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CONTENT

AGRICULTURAL SCIENCES

BIOLOGICAL SCIENCES

EARTH SCIENCES

GEOLOGICAL AND MINERALOGICAL SCIENCES

HISTORICAL AND ARCHEOLOGICAL SCIENCES

Сб. III Всероссийской (национальной) научной конференции (г.Новосибирск, 20 декабря 2018 г.)/Новосиб.гос.аграр.ун-т. – Новосибирск: ИЦ НГАУ «Золотой колос», 2018. – С.417 – 418.

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ECOLOGICAL AND TOXICOLOGICAL ASSESSMENT OF PESTICIDES USED TO PROTECT AGRICULTURAL CROPS

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Abstract

The article presents materials on the ecotoxicological assessment of pesticides that are used to protect crops. The aim of the research was to establish an ecotoxicological assessment of pesticides that are used to protect crops. The studies were carried out in the conditions of intensive chemicalization of agriculture in the forest-steppe of the right bank. It has been established that persistent organochlorine pesticides are one of the most common toxicants of the soil environment.

The ecological and toxicological assessment of pesticides is taken into account by the variability of their distribution in the environment. The degree of negative impact of pesticides for humans and their habitats under specific conditions of use is determined by the presence of their residues and their effect on the quality of the crop. Pesticides are chemical compounds that inhibit the development of a certain group of plants or other harmful organisms. Pesticides entering agrophytocenoses accumulate in separate objects and environments and are included in various migration chains. This is especially true for persistent pesticides that can persist in the environment for a long time.

The results of the research established that fungicides alto-super 330, tilt 250, when used against winter wheat diseases in the forest-steppe of the right bank, actively decomposed in the ears rather than in the stems. The intensity of decomposition of herbicides – esthe, puma-super 100, exactly and esterone in plants of spring wheat, barley and soil has been studied. Herbicide from the group of aryloxyalkanecarboxylic acids aesthetic, at consumption rates of 0.4; 0.6 l/ha degraded slowly in the stems and ears of spring wheat. During the harvesting period, no residual amounts were found in grain and soil.

When testing herbicides on spring barley crops at low doses of microquantities of drugs on the 30th day after treatment, there was esthete, within 0.78-1.20 mg/kg, esterone – 0.98-1.56 mg/kg, exactly – 0.032-0.022 mg/kg, respectively.

It has been established that the intensity of degradation of herbicides from the class of benzoic acid derivatives aesthetic, esterone and sulfonylurea derivatives depends exactly on the type of crop, for example, in spring barley for a longer period than in spring wheat under the same climatic conditions.

Keywords: pesticides; ecological and toxicological assessment; agricultural crops; organochlorine pesticides; soil; agrocenosis.

Today, scientific and technological progress has brought enormous benefits to mankind, however caused problems to be solved our future and our very lives are connected planet. Among them - the provision of humanity with food, energy, raw materials, as well as the problem of ecology. Population the planet is constantly growing, and to ensure its physiological nutritional needs need to produce more and more agricultural products. It is necessary to reduce crop losses from crop diseases, pests and weeds, with a total loss of about 34% of the potential harvest. Therefore, use plant protection products in agricultural production are of great importance.

Due to the intensive use of land, it is necessary to conduct systematic control over the state of its fertility, as well as the level of pesticide contamination of agricultural products.

Scientific and technological progress has brought great benefits to mankind, however, it has also caused problems, with the solution of which our future and life itself on our planet is connected. Among them – the provision of humanity with food, energy, raw materials, as well as the problem of ecology [1].

The world's population is growing steadily, and more agricultural products must be produced to meet its physiological nutritional requirements. At the same time, it is necessary to reduce crop losses from crop diseases, pests and weeds, the total losses from which amount to about 34% of the potential crop. Therefore, the use of plant protection products in agricultural production is of great importance.

