Scientific Papers. Series A. Agronomy, Vol. LVII, 2014
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

ELEMENTS OF EVOLUTION FOR TYPICAL CHERNOZEM HUMUS MODERATED UNDER VARIOUS TILLAGE CONDITIONS

Gheorghe JIGAU

Moldova State University
65a M. Kogalniceanu St., Bl. 1, MD-2009, Chisinau, Republic of Moldova

Corresponding author email: gheorghe.jigau@gmail.com

Abstract

Modern agriculture is distinguished from that practiced in seventies-eighties of last century through diversification of tillage methods, fertilization and soil maintenance. Alternative tillage systems lead to the formation of pedogenetic ambiance intrinsic that differs essentially from the ambiance created in the traditional system. No-Till tillage system favors the process of humus formation with his accumulation in the 0-20 cm layer. Also it is taking place preponderant accumulation of $N\text{-}NO_3$, $N\text{-}NH_4$, mobile forms of phosphorus and exchangeable potassium. Mini-Till and deep loosening without returning furrow lead to creating an ambiance in which the processes of humus formation only ensures sufficient compensation for losses of humus during crop growing.

Key words*: tillage methods, fertilization, soil maintenance, traditional system.*

INTRODUCTION

Modern agriculture is distinguished from that practiced in seventies-eighties of last century through diversification of tillage methods, fertilization and soil maintenance. Nowadays into the space between Prut and Dniester broader use have the traditional tillage systems. At the same time, extensively are used several versions among the alternatives – Deep loosening without returning furrow, Mini-Till, No-Till and Strip-Till.

At the moment in Moldova these works are practiced on more than 70 thousand hectares and area constantly increasing. The experience acquired in several agricultural units which practiced these methods about 10 years has highlighted many advantages of alternatives works.

Among them should be mentioned primarily significantly reduction of connected expenses (by 40-50%) for carrying out the works, already reduced after first two years, with 25-30% (wheat, barley, maize) expenses per unit of production (sunflower reduction constitutes more than 40%) as well is reduced after 4-5 year the amount of fertilizer consumed. An important element is to ensure the crops stability during dry years (this is obvious in the No-Till case) contributing to significant reduction of soil erosion. Despite these advantages, the specialized literature and information available on the impact of alternative work processes and the evolution of chernozems, most commonly, include only some episodic data.

The present researches are dedicated to the study of physical and agrochemical parameters dynamics of typical chernozem humus moderated.

MATERIALS AND METHODS

Researches were conducted within the north area of Moldova under production conditions. The pilot land has been arranged in 2009. Total surface is 160 hectares. That was subdivided into four plots as 40 hectares each, Structure of crops include wheat, barley, sugar beet and maize.

The research included applied studies on field and laboratory analyses. Applied field studies were conducted in the reference profiles. For analyzes methods were used STAS methods:

- Determination of bulk density - Kacinski method;
- Determination of moisture - Gravimetric method;
- Determination of humus content - $N\text{-}NO_3$, $N\text{-}NH_4$ – TINAO method;
- Determination of P_2O_5 and K_2O – Macighin method.

RESULTS AND DISCUSSIONS

The survey shows that the bulk density at the beginning of vegetation its values in all four variants throughout the profile (0-150 cm) remain in the range of optimal values (1.0-1.3 g/cm^3). Exception makes it the upper segment of the arable layer where the bulk density values were insufficient presented < 1 g/cm^3, which is determined by the high degree of structure dusting. At the same time and even at this stage, variants No-Till and deep loosening through the bulk density values and their distribution on profile are detached from other variants, in the plowing segment bulk density values vary in the range 10-100 cm from 1.03-1.20 g/cm^3 and the variant Mini-Till they vary from 1.05-1.23 g/cm^3.

In the case of No-Till variant bulk density varies in a low range of values (1.24-1.28 g/cm^3), which indicated the settlement and spatial undistributed distribution of solid constituents. Soil profile under deep loosening variant is distinguished by excessive aeration of surface segment (bulk density 0.84 g/cm^3). At depth bulk density values and their vertical distribution is typical for chernozems under natural regime (Figure 1).

