Influence of an anthropogenic factor on changes in the content and composition of humus in chernozems of the lake Sevan basin of the republic of Armenia

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Abstract. The article analyzes the results of research on the impact of anthropogenic factors on the changes in the content and composition of humus in chernozems . The studies showed that the amount of humus in arable soils consistently decreases. It was found that its content in the "A" horizon of virgin soil averages from 6.1 to 9.9%. It was determined that with prolonged plowing, the humus content in the arable layer decreased to 5.6% (to an average level). In a consistent pattern, there is also a decrease in the content of total carbon and nitrogen in arable variants. Research shows that as the humus content decreases, the amount of humic acids (HA) also decreases. It was found that with the depth of the profile, the relative content of HA (% of total C) decreases, while fulvic acids (FA) increase, and the type of humus transitions from fulvate-humate in the "A" and "B" horizons to humate-fulvate in the "BC" and "C" horizons. It was established that prolonged and unsystematic agricultural use of chernozems led to a decrease in humus content and a change in the qualitative composition of humus. Throughout the profile, these changes are expressed in a decrease in the total amount of humic acids, fulvic acids, and non-hydrolyzable residue.

1 Introduction

In the Republic of Armenia, chernozems usually occupy altitudes between 1300-2450 meters above sea level. They are found in large masses in the Lake Sevan basin. Here, they mainly occupy the western part of Lake Sevan at altitudes between 1910-2400 meters. On gentle slopes, parent materials are mainly represented by deluvial non-carbonate loams and clays. In more level conditions, soils most often develop on eluvial-deluvial clays and loams, underlain by thin layers of volcanic scoria-clastic or dense lava rocks. Currently, due to the widespread use of old methods of soil cultivation and irrigation, the issues of preserving and enhancing the fertility of chernozems are very acute. Chernozem soils, under prolonged and unsystematic agricultural use, undergo significant changes towards

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deterioration. Currently, the most important factors contributing to the deterioration of chernozems in the Republic of Armenia are changes in their humus state. Humus plays a primary role in creating soil fertility. The humus state of soils is greatly influenced by anthropogenic factors, the level of cultivation, etc. Naturally, this has a negative impact on soil fertility and crop yields.

2 Materials and methods

The research material was the soils of the chernozems 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 soil options. To study soils in nature, establish boundaries between different soils, and take soil samples for analysis, soil sections were laid.

To determine the location of the cuts, the "key" method was used. Soil sections are laid in similar areas of the relief, down to the depth of the parent rock, which are described and classified. On loose parent rocks, the depth of soil sections reaches up to 1-1.5 m, and in dense rocks they have relatively shallower depths. In such places, the cutting depth usually reaches the parent rock. [1].

Soil samples were taken from the main sections along genetic horizons and, if necessary, from half-sections. Selected soil samples are transferred from the field to the laboratory, where the samples are dried (in an air-dry state), then in an air-dry state, the samples are crushed and passed through a 1.0 mm sieve. After this, the resulting fine earth is used for various analyses.

Laboratory work was carried out in the laboratory of the National Agrarian University of Armenia using generally accepted methods in soil science. Under laboratory conditions, the following were determined: humus content according to the Tyurin method, group and fractional composition of humus according to Kononova and Belchikova [2-4].

3 Results and Discussion

Chernozems (Chernozems) - soils with a thick black and high-humus upper horizon, were identified by Dokuchaev in 1883 as “zonal” soils of tall-grass steppes of a continental climate in Russia. Chernozems correlate with the following soils: Calcareous Black Soils Kalktschernoseme (Germany), Eluviated Black Soils (Canada), Chernsols (France), Chernossolos (Brazil), Mollisols (USA), Chernozems (FAO) [5].

Depending on the water-thermal and altitudinal-geomorphological conditions of the environment, as mentioned above, three subtypes of chernozems are formed: chernozems leached, chernozems typical and chernozems carbonate.

Below, in general terms, the most determining conditions for the formation, characteristic features, methods and degree of industrial use of chernozems are given.

In the Republic of Armenia, Chernozems usually occupy between altitudes of 1300-2450 m above sea level. They are found in large massifs in the Lake Sevan basin. Here they mainly occupy the western part of Lake Sevan between altitudes of 1910-2400m.

