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RESEARCH ARTICLE

Study of the Soil-Ecological State of the Soils of the Objects of Study on the Example of the Foothill Zones of Azerbaijan in the Lesser Caucasus under Various Crops

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ABSTRACT

The studies were carried out on the following types of soils, most widespread within Azerbaijan: gray-brown, gray-earth-meadow, gray-brown, and mountain-gray-brown. Common to these soils is the deep penetration of humus into the soil profile and its very slow decrease down by profile. According to the results of our research, it is proved that in the soil the humus content in the 25–50 cm layer is from 2.00% to 2.12%, and the total nitrogen is from 0.112% to 176%, the content of mineral forms of nitrogen is almost identical with the previous soils, while some an increase in the content of phosphorus and exchangeable potassium relative to other studied soils. The amount of carbonates in these soils is low ($CaCO_3$ -6.4–10.4%). The absorbed bases are dominated by calcium, which is 60.3–76.7% of the total exchangeable cations. The amount of exchangeable sodium in the absorbed complex is low, 2.7–4.7% of the total, while the content of exchangeable magnesium is quite high. The moisture regime of mountain-gray-brown soils is determined mainly by the amount of atmospheric precipitation and the course of evaporation of soil moisture.

Key words: Carbonate content, leaching, mountain-brown, gray-brown, gray-meadow, gray-brown (chestnut), gray-brown (chestnut) soils, erosional relief, rainfed

INTRODUCTION

The territory of Azerbaijan is divided into two large zones. The first includes the low-lying and lowland foothills, where the cultivation of crops without artificial irrigation is impossible, that is, the irrigated zone. It makes up 60% of the total area and is an agricultural facility. The rest of the mountainous regions belongs to the second region with rainfed and semi-rainfed agriculture. In different periods of the 20th century, the land fund of the republic was studied mainly by Russian soil scientists and was included in new soil-geographic zones. Zakharov *et al*., Alekperov, and Volobuev research can find confirmation of the above opinions.[1-4]

Mountain brown soils are formed in the lower reaches of arid forests and shrubs. These lands were formed in the mountainous parts of the Greater and Lesser Caucasus at an altitude of 800–1200 m, in the middle and low mountains of the Nakhchivan and Lankaran regions. Mountain brown soils form a transition between mountain gray-brown soils and mountain black forest soils. Mountain brown soils are formed in arid conditions under light oak-hornbeam forests, in areas with a developed xerophytic grass cover.[5] These soils are formed in difficult relief-hydrothermal conditions.[6-8]

Depending on the formed ecological and geographical conditions, brown soils are divided into 3 subtypes: (1) Washed mountain brown; (2) typical mountain brown; and (3) carbonated mountain brown.

GEOMORPHOLOGICAL STRUCTURE OF THE TERRITORY

On the territory of Azerbaijan, the Lesser Caucasus is represented by its northern part, including the

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Karabakh volcanic plateau. The formation of mountain folds in the Lesser Caucasus coincides with different geological eras. The period of development of the main mountaineering phase in the formation of the modern relief of the Lesser Caucasus coincides with the Pliocene, which mainly fell on the time when the vertical elevation of different areas was complicated by fragmentation and was rich in sedentary movements.[9,6] Some of the large tectonic structures in the central part of the Lesser Caucasus, which is part of Azerbaijan, do not have their own shape in the relief. One of the main reasons for this is that these structures are subject to weak differential uplift in the middle mountain belt of the vast northern slope of the Lesser Caucasus in the orogenic phase, especially in its second half. Therefore, if we generally look at the surface structure of the northern slope of the Lesser Caucasus, then, despite the fact that the amplitude of the internal elevation reaches 1000–1200 m, the entire territory resembles a wide mountain plateau. On the border of the northern and eastern foothills of the Lesser Caucasus and the Kursk bend zone, there are low monoclinic ridges located in various structural elements and composed mainly of chalk marls, limestones, and partly volcanic rocks.

