Monitoring Of The Agro-Meliorative Condition Of Irrigated Gray-Meadow Soils In Saykhunobod District Of Syrdarya Region

[1] O‘. Toshbekov
[2] Z Madraximova
[3] S. Tilovboyev

[1] Associate Professor of the Department of Agro-soil Science and Reclamation, Uzbekistan
[2] Senior Lecturer, Department of Fundamental Medical Sciences, Uzbekistan
[3] Student, Gulistan State University, Uzbekistan

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Abstract

This article examines the water–physical properties of irrigated gray-meadow soils, as well as the dynamics of changes in the groundwater table and the degree of mineralization of saline groundwater over the years. Based on the monitoring results, recommendations are provided for the practical implementation of measures aimed at improving the agro-melioration condition of the soils.

Keywords: Irrigated soils, agro-melioration, mechanical composition, general physical properties, water properties, moisture capacity, groundwater (phreatic water), mineralization, critical depth.

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1. Introduction

The results of this research contribute, to a certain extent, to the implementation of the tasks defined in the Presidential Decree No. PF-5853 dated October 23, 2019, “On the Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020–2030,” as well as the Presidential Decree No. PF-60 dated February 2, 2023, “On the Development Strategy of New Uzbekistan for 2022–2026,” and other relevant regulatory and legal documents related to this field [1,4,5,6,7,8].

At present, the efficient and rational use of land and water resources in cultivated areas, the restoration and preservation of soil fertility, and the consistent increase in crop productivity are considered among the most important issues. Therefore, it is necessary to properly and timely implement various agrotechnical and melioration measures in the field, which requires detailed monitoring of soil properties and its melioration–ecological condition, as well as the development of scientifically substantiated proposals and recommendations based on the data obtained [2,3,9,10,11,12].

2. Selected Object, Research Objectives, And

Methods

Scientific research was conducted to monitor the agro-melioration condition of irrigated gray-meadow soils in Saykhunobod District of Sirdarya Region and to ensure their rational use.

In the main soil profiles established in the irrigated areas of the farm, the water–physical and agrochemical properties of the soils, as well as their melioration condition, were studied. In addition, based on the analysis of data collected by specialists of the Syrdarya Regional Melioration Service, indicators of the groundwater table depth and mineralization as of July 2024–2025 were examined. Field experimental and laboratory methods were used in the study.

Soil and parent rock materials consist of particles of various sizes and quantities. Mechanical elements that are similar in size and have comparable physical properties form the same fraction.

Changes in the size distribution of mechanical elements in the soil have a significant influence on its properties. Therefore, special attention should be given to the study of soil mechanical composition.

According to the obtained data, the mechanical composition of the soil in the upper layers is light loam, while in the lower layers it gradually alternates with

Table 1

Mechanical composition of the soil

Layer depth, cm	**Mechanical composition**							**Physical clay fraction**
	Particle size distribution by diameter, mm							
	>0,25	**0,25-0,1**	**0,1-0,05**	**0,05-0,01**	**0,01-0,005**	**0,005-0,0**	**<0,001**	
0-29	5,03	9,67	27,83	29,77	6,63	9,03	12,03	27,69
29-57	3,32	7,60	28,88	30,02	7,86	10,01	12,13	30,00
57-89	3,13	7,77	15,17	36,10	11,80	11,03	15,00	37,83
89-124	2,03	5,83	8,27	33,93	16,63	13,90	16,20	46,73
124-178	2,00	5,60	9,02	35,98	15,10	14,10	18,20	47.40

If fine sand particles are more abundant in the upper layer, the lower layers are dominated by coarse silt particles. Overall, throughout the soil profile, coarse silt particles (0.05–0.01 mm) are observed to constitute the largest proportion. This characteristic is typical for all soils of the Mirzachoʻl region and can be explained by the fact that the soil's parent material consists of loess deposits (Table 1).

The solid phase density of irrigated gray-meadow soils often varies from 2.68 to 2.74 g/cm³. In the soils we studied, similar results were obtained: in the upper layers, the solid phase density ranged from 2.64 to 2.67 g/cm³, while in the lower layers, this value increased up to 2.74 g/cm³ (Table 2).

Soil density is of significant importance in determining soil fertility, particularly for the healthy development of cultivated plants and for increasing their productivity. It should be noted that even though microaggregates in the soil exist in small quantities, they help prevent a sharp increase in soil density throughout the vegetation period and contribute to the formation of a stable physical regime.

Determining soil density allows us to identify and implement the appropriate agrotechnical measures necessary for agricultural practices.

Table 2.

Soil solid phase density, bulk density, and total porosity

Layer depth, cm	Soil solid phase density, g/cm³	Soil density g/cm³	Porosity%
0-29	2,64	1,31	50,4
29-57	2,67	1,44	46,1
57-89	2,69	1,40	48,0
89-124	2,71	1,40	48,4
124-178	2,73	1,44	47,3

According to the obtained data, the lowest soil density was observed in the upper cultivated layer, with a value of 1.31 g/cm³. The density of the lower cultivated layer was found to increase up to 1.44 g/cm³. Irrigation and tillage lead to variations in density in the upper and middle soil layers. Below the dense sub-cultivated layer, density decreased to 1.40 g/cm³, while in the lower layers, as the mechanical composition became heavier, density increased again to 1.44 g/cm³ (Table 2).