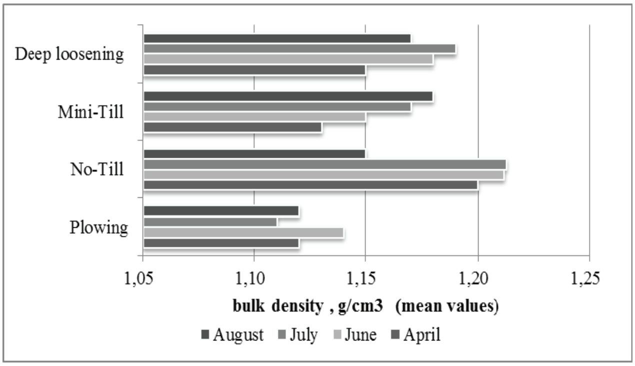

Figure 1. Bulk density dynamics in typical cernozem humus moderated in different tillage conditions

In all four cases the values of bulk density in the upper segment (0-30 cm) is not correlated with soil moisture, that fact is caused by different degree of structure modification but well as different organic matter content.

In June the soil profile under No-Till variant further detaches from the other variants. In his framework clearly distinguishes arable horizon (bulk density 1.16 g/cm^3) and subarable (bulk density from 1.35-1.32 g/cm^3). The analogue features bearing soil profile under plowing and deep loosening variants, and in it clearly distinguishes arable horizon (0-30 cm) with a distribution of bulk density values typical for them. Subarable horizons are characterized with values from 1.18-1.32 g/cm^3 (plowing) and 1.20-1.31 g/cm^3 (deep loosening). From our point of view at this stage determined role in the dynamics of bulk density returns to physic-mechanic processes, especially those blowing-contraction.

At the next phase (July, August) enhances the role of root system in the formation of agro-physic soil profile. Therefore the difference between agro-physical profiles in the various tillage variant is diminishes.

Dynamics of total reserves and productive of water are determined by tillage system used.

At the beginning of vegetation period with a maximum total reserves of water (877 m^3/ha) in the 0-30 cm layer characterized the No-Till variant. Of these more than 45% are productive reserves. Plowing, Mini-Till and Deep loosening is characterized by total reserves almost identical (Figure 2). However deep loosening variant detach from others tillage variants through increasing of water storage capacity (402 m^3/ha).

Later studied variants significantly detach through the consumption processes of water reserves in the 0-30 layer.

More intensive the water reserves are consumed in plowing variant. From Figure 3 we find that in June despite abundant precipitated from May and June, moisture content in 0-30 cm layer is reduced to interruption of capillary continuity. In July it is reduced to the level of hydroscopicity of the first 10 cm and wilting coefficient in 20 cm.

Mini-Till and deep loosening variants are characterized by relatively analog trend of water reserves consumption, but with different quantitative expression. However, under the variant Mini-Till the consumption of water reserves is attenuated.

No-Till is characterized by attenuated consumption of water. From Figure 2 we see that at the end of vegetation in the 0-30 cm layer is preserved about 50 % of total reserves at the beginning of vegetation and about 1/5 of useful reserves.

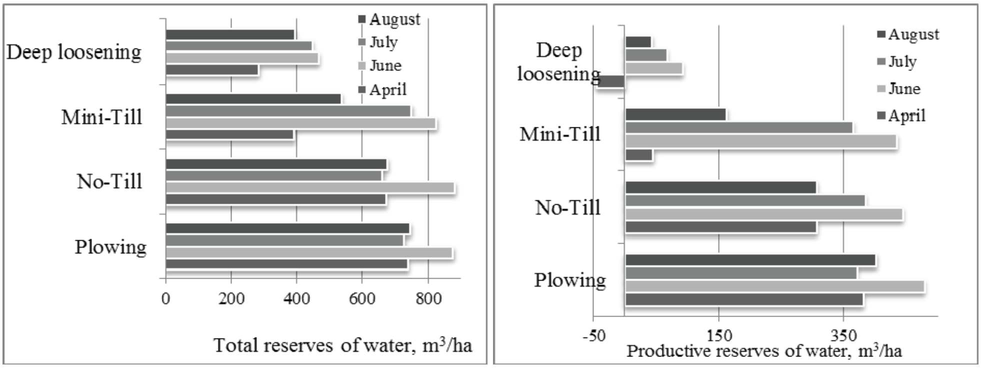

Figure 2. Dynamics of total reserves and productive reserves of water under typical chernozem humus moderated under various tillage conditions (0-30 cm layer)

Dynamics of water reserves in the 0-150 cm layer is correlated with their dynamics in the layer 0-30 cm, which allows us to conclude that in all tested variants is ensured the migration through capillary ascension from the deeper layers to surface layers. Comparative analysis of the dynamics of useful water reserves in the 0-150 cm layer shows that they are consumed more efficient in the deep loosening variant (Figure 3). Importantly, for all three variants of alternative tillage the useful water reserves in the layer 0-30 cm are sufficient to practice intermediate crops.

Based on the above mentioned we can conclude that the dynamics of soil physic characteristics create different functional framework for pedogenesis processes.

