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Genesis, Morphological Characteristics and Morphogenetic Features of Soils in The Field Experimental Area

Ko'ziev J.M.
Institute of Soil Science and Agrochemical Research, Institute of agriculture and agritechnologies of Karakalpakstan, Uzbekistan

Bazarboev I.O.
Institute of Soil Science and Agrochemical Research, Institute of agriculture and agritechnologies of Karakalpakstan, Uzbekistan

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Abstract: The article investigates the morphogenetic characteristics and soil profile formation patterns of irrigated meadow alluvial soils. According to the study results, these soils are formed on alluvial deposits accumulated in river valleys, with their profile comprising humus, transitional, and illuvial horizons. Morphological analysis indicated that the humus horizon is characterized by a high content of organic matter and plant roots, while the lower horizons exhibit increased moisture, changes in mechanical composition, and the presence of iron and carbonate spots. Additionally, under irrigated agricultural conditions, anthropogenic factors were found to moderately alter the physical and chemical properties of the soil. The obtained results provide a scientific description of the genesis, morphological features, and morphogenetic characteristics of irrigated meadow alluvial soils.

Keywords: Irrigated soil, meadow alluvial, morphogenetic characteristics, soil genesis, humus horizon, illuvial horizon, soil profile, biological activity, anthropogenic impact, alluvial deposits.

Introduction: Today, the issues of sustainable development of agricultural production, preservation and enhancement of soil fertility are of urgent global importance. According to the Food and Agriculture Organization of the United Nations (FAO), the total area of agricultural land worldwide is approximately 4.8 billion hectares, of which more than 1.5 billion hectares are arable lands. At the same time, although irrigated lands constitute only about 20% of the total agricultural land, nearly 95% or more of the world's agricultural products are produced on them. This situation requires a deep study of the genesis, morphological characteristics, and morphogenetic features of irrigated soils [6, 8].

The genesis and morphological characteristics of soil reflect its natural formation processes, geomorphological conditions, climatic factors, as well as the morphogenetic features arising under the influence of human activity. According to the results of international studies, approximately 33% of the world's agricultural lands are subject to degradation to varying degrees, and this situation is directly related to changes in the morphological and agrophysical properties of the soil. Therefore, determining the genetic horizons, morphological structure, and morphogenetic formation features of the soils in the area where field experiments are conducted is one of the important stages in scientific research [7, 9, 10].

The morphological description of the soil in the field experimental area is assessed through indicators such as genetic horizons in its profile, color, structure, mechanical composition, and the distribution of carbonates and salts. These indicators make it possible to evaluate the pedogenetic processes occurring in the soil, the impact of irrigation, and the influence of agrotechnical measures on soil formation. In this regard, studying the genesis, morphological characteristics, and morphogenetic features of the soil in the field experimental area is of great scientific importance for scientifically substantiating the agrochemical indicators of soils, the fertilizer application system, and obtaining high and stable yields from agricultural crops.

Therefore, identifying the morphological characteristics and morphogenetic features of the soil in the field experimental area, scientifically analyzing the patterns of their formation, and assessing the genetic structure of the soil profile is of important scientific value in modern soil science and agrochemical research.

Irrigated meadow alluvial soils are a soil type formed under the influence of water and agricultural activities, with the upper part consisting of additional agroirrigation layers. The thickness of the upper (agroirrigation) layer is usually 0.4–0.6 m, and this layer has a high humus content and favorable physical properties in the upper arable layer as a result of irrigation, repeated tillage, and the application of organic and mineral fertilizers [1, 4, 5].

In the soil profile, carbonates are more clearly manifested in the middle layers compared to other soil types. This situation is explained by the redistribution of calcium carbonates under the conditions of the irrigation regime and substance migration [1, 4, 5].

The irrigated meadow alluvial soil is characterized by a profile with a varied structure. Strong bioturbation is observed in the upper layers due to the activity of earth-burrowing insects, which ensures high porosity, good water permeability, and gas exchange. At the same time, biological activity is high, and the abundance of microorganisms and small fauna accelerates the mineralization processes.

