Impact of anthropogenic factor on changes in physical and chemical properties of chernozems in the lake Sevan basin of the republic of Armenia

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Abstract. This article focuses on the study of changes in the physical and chemical composition of mountain chernozems of the Republic of Armenia under the influence of an anthropogenic factor. It is established that under long-term and unsystematic agricultural use of chernozems in arable variants of soils, in comparison with virgin soil, significant changes in their physical and chemical properties are observed. Especially, absorption capacity decreases as a result of reduction of such important bases as absorbed calcium and magnesium. To improve the physical and chemical properties, increase fertility, effective use, and protection of mountain chernozems of the Lake Sevan basin of the Republic of Armenia, it is necessary to develop and apply a complete scientifically substantiated system of agrotechnical measures. Key words: anthropogenic factor, humus, total nitrogen, chernozems, carbonates, calcium, magnesium, sodium.

1 Introduction

The Republic of Armenia is a low-land, typically mountainous country. The average altitude of the territory above sea level is 1800 meters. The Republic is located within the geographical latitudes with significant values of aridity and continentality of climate. In addition, this is also favored by morphology and morphometric indicators of the surface relief, in particular, the prevalence of southern, south-eastern and south-western exposure of slopes. Complex geological structure, dissected relief, diversity of soil-forming rocks, climate and vegetation, and, finally, human economic activity, have determined the diversity and typological diversity of soil cover. Almost all zonal types of soils of the territory of Europe are found within the Republic.

The Republic is one of the regions least provided with soil resources. At present, the most important factors contributing to the deterioration of mountain chernozems of the republic are changes in their physical and chemical properties. This naturally has a negative impact on soil fertility and yield of agricultural crops.

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2 Materials and Methods

The research material was mountain chernozem soils of the Lake Sevan basin of the Republic of Armenia, which have undergone changes due to long-term and unsystematic human economic activity.

Field studies were carried out in similar relief areas, comparing virgin and arable variants of soils. To study soils in nature, to establish boundaries between different soils, to take soil samples for analysis, soil transects were laid.

The method <<key>> was used to determine the place where the transects were laid. Soil transects were laid in similar relief areas, up to the depth of the parent rock, which are described and classified. On loose parent rocks the depth of soil transects reaches up to 1-1.5 m, and in dense rocks they are relatively shallower. In such places, usually the depth of the cut reaches the parent rock.

Soil samples were taken from the main sections by genetic horizons and, if necessary, from half-sections. The selected soil samples are transferred from the field to the laboratory, where the samples are dried (in air-dry condition), then in air-dry condition the samples are crushed and passed through a 1.0 mm sieve. After that, the obtained melkozem is used for various analyses.

Laboratory works were carried out in the laboratory of the Department of Genesis and Geography of Soils of the Scientific Center of Soil Science and Agrochemistry named after G.P. Petrosyan. G.P. Petrosyan Scientific Center of Soil Science and Agrochemistry named after G.P. Petrosyan at the National Agrarian University of Armenia by methods generally accepted in soil science. The following were determined in laboratory conditions: humus content by Tyurin method, pH - electrometrically; CO2 - calcimetrically; absorbed bases (Ca, Mg) by Gedroits and Ivanov; Na, by Ananyan; absorption capacity by Bobko-Askinazi. [1].

3 Results

According to the WRB (World Reference Base for Soil Resources), the name of soils Chernozems - soils with thick black and highly humus upper horizon, were defined by Dokuchaev in 1883 as "zonal" soils of high grass steppes of continental climate in Russia. Chernozems correlate with the following soils: Calcareous Black Soils Kalktschernoseme (Germany), Eluviated Black Soils (Canada), Chernsols (France), Chernossolos (Brazil), Udolls of the order Mollisolei (USA), Chernozems (FAO) [2].

Depending on water-thermal and altitudinal-geomorphologic environmental conditions, three subtypes of Chernozems are formed, as mentioned above.

The most determining conditions for the formation, characteristic features, ways and degree of production utilization of Chernozems are outlined below.

Chernozems usually occupy the basin of Lake Sevan in large massifs, between 1900-2400 meters above sea level.

