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Biological Indicators And Fertility Of Leached Black Soil Depending On The Elements Of Crop Rotation Biologization Management And The Use Of Resource-Saving Tillage Systems.

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ABSTRACT

One of the indicators of soil fertility is a biological activity associated with the vital activity of living organisms. Continuous flow into the soil of crop residues and microbiological transformation are necessary conditions of humus formation. Organic matter contains a lot of stored energy due to which tiny fungi and microorganisms live, breed and carry out a lot of work in the soil. They destroy the fresh organic matter, converting it into inorganic mineral compounds. The article presents the dynamics of the processes of transformation and mineralization of soil organic matter. There was investigated the degree of influence of a clean and green manure fallow and the basic tillage systems on the dynamics of microbiological processes. It was found that the most favorable conditions for the synthesis of humus substances evolved in versions with green manure fallow, subsurface loosening and minimum shallow basic tillage.

Keywords: biological activity, humus, type of fallow, primary tillage.

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INTRODUCTION

Soil is a biological system, and all the substances conversion processes in it are determined by the activity of microorganisms. The intensification of agricultural production with the extensive use of various agricultural practices is accompanied by significant changes in the biological activity of soils. Under these conditions, inevitably increases the level of mineralization processes, resulting in high intensity of decomposition of organic residues and reduce their coefficients of humification [1, 2].

At present, worldwide scholars and agricultural practitioners are concerned about the growing decrease of humus content in arable soils. Under the conditions of intensive agriculture mineralization of humus significantly increases depending on the rotation type by 0.5–2.0 tons / ha per year. This means that the decrease of humus in soil could reach 1.0 % within 15–20 years. According to the Russian Research Institute of Agriculture and protection against soil erosion, using current processing technology black soils lose 0.8–1.2 % of humus in the topsoil, and more than 3.5 % on sloping lands within 30–40 years. Depending on the degree of intensification of agriculture (the proportion of row, grain, legume grasses in the rotation, the availability of clean fallow, the use of fertilizers, irrigation, etc.) and the type of soil humus content in the soil can be reduced annually by an average of 0.5–1.0 t / ha [8, 9].

In this context the study of the influence of biologization elements level of crop rotation and main processing systems on the fertility of leached black soil is the actual direction in conditions of forest-steppe of the Middle Volga.

MATERIALS AND METHODS

The studies were conducted in 2011-2014 at a stationary field experiment of the Department of General Agriculture and land management of Penza State Agricultural Academy in eight-field grain-fallow-grass crop rotation with the following crops alternation: 1. Black fallow – 0.3 hectares, green manure fallow – 0.3 hectares; 2. Winter wheat – 0.6 hectares; 3. Spring wheat – 0.6 hectares; 4. Vico oats with clover – 0.6 hectares; 5. Red clover of the first year of use – 0.6 hectares; 6. Red clover of the second year of use – 0.6 hectares; 7. Winter wheat – 0.6 hectares; 8. Spring wheat – 0.6 hectares.

The soil of pilot area is represented by leached black earth soil with loamy granulometric composition. The average humus content in the arable layer is 5.92 %, the reaction of the soil solution in the arable horizon is weakly acid (pHsol 5.0–5.1), the content of alkali-hydrolyzed nitrogen is from 81 to 98 mg per 1 kg of soil, of mobile phosphorus is of average value, of exchangeable potassium (according to Chirikov) is increased.

The purpose of research is to study the intensity and direction of microbiological processes, depending on the factors studied, aimed at improving fertility of soils and crop productivity.

The studies were conducted in winter wheat crops, placed in a fallow link of a crop rotation. In accordance with the research program the two-factor field experiment was founded in the following way.

Factor A – the form of fallow:

A_0 – fallow (control);
A_1 – green manure fallow (spring vetch + white mustard).

