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Kateryna Shemetun*, Anatolii Balaiev, Oksana Tonkha, Olena Pikovska

National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine

Microbiological assessment of sod-medium podzolic soil using various elements of biologisation

Abstract. To assess the ability of soils to self-repair and self-rehabilitation, it is important to monitor the indicators of soil microbiological activity. In conditions of manure deficiency, the restoration of organic matter of soils is provided by using non-commercial share of the crop and growing green manure crops, which is especially important for zonal soils of Ukrainian Polissia. The purpose of the study was to estimate the number of various physiological groups of microorganisms in sod-medium podzolic soil under the influence of various fertiliser systems. Field, laboratory, and statistical methods were used in the study. Field method: an experiment was conducted in a field of the Chernihiv Institute of Agricultural Microbiology and Agroindustrial Production of the NAAS with an area of sown plots of 102 m^2 on sod-medium podzolic light loamy soil with a humus content of 0.9-1.1% in 0-30 cm layer. The number of different groups of microorganisms that transform carbon and nitrogen compounds was determined in soil samples. Statistical methods – system analysis, mathematical and statistical analysis. Sowing of green manure such as lupine and oilseed radish had a positive effect on the number of ammonifiers (4.3-13.2 million CFU), which is 44-180% more than in the control. The mineral fertiliser system for potatoes also increased the number of ammonifiers by 15-50% compared to the option without fertilisers. The mineralisation-immobilisation coefficient was calculated as the ratio of the number of microorganisms that immobilise mineral forms of nitrogen to the number of organotrophs, and the pedotrophicity coefficient by the ratio of the number of microorganisms on soil agar to the number of microorganisms that grew on meat-peptone agar. It was established that the cultivation of green manure on sod-podzolic soil has a positive effect on the development of physiological groups of microorganisms and the microbiological processes tend to accumulate humus. The materials of the study are of practical value for agricultural producers who are engaged in growing potatoes on sod-podzolic soils in the possibility of replacing manure and mineral fertilisers in the fertiliser system of agricultural crops with green manure (lupine, oilseed radish)

Keywords: green manure, annual lupine, oilseed radish, physiological groups of microorganisms, pedotrophy coefficient

INTRODUCTION

Soil depletion occurs in conditions of intensive saturation of field crop rotations with agrocenoses that are demanding for fertility. Along with the phytomass of the crop, a significant amount of biophilic elements is permanently removed from the biological cycle. Unfortunately, fertilisation cannot fully compensate for these losses [1]. If earlier the microbiota to a certain extent eliminated the negative effect of the intensification of agricultural production, then in modern conditions there is a deterioration in both physical, chemical, and biological properties of soils. As a result, the quantity and quality of organic matter decreases, and contamination with pollutants occurs, which leads to a decrease in the number of soil microbiota, which, in turn, reduces the stability of biogeocenoses and their degradation [2]. The microbiological state of soils is an indicator, on the one hand, of the disorders that occur in them, on the other – an indicator of the ability of soils to self-repair and rehabilitation.

In modern conditions, due to a significant decrease in the number of cattle, the availability of manure

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*Corresponding author

to replenish organic matter is limited. A possible way to obtain nutrients and restore soil fertility is to use straw and green manure [3; 4].

Studies by S.V. Skrypnichenko and G.V. Skyba [5] established that favourable conditions for the development of soil microbiota were formed under the influence of the combined application of straw and green manure in the sod-podzolic soil. The most pronounced effect was on the development of fungi and nitrifiers: their number was higher than the control and variants with separate use of straw and green manure.

Similar results were obtained in China and showed that inoculation of straw increases the rate of its decomposition and improves the biological properties of soils. Moreover, the intensity of straw decomposition is affected by its placement. Thus, the use of soil-free treatments increased the content of total soil organic carbon (TOC), microbial biomass carbon (MBC), fungi, actinomycetes and bacterial populations, and cellulose activity [6; 7].

