БІОРІЗНОМАНІТТЯ ТА БІОБЕЗПЕКА ЕКОСИСТЕМ

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FUNCTIONING OF SOIL MICROBIOTA UNDER THE INFLUENCE OF HERBICIDES

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Висвітлено оцінку функціонування мікробіоти ґрунту за дії ґрунтових гербіцидів та встановлено зміну кількості мікроорганізмів основних еколого-трофічних груп, що своєю чергою призводить до перерозподілу домінуючих форм мікроорганізмів та зниження мікробного біорізноманіття. Відзначено перебудову видової структури мікроміцетів та зростання фітотоксичності ґрунту за застосування ґрунтових гербіцидів.

Ключові слова: *ґрунтові гербіциди, мікробіота, біологічна активність ґрунту, фітотоксичність.*

Soil microbiota plays a significant role in the circle of elements and energy in the biosphere, namely microorganisms make the synthesis and separate organic compounds, carry out the accumulation and rearrangement of biologically important substances, destroy and create minerals and compounds.

The functioning of the microcomplexes in the soil keeps the uninterrupted processes of transformation of the ground compound in ecotops (pathic). The influence of the external factors may lead to the ruining of natural cycles and balanced environmental conditions.

The soil systems may be fiercely misbalanced due to intensive agricultural usage, under which the balance is shifted to the development of microorganisms which takes part in the mineralization processes.

The intensive application of the soil herbicides provokes a discussion in the scientific circles and among the agricultural manufacturers. The controversial data prove the impact of pesticides on the soil microbiota. On the one hand, some data state that pesticides, mainly herbicides, do not influence the soil microorganisms. On the other hand, some sources highlight their significant impact.

In the majority of cases within the application of chemical plant protection products there might be a temporary decrease of some types or groups of microorganisms which consequently restore their number. Besides, there might be a decline of accumulating the microbial biomass and impoverishment of species diversity of bacteria and fungi because of the death of the competitive populations.

According to A. Kortekamp the pesticides, having accumulated in the soil, can either inhibit or stimulate the development of beneficial microflora, as well as pathogens which do not have the practical significance in the usual conditions.

Direct or indirect influence of the pesticides can reach the development of the soil diseases, growth, spore production, survival and competitive-saprophytic activity of the soil fungi. Pesticides may reduce or increase the density of some soilborne pathogens, change the mechanisms of the defense system of the life-giving plant, as well as the interaction between fungi and plants' roots.

At the same time, soil microflora is characterized with its selected sensitivity to herbicides. Chemical treatment usually leads to the death of some types and genera of microorganisms, which are sensitive to some

chemicals, activation of persistent mutants and types that use herbicides as the energy source. As a result, there is misbalance of the soil ecosystem and the conditions of the soil self-purification which takes place thanks to the activities of the consecutive change of microorganisms' races; contraction of the microbiological activity spectrum caused by both direct microbial impact of herbicides and environmental changes (Storchous) .

Many foreign and Ukrainian researches have confirmed that the effects of herbicides on the soil microorganisms depend on various factors: regulations and chemical features of the mediums, terms of its application, microflora composition, soil-climate conditions etc. A range of researchers discovered the correlation between the herbicides' influence on the soil microflora and pH, humidity, temperature and type of the soil, as well as the content of organiccompound in it.

In this regard it is important to look into the impact of soil herbicides in the soybean fields on the main taxonomic groups of microorganisms and biological activity of the soil within the forest-steppe belt of Ukraine.

MATERIALS AND RESEARCH METHODS

The evaluation of soil microbiota functioning under the effect of soil herbicides was carried out in the fields and laboratories in 2014–2016, having used themediumswhich belong to different toxic classes with its impact on the soil microorganisms: Primextra Gold containing S-Metolachlor, Atrazine and Fabian-Imazetapir on the soybean crops of the type «Lybid».

The investigation was held on the typical Chernozem with the humus of 4.2%, hydrolysed nitrogen — 125 mg/kg, floating phosphorus — 230, Potassium exchanging — 75 mg/kg of the soil, pH salt extension — 6.6.