Factor B – basic tillage system:

B_0 – Two-phase moldboard treatment, including disking at 0,08–0,10 m and the plowing to a depth of 0.25–0.27 m;
B_1 – A two-phase till methods, including disking at 0.08–0.10 m and moldboard tilling to a depth of 0.25–0.27 m;
B_2 – Minimum fine processing comprising double disking at 0.08–0.10 and 0.10–0.12 m.

The variants were made by the split plots. Repeated experience fourfold.

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EXPERIMENTAL PART

The continuous flow of crop residues and microbiological transformation into the soil are the necessary conditions of humus formation [3, 7]. The organic matter contains a lot of stored energy, through which tiny fungi and microorganisms live, breed and spend a great job in the soil. They destroy fresh organic matter, converting it into inorganic mineral compounds [4, 6]. The speed of transformation of various compounds, decomposition of plant residues and accumulation of nutrients, necessary to cultivated plants depend on the activity and orientation of biological processes in the soil [5].

For the entire period of research, the highest coefficient of mineralization of organic matter, calculated as the ratio of the number of bacteria on starch-ammonia agar and the total number of bacteria on meat-peptone agar, was observed on plots with fallow and on average this indicator in soil layer 0–0.3 m increased by 3 % compared with green manure fallow. In variants with plowing, this figure was increased to 1.40, with a minimum of small primary tillage it was reduced to 1.13 (figure 1). This tendency is confirmed by the strong negative correlation dependence between the rate of mineralization and the systems of main soil tillage (figure 2). The regression equation in this case was y = 1.4633 – 0.1125 x (r = -0.93). It should also be noted that the factor increases salinity reduces the content of organic matter in the topsoil. The analysis of the degree of influence of the coefficient of mineralization on the humus content (figure 3) shows close correlation between the indicators (r = -0.91).

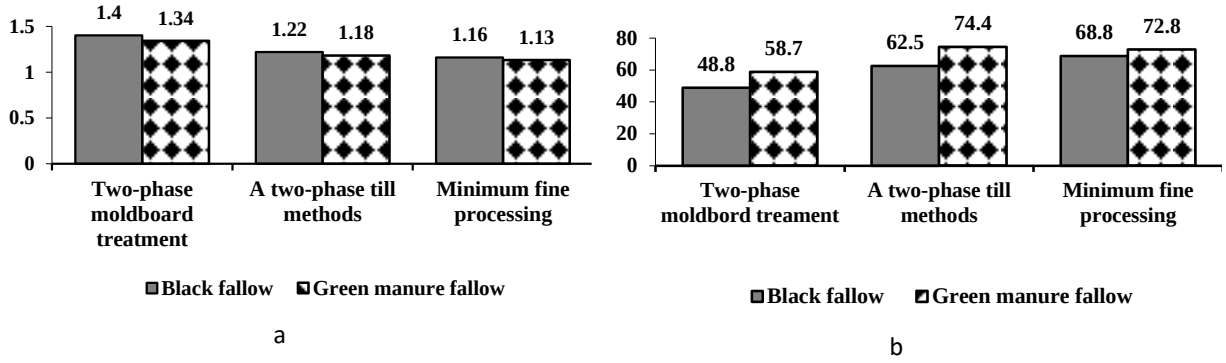
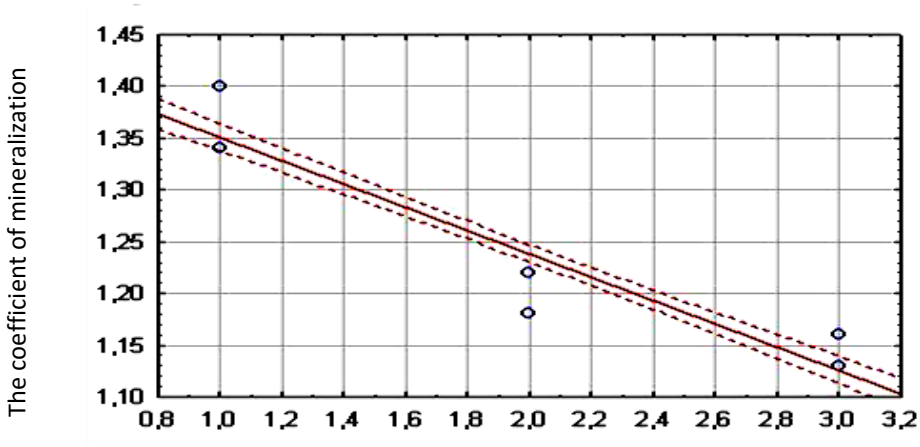


