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THE IMPORTANCE OF BIOMELIORANTS IN PREVENTING WATER WASTAGE AND SECONDARY SOIL SALINIZATION

O'. Toshbekov, S. Tilovboyev
Gulistan State University
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Abstract. This article demonstrates that the application of non-traditional reclamation measures, particularly the use of perennial trees as biological drainage systems, can produce positive results in forming and maintaining an optimal salt-water regime in the upper active layer (0–1 m) of irrigated meadow-gray soils. The study provides recommendations on selecting appropriate tree species by taking into account their reclamation and biological characteristics, protective functions, and ecological conditions, as well as on planting them along irrigation networks and field boundaries.
Keywords: irrigated soils, biological drainage, groundwater, mineralization, critical depth, hydrogeology, secondary salinization, phytomelioration, protective tree belts

Introduction. Currently, the reclamation condition of irrigated agricultural lands is deteriorating year by year. This is primarily associated with the inadequate functioning of existing collector-drainage systems and non-compliance with proper irrigation regimes. As a result, secondary soil salinization is increasing, leading to the deterioration of important soil properties and a gradual decline in soil fertility.

The implementation of the tasks set out in Presidential Decree No. PF-27 dated February 2, 2023, concerning the "Development Strategy of New Uzbekistan for 2022–2026," as well as Presidential Decree No. PF-60 on the "Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020–2030," is considered one of the pressing issues of the present day (1, 2).

The damage caused by soil salinization to agriculture is extremely significant. Cotton yields decrease by 20–25% in slightly saline soils, 40–50% in moderately saline soils, and up to 60–80% in highly saline soils. In highly saline and strongly salt-affected soils, cotton seedlings die as early as the initial stages of development (3).

One of the most important tasks in implementing fundamental reforms in the agricultural and water management sectors of the Republic, as well as in ensuring the efficient and rational use of water and land resources, is the introduction of scientific achievements and advanced production technologies.

At present, in the majority of irrigated areas of the Republic (approximately 60%), groundwater levels have risen, resulting in the formation of hydromorphic and meso-hydromorphic water regimes. Under hot climatic conditions, this creates favorable conditions for the accumulation of water-soluble salts in the upper soil layers.

The current state of agricultural production requires the application of intensive technologies in irrigated agriculture, the preservation, restoration, and improvement of soil fertility, and the protection of water resources. It is well known that irrigation creates conditions for a rise in groundwater levels, which, in turn, causes secondary soil salinization and reduces the productivity of agricultural crops. At the same time, considerable amounts of freshwater are lost due to physical evaporation from canal surfaces. Water losses resulting from filtration from canals and infiltration into agricultural fields not

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only reduce the available water resources but also contribute to the deterioration of the reclamation condition of soils. Among measures aimed at combating these problems and protecting the environment, phytomelioration is of particular importance, as it also serves as a means of maintaining bioecological balance.

As demonstrated by numerous researchers, lowering the groundwater table and increasing the thickness of the aeration zone improve the reclamation condition of agricultural lands and reduce the amount of water-soluble toxic salts in the upper soil layers (3, 4, 5).

In soils prone to secondary salinization, conventional reclamation measures may not always provide the expected results. Therefore, in order to establish an optimal salt-water regime in the upper active soil layer (0–1 m) and maintain it within optimal limits, it is necessary to introduce non-traditional reclamation measures, particularly the use of perennial trees and perennial leguminous grasses as biological drainage systems. In this regard, the selection of tree species should take into account their reclamation, protective, and biological characteristics, as well as the prevailing ecological conditions.

Observations have shown that areas where trees are planted along field boundaries possess specific soil conditions, characterized by heterogeneous soil-forming materials and changes over time. In low-lying areas, groundwater rises toward the soil surface, resulting in waterlogging and salinization. In elevated areas, groundwater occurs at greater depths, causing the upper soil layers to become excessively dry by the beginning of summer. Therefore, when selecting specific forest plant species, it is essential to take into account the groundwater level and degree of mineralization; planting different tree species without considering these factors should be avoided.