In gentle slopes, the parent rocks are mainly represented by dealluvial carbonate-free loams and clays. In more flat conditions, soils are most often developed on eluvial-deluvial clays and loams, below which are underlain by thin volcanic slag and clastic or dense lava rocks. Carbonation of soil-forming rocks in this subzone depends primarily on the composition of the parent rock. The parent rocks developing from the weathering products of the basic rocks are usually enriched with carbonates. In the form of small massifs, the mountainous rocks develop on alluvial-lake gravels, lava basic dense rocks, tuffolavas and on low thickness rubbly-sandy deposits of acidic rocks.

The relief of the territory is poorly articulated. Nevertheless, it is necessary to state that the mountain-steppe belt, in comparison with other soil belts of the republic, is less variegated and complex due to weaker dissected surface by ravine and gully network, uncomplicated composition of parent rocks, identity of large relief forms and moderate contrast of climatic conditions.

The main orographic relief elements of the belt, as well as of the whole Armenia, were formed in the Pliocene, but under the influence of post-Pliocene tectonic processes and volcanism they underwent significant changes.

The predominant part of the belt is represented by volcanic shield-shaped massifs in a complex combination with sloping hilly-wavy, hilly-uvalley or hilly-ridge plateaus of different heights and foothill plains

Compared to the average indicators of the territory of the republic, the mountain-steppe belt is characterized by less contrasting and complex climatic conditions. Here the climate is mainly formed under the influence of air masses of temperate latitudes, but under the influence of local complex orographic elements it undergoes certain changes.

The high elevation and south latitudinal position of the territory, as well as the transparency and purity of the air contribute to intensive solar radiation, which reaches 1.40-1.50 cal/cm2 in the basin of Lake Sevan in summer [3, 4].

This belt is characterized by significant fluctuations in daily and seasonal air temperatures, precipitation and humidity.

Soils are developed under steppe cereal-grass and tipchak-grass-soybean plant communities.

A small part of mountain chernozems are carbonate from the surface, but there are also low boiling soils and carbonate-free soils in which carbonates are absent in the upper humus horizon.

Carbonates are usually found below the B horizon and their content sometimes reaches 41.3%.

In cultivated soils there is a noticeable decrease in humus content, total nitrogen and sum of absorbed bases.

Results of pH in the soil profile of virgin and arable variants throughout the whole profile almost does not change. So, if in the upper horizon this indicator is 6.5, in the lower horizons it reaches up to 8.1. Approximately the same result is observed in cultivated soil variants (Fig. 1, 2).

Uncultivated chernozems are characterized by high absorption capacities [5-7].

One of the most important factors of soil fertility is its humus state. In order to find ways to regulate the humus state, detailed studies of the content, composition and chemical properties of humus in chernozems are necessary, and the influence of human agricultural activity on soil humus should be studied.

The humus state of soils is greatly influenced by anthropogenic factors, the level of cultivation, etc. [8-11].

According to literature data, there is a progressive loss of humus in arable soils.

In this regard, studies of humus state of mountainous soils of Armenia are of great importance, aimed at developing methods of preservation and accumulation of humus in the soil.

According to the indicators developed by Grishina and Orlov (1977), we evaluated the content, reserves and state of humus substances in chernozems and their changes under the influence of anthropogenic factors [12].

Our studies have shown that the amount of humus in arable soils is naturally decreasing. Its content in horizon A in virgin soils varies from 9.2 to 12.1 % on average (Fig. 1).

