Nature & Science
February 2026, Vol. 8, Issue 1, pp. 16–20
DOI: https://doi.org/10.36719/2707-1146/64/16-20

Agrochemical Characteristics of the Soils of the North-East Part of the Greater Caucasus (Gobustan District)

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Abstract. *The study investigated the agrochemical properties of the soils of the Gobustan region, located in the northeastern part of the Greater Caucasus. Effective use of fertilizers requires studying the specific characteristics of individual soil types and the amount of nutrients that can be absorbed in these soils. Therefore, before we started the experiment, we took soil samples from the gray-brown (chestnut) soils of the Gobustan region in order to study their agrochemical properties and determined the amount of nutrients absorbed in the laboratory. The results of the research on the mountain gray-brown (chestnut) soils studied under wheat show that the soils are weakly and moderately humified and have a neutral to slightly alkaline soil reaction. Ammonium nitrogen (NH_4-N), exchangeable potassium, and mobile phosphorus were studied, and scientifically substantiated agrochemical and agrotechnical measures were proposed in accordance with the existing indicators.*

Keywords: *Greater Caucasus, agrochemical properties, humus, soil reaction, nitrogen*

Introduction

The north-eastern part of the Greater Caucasus Mountain system of the Republic of Azerbaijan has complex geomorphological characteristics. The Gobustan district located in this area is characterized by a semi-desert landscape, low precipitation and high evaporation. Such conditions directly affect soil-forming processes and determine the formation of agrochemical properties of soils. The study of the soil cover in the Gobustan region was carried out by H. A. Aliyev, V. H. Hasanov, A. A.Ibrahimov and others, and it was determined that the following soil types are distributed in the area: mountain-meadow steppe, brown mountain-forest, gray-brown (chestnut), dark brown, gray-dark brown, gray soils.

The Gobustan district is located in the north-eastern part of the Greater Caucasus and is characterized by a semi-desert–dry steppe landscape, which directly affects soil-forming processes (Ismayilov, 1998). The low annual precipitation and high evaporation in the area weaken humus accumulation and cause agrochemical poverty of soils (Mammadov, 2007). Mainly gray, light-gray and gray-brown soils are distributed in the Gobustan area, which are considered characteristic for the arid climate zone (Volobuyev, 1953). Gobustan soils mainly have a neutral and weakly alkaline reaction (pH 7.3–8.3), which is explained by the predominance of carbonate parent rocks (Kovda, 1973). The conducted studies show that the humus content in gray soils usually does not exceed 1–2 %, which indicates low soil fertility (Salayev, 1979).

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Received: 19 October 2025; Accepted: 20 January 2026; Published online: 25 February 2026

The high content of calcium carbonate in soils is one of the main factors limiting the uptake of phosphorus by plants (Aliyev, 2015). The amount of mobile phosphorus is often at a low or medium supply level, which makes the application of mineral phosphorus fertilizers necessary (FAO, 2006). The low level of total nitrogen is related to the low content of organic matter and weak biological activity in soils (Hasanov & Abdullayev, 2016).

According to the FAO WRB system, Gobustan soils are mainly classified into the Calcisols and Cambisols soil groups (FAO, 2015). The analysis of agrochemical indicators shows that in Gobustan soils the development of agriculture is possible only with scientifically substantiated fertilization and soil protection measures (Mammadov & Khalilov, 2010). The study of agrochemical indicators of soils has important significance from the point of view of correct placement of agricultural crops, construction of the fertilization system on scientific bases and protection of soil fertility. From this point of view, the study of the current state of agrochemical characteristics of mountain gray-brown soils of the Gobustan District is a relevant scientific and practical issue.

Object and methodology of the research

The research was carried out on mountain gray-brown (chestnut) soils of the Gobustan district located in the north-eastern part of the Greater Caucasus. In order to determine the agrochemical characteristics of the area where we conducted the research, soil samples were taken from the experimental field by the envelope method without carrying out any agrotechnical and agrochemical measures, respectively from the 0–20, 20–40, 40–60, 60–80, 80–100 cm layers, and in these samples the amount of total and plant-available forms of nutrients was determined. Care of crops and agrotechnical measures were carried out at the agronomic norm accepted for wheat crops, taking into account the agrochemical indicators of the soils of the experimental field (Figure 1).

Figure 1. Gobustan district research area

In the taken soil samples humus (by the I. B. Tyurin method), total nitrogen (by the Kjeldahl method), easily hydrolyzable nitrogen (by the I. B. Tyurin and M. M. Kononova method), water-soluble nitrogen (by the colorimetric method with Nessler reagent), ammonium nitrogen (NH_4-N) (by the D. P. Konev method), nitrate nitrogen (by the Grandval–Lyaju method), total phosphorus (by the A. M. Meshcheryakov method), water-soluble phosphorus (by the Denige method in the modification of A. Malyugin and E. Khrenova), mobile phosphorus (by the B. M. Machigin method), total potassium (according to Smith), water-soluble potassium (by the V. G. Aleksandrov method), exchangeable potassium (by the P. B. Protasov method, by viewing in a flame photometer in a 1% ammonium carbonate extract), soil pH in suspension was determined using a potentiometer.

