Development of Technology for Application of a Closed Experimental System to Carbon Transfer Studies

Susumu NOZOE, Sho-ichi TSUGA, Osamu KOMATSUBARA,
Yasuhiro TAKO, Yuji NAKAMURA
Department of Environmental Simulation

Abstract

In order to verify dynamic models for estimation of ^{14}C transfer from the atmosphere to edible and inedible parts of 7 crops, an experiment to examine validity of the model calculation after continuous enhancement of atmospheric $^{13}C/^{12}C$ ratio during different stage in the growing period is planned for 2009. Then in FY2008, preliminary experiments were conducted to establish methods for obtaining appropriate values of atmospheric $\delta^{13}C$ and for controlling its temporal fluctuation which will be used in the 2009 study. It was found that the overall range of spatial variation was approximately 2‰ and a point representative of the atmosphere in the plant cultivation chamber was identified. It was also confirmed that $\delta^{13}C$ of the chamber atmosphere was stable (the range of fluctuation was within 1‰) during almost the whole lighting period.

To reconstruct realistic carbon metabolism models of humans and ruminants, experimental data concerning carbon mass flow are also necessary. It was confirmed that the amount of carbon in excrement could be accurately measured using a closed waste processing system. Necessary conditions for obtaining appropriate data about the daily cumulative respiratory CO_2 amount using the animal holding and human habitation module under [CO_2] control were also obtained.

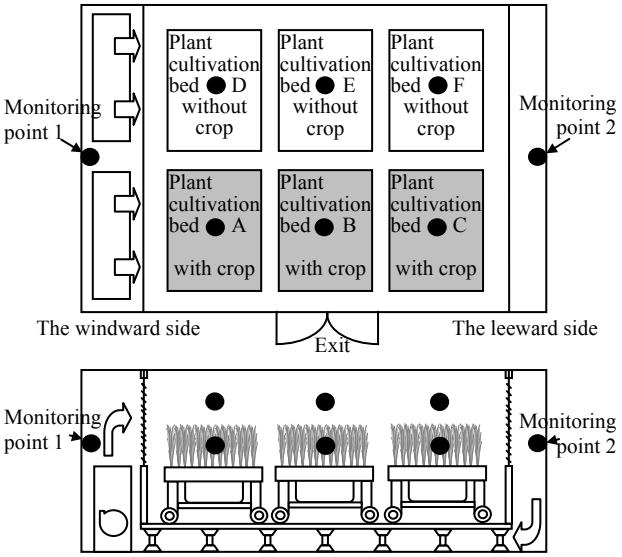

Fig. 1 The arrangement of measuring points (denoted by closed circles) in a plant chamber illuminated by artificial lighting, in which plants of orchard grass were grown on 3 of all 6 plant cultivation beds, in a test for evaluation of spatial difference in atmospheric $\delta^{13}C$ values.

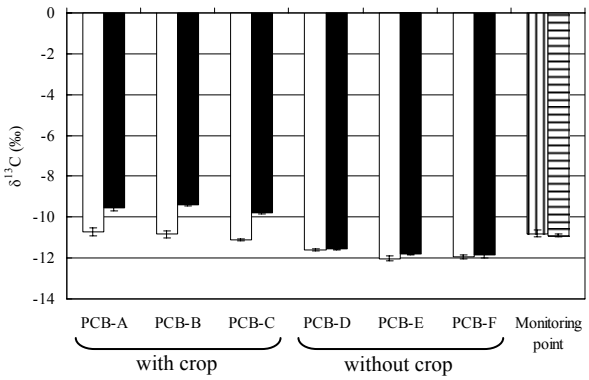

Fig. 2 An example of spatial variation in $\delta^{13}C$ of CO_2 in the atmosphere of a plant cultivation chamber, in which plants of orchard grass were grown on 3 of all 6 plant cultivation beds (n=3). Open, closed, vertically-striped, and horizontally-striped columns denote $\delta^{13}C$ values for middle level between ceiling and top of plant canopy, middle level in the canopy, "monitoring points 1" and "2" shown in Fig. 1, respectively. PCB: plant cultivation bed.

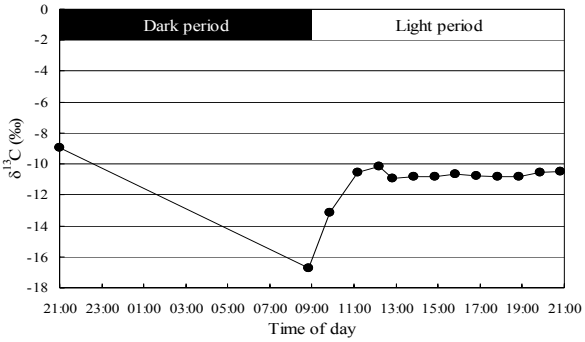

Fig. 3 An example of temporal fluctuation of atmospheric $\delta^{13}C$ value in a plant cultivation chamber illuminated by artificial lighting, in which plants of potato were grown.

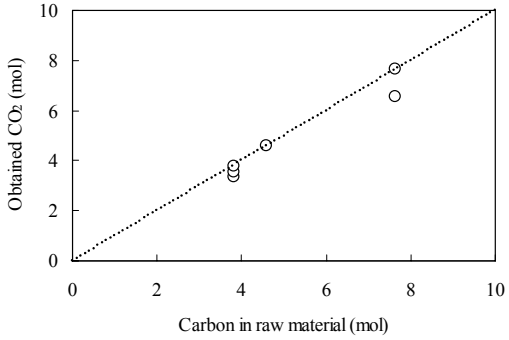

Fig. 4 The correlation between amount of carbon contained in raw material (human feces) and that in CO_2 obtained during carbonization and incineration processing.

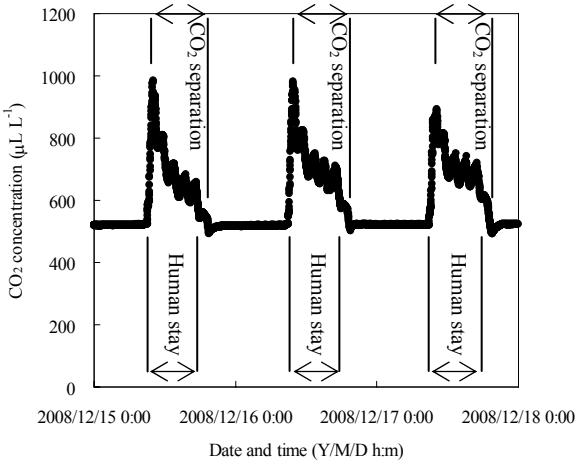

Fig. 5 An example of result of CO_2 concentration control of the animal holding and human habitation module atmosphere, in which an adult man stayed intermittently (8 hours/day × 3 days).