On gentle slopes, the source rocks are mainly represented by colluvial non-carbonate loams and clays. In flatter conditions, soils most often develop on eluvial-deluvial clays and loams, below which thin volcanic cinder-clastic or dense lava rocks underlie. Carbonation of parent rocks in a given subzone primarily depends on the composition of the bedrock. Source rocks, which develop from weathering products of basic rocks, are usually enriched in carbonates. The indicated soil-forming rocks are found in significant masses in the territories in the upper zone of the Sevan basin. In the form of small massifs, mountain

Chernozems develop on alluvial-lacustrine pebbles, lava basic dense rocks, tuff lavas and on thin crushed stone-sandy deposits of acidic rocks. When soils form on weathering products of basic lava rocks, carbonates mainly accumulate in the upper part of the parent rock and in the illuvial-carbonate horizon [6-8].

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

The humus status of soils is greatly influenced by anthropogenic factors, the level of cultivation, etc. (Orlov D.S. et al., 1988; Akhtyrtsev B.P. et al., 1987; Medvedev V.V., 2008).

According to literature data (Orlov D.S., et al. 1981), a progressive loss of humus occurs in arable soils. In this regard, studies of the humus state of mountain chernozems in Armenia, aimed at developing methods for preserving and accumulating humus in the soil, are of great importance.

Using the indicators developed by Grishina and Orlov (1977), we assessed the content, reserves and state of humic substances in chernozems, and their changes under the influence of anthropogenic factors.

Our research has shown that the amount of humus in arable soils is naturally decreasing. Its content in horizon A in virgin soil varies on average from 6.1 to 9.9% (Figure 1) [9-13].

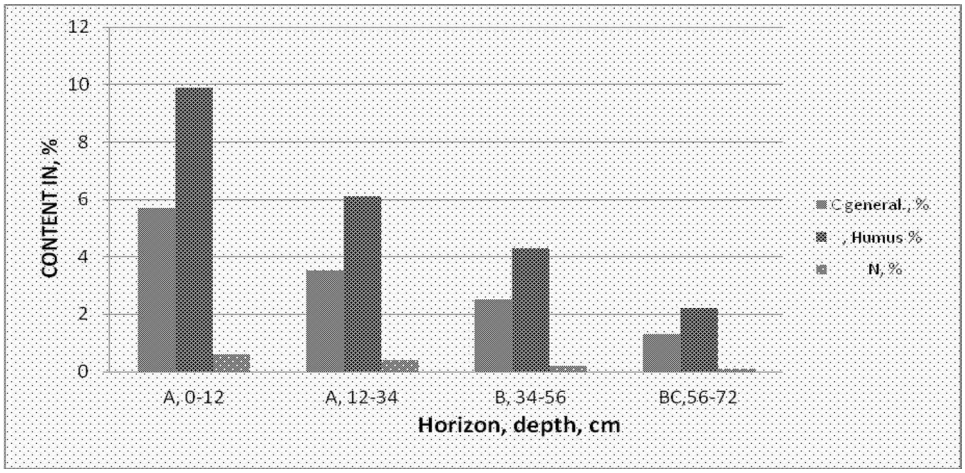

Fig. 1. Humus content chernozems, virgin soil.

With prolonged plowing in the arable layer, the humus content decreased to 5.6% (to the average level). (Figure 2).