Results

Efficient use of fertilizers requires the study of the specific characteristics of individual soil types and the amount of plant-available nutrients in these soils. Therefore, before the experiment was

established, in order to study the agrochemical properties of gray-brown (chestnut) rainfed soils of the Gobustan district, mixed soil samples were taken and the amount of assimilable nutrients was determined in the laboratory.

For analysis, soil samples were taken by the envelope method from 5 layers; 0–20, 20–40, 40–60, 60–80, 80–100 cm. As a result of the studies, it was found that in the 0–20 cm layer humus is 2.98%, decreasing to 0.84% in the 80–100 cm layer. Total nitrogen in the 0–20 cm layer is 0.18%, and in the 80–100 cm layer it is 0.08%. Total phosphorus ranges between 0.22–0.10 %, and total potassium varies between 2.65–1.45%. In the above-mentioned layers easily hydrolyzable nitrogen varies between 87–29 mg/kg, water-soluble ammonium 8.40–2.28 mg/kg, ammonium nitrogen (NH_4-N) 24.41–9.45 mg/kg, nitrate nitrogen 7.40–1.35 mg/kg, water-soluble phosphorus 6.45–2.32 mg/kg, mobile phosphorus 19.6–8.6 mg/kg, water-soluble potassium 42.12–15.08 mg/kg, exchangeable potassium between 277.00–162.90 mg/kg (Table 1). It should be noted that the high amount of total basic nutrient elements cannot indicate the degree of supply of these soils with nutrients that can be assimilated by plants. R. Mammadov proposed a scale evaluating the amount of humus in the Republic of Azerbaijan, according to this scale the soils of the experimental area are sufficiently humus and low-humus. For this, in all farms soil-protective agrotechnical measures should be correctly used and attention should be increased to improvement works.
Agrochemical properties of soils under the wheat plant

Table 1.
Gobustan district, gray-brown (chestnut) soils year 2025

Depth, cm	pH	Humus %	Nitrogen					Phosphorus			Potassium		
			General %	Hydrolyzed, mg/kg	N/NH_3		N/NO_3 mg/kg	General %	Water-soluble mg/kg	Mobile phosphorus, mg/kg	General %	Water-soluble mg/kg	Exchangeable mg/kg
					Water-soluble mg/kg	Absorbed mg/kg							
0-20	7,4	2,98	0,18	87	8,40	24,41	7,40	0,22	6,45	19,6	2,65	42,12	277,00
20-40	7,5	2,42	0,16	76	6,60	23,98	6,70	0,18	5,41	18,4	2,43	36,10	268,02
40-60	7,7	1,27	0,14	65	5,35	17,98	4,85	0,17	4,32	16,3	2,24	31,15	241,08
60-80	8,2	0,99	0,10	47	3,45	14,84	2,90	0,13	2,45	11,7	1,67	20,85	185,14
80-100	8,2	0,84	0,08	29	2,28	9,45	1,35	0,10	2,32	8,6	1,45	15,08	162,90

Discussion

In Azerbaijan gray-brown soils are the most widely distributed soil type. Its area is 1,883 thousand hectares and covers 21.4% of the territory of the Republic. These soils are encountered in the form of a wide belt in the foothill regions of the Greater and Lesser Caucasus, in the Ganja-Gazakh massif, in Gobustan and in the Nakhchivan Republic. They are located at a height of 200–400 m above sea

level. Gray-brown (chestnut) soils have 3 subtypes: a) dark, gray, light gray-brown (chestnut) (Salayev, 1979).

Without taking into account the potential and effective fertility of the soil, the efficient application of fertilizers in agriculture is not considered possible. By determining the total reserve of nutrients in the soil, it is possible to correctly apply fertilizers, increase the effective fertility of the soil and obtain a high yield. Determination of the total amount of soil nutrients forms an idea about the reserve nutrients there, which are considered a reserve for plant development. By agrochemical properties of the soil, mainly the reaction of the soil environment, the reserves and forms of nutrients present in the soil are meant.

For soils poorly supplied with nutrients necessary for agricultural crops, it is advisable to apply all of the recommended annual fertilizer rates, for moderately supplied soils half of this rate, and for highly supplied soils one-third or half of it (Bagirova & Bakhishov, 2021, pp. 54–57).

Conclusion

It has been determined that the reaction of the soil solution is weakly alkaline (pH-7.40-8.20). The soils of the area are relatively weakly supplied with nutrients easily assimilated by plants, including ammonium nitrogen (NH_4-N), mobile phosphorus (P_2O_5) and exchangeable potassium. In general, the amount of nutrients decreased as it went to lower layers. These soils, according to the gradation of nutrient supply, are weakly supplied. In order to obtain a high grain yield, it is necessary to apply fertilizers to the soils in certain norms and ratios. It should be noted that the high total amount of basic nutrients cannot indicate the degree of supply of these soils with nutrients assimilable by plants (Bagirova & Bakhishov, 2021, pp. 54–57).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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