Selection of the soil samples, counting the number of microorganisms of the main ecological-trophic and taxonomic groups was made by generally accepted methods. The direction of the microbiological processes in the soil was defined by K. Andreiuk, G. Iutynska with co-authors. The biomass of microorganisms in the soil was measured by rehydration methods. The intensity of the Carbon dioxide emission from the soil was estimated by Shtatnov'sabsorption method, potential nitrogen fixing activity of the soil rhizosphere was defined by Hardy acetylene method modified by Umarov. Nitrogen activity of the nodules structure (bubbles) of soybean was measured by Hardy acetylene-reduction method. Phosphatase activity in the soil rhizosphere was measured by Geller and Hinsberg's method.

Cellulose damaging activity of the soil was estimated by Kristens method modified by Zviagintsev.

Phytotoxicity of the soil was measured by Grodzynskyi's method modified by Mochalov-Sherstoboev.

Statistic processing of digital data was held by the analysis of variance.

RESULTS AND DISCUSSION

The microbial complexes' functioning in the soil guarantees the uninterrupted processes of transformation of the ground compound in the ground ecotops. Looking into the dynamics of their quantity gives an opportunity to unveil the mechanisms which define general directions of transforming the ground compound and the state of the ecosystem in general (pathic). Analysis of the microflora behavior under the application of the soil herbicide is essential for the ecological-agrarian estimation of the outcomes after chemical treatment.

We have found out that the soil herbicides Fabian and Primextra Gold didn'thave any significant impact on the quantity of microorganisms of the main ecological-trophic groups. There was a reduction in the number of ammonificating microorganisms in the soil of soybean agrosystems in comparison with the natural ecosystems. On average their share went down by 35–40%. The regularity of pesticides' influence on this group of microorganisms wasn't detected.

The visible confirmation of the negative impact of the soil herbicides on the microbiota is the increase of the amount of spores in the active phase of the plant's organogenesis

because the spore formation in the microorganisms is a response to effects of the unfavourable factors.

There was an increase in the amount of spore forms compared to the control and the soil of the natural ecosystem. The quantity of bacteria, which use mineral nitrogen, had a tendency to go up, and in an accompaniment with Primextra Gold the representatives of this group of microorganisms are likely to use the ingredients of the medium in their metabolism.

There was a slightly decreasing number of nitrogen fixing microorganisms compared to the control, though their number in the soil of agrosystems was 1.8–2 times less compared to this figure in the natural ecosystem.

Microorganisms, which are able to use nutrients from extremely diluted liquids, and those, which use liquids from soil stores for their biological process, didn't react to the pesticide treatment during our experiments. The quantity of oligotrophs and pedotrophs in all researched phases didn't show noticeable changes in comparison with the control.

Mycelial microorganisms showed a foreseen reaction on the soil herbicide, mainly the increase of their quantity. The number of streptomycetes grew up by 30–40%, micromycetes – by 10–15%. As a result, their general number was 40% higher than an amount of these microorganisms in the soil of the natural type. The index of *Azotobacter* microorganisms' content in the soil of the natural ecosystems is significantly higher than the one in the soil of agroecosystems. The highest share of fouling lumps was detected during the selection of the soil from the natural ecosystem, and it was equal to 79%.

The influence of herbicides Fabian and Primextra Gold on the bacteria of the genus *Azotobacter* was similar, their utilization led to the reduction of microorganisms by 40–45% compared to the variant, where soybean plants were grown up without application of the soil herbicides, and by 51–67% compared to the natural ecosystems.

The results of the investigation of the soybeans' soil rhizosphere's biological activity pointed out to the minor diminution of microbial biomass which in its turn testified about the attenuation of the microbiocenosis metabolic activity of the researched crop which was confirmed by the CO_2 emission intensity index.