Starting from the western borders of Azerbaijan, the mountains of the Lesser Caucasus are surrounded by the Shahdag frontal ridge. This ridge stretches east and southeast as a result of the folding of the Lesser Caucasus mountains. In the Azerbaijan part of the Lesser Caucasus, the following types of relief can be distinguished.

GLIAS-EROSIONAL RELIEF

This type of relief is represented by troughs and karsts in the valleys. Forming this type of relief is strictly limited on the northern slopes of Gamishdag, Shahdag and Murovdag. In the unexplored part of the Lesser Caucasus N.V. According to Dumitrashko, the glacial relief mainly covers large areas in Zangezur, the southern part of Goych and the Akhalkalaki plateau. Different researchers have different opinions about the glaciation of the Lesser Caucasus for different reasons: came to the conclusion that four ice ages played a key role in the formation of the landscape.[1,7]

Relief formed as a result of smoothing ancient surfaces. The main characteristic feature of this type of relief is that tectonic features are insecure in their response to substrates and lithology. It should also be noted that this landform is rarely found in large areas with which to compare N.V. According to the lower layers of this type of relief are not of subaerial denudation, but of abrasion origin, which is associated with fluctuations in the level of the upper Tertiary seas.[10,11]

Rock-tectonic mountain-erosion type of relief. It usually includes a group of terrain types. The main feature for them is the elements that determine the tectonics and lithological composition of the relief. Depending on the lithological composition of the substrate, one or another tectonic structure leads to the formation of a number of relief forms.

Finally, we can see young forms of lava origin (Pliocene-IV age), covering a very small area of the Lesser Caucasus. According to the features identified by this form of relief, being very young, was called a kind of "armored relief" and retained its original features better than the influence of exogenous processes.[2,12,13]

Below are the main soil and ecological characteristics of these soils, which play an important role in the life of soil microorganisms.[14]

GRAY-BROWN SOIL

The area of gray-brown soils in Azerbaijan is 710,000 ha or 8.3% of the total area of the republic. Wheat, corn, alfalfa, here, olives, and vegetables grow well on the soil. The parent rocks of the hilly-ridge part of the territory occupied by gray-brown soils are characterized by the presence of alluvial and deluvial bedrock saline rocks. The flat part of the territory is covered with deluvial sediments from 2 to 5 m thick. The climate is sharply arid, with long summers, short, and warm winters, the average annual temperature is 13–150°C, the annual amount of precipitation is within 173–237 mm, the maximum amount of precipitation falls in the autumn, as well as in the spring.[5,9,15,16]

The temperature regime of gray-brown soils is characterized by the following features: the minimum temperature values (4–60°C) are observed in the 0–40 cm layer in January, February, and December.

The maximum soil temperature (30–320°C) from the surface is observed in the summer months. The active temperature period is 240–250 days.

According to the state of natural moisture, gray-brown soils are distinguished by the presence of a long drying period. The fallout of a relatively large amount of atmospheric precipitation in spring and autumn at relatively low temperatures contributes to a noticeable increase in the moisture content in the upper soil layer. The moisture content in the soil profile remains practically unchanged here. The gray-brown soils of the experimental site are characterized by the following soil-ecological properties. The amount of humus in the upper layers of soils varies from 1.98% to 2.25%, and the total nitrogen is 0.156–0.175%, remaining the highest under alfalfa. The content of easily assimilable forms of nutrients in these soils is very low, where in the soil profile N-NO_3 varies from 5.3 to 6.7 mg/kg soil, and ammoniacal nitrogen (N-NH) 6.7–9.3 mg, while the amount of mobile phosphorus ranges from 5.8 to 7.8 mg, and exchangeable potassium is 162–207 mg/kg of soil. The amount of striped soil based in gray-brown soils is quite high, in the soil profile, it varies from 25.7 to 30.2 mg equivalent per 100 g of soil, in which exchangeable calcium (53.7–62.7%) has an advantage. The content of exchangeable magnesium is also high, amounting to 30.2–39% of the total amount of cations, while sodium is from 6.5% to 7.2%. In terms of texture, the gray-brown soils of Apsheron are light and medium loamy.[17,4] The soils are calcareous ($CaCO_3$-9.6–13.9%), the reaction of the soil medium is slightly alkaline and alkaline, and the pH value of the aqueous suspension is –7.8–8.1.

