Researching of chemical and biological elements in No-Till agrotechnology

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Researching of chemical and biological elements in No-Till agrotechnology. Fundamental and Applied Soil Science, 19(1), 8–14. doi: 10.15421/041902

The richness of civilization is the soil which 99% of it produces food. There is more than 95% of the gene pool of living matter in the soil of planet. In modern conditions, there is a problem of rational use of soil as place for natural formations (edafotops) which are the most important components of biogeocenosis. The relevance of this work is that the soil as nutrient in the biosphere performs a unique function. The most important parameter is the fertility of the soil, which determines the basic properties of terrestrial ecosystems: efficient production and stability. Estimation of the main factors of fertilized edafotop is a mandatory element of environmental monitoring. The purpose of this work is to study the dynamics of acidity and assessment of humus content in soil with sand and character changes on the number of microorganisms of major ecological-trophic groups and quantitative analysis of microalgae with typical chernozem processing and No-Till. Scientific novelty of results. For the first time the complex estimation of features humus formation in typical horizons layer was conducted and the dependence population of the complex microbial edafotop farm was installed on the territory farming systems of Semenivka district of Poltava region. For research were selected 17 soil samples in Semenivka district (Poltava region). The soil samples were selected in the localities which use standardized methods and techniques. The objects of study are samples chernozem typical from edafotop with different processing technology, in particular after making defecate of sugar production, selected on the territory of the farm agrocenosis. Subject of research is dynamics of humus, microbiota and algae in soils that are traditionally handled by biotechnology and No-Till, and the impact to defecate of sugar production on the soil acidity. As a result of research settled the following tasks: 1) it was selected the samples of chernozem with varying technology soil processing; 2) it was estimated humus content by Tyurin (titrimetric) and acidity of soil samples by potentiometry; 3) it was investigated the feasibility of using a defecate of sugar production as fertilizer; 4) it was found the number of complex microbial studied soils; 5) it was set the factors in the formation of complex microbial soil; 6) it was set of environmental measures aimed at restoring of soil fertility. Soil samples were prepared for analysis by standard procedure. During the research a method of potentiometry to determine pH (degree of acidity of the soil solution) was used. The concentration of humus titrimetric determined by using of chromium mixture and Mohr's salt (I. V. Tyurin method). Preliminary preparation of soil for microbiological analysis was performed by dispersing. For quantifying soil microorganisms was used the method of planting soil slurry into solid peptone-agar nutrient media and Zvyagintsev scale. Statistical analysis of the results of research was carried out using MS Excel. The practical significance of the results is the scientific substantiation of ecological and economic profitability of introducing technology No-Till in Ukraine. This agrotechnology will preserve and restore the fertile layer of soil (improving its chemical, physical and biological properties, increasing content of organic matter in the soil), reduce or eliminate erosion of soil (no need to spend extra money to solve this problem), accumulate and retain the moisture in the soil, which in turn will reduce dependence the crop on climatic conditions and increase crop yields. It is established that the use of No-Till system increased content humus, increased the number of microorganisms and soil microalgae, which can significantly affect the fertility of chernozem.

Keywords: edafotop; humus; No-Till; biotechnology; defekat; microbiocenosis; soil mesofauna; biogeocenosis

Introduction
The richness of civilization is the soil due to which produces 99% of food. The modern soil science has adopted the definition of the soil that combines both genetic and phytocoenotic properties. The problem of rational use of soil cover appears in modern conditions, taking into account the peculiarities of soils as natural formations—edafotops—which are the most important components of biogeocenosis (Kiryushin, 2005).

In agricultural production, the quality of soil plays a significant role—a complex characteristic of biological and physical-chemical properties. The problem of rational use of soil cover appears in modern conditions, taking into account the peculiarities of soils as natural formations—edafotops—which are the most important components of biogeocenosis (Kiryushin, 2005).

The main and most valuable functional property of the soil is its fertility due to the content of humus in particular. As a result of agro-economic exploitation, the loss of humus occurs, that causes a decrease in a fertility of soil. Under such circumstances the necessity to maintain a fertility using mineral fertilizers appears. The measures of such kind are causing new environmental problems. Thus, preservation and restoration of natural fertility of soils, and first of all, chernozem, is an actual problem, especially in Poltava region (Nykyforov, 2011).

