MORPHOLOGICAL FEATURES OF MIRZACHOL OASIS SOILS AND THEIR CHANGES

Shakhobiddin M. Turdimetov*

Professor, Doctor of Biological Sciences (DSc), Department of Agro-soil science and land reclamation, Gulistan State University, Uzbekistan,

*Corresponding author: turdimetov1970@mail.ru

https://orcid.org/0009-0005-3969-0592

Mokhinur M. Musurmanova

Phd Student Gulistan State, University, Uzbekistan,

joniqulova95@mail.ru, https://orcid.org/0009-0001-8759-8804

Maftuna D. Urazalieva

Researcher, Gulistan State University, Uzbekistan,

aplr85486@gmail.com, https://orcid.org/0000-0003-0138-4854

Zarina A. Khudayberdieva

Researcher, Gulistan State University, Uzbekistan,

xudoyberdiyevazarina0@gmail.com, https://orcid.org/0000-0001-6261-9165

Nasiba Y. Esanbayeva

Researcher, Gulistan State University, Uzbekistan,

nasibaesanbayeva@gmail.com, https://orcid.org/0000-0002-7152-1212

Dildora E Xo'jabekova

Researcher, Gulistan State University, Uzbekistan,

huzabekovad@gmail.com, https://orcid.org/0009-0005-3199-7311

Highlights

The paper investigates morphological signs of soil in the old part of Mirzachol, focusing on changes resulting from cultivation and irrigation.

Abstract

Morphological signs of soil are one of the main indicators of soil properties. As a result of cultivation and irrigation of soils, there are great changes in its morphological characteristics. The article presents the morphological characteristics of soil sections placed in the old part of Mirzachol. In order to compare the changes in the morphological characteristics of the soil, repeated soil sections were placed in the areas where the previous soil sections were placed and studies were conducted. As a result of the increase in the duration of development and irrigation, it was noted that there were changes in the depth of the arable layer, the color of the soil, the gypsum layer, and the depth of the carbonates.

Keywords

soil morphology; color; density; arable layer; gypsum; carbonates; gley layer; irrigation; development; salinity.

Introduction

The study of morphological features of the soil has both theoretical and practical importance. Most researchers believe that the morphological properties of soil are important in determining their diagnostic features, making their classification and familiarizing with their properties [10][12][24].

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L. Ivanov emphasized the necessity of using modern equipment and an innovative approach in determining soil morphology. [1]. In the macromorphological description of soils, there is a need to describe soil color using spectrodiometers [21] [23][26].

The morphological structure of the soil and its features are a long historical process of the soil formation process, and it is the result of the processes until a new body-soil is formed from the parent rocks that form the soil [2]. It is emphasized that morphological characteristics of the soil are studied at three different levels. By studying the morphological characteristics of the soil, it is possible to solve fundamental and practical problems related to soil science, soil biology, ecology and geography [3][6][19][25].

I.V. Gefke, L.V. Lebedeva [20] studied the morphological characteristics of soils developed under different conditions, highlighted the aspects of connection with their physical properties. As a result of the impact of cities, changes in the morphological characteristics of soils have also been noted.

M. Ansari Dezful et al. [4] reported changes in soil macromorphological and micromorphological characteristics in a drained system in Iran. 5 soil cross-sections were studied and compared under stressed conditions. They studied the relationship between the level of groundwater and morphological characteristics of the soil.

D. Wiharso, M. Utomo, Afandi, P. Cahyono, S. Loekito, N. Nishimura, M. Sengelar [5] studied changes in soil morphological features and properties as a result of human activities. As a result of Indonesia's humid tropical climate, topsoil leaching occurs. This is also reflected in changes in soil morphological features.

Morphological features and classification of soils composed of different parent rocks in Nigeria were studied by M.E.Nsor and I.J.Ibanga and etc.[22]. It is noted that their morphological characteristics are also different because the parent rocks that form the soil are different. The morphological characteristics of the soils, which are composed of sandy shale, have high water permeability and low moisture capacity.

I.Zewide, T.Tana, L.Wogi, A.Mohammed studied the morphology and physico-chemical properties of typical soils in southwest Ethiopia [7]. Cultivation of plants without the use of organic and mineral fertilizers has led to soil degradation. This is also reflected in their morphological features.

M.I.Gerasimova, N.B.Khitrov noted the existence of objective and subjective problems in the study of soil morphological features [9]. Subjective problems are associated with the one-sided approach of soil scientists to soil properties. This leads to incomplete coverage of soil morphological features. Objective problems are associated with the lack of universally accepted rules for writing soil morphological signs.