From a scientific point of view, these soils are classified as anthropogenically modified soils under the influence of water resources and agricultural processes, and their agrophysical and agrochemical properties change significantly depending on the irrigation system, fertilization, and soil tillage technology [4, 5].

The field experiment was carried out under the conditions of irrigated meadow alluvial soils, which are widely distributed in the territory of the Republic of Karakalpakstan. In this region, a large part of the land resources used in irrigated agriculture falls on meadow soils, which make up 93.7% of the total irrigated area. At the same time, meadow-takyr and takyr-meadow soils occur on relatively smaller areas and occupy almost 6% of the irrigated lands. In addition, the share of swamp-meadow soils is very small, constituting 0.3% of the total area [5].

This soil type is an irrigated meadow alluvial soil formed on the leveled plain of the ancient Amu Darya delta, consisting of layered alluvial deposits. This soil type is described on the basis of the 1-QQR-I section, the field contour is plowed (J.M. Ko‘ziev, I.O. Bazarboev, 20.10.2025).

1. Morphogenetic description of the irrigated meadow alluvial soil section:

Ao (humus layer) (0–28 cm) — color from light grayish to brownish, moisture medium, mechanical composition light loamy, structure cloddy to powdery, the layer is relatively loose and not compacted, small plant roots are abundant, semi-decomposed plant residues are observed in some places, the transition to the next layer is clear with a slight increase in moisture and partial compaction of mechanical composition downward.

A1 (transitional layer) (28–43 cm) — color dark grayish or brownish, moisture higher, mechanical composition light loamy, structure fine cloddy, plant roots decrease, carbonate spots are found in some places, the transition to the next layer is clear with an increase in density and moisture as well as mechanical composition.

B1 (illuvial layer) (43–70 cm) — color light brownish or yellowish-brownish, moisture high, mechanical composition medium loamy, structure dense cloddy, plant roots very few, iron compounds and carbonate spots are found in some places, the layer is characterized by increased density and moisture.

B2 (71–107 cm) — color yellowish or reddish-brownish, moisture high, mechanical composition from medium loamy, structure weakly developed, iron and carbonate compound spots are observed in some places, plant roots are almost absent, the transition to the next layer is clear with mechanical composition.

Bc (transitional layer) (107–153 cm) — color light brown or brownish, moisture even higher, mechanical composition light loamy, structure weakly developed, iron compounds and rust-like spots are observed in some places, the transition to the next layer is clear.

Bc (parent material) (153–195 cm) — consists of alluvial sandy deposits, color light grayish, mechanical composition sandy, structureless, plant roots are almost absent, moisture is high, the influence of groundwater is felt and it is limited by the groundwater table.

Morphological conclusion: From the morphological description of the section, it is evident that the soil profile consists of genetically distinctly differentiated horizons. In the upper part, a humus layer relatively rich in humus with a thickness of 0–28 cm and well-developed structure has formed, in which plant roots and semi-decomposed organic residues are abundant. This indicates the active occurrence of biological processes in this layer and the formation of soil fertility under the influence of irrigated agriculture.

The AB, B1, and B2 horizons located in the middle part of the profile are characterized by an increase in moisture, a relative increase in the heaviness of mechanical composition, and the presence of iron and carbonate compound spots. Illuvial processes are developed to a certain extent in these layers, and the migration of soil substances from the upper layers downward is observed. At the same time, the decrease in plant roots and the compaction of structure indicate genetic differentiation in the soil profile.

The lower part of the profile (BC and C horizons) is characterized by alluvial deposits, with a lightening of mechanical composition, almost undeveloped structure, and high moisture. In these layers, the influence of groundwater is felt, and the parent material forming the soil — alluvial sandy deposits — is clearly manifested. In general, the morphological characteristics of the section indicate that this soil belongs to the type of irrigated meadow alluvial soils and that they were formed under the influence of hydromorphic and alluvial processes.

