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# Caesium-137 soil-to-plant transfer for representative agricultural crops of monocotyledonous and dicotyledonous plants in post-Chernobyl steppe landscape

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The accident at the Chernobyl nuclear power plant in 1986 had a large-scale action on more than 2.3 million hectares agricultural lands in Russia. The area of radioactively contaminated chernozems of semi-arid steppe zone with initial levels of Cs-137 185-555 kBq/m2 in Tula region received the name “Plavsky radioactive hotspot”. Nowadays, after the first half-life period of Cs-137 arable chernozems of the region are still polluted with 3-6-fold excess above the radioactive safety standard (126-228 kBq/m2). Therefore, qualitative and quantitative characteristics of Cs-137 soil-to-plant transfer are currently a central problem for land use on the territory.

The purpose of the present study was revealing the biological features of Cs-137 root uptake from contaminated arable chernozems by different agricultural crops. The components of a grass mixture growing at the central part of Plavsky radioactive hotspot with typical dicotyledonous and monocotyledonous plants – galega (Galega orientalis, Fabaceae family) and bromegrass (Bromus inermis, Gramineae family) respectively – were selected for the investigation, that was conducted during the period of harvesting in 2015. An important point was that the other factors influenced on Cs-137 soil-to-plant transfer – the level of soil pollution, soil properties, climatic conditions, vegetative phase, etc. – were equal. So, biological features of Cs-137 root uptake could be estimated the most credible manner.

As a whole, general discrimination of Cs-137 root uptake was clearly shown for both agricultural crops. Whereas Cs-137 activity in rhizosphere 30-cm layer of arable chernozem was 371±74 Bq/kg (140±32 kBq/m2), Cs-137 activities in plant biomass were one-two orders of magnitude less, and transfer factor (TF) values (the ratio of the Cs-137 activities in vegetation and in soil) not exceeded 0.11. At the same time bioavailability of Cs-137 for bromegrass was significantly higher than for galega: TFs in total biomass of the crops were 0.11 and 0.01 correspondingly. But the most dramatic difference between the investigated crops was connected with peculiarities of Cs-137 distribution within above- and belowground parts of biomass. While TF in aboveground fraction of galega (0.02) was slightly higher than in belowground fraction (0.01), the bulk of Cs-137 in bromegrass was detected not in shoots but in roots (TFs 0.05 and 0.11 correspondingly).

More extensive examination of Cs-137 behavior in “soil-plant” systems of agricultural crops in the area of Plavsky radioactive hotspot has revealed that all investigated dicotyledonous plants with taproot system (potatoes, soya, amaranth, rape) accumulated 71±14% of Cs-137 inventories in aboveground biomass, whereas monocotyledonous plants with fibrous root system (wheat, barley, maize, cereal pasture species) deposited 94±5% of Cs-137 supplies in their belowground biomass. Thus, the first had effective biological root barrier protecting vegetation from general Cs-137 incorporation into biomass, but relatively active radionuclide translocation into shoots, while the second were characterized by slight rhizofiltration property and occurrence an additional barrier between roots and shoots determining only moderate radionuclide translocation into aboveground biomass. Such biological features should be taken into account in deciding on rehabilitation strategy of radioactively contaminated lands.

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