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Quality Assessment of Gypsum Soils of Mirzachol Oasis

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ABSTRACT
There are many factors that affect the quality of the soil, and they can be different depending on the characteristics of the regions. The article provides information about the properties of soils located in different regions of the Mirzachol oasis. To compare the properties of soil samples, soils with different degrees of gypsum were selected. Soil mechanical composition, agrochemical properties, carbonate and gypsum content, water absorption analyzes were studied and compared. Factors affecting the quality assessment of the soil have been identified.

Keywords: *Gypsum, alluvial, loess deposits, groundwater level, gray soil, meadow-gray soil, meadow soil, soil salinity, quality assessment, humus, nitrogen, phosphorus, potassium*

INTRODUCTION
Scientific data on the effect of gypsum on soil properties have been published by scientists from different countries. However, the data obtained varies according to the specific soil-climatic conditions of the regions.

O.S. Bezuglova, E.N.Minaeva, I.V.Morozov [1] researches on simple carbonate black soils provide information about the genesis of carbonate and gypsum layers. According to the results of the analysis, the level of seepage water is of great importance in the formation of carbonate layer in black soils. The meeting of salt and gypsum at a depth of 210-250 cm indicates its relict nature.

I.A. Yamnova [2] states that the amount and shape of gypsum is an indicator of soil properties. According to her, the intensity of gypsum formation is not the same in all hydromorphic soils. The form of gypsum formation depends on the conditions of formation of minerals depending on the degree of hydromorphism. Gypsum formation depends on crystal shape, size, solubility, and degree of hydration and is an indicator of salinity.

M.Rodriguez-Rastrero, A.Ortega-Martos [3], as a result of studying the profile of gypsum soils developed in different climatic conditions, noted that the gypsum layer developed differently in different vertical zones. In their studies in Spain, it was observed that the amount of gypsum was negligible at the top of the layer, but increased relatively at a depth of 30 cm.

V.D. Lim [4] provided information on the development of gypsum soils of Jizzakh region. The main property of gypsum soils is their high density and low water permeability.

But even with the same amount of gypsum, the water permeability of the soil can be different, it depends on the shape of the gypsum crystals, the depth and thickness of the gypsum layer. It is necessary to apply complex melioration measures, to reduce the damage of gypsum, to carry out desalination measures for the development of gypsum soils.

R.K.Kuziev, S.A.Arabov, A.U.Akhmedov [5] announced the results of research on the properties of gypsum soils of the Mirzachol oasis and their improvement. An increase in the amount of gypsum sharply worsens the water-physical properties of the soil. An increase in the absorption capacity of sodium and magnesium occurs, which has a negative effect on the growth of plants.

D. Alvarez and others [6] emphasize the need to improve the determination of the amount of gypsum. They compared different methods for determining the amount of gypsum and proposed their own methods for determining the form and amount of gypsum. When the amount of gypsum in the soil is low (less than 2 percent), it is recommended to use acetone, turbidimetry, or thermogravimetry methods.

I.V. Morozov, E.N. Minaeva, O.S. Bezuglovalar [7] studied the effect of atmospheric precipitation on the formation of gypsum layer in ordinary carbonate black soils. For this, they used long-term mathematical and statistical data on the depth of wetting of soil layers.

Yu.A.Vyal and others [8] provided information on the genesis of the grassland gypsum soils of the Penza region. The influence of mineralized seepage waters and the participation of hydrogen-accumulative and biogenic-accumulative processes played an important role in the formation of these gypsum soils. As a result of the study of the morphological characteristics of grassland gypsum soils, their diagnosis and classification was developed. The type and degree of salinity is determined.

N.D. Kiseleva, O.G. Lopatovskaya [9] studied the properties of gypsum soils distributed in the Priangare region. An increase in the amount of sodium in the soil absorption complex causes an increase in soil absorption capacity and a deterioration of its physical properties. In most cases, it is noted that the amount of gypsum varies from 12 percent to 21 percent.

