GEOGRAPHIC AND GENETIC FEATURES OF THE DEHUMIFICATION OF THE UKRAINE STEPPE ZONE SOIL

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Abstract

Comparative analysis of modern researches and materials of Ukraine steppe zone soil large-scale surveys, conducted by Professor Nabokikh O.G. in 1914-1915 years, showed the significant differences in the current humus state of soils as compared with the humus state in the beginning of the XXth century. At the same time, the data of modern agrochemical monitoring point to that there was a rapid decrease in the humus content in the soils of southwestern Ukraine in the 1990 to 2000 period, which was caused by a violation of the dynamic equilibrium between the intake of organic substances (a decrease in the norms of organic fertilizers) and the destruction of humus as a result of the agricultural use. At the present time, the new quasi-equilibrium humus state of the soils has been formed in accordance with modern agro-ecological conditions.

Keywords: agricultural use of soils, chernozems, dehumification, Ukraine

INTRODUCTION

The research task was to establish the geographical features of the humus content change in the soils of the Ukraine Steppe zone during the industrial period (from 1914th to the present time). The research task included studying the influence of both zonal and local factors on the transformation of the humus state of soils in agricultural and non-agricultural lands, establishing the factors of dehumification depending on the genetic features of soils, and the researching of transformation of the physical and physicochemical properties of soils interconnected with the humus state.

The data of modern agrochemical monitoring point to that there was a rapid decrease in the humus content in the soils of southwestern Ukraine in the 1990 to 2000 period, which was caused by a violation of the dynamic equilibrium between the intake of organic substances (a decrease in the norms of organic fertilizers) and the destruction of humus as a result of the agricultural use. At the present time, the new quasi-equilibrium humus state of the soils has been formed in accordance with modern agro-ecological conditions [1, 2].

MATERIAL AND METHOD

Cartographic, comparative-geographic and comparative-analytical methods have been used in order to establish the geographical features of the dynamics of the soils humus state in the steppe zone of Ukraine. The materials of large-scale soil surveys of 1914-1915 years, conducted under the guidance of Professor Nabokikh A.G. (3-mile topographic map with marks of soil selection sites on it and humus content percentage) and soil samples selected in 2005 and 2006 years on two key-profiles (routes) laid in the steppe zone of Ukraine have been used for a comparative analysis of humus content in soils in the beginning of the XXth and XXIst centuries. The first key-profile is Odesa-Petrivka, situated on the territory of the Limans`kiy region of Odesa oblast (fig. 1 & 2) was laid along the road (Starokievs`ke highway) from Odesa (4 km from the Black Sea till the Petrivka village, that is 54 km from the sea); it crosses three river valleys and several narrow watersheds in southern part of the middle Steppe and one river valley and a wide watershed on the border of the middle and northern Steppe.

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Fig. 1 Key-profiles of "Odesa-Petrivka" and "Odesa-Kubanka"

The second key- profile was laid in the territory of the Limans`kiy and Ivanivs`kiy regions of Odesa oblast along the railway from Odesa (it is 8 km from the Black Sea till the Kubanka village, that is 52 km from the Black Sea), it also crosses several narrow watersheds in the Dry Steppe, and it crosses a river valley and a wide watershed in the subzone of the middle Steppe as well. The points of selection coincided with the points shown on Professor Nabokikh A.G. 3 miles topographic map. The depth of material sampling for analysis was the arable layer of the soil. The determination of humus content in modern studies was done by Tyurin`s method with Simakov`s modification in mixed soil samples. The content of humus in soils in the beginning of XXth century, borrowed from Professor Nabokikh A.G. cartograms, was determined by Gustavson's method [3]. Taking into account that the content of organic carbon in humus is taken in an amount of 58% of the total mass of humus (1 g of carbon corresponds to 1.724 g of humus) by the Tyurin`s method and by Gustavson's method, it can be stated the identity of these methods from the results of the studies.

Genetic features of the humus state of soils and processes of dehumification were investigated in 2011-2016 years at 5 key sites in Rozdil`na region, Maloyaroslavets village, Molodizhne village, Gluboke village, Izmail town (subzones of the northern and middle steppes with common and southern chernozems), as well as certain soil crossovers within the Limans`kiy region of Odesa oblast.

