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Transfer from radioactively contaminated soil and accumulation of ^{137}Cs in agricultural crops with edible belowground part

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Crops with edible belowground part are of particular concern under growing on radioactively contaminated agricultural lands due to the possibility of direct passive transport of ^{137}Cs into the consumable tissues. Meanwhile, similar plants are currently found in the structure of crop rotation in the post-Chernobyl territories of the chernozem zone of Russia.

To assess bioaccumulation of ^{137}Cs in edible belowground parts of agricultural crops, a study was carried out in 2016-2019, ≈30 years after the Chernobyl accident, in the area of the "Plavsky radioactive hotspot" (Tula region). Agrosystems under study were located in the central (potatoes, carrot and beetroot) and peripheral (onion) sections of the contaminated area with the initial level of ^{137}Cs accumulation 185-555 kBq/m^2 and the current level of 80-170 kBq/m^2, which is still 2-4.5 times higher than the permissible value of the radionuclide content in soil.

An important radioecological feature of the study area is the deep rehabilitative plowing of soils up to 30 cm carried out after the Chernobyl fallout, which allowed to remove ≈70% of ^{137}Cs from the main 10-cm rooting zone of cereals and ≈35-40% from the 20-cm arable horizon of other crops of field rotation. However, potatoes, onions and root vegetables are cultivated with plowing up to 30; as a result, these crops interact with all ^{137}Cs accumulated in soils, the specific activity of which in the arable layer ranges from 170 (onions) to 390-420 Bq/kg (potatoes, carrot and beetroot).

Nevertheless, due to the strong fixation of ^{137}Cs in Luvic Chernozems (clay loamy texture, pH 6.5-7.2, humus 6-7%) and the adaptive capacity of the crops under study, the transfer of the radionuclide into the plant biomass is characterized by a low intensity. Transfer factors (TFs) of ^{137}Cs from soil to total biomass are estimated as 0.32 for potatoes, 0.31 for carrot, 0.26 for beetroot, and 0.18 for onions. The minimum TF for onion appears to be primarily related to its biological characteristics, namely, with being a monocotyledonous plant. the distribution of ^{137}Cs over plant tissues has a sharply different character for onions and other listed crops: the radionuclide's specific activity in onion roots is 2.5 times higher than in shoots (bulb and leaves), while ^{137}Cs concentrations in the aerial parts of potatoes, carrot and beetroot are ≈3.5, 6 and 6.5 times higher than in the roots, correspondently. The values of TFs in consumed potato tubers, taproots of carrot and beetroot, as well as onion bulbs (0.012, 0.011, 0.011, and 0.003, correspondently) are less than the respective TFs in the total biomass of these crops.

In this regard, the accumulation of ^{137}Cs in the yield of the studied crops does not exceed 5 Bq/kg, which fully complies with the sanitary safety standards and decreases the radioecological risk of their cultivation on radioactively contaminated lands.

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