Using of modern advances in agrarian science and biotechnologies makes it possible to influence actively on the soil fertility. Among the main means that increase the soil fertility there is a system of soil cultivation. Nowadays, two technologies are distinguished fundamentally: traditional (tillage) and No-Till (no plow tillage) (Carlos Krovetto, 2010).

For several centuries in a row, traditional tillage has been used in European countries, consisting of enveloping the arable layer, crumbling and mixing the soil with the use of a dump plow. During this treatment, less than 10% of plant residues remains after sowing, which reduces the organic content of the soil, reduces the fertilizing layer in as a result of water and air erosion, and also negatively affects its structure (Nebavskyy, 2011).

Now the agricultural producer is in a rather difficult situation. First, there is a decrease in soil fertility as a result of the use of intensive crops, water and wind erosion, which leads to a decrease in the yield of agricultural plants. Secondly, this is caused by general climate change, in particular, by the increase in droughts, which also leads to a decrease in the phytocoenotic productivity of the fields. Thirdly, over the last decades, the cost of agrotechnical equipment, fertilizers, chemical and biological plant protection products, etc., has risen. (Baker, 2007).

The ways of solving of these issues are very urgent tasks of modern agronomy. One of these ways is the introduction of agricultural technology No-Till, which allows:

- to reduce substantially the damaging effects of water and wind erosion, to preserve the soil fertility for future generations;
- to receive stable crops of cultivated plants, especially in conditions of drought conditions;
- to obtain sustainable yields of cultivated plants, especially in drought conditions;
- to reduce production costs for fertilizers significantly, pesticides and other;
- to reduce capital costs for the purchase of fuel and lubricants, agricultural machinery, its exploitation;
- to increase the profitability of agroindustrial complex (Nebavskyy, 2003).

Therefore, the purpose of this work is to study the dynamics of acidity, humus content in soils and determine of trends in the change in the number of microorganisms in the main ecological-trophic groups of soil under the conditions of traditional and ezerov tillage.

Thus, for the first time, a complex evaluation of the peculiarities of humus layer formation of typical horizons was carried out and the dependence of the species composition, number and biomass of the microbiocenosis of chernozem edafotop on the system of tillage was established on the territory of farm in Semenivka district of Poltava region.

It was also proposed to consider the No-Till agrotechnology as a dual biotechnology, because it has the characteristics of typical elements: bioconversion of the substrate (soil nutrients) to the target product (phytomass) is carried out by a biological agent (photobiont) in the bioreactor (edafotop). The process of bioconversion provides by biagents. Preparation of the substrate and the collection of the product is carried out using appropriate agricultural techniques.

**Materials and methods**

To conduct the researches, soil samples were selected from izedafotops of agroecosystem on the territory of Semenivka district of Poltava region, which were cultivated as by traditionally method as using the No-Till technology (Fig. 1). To identify changes in the content of humus and its degree of biogenicity, the results were compared for three years – 2014, 2015 and 2016. Soil samples were taken at localities using unified methods and techniques (Fomin, 2001).

The soil samples were prepared for analysis according to the standard method. During the research, a method of potentiometry was used to determine the pH (the degree of acidity of the soil solution). The concentration of humus is determined by titrimerity using a chromium blend and Moras’ salt (Tyrin method) (Fomin, 2001). Preliminary preparation of soil for microbiological analysis was carried out by dispersion method.

For the quantitative record of soil microorganisms in prepared soil samples, the inoculation of a soil suspension was carried out on solid peptone-agarified nutrient media from three consecutive dilutions.

After counting the number of colonies in all parallel cups, the average number of colonies per cup is determined, which is converted into 1 gram of air-dry soil by the formula:

$$ a = \frac{b \cdot c \cdot d}{e} $$

where

- $a$ – number of cells per 1 g of soil; $b$ – the average number of colonies per cup; $c$ – the dilution from which the seed was made; $d$ – the number of drops in 1 ml of suspension; $e$ – the mass of air-dry soil taken for analysis.

To compare the soils according to the degree of microorganisms’ enrichment, the table of D. G. Zyvyagintsev (1991) was used.

