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Factors affecting ^{137}Cs bio- availability under the application of different fertilizing systems

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Although it has been 25 years since the Chernobyl accident, it was generally found that radiocaesium remained bio-availability in some regions. Plant uptake of ^{137}Cs is depended from quantity of exchangeable radionuclide and strongly influenced by soil properties. The addition of fertilizers to soil induces chemical and biological changes that influence the distribution of free ions the different phases (soil and soil solution). In this study we try to estimate influence of different soil conditions affecting the ^{137}Cs bio-availability under the application of manure and inorganic fertilizers.

Our research carried out in 2001-2008 years on contaminated after Chernobyl accident sod-podzolic soil during of prolonged field experiment. The experimental site was located in south-west of Bryansk region, Russia. Contamination density by ^{137}Cs in the sampling point was equal to 475$\pm$30 kBq/m^2. The sequence of crops in rotation was: 1) potato; 2) oats 3) lupine 4) winter rye. Three fertilizing systems were compared: organic – 80 tons per hectare of cow manure; inorganic fertilizing system - different rates of NPK (low, temperate and high) and mixed – 40 tons per hectare of cow manure + NPK. Main soil properties and chemical form of ^{137}Cs and K (potassium) were detected. Radiocaesium activity was determined in soil and plant samples by gamma spectrometry, using a high purity Ge detectors. Overall efficiency was known to an accuracy of about 10-12%.

Obtained results shows, that various fertilizing systems influence soil properties, chemical forms of ^{137}Cs and K in soil and radionuclide soil-to-plant transfer in different ways. The highest reduction of exchangeable ^{137}Cs in soil was found in case with application of organic fertilizers and also – temperate NPK rates. Part of exchangeable ^{137}Cs is equal 6.8% (from total activity) in case of manure, 7.8% in case of inorganic fertilizers with control value – 10.2%. Caesium mobility in soil is affected by such soil properties as: soil pH$<$ available phosphorus $<$ humus content $<$ exchangeable Ca^{2+} and Mg^{2+} $<$ exchangeable K^{+}.

Inorganic fertilizers in high and temperate rates decrease ^{137}Cs transfer to crops in 2.3-5.5 times. Organic fertilizers are less efficient, but its application can decrease ^{137}Cs accumulation by farm crops during 2-3 years. Correlation analysis shows inversely proportional dependence between organic matter content and exchangeable form of ^{137}Cs in soil (r^2 = 0.81). A linear relation between ^{137}Cs transfer factors (TF) to plants and exchangeable radionuclide content has been found ($r^{2=}$0.68). Inversely proportional relation between the mobility level of potassium, its mobile form content and TF ^{137}Cs was detected (r^2 = 0.78).