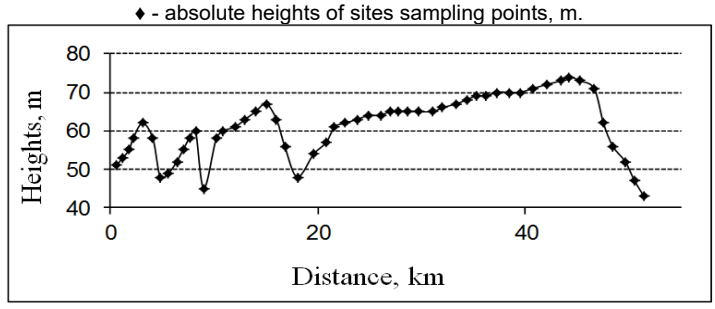

Fig. 2 Vertical profile of the route "Odesa-Petrivka"

RESULTS AND DISCUSSIONS

The humus amount in the Ukraine southern steppe zone chernozems of the over the last 100 years has decreased by approximately 25-40%. Humus content in soils of Odesa-Petrivka key- profile (fig. 3) has decreased in absolute values by 0.5-3.0%. At the same time in the beginning of the XXth century the number of

soil sections in which the humus content was less than 3.5% wastened, and the number of sites where the humus content was 3.5% and more was forty-three, then at the beginning of the XXIst century this number was thirty and twenty-three.

The humus amount in soils has decreased on average by 1.0-2.0%. In Odesa-Kubanka key-profile (fig. 4). In this case, the number of soil sections where the humus content was less than 3.5% at the beginning of the twentieth century was three, and areas with a humus content of 3.5% and more was thirty-eight.

At the beginning of the XXI-st century the number of sites with a humus content of less than 3.5% had been increased by 4.7 times, and with a content of more than 3.5% had decreased by 1.4 times.

▲ - humus content (%) in soils at the beginning of the XXth century.
■ - humus content (%) in soils at the beginning of the XXIst century

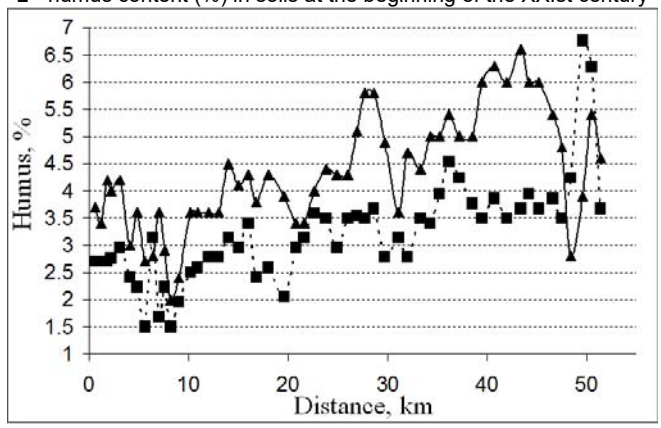

Fig. 3 Content of humus in soils of Odesa-Petrivka key-profile.

▲ - humus content (%) in soils at the beginning of the XXth century
■ - humus content (%) in soils at the beginning of the XIst century

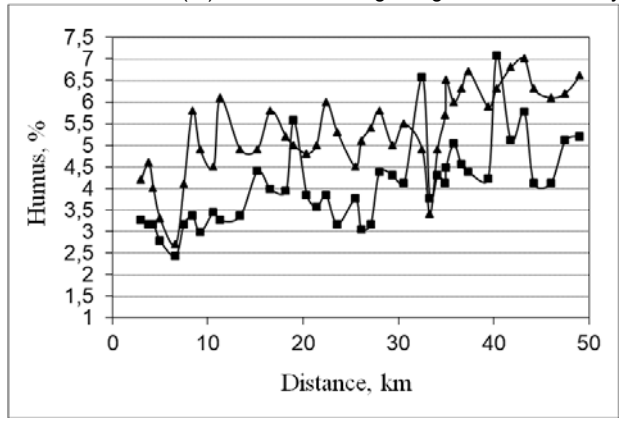

Fig. 4 Content of humus in soils of Odesa-Kubanka key-profile

In both cases, the decrease in humus content was mostly observed in automorphic soils, that is the chernozems of the southern wide watersheds in the northern part of the middle Steppe subzone, where the humus content has decreased by an average of 2.5% (from 6.0-6.5% to 3.5-4 0%). In the southern (coastal) part of the Steppe, the rate of dehumification under similar conditions is slightly less (from 3.4-4.2% of humus at the

