FOLIA POMERANAE UNIVERSITATIS TECHNOLOGIAE STETINENSIS
Folia Pomer. Univ. Technol. Stetin., Agric., Aliment., Pisc., Zootech. 2014, 315(32), 15–20

Maryana IVANKIV, Stakh VOVK, Vitaliy MARCYNOVSKY[1]

ACCUMULATION OF ORGANOCHLORINE PESTICIDES IN VEGETATION AROUND OF PLACES OF THEIR STORAGE

AKUMULACJA CHLOROORGANICZNYCH PESTYCYDÓW W ROŚLINNOŚCI WOKÓŁ MIEJSC ICH PRZECHOWYWANIA

Department of Animal Sciences and Biotechnology, Lviv National Agrarian University, Ukraine
[1]Department of Biology, Rivne State Humanitarian University, Ukraine

Streszczenie. Artykuł dotyczy problemu zanieczyszczenia ekosystemu pestycydami i remediacji zanieczyszczonych gleb. Przestawiono wstępne wyniki badań akumulacji pestycydów chloroorganicznych, takich jak DDT i jego metabolitów (DDE, DDD), HCH i jego izomerów – alfa, beta i gamma w roślinności z terenów przyległych do magazynów przeterminowanych środków ochrony roślin w miejscowości Viazova i miejscowości Hlynsko w dzielnicy Zowkiwskyj w Obwodzie Lwowskim.

Key words: accumulation, ekosystem, organochlorine pesticides, phytocenosis, phytoremediation, pollution soil.
Słowa kluczowe: akumulacja, ecosystem, fitocenoza, fitoremediacja, pestycydy chloroorganiczne, zanieczyszczenia gleb.

INTRODUCTION

The problems of environmental protection, eco- friendly products and efficient use of resources – are one of the most important issues. The success of the economy, safety of life and environmental conservation in the clean condition depend on. The correct solution of these problems depends largely on. The systematic use of pesticides in agriculture leads to the fact that they become permanent environmental factor that changes and creates macro- and microbiota. The pesticides primarily affect the agrophytocenosis and their components: farmland soils, vegetation, land and soil biota.

The use of agricultural chemicals is accompanied by environmental pollution of products, which are life-threatening for living organisms, including humans. The danger lies in the fact that non-compliance with safety regulations might cause direct poisoning by chemicals. In addition, having got into soil, water and air, they can poison the environment, make significant changes in habitats and the organisms that inhabit them (Sandermann 1992; Klisenko et al. 1994; Furdychko 2012). Some substances, especially those that are badly decomposed, may gradually accumulate in concentrations that exceed the permissible limits and become life-threatening.

Corresponding author – Adres do korespondencji: Stakh Vovk, Department of Animal Sciences and Biotechnology, Lviv National Agrarian University, Lviv, V.Velykogo 1, 80381, Lviv, Ukraine, e-mail: vovkstah@gmail.com

The accumulation of organochlorine compounds in the environment, including dichlorodiphenyltrichloroethane (DDT), hexachlorocyclohexane (HCH), as well as their accumulation in plants is one of the reasons of negative impact on crops with unpredictable consequences aftereffect in phytocenosis in the tissues of living organisms, which are used by people as food. The pathological consequences of this process make a great danger to humanity (Fedorov and Yablokov 1999; Furdychko 2012). In addition, it is well – known that DDT decomposes and creates metabolites of dichlorodiphenyldichloroethylene (DDE) and dichlorodiphenyldichloroethane (DDD), which are also toxic and more resistant in the environment substances. They are classified as "possible" carcinogen for humans (Klisenko et al. 1994; Furdychko et al. 2010).

It should be noted that an important aspect of this problem is the continued use of forbidden organochlorine drugs by private and individual farming's, which are still retaining a certain amount of dangerous pesticides, over decades, despite the fact that they might could lose their pesticidal function but might not lose its hazard. This is due to the high price of modern safe pesticides, as well as due to ignorance and lack of knowledge about the danger and harm of these drugs.

The basis of plants phytoremediational ability is the capasity of tolerant kinds to the accumulation and translocation of toxins, which enable the realization of phytoextraction pesticides. The fertilization of soil, contaminated by pesticides increases the phytoremediational ability of plants owing to lengthening of growing season, growing of plant height and, as a result, the increasing of biomass (Sandermann 1992; Klisenko et al. 1994; Green and Hoffnagle 2004; Furdychko 2012; Kacprzak 2013).

The concentration of pesticides in plants is determined by a complex of factors: the adsorption and properties of toxicants; type of soil; the physiological and biochemical characteristics of plants, including the capacity of the root system; the duration of the growing season; phase of development, as well as weather conditions. The combination of these factors determines the unequal distribution of pesticides in various parts of plants (Sandermann 1992; Schnoor 1998; Furdychko 2012).

