Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2018, 8(3), 28-31

ORIGINAL ARTICLE

Biological activity of the soil in sows of winter wheats depending on the main soil treatment in sequence

O.A. Tsyuk[1], S.P. Tanchyk[1], V.I. Kyrylyuk[1], T.V. Shevchenko[2]

[1]*National University of Life and Environmental Sciences of Ukraine, Ukraine*

[2]*National Academy of Agrarian Sciences of Ukraint, Kyiv 9, Omelianovycha-Pavlenka Street, Kyiv, 01010, Ukraine*

E-mail: tsyuk@ukr.net; toma.agrovet@gmail.com

Received: 20.04.2018. Accepted: 11.05.2018

The study of soil biological activity by the primary processing systems influence on the intensity of the decomposition of flax linen and the number of microarthropods in winter wheat crops. Cellulose-destroying soil ability by the method of applying linen cloth by Mishustin and Petrova; the number of soil microarthropods – according to the method of stationary study of soils. It is established that soil microbiological processes actively pass through the application of main dump-nonmoldboard soil tillage processing in the crop rotation. Among the precursors of winter wheat, the increased biological activity of the soil was marked the field after perennial grasses, but after corn for silage the field was with lower activity. The main dump-nonmoldboard soil tillage in the crop rotation creates the conditions for its high biological activity. The best conditions for biological activity in winter wheat sowings were formed after clover by one mowing; They were less favorable after corn for silage.

Keywords: Biological activity, soil, wheat, tillage, precursor, typical chernozem

Introduction

Soil fertility is formed under the influence of a complex of natural and anthropogenic factors, among which the leading role belongs to the biochemical activity of microorganisms. It doesn't only ensures continuous elements circulation – organogenes, but also determines the direction soil processes formation. The soil microflora is involved in the formation and regulation of almost all valuable soil properties (Balabanov et al., 2013; Svirskene, 2003; Tuev, 1989).

The biological properties of soils are one of the most important indicators of possible mobilization of soil fertility reserves (Tsyhichko, 2015). Soil favorable physical and chemical properties create good prerequisites for its biological activity. It is known, that microorganisms perform an important function in substances circulation of the biosphere – they decompose and mineralize organic matter in soil and synthesize nitrogen compounds from air nitrogen (Patyka et al., 1993; Symochko, 2008). Its established the direct correlation of soil biological activity from humidity, temperature and its physicochemical properties, the amount of radiant energy that soil receives from the number of microorganisms. The most vigorous processes of decomposition of organic matter occur in the upper layer where the overwhelming majority of microorganisms, roots of plants and plant remains are concentrated. Hence the measures of mechanical treatment have a significant effect on the biological activity of soil (Hanhur, 1997; Iutynska, 2006; Panov et al., 1983). The natural processes in soils that occur today can't ensure further agricultural crops increase. The widespread use of pesticides and artificial fertilizers with insufficient use of organic fertilizers has led to a rapid decrease in biological activity and effective land fertility (Ivaniuk, 2005; Prymak et al., 2007; Shcherbakova, 1983). It is necessary to include biological indicators of soil fertility for an objective assessment of the state of soils and solving environmental problems. They are more sensitive, capable of adequately characterizing the physiological and sanitary soil state and therefore they can serve as indicators of its current state of life (Patyka et al., 2012; Patyka et al., 2002). So, it is relevant to study the effect of soil cultivation on its biological activity. The purpose of this article is to determine the dependence of soil biological activity in winter wheat crops from primary processing systems.

Materials and methods

The studies were conducted during 2010-2017 in the Right-bank Forest-steppe on the agronomic research station of the National University of Life and environmental sciences of Ukraine (Kiev region, Vasylkivskyi district, Pshenychne village). The soil of the experimental field is chernozem, a typical low-humus light-loam with a humus content of 4.2-4.5% in the treated layer and a pH of 7.0-7.2 in the salt extract. The specific mass of the soil is 2.6 g/cm^3; The bulk density is 1.2-1.27 g/cm^3; Full humidity capacity – 38.4%, field humidity capacity – 28%; humidity of stable wilting – 10%; The depth of groundwater is 5-6 m.

