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INFLUENCE OF THE SOIL TILLAGE MINIMIZATIO ON THE STRUCTURE OF MICROBIAL POPULATIONS OF NITROGEN CYCLE OF THE CHERNOZEM TYPICAL[1]

R.P.Vilnyy

NSC 'Institute for Soil Science and Agrochemistry Research named after O.N.Sokolovsky
(ruslan-vilnyy@mail.ru)

Comparative reference of microbial cenosis structure in typical chernozem, per amount of main eco-trophic groups of microorganisms involved in processes of nitrogen-containing compounds' transformation due to soil tillage- minimizing approach, is accomplished.
Impact of tillage minimizing on distribution of nitric cycle microbial groupings in 0-10, 10-20, 20-30, 30-50 and 50-70 cm soil layers, is shown.
Specifics of soil processes per indices of mineralization, oligotrophy and typical chernozem organic matter transformation, in soil tillage minimizing conditions, are identified.

Key words*: soil tillage minimizing approach, microorganisms, biogenety, typical chernozem, cultivation, zero tillage, no-till*
([1] PhD O.I. Maklyuk is the Scientific Curator of this work)

Introduction. Soil tillage is an important link in the system of agriculture playing a leading role in formation and changes of biological properties of soils as an ecological environment for evolution of live organisms, while enabling activization of agronomically important microbial processes in soil. Functioning of soil microbiocenoses is a leading factor in formation of soil fertility. The structure and functioning of soil microbiological complex undergo changing in dependence on variety of environmental conditions [1].

Major advantage of minimum tillage technology (also called "conserving tillage") vs traditional techniques implies a liberation of mechanical pressure on the soil, maintaining and improving the soil fertility, and resource and energy saving efficiency. An important feature of minimum tillage approach is a fact that, unlike ploughing, the top-soil layer is not upturned, being only loosened [2].

The present-day systems enlist an innovative 'no-till' technique whose main features include minimal mechanical impact on soil, never-ruined perennial vegetation cover of live and dry plants, adaptive crop rotations, and special machinery employment [1].

Key feature of soil that reflects stresses on it by various tillage-cultivation technologies is biological activity of inherent micro-organisms and invertebrates.

Results of studies by L. B. Bìtyukova [3] suggest that microbial groupings in chernozem typical are represented by micro-organisms possessing variety of physiological functions which facilitate transformation of nitrogen-, carbon- and humus-compounds. Moldboard tillage, contrast to subsurface tillage, is stated to result in a deeper mineralization of nitrogen-containing organic compounds in soil, accompanied by increase in amount of ammonified and nitrified sporogenous bacteria and micro-organisms that assimilate reclaim mineral nitrogen from 0-40 cm-deep soil layer [3].

All above-said facts point out to actual must to continue studies for effect of minimizing the tillage stresses on certain types of soil, concerning formation of microbial groupings' structure in soil.

Objects and methods of the study. Studies were focused on microbial cenosis of chernozem typical undergoing various soil-tillage methods. Field studies were carried out on stationary experimental research fields of Kharkiv National Agrarian University named after V.V. Dokuchaev (Kharkiv region - North-East part of Ukraine). Experiment was launched in 2006 on a chernozem typical with purpose to assess efficiency of soil tillage technologies of stepwise intensity levels, in planting of grain cultures in dynamic crop-rotations.

Of four options of the experiment-scheme (implying various soil-tillage methods of basic technologies), we only chose two, such as:

-Pre-sowing 6-8 cm deep treatment with use of cultivator KPE-3,8,

-No-till – immediate sowing with use of Great Plains™ planting machinery complex.

Comparative analysis of chernozem typical inherent microbial characteristics at different tillage systems, as well as identification of dominance and biodiversity of particular microbial groupings, were accomplished in line with generally accepted soil-microbiology methods, including inoculation of specimen into selective nutrient media [4, 5], like:

- organotrophic bacteria, into beef-extract agar;
- actinomycetes and microorganisms that fix mineral N-compounds, into starch-and-ammonia agar;
- nitrogen fixators, into Döbereiner's nutrient medium;
- oligotrophic microorganisms, into hungry agar;
- oligonitrophilic microorganisms, into Ashby's nutrient medium.

Soil probes were sampled during buckwheat vegetation period 2012, per generally accepted methods [7, 8].

Changes in biological activity were assessed per integrated computation indices in the following manner:

• parameters of mineralization, oligotrophy and organic matter transformation (that characterize stresses of mineralization processes, as well and trophic regime of soil) were assessed via correlations among individual microbial groups;

• value of total biological index was obtained by method of G. Azzì [6].