The high resistant of organochlorine pesticides to disintegrate is an important prerequisite for their migration according to profile of the soil (Ivankiv and Vovk 2012) and in the adjacent environment: plants, air and water, which poses a risk for natural ecosystems and, consequently, human existence (Klisenko et al. 1994; Furdychko 2012). Therefore, assess the present condition of ecosystems vegetation; contaminated by pesticide is residues, it is important to environmentally.

The continuous use of organochlorine pesticides in various sectors of the economy especially in the agricultural sector has caused a notable defection of the biological balance of nature. It is characterized by toxic characteristics. That is why the study of the characteristics of their migration, accumulation and impact on components of the biocenosis and humans health is of considerable scientific and practical interest.

The aim of the work was to study the characteristics of migration and accumulation of residual amounts of organochlorine compounds in plants, such as DDT and its metabolites (DDE, DDD), HCH and its isomers – alpha, beta and gamma near the warehouses of durable preservation of banned and unusable pesticides in village Viazova and village Hlynsko of Zhovkivsky district of Lviv region for comparative characteristic of ecological condition of these settlements according to pollution by organochlorine pesticides.

MATERIAL AND METHODS

In order to monitor and measure the dynamic changes of the environment pollution by pesticides in areas of chemical depositories composition and in the surrounding areas, the sampling of plant material at a distance of 2 m, 5 m, 10 m and 50 m from the storage for the determination of pesticide residues. The samples of plants in amounts of 3–5 kg were collected in the phase of growth of if full physiological maturity. The plants were dug, purified from soil particles, washed under running water and dried. The thistle, wormwood, cutter normal, yarrow, nettle, sow thistle, couch grass and barley were selected for this research as a plant material.

The analysis of plant samples was carried out in the laboratory of Lviv Regional State Engineering Center of soil fertility and quality of products "Oblderzhrodyuchist".

The research was carried out in accordance with existing regulations and "Methodological guidance on the definition of traces pesticides in food, feed and the environment" (Klysenko et al. 1992). The determination of pesticide residues was carried out by thin layer chromatography according to the official methods (The Ministry of Health 1980).

RESULTS AND DISCUSSION

As a result of research it is found that plants have different chemical compounds accumulated balances of different groups, as shown by the results of the distance from the storage content of pesticide residues in plants is reduced (Table 1). It was found a significant excess of the maximum allowable concentration (MAC) residual pesticide DDT, especially its metabolites DDD and DDE, with no significant difference between the content of pesticides in different versions of the experiment is not selected. Thus, the samples grasses selected by 2 m, near the village of chemical composition, the content of residual amounts of the insecticide DDD was 0.131 mg · kg^{-1},which is more than the norm by 2.62 times, at the same distance in the nettles it was 0.123 mg · kg^{-1}, which is more than the norm by 2.46 times.

The content of residual amounts of DDD was found in plant material selected from 2 m from the chemical depository of Hlynsko and wormwood in the samples was 216.0 mg · kg^{-1}, and in samples of grasses – 112.01 mg · kg^{-1}, which is more than the norm by 4.32 and 2.24 times, respectively. It should be noted that even at a distance of 50 m from the warehouse, the excess of the maximum allowable concentration residual insecticide content was present and DDE was 65.0 mg · kg^{-1}, which is more than the norm by 1.3 times.

Our data suggest that the chemical depositories are still a significant source of pollution of organochlorine pesticides and their derivatives, including agrocenosis. Quantitative and qualitative characteristics of the vegetation within the safety zones pesticide formulations can serve as indicators of the degree of soil contamination by toxicants.

Table 1. The content of pesticide residues in plants around of places of their storage (village Hlynsko and village Viazova), mg · kg^{-1}, M ± m
Tabela 1. Zawartość pozostałości pestycydów w roślinach rosnących wokół miejsc ich przechowywania (miejscowość Hlynsko i miejscowość Viazova), mg · kg^{-1}, M ± m

