ANALYSIS OF THE PHYSICAL AND CHEMICAL INDICATORS OF THE MORPHOGENETIC DIAGNOSTICS OF THE CULTIVATED MOUNTAIN–BLACK SOILS OF THE MOUNTAINOUS SHIRVAN REGION

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Abstract

This study examines washed-out ordinary mountain black soils located in the mid-mountain belt of the Pirsaatchay river basin. These areas currently retain characteristics of a forest landscape. The objective of the research was to conduct a comparative assessment of soil-ecological changes over the past 60–70 years based on an analysis of the soils' physicochemical properties. The findings indicate that these processes have progressed rapidly under the combined influence of natural and anthropogenic factors. Owing to the dense vegetation cover and favorable hydrothermal conditions during the autumn and spring seasons, a high rate of organic matter restoration is observed. However, this process slows down during dry years. The organic matter content decreases with depth in the soil profile, primarily due to the vertical movement of the soil solution. At present, these soils are utilized in various branches of agricultural production.

1. Introduction

Black soils are poorly studied genetically and are still not unambiguously accepted. G.A. Salamov notes that these soils were formed as a result of the evolution of brown forest soils [19, p. 38]. The process of desertification has taken place in the areas that were freed from forests, and due to the relief and microclimate conditions, part of the brown soils that had become desertified have been transferred to black soils.

Although black soils do not occupy a large area in the country, including the study region, these soils are intensively used for various agricultural crops. Therefore, many research works have been carried out on the degradation of black soils [7, p. 228; 9, p. 654; 15, pp. 359-371; 21, pp. 102-107]. Based on our research in this direction, it can be said that the use of these lands for agricultural purposes for many years has led to changes in their morphological structure and physicochemical properties. A study conducted in the field of soil biology notes that intensive cultivation of these soils negatively affects the course of microbiological processes, changes the microbial composition of the soil, increases the intensity of mineralization, and as a result, the amount of total nitrogen and organic matter decreases [21, pp. 769-774].

On the southern and south-eastern slopes of the Greater Caucasus, numerous researchers — including H.A. Aliyev, M.P. Babayev, A.M. Jafarov, G.M. Jafarova, S.S. Novruzova, and others — have conducted studies, particularly in recent years, depending on the specific objectives of the research [3, 4, 5, 6, 12, 16, 17]

2.Material and method

The washed-out ordinary mountain-black soils of the Pirsaatchay basin constitute slightly more than 1% (2316.38 ha) of the total study area. These soils are widely distributed in temperate-warm climates around the world, under forests of various trees. Characteristic soil samples were taken to monitor changes in the study area. From soil analyses, the amount of humus and total nitrogen was determined by the I.V. Tyurin method, the absorbed Ca_2+ and Mg_2+ by the D.V. Ivanov method, the pH in aqueous solution by a potentiometer, the carbonation (CO2) in a calcimeter device by the Scheibler method, the hygroscopic moisture by drying in a drying cabinet at a temperature of 105° C for 6 hours and then by weighing, the granulometric composition by the N.A. Kachinsky method by working with $N_2P_2O_7$, and the density in the soil by the N.A. Kachinsky method in field conditions.

Table 1

Some diagnostic features of the washed anthropogenically modified mountain black soils of the Mountainous Shirvan region

Indicators	Shamakhi Plateau		
	raw	plow	orchard
Geographic coordinates	40º30'18,23" N 48º09'22,14" E	40º07'25,12" N 48º06'45,16" E	40º45'48,16" N 48º22'13,25" E
Horizon "A", cm	35-50	30	35
Thickness of humus horizon, A+AB, cm	45-50	32-47	50-52
Boils under the influence of 10% HCl	0	0	0
Depth of carbonate derivative, cm	75-80	70	75
Upper horizon hardness, g/cm³	1,35	1,40	1,90
Amount of physical clay in the upper horizon, (<0.01 mm)	71,46	76,44	65,50
Amount of silt fraction in the upper horizon (<0.001 mm)	41,86	46,04	27,92
pH (H2O), 0-20 cm	7,8	8,0	7,6
Amount of humus in horizon A (M±S), %	4,90±0,60	-	4,57±0,50
Amount of humus in the plow horizon, (0-25 cm), %	-	4,20±0,50	-
Phytomass, c/ha	65,4	-	57,5

3.Analysis and discussion

In recent years, the high level of anthropogenic pressure on nature has led to numerous negative environmental consequences. In order to mitigate these adverse impacts, it has become necessary to develop and implement environmentally safe zonal farming systems that ensure the management of agro-ecological parameters based on existing landscape conditions [15, p.3]. The progressive increase in anthropogenic degradation and the sharp deterioration of soil conditions have made the issue of preserving and enhancing soil fertility increasingly urgent [20, p.5]. Thus, in the modern period, soils become more vulnerable to contamination because anthropogenic influences primarily alter the soil microbiota, biochemical parameters, and biological activity [15, p.5].

