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QUANTITATIVE ASSESSMENT OF ^{137}Cs CONCENTRATED IN WATER-SOLUBLE FRACTION AND IN FUNGI OF SOILS OF POLISSIA FOREST ECOSYSTEMS

The problem of radioactive contamination of the environment has become especially important after the Chernobyl accident. It caused the negative effect on environmental and economic situation in Ukraine. After the accident, radiation contamination of forests was detected in eighteen regions of Ukraine. Forests of Polissia were the most radiation contaminated regions. The level of radiation contamination is still high in the northern parts of Zhytomyr region such as Narodychi and Ovruch districts.

In soils of forest ecosystems the major part of ^{137}Cs accumulation is in the upper forest floor layers as they are rich in organic matter. Radioactive caesium, concentrated in the upper layers of forest soil and the forest floor layer, is an active agent in the system of biological processes. It can be either biologically immobilized or migrate actively. A special role in the process of immobilization belongs to fungi. To understand the role of fungi in forest ecosystems and to assess their activity in soil it is important to know the development of fungi in soil. Morphogenesis, the formation and the spread of fungi mycelium biomass determines the physiological functions of fungi and their ability to accumulate resynthesis products. Fungi are the concentrators of different chemical elements, including radionuclides. Besides, fungi are involved in the process of ^{137}Cs circulation in forest ecosystems and they affect ^{137}Cs accumulation in forest vegetation. Fruit bodies of fungi are the object of radioecological research and studied quite well. According to Olsen research (1994), fungi' vegetative body – mycelium, forms more than 90 % of a single body biomass but it is not well studied. Therefore, the subject of this paper is the study of fungi mycelium in forest ecosystems of Ukrainian Polissia and the character of its radiation contamination. Besides, we have carried out a quantitative assessment of ^{137}Cs concentration in the water-soluble fraction and in fungi of soils in Polissia forest ecosystems.

Soil samples for the study were selected on the territory of the State Enterprise "Narodychi specialized forestry" (Bazar forestry) which is the part of nature reserve "Drevlyansky" (Narodychi district, Zhytomyr region). Sampling was carried out in different parts of the study area. These selected parts were homogeneous in the topography, vegetation and agrotechnical condition. Soil profile was divided into four horizons: forest litter (A_0) – 02 cm, mold horizon (A_h) – 2–6 cm, humus (A) – 6–13 cm and podzolic horizon (A_2) – 13–21 cm. The horizons' depth and their indices are indicated.

^{137}Cs specific activity in soil, in water-soluble fraction and in water-soluble fractions with the addition of fungicide "Benlat" was measured in the laboratory using gamma spectrometric installation. Water-soluble fraction of a sample was obtained by generally accepted methods (Lavkulich and Wiens 1970; Shuman, 1983): 5g of fresh soil was added to 35 ml of distilled water. The mixture was periodically stirred thoroughly and left to interact for two days (48 hours). After that, the soil mixture was filtered through a paper filter. Thus, the obtained filtrate was studied for ^{137}Cs content. Then, Fungicide "Benlat" was added to the rest of material after the extraction by distilled water; the ratio was 0.2 g of the preparation per 1liter of distilled water. Thus, obtained mixture was periodically stirred and left for 2,5 days again. After that, the mixture was filtered and the ^{137}Cs activity was measured in the filtrate. ^{137}Cs specific activity in samples was measured using gamma spectrometry install GDM 20.

The research results are presented in Table 1. Forest floor plays an important role in ^{137}Cs redistribution through other horizons of the soil. Forest floor parameters influence on the rate of radionuclides vertical migration in soil. The data in the table prove that the specific activity of the radioactive contamination in studied soil samples fluctuates over a wide range. The highest activity of radioactive caesium – 10334 Bq/kg is observed in the litter layer. The radioactivity in soil decreases with the increase of the soil profile depth. Thus, the value of the activity in podzolic horizon is of 1216 Bq/kg.

Table 1

^{137}Cs specific activity in different horizons of studied soil and in some of its fractions

Horizon and its depth, cm	^{137}Cs in soil, Bq/kg	^{137}Cs in water-soluble fraction			^{137}Cs in fungicide solution			^{137}Cs y in water-soluble fraction + fungicide, %
		Bq/l	Bq	%	Bq/l	Bq	%	
A_0 0-2	10334,3± 327,1	15,6± 7,67	0,55	1,1	4,5± 0,32	0,16	0,31	1,4
A_h 2-6	2773,7±64,2	8,3± 0,63	0,29	2,1	2,4± 0,25	0,08	0,61	2,7
A 6-13	1567,3±16,3	22,1± 7,11	0,77	9,8	–*	–	–	9,8
A_2 13-21	1216,3±6,2	47,5± 16,61	1,66	27,3	–	–	–	27,3

* Specific activity of radioactive caesium below detected level

The value of the radionuclide activity concentration in water-soluble fraction also depends on the depth of soil from which it was obtained. Thus, the radionuclide activity in water-soluble fraction obtained from the forest floor layer was 15,6 Bq/l, and in the fraction obtained from layer Ah – 8,3 Bq/l. ^{137}Cs activity increases in the water-soluble fractions obtained from the lower layers of soil and the values of activity are of 22,1 Bq/l and 47,5 Bq/l in soil layers A and $A_{2,}$ respectively. It can be explained by the fact that the intensification of the processes of organic matter decomposition is observed with the depth of the soil and the nutrients, as well as radionuclides, release from organic matter and pass into the soil solution.

The calculations show that the total number of radionuclide released in water-soluble fraction increases with the depth. The table data show that soil solution of upper soil layers rich in organic matter contains a relatively small portion of radionuclides: from 1.1 to 2.1% of its total content in the soil layer. It is clear that the bulk of the radiation contamination of the upper layers of the forest soil is deposited in organic, organo-mineral and mineral fractions of soil and soil organisms, including fungi. From 10 to 27 % of the total radionuclide activity in soil can be deposited in water-soluble fraction of deeper organo-mineral and mineral soil layers.

In order to estimate the total caesium activity concentrated in a vegetative body of fungi – mycelium we conducted additional radionuclide extraction by aqueous fungicide. The purpose of the extraction was to inactivate the fungi mycelium and to cause its hydrolysis. The radionuclide was expected to pass into solution which gives the possibility to measure this radionuclide. As can be seen from the Table, the radionuclide activity concentration in the fraction of fungicide solution is very low: 4,5 Bq/l and 2,4 Bq/l in the upper soil layers. The activity concentration of fractions from the fungicide solution obtained from deeper soil layers was below the detected level. The data show that in total, from 1,4 to 27,3 % of the total caesium activity can be deposited in water soil fraction and in the fraction of fungicide solution.

A fungicide when added to soil solution inactivates the growth of fungi and the intensity of ^{137}Cs accumulation in them are significantly reduced. The radiocaesium activity in the forest floor is almost two times higher compared to the activity in the mold horizon. The detector did not fix values in humus and podzolic horizons. The data give us grounds to consider that ^{137}Cs activity in samples of water-soluble fractions and with the addition of fungicide decreases with depth.

It should be noted that obtained data on the percentage of radionuclide solution are very likely underestimated. Thus, according to Vinichuk & Johanson (2003), about 15 (0,1 to 50) % of all radiocaesium in soil may concentrates in fungi mycelium. Probably, the complete hydrolysis of mycelium and radionuclide release require longer time. Thus, according to the research results the content of ^{137}Cs in water-soluble fractions of soils in Polissia forest ecosystems ranges from 1 to 27 %; and ^{137}Cs content in the fungi mycelium with extraction by fungicide solution is <1,0 %.