THE INFLUENCE OF SOIL TILLAGE ON THE SOME PHYSICAL INDICATORS OF CHERNOZEM CAMBIC FROM MOLDOVA

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Abstract

The paper presents research results of soil tillage influence on some physical properties of the chernozem cambic over 60 years period. For the witness soils were investigated the same indicators of cambic chernozem non modified anthropogenic from forest protection belt. The intensive agriculture in Moldova led to physical, chemical and biological soil degradation. The fallow cambic chernozem is characterized with loamy-clayey texture throughout the profile and a pronunciation cambic Bhw1 and Bhw2 horizons. The physical clay content varies in its profile from 51% in the fallow layer up to 55% in the cambic horizons, and clay content - from 35% to 38%, respectively. The arable cambic chernozems have a clayey-loamy texture, the physical clay content about 60-61% in the humiferous profile, 56-58% - in the BC and C horizons The clay content in A and B horizons varies between 39-40%, and in the BC and C horizons - within the limits of 56-57%. The conventional soil tillage system in Moldova based on the annual plowing with returning furrow had the effect of lowering the reserve of humus, through intensification of the organic matter mineralization in soil arable layer, decreasing hydrostability of the structural aggregates, increasing vulnerability of soil to degradation by compaction. Insufficient use of chemical and organic fertilizers, secondary strong compaction of the arable layer leads to decreasing their production capacity by two times.

Key words: soil tillage, physical properties, cambic chernozem, Moldova

Intensive agriculture exerts significant pressures on soils and insufficient knowledge of how soil reacts to them can have negative consequences manifested by degradation processes and decreasing production capacity (Canarache A., 1999). The main processes of soil degradation that affects with different intensity agriculture areas are water erosion (causes loss of fertile soil layer on the surface, damaging the land, sedimentation and silting), compaction and distructuration of arable layer, depletion of soil organic matter and nutrients, soil salinization and alkalization (Budoi Gh., Penescu A., 1996).

Soil tillage, have direct and beneficial effects and also long-term residual effect, acts on the physical and physic-mechanical properties of the soil, partly or wholly changing their values (Canarache A., 1999). Intensive agriculture in the Republic of Moldova has resulted in land degradation across the territory. The conventional soil tillage system based on annual plowing with the return furrow had the greatest influence on its physical properties, which in turn influenced the chemical and biological characteristics. This influence was manifested through the destructuring and compaction of arable layer, lowering reserve of humus in the soil and increased vulnerability to erosion process (Cerbari V., 2011).

MATERIAL AND METHOD

The researches were conducted on the experimental fields of the Institute of Soil Science, Agrochemistry and Soil Protection "Nicolae Dimo", located within the village Ivancea, district Orhei (Central zone of Moldova). To study changes in physical properties of chernozem cambic influenced by tillage were placed two soil profiles. Profile 1 - Chernozem Cambic (leachate) from forest strip, fallow 60 years, Profile 2 - Chernozem Cambic used on the arable used for field crops. Period of 60 years is sufficient to restore the initial parameters of chernozems under steppe vegetation in the forest belts in terms of not using the air mass of natural herbal vegetation (Cerbari V., Balan T., 2010). The values of physical characteristics of fallow cambic chernozem are used as a baseline to compare with those of arable chernozem. In carrying out their properties were used the classical methods of field, laboratory and office research. Morphological description of soil profiles were made based on the indicators approved by the methodology of soil studies.

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RESULTS AND DISCUSSIONS

The Chernozem Cambic from central area of Moldova are polygenetic soils. These soils were formed by the following steps of pedogenesis: under virgin forest vegetation → under steppe vegetation (during the great migrations of peoples) → under plowing (in the occurrence of contemporary agriculture). In the soil forming phase under forest vegetation the combination of clay migration illuvial process with alteration process "*in situ*" of mineral part of these soils led to the textural differentiation of their profile (Cerbari V., Lungu M., 2010).

The contemporary arable cambic chernozem from central part of Moldova have inherited from the pedogenesis phase influenced by forest vegetation a textural differentiated profile, with high content of fine clay with predominance of colloidal fraction. In terms of the existing system of agriculture these soils have undergone intensive degradation of arable layer. High content of clay, low humus content and deterioration of structure led to acceleration of the secondary compaction of arable layer. Insufficient use of organic and chemical fertilizers, strong compaction of arable layer led to a decrease in their production capacity.