This clear trend of development is highlighted for agricultural indices. In this respect the data from Table 1 shows that under pedogenetic framework created through practice of No-Till, already, within the first 4-5 years, is likely to favor the more rapid accumulation of organic matter in the soil. At the same, time however, this process is limited to 0-20 cm layer.

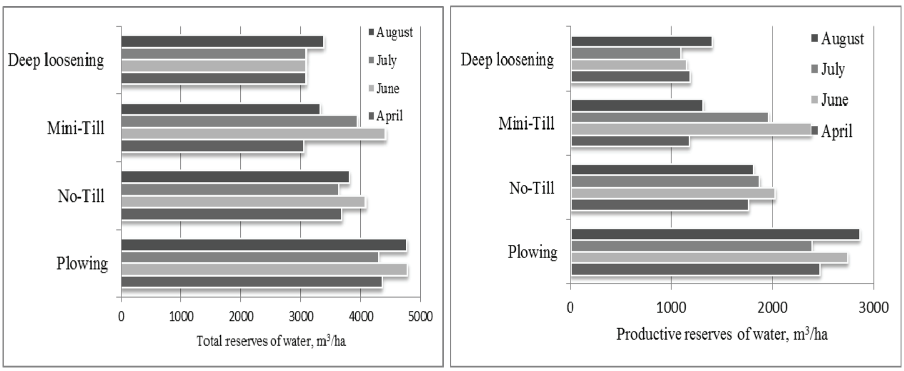

Figure 3. Dynamics of total reserves and productive reserves of water under typical chernozem humus moderated under various tillage conditions (0-150 cm layer thickness)

Table 1. Dynamics of humus content and its reserves

Tillage	Depth, cm	Humus content,%		Humus reserves, t/ha			
		Year		Year		Layer 0-50 cm	
		2013	2014	2013	2014	2014	2014
Plowing	0-4	4.18	4.20	38.8	39.1		
	16-20	4.08	4.05	42.0	41.7		
	26-30	3.86	3.80	43.2	42.6		
	48-52	3.39	3.40	40.4	40.5	164.4	163.9
No-Till	0-4	4.51	4.60	43.8	44.6		
	16-20	4.13	4.20	52.5	53.3		
	26-30	3.80	3.80	47.1	47.1		
	48-52	3.20	3.20	40.0	40.0	183.3	185.0
Mini-Till	0-4	4.26	4.30	41.0	41.7		
	16-20	3.97	4.00	41.7	42.0		
	26-30	3.80	3.80	42.9	42.9		
	48-52	3.20	3.20	37.1	37.1	162.7	163.7
Deep loosening without furrow returning	0-4	4.00	4.05	33.6	34.0		
	16-20	3.90	3.90	39.8	39.8		
	26-30	3.55	3.55	42.2	42.2		
	48-52	2.55	2.55	31.4	31.4	147.0	147.4

Specified phenomenon also reflected on other agrochemical indices. From Figures 4, 5, 6 and 7 we see that in the No-Till variant principal reserves of mineral nitrogen, mobile phosphorus and exchangeable potassium remain accumulated in the surface layer. This implies the conclusion, the layer is characterized by better capacity to provide useful water for plants, and their rood system will focus on the first, maximum 0-20 cm from the surface, implying several risks, including vulnerability to drought.

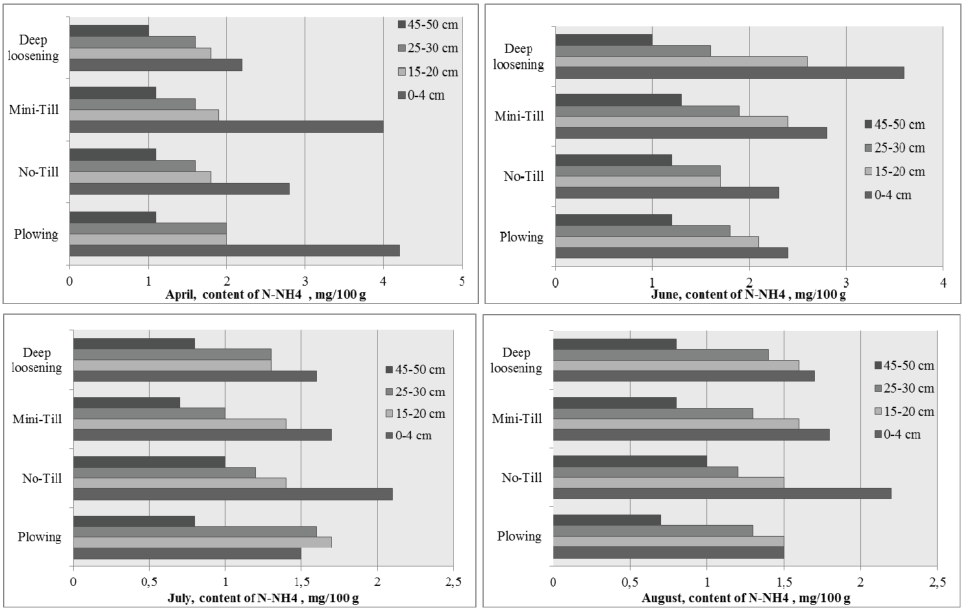

Figure 4. Dynamics of $N\text{-}NH_4$ in soil profile under various tillage system (April-August, 2013)