Thus obtained results were statistically processed using STATISTICA- 6.0® software.

Results and discussion. As stated above, anthropogenic impact causes changes in functioning and structure of soil micro-biocenosis which, in turn, leads to changes in the flow of soil processes and up-and-down soil fertility- evolution.

Assuming for leading role of N as a crucial biogeneous element responsible for maintenance of soil fertility and crops-harvest formation, we analyzed spatial and structural characteristics of main agronomically useful ecological and trophic groups of microorganisms involved in transformation of nitrogen-containing compounds under influence of two different methods of soil-treatment (i.e., no-till and pre-cultivation) in soil layers 0-10, 10-20, 20-30, 30-50 and 50-70 cm layers.

Amount of nitric-cycle microbial groupings revealed definite features of typical chernozem biogen dynamics.

On variant with cultivation in layer 20-30 cm the biggest amount (17,68 mio CFU/ g (million colony-forming units/ gram) was found for bacteria that exist by assimilating organic forms of nitrogen; many fewer (by 47.5 % and 41.5 %) above relevant indices of 0-10 cm and 10-20 cm layers, correspondingly. In this manner,

amount of bacteria in the layer of soil between 30 cm and 70 cm is decreasing by 58 % (Table 1).

The 'No-till' technology revealed a more uniform in-depth distribution of microorganisms, yet best supplied with this eco-and-trophic grouping are 10-20 cm and 20-30 cm soil-layers, whereas for 0-10 cm layer, this index is lower but slightly. With depth, amount of bacteria in 30-50 cm and 50-70 cm layers is by 39 % and 42 % lower, as compared with the most intensively-supplied option.

Table 1. Structure of microbial cenosis in typical chernozem by (a) complex cultivation and (b) zero tillage methods, during buckwheat vegetation period

Variant (a, b) & depth of soil-layer, cm	Amount of microorganisms (mio CFU/g)						
	Organic N assimilating	Mineral N assimilating	Actino mycetes	Nitrogen fixators	Oligo-trophes	Oligonit-rophiles	Denitri-ficators
(a) Cultivation							
0-10	9.27	47.66	7.85	2.64	9.84	15.98	3.00
10-20	10.34	46.11	6.91	2.54	8.63	14.46	3.50
20-30	17.68	19.47	6.25	4.07	9.76	17.35	1.30
30-50	7.27	16.12	6.99	1.11	7.40	8.23	2.00
50-70	7.31	6.78	2.36	0.47	6.43	4.60	1.30
(b) No-till							
0-10	8.63	16.56	7.40	3.76	5.70	18.67	3.50
10-20	9.00	13.42	8.40	2.17	5.17	16.97	1.30
20-30	8.90	9.98	2.99	0.95	9.28	20.78	1.30
30-50	5.46	4.87	2.17	0.70	3.88	3.93	1.30
50-70	5.21	5.86	2.35	0.46	2.98	6.13	1.30
Least significant difference (05)	4.13	2.7	2.25	0.6	1.83	5.29	0.52

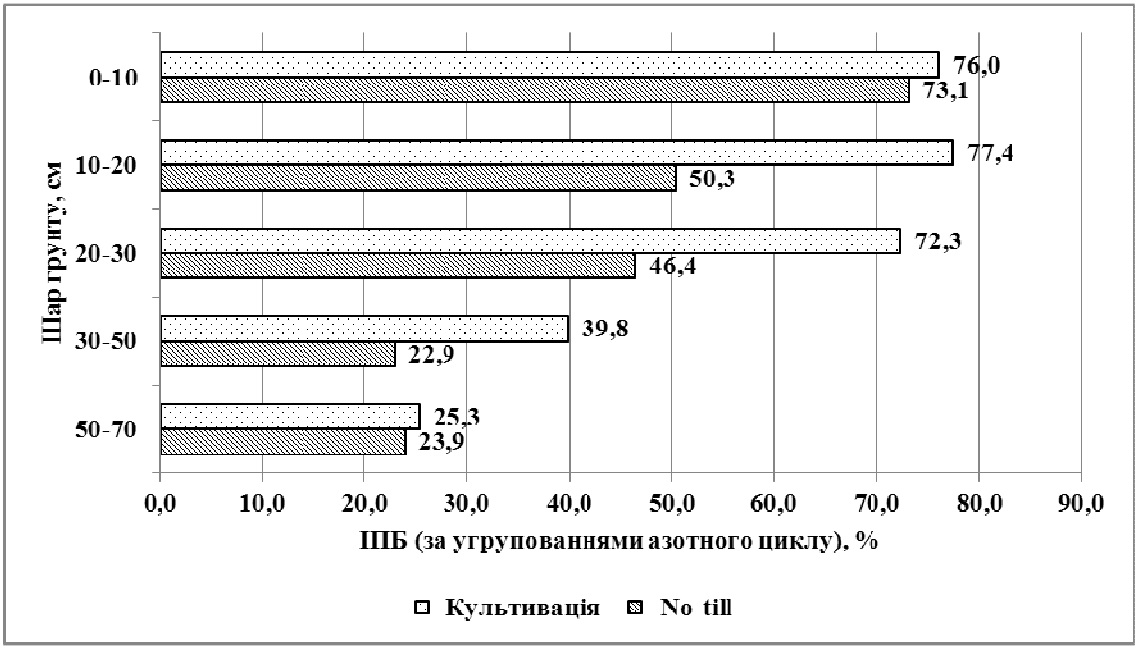
In general, soil biogene in layer 0-30 cm being cultivated, surpasses that of zero tillage option by 3,59 million CFU/g; yet such a difference is quite insignificant.

