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Study of Microbiological Processes in the Soil of a Two-Year Fallow

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ABSTRACT

A high degree of ploughing the soils is a destabilization factor of agrolandscapes and intensification of the erosion processes. Therefore, there arises a need to study the direction of the soil processes during the transfer of the arable land into a state of fallow. The state of microbiocenosis of a two-year-old abandoned land (fallow) was investigated using the gray forest soil in the variants of spontaneous overgrowth, sowing of grass mixtures and sowing of grass mixtures with simultaneous optimization of mineral nutrition of the phytocenosis as an example. It has been established that the least stable microbiocenosis is formed during the cultivation of the grass mixtures, which is characterized by the minimum total number of microorganisms (647.1 million CFU·g^{-1} of absolutely dry soil) and the minimum number of significant relations between the constituents (components) of the microbial community (98). The total number of microorganisms in the microbiocenosis of the spontaneous overgrowth variant and the legume-grass mixture exceeds that of the cereal grass mixture variant by 6.29 and 34.8%, respectively. A similar indicator for the total number of significant relations was 4.08%. Application of mineral fertilizers intensifies the process of mineralization of nitrogen compounds and slows down the consumption of the soil organic matter in the variants of sudden recovery of phytocenosis and cultivation of the legume-cereal grass mixture. The soil of the variant of the grass mixture is characterized by minimum total biological activity; it is 1.33 and 33.2% lesser than the total biological activity of the variants of spontaneous overgrowth and cultivation of the legume-grass mixture.

Keywords: microbiocenosis, fallow, minerlization, humus, phytotoxicity.

INTRODUCTION

Fallow is agricultural land, previously used as arable land but not used for more than a year, starting in autumn, neither for sowing crops, nor as black fallow (Adamchuk et al., 2020). Abandoned field is an example of secondary (recovery) succession. Fallow is a land on which organic matter accumulates, sod is formed, the soil becomes more dense and structural.

Historically, in Ukraine and some other countries, with large areas of land and in the absence of sufficient fertilizers, the fallow farming system was used, when part of the arable land in the steppe regions was periodically left for fallow (black fallows). This recovered soil fertility and helped control the weeds without requiring as much labor and energy as the fallow. It is known that a high degree of ploughing soils is a destabilizing factor for the agrolandscapes, the development of erosion processes, which does harm to the functioning of small rivers and the quality of the water resources, biodiversity and recreational attractivity of natural territorial complexes (Bogovin et al., 2017; Saiko et al., 2006).

Transfer of the agricultural land to a condition of the fallow state is relevant for Ukraine with a high share of arable land in the land fund, equal to 82% (Bogovin et al., 2017; Bogovin and Ptashnik, 2020). According to the decision of the Ministry of Agropolitics of Ukraine it was planned to bring about 12 million hectares of unproductive arable land to the fallow state. It is obvious that in Western Europe this problem is solved mainly in other ways; however, transfer of the former arable land to an unused state, and the reverse process also take place (Anderson et al., 2000). Thus, the Spanish scientists (Zornoza et al., 2009) studied changes in the microbiocenosis when transferred to a fallow land on the terraces of Eastern Spain, where the considered processes are quite widespread. Often, near large cities, former agricultural land is also no longer used for its intended purpose, and it is in an uncultivated state because of more expensive labor and a hope to sell this land at a high price for industrial purposes or for housing construction. Changes in the microbiological characteristics of soils as a result cultivation have been studied fully enough and comprehensively (Parinkina and Klyueva, 1995; Falkengren-Grerup et al., 2005; Guo and Gifford, 2002). However, the reverse process – removing of soils from agricultural use and their transfer to a fallow state – has not been sufficiently studied from the point of view of the microbiological processes, and it is of particular scientific interest (Shivani et al., 2022; Soares and Rousk, 2019; Zornoza et al., 2009). There are several ways of transferring soils to a fallow (abandoned field) state: 1) spontaneous overgrowth, 2) sowing of grass mixtures, 3) sowing of grass mixtures with simultaneous agrotechnical measures: application of mineral fertilizers, liming, mowing the green biomass, etc. (Bogovin et al., 2017). Being in a state of fallow positively affects the physical and agrochemical properties of the soils; processes are balanced of synthesis and degradation of the humus molecules, which ensure potential soil fertility, and the soil-forming processes are activated. Fallow lands, as well as pastures and forests, are components that stabilize the state of agrocenoses (Bogovin et al., 2017). The extraction of land from the crop rotation should not be spontaneous but should be carried out taking into account the fundamental laws of functioning of the ecosystems at all levels of their organization. Diagnosing the direction of soil processes in the course of soil selfrecovery can be most quickly performed according to the microbiological indicators, which makes it possible to identify changes at the very first stages, and those changes that cannot be detected by other methods (Parinkina and Klyueva, 1995). The advantages of the microbiological research methods are the ability to study the direction of mineralization and immobilization of the nitrogen compounds.

