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ASSESSMENT OF THE ECOLOGICAL CONDITION OF THE LAND AFTER THE APPLICATION OF MINERAL FERTILIZERS AND PESTICIDES

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Abstract

Soil protection from mineral fertilizers and pesticides implies taking a large number of organizational measures such as: development of new long-acting granular forms of fertilizers; application of complex forms of chemicals; application of rational input technology; creating and applying less toxic and less resistant/stable compounds and reducing the doses of their introduction into the soil; compliance with storage and transport rules, etc.

***Key words:** soil, mineral fertilizers, pesticides, ecology, microorganisms*

Introduction

Scientific workers, farmers and businessmen are dealing with issues of soil condition assessment. The increase in anthropogenic activity conditions the need to determine and forecast changes in the surrounding environment, as well as to assess the possibility of stable development, because the soil significantly determines the resource potential of the biosphere, which will be used by future generations of people. The consequences of soil deterioration are already reflected in a large number of global, regional and local environmental problems, which are related to the state of the atmosphere, hydrosphere, biological diversity, human health, etc. (Đukić et al., 2007, 2020).

When assessing the ecological state of the soil, it is very important to assess the content of both natural elements and compounds, as well as xenobiotic compounds in the soil (Muraviyev et al., 2000). Assessment of soil pollution is performed by comparing the content of polluting elements and substances in the studied soil with their basic content on the one hand, and on the other - with their maximum allowed content (MDK). At the same time, basic content means the content of chemical elements and substances in soils that are so far from the source of pollution that it is difficult to assume their change, caused by an anthropogenic factor (Đukić et al., 2013).

The aim of this paper is to indicate the need not only to assess the condition of the soil after the application of mineral fertilizers and pesticides, but also to take measures to prevent and eliminate the negative consequences of their application.

Soil pollution with mineral fertilizers

The application of mineral fertilizers (agrochemicals, fertilizers) in agriculture is conditioned by the natural removal of biogenic elements from the soil - compounds of nitrogen, phosphorus, potassium and others, which participate in the formation of biomass during the cultivation of agricultural crops and the need to fill their losses. The problem of replenishing nitrogen losses is particularly emphasized. Therefore, the application of mineral fertilizers is a factor in the intensification of agricultural production. At the same time, it is a substantial and difficult to control process, which leads to the introduction of a much larger amount of biogenic elements than is necessary to fill their natural losses. Because of this, there is a danger of deteriorating the quality of food products and pollution of the atmosphere and natural waters with excess agrochemicals (Mandić et al., 2012; Đukić et al., 2018a).

Excess nitrogen accumulates, mainly in the form of nitrates. If nitrogen is not absorbed by the soil in that form, it is easily washed out of it (rain, snow), passes into underground water and nearby water basins (Oenema et al., 2005; Shamrukh et al., 2001). In addition to the negative effects on plant growth, excess nitrogen and its leaching leads to pronounced leaching of potassium and, to a lesser extent, phosphorus (phosphate). Data on the most common mineral fertilizers are listed in Table 1.

Table 1. Characteristics of mineral fertilizers

Trade name	Basic active substance (chemical formula)	Solubility in water*	External appearance**	The color
Ammonium chloride	NH_4Cl	DR	K, G	White
Ammonium sulphate	$(NH_4)_2SO_4$	DR	K, G	White (colorless)
Amophos, diamophos	$NH_4H_2PO_4$, $(NH_4)_2HPO_4$	DR	G	Yellowish to blue (the shade is determined by the content of microelements)
Amofoska	$NH_4H_2PO_4$, $(NH_4)_2HPO_4$, NH_4Cl,KNO_3, KCl	DR	G	Pinkish
Plaster cast	$CaSO_4 \times 2H_2O$	TR	P	White, gray
Dolomite flour	$CaO \times MgO \times 2CO_2$	NR	P	Gray
Lime	$CaCO_3$	NR	P	White (to gray)
Potassium chloride	KCl	DR	K, G	White
Potassium	K_2SO_4	DR	P	White

