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 clarify factors controlling transferability of radiocesium from soil to crops, and to establish the countermeasures suitable for agricultural products in Aomori. A type of grass and rice were selected as our target products, and two things were done in FY 2016: 1) the establishment of an experimental method to study reduction of radiocesium transfer from soil to grass, and 2) the investigation of the effect of a transpiration inhibitor on cesium transfer to brown rice.

We established methods of soil analyses for evaluating the retention capacity of radiocesium in soil, making chemical speciation of potassium and radiocesium in soil, and measuring microbial activities in soil to study soil characteristics relating to radiocesium transfer from soil to grass. A small-scale cultivation experiment system using soils spiked with ^{137}Cs tracer was developed for the measurement of transfer of ^{137}Cs from soil to one type of grass (*Dactylis glomerata* L.). Twenty-nine soil samples were collected from Aomori, Miyagi, Fukushima and Tochigi Prefectures and used for the preliminary experiment by the established methods. Higher soil-grass transfer of ^{137}Cs was found in soils with low ability for potassium supply and radiocesium retention.

Two commercial transpiration inhibitors containing wax or paraffin were selected to test the effect on the transfer of stable Cs absorbed from the cultivation solution to brown rice. Rice plants (*Oryza sativa* subsp. *japonica*) were cultivated in a rain shelter, in sand-filled pots and cultivation solution. The transpiration inhibitor (2% or 0.7% wax concentration, or 1.8% or 0.7% paraffin concentration) was sprayed on the whole rice plant, twice a week from the vegetative growth stage until harvest. The cultivation solution, which was changed every two weeks, had Cs concentration of 0.05 μM from the vegetative growth stage until harvest. The Cs concentration in brown rice decreased 25%-35% by spraying the transpiration inhibitor compared to the control with water spraying. Dry weight of the above-ground part and yield components, such as number of spikelets per plant and percentage of ripened grains, were not affected by the spraying of transpiration inhibitors in comparison to the control. Similar decreasing effects of Cs concentration were observed for rice plants grown using cultivation solution with 0.01, 0.05 or 0.1μM Cs and spraying 0.7% wax transpiration inhibitor in the same manner as mentioned above. When we sprayed 0.7% wax transpiration inhibitor onto the whole plant from the vegetative growth stage to the blooming stage, then sprayed the inhibitor onto one of the ears, leaves/stem, and whole plant until harvest, the decreasing level of Cs concentration in brown rice, which was cultivated with 0.05 μM Cs cultivation solution, was not affected by the different plant parts being sprayed.

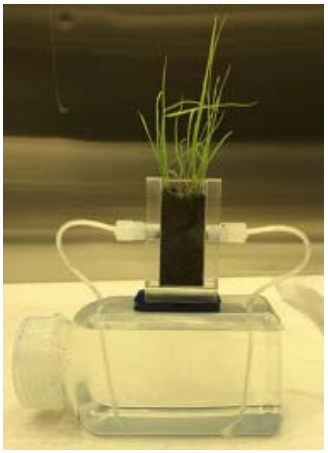

Fig. 1. Small scale plant cultivation system developed for evaluating transfer factor of radiocesium from soil to a type of grass during 3 d – 24 d after seeding.

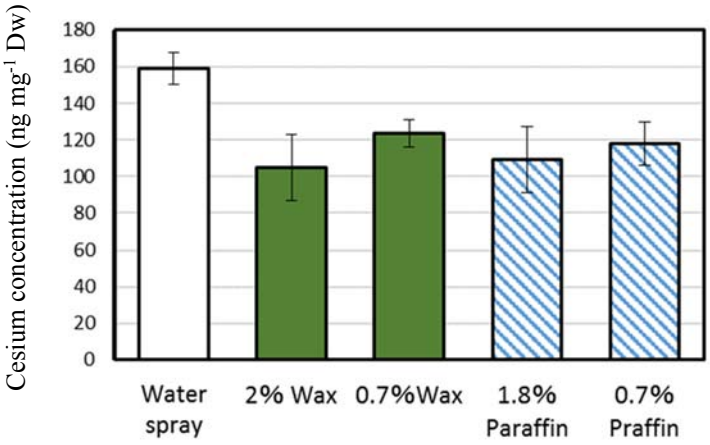

Fig. 2. Effect of transpiration inhibitor on cesium concentration in brown rice of rice plant.