Weathering of Iodine Deposited on Grass Leaf Surfaces

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Abstract

Radionuclides released into the atmosphere are deposited on the leaf surfaces of crop plants, taken up by the plants, and translocated from the leaves to other parts. Some amount of the radionuclides deposited onto the leaves is removed from the surface by the environmental process called weathering, i.e. removal by rain, wind, etc. Although weathering, foliar uptake and translocation are important processes involved in the radiation dose assessment of radionuclides from crops, parameters to describe those processes for ^{129}I, which is an important radionuclide for the safety assessment of the nuclear fuel reprocessing plant in Rokkasho, have not yet been elucidated. Since grasses are cultivated for livestock farming which is one of the important industries in Rokkasho, a research project to determine the behavior of iodine on the surface of grasses was launched in FY 2011. In FY 2013, we studied the following subjects: 1) the effect of the growth stage of grasses on the foliar uptake and volatilization of iodide applied as liquid droplets onto leaf surfaces, 2) the effect of light intensity on the volatilization of iodide applied as liquid droplets onto leaf surfaces, and 3) the effect of rainfall on the weathering of iodine deposited on leaf surfaces as dry aerosol, solution or inorganic I vapor (I_2).

After applying droplets of iodide solution onto the leaf surfaces of Orchard grass (*Dactylis glomerata* L. var. Akimidori II) at different growth stages, we placed each plant within an acrylic chamber and cultivated them for 7 d in the artificial climate chamber. The plant leaves were periodically collected, and the leaf surfaces were washed with solution containing detergent. The foliar uptake of I was measured by analyzing the plant leaf and the solution samples obtained by washing the surface. The I volatilized from the leaf surface was calculated by subtracting the sum of the I amounts in the plants and the washing solution from the amount of I initially applied on the leaf surface. At all growth stages, 32 d, 39 d, and 49 d after sowing, the amounts of I on the leaf surface of plants removable by washing decreased with time after the loading, while the amount of the volatilized fraction increased. The I content in the plant reached a maximum around 3 d after applying and then decreased. The behavior of I applied on the leaf surface was almost the same at all growth stages of the plant.

After applying droplets of iodide solution onto the leaf surfaces of Orchard grass at 32 d after sowing, each plant was placed within an acrylic chamber and cultivated for 3 d at different light intensities. The volatilized fraction of applied I was almost constant and had no dependence on the light intensities of 5, 10 and 30 klx.

After applying 1) gaseous I_2, 2) liquid droplets containing NaI or $NaIO_3$, or 3) dry aerosol containing NaI or $NaIO_3$, onto the leaf surfaces of Orchard grass, the plants were exposed at different rainfall intensities and rainfall durations using a rain simulator. These plant leaves were collected and treated after the rain exposure in the same manner as mentioned above. More I was removed from the leaf surfaces as the rainfall intensity increased. However, the increase rate of the I proportion removed from the leaf surfaces decreased

as the rainfall intensity increased. In an experiment with the rainfall intensity of 1.2 mm h^{-1}, the decrease in the proportion of I remaining was approximated by a function with two exponential terms for rainfall duration.

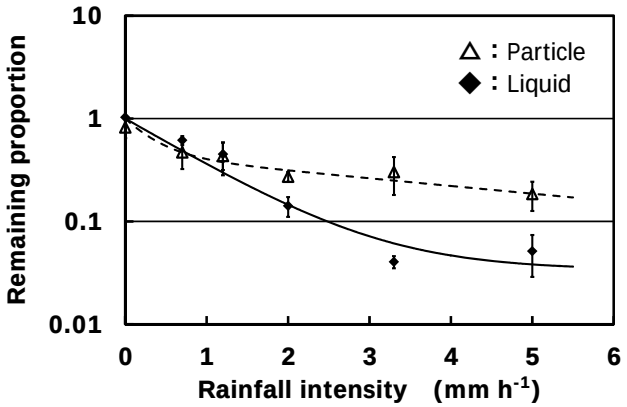

Fig. 1 Remaining proportion of I and rainfall intensity. Remaining proportion of I was defined as the ratio of the sum of amounts on leaf surfaces and in plants to that loaded initially on the leaf surfaces. Vertical bars indicate a standard deviation of 3 samples. The lines show least square approximation by a function with two exponential terms of rainfall intensity.