MOLDAVIAN GRAY FOREST SOILS TRANSFORMATION DUE DEFORESTATION AND AGRICULTURAL USE

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Abstract

With deforestation and employment in the agricultural use the forest soils from Codri area of Moldova begin another stage in its development under anthropogenic factor action in climatic conditions favorable for the development of steppe vegetation and formation of chernozem soil. Such changes as formation of the new (arable) layer with average thickness 34 cm from the genetic material of the former three horizons of gray forest soil (AEhţ + AEh + BEhtw), clay content increasing in arable layer as a result of increasing "in situ" weathering process followed by the reduction of the textural differentiation on the profile, humus content decreasing, balanced bulk density value increasing as the result of dehumification and weaker structure and hydrolytic acidity reduction by 2-3 times in arable layer is occurred.

Key words: greyzems, deforestation, Moldova, soil

With deforestation and employment in the agricultural use the forest soils begin another stage in its development. Being formed around the end of Pleistocene and early Holocene when the climate was more colder and more humid, favorable for forest vegetation growth development (Adamenco O.M. *et al*, 1996), and developed in the present time in semiarid climatic conditions corresponding to the chernozems area, gray forest soils from Republic of Moldova evolution is an interesting scientific research topic both in point of view of their development under the forest as well as farmland. Thus now under the forests continues to evolve gray forest soils due to the biological factor, but under the climate regime typical for chernozems area. It gives them some characteristics that distinguish them from the other regions.

To highlight and evaluate changes of arable grazyems proprieties under anthropogenic factor action in the specific conditions of Moldova, we aimed to investigate changes occurred in the morphology, properties and the elementary processes of gray forest soils (grayzems) employed in the agricultural use in Ivancea village, Orhei district, Moldova`s Codrii area. To achieve this research we use the comparative research method making comparison between grayzem under forest and grayzems aside employed in agriculture.

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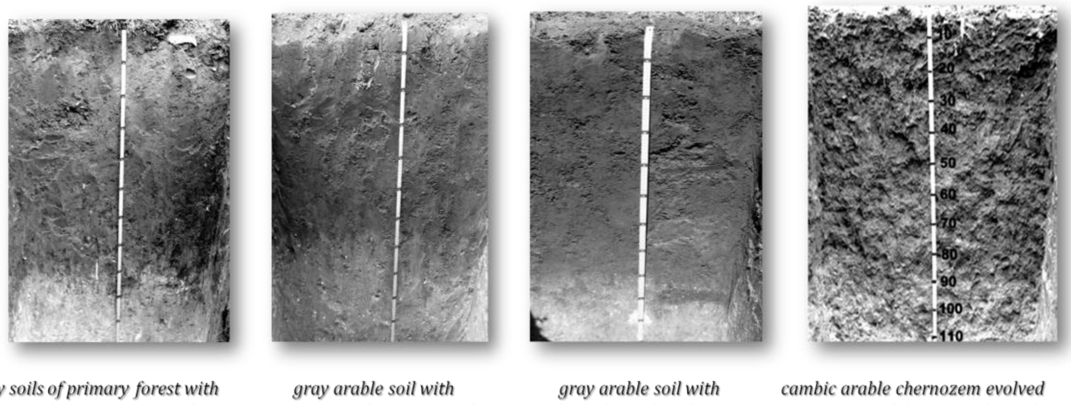

gray soils of primary forest with semiprofound humus profile | *gray arable soil with semiprofound humus profile (used as arable land about 100 years);* | *gray arable soil with moderately profound humus profile (free from the forest vegetation more than 100 years).* | *cambic arable chernozem evolved from gray soil during prolonged pedogenesis under the steppe vegetation*

Figure 1 **Forest and Arable greyzem soil profiles**

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MATERIAL AND METHOD

As the object of study were selected gray soils (grayzems) from the forest and those which were employed in agricultural use from the experimental field of Institute of Pedology, Agrochemisry and Soil Protectection from the village Ivancea, Orhei district, Codri area, in the Central part of Moldova, that are evolved on clayey-loamy loess deposits placed on the Pliocene alluvial deposits. Moldavian Codri area is located between the 150-250 m height, in the warm and semihumid climatic area.