The purpose of this work was to study the state of microbiocenosis of the gray forest soil of a two-year-old fallow (abandoned field), the phytocenosis of which is restored in various ways.

MATERIALS AND METHODS

Experimental investigations were performed on the gray forest coarse-silty light loamy soil in the northern part of the Forest-Steppe of Ukraine (Fastovsky district of Kyiv region) with a content of 0–20 cm soil layer of humus 2.5%, easily hydrolyzed nitrogen 7.6 mg, mobile phosphorus 14.5 mg and exchangeable potassium 12.3 mg per 100 g of dry soil, pH (KCl) – 6.7.

To collect the experimental material, different types of seeded herbage were used, spontaneously (suddenly) recovered phytocenoses of fallows (abandoned fields) and agrophytocenoses of grain-row crop rotation which have grown without fertilizers since 1987 (extensive agrophytocenosis) and with the fertilization $NPK_{211-316}$, against the background of ploughing by-products (intensive agrophytocenosis). The agrophytocenosis crop is corn (maize). In sudden recovery of grassy cenoses the effect of spontaneous overgrowth of the arable lands withdrawn from intensive crop rotation was used, which ensures maximum involvement of natural resources and mechanisms in the recovery process with minimal costs of fossil energy and manual and mechanized human labor. The main basis for this are the reserves of viable seeds in the soil, which in a 0–10 cm layer contain up to 30–40 thousand viable seeds per 1 m^2, in most cases belonging to 25–40 species of higher plants, as well as due to bringing in of the seeds from outside from the adjacent phytocenoses by herbivorous domestic and wild animals, birds, wind, surface water flows, with seed material of agricultural crops, etc.

When creating seeded herbaceous cenoses in an experiment, a mixture of cereal grasses was sown in uncovered early spring, consisting of *Bromopsis inermis* (Leyss.) Holub (12 $kg \cdot ha^{-1}$), *Festuca orientalis* (Hack.) V. Krecz. et Bobr.

(8 kg·ha^{-1}), *Phleum pratense* l. (4 kg·ha^{-1}) and legume-cereal (bean-cereal) mixture from the same cereals + *Medicago sativa* L. (10 kg·ha^{-1}) and *Trifolium pratense* L. (2 kg·ha^{-1} of seeds). Mineral fertilizers were applied in the form of ammonium nitrate, double superphosphate and potassium chloride. Sowing, fertilizing and the accompanying observation during the experiments were carried out according to the generally accepted methods in the grassland management. The soil sampling was carried out from the root-containing soil layer (0–20 cm) during the period of maximum vegetative development of the plants (the first ten days of June). The number of microorganisms of the main ecological-trophic, functional and systematic groups was estimated by using the method of sowing the soil suspension onto the appropriate nutrient media (Alef and Nannipier, 1995; Šimanský et al., 2019). Indicators of the intensity of the mineralization processes, the probability of formation of bacterial colonies, the total biological activity and phytotoxic properties of the soil were determined as previously described (Malynovska et al., 2021). The coefficient of the specific phosphate-dissolving activity was determined by the method developed by the authors and described in detail in (Malynovska, 2021).

Statistical assessment of the data obtained for the reliability and error of the experiments was determined according to the generally accepted methodology (Petersen, 1994; Welham et al., 2015; Bulgakov et al., 2022).

RESULTS AND DISCUSSION

From the results of the research presented in Table 1, it is evident that the maximum amount of ammonifiers was found in the rhizosphere of the legume-cereal (bean-cereal) mixture, grown applying mineral fertilizers – 140% more than during sudden recovery, and 42.9% more than when growing a cereal grass mixture. When analyzing the relations between the plants and the rhizospheric microorganisms, the group of ammonifiers was considered as an indicator group, since the substrate for the growth of ammonifiers are the protein substances of the root secretions and dead fragments of the roots and the root systems. In authors' opinion, the increased amount of ammonifiers indicates an increased amount of the root secretions since no other group of the investigated microorganisms is so closely related to their amount.

