Carbon Transfer in Agricultural Soil Containing Plant Biomass

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Abstract

C-14 released into the atmosphere from a spent nuclear fuel reprocessing plant is partly taken up by rice plants through photosynthesis. In Aomori Prefecture, the prefectural government has recommended that rice straw be buried in paddy fields after harvest for the purpose of soil improvement and/or for the prevention of air pollution by burning the straw. The purpose of this study is to model the movement of carbon through the atmosphere, plants and soil in agricultural fields, and to clarify possible long-term accumulation of ^{14}C in soil, which would be introduced in plant biomass by burying of rice straw. In this experiment, a stable isotope of carbon (^{13}C) was used as a substitute tracer for ^{14}C.

In April 2008, the ^{13}C-enriched rice straw was cut into pieces of 10 cm in length and buried as compost in paddy soil with the concentration 0.6 kg (dry weight)/m^2. The total amount of carbon released as CO_2 during the period from April to November, was 261 gC/m^2 from the soil with compost, compared to 175 gC/m^2 from the soil without compost. The highest ^{13}C concentration in CO_2 released from the soil was observed in June and July, which suggested that active degradation of rice straw buried in paddy soil occurred in early summer. The result of the analysis of carbon in the soil showed that about 49% of the carbon originally contained in the straw remained in the soil in November.

The compost consisting of ^{13}C-enriched rice straw and stubble was also spread onto a carrot field in July 2008. The total amount of carbon released during the period from July to November was 110 gC/m^2 and 65.4 gC/m^2 from the soils with and without compost, respectively. The concentration of ^{13}C in CO_2 released from the soil was the highest immediately after introducing the compost, and then decreased. It was also suggested that about 59% of the carbon in the straw remained in the soil in November, 4 months after adding it to the soil.

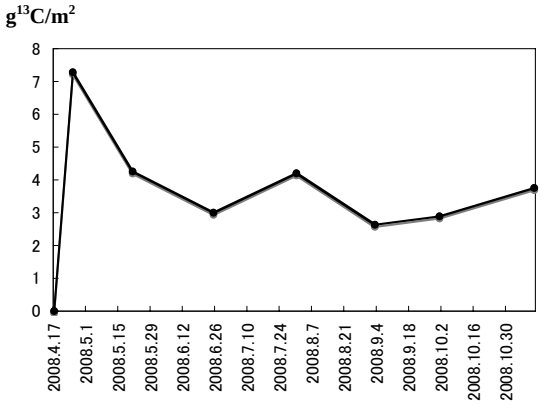

Fig. 1 The excess ^{13}C amount of the paddy soil buried with ^{13}C enriched straw

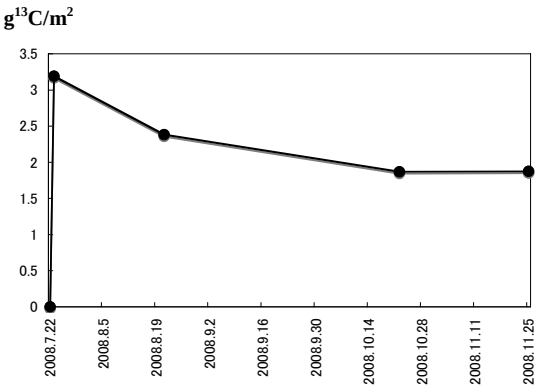

Fig. 2 The excess of ^{13}C amount of the carrot field spread with ^{13}C enriched compost

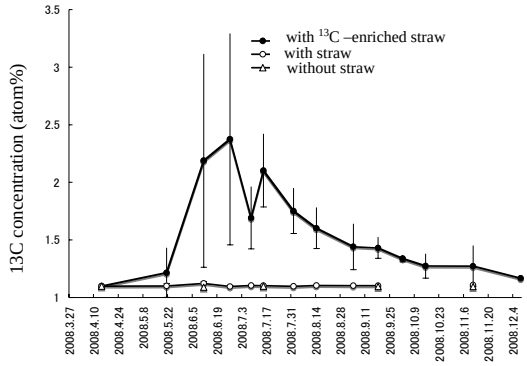

Fig. 3 The ^{13}C concentration of gases released from the paddy soil

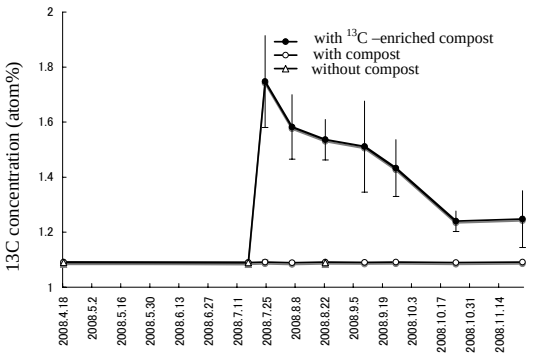

Fig. 4 The ^{13}C concentration of gases released from the carrot field