Gray-brown soils genetically occupy a transitional position between desert-steppe and sierozem soils.

SIEROZEM-MEADOW SOILS

Sierozem-meadow soils occupy 885000 ha or 10.3% of the republic's area. Wheat, corn, cotton, alfalfa, and other agricultural crops grow well on these soils. This type of soil develops in a dry climate, periodic, and constant capillary moistening with groundwater.[16]

In these soils, the meadow process dominates over the steppe, the groundwater level is found at a depth of 1–3 m. Sierozem-meadow soils in the upper horizons contain oozy particles. In the subsurface horizons of these soils, the beginning of about the formation of the illuvial horizon.

The heavy texture of the plow horizon of gray-meadow soils often "is the cause of crust formation."[8]

The gray-meadow soils of the experimental site are characterized by the following soil and ecological conditions: The humus content in the soil profile varies from 1.36% to 2.32%, and the total nitrogen content from 0.086% to 0.185%. The amount of nitrate nitrogen (N-NO3) ranges from 5.4 to 7.3 mg/kg, and ammonia nitrogen –6.5–9.2 mg, mobile phosphorus varies within 6.3–17.5 mg, and exchangeable potassium –185–236 mg/kg of soil.[18-22]

The amount of absorbed bases is high, in the composition of which calcium (50.2–56.5%) and magnesium (39.1–43.6%) predominate, while the amount of exchangeable sodium is from 5.4% to 6.9% of the total the amount of absorbed bases.

The content of carbonates in the soil profile is more evenly distributed and changes in the soil profile in a narrow range of 11.5–13.9%, the reaction of the soil medium is slightly alkaline and alkaline, and the pH of the aqueous suspension is 7.7–8.1.

GRAY-BROWN (CHESTNUT) SOILS

The dry steppe zone is located at an altitude of 200–600 m above sea level, it covers a strip of low mountains, foothills, and foothill plains of the Greater and Lesser Caucasus. The parent rocks of these soils are in most cases deluvial, proluvial – deluvial loamy sediments and sandy-pebble deposits.[23-25]

In the dry steppe zone of Azerbaijan, the average annual temperature is 10–120°C. The characteristic features of the dry steppe zone are pronounced aridity and poor vegetation cover.

Among the gray-brown (chestnut) soils of Azerbaijan, mountain soils, on which rain-fed agriculture is developed, and flat soils, on which only irrigated agriculture is possible, stand out sharply. Gray-brown (chestnut) soils are more common and account for 27.4% of the total area of the republic. More than 80% of chestnut plain soils are developed for various agricultural crops and are the main fund of the field lands of the irrigated zone.

Gray-brown (chestnut) soils can be referred to heavy loamy soils, the content of humus in a half-meter layer of soils varies from 1.12% to 2.97%, and total nitrogen –0.096–0.221%. The amount of nitrates varies from 5.3 to 7.5 mg, absorbed ammonia from 6.4 to 9.7 mg/kg of soil. The content of mobile phosphorus and exchangeable potassium in these soils varies, respectively, 10.3–19.3 mg to 197–227 mg/kg of soil. The amount of absorbed bases is 20.8–28.4 mg/kg of soil, with a predominance of absorbed calcium (60.5–72.7%), the amount of exchangeable sodium is low –3.6–6.7% of the total. Gray-brown (chestnut) soils are highly carbonate. The amount of $CaCO_3$ varies from 15.3% to 19.3%, the reaction of the soil medium is slightly alkaline, and the pH of the aqueous suspension is 7.6–7.8.