There is also information about the changes in the soils of the Mirzachol oasis and their properties as a result of the duration of irrigation [9-16]. However, the changes in soil morphological characteristics over long years have not been studied. With this in mind, we have conducted special studies to determine the changes in morphological features in almost 80 years.

Research Methods

In order to conduct research on the changes in the morphology of the soil as a result of the exploitation of the Mirzachol oasis and the duration of irrigation, S.P. Suchkov et al. This selected area is located in the “Yangi hayot” massif of Syrdaryo district. At the time of morphological characterization of the first soil cross-sections (in 1937) it consisted of irrigated light gray soils.

Soil sections placed by S.P. Suchkov in 1937 and 1959 were repeated by the author in 1993 and 2017, and the changes that occurred in the soil were highlighted.

Results and Discussions

Although Mirzachol is not located in such complex geomorphological conditions, it has its own soil and climate conditions. The soils of the Mirzachol region correspond to the region of gray soils distributed on the basis of height (vertical) regionalization. These soils are distributed in the desert area, at an altitude of 300-500 m above sea level, and gray soils are located in the lower part of the altitude region, in the region of light gray soils. In some massifs, groundwater and human economic activities affect the formation of gray soils and soil formation processes. As a result, intermediate soils are more widespread in the area. Gray-meadow, meadow-gray soils, and later irrigated meadow soils are formed from irrigated gray soils. Such an evolution of soils will certainly affect the properties and characteristics of the soil.

Grass-gray, gray-meadow soils belong to semi-hydromorphic soils, the level of seepage water is 2.5-5 meters. As a result of the further rise of the Sizot waters, irrigated meadow soils are formed. These soils are distinguished from the gray soils from which they were formed by the richness of humus, the darker color of the upper layer and the lumpy structure. The process of gleyation - the formation of a gley layer is also observed. The bluish-rusty layer is distinguished by its morphological features.

According to the classification of the World Reference Base on Soil Resources (WRB) [18], such soils are called *"gleyic"* and are defined as soils that are constantly moistened under the influence of seepage waters, and where reductive processes prevail..

Clayey and strongly clayey layers are usually characterized by structureless, dense, heavy mechanical composition and contain a lot of colloidal and turbid particles that worsen the water-physical properties of the soil.

The gliding process of soil changes its properties due to increased moisture. An increase in the amount of mobile iron compounds causes the structural level of the soil to deteriorate. Causes a sharp decrease in the amount of exchangeable potassium and mobile phosphorus, as a result of which the yield of agricultural crops decreases.

Morphological characteristics of soils are given below. 15.05. 1993. Sh.M. Turdimetov. Section №-39. Saykhunabad district, "Guliston" massif. Shorozak depression, consisting of layered lake-beds. Irrigated gray-meadow soils. Medium sand, seepage waters are located at 230 cm.

Ahaydov. 0-31 cm. It is gray in color, grayish-brown towards the bottom, dry, slightly moistened towards the bottom, granular-dusty structure, the upper side of the middle sand is porous, slightly thickened towards the bottom, root remains and plant parts are found. The transition to the next layer is clear, in terms of density and structure.

Under Ahaydov. 31-55 cm. Light gray in color, weakly moistened. Structureless, medium-sandy, densely jointed, plant remains, animal tracks, and small carbonate spots are found. Additions are not available. It is clear that it will pass to the next layer, in terms of color and density.

B_1.55-80 cm. It is gray in color, has a slight moisture content, has a medium consistency, and has a low density. Plant remains, roots are found, there are traces of insects. Carbonate stains have a flour-like appearance, stand out weakly. In the soil, small gypsum crystals are found at an imperceptible level, it is clear that they will pass to the next layer, according to their color, density and lesions.

$B_2$80-200 cm. Brown is colored, strongly moistened, medium sand, dusty, weakly condensed, traces of insects are observed. Gypsum is in soft aggregate and in the form of very small crystals. Seepage water is felt from 150 cm. The gley layer is weakly distinguished, bluish-gray and occurs from 170 cm. The transition to the next layer is sharp, in terms of color.

S. 200-220 cm. It consists of layered lake beds. Medium sandy soils. The depth of Sizot waters is 230 cm.

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10.05. 2018 year. Sh.M. Turdimetov. Section #18-1. Syrdaryo district, New Life massif. The third upper terrace of Sirdarya, consisting of loess deposits. Irrigated gray-meadow soils.

Ahaydov. 0-28 cm. It is gray in color, relatively darker on the upper side, dry, moistened on the bottom, has a fine granular structure, medium sand, porous on the top, slightly thickened on the bottom, roots and plant remains are found. The transition to the next layer is based on apparent density.