Effective and highly productive agriculture cannot do without the use of plant protection chemicals, but at the same time pesticides are one of the most dangerous types of chemical products for humans and the environment. Agrophytocenoses and their main components are primarily exposed to pesticides: agricultural soil, vegetation cover, ground and soil biota, water bodies, including groundwater [2, 3]. Pesticides entering agrophytocenoses accumulate in separate objects and environments and are included in various migration chains. This is especially true for persistent pesticides that can persist in the environment for a long time.

The most important component of food security is not only quantitative, but also qualitative indicators of food consumed by the population. The large-scale technogenic impact on the environment that has occurred over the past century has led to the pollution of the atmosphere, water and soil with various ecotoxicants. In such conditions, obtaining ecologically safe agricultural products becomes difficult.

Modern trends in the development of world agriculture convincingly indicate that, simultaneously with the task of providing the population with food, it is necessary to solve the problem of environmental protection, preservation of biodiversity, and reproduction of soil fertility [4, 5].

The process of migration of pesticides in the soil, their movement in soil – adjacent systems, as well as their residual amount is the result of a complex interaction of a number of factors. They can be divided into four main groups: the first group of factors is determined by the properties of pesticides; the second group is characterized by soil properties and agronomic factors; the third includes climatic conditions; and the fourth – the modes of ingress of chemical plant protection products. Moreover, for some substances, physical factors will be decisive, such as evaporation, for others – chemical or biological destruction (for example, the main way of decomposition of amidosulfuron is microbiological) [3].

A common factor determining the stability of almost all pesticides without exception is their ability to be adsorbed by soil particles, because in the adsorbed state they become inaccessible to microorganisms and are poorly amenable to chemical transformations. Numerous studies show a direct dependence of the accumulation of toxic substances on the content of humus in the soil due to the high sorption capacity of humic substances [4]. Therefore, in fertile structured soils, the maximum accumulation is observed in the upper arable layer, while in soils with a low humus content, the concentration of the pollutant differs little over the entire profile; in addition, an increased risk of groundwater pollution should be expected.

Pesticides are chemical compounds that inhibit the development of a certain group of plants or other harmful organisms without causing any particular harm to beneficial crops. But chemical agents provide only temporary relief, since over time they contribute to the development of resistance to constantly used agents.

The spread of pesticides in the environment occurs both physically and biologically. The first method is scattering by wind in the atmosphere and propagation through streams. The second is the transfer by living organisms along the path of nutrition. As organisms move to the higher links of the food chain, the concentrations of harmful substances increase, accumulating in internal organs, mainly in the liver and kidneys.

Pesticides stored in soils in a variety of ways, including through products of plant and animal origin, can enter the human body [6, 7].

In the environment, pesticides are spread through air, water, plants, animals, and the people who work with them. The protection of nature and the rational use of its resources is one of the important problems of our time, on the correct solution of which the development of the economy, the safety of life and the preservation of the environment in an ecologically clean state largely depend. The systematic use of pesticides in agriculture leads to the fact that they become a constant factor that negatively affects the ecology, changing and forming macro-and microbiocenoses [8].

Observance of a reasonable balance between the need to use pesticides and the possible negative consequences of their use is ensured by the state regulation of the circulation of pesticides. Evaluation of pesticide safety criteria, which include the toxic and logical characteristics of the active substance (allergenicity, reproductive toxicity, teratogenicity, mutagenicity, carcinogenicity, embryotoxicity), the impact on the human environment (drinking water, air, soil), quality and safety of food products using scientific research results of monitoring the content of active substances in environmental objects, prevents the degree of possible danger

of pesticides for human health and their environment in specific conditions of use [9].

Pesticides enter the soil in all cases of their use. Subsequently, a certain part of them decomposes into non-toxic products within several months and does not leave a noticeable negative effect, the other part persists for years and enters the system of circulation of substances in nature. Pesticides enter the atmosphere during evaporation, and then fall out of the rain, are washed out by precipitation or groundwater into deep subsoil layers, are carried by plant roots to the surface with a soil solution, and in trace amounts enter food and again into the soil. The duration of these processes depends on natural and anthropogenic factors, affect the decomposition of pesticides in the soil [10, 11].