On chernozem typical use of an organo-mineral fertiliser system with straw according to the previous studies reduced the overall biogenicity by 21-71% compared to the option without fertilisers, and by 23-78% – an organo-mineral fertiliser system with straw and green manure [8].

The development of bioenergy can lead to large-scale removal of grain straw from fields, which would have implications for soil organic carbon (SOC) and related properties. In 25 experiments lasting from 6 to 56 years, there was a tendency to increase the SOC content and total nitrogen content in the soil where straw was applied annually. However, the increase was significant in only six experiments and was <10% in most cases. The increase in microbial biomass C or N was always proportionally greater than for SOC or N. In the annual straw application simulation using the RothC model, a 90% increase in microbial biomass C over 100 years was achieved within 20 years, as biomass C moved to a new equilibrium value faster than the total SOC. The simulation also showed that if straw was removed within 50% of the years, the increase in SOC and C biomass was approximately 50% of what was applied annually. There is significant evidence that small changes in the total SOC have a disproportionately large impact on the physical properties of the soil, such as aggregate stability, water infiltration rate, and plough thrust, and that microbial activity is crucial for the formation of stable aggregates. Therefore, although changes in SOC by the addition or removal of straw are small, the removal of straw every year can lead to deterioration of the physical properties of the soil [9].

The use of vetch as green manure changed the structure of the bacterial community and affected functional groups that are associated with nutrient conversion, increased the number of bacteria involved in nitrogen fixation, nitrification, denitrification, methane oxidation, and sulphur reduction [10]. Sowing of oilseed radish according to the organo-mineral fertiliser system, which included leaving straw in the amount of 1.2 t/ha of crop rotation area with nitrogen compensation N_{12} and application of mineral fertilisers $N_{78}P_{68}R_{68}$ caused an increase in the microbial transformation of organic matter by 64% compared to the non-sideration variant [8].

The use of red clover as a green manure led to the development of high microbial biomass and indicators of enzyme activity in the soil, and increased the yield of onions [11].

A long-term study for 47 years [12] showed a significant effect of green manure at a rate of 4 t C ha^{-1} on the composition and function of soil microbial grouping, bacterial and fungal biomass, and total microbial biomass, but not arbuscular mycorrhiza (AM) fungi. The introduction of sawdust contributed to a greater development of fungal biomass. Protease and arylsulfatase activity were lower when using green manure compared to the mineral fertiliser variant, while acid phosphatase activity increased. It can be concluded that green manure had a beneficial effect on the microbial properties of the soil, but in some aspects, it differed from other organic materials (manure and sawdust), which could be explained by differences in their composition.

Studies have shown that legume green manure can improve the composition of microbial biomass and the content of organic matter in the soil [13; 14].

Study of the effect of green manure fertilisers of leguminous crops (*Vigna radiata*, *Vigna unguiculata*, *Glycine max*, *Cajanus cajan*, *Cyamopsis tetragonoloba*) and nitrogen fertilisers for microbial biomass of the soil for the cultivation of rice (*Oryza sativa*) and wheat (*Triticum aestivum*) increased the total microbial biomass by 1.79 times, bacterial biota – by 3.36, and fungi – by 1.46 times. The use of nitrogen fertilisers in comparison with the control increased the indicators by 1.40, 1.17, and 1.29 times, respectively. Therefore, biological indicators are highly sensitive to the beneficial effects of legume green manure in the rice-wheat system and can be used as an indicator of soil quality [15].

The authors explain the increase in the rate of mineralisation of C and N by sideration of leguminous crops due to the intake of "fresh" organic matter, in particular, organic N [15; 16], which affects the biological activity of the soil and subsequently the availability of N and C [8; 16; 17]. Studies [18] found a 205% increase in the accumulation-mineralisation coefficient (Ka-m) with the use of leguminous green manure compared to the control.

Studies conducted in China concluded that the use of inorganic nitrogen increased soil nitrification, while green manure reduced it, which is consistent with changes in the concentration of nitrates in the soil. These results indicate that the use of winter green manure is an effective practice for improving nitrogen management [18].