Under Ahaydov. 28-52 cm. Light gray color, weakly moistened, weakly granular structure, medium sand, densely jointed, traces of insects, plant and root remains, carbonate stains are found, weakly separated. The transition to the next layer is clear, through color and density.

$B_1$52-85 cm. Gray, slightly wet, medium sandy, slightly compacted, traces of insects, remains of plants and roots, inconspicuous carbonate stains, small gypsum concretions are found. Transition to the next layer by color and density.

$B_2$85-120 cm. Yellowish, slightly wet, medium sand, slightly denser joint, carbonate white spots, shiny gypsum crystals. The underside is slightly damp.

C. 185-200 cm. Loess sands.

Below is information on changes in the morphology of the soil as a result of development and duration of irrigation of the Mirzachol oasis. For this, the soil sections laid by S.P. Suchkov and others in the first years of irrigation of the Mirzachol oasis were selected. This selected area is located in the “Yangi hayot” massif of Syrdaryo district. At the time of morphological characterization of the initial soil cross-sections (in 1937) it consisted of irrigated pale gray soils.

Soil sections placed by S.P. Suchkov in 1937 and 1959 were repeated by the author in 1993 and 2017, and the changes that occurred in the soil were highlighted.

Below are the soil cross-sections laid in 1937, 1959, 1993 and 2017 and their description (Table 1).

In the data of Table 1, a change in the depth of the arable layer is observed with the increase in the duration of exploitation and irrigation. However, it should be noted that driving at the same depth for many years causes the formation of a “dense layer under the plug”.

Soil color is one of the main morphological characteristics. Changes in soil color are associated with changes in the amount of humus. The color of the soil was light gray in 1937 and changed to gray in 1958. The color of the transition layer “B” varies from grayish-brown to dark brown. Changes in the color of the morphological characteristics of the soil are especially noticeable in the carbonate layer. Carbonates in 1937 were pale yellow in color and weakly distinct, but in 1959 this layer appeared as sparse pale gray spots and weakly distinct. In the repeated sections of 1993 and 2017, the carbonate spots had a flour-like appearance and were weakly distinguished. This is directly related to the leaching of carbonates as a result of exploitation and irrigation.

Table 1. Morphological features of Mirzachol oasis soils and their changes

1937 (S.P. Suchkov). Irrigated light gray soils							
1	Layer thickness, cm	Driving 0-22	"B" passing) 20-60	Carbonated 30-50	Gypsum 60-200	Gleely from 180 cm	"C"(soil-forming rock) from a depth of 60 cm
2	Color	Light gray color	Gray is a lighter color, a darker color towards the bottom	Brown color	Brown color	Brown color	Brown color
3	Morphological differentiation of the layer: carbonate, gypsum,	-	-	Carbonated. Brown-yellow spot, well distinguished.	In the form of a collection of individual crystals, it stands out well	Not available	Loess colored sands
1959 (S.P. Suchkov). Irrigated light gray soils							
1	Layer thickness, cm	Driving 0-30	"B" (transitive)	Carbonated 30-53	Plaster 70-200	Glazed	"C" (soil-forming rocks) from 80 cm
2	Color	Gray color	Light gray color, light gray towards the bottom	Brown color	Brown color	Brown-gray	Brown color
3	Morphological differentiation of the layer: carbonate, gypsum, gley	-	-	Sparse light-gray spots, weakly stand out	Soft aggregates and small crystals in the form	Weakly stands out, bluish-gray from 180 cm	Loess colored sands
1993 (Sh.M. Turdimetov). Irrigated gray-meadow soils							
1	Layer thickness, cm	0-31	"B" (transitive)	Carbonated 31-55	Plaster 80-200	Glazed	"C" (soil-forming rocks) from 90 cm
2	Color	Grey	Light gray color, mottled-gray towards the bottom	Brown	Brown	Blue color	Brown
3	Morphological differentiation of the layer: carbonate, gypsum, gley	-	-	Carbonate stains have a flour-like appearance, stand out weakly	In a soft set and very small crystals	Stands out weakly, from 170 cm in bluish gray	Loess sands
2017 (Sh.M. Turdimetov). Irrigated gray-meadow soils							
1	Layer thickness, cm	0-33	"B" (transitive)	Carbonated 35-60	Plaster 90-200	Gleely, bluish color, from 160 cm	"C" (soil-forming rocks) from 90 cm
2	Color	Gray color, relatively darker	Light gray color, mauve color towards the bottom	Brown	Brown-color	Blue in color	Brown
3	Morphological differentiation of the layer: carbonate, gypsum, gley	-	-	Carbonate stains have a flour-like appearance, stand out weakly	Small plaster spots	Gleely, bluish color, from 160 cm	Loess sands

Changes in the gypsum layer are directly related to the grinding of gypsum over the years. Gypsum was found at a depth of 60-200 cm in the soil section taken in 1937, 30 years after the start of irrigation.