Degradation of pesticides in environmental objects depends on acidity, temperature, illumination of the environment, as well as on the physicochemical properties of the drug and the environment [12].

Among the groups of widely used pesticides are derivatives of chlorophenylbenzoyl – urea teflubenzuron, diflubenzuron, etc. It is interesting to note that diflubenzuron is more stable in sunlight, on the surface and inside plants [13, 14].

Persistent organochlorine pesticides are one of the most common soil toxicants. When entering the soil, some of them are sorbed by the soil complex, bind to organic matter, redistribute along the profile, transform and mineralize under the action of soil microflora. A certain part is absorbed by vegetation, and the other is carried out by surface and ground runoff, which determines their entry into water sources, and then into bottom sediments. When evaporated, pesticides can be dispersed in open air [15, 16, 17].

Pesticides can be dispersed in open air. Chemical substances that have entered the soil enter the human body through the medium in contact with the soil: water, air and plants through biological chains: soil – plant – human or soil – plant – animal – human. Therefore, when standardizing the content of toxicants in the soil, not only the danger posed by the soil in direct contact with it, but mainly the consequences of secondary pollution of the media in contact with the soil, is taken into account. At the same time, such factors as soil type, mechanical composition, microbiocenosis, temperature, pH, moisture and others are taken into account. The lower the humus content, pH and mechanical composition of the soil, the more dangerous its pollution with chemical toxicants and, in particular, organochlorine pesticides [18].

Organochlorine pesticides are characterized by a long decay period, as well as the property of movement and accumulation, that is, they are able to pass from soil to plants and accumulate in them, and, therefore, there is a danger of getting them into food, which is dangerous for humans. Organochlorine compounds belong to the group of strong carcinogens that cause cancer. In addition, they have negative consequences for human health (weakening of immunity, impairment of reproductive functions, etc.). The stability of these compounds contributes to their accumulation in the body, and they also do not lend themselves to rapid neutralization and removal from the human and animal body. Therefore, when even in small doses, organochlorine drugs and their metabolites enter the body of humans and animals are dangerous due to the summation effect [19].

Protection of plants against diseases by fungicides has reached a very impressive size by now. The greatest attention in the literature is paid to the derivatives of ethylene dithiocarbamic acid, which are widely used in various cultures. Of the metabolic products, ethylene thiourea is the most dangerous, which causes tumors in animals. The plants were found to contain residues in the amount of 1 mg/kg. Fungicides from this group maneb, mankotseb, zineb, according to most researchers, are dangerous to humans and animals [20].

Benzimidazoles and triazoles are one of the main representatives of systemic fungicides. These drugs are mainly used to protect crops from disease. According to the literature, no negative properties of these fungicides for the environment have yet been noted [20].

The ecological and toxicological assessment of pesticides is taken into account by the variability of their distribution in the environment. The degree of the negative impact of pesticides for humans and their habitat under specific conditions of use is determined by the presence of their residues and their effect on the quality of the crop [21, 22].

Based on the above, the intensity of decomposition of widely used pesticides was studied (imidacloprid, diflubenzuron, teflubenzuron, lambda-cyhalothrin, alpha-cypermethrin, fungicides-propiconazole, cyproconazole, epoxconazole, difenoconazole, flutriculfurofulphol furon, amidosulfuron, ethylhexyl ether of 2,4-dichlorophenoacetic acid, metsulfuron-methyl, iodosulfuron, amidosulfuron, clopyralid, bentosan, glyphosate) in crops.

Fungicides alto-super 330, tilt 250, when used against winter wheat diseases in the forest-steppe of the right bank, actively decomposed in the ears rather than in the stems (Table 1).