Soil microorganisms play an important role in maintaining the biogeochemical cycle of nitrogen for thousands of years, including due to their biological nitrogen fixation [19]. What is important is that plants cannot fully utilise the forms of nitrogen available to them. After all, mobile soil nitrogen compounds can be lost under the influence of both biotic and abiotic factors, as a result of which nitrogen reserves are even more depleted.

The purpose of the study was to estimate the number of different physiological groups of microorganisms in sod-medium podzolic soil using various elements of biologisation.

MATERIALS AND METHODS

The study was conducted in 2016-2019 in a long-term field trials of the Chernihiv Institute of Agricultural Microbiology and Agroindustrial Production of the NAAS in crop rotation with subsequent alternation of agricultural crops:

1. Winter wheat;
2. Corn;
3. Barley with Clover sowing;
4. Clover;
5. Winter rye;
6. Potatoes;
7. Oat;
8. Lupin.

The system of tillage in crop rotation was generally accepted for the Polissia zone of Ukraine: the main shelf tillage was carried out to a depth of 25-27 cm and it included stubble peeling after harvesting winter rye, cultivation, and ploughing. The area of sown plots in the field experiment was 102 m^2. The soil of the experimental site was sod-medium podzolic light loamy on glacial water deposits. The content of humus in the arable layer was 0.99-1.1%, the content of mobile phosphorus compounds according to Kirsanov [20] – 29.5-31.7, exchange potassium according to Maslova [21] – 10.8-13.9 mg/100 g of soil, pH – 5.0-5.5.

Soil samples were taken from layers of 0-10, 10-20, 20-30, and 30-50 cm of soil with a cane drill according to the DSTU ISO 10381-6-2001 [22] in the 3rd ten days of May. Samples were taken from five points in stationary experiments using the "envelope" method at the experimental site. Preparation of soil samples for the study of aerobic microbiota in laboratory conditions was carried out in accordance with DSTU ISO 10381-6-2001 [22]. Determination of the number of different groups of soil microorganisms was carried out by sowing soil suspension on solid nutrient media according to DSTU ISO 7847:2015 [23]. The total number of microorganisms that decompose organic compounds containing nitrogen was studied on meat-peptone agar (MPA). Microorganisms that assimilate mineral forms of nitrogen were studied on a starch-ammonia medium (SAA). The number of microorganisms that synthesise melanins – on Chapek medium at PH=5.0, decomposing humates – on medium with sodium humate, pedotrophs – on soil agar.

The mineralisation-immobilisation coefficient (Km-i) was calculated by the equation (1):

$$K_{m-i} = \frac{C_{SAA}}{C_{MPA}}, \quad (1)$$

where C_{SAA} – the number of microorganisms that developed on a starch-ammonia medium; C_{MPA} – the number of microorganisms on meat-peptone agar.

The pedotrophic coefficient (K_{ped}) was calculated by the equation (2):

$$K_{ped} = \frac{CSA}{CMPA}, \quad (2)$$

where *CSA* – the number of microorganisms on the soil agar; *CMPA* – the number of microorganisms grown on meat-peptone agar.

The organic matter transformation index (Ktor) was calculated according to B. Mukha [24], equation (3):

$$K_{tor} = (C_{MPA} + C_{SAA}) \cdot \frac{C_{MPA}}{C_{SAA}} \quad (3)$$

Statistical data processing was performed using the Statistica software suite.

RESULTS AND DISCUSSION

Table 1 shows the number of different groups of microorganisms in sod-medium podzolic soil with different fertiliser options.

