ORGANIC MATTER AND ITS DISTRIBUTION IN STRUCTURAL AGGREGATES OF LEACHED CHERNOZEMS UNDER DIFFERENT LAND USE SYSTEMS

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Abstract

In this paper, we studied the distribution of organic matter in structural elements of leached chernozems from the Central part of the Republic of Moldova. It was established that the arable leached chernozems used in conventional agriculture lost on average 2.29% organic matter from the arable 0-12 cm layer, in comparison with the fallow soil. The 12-20 cm soil layer lost on average 1.78% of organic matter. The implementation of environmental-friendly farming practices has favored partial restoration of the organic matter content in these soils. Thus, in the arable 0-12 cm layer the organic matter content increased by 0.08% and in the next 12-20 cm layer - by 0.27%. Loss of organic matter in soils led to degradation of soil structure. Thus, the 0-20 cm arable layer of leached chernozems has a less favorable structure for plant growth; in the structure of the soil predominate blocky aggregates. Cultivation of the mixture of herbaceous and leguminous grasses during the 2007-2015 years led to the partial restoration of the quality of the structure, especially in the 10-20 cm layer of the soil. Leached chernozem under the fallow has an excellent structure, characteristic for natural soils. According to our results, the organic matter is not evenly distributed in the structural aggregates of the investigated soils.

Key words: aggregates, leached chernozem, organic matter, soil structure

The use of soils in agriculture is inevitably followed by negative changes in their quality status. The content of organic matter in the soil is an important indicator of its quality and fertility. Organic matter plays a primordial role in soil formation. It contributes to the union of soil particles in structural aggregates, formation of the agronomic valuable structure and creation of favorable conditions for plant growth and development. Humus contains the basic nutrients for plants (N, P, K, S, Ca, Mg) and various microelements, which in the process of mineralization become accessible to plants. Soil structure is a morphologic and agronomic soil index that distinguishes it from parent rock and influence its fertility. In the recent decades, this particularly important property has considerably degraded that resulted in soil compaction, low crop yields, and expansion of erosion processes on wide surfaces, not only in the Republic of Moldova but also around the world. Restoring soil fertility and sustainable use is the primary purpose of modern agriculture.

The use of cover crops, especially of perennial grasses, is well known as an effective and environmentally friendly method of soil quality improvement.

MATERIAL AND METHODS

The investigations were carried out in 2015-2016 under the project for young researchers financed by Academy of Sciences of Moldova. The research was conducted in the Central part of Moldova at the Experimental station of Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo" from Orhei district, Ivancea village. The objects of study were:

Leached chernozem under fallow (Fw), located in the buffer strip within the fields (*figure 1, point A*). The buffer strip was planted about 60 years ago. Our previous researches, made in the Balti steppe, showed that the period of 60 years is enough for restoration of chernozems' natural characteristics and properties (Ciolacu Tatiana, 2013). Thus, leached chernozem under the fallow located in the buffer strip was considered as soil standard in the current research.

Leached chernozem under conventional tillage (CT), a long-term arable chernozem that is being plowed for at least 60 years (*figure 1, point B*).

Leached chernozem under cover crops (CC). The plot was established by laboratory of Pedology of our Institute in 2007 in order to determine soil quality restoration under cover crops (*figure 1, point C*) in conditions of use of grass as forage. For this purpose, a mix of lucerne and ryegrass was sown.

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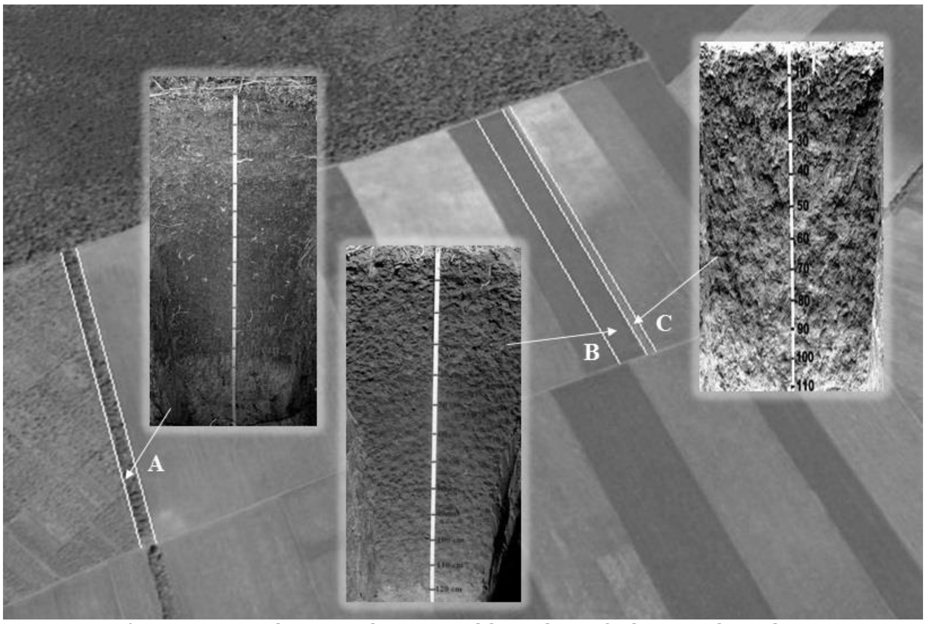

