UDC 631.434.6 / .417.2 / .431.1

Yu. Kravchenko,
Ye. Berezhniak,
candidates of agricultural sciences
A. Matviyiv
National University of Life and Environmental Sciences of Ukraine
S. Jan,
Yu. Chen,
T. Sun
North East Institute of Geography and Agroecology of the Chinese Academy of Sciences

Agrophysical properties of typical black earth and isohumusole at different techniques of their cultivation

Goal. Show changes in the content of humus, agrophysical properties of the typical black soil and isohumus of the temperate zone of the forest-steppe zone in different technologies of their use in the subzone of broadleaf forest-steppe (Ukraine) and Prairie (China). Methods. Field: core, breeding sample; laboratory: gravimetric, sieve, oxidimetric; statistical - dispersion analysis. Results Changes in parameters of humus, composition density, structural and aggregate state of chernozems in various soil cultivation technologies have been established. Conclusions The investigated chernozems are characterized by optimal and close to optimal agrophysical properties for growing corn on grain. The use of no-till on isogumbulose and shallow planar cultivations on typical chernozem contributed to the formation of a less densely, more humus layer of 0-20 cm, an increase in the content of agronomically valuable airborne and water-resistant aggregates. For plowing, the best humusoon accumulation in the layer of 10 - 20 cm typical black soil occurred, a less densified layer of 0 - 10 cm isohumulous was formed, more micro aggregates <0.25 mm were formed for dry and wet sifting.

Key words: chernozem, soil cultivation, humus, aggregate density, aggregates.

Chernozem is the national wealth of Ukraine [5]. Chernozem and black soil-like soils are also found in the plains of North America and southern Canada, the Pampas of South America, the foothills of the Transcaucasus and Transcaucasus in the north-eastern China [26]. The total area of the Chinese black earth is 1.24 × 106 km2, 54.5% of which are located in the Heilongjiang Provenance [25].

All of the black earths of the world are characterized by good structurism, having a depth of the geometrical horizons 18-25 cm for the surface, 10-25 cm for the upper transition and> 75 cm for the lower transition to the horizon, containing at least 1% humus, the degree of saturation of soils in the bases exceeds 50% throughout the profile [24, 30].

The peculiarities of the structure and properties of black earths are caused by regional pedogenesis and local processes of soil formation. Differences between chernozems, formed in different natural-geographical conditions, are well reflected in physical properties.

The physical state of the soil and the content of humus in the zone of placement of the main mass of the root system of plants in agrocentoses depend to a large extent on the methods of soil cultivation [23, 32, 34]. Traditional methods of cultivation with excessive loosening of the upper layer of soil result in enhanced mineralization of the organic matter of the soil, deterioration of the quality of humus, the reduction of the number of aggregates [29], the emergence of degradation phenomena in soils [17, 27, 31]. With the decrease in the depth of the treated soil layer for unploughed (planar) cultivation, the content of water-proof aggregates [14, 18] increases and their occlusion with humus substances [20], the optimal correlation between density and porosity is maintained, similar to virgin soils [14, 22, 33] increases permeability [35]. However, the application of minimal cultivation on weakly structured soils of light granulometric composition has the risk of increasing the density of assembly, reducing porosity and permeability through the formation of a plow sole in the upper part of the arable horizon.

Taking into account the relevance of the study of the physical parameters of soils and their role in the theoretical substantiation of soil cultivation systems, we have fixed field experiments and performed laboratory analyzes to determine the agrophysical indices of blacklands of Ukraine and China.