Table 1. The number of the main physiological groups of microorganisms in sod-medium podzolic soil under various fertiliser options, million tonnes. CFU in 1 g of absolutely dry soil

Fertiliser variant	Soil layer, cm	Ammonifying	Amylolytic	Pedotrophic	Humate-decomposing[1]	Micromicetes[1]
Without fertilisers (control)	0-10	3.8 ± 0.39	7.9 ± 0.39	0.42 ± 0.059	126.4 ± 28.52	3.3 ± 0.07
	10-20	4.2 ± 0.43	8.8 ± 0.41	0.45 ± 0.063	110.4 ± 22.35	3.5 ± 0.08
	20-30	4.7 ± 0.45	9.2 ± 0.53	0.49 ± 0.069	95.2 ± 19.21	3.8 ± 0.10
	30-50	6.2 ± 0.56	11.6 ± 0.59	0.55 ± 0.063	59.3 ± 4.08	4.6 ± 0.15
Green manure 1 – annual lupine	0-10	5.5 ± 0.22	3.8 ± 0.22	0.57 ± 0.009	96.4 ± 8.78	4.8 ± 0.15
	10-20	6.4 ± 0.30	4.5 ± 0.26	0.68 ± 0.073	65.3 ± 6.91	4.5 ± 0.16
	20-30	9.5 ± 0.56	5.2 ± 0.30	0.65 ± 0.063	55.2 ± 6.31	8.2 ± 0.29
	30-50	6.1 ± 0.49	7.4 ± 0.49	0.48 ± 0.075	38.9 ± 2.76	7.1 ± 0.26
$N_{120}P_{90}K_{120}$	0-10	5.7 ± 0.48	7.8 ± 0.46	0.65 ± 0.063	89.4 ± 9.3	4.2 ± 0.07
	10-20	6.9 ± 0.31	7.8 ± 0.47	0.93 ± 0.075	94.1 ± 3.59	5.2 ± 0.42
	20-30	5.4 ± 0.61	7.9 ± 0.48	0.90 ± 0.072	96.4 ± 8.78	5.4 ± 0.08
	30-50	5.1 ± 0.39	8.8 ± 0.61	0.50 ± 0.069	65.4 ± 6.92	3.2 ± 0.36

Table 1, Continued

Fertiliser variant	Soil layer, cm	Ammonifying	Amylolytic	Pedotrophic	Humate-decomposing[1]	Micromicetes[1]
Green manure 2 – oilseed radish	0-10	5.8 ± 0.48	6.4 ± 0.51	0.63 ± 0.003	49.9 ± 2.14	4.2 ± 0.08
	10-20	8.2 ± 0.79	6.6 ± 0.57	0.84 ± 0.081	39.3 ± 2.86	8.4 ± 0.34
	20-30	13.2 ± 0.41	7.0 ± 0.57	0.79 ± 0.055	37.2 ± 4.63	9.2 ± 1.71
	30-50	4.3 ± 0.13	7.3 ± 0.89	0.44 ± 0.045	95.2 ± 2.09	4.1 ± 0.36

Note: [1] thous. CFU/g of soil

In the soil layer of 30-50 cm, a decrease in the proteolytic activity of microorganisms was observed: where the greatest number of amylolytic and humate-decomposing bacteria was noted (11.6 ± 0.59), which was 54% more compared to the variant with annual lupine siderate, 31.8% compared to variant $N_{120}P_{90}K_{120}$, and by 58.9% compared to the option with oilseed radish.

Sowing of green manure (lupine and oilseed radish) had a positive effect on the number of ammonifiers (4.3-13.2 million CFUs), which is 44-180% more than the control. The mineral fertiliser system for potatoes also increased the number of ammonifiers by 15-50% compared to the non-fertiliser option, with the exception of the 30-50 cm layer, where the indicators were higher in the control. There were changes in the number of ammonifiers with soil depth from 3.8 ± 0.39 to 6.2 ± 0.56 million CFUs in 1 g of absolutely dry soil. Volkogon *et al.* [25] found that the variants using only mineral fertilisers showed an increase in the pool of mineral nitrogen immobilisers against the background of a small amount of ammonifiers, which indicates an increase in the mineralisation of microbial cenosis: the mineralisation-immobilisation coefficients in the flowering phase increased from 1.86 for the introduction of $N_{40}P_{40}K_{40}$ up to 2.42 per fertiliser $N_{120}P_{120}K_{120}$. At the same time, the effect of straw and green manure on the application of mineral fertilisers provided a reduction in the negative consequences of the intensification of mineral fertilisation of potatoes. Under these conditions, the mineralisation-immobilisation coefficient was 1.20 at the norm of $N_{40}P_{40}K_{40}$ and 1.23 with the introduction of $N_{120}P_{120}K_{120}$.