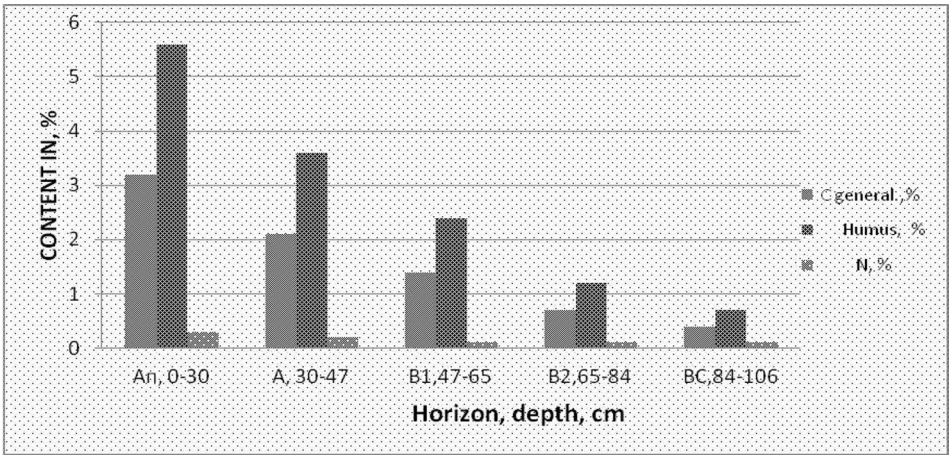

Fig. 2. Humus content chernozems, arable soil.

At the same time, a slight decrease was generally noted throughout the entire profile.

The loss of humus reserves in this layer is 10.7%. With long-term agricultural use, the level of soil humus reserves decreased by one order of magnitude, from high to medium. With the depth of the profile, reserve losses gradually decrease.

Naturally, in arable variants there is also a decrease in the content of total carbon and nitrogen. Humic substances of chernozems are characterized by an average enrichment with nitrogen. The C:N ratio in the "A" horizon of virgin soil is 9.5. On arable land, this ratio expands somewhat - to 10.7; in terms of the enrichment of humus with nitrogen, it remains within the gradation of virgin soils [14-18].

As a result of the study, it was established that, as in various subtypes of virgin soils, virgin and arable soils differ from each other in the qualitative composition of humus.

The degree of humification of chernozems is assessed as average. With the same fulvic-humate type of humus, the value of the ratio of SHA to SfK (depth of humification) in the "A1" horizon is 2.7, in the "A_2" horizon, respectively, 1.8 (Figure 3).

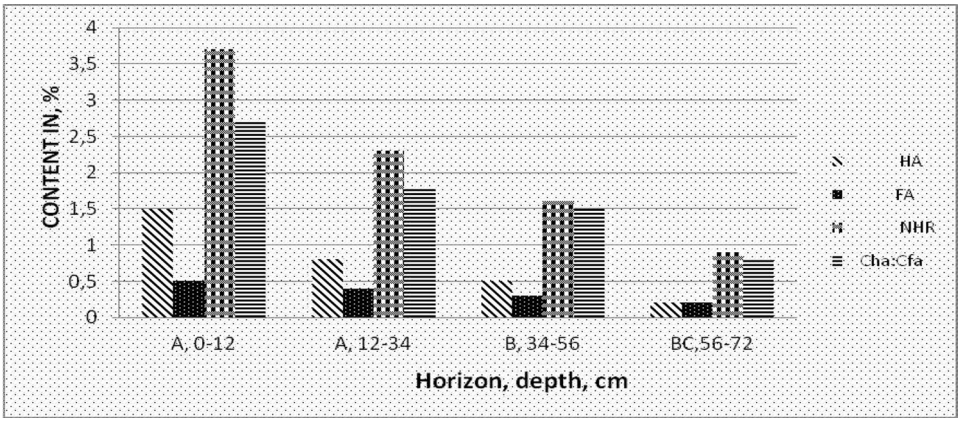

Fig. 3. Composition of humus chernozems, virgin soil.