Washed-out and carbonate subtypes of black soils are widespread in the Pirsaatchay basin. Washed-out ordinary mountain-black soils were formed on the Shamakhi plateau around the Chukhuryurd settlement at altitudes of 1000-1200 m above sea level.

The vegetation consists of various grassy mountain steppes and shrubs with sedges. There was a forest in these areas in the recent past. The few remaining forest trees (oak, alder) and shrubs (rosewood, cranberry, hawthorn, blackthorn) in the area prove this (Table 1).

To gain a comprehensive understanding of the washed, anthropogenically modified mountain black soils, let us present the morphogenetic description of one of the characteristic soil profiles of this soil type (Profile 10), based on the WRB International Classification System [4]. This soil profile was established to the left of the Chukhuryurd–Gizmeidan road, on a gently inclined slope in the north-western direction. The area is currently used under cereal cultivation.

„A_1"   0-20 cm dark grayish, granular–crumb structure; abundant fine fibrous roots; clay–loam texture; moist; shows no effervescence with 10% HCl; boundary is clear.

„A_2"   20-38 cm dark grayish, granular–crumb structure; fewer roots compared with the overlying horizon; soft; numerous earthworm channels; very moist; clayey; shows no effervescence with 10% HCl; boundary is clear.

„B"   38-55 cm brownish, blocky–subangular blocky structure; clayey; firmer than the overlying layer; occasional roots and fine rootlets; moist; shows no effervescence with 10% HCl; boundary is gradual.

„BC"   55-78 cm light brownish, clayey, blocky structure; compacted; no visible pedogenic concretions; moist; shows no effervescence with 10% HCl; boundary is clear.

„C"   78-108 cm yellowish-brown; clayey; moist; structureless; weakly developed carbonate accumulations are visible; exhibits weak effervescence with 10% HCl.

The characteristic features of these soils are that they are moist throughout the profile, carbonates are washed-out from the upper horizons, cracks occur in the vertical direction, the predominance of a lumpy and granular structure, the absence of boiling from the upper layer to the lower layer along the profile, the disappearance of solidification in the lower layers due to the decrease in humus, and their heavy granulometric composition.

In the washed-out ordinary mountain-black soils we studied, the amount of humus in the "A" horizon of the raw soil (M±S) varies between 4.90±0.60%. Under the orchard, this indicator is 4.57±0.50; in the plow layer, it is 4.20±0.50. According to the results of a study conducted on the same soil type and within the same geographical area 50 years ago, the humus content in the plow layer ranged between 4.6–4.8%, and based on R. H. Mammadov's gradation, it is classified as moderately humus-rich [19, p. 46]. In comparison, a decrease of 0.4-0.6% is observed. The amount of nutrients, including humus, decreases sharply along the profile. The humus content in raw washed-out ordinary mountain-black soils is higher than in the same soils under perennial plowing and orchards. This is also reflected in the results of the study conducted by Grishina and Orlov [11, pp. 42-47]. The use of land for agricultural purposes affects many of its parameters, including quantitative and qualitative indicators. Thus, while in raw soils the balance is maintained in the process of conversion of organic residues into humus and mineralization, in soils planted with cultivated plants the balance is disturbed and the dehumification process is accelerated.

The accumulation of bitumen, soluble compounds, and humic acids in the lower horizons is a characteristic feature of leached, anthropogenically modified mountain black soils. Thus, the humus reserve in a one-meter layer reaches 242 t/ha, nitrogen 23-30 t/ha [21, p. 47].

In washed-out ordinary mountain-black soils, carbonates ($CaCO_3$) gradually change along the profile of the soil section. Its amount increases relatively in the lower layers. The main reason for this is the carbonate content of the soil-forming rocks. These lands were subjected to erosion along the soil profile when they were under forest in the past. This process is still ongoing, although it is relatively slow. The process of turning these lands into steppes is currently ongoing. In the past, these lands were subjected to erosion along the soil profile when they were under forest. This process is still ongoing, although it is relatively slow. The process of turning these lands into steppes is currently ongoing.

The leached ordinary mountain black soils of the Pirsaatchay basin differ from the chernozems of the Russian Federation [19, pp. 1277–1288; 7, pp. 68–80] and from the anthropogenically modified mountain black soils within Azerbaijan [5] by their higher carbonate content and the comparatively weaker degree of leaching. At the same time, it is poorer than these soils in terms of the amount and reserves of humus.