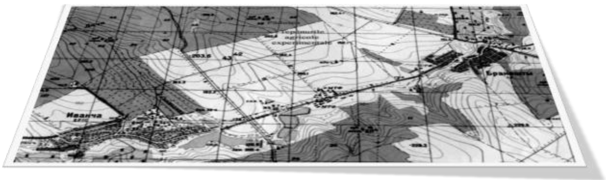

Figure 2 **IPAPS "N. Dimo" experimental fields location**

To highlighted the gray forest soils changes due the change of climatic conditions and agriculture use we study four tipe of soil (*figure 1,3*) located alongside each other:

- gray soils under primary forest;
- gray arable soil used as arable land about 100 years;
- gray arable soil free from the forest vegetation more than 100 years;
- cambic arable chernozem evolved from gray soil during prolonged pedogenesis under the steppe vegetation

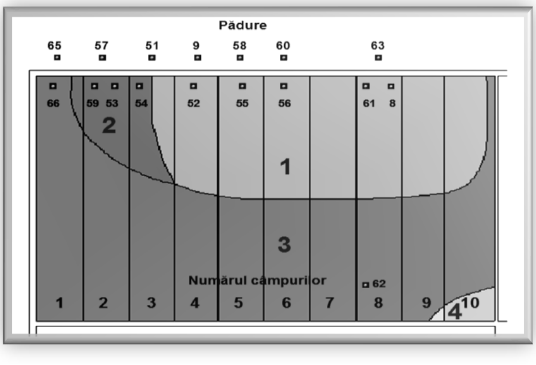

Figure 3 **Soil distribution scheme of investigated areas in the experimental field.**

Legend:
1 –*gray arable soil semimoderately humiferous with semiprofound humus profile (used as arable land about 100 years);*
2 - *gray arable soil semimoderately humiferous with moderately profound humus profile*
3 - *cambic arable chernozem moderately humiferous with deep profound humus profile*
4 –*eroded arable leached chernozem with moderately profound humus profile*

RESULTS AND DISCUSSIONS

Forest greyzems are characterized by a clear differentiation of the profile. During the depth 0-31 cm we can see three genetic horizons: AEhţ, AEh and Behtw with medium texture and low compaction, under which is located iluvial very compacted horizon. It was established that the loss of clay (90 t / ha) from eluvials horizons (AEhţ, AEh, BEh) of gray forest soil are about nine times smaller than its accumulation in iluvial horizons (835 t / ha), what confirm the leading role of alteration "in situ" processes in the textural profile differentiation of these soils in conditions of Moldova. Forest soils are also characterized by good structural state and soil aggregates hidrostability in 0-20 cm layer. Forest soils are characterized by thin fallow horizon on surface (8 ± 2 cm) with rich (8.52 ± 0.56 %) humus content. With the deep humus content decreases sudden and is equal to 2.93 ± 0.20 % in AEh horizon. Average value of hydrolytic acidity for 0-34 cm layer of gray forest soil is 6.9 ± 2.9 me/100g.

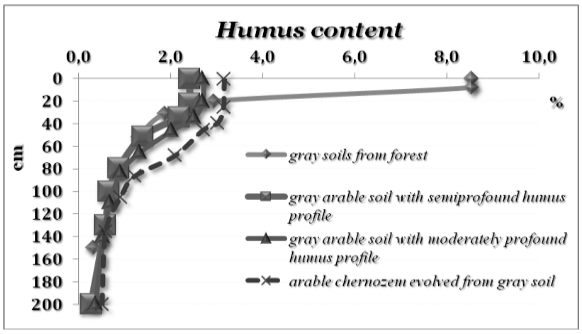

Figure 4 **Humus content of researched soils (average data)**

A common feature for both gray forest soils and the arable land is comparatively small depth (about 80 cm from surface) of occurrence of iluvial carbonate horizon extremely highlighted; the maximum carbonate content varies within 20-28%. Carbonates are shaped in massive accumulation of carbonate concretions and veined. This is a consequence of contrast warmer hydrothermal regime under which influence soils were formed. It should be mentioned that in forest soils carbonate accumulations are more expressed than in arable soils. Hydrothermal regime changes to a more humid on arable grayzems have led to a more homogeneous distribution of carbonates in the all parental rock.

