Transfer of Iodine and Cesium from the Surface of Leaf, Trunk or Fruit to the Interior of Apple Fruit

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Abstract

When radionuclides are released into the atmosphere during nuclear fuel reprocessing, some are deposited on the surfaces of crop plants; this is then followed by absorption and translocation to other parts of the plants. Apples are one of the important agricultural products in Aomori Prefecture, where the first commercial nuclear fuel reprocessing plant is undergoing final operating assessment activities. Since the behavior of radiocesium and radioiodine deposited on apple tree surfaces and their transfer to fruit are not well known, a research project to determine them was launched in FY 2016. In FY 2019, we studied 1) the absorption of stable I^- applied onto fruit surfaces, and 2) the absorption and translocation of stable Cs^+ applied onto leaf, trunk or fruit surfaces. In both studies, the target ions were applied as solid particles on the surface. Potted Plumleaf crab apple (*Malus sp.* cv. ALPS OTOME) trees, 2 to 3 years old, were used as the experimental plant for easy handling. Compartment models of absorption from various surfaces and translocation to fruit in apple tree were constructed for describing the behaviors of cesium (Cs) and iodine (I) by using results from the studies in FYs 2017-2019.

For 1), we cultivated the apple trees in artificial climate chambers and sprayed solid aerosols of NaCl containing NaI onto the fruit surfaces at early and late development stages and the fully mature stage, corresponding to 75-77, 117-120 and 145-147 days after flowering, respectively. The fruits were periodically collected from the trees, and their surfaces were washed with solution containing detergent, followed by peeling. The wash solution, peel and flesh samples were analyzed for I. At all growth stages, the remaining I proportion in the wash solution and peel samples after a few days were about 10% for each. I was not detected in the fresh samples. Therefore, most of the I applied onto fruit surface was volatilized into the atmosphere. The apparent absorption rates defined as the ratio of the proportion in fruit at the harvest date to the days after application of I was on the order of 10^{-3} d^{-1}.

For 2), we cultivated the apple trees in artificial climate chambers and sprayed solid aerosols of NaCl containing CsCl onto the leaf or trunk surfaces of apple trees at early and late fruit development stages, corresponding to 74-92 and 119-127 days after flowering, respectively. Solid aerosols were sprayed onto the fruit surfaces at early and late development stages and the fully mature stage, corresponding to 68-70, 111-113 and 144-148 days after flowering, respectively. The whole apple trees were periodically collected after the application and separated into their parts. The various Cs-applied samples were washed with solution containing detergent, and this was followed by analyzing those samples, other plant part samples and the wash solution for Cs. The Cs applied onto the leaf or trunk surfaces was absorbed from these surfaces and translocated into the fruits. The proportion of Cs applied onto the leaf surfaces that translocated into the fruits was higher than for Cs applied onto the trunk surfaces. Cs applied onto fruit surfaces was absorbed from the surfaces and transferred into the fresh samples. The Cs apparent absorption rates from fruit surfaces we

calculated was on the order of 10^{-3} d^{-1} and similar to the rate for I. The apparent absorption rates from the leaf and trunk surfaces of apple trees were on the order of 10^{-4} - 10^{-5} d^{-1}.

To describe the behavior of I and Cs on various surfaces and in the plant, we constructed a dynamic model with five compartments. In the model, the various surfaces were assumed to consist of two compartments with different uptake and volatilization rates. Volatilizing rates were not introduced for Cs. The constructed models were mostly able to reproduce the results from the studies.

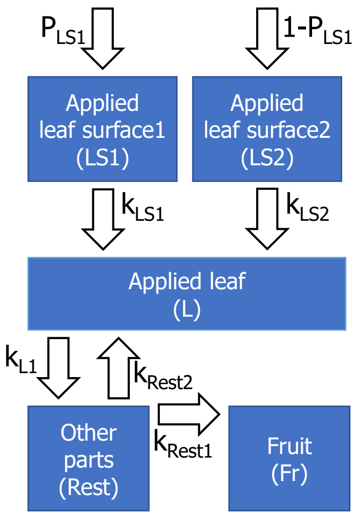

Fig. 1 Compartment model describing foliar uptake and translocation of Cs in apple plant.

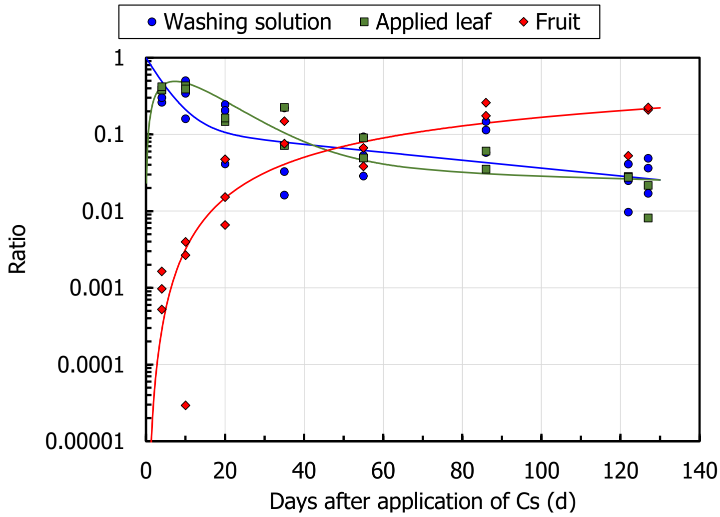

Fig. 2 Change in ratios of Cs in various parts after application of Cs. Ratios of Cs in various parts were defined as the ratio of the amounts in various parts to that loaded initially on the leaf surfaces. Solid curves show least square fitting lines obtained by the compartment model in Fig. 1.