The distance from the structure, type of weed Odległość od budowli, rodzaj roślinności	Organochlorine pesticides – Pestycydy chloroorganiczne					
	α-HCH	β-HCH	γ-HCH	DDE	DDD	DDT
	v. Hlynsko of Zhovkivsky district of Lviv region Hlynsko, dzielnica Zhovkivsky, obwód Lwów					
2 m, wormwood piołun	n.d.	n.d.	33.1 ± 1.34	29.01 ± 1.004	216.0 ± 6.23	n.d.
2 m, grasses trawy	n.d.	n.d.	29.3 ± 1.01	36.1 ± 1.25	112.01 ± 4.89	n.d.
5 m, burdock łopian	n.d.	n.d.	21.2 ± 0.73	83.2 ± 2.88	54.12 ± 1.56	n.d.
10 m, couch grass – perz	n.d.	n.d.	n.d.	64.0 ± 1.85	49.03 ± 1.53	n.d.
10 m, grasses trawy	n.d.	n.d.	15.05 ± 0.43	61.02 ± 2.11	46.04 ± 1.59	n.d.
50 m, grasses trawy	n.d.	n.d.	n.d.	65.0 ± 2.25	36.11 ± 1.46	n.d.
50 m, barley jęczmień	n.d.	n.d.	18.6 ± 0.51	76.5 ± 0.94	101.05 ± 1.23	n.d.
	v. Viazova of Zhovkivsky district of Lviv region Viazova, dzielnica Zhovkivsky, obwód Lwów					
2 m, nettle pokrzywa	n.d.	n.d.	37.02 ± 1.28	55.21 ± 1.91	123.0 ± 3.55	n.d.
2 m, grasses trawy	n.d.	n.d.	32.0 ± 1.29	48.1 ± 1.94	131.01 ± 5.29	n.d.
5 m, couch grass – perz	n.d.	n.d.	24.11 ± 0.70	24.09 ± 0.84	103.0 ± 3.57	n.d.
5 m, grasses trawy	n.d.	n.d.	n.d.	19.07 ± 0.77	101.0 ± 4.08	n.d.
10 m, grasses trawy	n.d.	n.d.	13.1 ± 0.454	n.d.	19.05 ± 0.77	n.d.
50 m, grasses trawy	n.d.	n.d.	n.d.	21.0 ± 0.72	n.d.	n.d.
50 m, barley jęczmień	n.d.	n.d.	21.9 ± 0.80	63.09 ± 1.25	97.05 ± 1.34	n.d.

n.d. – not detected – niewykryte.

For plants of each type the separately organochlorine pesticides trace amounts of above-ground and underground organs (mg · kg^{-1}) were determined, and the expected rate of bioaccumulation (ratio of pesticides in plant their content in rhizosphere soil) and translocation factor toxicants (ratio of pesticides in over ground part to content in the root system of plants) were counted (Table 2 and 3). Believe, that near the value of this ratio ≥ 1 plants have a high ability to move the toxicant from the root info the aerial parts and are promising for use in technology phytoextraction (White 2005).

Table 2. Bioaccumulation and translocation of DDT and its metabolites of wild plant species
Tabela 2. Bioakumulacja i przemieszczanie DDT oraz jego metabolitów w dzikich gatunkach roślin

Type of plant Rodzaj roślin	Bioaccumulation Bioakumulacja	Translocation Przemieszczanie
Wormwood – Piołun	1.24	0.97
Grasses – Trawy	0.98	0.64
Burdock – Łopian	0.63	0.16
Couch grass – Perz	0.28	0.09
Yarrow – Krwawnik	0.75	0.36
Sickleweed – Sierpnica pospolita	0.81	0.24
Bluegrass angustifolia – Poa angustifolia	0.63	0.45
Barley – Jęczmień	1.49	1.07

Table 3. Accumulation and translocation of HCH and its isomers of wild plant species
Tabela 3. Akumulacja i przemieszczanie HCH oraz jego izomerów w dzikich gatunkach roślin

Type of plant Rodzaj roślin	Bioaccumulation Bioakumulacja	Translocation Przemieszczanie
Wormwood – Piołun	1.02	0.61
Grasses – Trawy	0.73	0.27
Burdock – Łopian	0.34	0.11
Couch grass – Perz	0.13	0.04
Yarrow – Krwawnik	0.43	0.16
Sickleweed – Sierpnica pospolita	0.29	0.04
Nettle – Pokrzywa	0.78	0.26
Barley – Jęczmień	1.07	0.79

As it is shown in table, the translocation factor varies within 0.09–1.07 for DDT and HCH for – within 0.04–0.79. Thus, the rate of translocation depends only on the physiological characteristics of plants and can be used as a criterion of phytoremediational ability of wild--growing plant species.

Bioaccumulation factors characterize the intensity of the absorption of toxins and show the share their content in plants in relation to the contents in the soil (The Ministry of Health 1980; Furdychko et al. 2010; Furdychko 2012). Bioaccumulation factor takes a maximum value and is 1.14. These are empirical parameters, depending on the degree of contamination of the soil and can not serve as a criterion of phytoremediational ability of wild plant species.

CONCLUSIONS

Organochlorine pesticides DDT and its metabolites and HCH have the ability to accumulate in plant production. The degree of accumulation depends on the biological characteristics of plant and a phase of growth.

It is discovered that total DDT maintenance in rhizosphere soil at growing of species of natural flora at the soils with the long-term polycomponent contamination by pesticides diminishes on 25% depending on the plant species and initial level of soil contamination.

The receipt of DDT and its metabolites from soil in to wild species phytocenotic of study area, the processes of its accumulation and transformation in the tissues depends on the specific features, the initial level of soil contamination and the presence of phytotoxic substances.

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Abstract. This article deals with issues that relate to pollution of ecosystem by pesticides and restoration of polluted soils. The results of exploratory studies on the accumulation of trace organochlorine pesticides, such as DDT and its metabolites (DDE, DDD), HCH and its isomers – alpha, beta and gamma and heptachlor, in vegetation in areas adjacent to the warehouses of obsolete pesticides in the village Viazova and village Hlynsko of Zhovkivsky district of Lviv region are presented in the article.