Figure 1 – The Coefficients of mineralization (a) and transformation (b) of organic substances in soil layer 0–0.3 m in winter wheat (the heading stage).



Basic tillage systems
1 – Two-phase moldboard treatment
2 – A two-phase till methods
3 – Minimum fine processing

Figure 2 – The dependence of the coefficient of mineralization in the topsoil from the systems of primary tillage

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The value of transformation of ratio organic matter (PM) indicates the direction of the process of microbiological transformation of plant residues in the direction of the synthesis of humic substances or in the direction of mineralization of organic matter and it reflects the potential intensity of the accumulation of humus substances in the soil. In three years of research the transformation ratio in the plots after the green manure fallow was increased by 6–20 % with respect to control

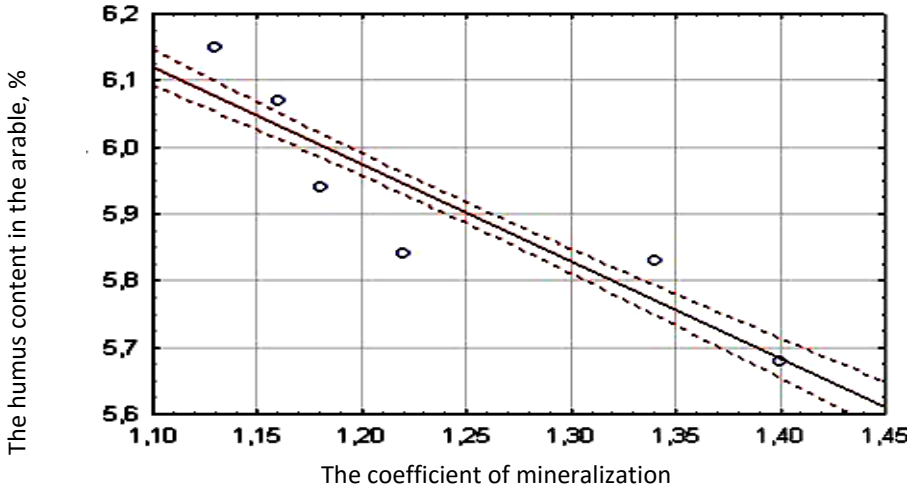

Figure 3 – The dependence of the content of humus in the topsoil on the coefficient of mineralization