Arable layer of the gray soil permanently used in agriculture around 100 years is the mixture of genetic material from three forest soil surface horizons AEhţ, AEh şi BEhtw. This layer has lost initial favorable structure and became rough and highly compact, texture has changed from the middle to middle-fine and the color from gray to reddish brown. The 0-30 cm layer practically lost its ability to keep the loose state after basic processing. Balanced bulk density of the arable layer at 10-30 cm depth (below the periodic tillage layer) to mid-summer reach values equal to 1.50 to 1.55 g/cm ³, and the degree of compaction - 17 - 18%. As a result, the state of physical quality of this layer becomes unfavorable for crop plants growth.

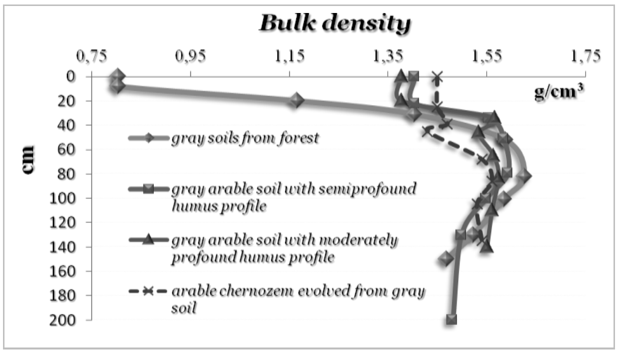

Figure 5 **Values of soil bulk density of forest and arable gray soils (average data).**

Gray arable soils throughout the profile are low in total phosphorus content, unlike the forest gray soils which are characterized by high content of total phosphorus in AEhţ horizon as a result of biological accumulation of this element from litter and other organic debris.

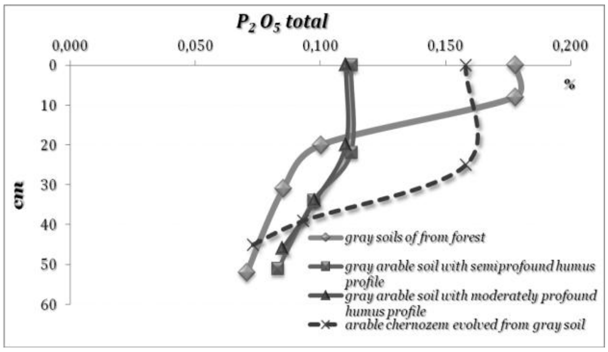

Figure 6 **Phosphorus content in researched forest and arable gray soils (average data).**

Caried out research also show that hydrolytic acidity value in arable layer was by 2-3 times lower like in the soils from the forest. This led to the eluvial-iluvial process and profile textural differentiation halting. Due to this soils become more suitable for the majority crop plants growth.

It was determined that remediation of the properties of these soils should be directed towards increasing the content of organic matter in arable layer and improving the unfavorable structural condition in plowed layer

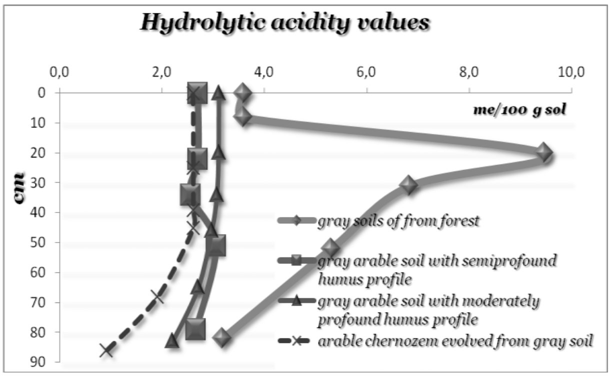

Figure 7 **Hydrolytic acidity values of researched forest and arable gray soils (average data).**

Arable gray soils also are characterized by unfavorable physical properties due to the high content of colloidal clay and compacted natural iluvial horizon located below 30-35 cm.