To record earthworms, the fields with traditional tillage technology and No-Till technology were selected. The size of one trial site is at least 50 cm × 50 cm (and in some cases 1 m × 1 m each if there is a very low density). There were eight sites on the one field with the next excavation to a depth of 50 cm. It is known that it is expedient to calculate the number of Lumbricus terrestris per unit of volume of soil (1 dm$^3$ or 1 m$^3$), since the area of one site from which the sample was taken is 0.5 × 0.5 = 0.25 m$^2$ and the depth is 0.5 m, the volume of one sample is 0.125 m$^3$.

To conduct algologic studies, an average sample of five individual samples was used; soil samples were taken from a depth of 0–5 cm. The preparation prepared for the count was studied under a microscope. The number of algae cells was determined by the formula:

$$ x = a \cdot b \cdot 20, $$

where

- $x$ – the number of cells in 1 g of soil; $a$ – the number of cells found in the count; $b$ – is the number of drops in 1 ml of suspension; 20 – the dilution in ml.
Results and discussion

A study of the humus content in chernozem edafotops under traditional and “zero” technological processing showed that tillage systems significantly affect their quantity (Table 1).

It was established that when applying the No-Till technology, the process of humification occurs (an increase in humus by 0.15% on average per year). At the same time, the loss of organic matter as a result of the agrarian exploitation of chernozem by the traditional technology (decrease of humus by 0.02% per one year) in all samples was recorded. The maximum growth of humus (by 0.57%) was recorded in soil sample No.4, which was processed using the No-Till technology, and the maximum loss (0.42%) was recorded in soil sample No.3, which was processed using the traditional technology (both fields are near the village Vasilyivka) (Fig. 1).

In the system of measures to improve the soil fertility, one of the main places is occupied by a scientifically based crop rotation. When planning crop rotation, soil and climatic conditions, specialization of the economy, availability of

Table 1
Content of humus at different tillage for three years

| No. | Place of samples selection, name of field (technology of processing) | Humus, % |  |  | Deviation |
|-----|---------------------------------------------------------------|----------|---|---|----------|
|     |                                                               | in 2014  | in 2015 | in 2016 |          |
| 1   | Biloguby (Trad.)                                              | 4,61 ± 0,005 | 4,66 ± 0,006 | 4,61 ± 0,005 | ± 0,005 |
| 2   | Biloguby (No-Till)                                            | 6,22 ± 0,011 | 6,22 ± 0,001 | 6,25 ± 0,001 | ± 0,002 |
| 3   | Kyrpychne (left) (Trad.)                                      | 5,96 ± 0,013 | 5,54 ± 0,001 | 5,75 ± 0,056 | ± 0,028 |
| 4   | Kyrpychne (left) (No-Till)                                    | 4,50 ± 0,008 | 5,07 ± 0,002 | 4,97 ± 0,005 | ± 0,048 |
| 5   | Kyrpychne (right) (No-Till)                                   | 6,37 ± 0,004 | 6,37 ± 0,004 | –          | ± 0,000 |
| 6   | Kyrpychne (right) (Trad.)                                     | 4,09 ± 0,007 | 4,20 ± 0,004 | –          | ± 0,013 |
| 7   | Chapayevske (No-Till)                                         | 3,73 ± 0,010 | 4,14 ± 0,003 | –          | ± 0,049 |
| 8   | Hrebli (No-Till)                                              | 4,87 ± 0,003 | 5,14 ± 0,007 | –          | ± 0,026 |
| 9   | Ocheretuyate (Trad.)                                          | 5,28 ± 0,010 | 5,59 ± 0,002 | –          | ± 0,027 |
| 10  | Inkubator (Trad.)                                             | 5,96 ± 0,014 | 5,90 ± 0,005 | 5,91 ± 0,025 | ± 0,004 |
| 11  | Inkubator (No-Till)                                           | 5,90 ± 0,005 | 5,90 ± 0,006 | 5,95 ± 0,004 | ± 0,004 |
| 12  | Khudoliyivka Substation (No-Till)                             | 5,15 ± 0,013 | 5,18 ± 0,007 | –          | ± 0,003 |
| 13  | Khudoliyivka Garden (No-Till)                                 | 3,94 ± 0,005 | 3,98 ± 0,003 | –          | ± 0,005 |
| 14  | Khudoliyivka Sinnik (No-Till)                                 | 5,23 ± 0,006 | 5,33 ± 0,006 | –          | ± 0,009 |
| 15  | Khudoliyivka Naumenko (Trad.)                                 | 6,06 ± 0,005 | 6,06 ± 0,004 | –          | ± 0,000 |
| 16  | Symie more (No-Till)                                          | 3,73 ± 0,010 | 3,78 ± 0,004 | –          | ± 0,006 |
| 17  | Khutorets (No-Till)                                           | 3,63 ± 0,005 | 3,78 ± 0,002 | –          | ± 0,019 |