S. Fazeli, A. Abtahi, R.M. Poch, H. Abbaslo [10] studied the soils of Fars province, located in the south of Iran, in order to determine the speed of the soil formation process, in particular, to study the accumulation of gypsum and its effect on soil porosity. The amount of gypsum in the soil varies from 0.02 to 42.1 percent and increases downwards. It has been noted that the deposition of gypsum in the field is in the form of powdery and worm-like crystals.

F.Ahmad, Md.Said, L.Najah [11] and A.Kumar Jha, P.V.Sivapullaiah [12] gave information about the solubility of gypsum in soil, the changes in soil properties as a result of soil alkalization. Analyzes of physico-chemical properties, absorption capacity and composition of gypsum-containing soils are presented.

According to Kh.Karimov [13], as a result of washing and development of gypsum areas, the redistribution of gypsum occurs, which is also reflected in their morphological features. Factors limiting the productivity of agricultural crops in the development of gypsum soils of Mirzachol include parameters such as genesis, degree of gypsum, soil density and mechanical composition. It is recommended to increase the plowing depth by 0.5-0.7 cm every year in order to ensure the crushing of gypsum in the soil.

Various scientists have provided information on the harmful effects of gypsum in soil, forms and soil improvement [14-18]. These data differ from each other according to the properties of the soils in the region, natural conditions and the depth of placement of gypsum.

In the Mirzachol oasis, changes in saline and gypsum soils as a result of irrigation, information on the reclamation condition of soils located in different geomorphological conditions have been sufficiently studied [19-22]. However, the properties and characteristics of the gypsum soils of this region have been little studied. The article focuses on these aspects.

RESEARCH METHODS

Special observations were made to study the properties and characteristics of gypsum soils of Mirzachol oasis and their quality assessment. For this purpose, the areas where gypsum soils of Mirzachol are scattered were selected, their properties and characteristics were studied and compared. Soil morphological characteristics were recorded in the field itself, soil samples were taken and analyzed. The granulometric composition of the soil, total humus, nitrogen, phosphorus, potassium, mobile phosphorus and potassium, water absorption was analyzed, the amount of gypsum and carbonates was determined. The influence of the level of gypsum and the amount of gypsum on the quality assessment of the soil was determined.

RESULTS AND DISCUSSIONS

In order to study the properties of gypsum soils of Mirzachol and their influence on soil quality assessment, farms located in different regions of Mirzachol were selected, located in Gulistan, Sardoba and Khavos districts. The 1st section was placed in the “Three heroes” massif in Gulistan district, located in the northeastern part of Mirzachol, the level of seepage water is 1-2 meters, it consists of irrigated grassland soils. Section 2 is located in Sh.Rashidov massif in Sardoba district, the seepage water level is found at a depth of 5 meters, it is composed of irrigated gray soils. Section 3 is located in the southern part of Mirzachol, in the Pakhtakor massif of Mirzaabad district, and consists of irrigated meadow-gray soils.

The soil formation of the Mirzachol oasis was influenced by seepage waters, and as a result of irrigation, the rise of seepage waters occurred. From automorph mode to semi-hydromorph and hydromorph mode. This had an effect on the properties of these soils, as well as on the gypsum state of the soil. Therefore, the irrigated soils of the Mirzachol oasis consist mainly of semi-hydromorphic and hydromorphic soils. Gray soils, which are irrigated only in Khovos and Sardoba districts, are found in a small area, formed on stone-gravel deposits, and are considered disadvantageous from a melioration point of view.

The 1st cross-section consists of old irrigated meadow soils located on the second upper terrace of the Syrdarya, consisting of layered alluvial deposits. Hydromorphic soils have been formed from automorphic soils in irrigated agricultural areas, under the conditions of groundwater resurgence and low runoff under the influence of irrigation water. In this case, it takes a long time for gray soils to change to grassy soils. Hydromorphic soils may revert to gray soils in conditions of reduced groundwater. This is a long-term process, and the transition from hydromorphic soils to automorphic soils includes meadow-gray, gray-meadow soil.

