Tritium Transfer from the Atmosphere to Crops

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Abstract

Trace amounts of tritium (^{3}H) are expected to be discharged into the environment from operation of the spent nuclear fuel reprocessing plant in Rokkasho, Japan. Since tritiated water (HTO) is transferred to plants through the leaf surface and root, it is necessary to assess the local radiological impact of ^{3}H from the reprocessing plant to predict the ^{3}H concentration in the edible parts of crops. In this study, a dynamic compartment model was established to describe tritium accumulation in a type of leafy vegetable plant.

In FY 2010, we investigated the deuterium enriched water (HDO) uptake of *Brassica campestris* (Komatsuna) via the root, and constructed a three-compartment model of hydrogen metabolism in the shoot, which has two compartments of free water with (FW1) and without (FW2) transpiration and a non-exchangeable organically-bound hydrogen (NxOBH) compartment in the shoot. Water from both the leaf surface and root enters into the FW1 compartment and is exchanged with the FW2 compartment. Free water in the FW1 compartment is transpired, and H in the free water is transferred to the NxOBH compartment mainly by photosynthesis. The free water resulting from degradation of NxOBH is returned to the FW1 compartment. Transfer parameters in the model, such as transpiration rate and rate constants of H transfer between compartments etc., were cited from the literature. Although the model fairly well described D concentration in free water in Komatsuna shoot, D concentrations in NxOBH were not examined.

In FY 2011, the HDO uptake via the leaf surface was studied using Komatsuna to obtain actual values of parameters in the model. Komatsuna plants were exposed to HDO vapor during a light or dark period at 15 d after seeding, and D concentrations in free water in the shoot during the exposure were determined. Komatsuna plants were also exposed to HDO vapor at 10, 15, 20 or 25 d after seeding, and D concentrations of NxOBH in the shoot harvested at 28 d after seeding were determined. The parameter values in the model were estimated from the results of the experiments, and some parameter values differed by a factor of 2-7 from those in the literature. The model using the obtained parameter values mostly well described D concentrations measured in free water and NxOBH of the shoot.

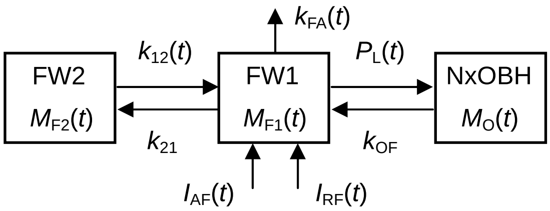

Fig. 1 Scheme of the dynamic three-compartment model.

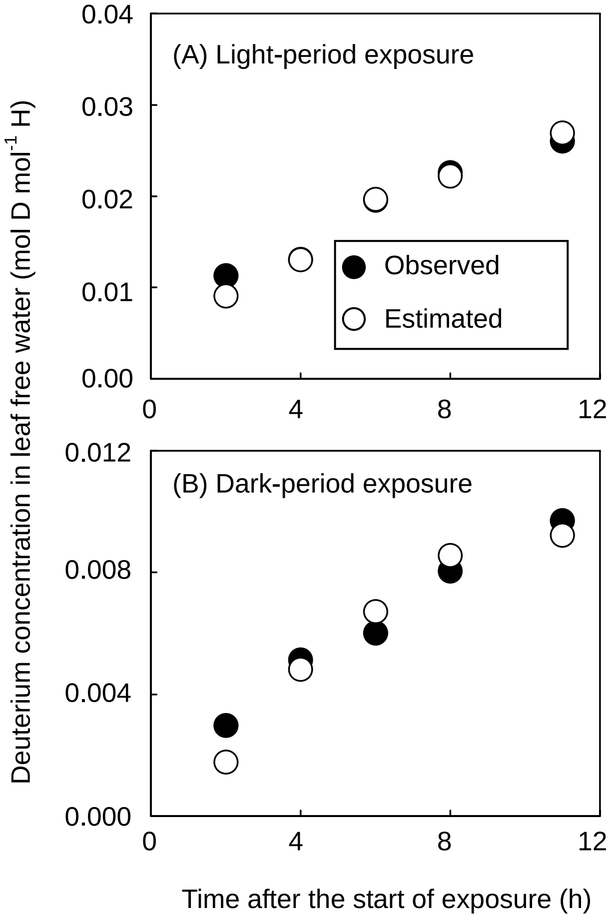

Fig. 2 Observed and estimated deuterium concentrations in free water of *Brassica campestris* shoot exposed to deuterium-enriched water vapor during light (A) or dark (B) periods at 15 d after seeding.

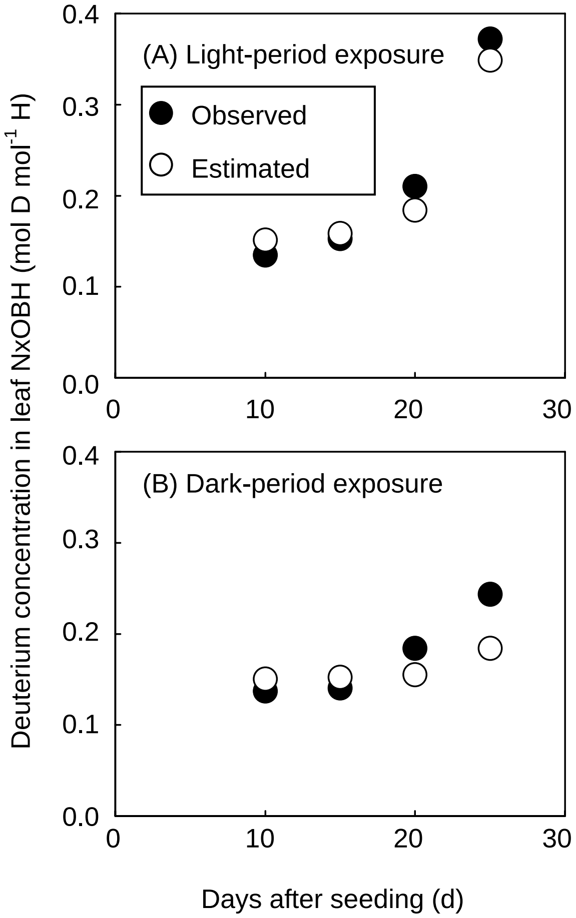

Fig. 3 Observed and estimated deuterium concentrations in NxOBH in *Brassica campestris* shoot exposed to deuterium-enriched water vapor during light (A) or dark (B) periods at 10, 15, 20 or 25 d after seeding and harvested at 28 d after seeding.