sulfate				
Urea	$Co(NH_2)_2$	DR	К, G	White
Lime flour	$CaCO_3$, $MgCO_3$	NR	P	Gray
Phosphorite flour	$Ca_5F_4(PO_4)_3 \times CaCO_3$	NR	P	Dark gray
Nitroamophos	NH_4NO_3, $NH_4H_2PO_4$	TR	G	White
Nitroamofoska	NH_4NO_3,KNO_3, $NH_4H_2PO_4$, NH_4Cl, KCl, $Ca(NO_3)_2$	DR	G	Pink
Nitrofoska	NH_4NO_3, $CaHPO_4$, $(NH_4)_2HPO_4$, KNO_3, NH_4Cl	TR	G	White
Precipitate	$CaHPO_4 \times 2H_2O$	NR	P	White-grey
Ammoniacal saltpetre	NH_4NO_3	DR	G	White
Lime saltpeter	$Ca(NO_3)_2 \times 2H_2O$	DR	K	White
Potassium nitrate	KNO_3	DR	K	White
Sodium nitrate	$NaNO_3$	DR	K	White
Superphosphate	$CaHPO_4 \times 2H_2O$, $Ca(HPO_4)_2$ X $2H_20$	TR	G	White, bluish, pink, black
Ecofoska	KH_2PO_4, K_2HPO_4	TR	G	Gray
Azofoska	NH_4NO_3, KNO_3, $NH_4H_2PO_4$, NH_4Cl, KCl, $Ca(NO_3)_2$	DR	G	Pink

** DR-well soluble, TR-hardly soluble, NR-insoluble. * G-granules, P-powder, K-crystals.

It can be seen from the table that mineral fertilizers are represented by compounds with different degrees of solubility, although hardly soluble compounds dominate.

Soil pollution with pesticides

In addition to mineral fertilizers, pesticides (poisonous chemicals intended to fight weeds, microorganisms, pests, etc.) belong to the means of intensive chemicalization of agricultural production. Humans use more than 400 pesticides, but only 30 have their MDK determined. Organo-chlorine pesticides (for example, DDT) are the most resistant to decomposition in the soil (and in the conditions of other natural environments). They are characterized by the most pronounced cumulative properties, i.e. they are able to accumulate in the tissues of plants and animals, and to be transmitted through food chains (Yang et al., 2012).

When crops are treated with pesticides, the main part of them remains on the surface of plants and soil. Pesticides are adsorbed by organic matter and mineral colloids of the soil. Data were obtained that humus adsorbs up to 80% of pesticides. Excess pesticide migrates, ending up in groundwater. The whole mass of "unadopted" pesticides behaves in the same way over time, because their adsorption in the soil is reversible. For example, after several years, pesticides introduced into the soil can be found in well water at a depth of up to 50m. By accumulating in soil and spreading through groundwater, pesticides can travel up food chains and cause disease in humans and animals.

The accumulation of pesticide residues also depends on the nature of the toxicants. The most resistant are pesticides from the group of organochlorine compounds and dienes. They remain in the soil for several years (tab. 2). In addition, the higher the dose, the longer the toxicant is retained. Organophosphorus compounds and carbamic acid products lose their toxicity in less than three months and do not create toxic metabolites during decomposition, which is why these compounds are more favorable for use.

Table 2. Duration of toxic effects of different pesticides

Pesticide name	Duration of action
Insecticides	
Toxaphene	6 years
Heptachlor	9 years
Aldrin	9 years
DDT	10 years
XXCH	11 years
Chloridan	12 years
Herbicides	
2-4-5-T	6 months
Diuron	16 months
Simazine	17 months
Atrazine	17 months
Gordon	19 months
Monuron	36 months

When pesticides are introduced by aviation methods, they are dispersed and can be transported by air masses over great distances. Many pesticides and their metabolites* are found where they have never been applied (for example, in Antarctica). The systematic

* metabolites - intermediate products of the transformation of pesticides found in the surrounding environment

application of pesticides (resistant and cumulative) in large quantities leads to the fact that the main sources of pollution of the surrounding environment become snow, rain and underground water.