Section 2 was placed in the H.Olimjon section of Sh.Rashidov massif, Sardoba district, and consists of irrigated gray soils that are rare in Mirzachol. It is composed of loess deposits and is close to loess sands in most of its properties. Newly formed carbonates, visible in a certain part of the profile in natural gray soils, occur in various forms. The depth of their distribution increases towards light gray soils. The results of the analyzes show that carbonates are most concentrated in approximately the middle part of the gray soil profile. Compared to the parent rocks that formed them, gray soils are somewhat rich in carbonates.

Section 3 is located in the region of the most plastered soils of the Mirzachol oasis and belongs to the type of permeable soils. The process of irrigation dramatically changes the composition of water-soluble salts and their location in the profile of light gray soils. This situation is directly related to the hydrogeological conditions of the places.

As a result of irrigation, seepage water begins to rise because it cannot flow to another area. After irrigating these lands, the groundwater level will rise, and a new balance will appear in the water balance of the soil. The consumption part of this balance increases due to evaporation of soil moisture directly from the surface of the earth due to plant transpiration. This process continues continuously as long as plant vegetation and air and soil temperatures are positive. Because, when the level of underground water increases, the wet place evaporated through the capillary paths of the soil is constantly filled. Of course, the irrigated light-colored gray soil that develops under such conditions begins to completely change its properties. The process of soil formation takes place under irrigation hydromorphic conditions, and gley layers characteristic of hydromorphic soils are formed.

If we pay attention to the mechanical composition of the soil, the characteristic feature of all gray soils is the predominance of “large dust” (0.05-0.01 mm) particles (Table 1). If we pay attention to the data in the table, it can be seen that its amount is higher than the amount of other particles in all three soil sections. In the 0-30 cm layer of section 1-23, large dust particles make up almost half of all particles. The amount of particles larger than 0.25 mm is almost 10% in the arable layer of irrigated gray soils, and its amount is around 5-8% in the other sections. Particles of 0.25-0.1 mm are distributed almost uniformly in the layers of all sections, only in the 0-30 cm layer of section 3-23 its amount reaches 26%.

TABLE 1: Mechanical composition of the research object

Layer depth, in cm	Mechanical composition of fractions, relative to the absolute dry mass of the soil, in percent							
	1-0,25	0,25-0,1	0,1-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	Physical clay aggregate
Section 1-23. Irrigated grassland soils. Z. Khudoyberdieva, 2023								
0-30	6,0	7,7	14,1	47,0	10,0	13,6	1,6	25,2
30-50	5,7	7,7	8,1	28,7	6,8	28,3	4,3	39,4
Section 2-23. Irrigated gray soils. Z. Khudoyberdieva, 2023								
0-30	9,4	10,5	11,0	32,6	7,2	15,9	13,5	36,6
30-50	8,6	9,3	14,6	24,6	9,5	17,5	15,9	42,9
Section 3-23. Irrigated grassland soils. Z. Khudoyberdieva, 2023								
0-30	6,0	26,0	22,7	20,7	4,8	11,1	8,7	24,6
30-50	7,8	12,3	14,0	27,8	11,9	14,3	11,9	38,2

If we pay attention to the amount of “physical clay” in the table, we can see that the mechanical composition of the soils consists mainly of medium sand. The upper layers of sections 1-23 and 3-23 are considered to consist of light sand. The mechanical composition of the soil is considered one of the important properties, and it is one of the main indicators in determining the norms of soil cultivation, irrigation and salt washing.

The agrochemical parameters of the soil are considered to be one of the main properties when determining the rate of fertilizers and planting crops. The content of humus in the soils of the study area is as low as all gray soils (Table 2). The amount of humus is directly related to the salinity of the soil.