Fig. 1. Sceleton-chart of localities where soil samples were taken
equipment, fertilizers and other conditions are taken into account. The need to alternate crops is justified by the fact that plants do not equally use nutrients from the soil: some use more nitrogen, others – phosphorus, and others – potassium, so when alternating crops, effective fertility is maintained for a long time.

In the process of harvesting, the acidity of the soil plays an important role, which increases due to the violation of the cycle of biological restoration of land resources. Under the conditions of modern agriculture, plant remains do not remain in the soil. As a result, the natural cycle is stopped and they are trying to restore it through chemical fertilizers, which help to obtain high yields, but deplete the soil, making it acidic and unsuitable for further effective use.

One of the ways to eliminate excess acidity is to prepare defecate from sugar production. During research, aqueous solutions of such defecate were prepared with concentrations of 1, 4, 12, and 25%, respectively. The measured pH of these solutions is 8.88; 9.11; 8.85 and 8.63, respectively, which is confirmed by the composition of defecate (60–75% Calcium)

Changes in the pH of solutions with changes in the concentration of defecate are most likely due to the hydrolysis of calcium hydroxide, that is, the release of Ca\(^{2+}\) and OH\(^{-}\) ions.

With increasing of defecate concentration in an aqueous solution, the equilibrium shift goes towards the formation of low-soluble Ca(OH)\(_2\), in turn, is reflected in the pH value.

Based on the results obtained, we can conclude that the optimal from agrochemical point of view, and from the point of view of the biological activity of the soil solution is the concentration of defecate from 3 to 6%, because in this interval there was an increase in pH to the maximum value.

At higher concentrations, it ceases to be digestible for plants, which can affect crop yields. In addition, high concentrations of defecate solution can lead to soil liming, which is a factor in the formation of ecological and chemical risk in agroecosystem.

### Table 3: Indicators of soil acidity under different conditions of tillage

| No.  | Place of samples selection | 2014 | 2015 | 2016 |
|------|---------------------------|------|------|------|
| 1    | Bilotuhy (Trad.)          | 8,30 | 8,26 | 8,27 |
| 2    | Bilotuhy (No-Till)        | 8,30 | 8,24 | 8,29 |
| 3    | Kyrpychne (left) (Trad.)  | 7,90 | 8,00 | 7,97 |
| 4    | Kyrpychne (left) (No-Till)| 8,40 | 8,43 | 8,40 |
| 5    | Kyrpychne (right) (No-Till)| 8,35 | 8,32 | 8,34 |
| 6    | Kyrpychne (right) (Trad.) | 8,52 | 8,55 | 8,54 |
| 7    | Chapayevskie (No-Till)    | 8,20 | 8,23 | 8,22 |
| 8    | Hrelia (No-Till)          | 8,66 | 8,61 | 8,64 |
| 9    | Ocheretuvate (No-Till)    | 9,13 | 9,10 | 9,12 |
| 10   | Inkubator (Trad.)         | 8,30 | 8,33 | 8,33 |
| 11   | Inkubator (No-Till)       | 8,56 | 8,52 | 8,54 |
| 12   | Khudoliyivka Substation (No-Till) | 7,70 | 7,67 | 7,68 |
| 13   | Khudoliyivka Garden (No-Till) | 6,97 | 7,00 | 6,99 |
| 14   | Khudoliyivka Simnyk (No-Till) | 6,90 | 6,88 | 6,89 |
| 15   | Khudoliyivka Naumenko (Trad.) | 8,40 | 8,42 | 8,41 |
| 16   | Synie more (No-Till)      | 8,34 | 8,30 | 8,32 |
| 17   | Khotorets (No-Till)       | 8,39 | 8,40 | 8,40 |

It is well known about the significance of the decomposition of organic substances trapped in the soil and its enriching with humus from earthworms. These animals are the main soil improvers, whose activities cannot be fully compensated, since they perform various functions: mechanical and chemical destruction of the cell structure of plant residues; mineralization and humification of organic; neutralization of acidic decomposition products of plant tissues, selective stimulation of certain groups of bacteria, fungi and algae; increased mobility of Nitrogen, Potassium, Phosphorus, Magnesium and Calcium. Representatives of the family Lumbricidae are the most common in the soil. Important factors affecting their abundance are soil moisture and the presence of nitrogen-containing organic matter (Nazarenko, 2004).