The number of ammonifiers in the rhizosphere of the plants is positively affected by the application of mineral fertilizers (with the exception of the grass mixture); during sudden recovery the amount of ammonifiers increases by 85.5% when mineral fertilizers are applied, by 57.9% when growing a legume-grass (bean-cereal) mixture, and by 40.7% on agrobiocenosis. Application of fertilizers leads to an increase in the number of immobilizers of mineral nitrogen in all the variants of the experiment: with sudden recovery of phytocenosis – by 207.5%, when growing a legume-grass mixture – by 24.1, when

Table 1. The number of microorganisms of the nitrogen and phosphorus cycle in the gray forest soil of a two-year fallow and agrobiocenosis, million CFU·g^{-1} of absolutely dry soil

Variant		Ammonifiers	Immobilizers of mineral nitrogen	Oligonitrophils	Azotobacter % fouling of soil lumps	Denitrifiers	Nitrifiers	Mineral phosphate mobilizers	Organic phosphate mobilizers
Sudden recovery	Two-year fallow	200.0	56.4	20.6	92.0	119.8	0.14	10.3	0.01
Sudden recovery + $N_{90}P_{40}K_{70}$		371.1	164.2	106.7	99.3	114.3	0.16	46.1	5.08
Bean-cereal mixture		304.1	81.7	24.4	48.7	116.7	0.17	13.1	2.42
Bean-cereal mixture + $P_{40}K_{70}$		480.0	101.4	75.7	27.3	114.6	0.18	28.1	4.24
Cereal mixture		336.2	43.2	37.5	54.7	26.8	0.40	6.43	0.01
Cereal mixture $N_{45}+N_{45}$		234.1	67.2	41.5	58.0	4.75	0.23	4.22	1.06
Cereal mixture + $N_{90}P_{40}K_{70}$		365.9	131.3	60.1	24.0	46.9	0.12	3.82	2.08
Agrophytocenosis extensive (control)		214.0	26.2	32.1	100.0	10.5	0.24	8.86	1.11
Agrophytocenosis intensive		300.9	76.9	65.0	50.7	50.1	0.15	18.4	10.0
LCD_{05}		4.2	10.8	3.80	6.2	4.6	0.03	3.0	1.0

growing a cereal grass mixture – by 55.6 and 203.9%, respectively (Table 1). Similar trends are observed for oligonitrophils, pedotrophs, polysaccharide-synthesizing microorganisms, and micromycetes (Table 1, 2). The amount of denitrifiers in the soil of a two-year fallow (abandoned) forest increased approximately twice in contrast to the soil of a one-year fallow, which indicates the ongoing compaction of the soil and the creation of more and more anaerobic conditions (Skuryatin, 2003). The process of soil compaction occurs with approximately the same intensity in the variants of sudden recovery and cultivation of legume-grass (bean cereal) mixture, as evidenced by the same amount of denitrifiers in these variants of the experiment. Introduction of the mineral fertilizers does not affect the number of denitrifiers in the above-mentioned variants of the experiment; however, it increases their physiological activity: during sudden recovery of phytocenosis – by 13.5 times when growing a legume-grass (bean-cereal) mixture – 10.3, when growing a cereal grass mixture – by 11.3 times (Table 1, 3). Thus, when readily-available exogenous nitrogen is introduced, the intensity of the denitrification process increases sharply. The minimum amount of denitrifiers is observed in the rhizosphere soil of the grass mixture; moreover, when only nitrogen fertilizers are applied, the number of microorganisms decreases by 5.64 times, and when $N_{90}P_{40}K_{70}$ is applied, it increases by 1.75 times. This indicates the general non-optimal conditions for the plant growth in the variant of the experiment with the introduction of only nitrogen mineral fertilizers. The variant of sudden recovery of the phytocenosis of a two year's old fallow, as well as a one-year's one (Malinovska et al., 2007), is characterized by a high content of azotobacter. When growing a legume-grass (bean-cereal) mixture (especially with the application of mineral fertilizers), the amount of azotobacter decreases sharply; this can be explained by competition from symbiotic and associative nitrogen fixers, which are purposefully supported by plants in their rhizosphere and have a depressing effect upon the free-living nitrogen fixers to which azotobacter belongs. Similar relationships were observed earlier when studying the survival of azotobacter in the microbiocenosis of the soybean and wheat rhizosphere (Malinovska and Soroka, 2009). Extensive agrobiocenosis has been characterized by the maximum amount of azotobacter (100% fouling of the soil lumps) for many years (Malinovska et al., 2007; Malinovska and Soroka, 2009), which, in authors' opinion, shows the impossibility of using azotobacter as an indicator of the soil fertility, as it was previously practiced.