The research was conducted during 2021–2023 on irrigated meadow-gray soils distributed within the territories of the “G‘alaba” Water Consumers Association (WCA) in Boyovut District of Syrdarya Region, the “Jasur Nemat o‘g‘li” farm in Mirzaobod District, and the “Sarmirza” farm in Guliston District. The study areas differed in their lithological-geomorphological, hydrogeological, and soil-climatic conditions.

To monitor changes in groundwater levels with different degrees of mineralization, observation wells (piezometers) were excavated to a depth of 3–3.5 m, and plastic pipes with a diameter of 50 mm were installed in them. The sections of the pipes installed in the wells were covered with fine-mesh screens, while their lower ends were sealed with caps.

Groundwater levels were consistently measured from the mouth of each observation well. The number of observation wells was determined depending on the reclamation condition of the area and the types of trees planted. All wells were numbered.

The dynamics of changes in groundwater level and mineralization under the influence of biological drainage systems were monitored every 10 days throughout the plant growing season.

The objective of our study was to determine the reclamation and hydrogeological significance of trees planted along canals and irrigation networks and to identify tree species that are salt-tolerant, long-lived, and characterized by a high transpiration coefficient.

According to data reported in the literature, plane trees can be planted along field boundaries in areas with low and moderate salinity, as well as along canals in relatively moist locations where the groundwater table is at a depth of 2.0–3.0 m. This tree species is long-lived and tall, resistant to diseases and pests, and has a strong trunk with dense branching. It provides effective shade over the water surface of canals and thereby reduces water loss through evaporation (2).

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Poplar is recommended for planting in moderately saline areas with high moisture content, where the groundwater table is located at a depth of 1.0–1.5 m. Under such conditions, poplar is tolerant of salinity and dry atmospheric conditions and develops a downward-leaning trunk. It suppresses the development of weeds and can reach a height of 20–25 m. Due to its rapid growth, poplar provides economic benefits within a relatively short period and can subsequently be used as timber.

Black ash is moisture-loving and salt-tolerant and grows well when planted along irrigation networks. It is recommended for establishing protective tree belts in areas with low to moderate salinity and groundwater levels at a depth of 1.5–2.0 m.

White acacia and elm are primarily used to establish protective tree belts. These tree species are also salt-tolerant, require relatively little moisture, and are not demanding with regard to soil type. Due to their rapid growth, planting them along canal banks in areas where the upper soil layer is saline and groundwater is located at a depth of 2–3 m or deeper can produce positive results.

The study of the hydrogeological significance of protective tree belts and the growth characteristics of trees enabled us to identify the biomeliorative properties of tree species such as plane tree, poplar, willow, black ash, white acacia, elm, and mulberry. These species can grow successfully and perform protective functions along irrigation networks and canals when appropriate agrotechnical practices are applied.

In addition to collector-drainage networks, biological drainage systems also play an important role in lowering groundwater levels to an optimal depth. Observations showed that 2–4 rows of trees planted along irrigation networks and field boundaries ensured a significant reduction in groundwater levels. In areas planted with plane trees, poplars, willows, black ash, and mulberry, the reduction in groundwater level reached 54–63 cm by mid-summer compared with the control variant (Table 1).

Effect of Protective Tree Belts on Groundwater Levels

(Table1)

Tree species	Dynamics of Changes in Groundwater Level, cm							Average annual, cm	Difference compared with the open field, cm
	III	IV	V	VI	VII	VIII	IX		
Poplar	170	225	267	290	325	300	275	272	54
Plane tree	250	260	280	300	330	295	260	281	63
Black ash	218	232	275	295	300	287	258	280	62
Open field	180	200	222	250	254	212	213	218	0

Number of rows of trees planted along irrigation networks as biological drainage systems