TABLE 2: Agrochemical indicators of the research object and degree of plastering

Depth, cm	Humus, %	Gross, %				Carbohydrates, %	Gypsum, %	Active, mg/kg	
		N	C:N	P2O	K2O			P2O	K2O
Section 1-23. Irrigated grassland soils. Z. Khudoyberdieva, 2023									
0-30	1,207	0,105	6,67	0,100	2,50	6,93	1,921	20,5	280,0
30-50	0,641	0,061	6,09	0,070	3,00	7,71	0,593	2,5	280,0
Section 2-23. Irrigated gray soils. Z. Khudoyberdieva, 2023									
0-30	0,314	0,031	5,87	0,060	2,70	5,91	14,354	11,2	158,9

30-50	0,251	0,026	5,60	0,060	1,80	5,91	14,104	12,0	168,5
Section 3-23. Irrigated grassland soils. Z. Khudoyberdieva, 2023									
0-30	0,502	0,045	6,47	0,070	2,80	4,97	17,776	10,4	139,7
30-50	0,376	0,023	9,48	0,070	2,10	5,91	19,707	9,6	120,4

In section 1-23, which is weakly saline and not plastered, the amount of humus in the arable layer increases by only 1 percent. The amount of humus in the remaining soil sections does not reach 1%. This indicates that these soils are low in humus. The amount of nitrogen in the soil depends on the amount of humus. The amount of total nitrogen varies from 0.023 to 0.105 percent, relatively more in the plowed layer. Focusing on the soil C:N ratio, it was 5-6 in all layers, and increased from 9 in the 30-50 cm layer of section 3-23. The C:N ratio is the main factor indicating the quality of humus. The amount of total phosphorus is 0.060-0.100 percent. The amount of total potassium is around 2-3 percent and is not evenly distributed in the soil profile.

The amount of carbonates in the soil is relatively higher in irrigated meadow soils than in other soils and is 6-7 percent. In other soils, it was 4.97-5.91 percent.

The amount of gypsum is one of the main indicators that affect many properties of the soil. The three soil cross-sections mainly differ from each other in terms of the amount of gypsum. The amount of gypsum in grassland soils located in Gulistan district is around 0.5-2% and it does not affect the growth of plants. It has an indirect effect on soil properties.

In section 2-23, the amount of gypsum is more than 14 percent and belongs to weak gypsum soils. The degree of gypsification, the form of gypsum accumulation and the state of placement in the soil section determine the properties of these soils. 10-30 percent of gypsum in sand and clay soils dramatically increases the density of the soil. The distribution of such layers in the upper part of the soil section sharply reduces the productivity of the soil. Although the solubility of gypsum is low, it deteriorates soil properties to a certain extent.

The soils of the section 3-23, which is the main gypsum area of Mirzachol, are also unfavorable in terms of the quantity and depth of gypsum. 17.8 percent of gypsum is located in the 0-30 cm layer of this section, and it can be observed that its amount increases further downwards. In a layer of 30-50 cm, the amount of gypsum reached almost 20%. As a result of increasing the density of the soil, gypsum makes it difficult for the roots of cotton, wheat, vegetables and other crops to penetrate deeply, and it worsens the soil's water-physical properties and nutrient regime. A high (15% or more) crystal gypsum and its location close to the surface causes suffocation as a result of watering and creates conditions for the plant to dry out, the amount of useful moisture decreases.

The amount of mobile phosphorus in the soil is characteristic of all gray soils and is considered to be undersupplied in the soil. Its amount decreased to 10-20 mg/kg in the driving layer, and 2.5 mg/kg in the sub-driving layer. In terms of mobile potassium, gray soils are relatively well supplied. The amount of mobile potassium in section 1-23 is 280 mg/kg and belongs to the moderately supplied group. In sections 2-23 and 3-23, the amount of mobile potassium is in the range of 100-200 mg/kg and belongs to the low-supply group. Taking into account the agrochemical properties of soils, it is possible to use fertilizers in a differentiated manner.