To improve studied grayzems quality was appreciated effect of some agro-pedo-ameliorative measure on the physical and chemical characteristics of these soils (as resistance to penetration, bulk density, degree of compaction, hydrolytic acidity, pH, etc.) and winter wheat productivity

We investigated five different soil improvement measures:

• EP1 - blank, topsoil procesing with discs and harrows to 12-15 cm depth;

• EP2 - 40 cm depth soil plowing with paraplow (subsoiling) + topsoil procesing;

• EP3 - 40 cm depth soil plowing with paraplow+ introduction of 12.5 t/ha of beet lime + topsoil procesing;

• EP4 - 40 cm depth soil plowing with paraplow+ introduction of 12.5 t/ha of beet lime and a dose of 50 t / ha livestock manure + topsoil procesing;

• EP5 - 40 cm depth soil plowing with paraplow+ 50 t/ha livestock manure introduction + topsoil procesing.

The carried out research have demonstrated that in the experemental field subjected to subsoiling the resistance to penetration in the 15-40 cm layer substantially descrease from 15 to 11 kg/cm^2 in arable layer and from 21 to 13 kg/cm^2 in postarable layer. This facilitated plant roots to penetrate soil to the depth of 35-40 cm while the thickness of the roots spreading in the blank experimental field did not exceed the depth of 20-25 cm.

The best influence on the wheat harvest had a subsoiling with beet lime and livestock manure introduction (combined method). If subsoiling increased harvest by about 4.4 q/ha compared to the blank then cumulative effect of subsoiling, beet lime and livestock manure introduction increased harvest by about 11.5 q/ha due to improved hydrological and nutrition conditions in the soil. Broadly speaking we find that subsoiling helped to increase yield by 12%, the beet lime introduction – by 2%, livestock manure introduction – by 12%, and combined method increased the harvest -by 32% compared to the blank.

During the research were determined three stages of degradation and gray soil regradation in the investigated region what corresponds to identified soil types:

I. stage of conservative degradation - at this stage takes place the homogenization of the upper part of the profile, dehumification, destructuring of structural aggregates and soil compaction, reducing soil acidity, stopping eluvial-iluvial and cambic processes what led to the decreasing of humuso-accumulative processes intensity and morphological and textural differentiation in the profile.

II. Stage of partial regradation as a result of the short phases of arable gray soil pedogenesis in steppe vegetation (long swarding). It is characterized by humification process intensification and humus profile thickness increasing without significant changes in humus quality.

III. Stage of regradation in chernozem under the influence of pedogenesis process under the steppe vegetation. Among characteristic features of soil at this stage are listed the intensification of humus accumulation, higher humus quality and the formation of the deeper humus profile.

CONCLUSIONS

Soils evidenced on the research area are characterized by the following morphological characteristics and common features: comparatively small depth of carbonates leaching (80-90 cm from ground surface) followed by formation of a highlighted iluvial carbonate horizon very compact when is dry; strong argilization in the middle part of the profile; the similar way of the clay distribution on the profile; existence of the special formation inherited from pedogenesis stage in forest vegetation (holes of the former roots of trees, Fe_2O_3 and MnO_2 cutan on the walls of these holes)

Gray soils used about 100 years in agriculture are characterized by following changes in morphological characters and properties:

- formation of the arable layer with average thickness 34 cm from the genetic material of the former three horizons of gray forest soil (AEhţ + AEh + BEhtw);
- increase in arable layer by about 6.0% clay content compared with the analog section of the forest soil as a result of increasing "in situ" weathering process followed by the reduction of the textural differentiation on the profile;
- humus content decrease in arable layer 0-34 cm on average by 1.74% (43 percent of initial content) compared to the humus content in the same section of the forest soil;
- resistance to compaction loss in arable layer, balanced bulk density achieve values to the 1.55 - 1.57 g/cm3 (strong compaction) and poor physical condition as the result of dehumification and weaker structure;
- hydrolytic acidity value descreasing by 2-3 times in arable layer and the eluvial-iluvial process and profile textural differentiation stopping (positive change);
- cambic arable chernozem is characterized by intensification of humus accumulation process, higher quality humus formation (humato – fulvic or humatic) and the deeper humiferous profile.

The most effective studied gray soil improuvement measures were found to be subsoiling with beet lime and livestock manure introduction. The combined method of the researched grayzems physical and chemical improvement is more effective than the methods applied separately.

ACKNOWLEGMENTS

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