So, the content of alto-super 330, (according to propiconazole) on the 1st day after treatment was 1.84 mg/kg in the stems, 1.81 mg/kg in the ears, and on the 10th day its concentration decreases to 1,38 mg/kg in stems, 1.35 mg/kg in ears. The second active ingredient of the fungicide ciproconazole on the 10th day after treatment in the stems contained 0.42 mg/kg, in the ears – 0.38 mg/kg, on the 20th 0.31 and 0.28 mg/kg, respectively. Fungicide tilt 250, degraded gradually. During the harvesting period, no residual amounts of the studied fungicides were found in grain and straw.

Table 1

Decomposition rate of fungicides in winter wheat plants

Option	Consumption rate, l/ha	Object under study	Active ingredient content, days after treatment, mg/kg			
			1	10	20	during harvesting grain
Alto super, 330, (propiconazole, 250 g/l	0,5	stalks of ears	1,84 1,81	1,38 1,35	1,01 0,99	not found not found
+ cyprocoanzole, 80 g/l)		stalks of ears	0,57 0,51	0,42 0,38	0,31 0,28	not found not found
Tilt 250 (propiconazole, 250 g/l	0,5	stalks of ears	2,0 1,8	1,5 1,35	1,1 0,9	not found not found

The intensity of decomposition of herbicides – esthe, puma-super 100, exactly and esterone in plants of spring wheat, barley and soil has been studied (Table 2, 3).

Table 2

Intensity of decomposition of herbicides in spring wheat plants

Option	Consumption rate, l/ha	Object under study	Active ingredient content, days after treatment, mg/kg		
			20	30	during harvesting grain
Estet (2-ethylhexyl ester of 2,4-D dichloro-phenoacetic acid, 600 g/l)	0,4	stalks of ears soil	1,31 1,12 0,81	1,00 0,91 0,58	not found not found not found
	0,6	stalks of ears soil	1,44 1,33 1,00	1,13 0,90 0,77	not found not found not found
Puma-super 100, (fenoxa-prop-p-ethyl, 100 g/l + mefenpyrdiethyl, 27 g/l)	0,6	stalks of ears soil	0,91 0,60 0,83	0,31 0,11 0,41	not found not found not found
	0,9	stalks of ears soil	1,00 0,94 1,0	0,40 0,33 0,51	not found not found not found
Akkurat (metsulfuron-methyl 600 g/kg)	8	stalks of ears soil	0,05 0,03 0,01	0,01 0,01 0,009	not found not found not found
	10	stalks of ears soil	0,055 0,041 0,021	0,021 0,016 0,010	not found not found not found

Herbicide from the group of aryloxyalkanecarboxylic acids aesthetic, at consumption rates of 0.4; 0.6 l/ha degraded slowly in the stems and ears of spring wheat. During the harvesting period, no residual amounts were found in grain and soil.

Highly selective herbicide puma-super 100, decomposed more actively in the soil from under the wheat.

The sulfonylurea derivative metsulfuron-methyl on the 30th day after treatment was contained within 0.009-0.01 mg/kg at a consumption rate of 8 g/ha, 0.01-0.02 mg/kg at a consumption rate of 10 g/ha. No residues were found during the harvest.

It was found that during the treatment of spring wheat crops with herbicides, the persistence of esthete, puma-super 100, exactly in the stems of the crop, was observed.

When testing herbicides on crops of spring barley at low doses of the content of trace amounts of drugs on the 30th day after treatment, there was esthete, within 0.78-1.20 mg/kg, esterone – 0.98-1.56 mg/kg, exactly – 0.032-0.022 mg/kg, respectively.