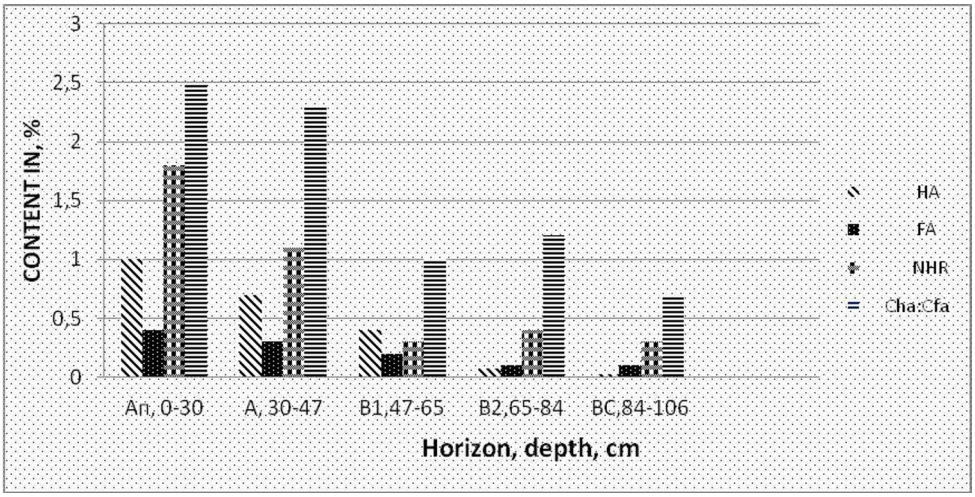

Fig. 4. Composition of humus chernozems, arable l soil.

The data in Figures 1-4 show that with a decrease in humus content, the amount of humic acids (HA) also decreases. It has been established that with the depth of the profile the relative content of HA (% of Total) decreases, and fulvic acids (FA) increases, and the type of humus from fulvate-humate in horizons "A" and "B" turns into humate-fulvate in horizons BC and with [18-23].

Chernozems are characterized by a high HA content. The content of HAs, free and bound with mobile R_2O_3, in the "A" horizon of virgin soil is 1.5% of the total mass of the soil. With depth along the profile, the HA content decreases in the BC horizon and is almost absent in the C horizon, amounting to 0.07-0.03%. According to Ponomarev et al., this phenomenon is explained by the migration of calcium humates along the profile. According to Orlov, such redistribution along the soil profile of chernozems is a consequence of the profile distribution of calcium salts. The deep layers of the profile are saturated with calcium and, due to the usual chemical reactions of the exchange decomposition of free HAs, turn into calcium humates.

During agricultural use, a significant change in the qualitative composition of humus chernozems has been established. Throughout the profile, these changes are expressed in a decrease in the total amount of HA, FA and non-hydrolyzable residue (NHR). The composition of humus and its quantity in the upper layers of soil are especially subject to change.

There is also a decrease in the amount of HA carbon in both fractions. Particularly noteworthy is the sharp decrease in the content of labile HAs in the Apax horizon. chernozems, which is an indicator of the intensity of new humus formation and, to a large extent, determines the level of soil fertility. The loss of humus reserves occurs due to NHR, HA and FA. With the noted changes, the value of the Cha: Cfa ratio changes slightly, and the type of humus remains the same [24-26]..

With long-term and unsystematic agricultural use, a significant change in the qualitative composition of humus chernozems has been established. Throughout the profile, these changes are expressed in a decrease in the total amount of humic acids, fulvic acids and non-hydrolyzable residue. The composition of humus and its quantity in the upper humus-accumulating soil horizons are especially subject to change. There is also a decrease in the amount of humic acid carbon in both fractions. Particularly noteworthy is the sharp decrease in the content of labile humic acids in the Apach horizon. chernozems, which is an indicator of the intensity of new humus formation and largely determines the level of soil

fertility. The loss of humus reserves in chernozems occurs due to humic acids, fulvic acids and non-hydrolyzable residue.

Thus, the deterioration of the humus state of cultivated soils during long-term and unsystematic agricultural use necessitates the adoption of measures for the expanded reproduction of their fertility, including the application of 70-80 t/ha of organic and 200-250 kg of mineral fertilizers. At the same time, it is necessary to increase the proportion of perennial grasses in crop rotation, carry out plowing and all types of other treatments during the period of soil ripeness. If possible, minimal or no-tillage will be used in the adaptive landscape farming system.

4 Conclusion

- Chernozems soils are characterized by high humus content, good aggregation, and a high degree of base saturation.
- Humus formation in chernozems occurs with a predominance of humic acids over fulvic acids throughout the entire profile.
- The humus content in the humus-accumulative horizon of virgin soils was 9.9%, and in cultivated varieties it was significantly less than 5.6%.
- Long-term and unsystematic agricultural use of chernozems has led to a decrease in humus content and a change in the qualitative composition of humus. Throughout the profile, these changes are expressed in a decrease in the total amount of humic acids, fulvic acids and non-hydrolyzable residue.
- To increase fertility, it is necessary at the government level to develop a legal framework for the use of mountain chernozems, introduce a system of crop rotation and restore their productivity.

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