Figure 1 **Experience scheme and location of observation sites**

The experience is located in the hilly part of Codrii, in the Central Moldova. The site is situated in the absolute altitudes range of 150-250 m, in the warm, semi humid climatic zone of Center, subzone 1, which is characterized by the following climatic indices: the solar period - 300 days; duration of insolation – 2100-2150 hours; average annual temperature – 8.5-9.0°C; the sum of active temperatures (higher than 10°) – 3000-3150. Annual rainfall amount – 550-600 mm. Evaporability – 800-820 mm. Vegetation period – 178-182 days (Lungu Marina, 2010).

For soil analyzes were used approved methods: soil structure and aggregates hidrostability - Savvinov's method (Vadiunina A.F., Korceaghina Z.A., 1986), organic matter content after Tiurin (Sokolov A.V., 1975).

RESULTS AND DISCCUSSIONS

The content of organic matter in leached chernozems is in close dependence on the use of these soils. According to the results of our research, arable leached chernozems, being used for more than 60 years in conventional agriculture, lost on average 2.29% of organic matter from the arable layer 0-12 cm, compared to the fallow soil (*figure 2*). The next soil layer (12-20 cm) lost on average 1.78% of organic matter.

The implementation of environment-friendly practices conducted to the partial restoration of organic matter content in leached chernozem. Thus, the content of organic matter in the arable layer (0-12 cm) increased in the period 2007-2015 by 0.08% (about 0.01% annually) and in the next layer 12-20 cm – by 0.27% (0.03% annually).

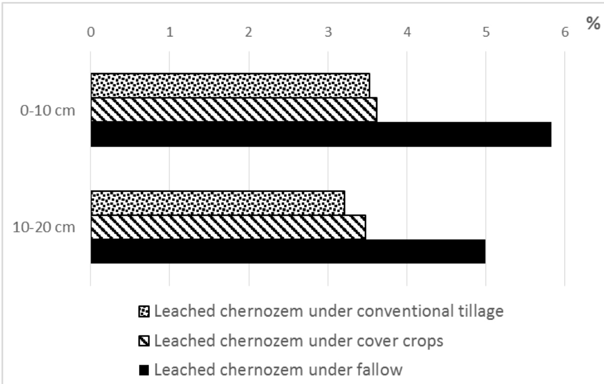

Figure 2 **Organic matter content in leached chernozems under different land use systems**

Conventional agriculture applied for about 60 years on studied leached chernozems, conducted to loss of organic matter, which inevitably led to loss of soil structure, especially in 0-10 and 10-20 cm layers of soil. According to our data, the layer 0-10 cm of CT soil is characterized by a good quality of soil structure (*figure 3*).

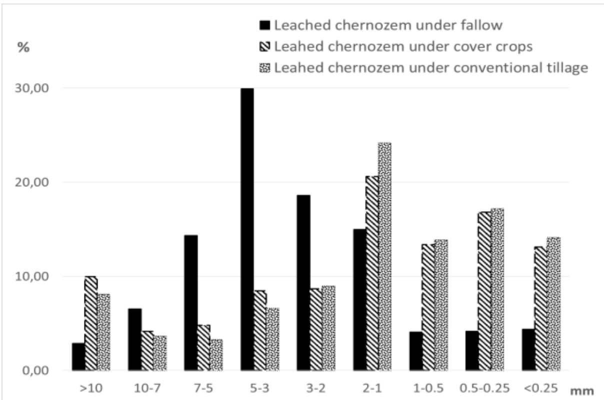

Figure 3 **Soil structure of 0-10 cm layer of leached chernozems under different land use systems**

Sum of agronomic valuable aggregates is on average 77,77%. The fifth part (22,23%) of soil structure consists of blocky aggregates >10 mm and very thin aggregates <0.25 mm. The good quality of this layer was achieved by recent soil works.

The next layer reflects actual state of affairs regarding soil structure of arable soils. Sum of agronomic valuable aggregates is on average 57.66% that makes only half of the soil aggregates (*figure 4*). The rest of soil structure consist of blocky aggregates >10 mm – 40.86% and very thin aggregates <0.25 mm – 1,48%.