At the foundation of forest protection strip the fallow cambic chernozems was sloppy. The Ahb1 and Ahb2 horizons were formed from soil material of former arable layer buried by sub-soiling at 25-60 cm of depth. Further the soil evolved on the clayey-loamy alluvial loess material, laid on the quaternary deposits. The soil profile was leached of carbonates until BCk horizon, depth 95 cm. Chernozem cambic, fallow 60 years, has the type of profile: Ahţ1 → Ahţ2 → Ahb → Ahb2 → Bhw1 → Bhw2 → BCk1→ BCk2 → Ck. Chernozem cambic on the arable is characterized by the profile type: Ahp1 → Ahp2→ Ahp →Bhw1→ Bhw2→ BCw1→ BCk2 → Ck.

Texture of soils (particle size / mechanical composition) is result of rocks weathering and alteration with various sizes of agregates, predominantly silicate. Land use (plowing and tillage) in agriculture led to significant changes of texture - particle size fractions content (*Table 1*).

Table 1

Texture of follow and arable cambic chernozems

Horizon and depth, cm		Size fractions, mm; content, % g/g						
		1,0-0,25	1,0-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
Profile I. Chernozem cambic loamy-clayey, follow (forest belt)								
Ahţ 1	0-13	0.4	13.4	35.6	4.9	10.5	35.2	50.6
Ahţ 2	13-25	0.6	14.6	33.2	5.3	10.8	35.5	51.6
Ahb1	25-40	0.6	14.5	32.4	6.5	10.4	35.6	52.5
Ahb2	40-60	0.5	14.2	32.2	6.8	10.3	35.5	52.6
Bhw1	60-75	0.4	14.4	30.9	6.4	10.1	37.8	54.3
Bhw2	75-95	0.4	12.3	32.1	7.1	10.3	37.8	55.2
BCk1	95-110	0.5	11.9	32.5	7.7	10.9	36.5	56.1
BCk2	110-130	0.3	11.6	32.0	7.3	13.6	35.2	56.1
Ck	130-150	0.4	12.4	32.2	6.3	15.6	33.1	55.0
Profile II. Chernozem cambic clayey - loamy, arable (crop field)								
Ahp 1	0-10	0.7	5.1	34.0	7.5	13.5	39.2	60.2
Ahp 1	10-25	0.7	6.9	32.2	7.6	13.6	39.0	60.2
Ahp2	25-35	0.8	6.8	32.0	7.8	13.4	39.2	60.4
Ahp	35-50	0.5	6.7	32.8	7.1	13.2	39.7	60.0
Bhw1	50-70	0.4	7.4	32.1	8.4	11.9	39.8	60.1
Bhw2	70-95	0.6	5.6	33.6	8.3	12.4	39.5	60.2
BCw1	95-120	0.5	5.1	36.0	7.7	12.0	38.7	58.4
BCk2	120-130	0.5	5.0	38.1	7.4	12.4	36.6	56.4
Ck	130-150	0.5	5.1	38.3	7.5	12.5	36.1	56.1

Chernozem cambic fallow is characterized with loamy-clayey texture throughout the profile and pronounced Bhw1 and Bhw2 cambic horizons. The content of physical clay varies from 51% in fallow layer, up to 55% in cambic horizons and clay content - 35% and 38%, respectively.

Chernozem cambic arable has clayey-loamy texture. Physical clay content in humus horizon is 60-61%, in BC and C horizons - 56-58%. The clay content in horizons A and B was ranges between 39-40%, while in BC and C horizons - 56-57%.

The clay has the main role in the formation of a large number of physical and chemical soil properties. The clay and humus content depends on the water adsorption, exchangeable cations and nutrients, adhesion and plasticity, shrinkage and swelling in the soils (Blaga Gh., et.al., 2005). The soil tillage has contributed to increasing the clay content (<0.001) in the chernozem cambic use on the arable with 10% in comparison with the same on the follow use.

The soil tillage influenced the clay migration or argillic alteration process on 0-70 cm depth of the arable chernozem. On the entire depth of the fallow soil, clay has visible meanings in the illuvial horizons. This situation occurs in soils of the steppe zone, where the clay fraction of the profile is about the same as exists in the parent material. Argillic alteration coefficient (Ka) - the ratio of the clay content in the genetic horizons and parental material throughout the depth of the fallow soil profile is kept (*figure 1*).

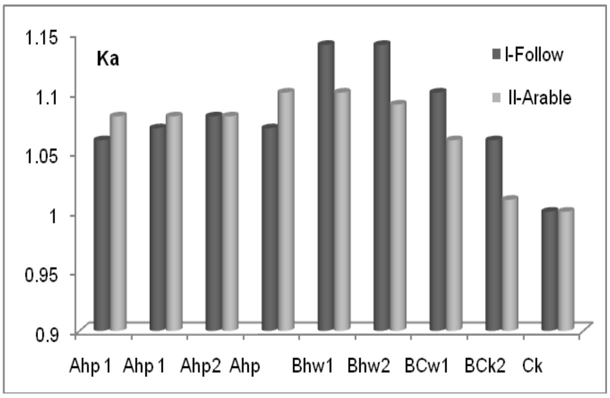

Figure 1 **Ka in the cambic chernozems**

Density is a soil property exchanges hard in time, which is determined by mineralogy composition and humus content. The humus content is higher, the density is lower (*figure 2, 3*).