As for the soil reaction, in leached mountain chernozem soils, alkalinity increases with depth. Of the absorbed bases, calcium cation predominates. (Figure 1.) Throughout the profile, this parameter ranges from 42.5 to 45.0 mg-equivalent and is considered high. Magnesium cation takes the second place and gradually decreases with depth. While Ca_2+ in the accumulative horizon is 42.5 mg/eq, in the parent rock this indicator is 45 mg/eq. Compared to the results of the study conducted before us in the same area, the amount of absorbed bases is relatively low. This can be attributed to the process of soil desertification that has occurred in the last 60-70 years. Thus, calcium compounds in the soil are formed as a result of the decomposition of forest and natural grass plants (organic matter). The intensive development of agriculture in the last 60-70 years is associated with the failure to return organic matter to the soil, disrupting the balance. This can be attributed to the process of soil desertification that has occurred in the last 60-70 years. Thus, calcium compounds in the soil are formed as a result of the decomposition of forest and natural grass plants (organic matter). The intensive development of agriculture in the last 60-70 years is associated with the failure to return organic matter to the soil, disrupting the balance. The amount of absorbed Na is low, at 1.34 mg/eq. Absorbed hydrogen ions are observed in very small amounts (0.06 mg/eq) in the upper two layers [12, p. 50].

According to their granulometric composition, these soils are light and medium clay soils. The content of physical clay (< 0.01 mm) in the upper horizon ranges from 65.50% to 76.44%, and this value relatively decreases from the upper horizon toward the parent material. The silt fraction (<0.001 mm) varies in the same way. The highest amount is observed in the upper layers of the soil. Dust and silt fractions reach their highest values along the soil profile in the upper horizon or in the plow and under the plow layers. The decrease of these fractions along the profile and the increase of physical sand particles are also noticeable. The accumulation of fine particles in the middle layers is due to washing along the profile.

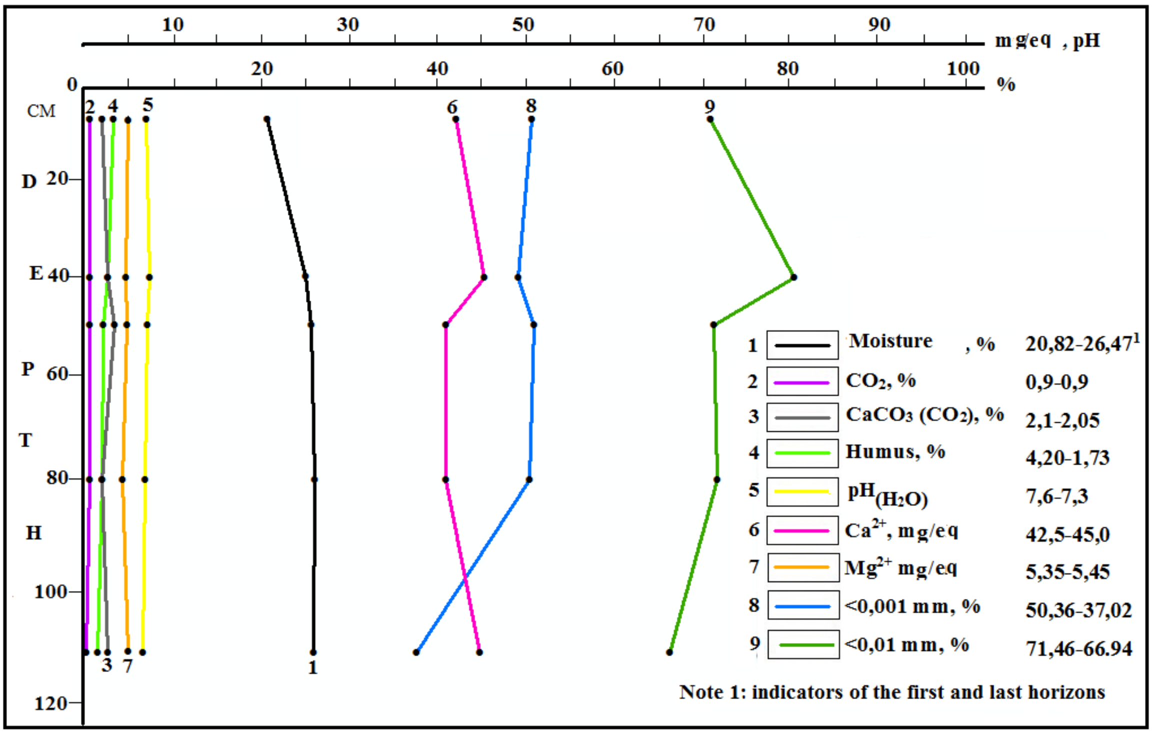

Figure 1. Some physical and chemical properties of leached cultivated mountain chernozem soils

One-half oxides (R_2O_3) are distributed evenly along the profile, like silicon. The amount of aluminum oxide (Al_2O_3) from its composition (Al_2O_3 + Fe_2O_3) is 18-19%, and both decreases and relatively increases along the profile [19, p. 50].

