Transfer and Accumulation of Radionuclides in Agricultural and Marine Products

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Abstract

Radionuclides (^{3}H, ^{14}C, ^{129}I, etc.) are released into the atmosphere from the first Japanese commercial nuclear fuel reprocessing plant in Rokkasho Village, Aomori Prefecture. The transfer and accumulation of such radionuclides to commercially important agricultural and marine products sampled around the plant, such as Chinese yam (*Dioscorea polystachya*) and olive flounder (*Paralichthys olivaceus*), are not adequately understood. The purpose of this research project is to experimentally determine the transfer and accumulation of the radionuclides in Chinese yam and olive flounder. Such experimental data will be used to develop capabilities to explain future changes in radionuclide levels in the target species when consumed as food after the plant is fully operating.

Controlled amounts of ^{14}C are released into the atmosphere with the steady operation of the reprocessing plant. In studying the transfer and accumulation of ^{14}C in Chinese yam in FY 2021, temporal changes in plant parts were determined in the field to estimate the transfer rate of ^{14}C from the atmosphere to the plant parts via leaf photosynthesis. An extensive growth of tubers was observed from mid-August to mid-September. This suggested that a large amount of ^{14}C which was photosynthetically fixed during this period could be translocated into the tubers. In addition, a pot cultivation method for Chinese yam from bulbils was developed for experimental exposure of the plant to $^{13}CO_2$ as a substitute for $^{14}CO_2$. Plants were cultivated using Wagner pots (1/2000 a) filled with sand and fertilized using liquid nutrient solutions. Harvested tuber weight of potted plants was comparable to that observed in the field.

The main chemical form of ^{3}H released into the ocean from the reprocessing plant is tritiated water (HTO). In the second part of the study, the marine fish, olive flounder, were experimentally exposed to deuterated water (HDO) as a substitute for HTO. Olive flounder aged more than 140 days were reared in seawater containing HDO with 2 mmol D mol^{-1} H at 7, 10, 15, 20, and 23°C. The turnover rate of the non-exchangeable form of organically bound deuterium (NxOBD) in muscle of olive flounder tended to increase with temperature. The concentration of NxOBD in the muscle reached a steady state in fish reared at 15, 20, and 23°C around 160 days after the start of the exposure. The steady-state concentration was approximately 20% of that of the ambient water.

Next, olive flounder were experimentally reared in seawater containing ^{129}I, in order to simulate exposure of the fish to ^{129}I discharged from the reprocessing plant. Olive flounder aged more than 200 days were exposed to ^{129}I-enriched seawater for 28 days. The chemical form of ^{129}I added to the seawater was iodide (I^-). The concentration of ^{129}I in muscle of olive flounder increased during the first 4 days after the start of the exposure, and then equilibrated toward the end of the exposure. This result indicated a rapid turnover rate of ^{129}I in muscle of olive flounder.

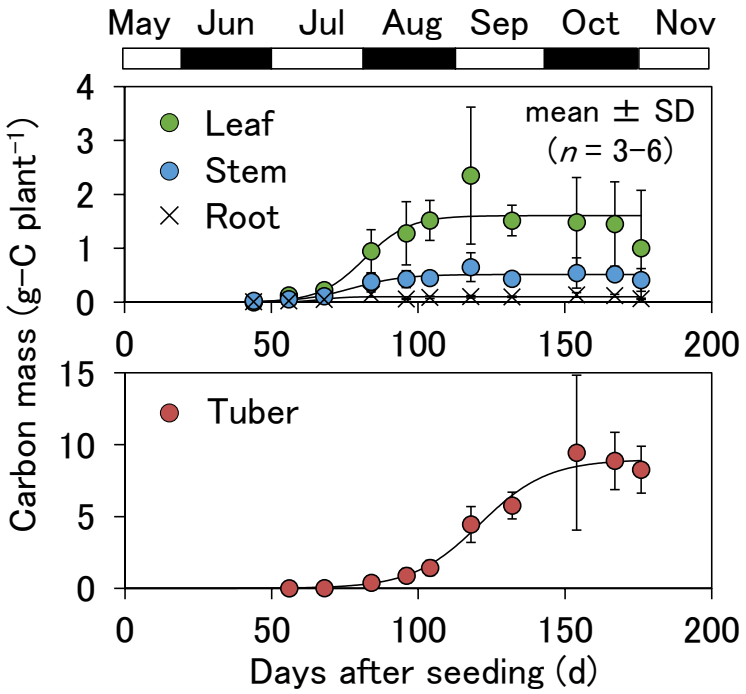

Fig. 1 Temporal variations in the carbon mass of the leaf, stem, root, and tuber of Chinese yam raised from bulbils in the field.