Behavior of Radionuclides on Crop Ground Surface

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Abstract

Root crops (Chinese yam, radishes, etc.), grass, and apples are important crops for the areas surrounding the first commercial nuclear fuel reprocessing plant in Aomori Prefecture and for the prefecture itself. We have conducted studies on leaf absorption, translocation, and weathering for radishes and grasses, and on absorption from leaf, trunk, and fruit surface and translocation for apples. However, weathering for depositions on the leaf and fruit of apple tree, and leaf absorption, translocation and weathering for Chinese yam are not well known. Therefore, we aimed at: obtaining empirical data on weathering of radiocesium deposited on the fruit surface and leaf of apples, and on foliar absorption, translocation, and weathering of radiocesium deposited on the leaf surface of Chinese yam; and clarifying transfer parameters involved in these processes, thereby providing a reliable means to predict the behavior of radiocesium transferred to crops under abnormal release conditions. In FY 2021, we studied the effect of rainfall on the weathering of cesium (Cs) deposited on fruit or leaf surfaces of the apple tree as dry aerosol. Potted 3-y-old 'Fuji' apple (*Malus Domestica*) trees grafted on M. 9 rootstock were used as the experimental plant.

After applying dry aerosol containing CsCl onto the fruit surfaces at three different fruit development stages (early fruit development, fruit development, and late fruit development), the plants were exposed at different rainfall intensities and rainfall durations using a rain simulator. Exposed fruits were collected and the surfaces were washed with a solution containing detergent. The fruit uptake of Cs was measured by analyzing the fruit and the solution samples obtained by washing the surfaces. In an experiment with the rainfall intensity of 1.2 mm h^{-1}, the decrease in the remaining proportion of Cs applied on the fruit surface at the late fruit development was approximated by a function with two exponential terms for rainfall duration. And in an experiment with the duration of rainfall of 1 h, two components with different efficiencies for cesium removal for rainfall intensity were found to exist. Furthermore, the remaining proportion of Cs on the fruit surface exposed to rainfall intensity of 1.2 mm h^{-1} for 1 h tended to increase as the growth stage of the fruit progressed.

After applying dry aerosol containing CsCl onto the leaf surfaces of apple trees at the leafing stage and leaf growth arrest period, the plants were exposed at different rainfall intensities and rainfall durations using the rain simulator. Exposed plant leaves were collected and treated in the same manner as mentioned above. As with the results obtained for fruit surfaces, in an experiment with the rainfall intensity of 1.2 mm h^{-1}, the decrease in the remaining proportion of Cs applied on the leaf surfaces at the foliation stage was approximated by a function with two exponential terms for rainfall duration. And in an experiment with the duration of rainfall of 1 h, two components with different efficiencies for cesium removal for rainfall intensity were found to exist. There was a tendency for less removal from the fruit surface as growth progressed, while removal from the leaf surface showed a tendency to become easier in the leafing stage.

We constructed a compartmental model for absorption from the surface of each part of the apple tree and translocation to the fruit. Then, data obtained from the experiments conducted between FY 2016 and FY 2019

were applied to the compartment model and the values of the transfer parameters were obtained. Furthermore, we obtained an equation between the remaining proportion and duration of rainfall or intensity of rainfall from the experiments conducted in FY 2020 and FY 2021 for the weathering factor from the surface of each part of the apple tree and we obtained transfer parameters that can be incorporated into the advanced environmental transfer and dose assessment model.

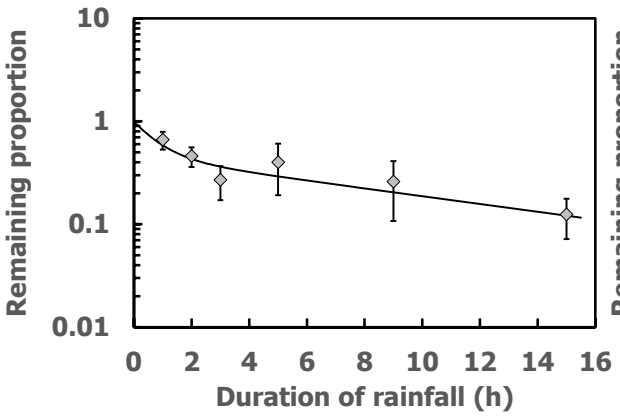

Fig. 1 Remaining proportion of Cs and duration of rainfall. Remaining proportion of Cs was defined as the ratio of the sum of amounts on fruit surfaces and in fruits to that loaded initially on the fruit surfaces. Each vertical bar indicates the standard deviation of five samples. The line shows least square approximation by a function with two exponential terms of duration.

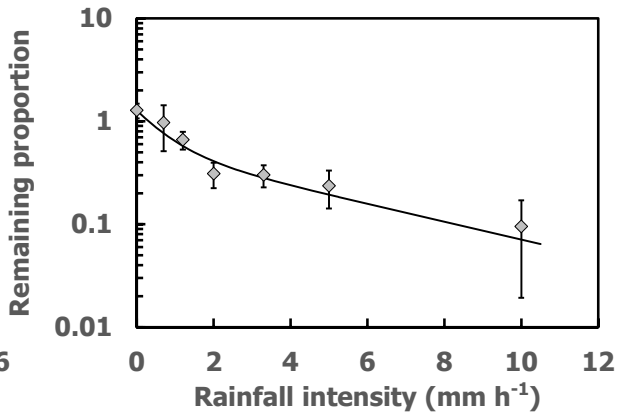

Fig. 2 Remaining proportion of Cs and rainfall intensity. Remaining proportion of Cs was defined as the ratio of the sum of amounts on fruit surfaces and in fruits to that loaded initially on the fruit surfaces. Each vertical bar indicates the standard deviation of five samples. The line shows least square approximation by a function with two exponential terms of rainfall intensity.