Application of mineral fertilizers leads to an increase in the number of polysaccharide-synthesizing bacteria: 9.13 times during sudden recovery of phytocenosis, 1.82 times when growing a legume-grass (bean-cereal) mixture, 1.79 times when growing a cereal grass mixture, and 6.02 times on agrobiocenosis (Table 2). Consequently, it is impossible to regard a group of polysaccharide-synthesizing bacteria as an unambiguous indicator of a lack of mineral

Table 2. The number of microorganisms of the carbon cycle in the gray forest soil of a two-year fallow and agrobiocenosis, million CFU·g^{-1} of absolutely dry soil

Variant		Pedotrophs	Cellulose-destructive	Polysaccharide-synthesizing	Autochtho-nous	Streptomicro-micetes	Micromi-cetes	Total amount
Sudden recovery	Two-year fallow	110.2	37.4	4.36	20.8	15.6	0.17	687.8
Sudden recovery + $N_{90}P_{40}K_{70}$		133.3	86.6	39.8	14.0	26.3	0.41	1207.4
Bean-cereal mixture		128.7	87.3	4.95	25.7	34.3	0.27	872.5
Bean-cereal mixture + $P_{40}K_{70}$		173.8	80.3	9.03	23.7	25.7	0.30	1144.4
Cereal mixture		29.3	62.2	6.43	20.1	23.6	0.20	647.1
Cereal mixture $N_{45}+N_{45}$		48.6	28.7	3.52	19.0	25.0	0.31	536.2
Cereal mixture + $N_{90}P_{40}K_{70}$		74.3	27.6	11.5	19.7	28.8	0.37	796.5
Agrophytocenosis extensive (control)		32.9	62.8	1.48	26.3	8.49	0.17	525.2
Agrophytocenosis intensive		79.5	88.9	8.91	25.7	35.3	0.25	810.7
HIP_{05}		3.4	8.5	1.0	5.2	2.0	0.04	

elements in the soil since their number also depends on the intensity of the phytocenosis development, the number of root shoots and the ratio of carbon to nitrogen in the soil, which changes with the application of mineral fertilizers, ploughing in of by-products, and etc. A similar trend is observed for the microorganisms that mobilize mineral and organic phosphates (Table 1).

The number of autochthonous microorganisms decreases as a result of application of mineral fertilizers in the variant of sudden recovery by 48.6%, legume-grass (bean-cereal) mixture – 8.44. grass mixture – by 5.79% (Table 2), which is accompanied by a slowdown in the destruction of humic substances by 80.0%, 47.1 and 158.9%, respectively (Table 4). According to long-term data, the extensive agrobiocenosis is characterized by maximum activity of the humus destruction where mineral and organic fertilizers have not been applied since 1987 – 79.9%, which is 2.47 times more than the activity of the humus destruction in the intensive agrobiocenosis (Table 4). Thus the data obtained by the authors earlier when studying the regularities of the development of microbial communities in the fallows (abandoned fields) and agrobiocenosis, are confirmed, application of mineral fertilizers in optimal doses reduces the intensity of the humus destruction (Malinovska et al., 2007; Malinovska and Soroka, 2009). The least activity of the humus destruction is charactic for the soil of the variant of sudden recovery of phytocenosis and cultivation of a legume-grass (bean-cereal) mixture with the application of mineral fertilizers. Growing grass mixtures or cereals in a monoculture (wheat), according to long-term data, leads to an intensification of the processes of the humus decomposition in comparison with the cultivation of the legumes (beans) and legume-grass (bean-cerela) mixtures (Malinovska et al., 2007; Malinovska and Soroka, 2009).

Analysis of the list of appearance of the microorganism colonies shows that the microorganisms of the rhizosphere of the legume-grass (bean-cereal) mixture are characterized by the highest physiological and biochemical activity, especially ammonifiers, oligonitrophils, cellulolytics, micromicetes, streptomicromicetes and mineral phosphate mobilizers (Table 3). One of the least active microorganisms is the rhizosphere of the grass mixture (without fertilization) and extensive agrobiocenosis. The mineralization processes of the nitrogen compounds are intensified when the mineral fertilizers are applied in almost all variants of the experiment with the exception of the variant of the legume-grass (bean-cereal) mixture where nitrogen fertilizers are not applied (Table 4). The consumption of the soil organic matter with the application of mineral fertilizers slows down in the variants of sudden recovery of phytocenosis and cultivation of the legume-grass (bean-cereal) mixture: the index of pedotrophy decreases by 53.5% and 16.9%, respectively. However, when growing a grass mixture, the application of mineral fertilizers leads to an intensified consumption of the soil organic matter.