In the variants with green manure, the highest content of this group of microorganisms was in a layer of 20-30 cm and was 9.5 ± 0.56, respectively, in the variant with lupine and 13.2 ± 0.41 million CFUs in 1 g of absolutely dry soil with oilseed radish. This redistribution is explained by the embedding of the bulk of green fertiliser in this layer. Under the mineral fertiliser system, the content of ammonifying microorganisms did not change much in the soil layers and amounted to 5.1 ± 0.39-6.9 ± ± 0.31 million CFUs in 1 g of absolutely dry soil.

The largest number of humate-decomposing microorganisms, which according to the studies by G.O. Iutynska [26] take part in the decomposition of the nuclear part of humus substances, was obtained on the variant without fertilisers and amounted to 126.4 ± 28.52 in the 0-10 cm layer and 59.3 ± 4.08 in the 30-50 cm soil layer. In the variant with lupine green manure, the content of this group of microorganisms was 96.4 ± 8.78 in a 0-10 cm layer and amounted to 38.9 ± 2.76 million CFUs in 1 g of absolutely dry soil in a 30-50 cm layer. Consequently, the content of humate-decomposing microorganisms with depth decreased on variants with green manure, which indicates a slowdown in the decomposition of organic matter in the soil with depth and creates prerequisites for an increase in humus reserves, which is especially important for poor sod-podzolic soils.

According to the mineral fertiliser system $N_{120}P_{90}K_{120}$, the content of this group of microorganisms was high and amounted to 65.4 ± 8.78 – 96.4 ± 8.78 million tonnes. CFU in 1 g of absolutely dry soil, which indicates an accelerated decomposition of organic matter in soils, which is especially dangerous for sod-podzolic soils.

The opposite relationship was obtained by the number of micromycetes involved in the synthesis of humus substances. Thus, it is advisable to consider green manure crops of oilseed radish and lupine by the number of the above-mentioned bacteria (the largest number of micromycetes and the smallest – humate-decomposing) as a source of organic matter recovery. Compared to the control, the number of microorganisms was 1.8-2.5 times higher depending on the soil layer.

Changes in the structure and functioning of microbial cenosis of soils occur under the influence of its involvement in agro-industrial production. O.S. Demyanyuk et al. [27] found that on low-fertile soils, such as sod-podzolic and grey forest without fertilisation, the impact of agricultural activities on the soil microbiota was greater compared to chernozems, which led to a decrease in the total number of microorganisms by 2.2-4.5 times. This fact is also confirmed by the results of the conducted studies, namely a large number of humate-decomposing and amylolytic and the smallest pedotrophic microorganisms and micromycetes for growing table potatoes.

Table 2 shows the coefficients of soil microbiological processes under different fertiliser options.

Table 2. Orientation of microbiological processes in sod-medium podzolic soil under various fertiliser options

Fertiliser variant	Soil layer, cm	K_{ped}	K_{m-i}	K_{accum}
Without fertilisers (control)	0-10	0.11	2.1	0.38
	10-20	0.11	2.1	0.42
	20-30	0.10	2.0	0.47
	30-50	0.09	1.9	0.62
Green manure 1 – annual lupine	0-10	0.10	0.7	0.15
	10-20	0.11	0.7	0.44
	20-30	0.07	0.5	0.85
	30-50	0.08	1.2	0.61
$N_{120}P_{90}K_{120}$	0-10	0.11	1.4	0.37
	10-20	0.13	1.1	0.39
	20-30	0.17	1.5	0.44
	30-50	0.10	1.7	0.41
Green manure 2 – oilseed radish	0-10	0.11	1.1	0.58
	10-20	0.10	0.8	0.82
	20-30	0.06	0.5	1.34
	30-50	0.10	1.7	0.23

