximum salt washing rate was required in 1st variant, where the brine was not washed, and the second crop was not planted. This averaged 5777 m^3/ha in the average salinity area and 6056 m^3/ha in the strongly saline area.

The saline leaching rate for 2 nd variants planted with saline washed and replanted white corn was 3541 m^3/ha in the average saline area and 3687 m^3/ha in the strongly saline area, which is 2136 m^3/ha in accordance with the above salinity levels compared to the unsalted and replanted options. ha and 2369 m^3/ha . The saline leaching rate in 3 variants of saline washed and replanted is 3811 m^3/ha in the average saline area and 4055 m^3/ha in the strongly saline area, which is 1966 m^3/ha in accordance with the above salinity levels compared to the non-saline and replanted options and 2001 m^3/ha, respectively.

When combined with seasonal irrigation and saline leaching required after repeated sowing of white corn planted as a biomeliorant with good results, the total was 6917 m^3/ha in the average saline area and 7393 m^3/ha in the strongly saline area, which is the water norm. is 1140 m^3/ha (moderately saline) and 1337 m^3/ha (strongly saline) more than the required saline wash rates. However, the positive side of this is explained by the fact that the yield from repeated crops and the formation of favorable water and salt regimes in the soil.

Productivity of biomeliorant plants. Seedling thickness of white corn in the average saline area was 54.7 thousand / ha, stem length was 168 cm,

Table 2. Influence of biomeliorants on soil moisture and salt regime (average 3-year layer 0-100 cm)

Variant	Soil moisture,%		Chlorine ion,%	
	Before planting	In the fall	Before planting	In the fall
		Moderately saline area		
1	11,3	8,0	0,030	0,061
2	11,7	14,9	0,030	0,039
3	11.4	14.2	0.030	0.041
		Strongly saline area		
1	11,1	8,6	0,040	0,075
2	12,8	15,4	0,040	0,048
3	12.6	15.1	0.040	0.050

grain yield was 25.0 c/ha and stalk yield was 183.2 c/ha. The seedling thickness of white corn in the strongly saline area was 49.0 thousand / ha, and the average stem length during the last observation period of the growing season was 145 cm. In this variant, 21.2 c/ha of grain and 168 c/ha of stalks were obtained.

Seedling thickness of moss planted after autumn wheat in the average saline area was 155.7 thousand / ha, stem length was 60.0 cm, grain yield was 17.0 c/ha. Seedling thickness of moss in the strongly saline area: 154.7 thousand / ha, stem length 63.0 cm, grain yield 15.2 c/ha. No crop was harvested from the strongly saline area.

CONCLUSION

Based on the analysis of the results of research on the prevention of soil salinization and reduction of water consumption in saline leaching through the cultivation of phytomeliorant plants in the conditions of light gray meadow, medium and strongly saline, weakly gypsum, medium mechanical soils of Syrdarya region, the following conclusions can be drawn:

1. The intensity of salt restoration at the end of the growing season was lower than in the control (plowed) variant in the planted version of the experimental field phytomeliorant plant. At the end of the growing season, the content of chlorine in the medium saline soils increased from 0.030% to 0.039% in the 0-100 cm layer, in the 0-100 cm layer from 0.030% to 0.041% in the mung planting variant, and from 0.030% to 0.061% in the uncultivated field. . The salt accumulation coefficient for chlorine ion was 1.30 in the field planted with white corn, 1.37 in the field planted with Mung, and 2.03 in the field not plowed and cultivated.
2. At the end of the growing season, in strongly saline soils, the content of chlorine in the soil in the variant planted with white corn increased from 0.040% to 0.048% in the 0-100 cm layer, in the variant planted with moss from 0.040% to 0.050%, in the uncultivated field from 0.040% to 0.075%. increased to. The salt accumulation coefficient for chlorine ion was 1.20 in the field planted with white corn, 1.25 in the field planted with mung, and 1.88 in the field not plowed.
3. Seedling thickness of white corn in the average saline area was 54.7 thousand/ha, stem length was 168 cm, grain yield was 25.0 t/ha and stalk yield was 183.2 t/ha. The seedling thickness of white corn in the strongly saline area was 49.0 thousand / ha, and the average stem length during the last observation period of the growing season was 145 cm. In this variant, 21.2 c/ha of grain and 168 c/ha of stalks were obtained.
4. Seedling thickness of moss planted after winter wheat in the average saline area: 155.7 thousand / ha, stem length 60.0 cm, grain yield 17.0 c/ha. Seedling thickness of moss in the strongly saline area: 154.7 thousand/ha, stem length 63.0 cm, grain yield 15.2 c/ha. No crop was harvested from the strongly saline area.
5. When saline leaching was carried out in the experimental field, the highest salinity leaching rate was observed in the plowed and uncultivated field, with an average salinity of 5,777 m^3/ha and 6056 m^3/hain the strongly saline area over the years. As a phytomeliorant, the saline leaching rate in the field planted with white corn is 3541 m^3/ha in the average saline area and 3687 m^3/hain the strongly saline area, which is 2136 m^3/ha and 2369 m^3/ha, respectively, compared to the saline unwashed and replanted options.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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