2. Morphogenetic features:

Genesis: The studied soil was formed on the basis of alluvial deposits accumulated in river valleys, and its genesis is closely related to hydromorphic conditions and alluvial processes. As a result of periodic floods and water flows of rivers, sandy, loamy, and silty deposits of various mechanical compositions were formed in layers. Subsequently, soil formation processes developed on these deposits under the influence of natural meadow vegetation and cultivated crops. As a result, a humus horizon was formed, and genetic layer differentiation occurred throughout the profile.

Soil formation processes: In irrigated meadow alluvial soils, soil formation processes mainly occur under the influence of alluvial, humus formation, illuvial, and hydromorphic processes. In the upper layers, the mineralization of organic matter and the formation of humus substances occur actively. At the same time, under the influence of irrigation and groundwater, soil solutions move, and certain mineral substances migrate to the lower layers. This causes a certain degree of differentiation of mechanical and chemical composition throughout the profile.

Characteristics of the humus layer: The humus layer is usually located in the upper part of the profile, and its thickness and morphological characteristics are formed depending on the vegetation cover and agricultural influence. This layer has a relatively dark color, cloddy structure, and mechanical composition often loamy or silty. Plant roots and organic residues are abundant in it. Humus substances improve the physical properties of the soil, stabilize its structure, and increase the level of fertility.

Biological activity: Biological activity in this soil is mainly manifested intensively in the humus layer. In this layer, microorganisms, fungi, and various soil fauna are active, providing the mineralization of organic matter and humus formation processes. In addition, the interaction between plant roots and microorganisms is of great importance in the formation of mobile forms of nutrients in the soil.

Anthropogenic impact: Under irrigated agricultural conditions, the morphological and agrochemical properties of the soil change significantly under the influence of human activity. As a result of regular plowing of lands, irrigation, and the application of mineral and organic fertilizers, the physical and chemical properties of the humus layer are formed. At the same time, under the influence of irrigation water and agrotechnical measures, the moisture regime in the soil profile changes; in some cases, the redistribution of salts or the intensification of illuvial processes occurs.

CONCLUSION

In conclusion, the morphological observations carried out on the section showed the presence of a layer enriched with humus and plant roots with a well-formed structure in the upper part of the soil profile, and the step-by-step formation of genetic horizons downward as a result of changes in the moisture regime, mechanical composition, and mineral compounds. The manifestation of alluvial sandy deposits and the influence of groundwater in the lower part of the profile confirms that these soils developed in a hydromorphic regime on the basis of river deposits. In this regard, these soils were characterized as a soil type with a morphogenetically stable profile formed under the influence of natural alluvial processes and long-term irrigated agriculture.

In conducting agriculture under the conditions of this irrigated meadow alluvial soil, it is necessary to apply a scientifically based agrotechnological system that takes into account the soil moisture regime, mechanical composition, and the influence of groundwater. In this condition, it is advisable to introduce a crop rotation system to improve the physical condition of the soil and sustainably maintain its fertility. Crop rotation, especially alternating cotton, grain crops, and fodder crops, helps maintain the balance of nutrients in the soil and prevent a decrease in humus content.

In addition, the scientifically based use of mineral and organic fertilizers in recommended rates, increasing organic matter to improve the agrophysical properties of the soil, and maintaining optimal soil moisture are important. Irrigation work should be carried out in normative manner, taking into account the mechanical composition of the soil and the depth of groundwater, because excessive irrigation can lead to waterlogging or salinization of the soil.

Furthermore, constant monitoring of the meliorative condition of the lands, effective use of drainage systems, and timely implementation of agrotechnical measures to reduce soil compaction are of great importance. An agrosystem organized in this way will make it possible to obtain stable and high yields of agricultural crops on irrigated meadow alluvial soils.

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