V.P. Patyka *et al.* [28] recommend assessing the ecological state of agricultural soils and establishing the microbiological processes in soils, determining the coefficients of pedotrophy, oligotrophy, and the coefficient of mineralisation-immobilisation. The pedotrophic coefficient indicates the functionality of the soil microcenosis structure and indicates the degree of organic matter development. K_{ped} on all variants was low and amounted to 0.06-0.13. At the control, it did not change much for the layers of sod-podzolic soil and amounted to 0.09-0.11. Options with green manure practically did not differ in this coefficient: for growing lupine, Kped was 0.08-0.11, and oilseed radish – 0.06-0.11. According to the mineral fertiliser system, the highest value of the pedotrophy coefficient was set in a layer of 20-30 cm – 0.17.

Study by V.P. Patyka *et al.* [28] found that the coefficients of pedotrophy in agricultural land soils were lower and amounted to 0-0.177 compared to soils of natural cenoses (K_{ped} = 0.739-963). The researchers note an increase in the intensity of decomposition of organic matter in the soil and natural ecosystems, in particular, humus compounds. As a result of our research, it was also established that with intensive agricultural use, namely the cultivation of table potatoes on sod-podzolic soil, a low degree of organic matter development was noted in all variants of the experiment.

The coefficient of organic matter accumulation characterises the intensity of accumulation of these compounds in the soil. The highest accumulation rates were observed in a layer of 20-30 cm for all fertiliser options, which is probably conditioned by the use of shelf tillage, in which the largest amount of earned organic substances of green manure crops and plant residues enter soil layer.

At the control, the accumulation coefficient gradually increased with depth and amounted to 0.38, 0.42, 0.47, and 0.62 in soil layers of 0-10, 10-20, 20-30, and 30-50 cm, respectively. Close to the control for the value of this coefficient was the option of mineral fertiliser for table potatoes $N_{120}P_{90}K_{120}$ and was 0.37; 0.39; 0.44, and 0.41, respectively, for layers of sod-podzolic soil.

Growing green manure increases the accumulation of organic matter in the soil and K_{accum} in the 0-30 cm layer, it was 0.85 on the variant with lupine and 1.34 on the variant with oilseed radish, lower values were set on the control – 0.47, and on the mineral fertiliser system – 0.44.

In the variant with green manure, it is necessary to pay attention to the additional application of nitrogen, since there is an accumulation of organic matter in the soil and the mineralisation-immobilisation coefficient in a layer of 20-30 cm is K_{m-i} = 0.5, which is 2 times less than the optimal (1.0). In particular, the intensity of mineralisation-immobilisation processes was highest in the variant without fertilisers, where this coefficient was 1.9-2.1. According to the mineral fertiliser system, this indicator in a layer of 10-20 cm approached the optimal one and amounted to 1.1.

Thus, on sod-podzolic soil, the cultivation of green manure has a positive effect on the development of physiological groups of microorganisms and the microbiological processes tend to accumulate humus. Similar conclusions are drawn by O.Yu. Kolodyazhnyy and M.V. Patyka [29] that the use of an ecological system of agriculture with differentiated tillage positively affected the microbiological processes for growing winter wheat and contributed to the accumulation of organic matter and mineral nitrogen in the soil, and increased the number of different groups of microorganisms: ammonifying bacteria – up to 4.63, spore-forming – up to 0.65, actinomycetes – up to 0.87 million CFUs/g of absolutely dry soil.