The purpose of research. To establish changes in the content of humus, agrophysical properties of the typical black earth and isohumus of the temperate zone of the forest-steppe zone in different technologies of their use in the subzone of broad-leaved Forest-Steppe (Ukraine) and Prairie (China). The typical Chernozem of the Right Bank Forest-steppe of Ukraine and the Kitas "black soil", which according to the classification corresponds to the order of consistency, is chosen as isohomusol, the subordination of udic isohumasol, and the hapli-udic isohumasol group respectively to the taxonomic classification of soils (ST) [19] or to the large group of "black soils" - according to the Genetic classification of soils in China (GSCC) [21]. The international analogues of the Chinese black soil are phaeosis (haplic-luvic Phaeozems; WRB, FAO) [6], mollisols (udoll Mollisols; USA), brunosoli (Brunosols, argentina) [16], blackheads (Chernossolos Argilúvicos, Brazil) [12], black earths were drained (Ukraine, Russia). The investigated Chinese soil is characterized by a transient ustic-udic humidification regime [28]. In the article the words: isogimusol, black soil and black earth are used as synonyms.

Materials and methods of research. Experimental studies in Ukraine were conducted under the conditions of the NUPi of the NUBiP of Ukraine "NDG Velykonityns'ke" of the Fastovsky district of the Kyiv region during 2010 - 2013 on the chernozem typical in the stationary experiment Department of Soil Science and Soil Conservation MK Chics The agricultural crop in the year of the study was maize for grain. Short-term crop rotation had the following alternation of crops: soybeans - winter wheat - corn for grain - spring barley. In the crop rotation, 3 variants of the main soil treatment were studied: traditional (CT), which was based on a plow plow at a depth of 25-27 cm; soil protection (DT) - on a multi-depth, non-polar (planar) cultivation of 25-27 cm; Soil protection (RT) - on a milky, non-polar (planar) cut on 10-12 cm. The norm of fertilizing per 1 hectare of crop rotation area - manure, 12 t / ha + + N50P45K45.

Field studies of chernozem of China were carried out in 2010-2011 under the conditions of the Hailounu Science and Monitoring Station (47 ° 26'N, 126 ° 38'E) in the Heilongjiang Province of the Northeastern Institute of Geography and Agroecology of the Chinese National Academy - my sciences. The agricultural crop in the year of the study was maize for grain. The crop rotation consisted of 2 crops: soybeans and corn for grain. In the experiment, 3 soil tillage systems were studied: no-till (NT), unplaced (planar) cultivation of 25-27 cm (RT) and traditional tillage at a depth of 27-30 cm (CT) with crests forming a whitish 25 cm. Mineral fertilizers were introduced to a depth of 10 cm during corn sowing in the normal N69R51, 75K15 + feeding of N69 in a worm in the phase of 3 true leaves.

Samples of soil for conducting research were selected according to the current standard DSTU 4287: 2004 [10]. The soil density was determined according to DSTU ISO 11272 - 2001 [9]; the content of moisture - DSTU ISO 11465 - 2001 [8], the total content of humus - according to DSTU 4289: 2004 [11], the separation of the average soil sample in a dry state on the fraction of macro aggregates - according to DSTU 4744: 2007 [7], the division of the average sample in water on the fraction of water-proof macro aggregates - on the device I.M. Baksheyev [1] for typical black earth (CHT) and on the device DIK-2001, Daiki Rika Kogyo Co. Ltd., Japan for isogumous (IG) [13]. According to the results of sifting the soil in a dry state, the coefficient of soil texture Kstr according to the formula:

……

where A - content of macro aggregates in the size 0,25 - 10,00 mm,%; B - the sum of the contents of macro aggregates of soil with a diameter greater than 10.0 mm and aggregates smaller than 0.25 mm,%. The reliability of the results was determined by means of a dispersion analysis. The main parameters of Ukrainian and Chinese chernozem are given in Table. 1.

1. Parameters of the properties of chernozem typical and isozamoimus at the time of laying the field experiment

Results of research. The density of the studied soils was optimal for the cultivation of maize on grain [4] and depended on the depth of the soil layer and cultivation techniques (Fig. 1). The smallest values of

density were recorded for RT (1.28 g / cm3) in CT and CT (1.16 g / cm3) in IG in the layer 0-10 cm and RT (1.31 g / cm3) in CHT and NT (1.21 g / cm3) in IG in the layer 10 - 20 cm (Fig. 1a, b).