In the stationary two-factor experiment crop rotation is typical for the Forest-Steppe zone with alternating crops: clover – winter wheat – sugar beet – corn for silage – winter wheat – grain corn – pea – winter wheat – sugar beet –barley with clover.

The biological activity of the soil was studied in three fields with winter wheat.

There were studied in the experiment, such variants of basic tillage systems as: 1) differential treatment (control), which is recommended in the Forest-Steppe and provides 6 plowings for the crop rotation, two surface cultivations for winter wheat after peas and corn for silage and one flat cutting for barley after sugar beet; 2) flat cutting for all crops, except for surface treatment with disk tools for winter wheat after peas and corn for silage; 3) dump-nonmoldboard soil tillage consisting of a longline plowing for the sugar beet, superficial disc drive for winter wheat after peas and corn for silage and flat-top loosening for other crops; 4) surface cultivation with disc tools for all crop rotation. The area in experiment is 93.6 m^2, with fourfold repetition.

There is in the experiment the second studied factor was two systems of farming. It is indicated the resource provision as the main feature of agriculture systems.

There is a feature of the agriculture studied systems are the options of resource provision for reproducing the productive cultivated land potential. According to the industrial farming system per 1 hectare of arable land, 12 tons of organic and 300 kilograms of active mineral fertilizers are introduced in the crop rotation (N92P100K108) with appropriate chemical protection of crops.

The basis of the biological model of the farming system is the introduction of 17 tons/ha (12 tons of manure and 5 tons of by-products and mass of sideral crops in terms of manure) of arable land of organic fertilizers in crop rotation without the use of industrial agrochemicals using biological crop protection agents.

In biological farming the seeds of winter wheat were treated before sowing with a complex polyfunctional biological preparation containing azotobacterin, phosphoenterin and biopoliticide, the bioagents of which are strains with different dominant functions: Nitrogen fixation – *Azotobacter vinelandii* 10702, Phosphate mobilization – *Enterobacter nimipressuralis* 32-3, Antagonism to phytopathogens – *Paenibacillus polymyxa*. Agrophil was used as a reference basis with Rhizobium radiobacter 10 strain. The inoculation was carried out with an aqueous suspension of cultures, or preparations, at a rate of 2% of the weight of the seeds, the load of bacteria per seed was: *A. vinelandii* 10702 - 4.8×10^6, *E. nimipressuralis* 32.3-41.7 × 10^6, *R. radiobacter* 10-77.1 × 10^6, *Paenibacillus polymyxa* 11-0.4 × 10^6 CFU.

The biological activity of the soil was determined by the method of E.M. Mishustin and A.N. Petrova. The exposure of linen cloth duration was 60 days. The determination of the number of ground microatropods was carried out in triplicate (Zvyagintsev, 1991).

Results and discussion

The carried out researches of biological activity of soil in winter wheat crops under the influence of various systems of basic processing testify to the importance of this effect (Table 1). The greatest decomposition of linen cloth was observed on variants without slice rotation.

The use of various treatment systems causes different microorganisms activity along the profile of the arable layer. In particular, both as planar as surface cultivation promoted more intensive activity of microflora in the upper (0-10 cm) soil layer with a gradual decrease in the lower layers. The difference between these layers is on average 12%.

Table 1. Effect of basic tillage systems on the intensity of cellulose decomposition of microorganisms, % (average 2010-2017).

Precursor	Soil layer, cm	Main soil tillage variant			
		Differentiated (K)	Flat cutting	Dump-nonmoldboard	Surface layer
Clover	0-10	35.1	41.8	43.7	42.7
	10-20	36.9	38.0	40.3	39.9
	20-30	33.3	34.2	35.2	36.1
Pea	0-10	33.1	37.0	39.9	38.9
	10-20	35.0	35.0	38.0	38.0
	20-30	30.0	32.0	33.2	34.2
Corn for silage	0-10	31.0	34.0	34.2	36.1
	10-20	35.0	32.3	30.4	33.2
	20-30	30.0	30.4	29.9	31.3
LSD_{05}		1.8	2.2	2.5	1.9

In the case of using differentiated soil cultivation in crop rotation, its biological activity varies radically. Layer of 10-20 cm of soil had the highest activity. The difference in the decomposition rates of the canvas is less noticeable and averages 3-5%.

