Reducing Transferability of Radionuclides from Soil to Crops

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Abstract

Several radionuclides, including radiocesium and radioruthenium, can be released to the environment after possible accidents in spent nuclear fuel reprocessing plants. Countermeasures to reduce radiocesium transfer from soil to crops have been investigated extensively since the 2011 accident at the Tokyo Electric Power Company's Fukushima Dai-ichi Nuclear Power Station, and their effectiveness were found to depend on many factors including types of crops and soil. The aim of this study is to clarify the mid- to long-term effects of countermeasure techniques for reducing transfer from soil to grass and translocation from rice shoot to brown rice. In addition, characteristics of radiocesium mobility in soil are also investigated. In FY 2021, we: 1) investigated the effect of spraying calcium (Ca) onto rice shoot on cesium (Cs) translocation from leaf to brown rice; 2) established a laboratory experimental method for investigating radiocesium transfer from soil to grass at different cultivation periods; 3) established an experimental grassland for investigating long-term effects of countermeasures to reduce radiocesium transfer from soil to grass; and 4) established an analytical method for stable ruthenium (Ru).

Rice plants (*Oryza sativa subsp. japonica* 'Masshigura') were grown in soil pots. Solution containing Ca with different concentrations as well as Cs were sprayed onto shoots during the vegetative growth period. Spraying Ca decreased the Cs concentration in brown rice, while it did not affect grain yield. The Spraying Ca is suggested to be effective for reducing transfer of radiocesium deposited in the vegetative growth period to brown rice.

A cultivation experiment system using soils spiked with ^{137}Cs tracer was developed for the measurement of transfer of ^{137}Cs from soil to orchardgrass (*Dactylis glomerata* L.) in three different cultivation periods. Higher concentrations of ^{137}Cs in shoots observed at the third cultivation were suggested to be caused by transfer both from root to shoot and from soil to grass.

We developed grassland plots with different soils and various applications of chemical fertilizers or amendments. Analysis of the soils collected from each plot showed that soil properties affected transferability of radiocesium from soil to grass, and especially the properties of exchangeable potassium and available phosphate were changed with the application of chemical fertilizers or amendments.

We confirmed that Ru-K edge X-ray absorption near the edge structure can be applied for speciation analysis of Ru added to soil samples. In addition, we developed a chemical separation method to remove molybdenum which interferes with Ru measurement in sample solutions by ICP-MS.

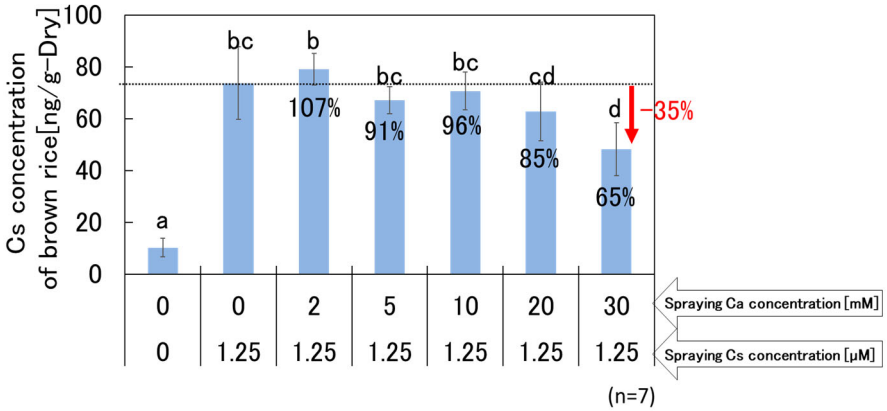

Fig. 1 Effect on cesium concentration in brown rice from spraying calcium chloride ($CaCl_2$) onto shoots.

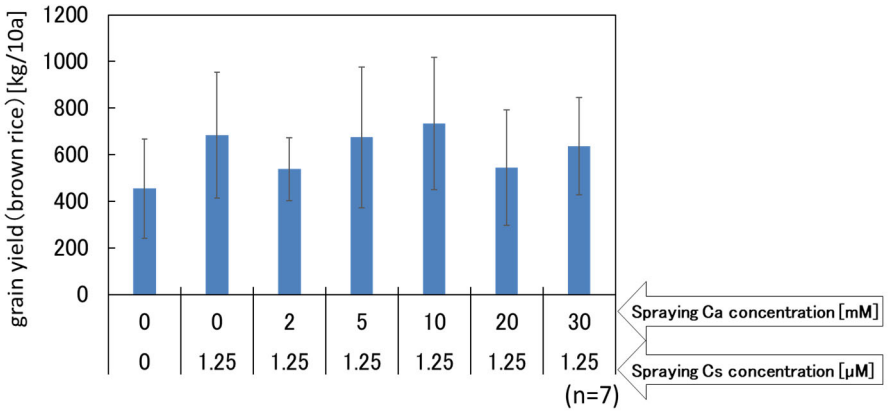

Fig. 2 Effect on grain yield from spraying calcium chloride ($CaCl_2$) onto shoots.