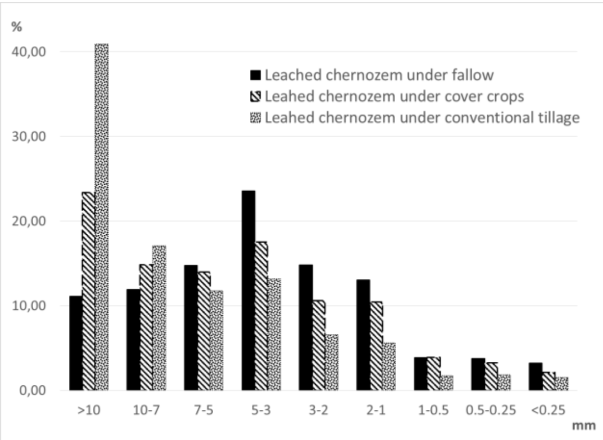

Figure 4 **Soil structure of 10-20 cm layer of leached chernozems under different land use systems**

Leached chernozem under cover crops partially restored quality of soil structure due to annual flux of fresh organic matter in soil and physical action of root system of cultivated plants. This can be observed in 10-20 cm layer (*figure 4*) where the sum of agronomic valuable aggregates increased to 74.5%. There are two times less of blocky aggregates of size >10 mm – 23.38%.

Leached chernozem under the fallow is characterized by an excellent soil structure in the whole soil profile with prevalence of aggregates of size 5-3 mm.

Soil structure is an agrophysical index of soil fertility and the most of the soil formation processes take place in the structural aggregates. Soil aggregates physically protect soil organic matter (Tisdall and Oades, 1982), determine nutrients availability (Wang *et al*, 2001) and influence microbial community structure (Hattori, 1988). Soil tillage and disturbance of soil natural aggregates always lead to loss of both organic matter and soil number and stability of aggregates (Six L. *et al*). Based on this, the content of organic matter in the soil structural aggregates was studied within the project.

Our research results showed that the average content of organic matter in CT soil decreased in all aggregate-size classes, in comparison with the fallow soil, by 2.12-2.65% in 0-10 cm layer. The lowest content of SOM was found in aggregates <0.25 mm – 3.25% (*figure 5*). The layer of 10-20 cm lost about 1.33-2.31% of SOM (*figure 6*). By lowest content (1.33%) are characterized the aggregates of size 3-2 and 2-1 mm.

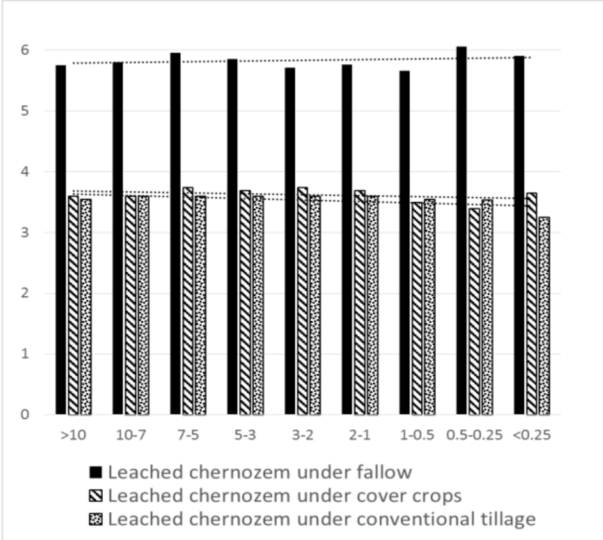

Figure 5 **Humus content (%) in structural aggregates of 0-10 cm layer of leached chernozems under different land use systems**

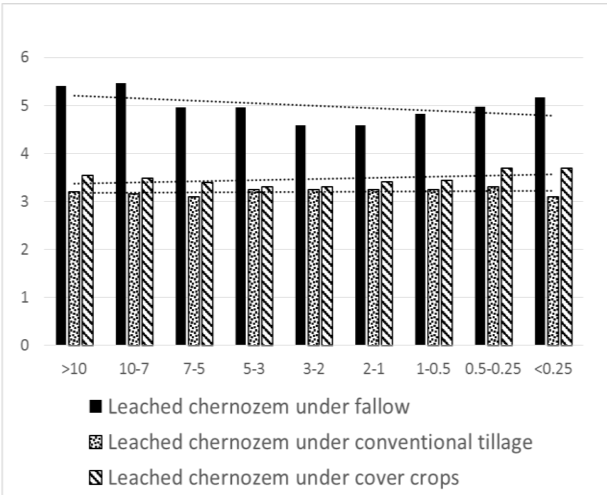

Figure 6 **Humus content (%) in structural aggregates of 10-20 cm layer of leached chernozems under different land use systems**

Cultivation of cover crops increased total SOM content in CC soil in comparison with CT soil. The increase of SOM is not distributed uniformly in soil aggregates (*figure 7*). In the first 10 cm of soil the major increase is observed in aggregates of size <0.25 mm – 0.39%. A significant increase was established in aggregates of sizes 7-5, 5-3, 3-2, 2-1.

