Carbon Transfer in Agricultural Soil containing Plant Biomass

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Abstract

Rice is one of the most important food crops in Japan. The operation of a spent nuclear fuel reprocessing plant will accompany the release of ^{14}C into the atmosphere, which can be taken up as CO_2 by rice plants through photosynthesis. The weight of edible part is less than half of the total weight of the plant, and large amounts of plant residues as stubble and rice straw are left after harvest in the paddy fields. Some parts of the rice straw (leaves and stem) are used as compost with dung in agricultural fields for vegetation cultivation. In addition, in Aomori Prefecture, it is recommended by the prefectural government that rice straw be buried into the paddy fields after harvest for the purpose of soil improvement and/or for the prevention of air pollution by combustion. Then, ^{14}C absorbed and fixed in rice plants is artificially added into agricultural fields. The purpose of this study was to model the migration of carbon between the atmosphere, plants and soil in an agricultural field, to clarify the probable long-term accumulation of ^{14}C in the soil.

Changes in carbon amount and ^{13}C concentration in CO_2 gas released from the soil where ^{13}C -enriched rice straw had been buried were analyzed by a closed chamber method. The highest ^{13}C concentration in CO_2 released from the soil was observed in early summer, which suggested that active degradation of rice straw occurred in paddy soil at that time. The compost consisting of ^{13}C-enriched rice straw and stubble was also used in a carrot field. The concentration of ^{13}C in CO_2 released from the soil was the highest immediately after introducing the compost, and then slowly decreased. These data suggested that in both paddy and farm fields, organic materials in rice straw would be decomposed first rapidly with the half-life of less than 3 months, and then relatively slowly with that of 2 to 3.5 years.

It was also suggested that the carbon originally contained in the rice straw buried in paddy soil, was taken up again by rice plants. The concentration of ^{13}C in the plant was the highest in June, when the release of the highest concentration of ^{13}C from the soil was observed.

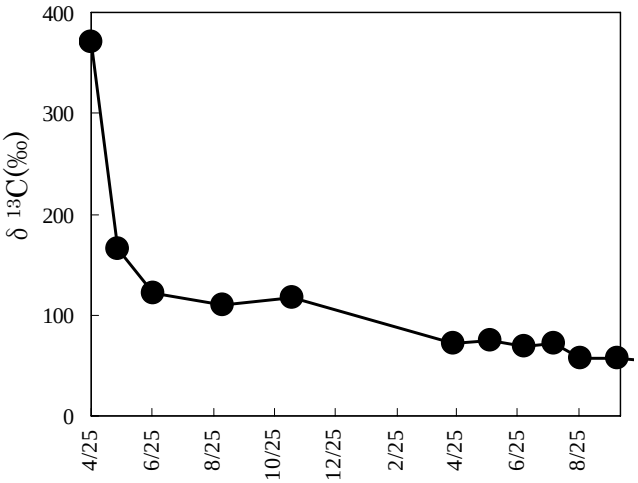

Fig. 1 Variation in $\delta^{13}C$ in the paddy soil.

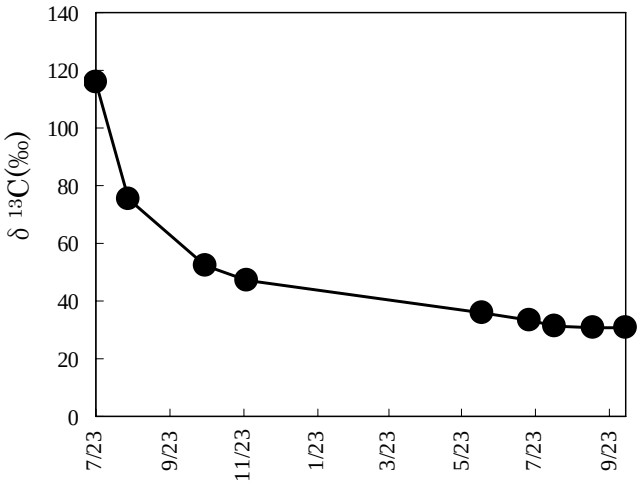

Fig. 2 Variation in $\delta^{13}C$ value in the carrot field soil.

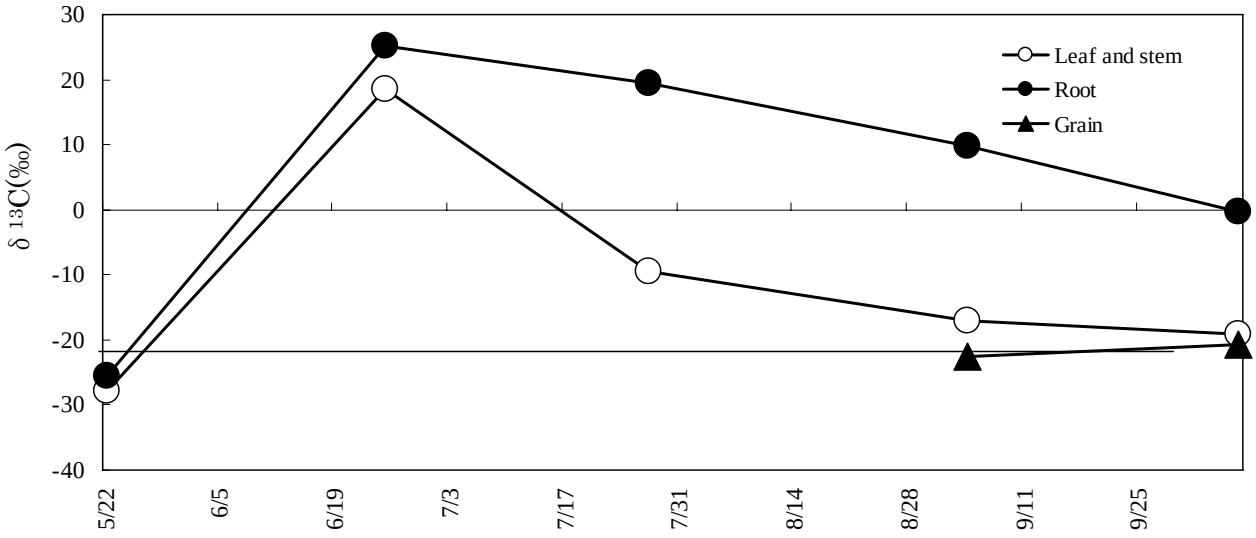

Fig. 3 Seasonal changes of $\delta^{13}C$ value of the rice plant cultivated by Wagner pot with ^{13}C-enriched rice straw buried in the soil.