Table 3. Formation probability of colonies of microorganisms (λ, $h^{-1} \cdot 10^{-1}$) in the gray forest soil of a two-year fallow and agrophytocenosis

Variant		Ammonifiers	Immobilizers of mineral nitrogen	Oligonitrophils	Pedotrophs	Cellulose-destructive	Micromicetes	Mineral phosphate mobilizers	Autochthonous	Denitrifiers	Polysaccharidesynthesizing	Streptomicromicetes
Sudden recovery	Two-year fallow	3.29	0.76	4.73	2.07	1.62	1.48	3.43	0.86	5.78	0.24	0.45
Sudden recovery + $N_{90}P_{40}K_{70}$		2.21	0.56	11.6	1.32	2.25	4.15	3.20	1.52	0.35	0.86	0.89
Bean-cereal mixture		2.99	0.80	4.71	3.23	0.87	3.05	1.31	1.29	18.0	0.96	1.07
Bean-cereal mixture + $P_{40}K_{70}$		6.55	0.67	12.0	1.34	3.89	7.01	3.87	1.19	0.93	0.76	1.12
Cereal mixture		3.07	0.41	11.6	0.54	1.55	3.53	4.58	0.94	0.98	0.96	1.05
Cereal mixture $N_{45} + N_{45}$		1.77	0.62	14.8	1.83	1.85	4.39	3.73	1.16	3.38	0.71	0.94
Cereal mixture + $N_{90}P_{40}K_{70}$		1.86	0.50	11.3	2.26	0.54	4.02	3.73	1.03	0.19	1.10	0.91
Agrophytocenosis extensive (control)		0.62	0.72	11.1	1.83	0.56	2.71	7.40	1.13	1.69	0.96	0.90
Agrophytocenosis intensive		4.43	0.95	11.8	2.02	2.31	2.95	6.49	1.10	22.6	0.48	0.86

The maximum total biological activity is caracteristic for the soil of the variant of sudden overgrowth with the application of mineral fertilizers at a dose of $N_{90}P_{40}K_{70}$. It is by 22.2% higher than the activity of the soil in the legume-grass (bean-cereal) mixture with the application of mineral fertilizers at a dose of $P_{40}K_{70}$ and by 70.2% – the soil activity in the variant of the grass mixture with the application of $N_{90}P_{40}K_{70}$. As a result of the optimization of the mineral nutrition of the phytocenosis, the total biological activity of the soil increases: in the variant of sudden overgrowth, by 86.1%; in the legume-grass (bean-cereal) mixture, by 15.9; in the grass mixture, by 10.8; and in agrobiocenosis, by 58.1%.

As in the previous years of research, the maximum phytotoxicity is characteristic for the soil of the rhizosphere of the grass mixture and the extensive agrobiocenosis (Table 4). The soil toxicity of the rhizosphere of the grass mixture exceeds the toxicity of the soil of the variant of sudden recovery by 44.5%, the variant of cultivation of the legume-grass (bean-cereal) mixture – by 48.4%. The toxicity of the extensive agrobiocenosis exceeds that of the intensive agrobiocenosis by 18.9%, which is consistent with the data of the previous investigations (Malinovska et al., 2007). The obtained egularity contradicts to some extent the idea that the elements of intensive technologies: mineral fertilizers. ameliorants. pesticides – contribute to an increase in the biological toxicity of soils. The least toxic soil is in the variant of growing a legume-grass (bean-cereal) mixture with the application of mineral fertilizers at a dose of $P_{40}K_{70}$. The efficiency and direction of microbiological processes in the soil depend both on the number of microorganisms of the corresponding groups and on the specifics of the functional relations between them.

On the basis of the data on the development dynamics of microorganisms in the investigated variants of the experiment, the correlation coefficients between the indicators of the number of microorganisms of different ecological, trophic and functional groups during the growing season were calculated, and correlation matrices were constructed.

The performed analysis showed that in terms of the number of significant correlations (r = 0.333-0.999), the most stable microbial communities of the soil of the variants of sudden overgrowth and cultivation of the legume-grass (bean-cereal) grass mixture are 102 connections (links), which is by 4 connections (links) more than in the variant of growing the grass mixture (Table 5).