One more index, which describes the soil biological activity, is its phytotoxicity that

Table 1

Quantity of microorganisms of the main ecological-trophic and taxonomic groups under the effect of the soil herbicides

Variant	Ammonification medium, mln.KUO/g	Quantity of spores, mln.KUO/g	Bacteria that use mineral nitrogen, mln.KUO/g	Nitrogen fixing microorganisms	Oligotrophs	Pedotrophs	Phosphate mobilizing microorganisms	Streptomycetes	Micromycetes (thous.KUO/gASG)	Azotobacter, fouling lumps, %
Control	5.3	0.1	8.3	10.9	10.1	1.2	1.9	3.5	12.0	47.8
Fabian	4.9	0.3	8.2	10.5	9.4	1.3	1.7	4.4	10.8	26.5
Primextra Gold	4.5	0.5	9.1	10.3	9.6	1.6	1.6	4.8	11.7	31.0
Natural ecosystem	6.4	0.2	5.0	20.2	10.5	0.8	3.0	2.8	12.3	79.0
HIP_{05}	0.5	0.04	0.7	1.1	0.8	0.2	0.2	0.8	1.3	8.0

Note:* mln. KUO/gASG.

is measured by inhibiting the germination of seeds.

In the course of research there was a soil phytotoxicity rise under the treatment of medium Fabian and Primextra Gold. It is to be underlined that this index had accumulative character.

Within the experiment the phytotoxicity was gradually going up, especially under Primextra Gold, and constituted 18.3% which was 3.3 times higher compared to the control.

Ecological coefficients demonstrated the dependency on treatment of pesticidesless. On the contrary, they were mainly dependable on their belonging to agrarian or natural ecosystems.

In terms of ecological well-being, the soil indexes of the natural ecosystems turned out to be optimal. To be emphasized that cultivation of soybean plants positively influences the process of humus accumulation — for the three years of studies the coefficient of humus accumulation has been on average equal to the one of the natural ecosystem.

The reconstruction of the sort structure of micromycetes was also registered. In general, it was typical for micromycetes to have the reallocation according to the dominance of the types which were available in the control soil. There was an increasing share of phytotoxicmicromycetes and conventionally pathogenic ones as well (Picture 1).

The soil herbicides Fabian and Primextra Gold have an impact on the next crop in the alteration of crops. That is a reason to use these mediums one more time in case of soybean cultivation. Nevertheless, the studies have proved that such activities lead to damaging the quality of soil. Besides, application of herbicides with the same main substance

Table 2

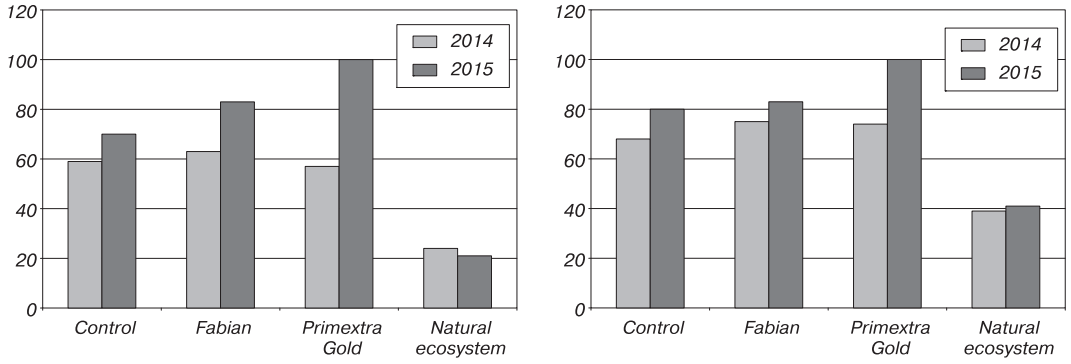
Soil biological activity under the effect of the soil microorganisms

Variant	Breath, mg CO_2/kg g	Biomass, mkgC/g soil	Phytotoxicity, %	Antimicrobial activity, %	Phosphate activity mgP_2O_5/100 g soil per 1 hour.	polyphenol oxidase activity mgpurpurgalin/ g soil	Peroxidaseactivity, mg purpurgalin/ g soil
Control	120.8	530.3	5.5	2.9	6.0	0.317	0.262
Fabian	102.5	485.0	16.5	3.6	4.4	0.293	0.255
Primextra Gold	100.1	511.0	18.3	2.4	4.2	0.292	0.265
Natural ecosystem	107.9	596.4	3.4	12.4	1.4	0.275	0.268
HIP_{05}	8.9	21.3	4.7	0.6	0.7	0.014	0.017