CONCLUSIONS

Table potato fertiliser systems had an impact both on the number of individual groups of microorganisms and on the microbiological processes in sod-podzolic light loamy soil, which were estimated by pedotrophic coefficients (K_{ped}), mineralisation-immobilisation (K_{i-m}) and accumulation of organic matter (K_{accum}).

It was established that growing table potatoes without fertilisation (control) leads to accelerated mineralisation of organic matter of the soil and contributes to the intensity of transformation processes of nitrogen compounds in sod-medium podzolic light loamy soil. This variant provided the largest number of humate-decomposing microorganisms, the smallest number of micromycetes, and the mineralisation-immobilisation coefficient 2 times more than the optimal. Similar values were obtained on the mineral fertiliser variant $N_{120}P_{90}K_{120}$.

Cultivation of lupine and oilseed radish increased the number of ammonifiers by 44-180% compared to the control, and there was a tendency to humus accumulation. According to the pedotrophic coefficient, a low degree of development of soil organic matter was established in all variants of the experiment, its values were 0.06-0.13 and did not depend much on the fertiliser option.

According to the content of various groups of microorganisms and the coefficients of pedotrophy, mineralisation-immobilisation, and accumulation, a positive effect of sideration on the processes of humus formation was established. In further study, it is planned to investigate the effect of combining the cultivation of green manure against the background of full mineral fertiliser on the biological activity of the soil.

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Катерина Ігорівна Шеметун, Анатолій Джалілович Балаєв, Оксана Леонідівна Тонха, Олена Володимирівна Піковська

Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна

Мікробіологічна оцінка дерново-середньопідзолистого ґрунту за застосування різних елементів біологізації

Анотація. Для оцінки здатності ґрунтів до самовідновлення і самореабілітації важливо проводити моніторинг показників мікробіологічної активності ґрунтів. В умовах дефіциту гною відновлення органічної речовини ґрунтів забезпечується шляхом використання нетоварної частки врожаю та вирощуванням сидеральних культур, що особливо актуально для зональних ґрунтів Полісся України. Метою досліджень була оцінка чисельності різних фізіологічних груп мікроорганізмів у дерново-середньопідзолистому ґрунті під впливом різних систем удобрення. У роботі були використані польові, лабораторні і статистичні методи. Польовий метод: дослідження проводили у стаціонарному досліді Чернігівського інституту АПВ НААН із площею посівних ділянок 102 м^2 на дерново-середньопідзолистому легкосуглинковому ґрунті із вмістом гумусу 0,9–1,1 % в шарі 0–30 см. У зразках ґрунту визначали чисельність різних груп мікроорганізмів, що трансформують сполуки карбону та нітрогену. Статистичні методи – системний аналіз і математико-статистичний. Посів таких сидератів, як люпину і редька олійна позитивно вплинув на чисельність амоніфікаторів (4,3–13,2 млн. КУО), що більше на 44–180 % порівняно з контролем. Мінеральна система удобрення картоплі також збільшила чисельність амоніфікаторів на 15–50 % порівняно з варіантом без добрив. Коефіцієнт мінералізації–іммобілізації розраховували як відношення чисельності мікроорганізмів, що іммобілізують мінеральні форми нітрогену до кількості органотрофів, а коефіцієнт педотрофності за відношенням чисельності мікроорганізмів на ґрунтовому агарі до чисельності мікроорганізмів, що виросли на м'ясопептонному агарі. Встановлено, що на дерново-підзолистому ґрунті вирощування сидератів позитивно впливає на розвиток фізіологічних груп мікроорганізмів і спрямованість мікробіологічних процесів має тенденцію щодо накопичення гумусу. Матеріали статті складають практичну цінність для виробників сільськогосподарської продукції, які займаються вирощуванням картоплі на дерново-підзолистих ґрунтах у можливості заміни гною і мінеральних добрив у системі удобрення сільськогосподарської культури на сидерати (люпин, редьки олійна)

Ключові слова: сидерат, люпин однорічний, редька олійна, фізіологічні групи мікроорганізмів, коефіцієнт педотрофності