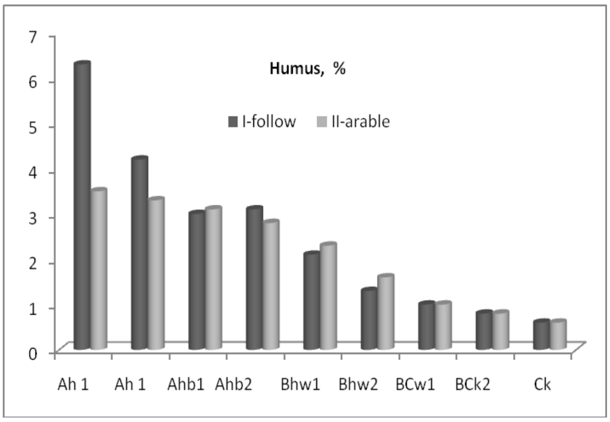

Figure 2 **Humus in the cambic chernozems, %**

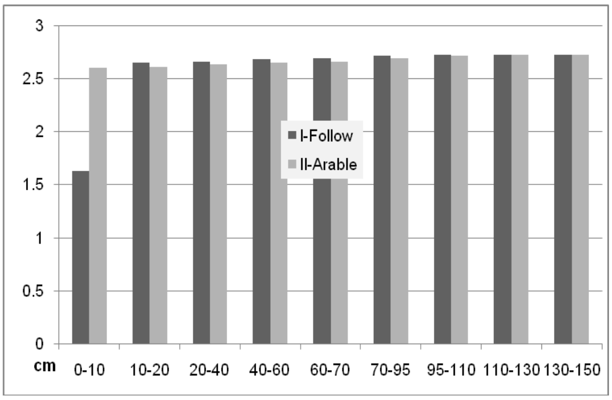

Figure 3 **Density of the cambic chernozems, g/cm^3**

Apparent density values of soil are closely correlated with the degree of compaction, and ranges from 1.04 to 1.55 g/cm^3 in the fallow chernozem, from 1.24 to 1.52 g/cm^3 in the arable chernozem. Lower bulk density values are recorded in the upper layers, where compaction is lower. Higher values were characteristic for arable soil, at 20-35 cm depth, and cambic horizons of fallow soil (*figure 4*).

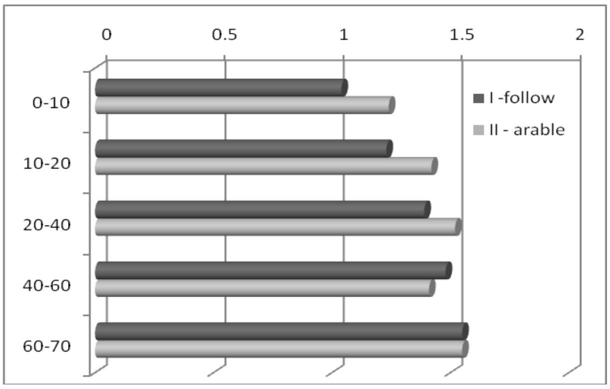

Figure 4 **Apparent density in the cambic chernozems**

Total porosity values are directly related to those of apparent density (*figure 5*).

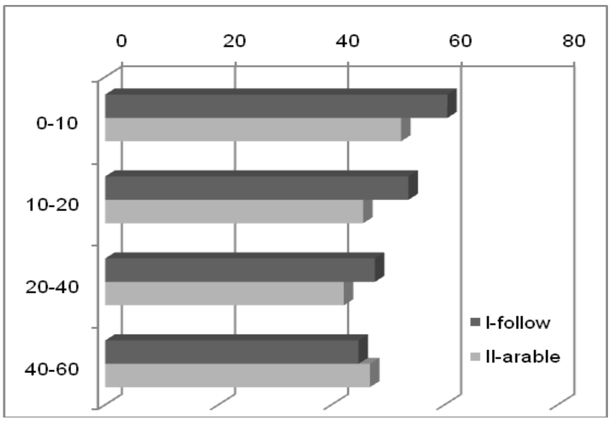

Figure 5 **Porosity in the cambic chernozems, %**

Soil compaction is a process caused by anthropogenic causes, after which greatly increases the apparent density and total porosity falls below normal values (arable and cambic horizons).