For each of the studied fields, the number of earthworms in the total soil volume of 1 m\(^3\) was determined (Table 4). Investigations have shown that their number is much higher in edafotop treated using the No-Till technology, because the soil cover is not disturbed. The channels created by the earthworms improve water infiltration into the soil, increase soil aeration and the availability of Nitrogen for plants. The traditional technology of tillage damages the medium of survival of the earthworms, thereby reducing the number of their populations.

Plants of different classes of *Triticum durum* L. and *Pisum sativum* L. were selected as test crops for determining the biological activity of the investigated defecate of sugar production. The test culture (100 grains in each) in Petri dishes were immersed in solutions with different concentrations of defecates. Distilled water is used for control. Observations made it possible to reveal the dependence of the speed and frequency of germination of the grains, as well as the length of the hypocotyls on the concentration of the solutions (Table 2).

### Table 2: Statistical processing results

| Test-object          | Control | Concentration 4% | Concentration 12% | Concentration 25% |
|----------------------|---------|------------------|-------------------|-------------------|
| *Triticum durum* L.  | 80,25±  | 83,50±           | 77,50±            | 81,00±            |
| *Pisum sativum* L.   | 97,75±  | 97,00±           | 96,25±            | 96,50±            |

Thus, the expediency of using the defecate of sugar production as an amelioration for edafotop of farming in the Semenivka district (Poltava region) has been proved, because its transfer into the soil leads to improvement in its structure, increase of enzymes activity, increase the quantity of Calcium and Magnesium.

It was also found that when tilling the soil according to the traditional system and using the No-Till technology, the pH value is within 7.00–9.13, therefore, the introduction of a defect is not recommended, as it causes alkalization of the soil. But under conditions of edafotop, where the pH value is less than 7, introduction of defecate of sugar production is advisable (field «Khudoliyivka Simnyko» (Table 3).
The use of soil, especially when applying various technologies for growing crops, leads to a change in the state of microbiocenosis, which according to many researchers can be one of the integral indicators of soil fertility (Zviagencev, 1999). The study of the quantitative state of the soil microbiota allows adjusting the conditions and methods of farming in order to optimize it, and therefore affect the fertility factors of the soil. To study and record the soil microorganisms was conducted a surface sowing on solid agarized medium for their quantitative estimation.

The data of the comparative analysis of experimental results in determination of the quantitative composition of microorganisms in chernozem biogeocenosis, which are subjected to traditional tillage and where the technology of «zero» processing is used, has shown for three years, that, while using of No-Till technology (Table 5), the enrichment of soil by microorganisms (an increase of average of 7%) increased and the number of microbiota was decreased due to the agrarian exploitation of chernozem by traditional tillage technology (a decrease of average of 2.5%) in all samples (Table 5). The maximum increase in the number of soil microorganisms (by 20%) was recorded in a sample of chernozem, selected at the site with using No-Till technology near Khudoliyivka village, and the maximum loss (7%) was in the sample from the edafotop of agrocenosis with the traditional processing at the site between villages Khudoliyivka and Khilivka.

The results of microbiological inoculations of the studied soil samples demonstrate a high total amount of soil microorganisms at «zero» processing (4.0–7.3 mln/g of air-dry soil). Smaller parameters had soils with traditional cultivation technology (3.0–5.0 mln/g of air-dry soil), where the degree of microorganisms was reduced by average of 2.5% in all samples. The smallest parameter of the quantitative composition of soil microorganisms from sample No. 6 were characterized by microorganisms were taken between the villages Chapaivka and Egorivka (3.0–3.1 mln/g of air-dry soil). Such a decrease in the total number of microorganisms is due to the lack of organic residues in the soil and soil climatic conditions.

It is important to note that beside the cultivation technology the crop rotation of grown plants in crop production affects the dynamics of number of microbiota in edaphotop. According to experimental data, the greatest increase in the quantitative composition of microorganisms is observed in the case of crop rotation corn – corn (Table 6). In our opinion, this is due to the fact that corn has big residues of stubble and provides additional moisture and appropriate trophism for them.

