Behavior of Trace Elements on Leaf Surfaces of Crop Plants

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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 to other parts from the leaves. Some amount of the radionuclides deposited onto the leaves is removed from the surfaces by the environmental process called weathering, i.e. removal by rain, wind, etc. Although weathering and translocation are important processes involved in the radiation dose assessment of radionuclides from plants, site-specific parameters to describe those processes have not yet been elucidated. This work aims to establish site-specific parameters for those processes for Cs, Sr, and I using stable elements in a climate chamber in which meteorological conditions are controlled. The effect of rainfall on the behaviors of Cs and Sr on leaf surfaces was studied in FY 2009.

After applying solid aerosols of NaCl containing Cs and ^{86}Sr onto the leaf surfaces of radish, *Raphanus sativus*, the plants were treated at different rainfall intensities and duration time of rainfall using a rain simulator. After plant samples were collected, leaf surfaces were washed with acidified water containing detergent and the washing solutions for each sample were collected. Each washing solution and plant sample was analyzed for Cs and Sr.

Since results for Cs and ^{86}Sr were similar to each other, those for Cs are described hereafter. Analysis results showed that more Cs was removed from the leaf surfaces as the rainfall intensity and time increased. The remaining proportion of Cs on the leaf surfaces for rainfall intensity was approximated by a function with two exponential terms of time. The fraction of the compartment with faster decreasing rate was 0.7 - 0.9 except for the rain intensity of 1.2 mm h^{-1}.

To examine the aftereffect of rain, plants loaded with the target elements on the leaf surfaces were treated for 1 or 3 h at the rainfall intensity of 0.7 mm h^{-1}, and then were maintained for 1 or 4 d in the chamber at 20°C and 70% relative humidity with 12 h light cycle at 20,000 lx. The surface absorption, which was defined as the ratio of the amount of Cs in the plant to the sum of that on leaf surfaces and in the plant, just after the rainfall treatment was equal to or larger than the control value without the treatment. Although surface absorptions for 1 or 4 d after the treatment showed a relatively large variation, they were affected by rainfall, and tended to increase with rainfall intensity.

The absorption ratio was defined here as the ratio of the amount of Cs in the plant to that loaded initially on the leaf surfaces, and used as an index of Cs remaining in the plant. The absorption ratio of Cs for the plant treated with rainfall did not significantly differ from that for the control plant. Although part of the Cs on the leaf surfaces was removed by the rainfall, the surface absorption tended to increase more than for the control. Therefore, the overall effect of rainfall on the absorption ratio became unclear and further analysis of the results is required for elucidating the weathering effect of rain.

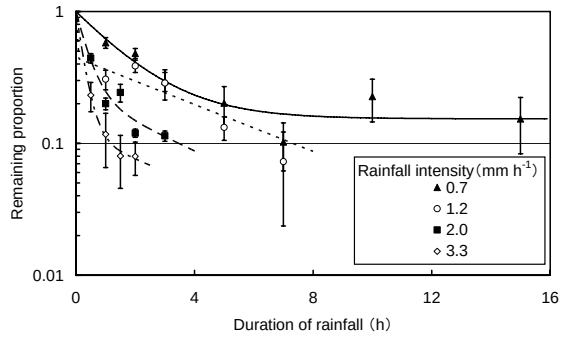

Fig. 1 Remaining proportion of Cs on leaf surfaces and rainfall duration. Vertical bars indicate the standard deviation of 3 samples. The lines show a least square approximation by a function with two exponential terms of duration time.

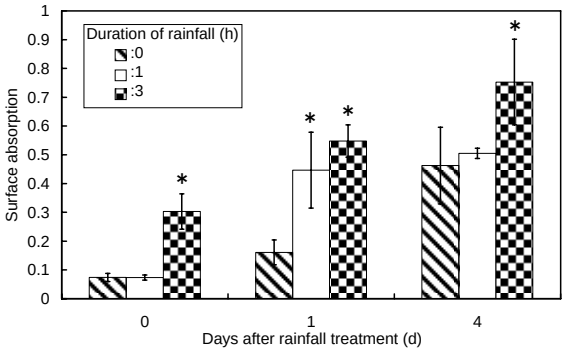

Fig. 2 Surface absorption defined as the ratio of the amount of Cs in plant to the sum of that on leaf surfaces and in plant. Vertical bars indicate the standard deviation of 3 samples.
* indicates a statistically significant difference from the control with no rain treatment.

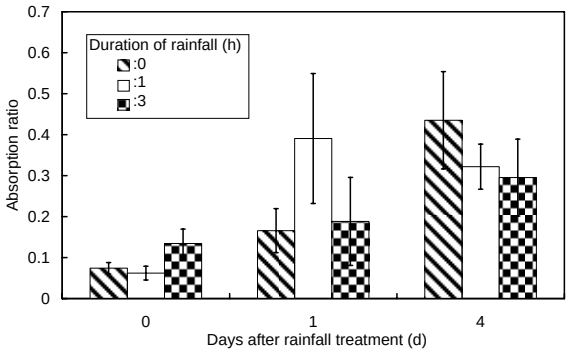

Fig. 3 Absorption ratio of Cs defined as the ratio of amount of Cs in plant to that loaded initially on the leaf surfaces. Vertical bars indicate the standard deviation of 3 samples.