One of the factors affecting the quality of the soil is the level of soil salinity. According to Table 3, the amount of dry residue is greater than 0.3 percent in all soil sections. In section 1-23, the amount of dry residue does not reach 1%, considering the amount of chlorine and sulfates in the soil, we can see that these soils belong to weakly saline soils. The amount of carbonates is almost uniformly distributed in all sections and depths, its amount is from 0.020 to 0.034 percent.

Chlorine in the soil is a fast-acting ion among anions, and its amount has a great effect on the growth and development of plants. The amount of chlorine in section 3-23 is below the toxic level, in the remaining sections its amount exceeds 0.007 percent. 0.014% in the arable layer of section 1-23, and 0.032% in section 2-23. The amount of SO4-sulfates directly depends on the amount of gypsum in the soil. In section 1-23, its amount is 0.174-0.348%, in sections 2-23 and 3-23, its amount is around 0.7%. The mechanism of salinity effect on plants is explained by the effect on the osmotic pressure of the soil solution and by the toxic action of the salts themselves. The tolerance of most cultivated plants to soil salinity varies in different phases. In the early stages of development, the tolerance to salt is low, and in the later stages, relatively, the tolerance to salt increases. Due to the high concentration of salts in the soil, plants cannot absorb them. In such cases, despite the presence of moisture in the soil, plants die in the soil, their growth and development slow down. The soils of the study area belong to the group of weakly saline soils.

TABLE 3: Soil water absorption analysis results

Section №	Depth, cm	Dry residue, %	HCO3	Cl	SO4	Ca	Mg	Na	Anion-cation	The sum of the components
Irrigated grassland soils. Z. Khudoyberdieva, 2023										
1-23	0-30	0,545	0,0211	0,014	0,348	0,135	0,006	0,017	7,96	0,531
			0,342	0,39	7,23	6,74	0,49	0,73	7,23	
	0-30	0,320	0,018	0,031	0,174	0,075	0,012	0,004	4,79	0,305
			0,30	0,87	3,62	3,74	0,99	0,16	4,63	
Irrigated gray soils. Z. Khudoyberdieva, 2023										
2-23	0-30		0,034	0,032	0,710	0,222	0,041	0,041	16,24	1,063
		1,166	0,56	0,89	14,79	11,08	3,36	1,80	14,44	
	0-30		0,024	0,028	0,670	0,188	0,046	0,046	15,15	0,990
		1,102	0,40	0,79	13,96	9,38	3,75	2,01	13,13	
Irrigated grassland soils. Z. Khudoyberdieva, 2023										
3-23	0-30	1,080	0,022	0,009	0,700	0,260	0,019	0,015	15,19	1,014
			0,36	0,25	14,58	12,97	1,58	0,63	14,55	
	0-30	0,295	0,020	0,009	0,710	0,264	0,020	0,012	15,36	1,024
			0,32	0,25	14,79	13,17	1,68	0,50	14,85	

Reminder 1- in percent, 2- in mg/eq

If we pay attention to the quality assessment of the soils in the three regions of the Mirzachol oasis, it can be seen that the salinity level and gypsum level are the most important factors affecting the quality score. According to the results of soil quality assessment, irrigated meadow soils have a quality score of 63, irrigated gray soils have a score of 54, and irrigated grassland soils have a score of 38.

CONCLUSIONS

One of the main factors affecting soil reclamation is the level of soil gypsum. Compared to plastered soils, non-plastered soils have better humus content, level of supply with nutrients, and soil density. When the properties of these three types of soils are compared, it can be observed that the soil quality assessment also has different indicators. Therefore, in order to increase soil fertility and get a high yield from crops, it is necessary to carry out measures to improve the gypsum condition of the soil.

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