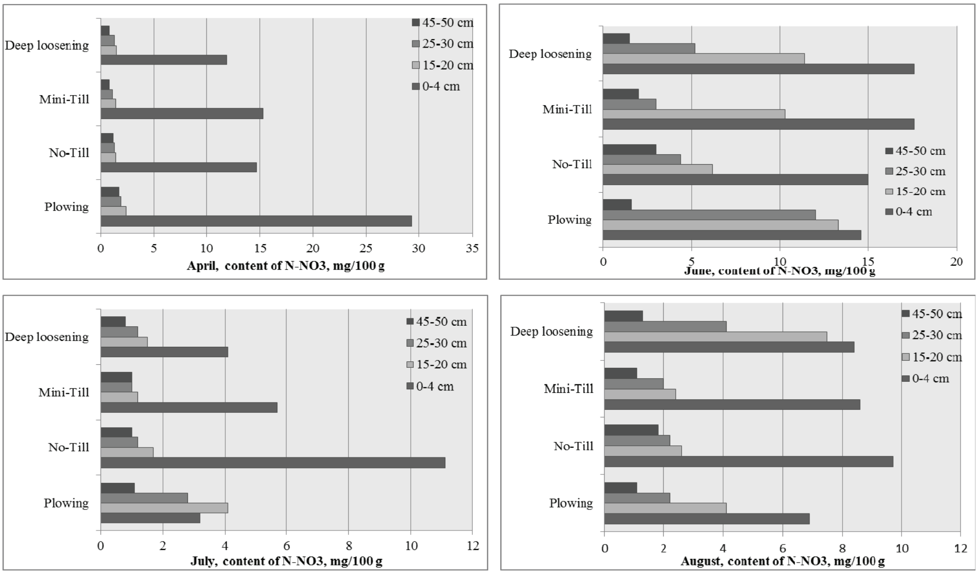

Figure 5. Dynamics of $N\text{-}NO_3$ in soil profile under various tillage system (April-August, 2013)

In the case of Mini-Till and deep loosening variants, processes of humus formation are performed in a sufficient proportion to ensure the stability of humus content in arable layer. Compared to Mini-Till variant in the alternative variants No-Till and deep loosening is resulting intense mineralization processes of organic waste, which leads to the formation and accumulation of large quantities of $N\text{-}NO_3$ in the 0-30 cm layer. Through the values of this parameter these variants carries several common features with plowing variant and substantial is detached from No-Till variant. For directing the processes of decomposition of vegetal debris with the meaning of formation and humus accumulation, it requires the involvement in the pedogenesis the vegetal debris reserves richest in nitrogen. This implies cultivation of nitrogen accumulator plant as intermediate crops.

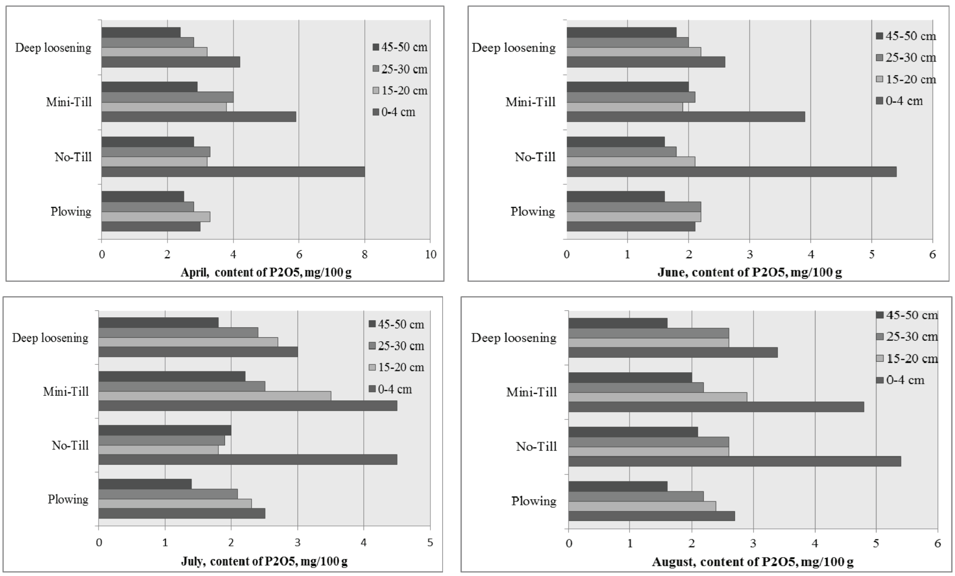

Figure 6. Dynamics of P_2O_5 in soil profile under various tillage system (April-August, 2013)