Mountain gray-brown soils. Mountain gray-brown soils in the republic are mainly confined to a relatively arid belt of light forests ranging from 700 to 1200 m above sea level and the middle region of mountains and foothills. The total area of these soils is 11.5% of the total area of the republic.[26]

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Forests covering mountain gray-brown soils, as well as beech forests, are of great water conservation (water retention) and soil protection significance. Soils are formed in a relatively dry, moderately warm climate with an average annual temperature of 8–110°C, and a maximum summer temperature of up to 20°C. The average annual rainfall does not exceed 360–600 mm. In the soil profile, humus is morphologically separated at a depth of 6.0–6.5% and carbonates at a depth of 80–90 cm. To see this change more clearly, areas were selected according to the degree of soil erosion in the plantations and hayfields of the areas formed by carbonate-washed mountain soils, soil sections were made, detailed information on their morphological structure and agrochemical composition was obtained. The following is a morphological description of the profile of section 1 [Figure 1]:

The composition of the silt fraction varies between 24.0 ± 2.4% in the top layer and 56.8 ± 4.9% in the physical clay. The amount of sludge particles in the skin increases, especially in the Bt layer [Table 1].

SECTION 2

- Avz 0–12 heavy and medium clayey, dark brown, granular-soft, soft, many loop-shaped plant roots and worm tracts, moist, and gradual transition
- Avz/B12–34 medium clayey, brown, broken topavari-granular, relatively hard, small rock fragments, sparse roots, moist, and gradual transition
- Btca 34–61 lightly clayey, light brown, weakly loamy, relatively hard, numerous small rock fragments, moist, and clear transition
- Btca/C 61–90 medium clayey, light brown, broken small nuts, soft, rocky, moist, and gradual transition

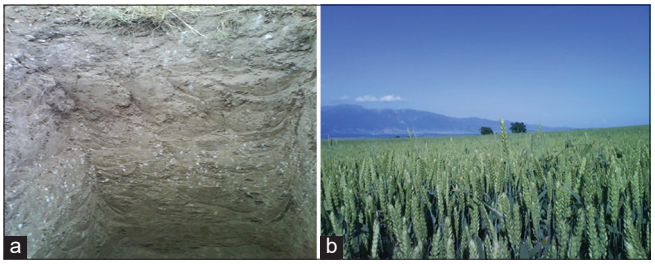

Figure 1: (a and b) Shamkir region carbonate mountain brown soils (under grain)

