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THE DYNAMICS OF ^{137}Cs ACCUMULATION BY TWIGS OF TREES

As a result of accident on Chernobyl nuclear power plant in 1986 the large areas of Ukraine, namely the South-western part of the East European plain and Polessye were radioactively contaminated.

Before the accident at Chernobyl Nuclear Power Plant (Chernobyl NPP) the levels of radioactive contamination of Zhytomyr region were 1–2 Bq/m^2 and were caused mainly by nuclear weapons tests (global fallout). As a result of the Chernobyl accident during April 26 - May 5, 1986 around 50 MKi of radioactive substances, including hazardous radionuclides such as ^{137}Cs, ^{90}Sr, $^{238\text{-}241}$Pu etc. has been released in the environment.

Radioactive contamination caused great ecological damage to the environment of Zhytomyr region, especially the area of Polessye, which preclude traditional nature and limited forest management.

Forest ecosystems of Zhytomyr region are the most affected areas in Ukraine in terms of fallout deposition level as well in terms of size of contaminated area (Orlov, 2011).

According to the same data, radioactively contaminated forest area state forestry of Ukraine in the mentioned region decreased in 2011 to 316.9 thousand ha or 42.4% of the forest area, mainly due to the physical decay of radionuclides. Analysis of the literature shows that the dynamics of ^{137}Cs accumulation by trees shoots of rowan, buckthorn and birch in Ukrainian Polessye has been studied only occasionally. In Belarus and Ukraine only a few research on this topic were carried out. Thus, Belarusian scientists studied the intensity of ^{137}Cs and ^{90}Sr accumulation by buckthorn (*Rhamnus frangula*), which was studied as a component of forest ecosystems (Bulko and Gomel, 1995). In Ukraine ^{137}Cs accumulation by medicinal plants, including buckthorn, birch, and rowan on radioactive polluted territory of Zhytomyr region was studied by Krasnov et al., (2005).

However, the dynamics of ^{137}Cs accumulation by young shoots/twigs of some tree species during the growing season is not well studied, and the impact of meteorological conditions (air temperature and rainfall) on the process of radionuclide accumulation by trees is not investigated.

The aim of this study was to analyze an accumulation of radiocaesium (^{137}Cs) by shoots/twigs of three tree species: buckthorn (*Frangula spp.*), birch (*Betula spp.*) and rowan (*Sorbus aucuparia* L.) during the vegetation period and to analyze if activity concentration in tree compartments depends on meteorological parameters such as mean monthly air temperature and amount of precipitation. Studies were conducted in Bazar forestry, Zhytomyr region, Ukraine, located about 70 km (51º05’35” N, 29º18’56” E) from Chernobyl NPP. 4 permanent experimental plots (p.e.p.), with a fall out deposition level by ^{137}Cs between 7 to 10 Ki/km^2 in the optimal site conditions and places of common growth of the studied species. Plots were established in oak-pine plantations with well-developed understory of buckthorn (*Frangula spp.*), birch (Betula spp.), and rowan (*Sorbus aucuparia* L.).

Young shoots/twigs and leaves of studied tree species were sampled four times during the vegetation season of 2012, namely in May, June, July and August. Samples were taken from the lower and middle parts of tree crowns by using secateurs over the entire area of a test plot. In the laboratory collected samples were air-dried to constant weight, crushed and mixed thoroughly. Samples were placed into plastic containers (geometry) 35 or 60 ml, for gamma spectrometric measurements.

Measurement of ^{137}Cs performed in a radiological laboratory using NaI scintillation spectrometry system "GDM-20". Each sample was measured to achieve the error below 5% but not longer than 24 hours. The obtained data about the activity concentration of measuring samples were processed using software packages Windas and Microsoft Excel.

Data obtained in this study evidence that the highest activity concentration of radiocaesium was found in rowan - 4047,0 Bq/kg (min = 3500, max = 5020) at the beginning of the vegetation period (May). In birch the radioactivity of shoots was a one-third lower (2 975,0 Bq/kg (min = 1570, max = 4380)), and the lowest value was observed in buckthorn – 1792,0 Bq/kg (min = 1770, max = 1814). The activity concentration of radiocesium in buckthorn decreased during the growing season until August, and in the last month was observed an increase of activity compared to July (August - 1 360,0 Bq/kg (min = 1150, max = 1580) in July - 1 183,7 Bq/kg (min = 766, max = 1790)). Similar trends were also observed in the shoots of birch: ^{137}Cs activity reduced from 2 975,0 Bq/kg (min = 1570, max = 4380), in May to 1 822,7 Bq/kg (min = 783, max = 2530)in August. A similar trend was observed in shoots of rowan, although at the end of the growing season (August) activity was still quite high (2 102,0 Bq/kg (min = 1566, max = 2554)). If we consider the dependence of shoots activity of the studied trees species on monthly amount of precipitation value during the corresponding months (Figure 1) it can be found that with exception of rowan (R^2 = 0,64) there were no relationships between these parameters.