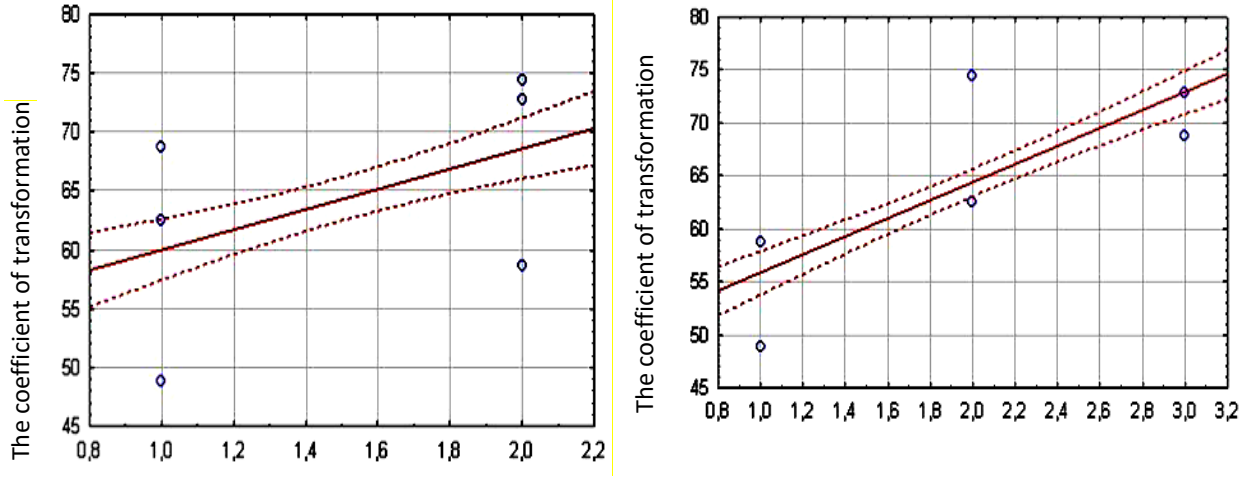

Figure 4 – The dependence of the coefficient of transformation from the type of fallow and basic tillage systems

The analysis of the degree of influence of fallow types systems and the basic processing of soil on the transformation ratio of organic matter (figure 4) showed the presence of the average correlation between species pair and ratio (r = 0.49). Strong direct correlation was observed between the rate of organic matter transformation and tillage systems, which was expressed by the regression equation y = 47.283 + 8.5250 x and a correlation coefficient of 0.79, which in turn explains the strong direct relationship (r = 0.86) of humus content from the transformation ratio of organic matter (figure 5).

Research has shown that in variants with plowing was a uniform distribution of humus in arable layer (table 1). Subsurface tillage and minimum fine processing contributed to the differentiation of the humus content in the upper soil layers. In a variant with a minimum shallow tillage in the 0–0.3 m layer the

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percentage of humus was the highest – 6.07–6.15 %. Assessing the role of species fallow, it should be noted that in all tillage systems after green manure fallow there was observed an increase of humus content in the plough horizon by 0.11 %, while this indicator was in the range of 5.83–6.15 %.

Table 1 – Content of humus depending on the type of fallow and basic tillage systems, %

Main tillage system	Soil layer, m	Type of fallow	
		Black fallow	Green manure fallow
Two-phase moldboard	0-0.1	5.87	6.01
	0.1-0.2	5.84	5.97
	0.2-0.3	5.32	5.51
Two-phase subsurface	0-0.1	6.13	6.22
	0.1-0.2	5.89	6.09
	0.2-0.3	5.49	5.51
Minimum shallow	0-0.1	6.21	6.34
	0.1-0.2	6.09	6.11
	0.2-0.3	5.91	5.99

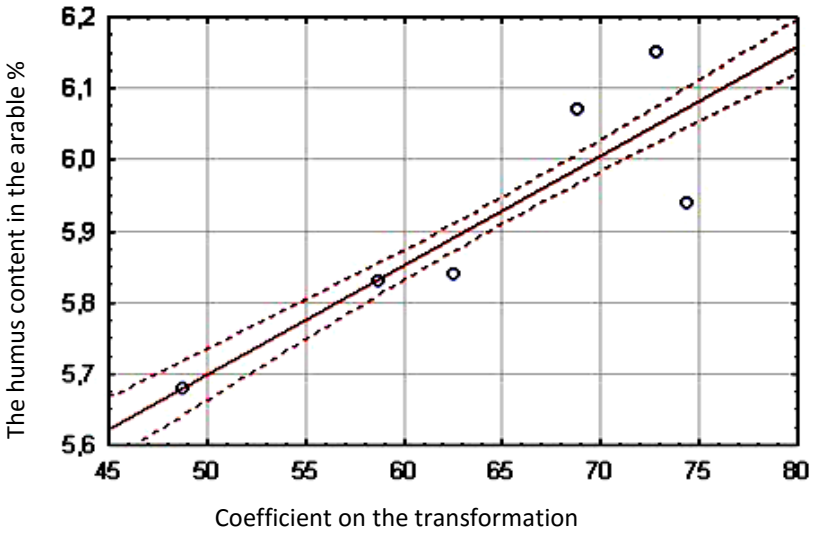

Figure 5 – The dependence of humus coefficient on the transformation of organic matter