Table 3

Ecological coefficients of the soil under the effect of the soil herbicides

Variant	Coefficient of mineralization/ immobilization	Coefficient of pedotrophy	Coefficient ofoligotrophy	Coefficient of humus accumulation
Control	1.3	0.2	0.6	0.7
Fabian	1.4	0.2	0.6	0.7
Primextra Gold	1.7	0.3	0.6	0.8
Natural ecosystem	0.6	0.1	0.8	0.8



Picture 1. Share of phytotoxic and conditionally pathogenic micromycetes in the soil under effect of the soil herbicides

may cause the growth of phytopathogenic and toxic fungi.

This determines a necessity to change herbicides if the crops are cultivated on the same ground areas. Such actions can help to preserve the soil characteristics, prevent from its exhaustion, and gain a high index of crop yield.

CONCLUSIONS

The results of the influence of the soil herbicides Fabian and Primextra Gold on the soil biological characteristics in the soybean crops of the variety«Lybid» didn't convincingly demonstrate the decrease of their biological activity in regard to the quantity of microorganisms of the main ecological-trophic groups, fermentative activity, CO_2 emission intensity, general microbial biomass, but there was rearrangement of the dominant forms of microorganisms and reduction of microbial biodiversity, as well as decrease of biodiversity of the soil microbial groups which led to the increase a share of toxic and conditionally pathogenic micromycetes in the soils.

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TAXONOMIC STRUCTURE OF AGRICULTURAL LANDSCAPES OF CONNECTED AREAS IN VINNYTSIA REGION ECONETWORK

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Охарактеризовано сучасний стан напівприродних фітоценозів деяких районів Вінницької обл. Під час дослідження флори регіону встановлено її загальний видовий склад, здійснено систематичний, біоморфологічний та еколого-ценотичний аналізи. Визначено, що фіторізноманіття досліджуваних територій налічує 268 види, які належать до 168 родів, 52 родин. Встановлено, що за екологічною приналежністю рослинність агроландшафтів відноситься до лучного, лучно-степового, лісового неморального угруповань. Наявність в цих угрупованнях апофітних та рідкісних видів рослин свідчить про цінність вказаних територій для збереження рослинного різноманіття.

Ключові слова: *агробіорізноманіття, екомережа, напівприродні фітоценози, біота, адвентивні види.*

In recent years the plant cover of our country is being transformed under the influence of anthropogenic factors. Preservation of floral and landscape diversity is an instrument of ecological balance maintaining in biosphere [1]. Ecological network brings together all branches of biodiversity into a single spatial system. Structural elements of ecological network are key areas (natural nucleus), connecting areas (ecological corridors), buffer zones, renewable areas (zones of natural landscapes renaturalization) [2]. On the territory of Vinnytsia region structural elements of the ecological network have three levels: national, regional and local. The last is formed within the limits of administrative districts and that is mostly river valleys and forest belts. From literary sources it is known that the area of Vinnytsia region is located within the most cultivated region — Right-Bank of Forest Steppe of Ukraine, where leading place belongs to agrarian landscapes [2, 3]. According to the assessments of Yu. Odum, optimal ratio between natural and anthropogenic landscapes should be 60% to 40% [4].

Within the investigated areas under natural vegetation is about 30% of the area that shows non-optimal landscape and ecological structure of the territory. The share of natural landscapes of the Vinnytskyi district — 31.9%, Zhmerynskyi — 34.5%. The smallest share of natural landscape is in Mohyliv–Podilsky and Tyvrivsky areas — 17.6% and 27.4% respectively [5]. As result of literature data analysis we found that in Vinnytsia region the following types of vegetation as forest, meadow, steppe, rock-steppe and wetland are presented. Therefore the purpose of our study was to determine the species composition of plant communities of seminatural phyto-