There also was a negative correlation between a values of activity concentration of ^{137}Cs in buckthorn and birch shoots and value of average temperature of month (R^2 = 0,84 for buckthorn and R^2 = 0,52 for birch), namely with an increase in average monthly air temperature the uptake of radionuclides into shoots of these tree species decreases (Figure 2).

For rowan shoots/twigs the dependence between these parameters has not been found: the radionuclide content in shoots of the studied species varies throughout the growing season regardless of average monthly air temperature.

An obtained data gives a reason to believe that an uptake of radiocaesium in shoots/twigs of the studied tree species is only weakly depends on average monthly air temperature and monthly amount of precipitation. It should be also mentioned that such dependency is complicated by large variation of activity concentration of radionuclide within the study area (200 m^2). Based on the results obtained in this study it can be concluded that:

1. Activity concentration of ^{137}Cs in shoots/twigs increases in the following order: buckthorn (1792,0 Bq/kg(min = 3500, max = 5020)), birch (2 975,0 Bq/kg (min = 1570, max = 4380)), rowan (4047,0 Bq/kg (min = 1770, max = 1814)).

2. During the vegetation season radiocesium activity concentration in shoots/twigs of investigated tree species was highest in May (4 047,0 Bk/kg) and gradually decreased in August (1 360,0 Bq/kg).

3. Activity concentration of ^{137}Cs in young shoots/twigs of buckthorn and birch seemed to be negatively correlated with on average monthly air temperature and on monthly amount of precipitation.

4. Except of rowan we did not find dependence between monthly amount of precipitation and ^{137}Cs activity concentration in shoots/twigs of buckthorn and birch.

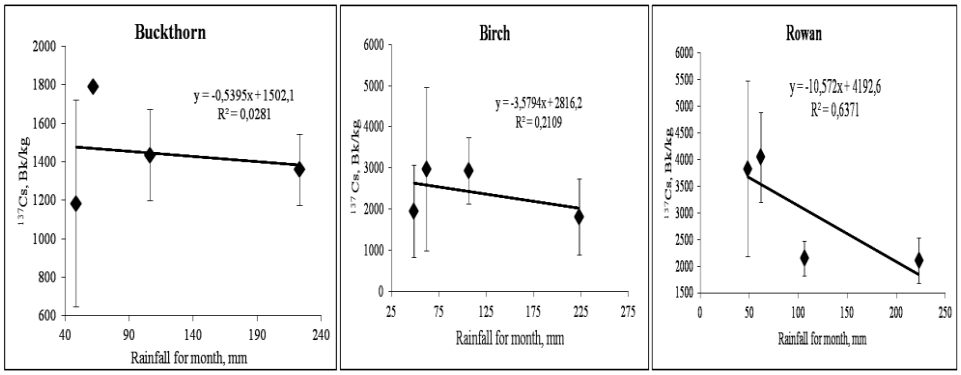

Fig. 1. Dependence of the specific activity of 137Cs in buckthorn, birch and rowan and average rainfall during the growing season in the studied trees

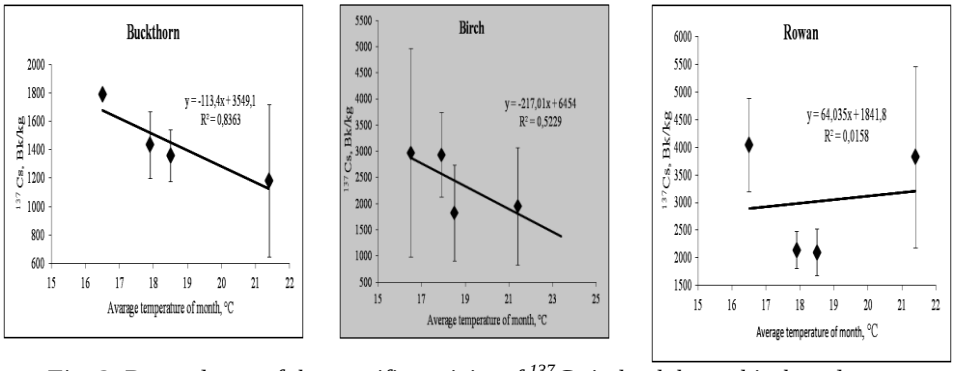

Fig. 2. Dependence of the specific activity of ^{137}Cs in buckthorn, birch and rowan and the average air temperature during the growing season in the studied trees