The analysis of the degree of influence of fallow types and systems of main soil tillage on humus content in arable layer of soil shows the average correlation between the humus content and the form of steam, while the regression equation was y = 5.7533 + 0.11000 x, and the correlation coefficient amounted to 0.35. The strong positive correlation was observed between the content of humus in the topsoil and the systems of primary tillage. The dependence is expressed by regression equation y = 5.5633 + 0.17750 x. The correlation coefficient amounted to 0.92.

CONCLUSIONS

In variants with plowing there was a uniform distribution of humus in arable layer. No-till and minimum tillage shallow processing facilitated the differentiation of the humus content in the upper soil layers. In a variant with the minimum shallow tillage in the 0–0.3 m layer the percentage of humus was the highest – 6.07–6.15 %. On all systems of tillage after green manure fallow there was observed an increase of humus content in the topsoil by 0.11 %, while this indicator was in the range of 5.83–6.15 %. The highest coefficient of mineralization of organic matter was observed on plots with fallow, on average, this ratio in soil layer of 0–0.3

m was increased by 3 % compared with green manure fallow. In variants with plowing, this figure was increased to 1.40, with a minimum shallow tillage it decreased to 1.13.

The most favorable conditions for the synthesis of humus substances evolved in the variants with green manure fallow, subsurface loosening and minimal shallow primary tillage.

REFERENCES

[1] Bogomazov, S. V. The Role of Cultural Practices and Abiotic Factors in the Yield Formation of Winter Wheat / Bogomazov S. V., G. E. Grishin, N. N. Tikhonov, A. G. Kozmin // Niva Povolzhya. 2015. No: 2 (35). S. 2-8.

[2] Borisova, E. E. The Influence of Spring Wheat Predecessors on the Biological Activity and the Density of the Composition of Light-grey forest soils / E.E. Borisova, // Bulletin of NGII. 2013. No: 12 (31) http://cyberleninka.ru/.

[3] Kirasawa, N. A. The Influence of basic cultivation of soil on its biological activity in a grain-fallow crop rotation link: dis. ... candidate. of agricultural Sciences: 06.01.01 / Kiryasowa Natalia Aleksandrovna. Kinel, 2007. 176 p.

[4] Kulikova, A. Weather conditions, soil fertility, fertilizer and crop / A. Kulikova, V. N. Tigin, A. I. Golubkov // Agriculture. 2008. No. 2. Pp. 17-18.

[5] Lebedeva, T. B. Improvement of soil fertility / T. B. Lebedeva. Penza: RIO pgsha, 2003. 52 p.

[6] Markovskaya, G. K. Biological activity of ordinary black soil in the cultivation of spring wheat / G. K. Markovskaya, N. A. Melnikova, Nechaeva E. H. // Bulletin Samara state agricultural Academy. 2015. No. 4. P. 52-57.

[7] Markovskaya, G. K. The Influence of different methods of basic soil tillage on its biological activity in spring wheat crops / G. K. Markovskaya, E. Nechaeva, N. A. Melnikova // Bulletin of Saratov state agricultural UNIVERSITY n.a Vavilov. No. 2. 2014. P. 22-25.

[8] Morozov, V. I. The Efficiency of biologization methods of crop rotations with winter wheat in forest-steppe of the Volga region / V. I. Morozov, M. I. Podsevalov, A. L. Toigildin, A. A. Asmus, N. A. Hayretdinova // Niva Povolzhya. 2008. No. 3. S. 39-42.

[9] Pavlikova, E. V. The Evaluation of the effect of field crop rotations on soil fertility and productivity in forest-steppe zone of the Middle Volga region / E. V. Pavlikova, O.A. Tkachuk // Modern problems of science and education. 2014. No. 3. S. 710. http://elibrary.ru/download/27857949.pdf.