Both studied black earths have a humus-accumulative type of profile with a post-diminution of the content of organic matter of the soil to the rock (Table 1). Redistribution the content of humus in the IG did not change significantly in CT and RT and decreased by 0.53% in the lower horizon by 10-20 cm behind NT (Fig. 2). In CW with a high content of organic matter, the soil decreased by 0.21, 0.51 and 0.77% for CT, DT and RT, respectively. The best humus accumulation in the layer 0 - 20 cm was observed for flat soil cultivation and no-till.

The analysis of the structural state showed good structure [3] of black earth typical of all tillage technologies (Table 2). A similar pattern was observed in the Chinese black soil, with the exception of a layer of 10 - 20 cm in the variant with a plow where Kstr was 0.9, which corresponds to satisfactory parameters. IG in comparison with TT was characterized by a larger content of bryoles> 10, macro aggregates - 5-10 mm and less - <0.25 mm of dusty microaggregates. By classification SI Dolgova and P.U. Bakhtin [2], the content of agronomically valuable aggregates in the size of 0.25 - 10 mm in NT is estimated as good; replaceable - for DT and NT - in a layer 0 - 5 cm, satisfactory - for CT in the layer 10 - 20 cm and good for all other cultivations and depths - in IG (Table 2).

The structural composition of soils based on the content of water resistant aggregates> 0.25 mm was characterized as good, ranged from 54.84 to 66.78% and was the highest in RT in CHT and NT in IG. The most water-resistant aggregates accumulated in fractions: 0.5-10 mm - for NT, <0.5 mm for CT - in IG; 0.5 - 10 mm for DT, 1-5 mm and <0.5 mm for CT, 0.5 - 1.0 mm for RT - for CT (Fig. 3). The total content of all small fractions <0.25 mm was the highest for CT: 37.84% for TH and 45.16% for IG. The content of aggregates 5 - 10, 2-5 and 1 - 2 mm fractions did not have a statistically significant difference in the chernozem of the type and increased from large to small fractions in izogumulsol. The ratio of fractions of contents of aggregates in the size of 0,25-10 mm to the smallest fraction <0,25 mm was 1,21, 1,66 - for CT, NT in IG and 1,64, 1,87, 2,01 - for CT, DT and RT in the CT, respectively.

2. Structural and aggregate state of chernozem typical depending on methods of cultivation of corn on grain, in% to the mass of dry soil

Conclusions

The investigated black earths are optimal and close to optimal agrophysical properties for growing corn on grain. Isogimusol compared to typical black soil was characterized by a lower aggregate density, a higher content of hummus, airborne aggregates> 5 mm, water resistant micro aggregates <0.25 mm. Soil cultivation technologies have changed the parameters of density, humus, structural and aggregate state of soils. Untreated soils and no-till cultivation technologies contributed to a better humus accumulation of the upper layer of 0-10 cm and the formation of a larger number of agronomically valuable (for dry and wet sieving) aggregates in the size of 10 - 0.25 mm. The best parameters of agrophysical properties ensured a shallow, flat-cut cultivation on CH and no-till on IG. The application of plowing on the TT positively influenced the formation of humus in a layer of 10 - 20 cm (3.43% for CT against 3.41 and 3.21% for DT and RT), reducing the abscissiness of airborne aggregates> 10 mm (6,9% for CT against 8.2 and 10.6% for DT and RT) in the 0-5 cm layer. CT in the IG did not have any advantages over RT and NT.

Bibliography

1. *Вадюнина А.Ф.* Методы исследования физических свойств почв/А.Ф. Вадюнина, З.А. Корчагина. — М.: Агропромиздат, 1986. — 416 с.

2. *Долгов С.И.* Агрофизические методы исследования почв/С.И. Долгов. — М.: Наука, 1966. — 259 с.

3. *Медведев В.В.* Структура почвы: методы, генезис, классификация, эволюция, география, мониторинг, охрана/В.В. Медведев. — Х.: «13 типография», 2008. — 406 с.