In subsequent surveys, the apparent depth of gypsum deepened, and the apparent depth of gypsum decreased to 90 cm in the 2017 replicate soil cross-sections. There have also been changes in plaster forms. If in the initial sections they appeared in a collection of separate crystals, well separated, then in the results of 2017 they appeared as small gypsum spots. Although gypsum is a difficult soluble compound, it has a mottled appearance with increasing duration of irrigation.

The occurrence of gypsum in the soil layers has a negative effect on the water-physical properties of the soil and causes a decrease in their productivity. A hard plastered layer destroys the water, air and other conditions of the soil, reduces its biological activity. All this causes damage to the root system of the plant.

As a result of the soil being wet for a long time, the process of glaciation occurs. This is directly related to the grazing process. Although the gley layer is found after 180 cm in 1937, it is not observed to be morphologically distinct. In 1959, a weakly distinct bluish-gray gley layer began to appear. In the repeated soil section of 1993, this layer is encountered at 170 cm and has a weakly distinct, bluish color. In the soil section of 2017, it is observed that the gley layer is located higher, and it is possible to observe that the gley has a bluish color.

A long irrigation period does not always lead to good soil fertility. If the irrigation rate exceeds the specified amount, the ditches do not work well, and the seepage water rises. This causes an increase in the level of salinity and, to some extent, a change in the morphological features of the soil.

As a result of irrigation, the microclimate decreases by 7-8 °C. Microbiological processes in the soil slow down and the mineralization of organic matter slows down. Due to the fact that plant body and root residues remain in the soil every year and as a result of slowing down the decomposition of organic matter, the reserve of humus increases. This causes it to have a darker color. The appearance of rust-like spots, bluish spots on the soil profile is associated with the formation of a gley layer.

Also, in order to study the changes in the agrochemical properties of the soil, the soil samples taken from these sections were analyzed (Table 2).

Table 2. Agrochemical description of light gray soils of Mirzachol and its changes

Depth, cm	Agrochemical analysis			
	humus, %	nitrogen, %	gross P_2O_5	P_2O_5 in carbon ammonium absorption, mg/kg
Section 6. 1957 S.P. Suchkov. Syrdaryo District “Yangi hayot” farm. It has been irrigated for 30 years.				
0-28	1,1	0,09	0,172	16,6
28-42	1,0	0,06	0,148	13,6
42-52	0,9	0,05	1,145	8,5
52-62	0,8	0,05	0,133	-
Section 6. 2018 Sh.M. Turdimetov. “Yangi hayot” massif, Syrdaryo district. It has been irrigated since 70 years. (2018)				
0-30	1,2	0,055	0,179	10,6
32-52	1,1	0,052	0,177	8,2
52-66	1,0	0,46	0,153	5,0
66-85	0,7	0,031	0,114	

Irrigation and cotton planting greatly increased the biological activity of Mirzachol soils, that is, the total amount of microorganisms and microflora involved in humification and humus processing increased sharply. Significant changes have also occurred in the amount of soil humus and nutrients.

In the first year of soil cultivation, the content of soil humus and nitrogen is drastically reduced due to disturbance of the turf layer, which can also be seen in the sixth soil section. This is due to the low productivity of unfertilized, newly reclaimed gray soils of the soil production capacity compared to the reserve and ancient reclaimed soils. Plant phosphate nutrition is improved by annually fertilizing the soil with phosphorus fertilizers.

Also, gray meadow soils in this area are rich in terms of humus, nitrogen and mobile phosphorus compared to protected areas. The increasing culture of irrigated agriculture and the regular use of high amounts of phosphorus fertilizers have caused the gradual accumulation of total and mobile phosphorus. As a result of application of organic substances and nitrogen fertilizers, the number of microorganisms increased, nitrification processes increased dramatically. This site is characterized by high biogenicity of both upper and lower layers.

Conclusion

As a result of soil development, there are great changes in its morphological characteristics and properties. Especially, under the influence of irrigation, the migration of nutrients, mixing with the lower layers occurs. We can see this in the example of Mirzachol soils. With the increase in the duration of irrigation, the rise of seepage water occurred, as a result of which a new water regime-irrigation type of the soil appeared. This, in turn, causes a change in the morphological characteristics of the soil, the formation of a new soil profile. The obtained information serves to enrich the information on soil evolution.

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