Tritium Transfer from the Atmosphere to Crops

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Abstract

Although its amount is normally limited, tritium (^{3}H) is released into the atmosphere from operation of the spent nuclear fuel reprocessing plant in Rokkasho, Japan. Tritiated water (HTO) enters crop plants by foliage uptake from the atmosphere and by root uptake after deposition to the ground, which may cause a possible increase in the internal radiation dose of residents in the vicinity of the reprocessing plant who consume these crop plants. Therefore, estimation of the ^{3}H concentration in the edible parts of crops is necessary for the assessment of the local radiological impact of ^{3}H from the reprocessing plant. In this study, a dynamic compartment model was established to describe tritium accumulation in a root vegetable plant.

We investigated the deuterium enriched water (HDO) uptake of radish plant (*Raphanus sativus* L.) via the leaf and the root. Radish plants were exposed to HDO vapor or HDO-enriched nutrient solution during a light or dark period at 14 d after seeding, and free water deuterium (FWD) concentrations in free water in the leaf and root during and after the exposure were determined. Radish plants were also exposed to HDO vapor at 10, 12, 14, 15, 17 or 19 d after seeding, and organically bound deuterium (OBD) concentrations in the leaf and the root harvested at 20 d after seeding were determined.

From the data obtained, we constructed a five-compartment model of deuterium metabolism in the plant. In this model, the leaf consisted of a FWD compartment and two OBD compartments (OBD1 and OBD2), while the root consisted of a FWD compartment and an OBD compartment. In the leaf, the FWD, OBD1 and OBD2 compartments were sequentially connected to each other, and the FWD and OBD compartments in the root were connected similarly. The OBD1 had output to the root OBD compartment through translocation. Part of the HDO uptake via root directly entered the leaf FWD compartment, and the root FWD compartment had output to soil water.

The values of transfer parameters in the model were estimated from the results of the experiments. Although the model well estimated the OBD concentrations with good agreement to the observed values, estimated FWD concentrations in leaf and the root did not agree well with the observed values. Further study is required to improve the accuracy of the five-compartment model of deuterium metabolism.

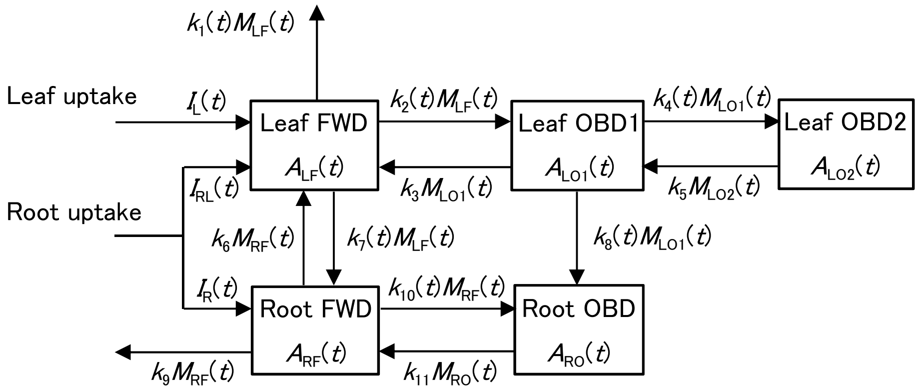

Fig. 1 Scheme of five-compartment model of deuterium metabolism in radish plant.

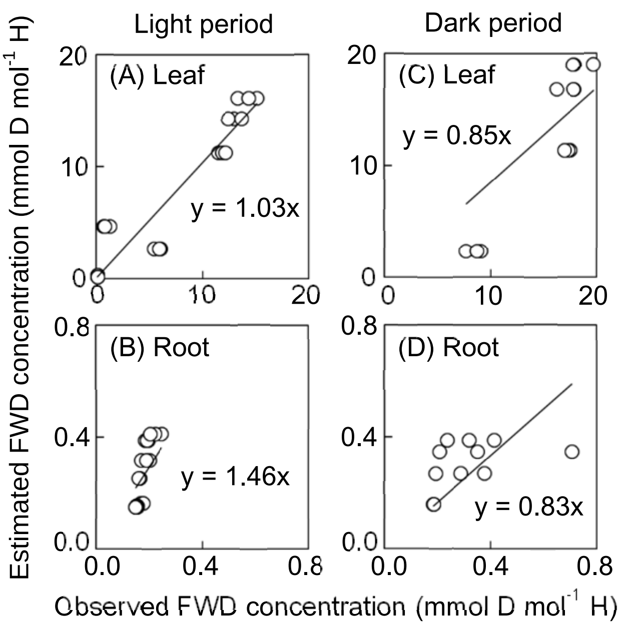

Fig. 2 Observed and estimated deuterium concentrations in free water of leaf (A, C) and root (B, D) of radish plants exposed to deuterium-enriched water vapor during light or dark periods at 14 d after seeding.

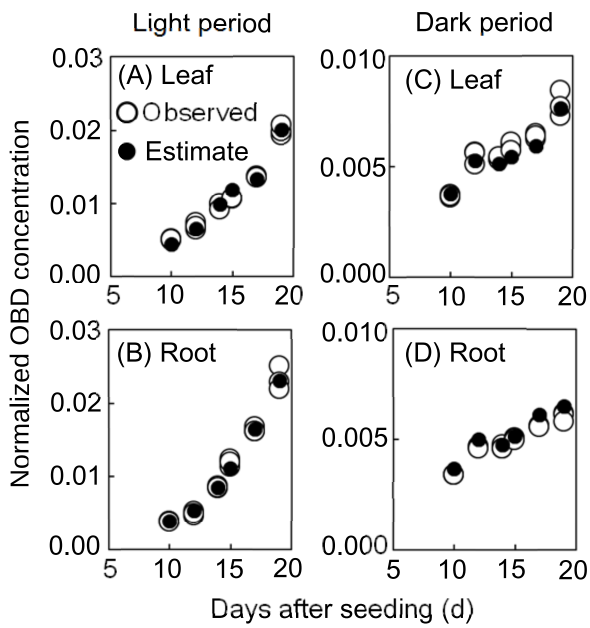

Fig. 3 Observed and estimated OBD concentrations in leaf (A, C) and root (B, D) of radish plants exposed to deuterium-enriched water vapor during light or dark periods at 10, 12, 14, 15, 17 or 19 d after seeding and harvested at 20 d after seeding. Values of the observed and estimated OBD concentrations are normalized by deuterium concentrations in air moisture during each exposure.