### Table 4
The number of Lumbricusterrestris in Poltava chernozem with different technologies of tillage (2016)

| No. | Place of samples selection | Quantity | Lumbricusterrestris (pieces×1 m³) |
|-----|---------------------------|----------|-----------------------------------|
| 1   | Biloguby (Trad.)          | 15       |                                   |
| 2   | Biloguby (No-Till)        | 16       |                                   |
| 3   | Kyrypychne (left) (Trad.) | 28       |                                   |
| 4   | Kyrypychne (left) (No-Till)| 36      |                                   |
| 5   | Inkubator (Trad.)         | 25       |                                   |
| 6   | Inkubator (No-Till)       | 35       |                                   |

### Table 5
Changes in the quantitative composition of microbiota in Poltava chernozem with different processing technologies

| No. | Place of samples selection | Number of bacteria per MPA (mln/g) | Degree of soil enrichment by microorganisms on the Zvyagintsev scale |
|-----|----------------------------|-----------------------------------|---------------------------------------------------------------|
|     |                            | 2014  | 2015  | 2016  | 2014 | 2015 | 2016 |
| 1   | Biloguby (Trad.)          | 3,2   | 3,0   | 3,3   | Middle enrichment | Middle enrichment | Middle enrichment |
| 2   | Biloguby (No-Till)        | 5,9   | 6,1   | 6,5   | Rich            | Rich            | Rich            |
| 3   | Kyrypychne (left) (Trad.) | 4,0   | 3,9   | 4,0   | Middle enrichment | Middle enrichment | Middle enrichment |
| 4   | Kyrypychne (left) (No-Till)| 5,0  | 5,5   | 5,4   | Middle enrichment | Rich            | Rich            |
| 5   | Kyrypychne (right) (No-Till)| 7,0  | 7,3   |       | Rich            |               |               |
| 6   | Kyrypychne (right) (Trad.)| 3,0   | 3,1   |       | Middle enrichment | Middle enrichment |               |
| 7   | Chapayevske (No-Till)     | 4,2   | 5,0   |       | Middle enrichment | Middle enrichment | Rich            |
| 8   | Hrebli (No-Till)          | 4,8   | 5,5   |       | Middle enrichment | Rich            |               |
| 9   | Ocheretuvate (Trad.)      | 4,0   | 3,9   |       | Middle enrichment | Middle enrichment | Middle enrichment |
| 10  | Inkubator (Trad.)         | 5,0   | 4,9   | 4,8   | Rich            | Middle enrichment i | Middle enrichment |
| 11  | Inkubator (No-Till)       | 5,5   | 5,2   | 6,0   | Rich            | Rich            | Rich            |
| 12  | Khudoliyivka Substation (No-Till)| 5,5 | 5,8   |       | Rich            | Rich            |               |
| 13  | Khudoliyivka Garden (No-Till)| 4,0 | 4,5   |       | Middle enrichment | Middle enrichment |               |
| 14  | Khudoliyivka Sinnyk (No-Till) | 5,2 | 5,4   |       | Rich            | Rich            |               |
| 15  | Khudoliyivka Naumenko (Trad.) | 4,7 | 4,4   |       | Middle enrichment | Middle enrichment |               |
| 16  | Synie more (No-Till)      | 4,0   | 5,1   |       | Middle enrichment | Rich            |               |
| 17  | Khutorets (No-Till)       | 5,2   | 5,1   |       | Rich            | Rich            |               |
Regarding humus content, its slight increase (by 0.05%) is clearly traced along with a significant increase (by 20%), depending on the degree of soil microbial enrichment in the sample, selected from the No-Till system cultivation in «Synie more» (Table 5), which may be explained by the fact that corn is a sufficiently debilitating culturing for soils, and for microorganisms it is an additional nutrient medium. At the same time, microbiota provides high yield of corn due to the enzymatic mineralization of humic substances.

When crop rotation soybean – wheat in samples taken from traditional and «zero» cultivation technologies (the field «Incubator») there is a slight decrease in the total number of microflora, that can be explained by an insufficient amount of stubble from these crops, and as a result, insufficient conservancy of moisture and nutrients to nourish microorganisms. In the same samples, the humus content did not increase (Table 6), which may be due to the low physiological activity of microorganisms, as well as the depleting of soil by soybeans as a culture (decrease in the humus content in the sample during traditional processing – the field «Incubator»).