Especially suppressive pesticides act on soil bacteria, which are under their direct influence. 99% of pesticides suppress the bacterial community so strongly that it can be restored only after 1-2 months, i.e. during 1,000-10,000 generations of bacteria and has far-reaching consequences for the entire community of soil organisms (Baćmaga, Kucharski, 2015; Đukić et al., 2018b).

The soil is detoxified with the breakdown of pesticides into non-toxic components. Oxidation, reduction and hydrolysis reactions contribute to the decomposition of toxicants. Pesticides are most actively decomposed by soil microorganisms (Đukić et al., 2013, 2015). With the participation of microbial enzymes in the soil and soil solution, the processes of hydrolysis, oxidation-reduction, etc. are actively taking place. It is characteristic that microorganisms use carbon, nitrogen, phosphorus and potassium for their life activity, which were the constituent parts of pesticide molecules.

Application of mineral fertilizers and pesticides causes various environmental problems.

Conclusion

Soil protection from mineral fertilizers and pesticides implies taking a large number of organizational measures, such as: development of new long-acting granular forms of fertilizers; application of complex forms of chemicals; application of rational input technology; creating and applying less toxic and less resistant/stable compounds and reducing the doses of their introduction into the soil; compliance with storage and transport rules, etc.

Literature

Baćmaga M, Kucharski J. (2015): Microbial and enzymatic activity of soil contaminated with azoxystrobin. Environmental Monitoring & Assessment, 187 (10): 615

Ђукић Д., Ђорђевић С., Трифуновић Б., Мандић Л., Марковић Г., Машковић П., Танасковић С., Брковић Д. (2013): Биоиндикација и биотестирање загађености животне, средине, „Будућност“ ДОО, Н. Сад 337. стр.

Ђукић Д., Јемцев В.Т., Ђорђевић С., Трифуновић Б., Мандић Л., Пешаковић М. (2013): Биоремедијација земљишта, Штампарија "Будућност" ДОО, Нови Сад, 207 стр.

Ђукић Д., Јемцев В.Т., Семенов А., Иутинска Г., Селицка О. (2018а): Еколошка биотехнологија (књига 1), Агрономски факултет у Чачку, 844 стр.

Ђукић Д., Јемцев В.Т., Семенов А., Иутинска Г., Селицка О. (2018б): Еколошка биотехнологија (књига 2), Агрономски факултет у Чачку, 754 стр.

Ђукић Д., Мандић Л., Ђорђевић С. (2015): Микробиолошка и фиторемедијација загађених земљишта и вода. Агрономски факултет у Чачку, 294 стр.

Ђукић Д., Семенов А., Лутовац М., Мандић Л., Иутинска Г., Подгорски В. (2020): Земљишни екосистеми - загађење и очишћење, Агрономски факултет у Чачку, 628 стр.

Ђукић, Д., Јемцев, В.Т Кузманова Ј. (2007): Биотехнологија земљишта. Будућност, Нови Сад, 529 с.

Mandić L., Đukić D., Pešaković M. (2012): Microbiological Characteristic of Vertisol under different Fertilization Systems. Journal of Central European Agriculture, Vol. 13, No 1, p. 1-9.

Muraviyev, A.G., Karryev, B.B., Lyandzberg, A.R. The evaluation of soil enviromental conditions. Christmas+, St.-Petersburg, 2000,164 p.

Oenema O, van Liereb L, and Schoumans O (2005) Effects of lowering nitrogen and phosphorus surpluses in agriculture on the quality of groundwater and surface water in the Netherlands. Journal of Hydrology 304: 289–301.

Shamrukh M, Corapcioglu MY, and Hassona FAA (2001) Modeling the effect of chemical fertilizers on ground water quality in the Nile valley aquifer, Egypt. Ground Water 39: 59–67.

Yang, D., Qi, S.H., Zhang, J.Q., Tan, L.Z., Zhang, J.P., Zhang, Y., Xu, F., Xing, X.L., Hu, Y., Chen, W., Yang, J.H., Xu, M.H., 2012. Residues of organochlorine pesticides (OCPs) in agricultural soils of Zhangzhou City, China. Pedosphere 22 (2), 178–189.