Table 1: Soil ecological characteristics of the soils of the objects of study

soil	Depth, cm	Humus, %	Total Nitrogen,%	NMO_3	mg/kg soil			Absorption amount basis,mg.eq 100 g of soil	% from the sum			$CaCO_3$ по CO_2	Particle size, mm		pH aq. sus
					K-NO_3	P_2O_5 подв.	K_2O обм.		Ca	Mg	N_3		<0,001	0,01	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Gray-brown irrigated, under winter wheat	0-25	1,89	0,156	5,3	7,9	6,6	196	26,7	60,2	33,9	6,9	9,6	27,4	59,6	7,9
	25-50	0,90	0,079	5,7	6,7	5,2	162	28,3	61,4	31,4	7,2	12,3	22,7	62,7	8,1
under the corn	0-25	2,05	0,162	6,2	8,3	7,8	207	27,9	62,7	30,2	7,1	10,7	30,2	68,5	7,8
	25-50	1,02	0,089	5,9	6,9	6,3	170	30,2	60,9	32,1	7,0	13,6	24,5	60,7	8,0
under the alfalfa	0-25	2,25	0,175	6,7	9,3	6,9	197	25,7	57,5	36,0	6,5	11,7	31,4	59,7	8,0
	25-50	1,12	0,115	6,3	7,8	5,3	169	28,6	53,7	39,6	6,7	13,9	25,2	60,9	8,1
Serozem-meadow, irrigated, under wheat	0-25	2,25	0,176	6,7	8,0	17,2	212	31,2	56,5	38,1	5,4	11,5	22,7	58,6	7,7
	25-50	1,76	0,086	5,4	6,5	9,0	196	29,6	50,2	43,6	6,2	12,3	25,4	54,9	8,0
under the corn	0-25	2,27	0,178	7,3	9,2	17,5	215	32,7	54,4	39,6	6,0	10,9	23,9	56,9	7,8
	25-50	1,36	0,09	5,0	6,7	9,2	185	30,9	51,2	42,1	6,7	13,4	30,8	50,4	7,9
under the alfalfa	0-25	2,32	0,185	6,5	8,5	16,9	236	33,7	52,5	41,1	6,4	11,7	20,7	57,4	7,8
	25-50	1,78	0,097	5,7	6,9	6,3	197	31,9	50,4	42,7	6,9	13,9	26,5	51,6	8,4
Grey-brown under the skin	0-25	2,89	0,215	7,5	9,7	18,5	225	27,6	67,2	28,2	3,6	17,3	25,7	57,6	7,6
	25-50	1,12	0,112	7,0	8	11,4	205	26,3	60,5	34,3	5,2	18,6	22,5	59,4	7,7
under the corn	0-25	2,78	0,210	6,2	8,7	18,0	227	28,4	71,7	22,6	4,7	15,3	22,7	58,6	7,7
	25-50	1,15	0,096	5,3	7,2	10,6	200	24,5	64,5	29,4	6,1	16,9	21,9	59,9	7,8
one	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
under the alfalfa	0-25	2,97	0,221	6,0	8,9	19,3	215	23,4	69,7	6,0	4,3	17,5	24,4	56,2	7,8
	25-50	1,21	0,125	5,7	6,4	10,3	197	20,8	62,5	31,8	6,7	19,3	23,2	57,8	7,7
Mountain grey-brown under wheat	0-25	3,21	0,256	6,7	8,7	19,7	234	31,5	69,7	27,6	2,7	6,4	27,3	63,0	7,7
	25-50	2,12	0,136	5,3	7,6	9,8	207	28,9	60,3	36,1	3,6	10,2	26,4	62,7	7,9
under the corn	0-25	3,05	0,240	6,4	9,5	21,2	227	33,6	75,8	21,8	3,4	5,9	296,5	64,6	7,6
	25-50	2,00	0,112	5,0	7,3	14,7	197	30,7	62,9	32,6	4,5	8,7	24,2	60,5	7,9
under the alfalfa	0-25	3,36	0,265	6,0	10,7	19,6	215	33,9	76,7	20,4	2,9	7,2	27,5	62,9	7,8
	25-50	2,27	0,176	5,2	18,3	11,2	186	29,6	74,4	30,9	4,7	10,4	24,7	60,7	8,0

- Ccal 90–113 medium clayey, light brown, broken fine-grained, medium-sized, small rock fragments, low moisture, and gradual transition
- Ccal/D113–147 top layer repetition, transition to floor rock.

As can be seen from the description of sections of carbonate-washed mountain-black soils, the main reason for this is the parallel anthropogenic impact on arable lands, as well as the intensity of man-made impact (heavy tonnage agricultural machinery). This is due to the fact that during the plowing, sowing, and cultivating works in the fields, heavy tonnage of agricultural crops is spread by spraying the surface of the crop. As a result, surface washing intensifies and covers large areas and reduces productivity.

In such conditions, the failure to implement special soil-protective agrotechnical control measures leads to the rapid development of the process of clay in the lower layers of the soil, and the latter leads to increased erosion and leaching of arable soil.

