Reducing Transferability of Radionuclides from Soil to Crops

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Abstract

Countermeasures for reducing radiocesium transfer from soil to crops have been investigated intensively after the 2011 accident at the Tokyo Electric Power Company Fukushima Dai-ichi Nuclear Power Station, and their effectivenesses were found to depend on many factors including types of crop and soil. The aims of this study are to establish the countermeasures suitable for reducing radiocesium transfer from soil to grass and its translocation from rice shoot to brown rice. In FY 2017, we investigated: 1) soil factors controlling the radiocesium transfer to grass from soil in the Kamikita region, Aomori; 2) trials of various methods to reduce the transfer; and 3) the effect of a transpiration inhibitor on cesium translocation to brown rice.

Soil-to-grass (*Dactylis glomerata* L.) transfer factor (TF) of ^{137}Cs was obtained by the small-scale short-term cultivation experiment, which was established in FY 2016, using soils spiked with ^{137}Cs tracer in an artificial climate chamber. The TFs of ^{137}Cs in soils from the Kamikita region were generally higher than those in soils from other regions outside of the prefecture. Correlation analysis between the TFs and various soil factors, such as exchangeable ^{137}Cs concentration and radiocesium interception factor, showed that the potassium concentration extractable by boiling in 1 M nitric acid was the best independent variable to explain the variation of TFs, suggesting that the potassium supplying ability in grassland soils in the Kamikita region controls their TFs.

The reducing abilities of various soil fertilizers and additives were tested by the cultivation method mentioned above for two groups of soil that were selected from the experimental results in FY 2016: soils with low potassium-supply ability and soils with low ^{137}Cs-retention ability. For the first group, all of the potassium fertilizers and materials tested showed the reducing effect of TF, with the highest by potassium chloride, which is a fast-acting fertilizer. For the second group, some zeolite and vermiculite materials, which were additives for fixing ^{137}Cs, showed the highest effect, and that effect might be strengthened by their potassium-supply ability.

Rice plants (*Oryza sativa* subsp. *japonica*) were cultivated in sand-filled pots, installed in a rain shelter, with cultivation solution containing 0.01 μM Cs. A transpiration inhibitor (0.7% wax concentration) was sprayed on the whole rice plant, twice a week during three developing stages: 1) late vegetative growth, 2) the young panicle formation - blooming and 3) the blooming – harvest stages. The rice plants sprayed with the inhibitor during 1)-3) stages and the control with water spraying were also prepared. The Cs concentration in brown rice decreased 25% more than the control by spraying during 1)-3) stages, while decreases of 20%, 15% and 0% were found for the spraying during 1), 2) and 3) stages, respectively.

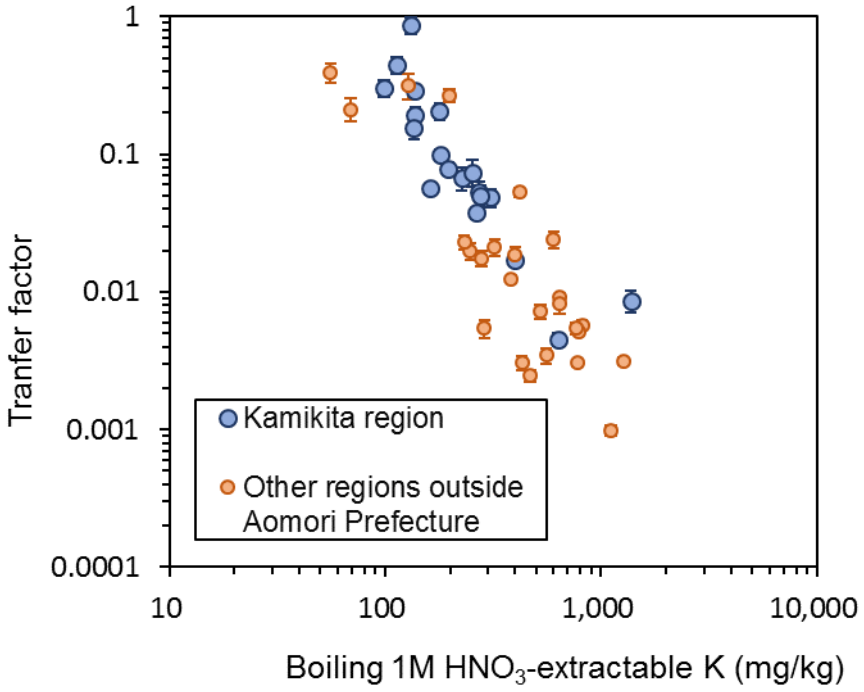

Fig. 1 Relationship between transfer factor of ^{137}Cs from soil to grass and potassium concentration extractable with boiling 1 M nitric acid in soil.

Blue circles indicate soils from grassland in Kamikita region in Aomori.

Orange circles indicate soils from other regions outside the prefecture including Iwate, Miyagi, Fukushima and Tochigi.