In the case of using differentiated soil cultivation in crop rotation, its biological activity varies radically. The most active activity was a layer of 10-20 cm of soil. The difference in the decomposition rates of the canvas is less noticeable and averages 3-5%.

Usage of dump-nonmoldboard soil tillage promotes high biological activity among the precursors, as well as throughout the arable layer.

Favorable conditions for high level of biological soil activity were observed after the clover. Biological indicators after corn for silage were worse.

As shown by Makarov (Makarov, 1984), differences in biological activity after various precursors are due to unequal conditions for the activity of soil microorganisms. So, perennial fodder plants leave behind themselves more stubble residues than the

annuals. Their agronomic value is determined by the ratio of nitrogen to carbon. The largest content of nitrogen, and, correspondingly, the lowest C : N ratio has corn for silage. There is in the soil the decomposition of organic matter with a high C : N ratio occurs much more slowly.

So, the main dump-nonmoldboard soil tillage in the crop rotation processing increases the intensity of linen cloth decomposition, which indicates intensified activity of soil microflora. After the clover on 1 mowing there was an active decomposition of the linen cloth and favorable conditions for the functioning of the agrocenosis due to better availability of humidity, nutrients in accessible forms and improvement of the agrophysical properties of the soil.

It is known that collembolans play an important role in the formation of the soil part of the structure of agrocenoses, as one of the main components of soil groupings. The important catalytic function of springtails in the processes of organic degradation causes a growing interest in these objects. They are characterized by the dynamic development of the population, the ability to respond quickly to changes in the environment (including those related to agrotechnics), which makes it possible to use them as an indicator of the state of soils (Hrynyk et al., 2011; Iutynska et al., 2005). The total number of springtails with different treatment methods and precursors of the changes is not the same (Table 2).

Synecological approach to bioindication is currently in the process of becoming. It is suitable for assessing the dynamics of abundance, biomass, species diversity, structure, dominance, the ratio of life forms of long-lived and short-lived species, large and small-sized species. It is natural that these indicators differ in disturbed and intact ecosystems and in soils treated in one way or another. Thus, deep plowing is more severe than surface plowing, affecting the species diversity of the springtail. The nature of the soil cultivation essentially reflected on the vertical distribution and weakly - on the seasonal dynamics of the total number of colembulans (Kolodyazhnyy et al., 2014).

Table 2. The number of microatropods depending on the main soil tillage and the precursors under winter wheat, thousand specimens/m^2 in the 0-5 cm layer (2010-2017).

Systems of main soil tilliage		Precursor					
		Clover		Pea		Corn for silage	
	Agricultural system	Mites	Colembulans	Mites	Colembulans	Mites	Colembulans
Differentiated (control)	I	2.3	5.0	2.5	5.0	2.0	3.1
	B	2.7	5.8	2.9	6.1	2.2	3.4
Surface	I	3.0	7.2	3.2	6.9	2.4	4.3
	B	4.2	8.0	4.5	8.6	2.4	5.1

I - Industrial system of agriculture; B - Biological system of agriculture.

Under the experimental conditions the amount of microatropods was 2.1-8.0 thousand specimens/m^2. The greatest concentration of soil population was observed in the areas of surface tilliage in comparison with the differentiated one, which is associated with a higher activity of the processes of organic degradation. Optimal for the bulk of the microatropod population living layer - the enzymatic layer of litter, lies between the upper layer of fresh organic matter and the preserved structure and the lower part of the humus horizon of the soil.

The use of the industrial model of farming system of in winter wheat crops caused a significant decrease in the number of microatropods in the soil layer of 0-5 cm relative to the biological system of farming. This decrease was 11-30%, depending on the basic tillage and precursors. The use of clover on 1 mowing as a precursor, for winter wheat determined the formation of the greatest number of mites and colembulans that we took into account. This is due to the fact that perennial grasses leave more quality plant residues than annual ones. The smallest number of these organisms were characterized by samples that were selected in variants where winter wheat was sown after corn for silage.