REFERENCES

1. Alekperov KA. Soil Erosion Map and Land Protection. Moscow: 1980. p. 219.
2. Antonov BA. Small Caucasus. In: Geomorphology of Azerbaijan Publishing House of the Academy of Sciences of Azerbaijan. Baku: SSR; 1959. p. 193.
3. Zakharov SA. Fighting forest and steppe in the Caucasus. Soil Sci 1935;4:51-5.
4. Zaslavsky MN. Soil Erosion and Slope Agriculture. Chisinau; 1966. p. 318.
5. Genesis, Geography and Efficient Use of Forest Lands of Azerbaijan. Vol. 25. Baku: Works of the Institute of Geography of ANAS; 1990, p. 51-3.
6. Iziumov AN. Soil and Soil Erosion and Research in the Gadabay Region for the Rational Use of the Land Fund in Connection with the Expansion of Potato Culture by the Development of Animal Husbandry; 2000. p. 213.
7. Zeynalov AK. In: Azerb AN, editor. Forest soils of the Murovdag ridge of the Lesser Caucasus. SSR; 1949. p. 70-4.
8. Ostrovski Y, Aliyev Z. Using GIS Programs in the Study of Soil Erosion in Azerbaijan and Determining the Conditions for their Protection. Educational materials. Poland: ITP; 2010. p. 117.
9. Baku, Agroclimatic Atlas. Oxford: Republic of Azerbaijan; 1993. p. 10.
10. Agaev NA. Agrochemical Grouping of Soils in the Lesser Caucasus by the Content of Nutrients and their Effect on Potato Productivity. Report VASKHNIL No. 5; 1989. p. 15-8.
11. Azizbekov SA. In: Gubkin AN, editor.Geology and Petrography of the Northeastern Part of the Lesser Caucasus. Institute of Geology. Baku: SSR; 1947. p. 47.
12. Ibrahimov AA Study of Erosion in Mountain-Meadow and Mountain-forest Zones of Shamkhor (Shamkir) and Gadabay Regions. Baku: Scientific Fund of the Institute of Soil Science and Agrochemistry; 1972. p. 170.
13. Braude ID. Soil erosion, drought and control of them in the Central Administrative Center. Moscow: Nauka Publishing House; 1965. p. 104.
14. Babayeva KM, Surface Improvement of Eroded Pastures around Gadabay Region. Baku: Scientific fund of the Institute of Soil Science and Agrochemistry; 2014. p. 55.
15. Williams VR. General Agriculture with the Basics of Soil Science. S/Khozgiz; 1931. p. 375.
16. Volobuev VR. In: Azerb AN, editor. Soil Ecology. Baku: SSR; 1963. p. 259.
17. Volobuev VR. In: Azerb AN, editor. Soils and Climate. Chisinau: Soil Science; 1953. p. 236.
18. Remeo Charp L and Map of Azerbaijan. Russia: MUTTP Publication, 1991. p. 23.
19. Alekperov KA. Protection of Soils from Erosion in Azerbaijan. SSR; 1979. p. 220.
20. Akimtsev VV. Soils of the Ganja Region. Azerbaijan: BAUM Publisher; 1928. p. 107.
21. Gulahmadov AX. Land Cover of IlichYolu Collective Farm, Slavyanka Village, Gadabay Region and Ways of its efficient use. Baku: Scientific fund of the Institute of Soil Science and Agrochemistry; 1980. p. 26.
22. Ibrahimov A. Adverse Effects of Soil Erosion on the Ecological Situation in Azerbaijan and ways to Prevent it (Effective Use of Eroded Lands in Azerbaijan v) Proceedings of the Institute of Erosion and Irrigation. Vol. 2. Baku; 1998. p. 40-3.
23. Molchanov AA. Forest and Climate. Moscow: AN SSR; 1962. p. 127.
24. Mustafayev XM. Soil Erosion and Control Measures. Baku: Azerbaijan State Publishing House; 1974. p. 175.
25. Zonn SB. Soil Moisture and Forest Plantations. Moscow: SSR; 1959. p. 168.
26. Mustafayev HM. Measures to Combat Water and Wind Erosion. Baku; 1978. p. 228.