The leached ordinary mountain chernozem soils investigated in this study undergo a certain degree of transformation depending on the direction of human economic activity. (Table 1). As can be seen from this, the thickness of the humus horizon (A+AB) varies between 65-70 cm in the raw field, while this indicator is 52-57 cm in the plowed field, and 60-67 cm under the orchard.

Visually, carbonate formations in the profile change as a result of human economic activity. In virgin areas, secondary formations are observed at depths of 75–80 cm, whereas in cropland and orchards they occur closer to the soil surface. With regard to the physical properties of these soils, their bulk density ranges from 1.35 to 1.90 g/cm³. The highest index was observed in orchard soils. As for the amount of physical clay, this index reaches 76.44% in plowed soils. In orchard soils, it reaches 65.50%, and in raw fields, it reaches 71.46%. The silt fraction also occurs in plowed soils.

Among the nutrient constituents, the humus content in virgin soils reaches up to 5%, being close to the indicators of natural soils and is therefore evaluated as moderately humus-rich. In these soils used under cultivation, the humus content amounts to 4.20%. Compared with other soils of the same semi-subtype in the region, the humus content in the study area is relatively low. This can be explained not only by anthropogenic factors but also by natural factors, particularly the high influence of relief and slope aspect.

In the study area, cultivated mountain chernozem soils occur as thick, moderately thick, and thin profiles depending on relief and altitude. Moderately thick and thin leached cultivated mountain chernozem soils have developed on the south-eastern slopes of the Dubrar Mountain at elevations of up to 1500 m.

The leached cultivated mountain chernozem soils of the Pirsaatchay basin are replaced by mountain meadow soils toward the north-western direction, while toward the south and south-eastern directions they are gradually replaced first by steppe-brown and grey-brown soils. Since these soils are similar to mountain-meadow soils in some morphological characteristics, some researchers believe that mountain-black soils were formed from the evolution of mountain-meadow soils under the influence of xerophytization [2, pp. 14-23; 15, p. 238].

Based on the results obtained specifically for this soil type, it can be concluded that, at elevations of 600–1200 m within the Pirsaatchay basin, the relatively arid conditions and the favorable environment for the development of mountain steppe vegetation have led to the widespread distribution of thin and moderately thick leached cultivated mountain chernozem soils.

4. Conclusion

Based on the physical and geographical conditions in which these lands were formed, the genetically preserved characteristics of the lands, and the opinions of researchers before us, we can conclude that these lands were also covered with forest in the recent past, and as a result of natural and anthropogenic influences, the ecological balance was disrupted and a deep process of desertification took place, resulting in the formation of ordinary washed-out mountain-black soils.

At the same time, a comparative analysis of soil monitoring results shows that, under the intensive influence of human economic activity, these soils have undergone an average of 15-20% dehumification (humus loss).

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YUYULMUŞ ADİ DAĞ-QARA TORPAQLARIN FİZİKİ-KİMYƏVİ PARAMETRLƏRİNİN MÜQAYİSƏLİ SƏCİYYƏSİ (PİRSAATÇAY HÖVZƏSİ TİMSALINDA)

A.A.Haqverdi

Xülasə. Məqalədə Pirssatçay hövzəsinin orta dağlıq qurşaqlarının yuyulmuş adi dağ-qara torpaqlarından bəhs olunur. Hal-hazırda bu ərazilərdə meşə landşaftının əlamətləri qalmaqdadır. Tədqiqatın məqsədi son 60-70 il müddətində torpaq-ekoloji nöqteyi-nəzərdən daha az antropogen təsirə məruz qalmış ərazidə gedən prosesi fiziki-kimyəvi analiz nəticələrinə görə müqayisəli şəkildə qiymətləndirilməkdən ibarət olmuşdur. Müəyyən edilmişdir ki, burda qarşılıqlı təbii və antropogen təsir nəticəsində bozqırlaşma prosesi sürətlə getmişdir. Bu torpaqlar bitki örtüyü ilə zəngin olduğuna və payız, yaz vaxtı optimal hidrotermik şərait mövcud olduğu üçün üzvi maddələrin bərpa olunma intensivliyi yüksəkdir. Bəzi illər quraq keçəndə bu proses pozulur. Dərinliyə gəldikdə torpaq məhlulunun şaquli hərəkətindən asılı olaraq üzvi maddələr dərinliyə doğru tədricən azalır. Hazırda bu torpaqlardan kənd təsərrüfatı bikiçiliyinin müxtəlif istiqamətlərində istifadə olunur.

Açar sözlər: bozqırlaşma, humus, qranulometrik, profil, fiziki gil