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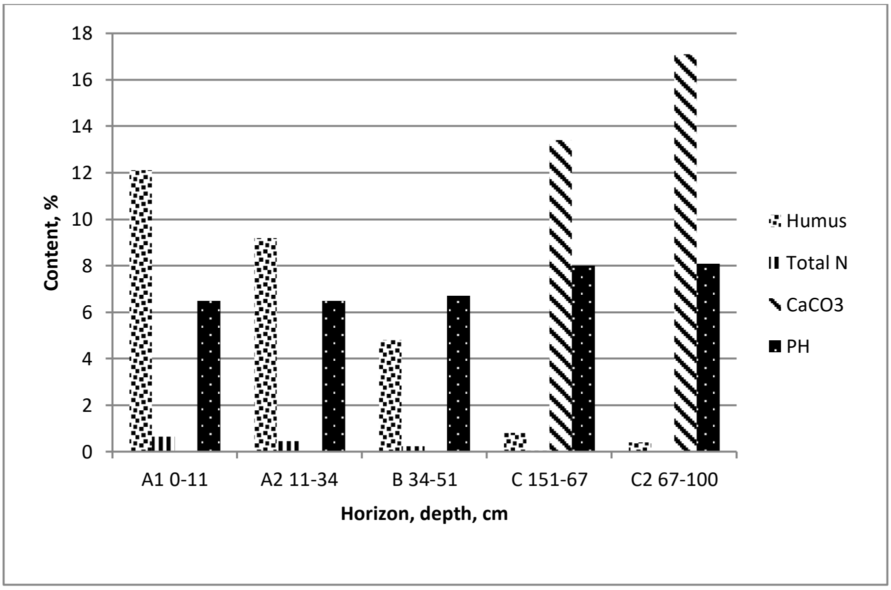

Fig. 1. Physical-chemical parameters of chernozems, Tselina (virgin land)

Under long-term plowing the humus content in the arable layer decreased to 7.4 % (to the average level). At the same time, its insignificant decrease in general was observed throughout the whole profile (Fig. 2).

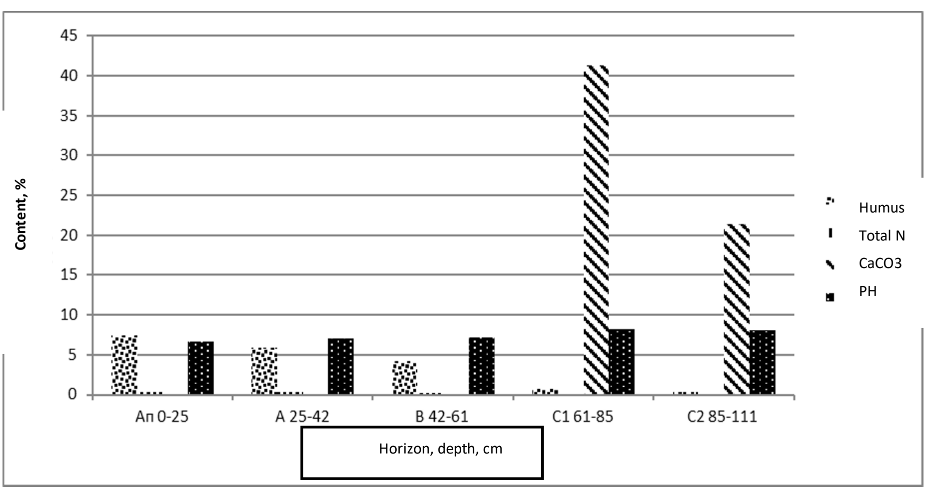

Fig. 2. Physical-chemical parameters of chernozems, Arable land

The absorbed complex of the studied soils is saturated with bases. The main elements are calcium and magnesium, the sum of which in the upper horizons of virgin chernozem varies in the range of 57.0-66.0 mg-eq per 100 g of soil. The sum of absorbed bases down the profile decreases in accordance with the reduction of humus content. Among the absorbed bases, exchangeable calcium predominates. Absorbed magnesium in the upper horizons of virgin soil is 8.0 mEq per 100g of soil. In the lower horizons the content of this element is somewhat less (3.4 mEq per 100 g of soil on virgin lands and 1.4 mEq on arable land), which, apparently, is related to the mineralogical composition of soils. The content of absorbed sodium is insignificant (1.0-2.1 mEq per 100 g of soil) (Fig. 3).