No-Till variant is distinguished from other variants through the intensive accumulation of phosphorus. In other alternatives tillage the phosphorus accumulation is less pronounced. In fact the proportions of phosphorus accumulation correlates well with organic matter content, this implies that the phosphorus in the alternative systems condition is accumulated in organic compounds (Figure 6).
Exchangeable potassium content in the investigated variants varies within range of values. As in the case of phosphorus with high-intensity of accumulation is characterized potassium in No-Till variant. At the same time is accumulating with significant accumulation intensity are characterized Mini-Till and deep loosening variants. In No-Till variants accumulation occurs in 0-10 cm layer.
Contrast to this, in the case of variants Mini-Till and deep loosening was found accumulation of potassium on the entire thickness of 0-30 layer. In this regard variants Mini-Till and deep loosening tillage variant are identical. This conclusion implies that in these variants arable horizons is more functional than the No-Till variant.

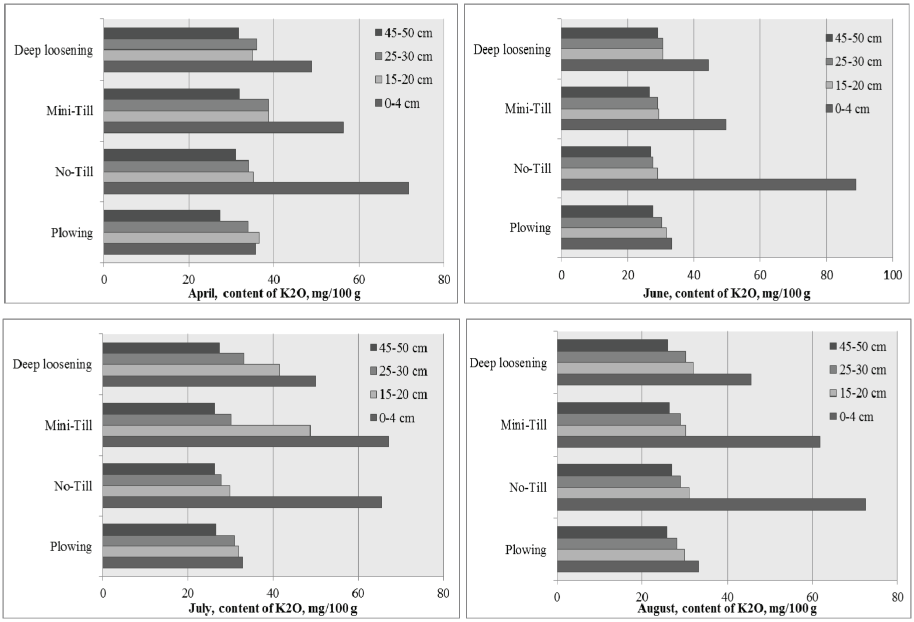

Figure 7 Dynamics of K_2O in soil profile under various tillage system (April-August, 2013)

CONCLUSIONS

Alternative tillage systems lead to the formation of pedogenetic ambiance intrinsic that differs essentially from the ambiance created in the traditional system.
No-Till tillage system favors the process of humus formation with his accumulation in the 0-20 cm layer. Also it is taking place preponderant accumulation of $N\text{-}NO_3$, $N\text{-}NH_4$, mobile forms of phosphorus and exchangeable potassium.
Mini-Till and deep loosening without returning furrow lead to creating an ambiance in which the processes of humus formation only ensures sufficient compensation for losses of humus during crop growing.
Within these accumulation processes of macro elements are reflected throughout the arable layer thickness (0-30 cm).

REFERENCES

Jigau Gh., 2013. Regional conservative tillage system of chernozems between Prut and Dniester, Agronomy Series of Scientific Research, vol. 56, Issue 2, p. 51-56.
Jigau Gh., 2010. Conceptual and methodological framework in the implementation of the resource-conservative technologies in the Carpato-Danubian-Pontic area, Present Environment and sustainable development, nr. 4, p. 5-37.