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General Physical Properties of Rain-Soaked Soils (On the Example of Zaaminsky District)

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Abstract: The article analyzes the general physical properties of rain-soaked soils of the Zaaminsky district. In conditions of climatic changes on rich soils, and always planting the same type of crop leads to a change in soil properties. The general physical properties of soils are of great importance for determining soil fertility, moisture consumption, mobility, and nutrient absorption. In the upper layer of undeveloped typical gray-earth soils, the density is 1.30-1.32 g/cm3, in the lower layers 1.38-1.40 g/cm3, compacting from top to bottom. On the southern slope of the rain-fed soils, it can be seen that in the arable and sub-arable soil layers it is 1.28-1.32 g/cm3, and in the lower layers it is 1.36-1.40 g/cm3.

Keywords: Dryland soil, light-colored loess soil, typical loess soil, dark-colored loess soil, nutrients, general physical properties, bulk density, specific gravity, total porosity.

Introduction: The physical properties of soil are among the key factors determining its fertility. Among these, soil density and the structural condition of the plow layer play a leading role. The density of the soil layer influences the formation of its structure, aggregate index, water-air ratio, heat exchange within the soil, the ratio between solid parts and pores, the amount of particles, and their interrelation. Soil layer density depends on its quantitative composition, the ratio of aggregates of different sizes, and its granulometric composition. The magnitude of soil density also reflects the rate of anthropogenic impact on the soil [1].

Soil density, along with total porosity, is also related to the qualitative composition of the pores. As soil density increases, "active" capillary porosity and aeration decrease, negatively affecting the soil's water and air properties. In sandy loam and silty loam soils, the water-physical condition is determined by the amount and quality of organic matter. Therefore, optimizing soil physical properties requires addressing organic matter deficiency to create a positive balance that enhances fertility [1,2,3,4].

METHODS

The object of research was the typical loess soils (bo'z soils) found in the Zomin district of Jizzakh region. Soil studies were conducted according to standard methodologies widely accepted across the Republic.

RESULTS AND DISCUSSION

The general physical properties of soil are of great importance in determining fertility and obtaining high yields from agricultural crops, especially in rainfed (non-irrigated) soils where these factors are more pronounced. We studied the main ongoing processes in the typical loess soils of the Zomin district. New agrotechnological methods were applied to improve soil fertility, and chickpeas (no'xat) were cultivated. Before planting, both cultivated and uncultivated rainfed soils were analyzed.

The degradation of soil physical properties complicates water, nutrient, and air supply to plants, as well as soil tillage processes. Studying the general physical properties of rainfed typical loess soils serves as a scientific basis for improving soil fertility, increasing crop yields, and implementing scientifically grounded farming systems.

Improvements in the physical properties of typical loess soils are primarily related to the abundance of microaggregates and the activity of soil microorganisms. Soil density depends on its mineralogical and mechanical composition, structural condition, organic matter content, and the overall level of agricultural management. Soils rich in humus and possessing good structure typically have lower density. Soil density significantly influences its water and air characteristics, the activity of microorganisms, and the accumulation of essential nutrients for plant growth. In soils with high density, plant root respiration and nutrient absorption become more difficult, creating unfavorable conditions for plant development.

In the upper layer of undisturbed typical loess soil, density ranged between 1.30–1.32 g/cm³, while in the lower layers it increased to 1.38–1.40 g/cm³, indicating densification with depth. In the plow and sub-plow layers of rainfed soils on southern slopes, density ranged from 1.28–1.32 g/cm³, while in deeper layers it increased to 1.36–1.40 g/cm³ (see Table 1).

Table 1

General Physical Properties of Rainfed Typical Loess Soils

Profile Number and Name	Depth, cm	Density, g/cm³	Specific Gravity, g/cm³ |	Total Porosity, %
K-1 Undisturbed Soil	0-5	1,30	2,60	50,0
	5-46	1,32	2,62	49,6
	46-62	1,38	2,64	47,7
	62-91	1,40	2,65	47,1
K-2 – Southern Slope Cultivated Rainfed Soil	0-12	1,28	2,62	51,1
	12-47	1,32	2,65	49,4
	47-69	1,36	2,66	48,8
	69-163	1,40	2,67	47,5

The bulk density of rainfed typical loess soils varies depending on the degree of land cultivation and the implementation of agrotechnical measures. An increase in soil density leads to reduced air and water permeability, negatively affecting the plant's access to moisture, air, and nutrients.

In undisturbed typical loess soils, total porosity in the upper layers ranges from 49.6% to 50.0%, while in the lower layers it decreases to 47.1%–47.7%. In rainfed soils, total porosity in the plow and sub-plow layers is 49.4%–51.1%, and in the deeper layers, following the same pattern, it decreases to 47.5%–48.8%. In both soil types, a gradual reduction in porosity is observed with depth (see Table 1).

The specific gravity in the upper layer of undisturbed soil is 2.60–2.62 g/cm³, while in the lower layers it reaches 2.64–2.65 g/cm³. In rainfed soils, specific gravity in the plow and sub-plow layers ranges from 2.62–2.65 g/cm³ and rises to 2.64–2.67 g/cm³ in the deeper layers (Table 1).

Total soil porosity is one of the most important indicators that governs air and heat exchange, root system development, and microbial activity. According to agro-physical analyses, the reclamation of previously uncultivated land promotes an increase in the porosity of typical rainfed loess soils.

Soil bulk density is influenced by its fertility, especially by the content of organic matter (humus), as well as by its mechanical and microaggregate composition. It may change significantly depending on the proper or improper use of agrotechnological practices. The continuous grazing of large and small livestock and the use of heavy machinery negatively affect soil density and lead to compaction.

Under current climate change conditions, the efficient use of rainfed soils requires timely application of organic and mineral fertilizers, implementation of agrotechnical measures, and adoption of modern agro-technologies.

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