Soil resistance to penetration depends on the particle size composition, degree of compaction and structure, humus and moisture content. The lowest values of penetration resistance were recorded on the layer 0-10 cm (7-9 kgf/cm^2) in both soils, and 2 times higher values on underlying horizons (*figure 6*).

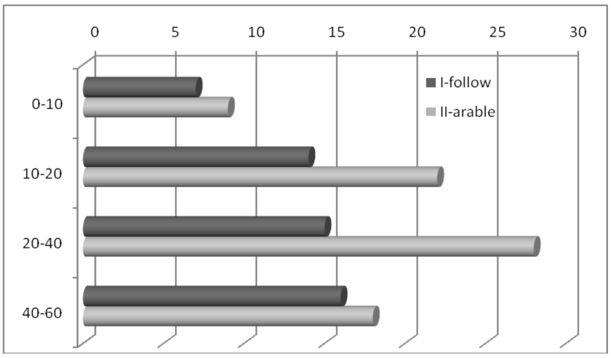

Figure 6 **Resistance to penetration of soils**

Hygroscopic coefficient is one of the main indices of soil moisture, the apparent changes that occur on the retention, mobility and accessibility of water for plants. Hygroscopic coefficient values in the investigated soils are between 9% and 12% (*figure 7*).

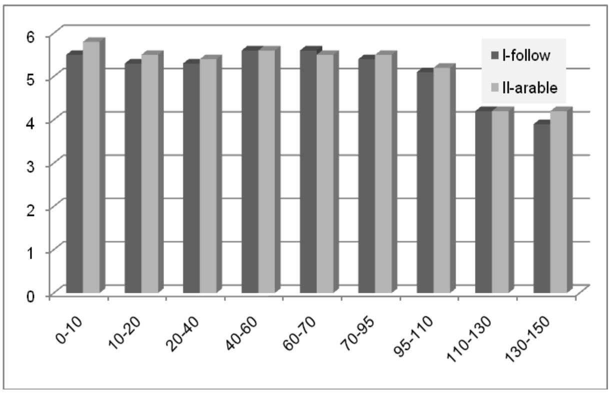

Figure 7 **Hygroscopic coefficients in the soils**

Thus, soil tillage directly or indirectly affect all of its physical properties, both arable layer and layers in the immediate vicinity. Chernozem cambic investigated is characterized by high content of fine clay which, under dehumification and destructuring of their arable layer is arranged to strong secondary compaction. These soils are a enough difficult production object in agriculture, which requires the application of special measures to improve the their physical properties of use in agriculture.

CONCLUSIONS

Texture as the main physical indicators of the soils plays an important role in determining the most physical properties. The production capacity depends on size composition of the soil, its agronomic and improvement characteristics, and higher recovery technology. As a quality texture is virtually unchanged, agricultural and reclamation technologies must adapt to the specifics of soil textural. To prevent land degradation and restoring the physical properties of chernozem cambic used on the arable is recommended proper use of agricultural machinery, execution of agricultural operations at the optimal epoch, avoiding excessive farm works, application of organic fertilizers and residues in the soils, etc. higher recovery technology.

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REFERENCES

Blaga Gh., Filipov F., Rusu I., Udrescu S., Vasile D., 2005 - *Pedologie*. Cluj-Napoca: Editura Academic Pres, 420 p.

Budoi Gh., Penescu A., 1996 - *Agrotehnica*. București: Editura Ceres, 438 p.

Canarache A., 1999 - *Diferențierea sistemelor de lucrare a solului în funcție de condițiile de sol și teren din România.* In: Alternative de lucrare a solului. Vol.II. Cluj-Napoca, pp.215-223.

Cerbari V., 2011 - *Programul de dezvoltare şi implementare a tehnologiilor conservative în agricultură*. Agricultura Moldovei, nr. 4-5, pp. 7-9.

Cerbari V., Balan T., 2010 - *Cernoziomurile tipice din zona călduroasă semiumedă a Moldovei de Nord*. În: Monitoringul calităţii solurilor Republicii Moldova. Chisinau: Pontos, pp.98-116.

Cerbari V., Lungu M., 2010 - *Cernoziomurile levigate (cambice) din zona călduroasă semiumedă a Moldovei centrale*. În: Monitoringul calităţii solurilor Republicii Moldova. Chisinau: Pontos, pp.172-179.

Крупеников, И.А.; Скрябина, Э.Е., 1976 - *Процессы оглинивания черноземов Придунайского региона.* Почвоведение. №11, с.3-13.