Table 3

Intensity of decomposition of herbicides in spring barley plants

Option	Consumption rate, l/ha	Object under study	Active ingredient content, days after treatment, mg/kg		
			20	30	during harvesting grain
Estet (2-ethylhexyl ester of 2,4-D dichloro-phenoacetic acid, 600 g/l)	0,4	stalks of ears	1,40	1,20	not found
		soil	1,36	1,14	not found
			1,01	0,78	not found
	0,6	stalks of ears	1,81	1,43	not found
		soil	1,33	1,10	not found
			1,20	0,90	not found
Puma-super 100, (fenoxa-prop-p-ethyl, 100 g/l + mefenpyrdiethyl, 27 g/l)	0,6	stalks of ears	2,33	1,56	not found
		soil	1,82	1,18	not found
			1,51	0,98	not found
	0,9	stalks of ears	2,56	1,66	not found
		soil	1,86	1,20	not found
			1,67	1,08	not found
Akkurat (metsulfuron-methyl 600g/kg)	8	stalks of ears	0,06	0,032	not found
		soil	0,04	0,022	not found
			0,03	0,011	not found
	10	stalks of ears	0,060	0,032	not found
		soil	0,051	0,026	not found
			0,035	0,013	not found

At increased consumption rates on the 30th day after treatment, the concentration of these herbicides in the test objects differed little from the minimum doses. During the harvesting period, no residual amounts of herbicides were found in grain, straw and soil, with the exception of Esterone, which was contained in trace amounts in the stems.

It has been established that the intensity of degradation of herbicides from the class of benzoic acid derivatives aesthetic, esterone and sulfonylurea derivatives depends exactly on the type of crop, for example, in spring barley for a longer period than in spring wheat under the same climatic conditions.

As a result of studying the set of factors characterizing the use of pesticides, including the concentration of the active substance in the formulation used, consumption rates, processing time, the number of treatments, the use of auxiliary substances and methods, the area of application that determine the required amount, processing time, intervals before harvesting, it is recommended:

- pesticides based on active ingredients – imidacloprid, diflubenzuron, teflubenzuron, lambda-cyhalothrin, alpha-cypermethrin, fungicides - propiconazole, cyproconazole, epoxconazole, difenoconazole, flutriafol, herbicides-fenoxylsaprop-fuldosulfuron ethylhexyl ester of 2,4-dichlorophenoacetic acid, metsulfuron-methyl, iodosulfuron, amidosulfuron, clopyralid, bentosan, glyphosate should be used in the conditions of the right-bank Lis-steppe in accordance with the established regulations for their use, since residual amounts in the samples are not found to yield maximum levels of alpha 2,4-dichlorophenoacetic acid, glyphosate, which are persistent in cereal plants.

The potential health hazard of pesticides can be reduced:

- strictly observing safety precautions when working with pesticides;

- use pesticides that have passed the state registration in accordance with the established procedure and are included in the State Catalog (Register) of pesticides;

- comply with the established requirements for the import of pesticides, their packaging and labeling, as well as with the hygienic regulation of the conditions for the use of pesticides on the territory of the Member States of the customs union.

Pesticide handling should not lead to:

- exceeding the hygienic standards for the content of residual amounts of pesticides, toxic and hazardous metabolites and compounds, persistent organic pollutants in agricultural products, established in accordance with the legislation in the field of sanitary and epidemiological welfare of the population;

- the emergence of pathogenic microflora, enterococci and other dangerous biological agents in environmental objects as a result of the use of pesticides;

- violation of the natural microbiocenosis of soils.

Widespread use of pesticides in agricultural production can cause them to pollute the environment. Particularly dangerous are soil herbicides, the remnants of which can be stored in the soil from 18 to 24 months.

So, the pollution of agricultural crops with residual amounts of pesticides occurs due to the use in the fight against weeds, pests and diseases of crops. The introduced pesticides partially decompose under the influence of temperatures, solar insolation, humidity, partially pass into the plant and a relatively small amount of them remains in the soil. When used intensively and at significant doses, pesticides can accumulate in soil, wastewater and plant products, causing serious environmental problems.

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