Soil porosity determines properties such as water-holding capacity, water retention, and air regime. The highest porosity was observed in the upper cultivated layer, reaching 50.4%, while in the sub-cultivated layer it was 46.1%. These values also varied depending on the soil's mechanical composition, organic matter content, and granularity (Table 2).

Literature indicates that a high content of coarse silt particles in the soil reduces water permeability and water supply while increasing capillarity, i.e., the upward movement of water through capillaries. N.I. Kachinskiy emphasized that water rises through capillaries more easily in sand and loamy sands, gradually moving toward loess-like sandy loams [1,3]

According to the data, laboratory experiments conducted by L. Tursunov and I. Felitsiant showed that, in soils where the mechanical composition becomes heavier from the lower layers to the upper layers, it took 844 hours for moisture to rise through capillaries to a depth of 120 cm. In soils with the same light loam composition, it took 950 hours, while in soils that become lighter from the lower to upper layers, it took 2,688 hours [1,3].

In the soils we studied, the second scenario was observed, which leads to moisture accumulation in the upper soil layers due to the capillary rise of groundwater. If the mineralization of the groundwater is less than 3.0 g/L, crops can use groundwater even under water-deficit conditions, meaning there is no need to lower the groundwater table to 2.5–3.0 m.

The optimal soil water regime should ensure that the moisture in the root zone remains within 70–100% of the field capacity. Analysis of long-term data shows that the volume of available water in a 1-meter soil layer per hectare, moistened up to the minimum moisture capacity, is 700–1,100 m³ in sandy soils, 1,200–1,700 m³ in sandy-loam, light, and medium loam soils, and 1,800–2,650 m³ in heavy loam and clay soils. In our experiments, this indicator amounted to 3,428 m³ per 1-meter soil layer. This may be related to the proximity of the groundwater (phreatic water) and its capillary rise (Table 3).

Table-3

Field capacity (FC) of soils in the experimental area

Layer depth,	Density g/cm³	Field soil moisture capacity			
		Relative to	Relative to	mm/ha	m³/ha

cm		soil weight,%	soil density, %		
0-10	1,31	23,5	30,7	30,7	307
10-20	1,31	23,8	31,2	31,2	312
20-30	1,31	22,7	29,7	29,7	297
30-40	1,44	23,1	33,3	33,3	333
40-50	1,44	23,8	34,3	34,3	343
50-60	1,44	24,6	35,4	35,4	354
60-70	1,40	25,4	35,5	35,5	355
70-80	1,40	26,5	35,7	35,7	357
80-90	1,40	27,2	38,1	38,1	381
90-100	1,40	27,8	38,9	38,9	389
0-100					3428

The groundwater table varies throughout the year, depending largely on the relief and microrelief of the agrolandscape, the amount of irrigation and seasonal irrigation norms, and the degree of land development. In most cases, the water table rises (to 1.5–2.0 m) during the autumn–winter irrigation period and throughout the vegetation period, whereas its depth decreases to 2.5–3.0 m around November–December.

According to the data from the Syrdarya Regional Melioration Service, during the studied years in Saykhunobod District, the groundwater depth varied. As of July 1, 2024–2025, in 88.0–88.6% of the total area, groundwater was observed at a depth of 1.5–2.0 meters (Table 4).

Table-4
Dynamics of groundwater (phreatic water) levels at different depths in Saykhunobod District during 2024–2025.
(as of july 1)

Years	Monitored area, ha	Groundwater table (m) and area, ha						Areas with groundwater table above 2.0 m	
		0-1	1-1,5	1,5-2	2-3	3-5	>5	ga	%
2	3	4	5	6	7	8	9	10	11

2024	31720	-	816	27104	3800	-	-	27920	88,02
2025	31687	-	1635	26439	3613	-	-	28074	88,60

In these areas, the mineralization of groundwater was up to 3.0 g/L, accounting for 64.8–65.0% of the total area (Table 5).

Table-5

Dynamics of groundwater (phreatic water) mineralization in Saykhunobod district during 2024–2025 (as of July 1)

Years	Moni tored area, ha	Areas with different groundwater mineralization (g/L), ha					Areas with groundwater mineralization above 3.0 g/L	
		0-1	1-3	3-5	5-10	>10	ga	%
2	3	4	5	6	7	8	9	10
2016	31720	-	26555	5165	-	-	5165	64.8
2019	31687	-	20588	5973	-	-	5973	65,0

Based on the data obtained from the agro-meliorative monitoring of the soil, it can be concluded that, since more than 88.0% of the area has groundwater (phreatic) levels at 1.5–2 m and the mineralization of groundwater is less than 3.0 g/L, it is appropriate to use groundwater and collector-drainage water for irrigating crops during the vegetation period. Considering that these waters are of good and satisfactory quality, their use is advisable for ensuring water supply to agricultural crops under conditions of annual water scarcity.

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