Thus, the original microbiological studies of edafotops confirmed that the number of soil microorganisms, in addition to the soil-climatic conditions, also depends on the technologies of agrarian cultivation of soils. After all, the species composition and the number of microorganisms depend on the photothermal gradient of abiotic factors, as well as the structural and functional organization of phytoceneses.

Algae, unlike most other microorganisms of edafotop, contribute to the enrichment of soils with organic matter and oxygen. Soil algae are single- and multicellular microorganisms (sometimes mobile) that have specific pigments of the chlorophyll type, which ensure the assimilation of carbon dioxide and photosynthesis of organic matter. Using moisture, they enrich the surface with fresh organic matter, cause increased destruction of primary minerals, and increase the dispersion of the solid phase. Some algae play a significant role in the transformation of the compounds of Silicon and Calcium in the soil, while others have the ability to capture Nitrogen. The amount of algae in the soil depends on the environment, especially on the water and salt regimes of the soil, on the terrestrial vegetation, etc., and in cultivated soils - from agrotechnics (Zviagencev, 1999). Therefore, quantitative counting of soil microalgae is one of the important aspects when studying soil fertility.

The results of algological studies of soil showed a high total number of microalgae in samples taken at sites using No-Till agrotechnology, which indicates their steady humidity. It is No-Till technology that helps to enrich the soil with water, which leads the increasing of number microalgae and that is necessary for active formation of organic matter. Samples that selected on sites with traditional agrotechnology showed a sufficient level of enrichment with microalgal biomass, but quantitatively, the parameters are considerably inferior to the biotechnology No-Till (Table 7).

Table 6
Correlation of changes in the content of humus and the number of microorganisms in chernozem with different cultivation technology for 2 years

| No. | Place of samples selection | Humus content, % 2014 | Number of bacteria per MPA (mln/g) 2014 | Humus content, % 2015 | Number of bacteria per MPA (mln/g) 2015 | Crop rotation |
|-----|---------------------------|------------------------|----------------------------------------|------------------------|----------------------------------------|---------------|
| 1   | Biloguby (Trad.)          | 4.61 ± 0.005           | 3.2±0.030                              | 4.66 ± 0.006           | 3.0±0.030                              | Sunflower – Corn |
| 2   | Biloguby (No-Till)        | 6.22 ± 0.011           | 5.9±0.015                              | 6.22 ± 0.001           | 6.1±0.015                              | Sunflower – Corn |
| 3   | Kyrpychne (left) (Trad.)  | 5.96 ± 0.013           | 4±0.012                                | 5.54 ± 0.001           | 3.9±0.012                              | Sunflower – Corn |
| 4   | Kyrpychne (left) (No-Till)| 4.50 ± 0.008           | 5.0±0.045                              | 5.07 ± 0.002           | 5.5±0.045                              | Sunflower – Corn |
| 5   | Kyrpychne (right) (No-Till)| 6.37 ± 0.004          | 7.0±0.019                              | 6.37 ± 0.004           | 7.3±0.019                              | Oil seed rape – Corn |
| 6   | Kyrpychne (right) (Trad.) | 4.09 ± 0.007           | 3.0±0.015                              | 4.20 ± 0.004           | 3.1±0.015                              | Oil seed rape – Corn |
| 7   | Chapayevskoe (No-Till)    | 3.73 ± 0.010           | 4.2±0.082                              | 4.1±0.003             | 5.0±0.082                              | Corn – Fall wheat |
| 8   | Hrebli (No-Till)          | 4.87 ± 0.003           | 4.8±0.064                              | 5.1±0.007             | 5.5±0.064                              | Sugar-beet – Sunflower |
| 9   | Ocheretuvate (Trad.)      | 5.28 ± 0.010           | 4.0±0.012                              | 5.59 ± 0.002           | 3.9±0.012                              | Sugar-beet – Sunflower |
| 10  | Inkubator (Trad.)         | 5.96 ± 0.014           | 5.0±0.009                              | 5.90 ± 0.005           | 4.9±0.009                              | Oil seed rape – Fall wheat |
| 11  | Khudolievivka Substation (No-Till) | 5.15 ± 0.013 | 5.5±0.018                              | 5.90 ± 0.006           | 5.2±0.018                              | Oil seed rape – Fall wheat |
| 12  | Khudolievivka Garden (No-Till) | 3.94 ± 0.005          | 4.0±0.055                              | 3.98 ± 0.003           | 4.5±0.055                              | Corn – Fall wheat |
| 13  | Khudolievivka Sinnyk (No-Till) | 5.23 ± 0.006          | 5.2±0.017                              | 5.3±0.006             | 5.4±0.017                              | Corn – Fall wheat |
| 14  | Khudolievivka Naumenko (Trad.) | 6.06 ± 0.005          | 4.7±0.031                              | 6.0±0.004             | 4.4±0.031                              | Corn – Fall wheat |
| 15  | Khudolievivka Synie more (No-Till) | 3.73 ± 0.010          | 4.0±0.045                              | 3.78 ± 0.004           | 5.1±0.045                              | Corn – Sunflower |
| 16  | Khutorets (No-Till)       | 3.63 ± 0.005           | 5.2±0.009                              | 3.78 ± 0.002           | 5.1±0.009                              | Sunflower – Corn |

