Aging Effect on Speciation and Soil-to-Plant Transfer of Cs and I in Soil

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Abstract

Aging effect of radionuclides in soil after deposition is an important factor for their speciation and soil-to-plant transfer. Radiocaesium and radioiodine released from nuclear fuel reprocessing plants are important radionuclides for the assessment of radiation exposure for the public. We have already reported the aging effect of Cs and I in an Andosol soil sample collected from grassland in Rokkasho where a large-scale spent nuclear fuel reprocessing plant is located. From FY 2009, the effect of fertilizers on the aging was examined using the soil sample. The soil sample was mixed with a composite chemical fertilizer, which had the recommended N-P-K composition, and then stable Cs or I was added. The sample was put into plastic pots, and then stored in an artificial climate chamber. Orchardgrass (*Dactylis glomerata* L.) was cultivated in the pots for 28 d several times during the storage period, and the soil-to-plant transfer factors of Cs and I were determined. Extractability of the target elements from a portion of the soil in the cultivation pots by pure water or 1 M ammonium acetate solution for Cs, and only pure water for I was occasionally determined.

In FY 2009, the soil-to-plant transfer factors and extractability of Cs and I were measured up to 113 d after their addition. In FY 2010, we continued the experiment until 512 d after the addition. The transfer factor of both target elements rapidly decreased with time up to approximately 100 d after the addition, and then the decrease became slower thereafter. At the early stage, the transfer factor of I added in the form of I^- decreased faster than when added as IO_3^-. The decreasing patterns of the transfer factor were approximated with a combination of two exponential functions, and regression results, which are usable for modeling of temporal change of the transfer factor, were obtained for both target elements. The decreasing patterns of the extraction yield with pure water and ammonium acetate solution for Cs, and with pure water for I, were similar to those of their transfer factors.

Although the transfer factors of Cs observed in the soil with the fertilizer application were generally lower than those without the application, a statistically significant difference was observed in them only at 86 - 113 d after the addition of Cs. The effect of the fertilizer application on the transfer factor of I after addition as both I^- and IO_3^- was opposite that on Cs. The transfer factors of I with the fertilizer application were generally higher than those without the application during the experiment. Although the statistically significant differences at several cultivation stages after the addition were observed, further study is required to elucidate the effect of fertilizer on behavior of Cs in soil.

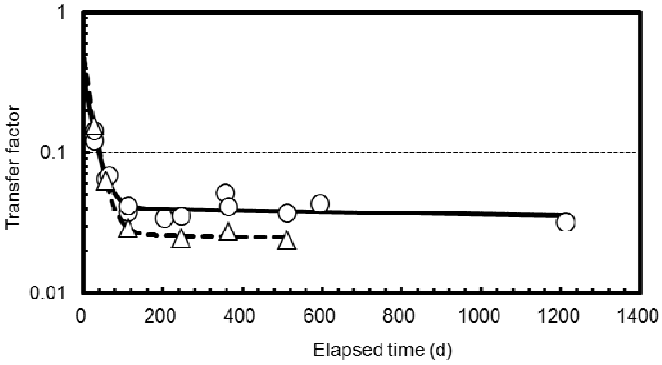

Fig. 1 Temporal changes of soil-to-grass transfer factor of Cs after addition of Cs to soil
○: Without fertilizer application
△: With fertilizer application
Results for the soil without fertilizer application include those obtained in the long-term experiment from FY 2007. The solid and broken lines indicate regression curves for the soil without and with fertilizer application, respectively.

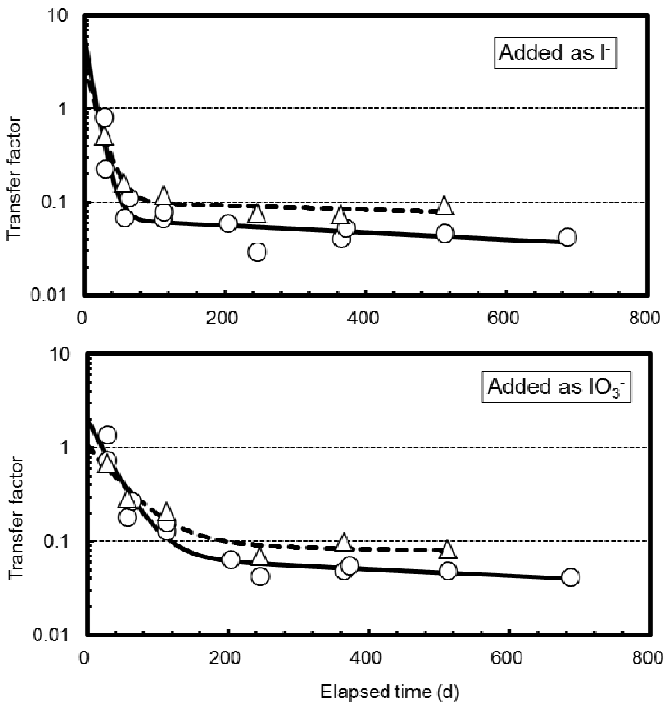

Fig. 2 Temporal changes of soil-to-grass transfer factor of I after addition of I^- or IO_3^- to soil
○: Without fertilizer application
△: With fertilizer application
Results for the soil without fertilizer application include those obtained in the long-term experiment from FY 2007. The solid and broken lines indicate regression curves for the soil without and with fertilizer application, respectively.

Table 1 Parameters in the regression curves for the temporal changes of soil-to-grass transfer factor of Cs and I after the addition.

	a_1	a_2	λ_1	λ_2
Cs				
Without fertilizer application	3.1E-1	4.0E-2	4.2E-2	9.9E-5
With fertilizer application	4.6E-1	2.6E-2	4.4E-2	9.9E-5
I				
Added as I^-				
Without fertilizer application	5.6E+0	6.7E-2	9.5E-2	8.6E-4
With fertilizer application	2.9E+0	1.0E-1	6.7E-2	4.8E-4
Added as IO_3^-				
Without fertilizer application	1.9E+0	7.0E-2	3.3E-2	8.2E-4
With fertilizer application	9.7E-1	9.2E-2	2.2E-2	2.8E-4

$TF = a_1 \exp(-\lambda_1 t) + a_2 \exp(-\lambda_2 t)$
TF, Transfer factor
t, Elapsed time after the addition (d)