Quite different dynamics, per microbial cenosis amount in 0-30 cm soil layer, exists under cultivation conditions among grouping of micro-organisms that assimilate mineral forms of nitrogen; where decrease is traceable at 20 cm deep and down, though in general, index of biocenosis here is rather significant and makes up 37.7 mio CFU/g, thus by 2.8 times outstripping the same index in no-till regime.

Special attention was paid to the amount of microorganisms capable of nitrogen fixation. Two ecology-trophic groupings that use carbon from such sources as organic acids' salts and sugars were investigated. More uniformly, these groups scatter around 0-30 cm layer, no matter whether cultivated or zero-tilled. Assuming for all these index fluctuations, an average amount of N-fixators at this depth makes up: -19.10 mio CFU/g under cultivation regime, and -18,69 mio CFU/g in no-till conditions.

Generalization of thus obtained results via integrated index demonstrates the similar (for both types of tillage) trend of decrease in amount of microorganisms in soil strata below 30 cm (Fig. 1). In cultivation regime, this index is slightly prevailing; yet, on resuming particullar groupings, such the dynamics is explainable by a considerable amount of microorganisms that fix up mineral forms of nitrogen, and denitrifìcators as well. In its turn, the zero tillage variant has greatly differed in amount of nitrogen fixators in the upper soil layer, thus outstripping the same index of cultivation regime by 22 %.

The most biogenically-active in no-till regime is 0-10 cm soil layer, whereafter soil biogenety is reducing significantly. In the 0-10 cm layer, no-till approach promotes a richer microflora formation, versus that under cultivation regime. These phenomena are explainable by formation of favourable conditions of soil-water supply from 0-10 cm 'daily' surface layer, which condition is impossible with cultivation regime, especially in the Forest-Steppe zone, where droughty period may last for several months.



Legend: *Y- axis - Soil layer, cm X- axis - nitric-cycle microbial grouping index (%)*

Figure 1. *Influence of soil-tillage minimization approach on biogene of typical chermozem (per amount of nitric-cycle microbial groupings) during buckwheat vegetation*

By present day, researchers keep to different opinions as to need to intensify aboriginal microflora that promises accelerated of mineralization process activation. It was thus stated that in the process of soil tillage, organic residues are readily intermixing with mineral particles of soil, thus resulting in (a) enhancement of plant residues' interactive surface to contact with soil- microflora, and (b) acceleration of organic matter decomposition and mineralization with CO_2 emission [9].

Due to subsurface tillage approach, post-harvest residues stay concentrated within 0-15 cm deep soil layer. Succession of microorganisms that decompose the plant residues becomes similar to microbial complex of virgin soil. Amount of bacteria and actinomycetes, capable of existing on mineral nitrogen forms, increases also [10]. Hence, it's worth controlling these processes via introducing innovative methods, such as no-till techniques.

Conclusions. Our studies revealed the fact that due to more or less minimized soil-tillage stress, spatial and functional structure of microbial complex in typical chernozem undergoes definite rearrangements. With pre-sowing cultivation option, the highest level of soil biogene was observed in 0-30 cm deep layer.

Thus, on reviewing the above-cited results, it can be noted that for development of all the ecologo- trophic groups of microorganisms studied, ideal conditions occur in 0-30 cm- deep layer, no matter whether 'no-till' or 'pre-cultivation' decision is taken. However, tendency to upgrowth of such notable cenosis as N-fixators was found specifically with no-till option.

Yet in general, level of biogene generation in main bulk of plant-root system (0-30 cm) being cultivated, is by 7.7 % higher as compared to zero tillage conditions.

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