The next soil layer 10-20 cm is characterized by a significant increase of SOM in aggregates of size >10, 10-7, 7-5 and 0.5-0.25, <0.25 mm (*figure 8*).

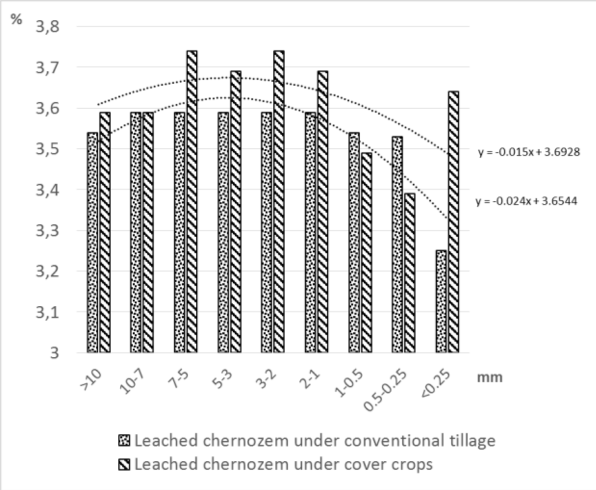

Figure 7 **Soil organic matter increase in 0-10 cm layer of CC soil compared to CT soil**

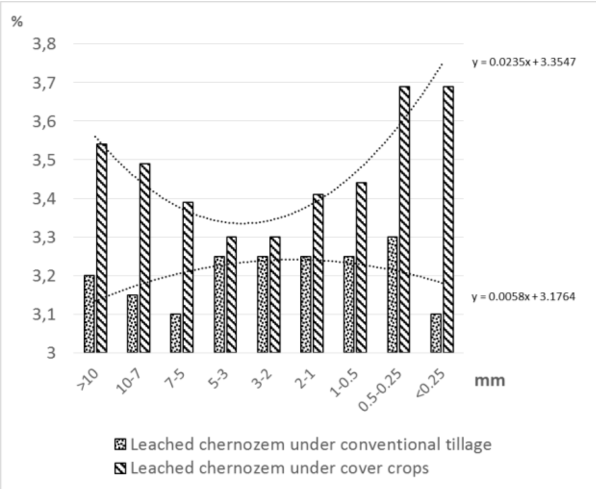

Figure 8 **Soil organic matter increase in 10-20 cm layer of CC soil compared to CT soil**

There was a very small increase in aggregates of size 5-3, 3-2, 2-1 and 1-0.5 mm. The biggest increase was established in aggregates of size <0.25 mm, the lowest – in aggregates 5-3, 3-2 mm.

CONCLUSIONS

The investigations carried out on leached chernozems showed that CT soil, during 60 years of tillage, lost on average 2.29% of organic matter from the arable layer 0-12 cm, compared to the fallow soil. The next soil layer (12-20 cm) lost on average 1.78% of organic matter. Cover crops grown for 8 years increased the content of SOM in the arable layer (0-12 cm) by 0.08% (about 0.01% annually) and in the next layer 12-20 cm – by 0.27% (0.03% annually).

Soil structure of CT soil is characterized by blocky aggregates that make almost half of the total amount of the soil mass. Leached chernozem under cover crops partially restored its structure due to annual flux of fresh organic matter and physical action of root system of cultivated plants. Sum of agronomic valuable aggregates in 10-20 cm layer increased to 74.5%. There are two times less of blocky aggregates of size in comparison with CT soil.

Average content of organic matter in CT soil decreased in all aggregate-size classes, in comparison with the Fw soil. The lowest content of SOM was found in aggregates <0.25 mm – 3.25% (0-10 cm layer) and aggregates of size 3-2 and 2-1 mm – 1.33% (10-20 cm layer).

The increase of SOM in CC soil is not distributed uniformly in soil aggregates. In the first 10 cm of soil the major increase is observed in aggregates of size <0.25 mm – 0.39%. A significant increase was established in aggregates of sizes 7-5, 5-3, 3-2, 2-1. The next soil layer 10-20 cm is characterized by a significant increase of SOM in aggregates of size >10, 10-7, 7-5 and 0.5-0.25, <0.25 mm.

ACKNOWLEGMENTS

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