beginning of the XXth century to 2.0-2.5% at the beginning of the XXIst century). The exception is several places on the key profiles of Odesa-Kubanka, which is a multi-year layland.

Geographical features of dehumification (it is more observed along the northern border of the middle Steppe and it is less observed in the south in the foreland) also showed the fact of leveling of the humus zoning, which was quite expressive at the beginning of the XXth century.

A consistent pattern in the variation of humus content in topographic low and river valleys, where there is a distribution of semihydromorphic and hydromorphic soils (the number of these places on both key profiles does not exceed 10% of the total number of points) has not been revealed. The decrease in the content of humus in meadow and meadow-chernozemic soils has almost not occurred, or its content has even slightly increased (in the meadow soils of the Balay river-valley at the Odesa-Petrivka key-profile and the Odesa-Kubanka key profile in the north of the middle Steppe subzone) .

Thus, the presented data indicate that, in the modern conditions, the chernozems of the southern aligned watershed spaces of the southern and northern parts of the middle Steppe are relatively more homogeneous by humus content than it was 100 years ago. On the other hand, these features indicate the different rate of dehumification of soils in separate subareas of the Steppe.

According to the indicators of environmental assessment of soils, proposed by S.V. Krokhin [4], plowing chernozems, irrigated chernozems and chernozems withdrawn from irrigation have more optimal qualitative indices of the humus state of soils (Table 1).

Table 1 Assessment of the ecological status of the chernozems in the southern humus state (layer 0-20 cm)

Name of soil	Humus content, %	Stocks of humus, t/ha	The content of the passive form of colloidal humus (PH), %	The content of the active form of colloidal humus (AH), %	The degree of humus activity, AH/PH×100, %
Southern black soil, arable land	2,76 Satisfactory	68,3 satisfactory	1,99 unsatisfactory	0,77 unsatisfactory	39 optimal
The southern chernozem, 40-year-old lealand	4,16 Medium	94,6 satisfactory	3,62 optimal	0,54 unsatisfactory	15 unsatisfactory
Southern chernozem, derived from irrigation	2,47 Satisfactory	60,0 satisfactory	1,63 unsatisfactory	0,84 unsatisfactory	51 excellent

It was found by the humus state and the processes of dehumification studies depending on the genetic features of the Steppe of Ukraine soils, that the trend of accumulation of humus is gradually decreasing in the following sequence: ordinary chernozems, ordinary mycelial calcareous chernozem, southern chernozems, southern post-irradiation chernozems and southern calcareous chernozems. Similarly, the parameters of the qualitative composition of humus are changing: the ratio of Сгк:Сфк, the degree of humification, the condensation of humic acid molecules, the stability of humus are narrowed.

Intensive agricultural use of soils affects the qualitative properties of humus: the solubility of humic substances increases, the activity of colloidal humus increases and the condensation of humic acid molecules promotes "rejuvenation" of humus. Cultivation of chernozems is accompanied by a decrease in the total humus content in the arable layer, it is accompanied by a decrease in the content of passive and an increase in the content of the active form of colloidal humus.

CONCLUSIONS

1. The amount of humus in chernozems of the southern steppe zone of Ukraine has decreased by approximately 25-40%. Over the past 100 years. The largest losses of humus are in ordinary chernozems and southern chernozems in the middle steppes along the northern border, in which the decrease in humus content during 100 years is 40%, and the lowest losses of humus are in the south of the middle-steppe subzone, where the southern chernozems have lost about 25% of humus.

2. Humus losses are not observed in soils of hydromorphic landscapes.

3. Cultivated soils with a lower humus content in the plow layer have a greater degree of humus activity, revealing their best ecological state.

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