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 (I) on the surface of grasses was launched in FY 2011. In FY 2014, we studied the following subjects: 1) the effect of the growth stage of grasses on the foliar uptake and volatilization of iodate applied as liquid droplets onto leaf surfaces; and 2) the effect of fog on the weathering of I deposited on leaf surfaces as dry aerosol, solution or inorganic I vapor (I_2).

After applying droplets of iodate 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 that was placed in an artificial climate chamber where the plants were cultivated for 7 d. 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 two growth stages, 39 d and 49 d after sowing, more than about 80% of the I applied at 7 d remained on the leaf surface of the plants, and furthermore the I applied was not volatilized during the 7-d period after application. The behavior of I was almost the same at the two growth stages of the plant. These behaviors of iodate were different from those of iodide studied in FY 2013 showing that most of the I was absorbed into the leaf interior and partly volatilized to the atmosphere.

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 to fog with different atmospheric liquid water contents and exposure durations. The exposed plant leaves were collected and treated in the same manner as mentioned for the first study. The I applied as I_2 was not removed from the leaf surfaces by the exposure to fog with the atmospheric liquid water content of 47 mg m^{-3} for 24 h. On the other hand, the I applied as iodate of a dry aerosol or liquid droplets was removed by fog with 47 mg m^{-3} liquid water content, and decreased with a second order exponential function of fog duration. The effect of atmospheric water content of fog on the leaf surface retention of I applied as iodide of the dry aerosol or liquid droplets was studied at fixed fog duration of 16 h. The retention after fog exposure decreased with atmospheric liquid water content, then reached an almost fixed value in high atmospheric liquid water content.

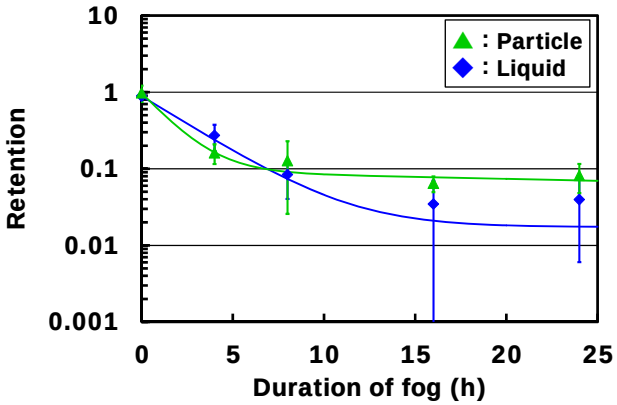

Fig. 1 Retention of I and duration of fog. Retention of I was defined as the ratio of the amounts on leaf surfaces to that loaded initially on the leaf surfaces. Vertical bars indicate a standard deviation of 3 samples. The lines show least square approximation by a function with a second order exponential term of duration of fog.

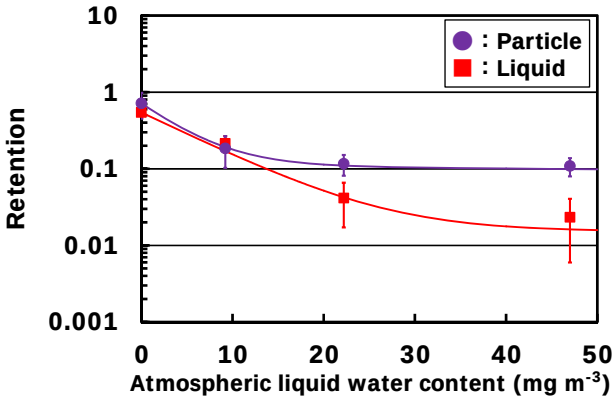

Fig. 2 Retention of I and atmospheric liquid water content of fog. Retention of I was defined as the ratio of the amounts on leaf surfaces to that loaded initially on the leaf surfaces. Vertical bars indicate a standard deviation of 3 samples. The lines show least square approximation by a function with a second order exponential term of water content of fog.