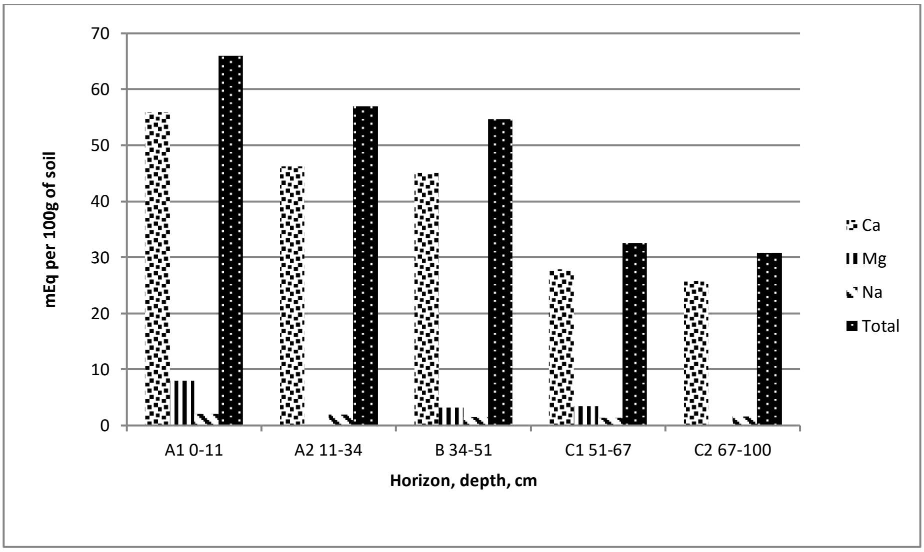

Fig. 3. Absorbed bases of chernozems, Tselina

In arable soils there is a noticeably decreased absorbed base, which is clearly visible in the arable horizon, where this index decreases to 52.8 mgEq per 100 g of soil (Fig. 4) [13-19].

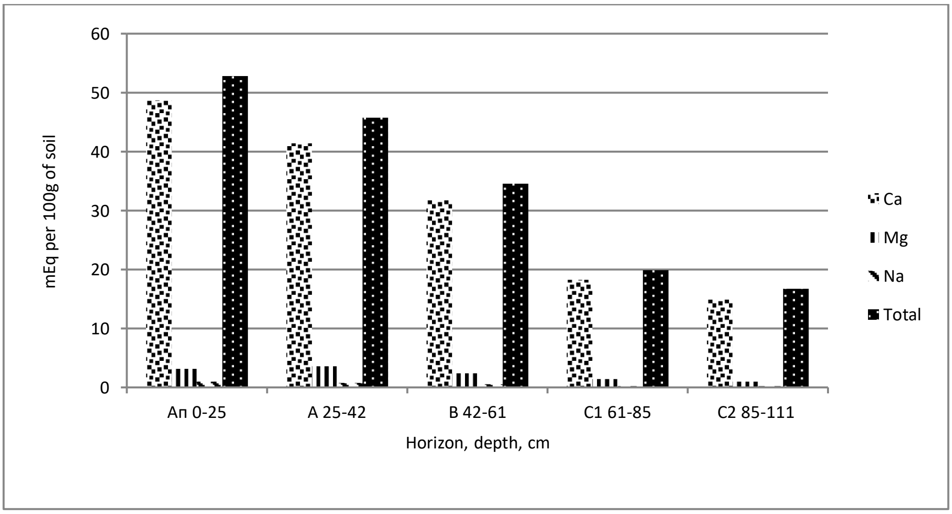

Fig. 4. Absorbed bases of chernozems, Arable land

These data are close to the results of other authors [19-25].

Thus, the results of the study of physical and chemical properties of mountain chernozems, as well as the analysis of anthropogenic impact of soils give grounds to assert that long-term and unsystematic use of soils leads to some deterioration of their physical and chemical properties. Especially absorption capacity decreases due to reduction of such important bases as absorbed calcium and magnesium. It should be noted that from the characteristics of chernozems it is clear that these soils have high natural fertility and with skillful and correct use it is possible to obtain high and stable yields of agricultural crops.

4 Conclusions

1. Soils of mountain chernozems are characterized by high absorption capacity. Calcium and magnesium predominate in the composition of exchangeable cations.
2. There is a decrease in the amount of calcium and magnesium in arable areas.
3. Humus content in untilled chernozems is rather high.
4. In cultivated soils, there is a significant decrease in its content.
5. To maintain a positive balance of calcium and magnesium, it is necessary to apply calcium containing organic and mineral fertilizers.
6. In order to maintain a positive balance of humus, it is necessary to follow sowing and apply organic fertilizers.
7. To improve the physical and chemical properties of mountain chernozems, it is necessary to take reclamation measures.

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