Optimization of the mineral nutrition of the phytocenosis contributes to an increase in the stability of the microbial community of the soil: in the variant of sudden overgrowth, by 7.84%; in the legume-grass (bean-cereal) mixture, by 20.6; the grass mixrure, by 8.16%. When agrobiocenosis are included into the analysis, it is revealed that the microbial community of the extensive agrobiocenosis is characterized by the least stability due to the insufficient formation of highly significant links. The stability of the microbial community of the intensive

Table 4. Intensity indicators of mineralization processes and phytotoxicity of the gray forest soil of a two-year fallow and agrophytocenosis

Variant		Pedotrophy index	Oligotrophy coefficient	Nitrogen mineralization coefficient	Humus mineralization activity, %	Total biological activity	Specific phosphate mobilizing activity	Mass of 100 plants of winter wheat, g
Sudden recovery	Two-year fallow	0.551	0.103	0.282	18.9	0.372	625.9	18.5
Sudden recovery + $N_{90}P_{40}K_{70}$		0.359	0.288	0.442	10.5	0.870	1164.7	18.3
Bean-cereal mixture		0.423	0.080	0.269	20.0	0.434	822.6	19.0
Bean-cereal mixture + $P_{40}K_{70}$		0.362	0.158	0.211	13.6	0.458	953.1	19.5
Cereal mixture		0.087	0.124	0.129	68.6	0.815	617.7	12.8
Cereal mixture N_{45} + N_{45}		0.208	0.177	0.287	39.1	0.295	555.6	15.6
Cereal mixture + $N_{90}P_{40}K_{70}$		0.203	0.164	0.359	26.5	0.213	684.2	12.4
Agrophytocenosis extensive (control)		0.154	0.150	0.122	79.9	0.214	0.214	14.8
Agrophytocenosis intensive		0.264	2.16	0.256	32.3	0.557	0.557	17.6

Table 5. The number of correlation links between the components of microbial communities of the gray forest soil of a two-year's old fallow and agrobiocenosis

Variant		Number of correlations						
		Medium-significant connections (r = 0.333 – 0.665)			Highly-significant connections (r = 0.666 – 0.999)			Total in variant
		Straight	Reverse	Total	Straight	Reverse	Total	
Sudden recovery	Two-year fallow	34	34	68	13	21	34	102
Sudden recovery + $N_{90}P_{40}K_{70}$		37	34	71	19	20	39	110
Bean-cereal mixture		40	40	80	12	10	22	102
Bean-cereal mixture + $P_{40}K_{70}$		52	40	92	21	10	31	123
Cereal mixture		31	43	65	17	16	33	98
Cereal mixture N_{45} + N_{45}		42	29	71	15	19	34	105
Cereal mixture + $N_{90}P_{40}K_{70}$		47	39	86	13	7	20	106
Agrophytocenosis extensive (control)		27	30	57	14	11	25	82
Agrophytocenosis intensive		42	36	78	15	12	27	105

agrobiocenosis corresponds to the indicators of the soil removed from cultivation.

Consequently, when restoring phytocenosis of the gray forest soil, the most appropriate is the cultivation of legume-cereal (bean-cereal) mixtures, which ensure the formation of the most balanced that allow to restore the soil fertility.

CONCLUSIONS

By an example of different variants for restoring the phytocenosis of a fallow and agrobiocenosis with diverse agrotechnical loading, it was established that application of mineral fertilizers in optimal doses significantly reduces the intensity of the humus destruction. The study of the state of the microbiocenosis of a two-year-old fallow confirmed the data of previous research: cultivation of the cereal crops leads to an intensification of the decomposition processes of the humus in comparison with the cultivation of legume-grass (bean-cereal) mixtures and the sudden recovery of phytocenosis. Introduction of mineral fertilizers in optimal doses intensifies the mineralization process of the nitrogen compounds and slows down the consumption of the soil organic matter in the variants of sudden recovery of phytocenosis and cultivation of the legume-cereal (bean-cereal) mixture. When cultivating a cereal grass mixture, an application of mineral fertilizers leads to intensified consumption of the organic matter. By their phytotoxic properties, the recovery variants of the phytocenosis of the fallow are arranged in the following order: a bean-cereal mixture < sudden recovery < a cereal mixture (N_{45} + N_{45}) < a cereal mixture without fertilizers < a cereal mixture + $N_{90}P_{40}K_{70}$.

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