Table 7
Quantitative indicators of the composition of microalgae in Poltava chernozem with different tillage technologies in 2016

| Sample No. | Number of cells in 1 g of soil |
|------------|-------------------------------|
| 1. Incubator (Traditional) | 460 000± 0.005               |
| 2. Incubator (No-Till)     | 1 500 000± 0.012              |
| 3. Kyrpychne (left) (Traditional) | 320 000± 0.008               |
| 4. Kyrpychne (left) (No-Till) | 900 000± 0.006               |
| 5. Biloguby (Traditional)  | 370 000± 0.031                |
| 6. Biloguby (No-Till)      | 1 200 000± 0.007              |
Conclusion

1. The acceleration of the process of humification (humus increase by 0.15% on average in one year) has been established due to using No-Till technology and the loss of organic matter due to the agrarian exploitation of chernozem by traditional technology (humus reduction by 0.002% over one year) in all samples. The maximum growth of humus (by 0.57%) was recorded in the soil sample using No-Till technology – the field «Kyrpychne-1», while the maximum loss (0.42%) was in the soil sample, which was processed according to the traditional technology, the field «Kyrpychne-1» (both fields are near village of Vasilivka).

2. The dependence of the number of earthworms on soil cultivation technology was recorded. According to No-Till technology, the number of Lumbricusterrestris is growing significantly (16–36 pcs/m³). In the cultivated fields under the traditional technology the number of Lumbricusterrestris population was changing (15–28 pcs/m³).

3. From the agrochemical point of view of the the soil solution’s biological activity, the concentration of defecate of sugar production is optimal from 3 to 6%. The increase in the concentration of the solution causes the increase in seed germination of the test cultures Triticum dicoccon, Pisum sativum to 85.00–97.00% and does not affect the length of the hypocotyls. At low concentrations, the length of the shoots is different, but the number of germinated grains decreases.

4. It has been established that as the traditional tillage as No-Till technology had the pH value within the range of 7.00–9.13, so defecate fertilizing is not recommended because it causes soil alkalization. But in the conditions of the edafotop the pH value is less than 7, the introduction of defecate where the pH value is less than 7, the introduction of defecate of sugar production is appropriate (field «Kudoliiyivka Sinnyk» (No-Till)).

5. A high total amount of microorganisms in zero cultivated land (4.0–7.3 mln/g of air-dry soil) was established. An increase in the degree of microbiota enrichment was recorded on average by 7%. Lower parameters were established for soils with traditional cultivation technology (3–5 mln/g air-dry soil), where the degree of microbiota enrichment decreased by an average of 2.5% in all trials. The smallest parameter of soil biogenesis was the sample taken between villages of Chapayevka and Yegorivka (3,0–3,1 mln/g air-dry soil).

6. The results of algological studies of soils showed the high number of microalgae in samples with edafotscultivated using No-Till agrobiotechnology (0.9–1.5 mln cells per 1 g). In samples taken at sites with traditional agrotechnology the number is 320–460 k cells per 1 g (it is in three times less than technology No-Till).

7. The maximum increase in number of soil microorganisms is registered at the crop rotation of corn – corn, and an increase in humus in crop rotation of sunflower – corn.

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