Conclusion

So, surface and nonmoldboard soil tillage increase the number of microatropods. The dump-nonmoldboard soil tillage in the crop rotation creates the conditions for high biological activity. The best conditions for biological activity in winter wheat crops were formed after a clover on 1 mowing; they were less favorable after corn for silage.

References

Balabanov S.S, Besedin N.V, Kartamyshev N.I, Timofeeva N.M. (2013). Change of the biological activity of the soil depending on the main processing and fertilizer system in grain-treatment of nor then crops. Bulletin of the Kursk State Agricultural Academy, P.167-172.

Hanhur V.V. (1997). Economic and energy valuation rotation for farms left bank steppes of Ukraine [abstract of dissertation]. Dnipropetrovsk, 21 p.

Hrynyk I.V, Patyka VP, Shykula Yu.M. (2011). Microbiological basis of improving yield and quality of crops. 4: 7-10. (in Ukraine)

Iutynska G.O. (2006). Soil microbiology. Kiev: Aristei, 284.

Iutynska H.O, Yamborko N.Ya. (2005). The stability of soil microbial communities to toxic and mutagenic pesticides in various agricultural technologies of growing crops. Scientific herald NAU. 81: 21–25. (in Ukraine).

Ivaniuk V.Ia. (2005). Effect of tillage and fertilization systems on crop rotation productivity in the western forest-steppe. Scientific Papers of the Institute of Agriculture UAAS., 3: 14-18.
Kolodyazhnyy O.Y., Patyka M.V. (2014). Porivnyalna kharakterystyka mikrobiomu chornozem typovoho v ahrotsenozi pshenytsi ozymoyi za riznikh system zemlerobstva. Biological resources and nature management, Vol. 6, 3-4: 81-87.
Makarov I.P. (1984). Minimization of tillage. Theoretical and practical foundations of zonal soil cultivation systems, 3-7.
Panov N.P., Stratonovich M.V., Khripunov G.L. (1983). Biological activity of soil as an indicator of the effectiveness of fertilizers. Dokl., 3: 3-4.
Patyka M.V., Tanchyk S.P., Kolodyazhnyy O.Yu., Ivanyuk M.F., Kruhlov Yu.V., Mel'nychuk M.D., Patyka T.I. (2012) Formuvannya bioriznomanyattya ta filotipovoyi Struktury eubakterial'noho kompleksu chornozem typovoho pry vyroshchuvannya pshenytsi ozymoyi. Dopovidi NAN Ukrayiny, 11: 163-171.
Patyka V.P., Sherstoboieva O.V. (2002). Agroecology monitoring and paspotryzatsiya farmland. Methodological approaches to microbiological monitoring of soil agroecosystems, 131-136.
Patyka V.P., Tykhonovych I.A., Filip'iev I.D. (1993). Microorganisms and alternative agriculture. Kiev: Urozhai, 176.
Prymak I.D., Yeshchenko V.O., Manko Iu.P., Trehub M.I., Prymak O.I. (2007). Resource-saving technologies of mechanical tillage in modern farming Ukraine. Kiev: KVITs, 272.
Shcherbakova T.A. (1983). Enzymatic activity of soils and transformation of organic matter. Minsk: Science and Technology, 222.
Svirskene A. (2003). Microbiological and biochemical indicators in the evaluation of anthropogenic impact on soils Pochvovedenie, 2: 202-210.
Symochko L.Iu. (2008). The biological activity of the soil natural and anthropogenic ecosystems in lowland conditions of Zakarpattya. Scientific herald the Uzhgorod University, 22: 152-154.
Tsyhichko H.O, Makliuk O.I. (2015). The dynamics of chemical activity of typical chernozem organic and conventional farming systems. Agrochemicals & Soil, 82: 91-97.
Tuev N.A. (1989). Microbiological processes of humus formation. Moscow: Agropromizdat, 239.
Zvyagintsev D.G. (1991). Methods of soil microbiology and biochemistry. Moscow: MGU, 304.

Citation: Tsyuk, O.A., Tanchyk, S.P., Kyrylyuk, V.I., Shevchenko T.V. (2018). Biological Activity of the Soil in Sows of Winter Wheats Depending on the Main Soil Treatment in Sequence. Ukrainian Journal of Ecology, 8(3), 28-31.