4. *Медведев В.В.* Плотность сложения почв. Генетический, экологический и агрономический аспекты/В.В. Медведев, Т.Е. Лындина, Т.Н. Лактионова. — Х.: «13 типография», 2004. — 243 с.

5. *Позняк С.* Чорнозем — національне багатство України/С. Позняк//Вісн. НТШ/Світова рада Наукових товариств імені Тараса Шевченка. — Львів, 2011. — № 45. — С. 49 – 51.

6. *Польчина С.М.* Основні типи ґрунтів у системі WRB: навч. посіб. Ч. 2/С.М. Польчина. — Чернівці: Рута, 2007. — 132 с.

7. *Якість* ґрунту. Визначання структурно-агрегатного складу ситовим методом у модифікації Н.І. Саввінова: ДСТУ 4744:2007. — [Чинний від 2008-01-01]. — К.: Держспоживстандарт України, 2007. — 15 с. — (Нац. стандарт України).

8. *Якість* ґрунту. Визначання сухої речовини та вологості за масою. Гравіметричний метод: ДСТУ ISO 11465 – 2001. — [Чинний від 2003-01-01]. — К.: Держспоживстандарт України, 2001. — 10 с. — (Нац. стандарти України).

9. *Якість* ґрунту. Визначання щільності складення на суху масу: ДСТУ ISO 11272 – 2001 — ДСТУ ISO 11272 – 2001. — [Чинний від 2003-07-01]. — К.: Держспоживстандарт України, 2001. — 15 с. — (Нац. стандарти України).

10. *Якість* ґрунту. Відбирання проб: ДСТУ 4287:2004. — ДСТУ 4287:2004. — [Чинний від 2005-07-01]. — К.: Держспоживстандарт України, 2004. — 10 с. — (Нац. стандарти України).

11. *Якість* ґрунту. Методи визначення органічної речовини: ДСТУ 4289:2004. — [Чинний від 2004-05-30]. — К.: Держспоживстандарт України, 2005. — 16 с. — (Нац. стандарт України).

12. *A Handbook* of Soil Terminology, Correlation and Classification; edited by P. Krasilnikov, Juan-José I. Martí, R. Arnold, S. Shoba. — 1 st ed. — Earthscan, 2009. — 448 p.

13. *A novel* soil wetting technique for measuring wet stable aggregates/T. Sun, Q. Chen, Y. Chen et al.//Soil and Tillage Research. — 2014. — V. 141. — P. 19 – 24.

14. *Aggregation* and soil organic matter accumulation in cultivated and native grassland soils/J. Six, E. Elliott, K. Paustian et al.//Soil Sci. Soc. Am. J. — 1998. — V. 62. — P. 1367 – 1377.

15. *Changes* in soil profile properties as affected by 44 years of continuous no-tillage/S. Mestelan et al.// Proc. 17th ISTRO Conf., 28 August — 3 September. — Kiel, Germany, 2006. — P. 1135 – 1140.

16. *Duran A.* An overview of South American Mollisols: soil formation, classification, suitability and environmental challenges/A. Duran//New advances in research and management of world Mollisols. — Northeast Forestry University Press, Harbin, 2010. — С. 31 – 45.

17. *Gilley J.* Tillage effects on soil erosion potential and soil quality of a former Conservation Reserve Program site/J. Gilley & J. Doran//Soil and Water Conservation. — 1997. — V. 52. — P. 184 – 188.

18. *Grandy A.* Aggregation and Organic Matter Protection Following Tillage of a Previously Uncultivated Soil/A. Grandy and G. Robertson//Soil Sci. Soc. Am. J. — 2006. — V. 70. — P. 1398 – 1406.

19. *Handbook* of Soil Sciences: Properties and Processes; edited by P.M. Huang, Y. Li, M.E. Sumner. — 2nd ed. — CRC Press, 2011. — 1442 p.

20. *Haynes R.J.* Stability of soil aggregates in relation to organic constituents and soil water content/ R.J. Haynes and R.S. Swift/J. Soil. Sci. — 1990. — V. 41. — P. 73 – 83.