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Water flow rate in the irrigation network, m³/s	Amount of water lost per day from a 1 km-long irrigation network, m³	Tree species and number of rows planted as biological drainage					
		Poplar (one plant evaporates 0.474 m³ of water per day).		Plane tree (one plant evaporates 0.433 m³ of water per day).		Black ash (one plant evaporates 0.284 m³ of water per day).	
		Number of plants per 1 km	Number of rows	Number of plants per 1 km	Number of rows	Number of plants over a 1 km distance	Number of rows
5	410	799	2	602	2	782	3
10	410	799	2	602	2	782	3
20	1094	2132	4	1606	3	1102	4
30	1231	1920	4	1808	3	1227	4

The effect of perennial trees planted at different times on the dynamics of groundwater level changes is presented in Figure 1

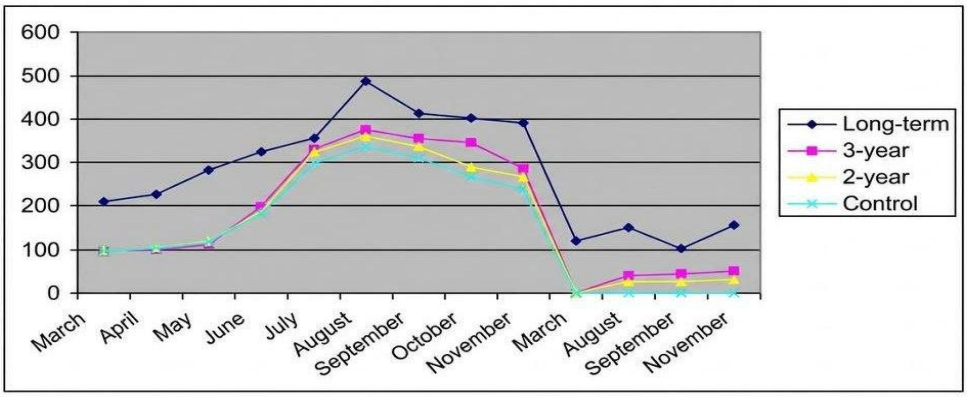


Figure 1. Dynamics of Changes in Groundwater Levels

Depending on the water discharge in inter-farm and on-farm irrigation networks (m³/s) and the amount of water lost per day through irrigation networks (m³), the number of trees to be planted along

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irrigation networks as biological drainage systems (the number of plants and rows per 1 km) is presented in Table 2.

Syrdarya Region is one of the areas of the Republic characterized by highly saline soils, shallow groundwater, and strong desert winds. In order to improve the reclamation condition of agricultural lands, reduce excessive soil moisture, and increase the production of cotton, grain, vegetables, and melons, it is advisable to establish 2–4-row protective tree belts along the windward sides of irrigation networks in agricultural areas. Such tree belts can help reduce evaporation from water flowing through irrigation networks over large agricultural areas.

Based on the results of the research conducted, it can be concluded that one of the low-cost methods that can be used to reduce soil salinity or prevent its development is the use of plants, particularly phytomeliorants.

References

1. Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020–2030, Presidential Decree No. PF-5853.
2. O. Toshbekov, A. Altmishev. The Importance of Phytomelioration in Managing Groundwater Levels and Mineralization. Monograph, Gulistan, 2017, pp. 85–93.
3. Presidential Decree No. PF-60 dated February 2, 2023, “On the Development Strategy of New Uzbekistan for 2022–2026” (PF-27).
4. U. Toshbekov, R. Rakhmonov, D. Kim, Sh. Botirov. The Influence of the Licorice Plant on the Change in the Amount of Toxic Salts in Saline Soils. 4473-Article Text-8227-1-10-20210502, pp. 1217–1222.
5. O. Toshbekov, S. G. Anarkulova, Sh. Bobobekova. Monitoring the Dynamics of Groundwater Level and Mineralization in Irrigated Gray-Meadow Soils. In Water-Energy and Food Security in the Context of Global Climate Change and Water Scarcity, February 25–26, 2025, pp. 86–89.