Carbon Transfer and Accumulation in Forests, Wetlands and Farmlands

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Abstract

The operation of the spent nuclear fuel reprocessing plant in Rokkasho, Japan, is accompanied by the discharge of a small amount of ^{14}C mainly in the form of $^{14}CO_2$, which will transfer into terrestrial ecosystems and will be accumulated in them. In order to predict the fate of ^{14}C discharged from the reprocessing plant, it is necessary to develop a transfer and accumulation model of carbon in terrestrial ecosystems, including the processes of photosynthetic fixation of carbon and the decomposition of organic matter. Various ecosystems, such as forests, wetlands, paddy fields, farmlands and pastures are found around the reprocessing plant. To estimate carbon transfer rates from the atmosphere to plants in forests and tree plantations which are the most widespread, we investigated the above-ground net primary productivity (ANPP) in actual fields. For the estimation of carbon fixation rates in tillage, we studied the gross primary productivities (GPPs) of representative crops and vegetation in paddy fields, farmlands and pastures using the Closed Plant Experiment Facility. The decomposition rates of organic matter were also measured in soils of those ecosystems to get carbon balance in the target fields.

The ANPPs at a *Fagus crenata*-dominated forest and a *Quercus crispula*-dominated deciduous broad-leaved forest, and those at a 19-y-old and a 65-y-old *Cryptomeria japonica* tree plantation were estimated as 0.9, 0.9, 2.1, and 6.0 kg-dry m^{-2} y^{-1}, respectively, based on the summation of annual fine litter fall and annual wood increment in the above-ground biomass from 2010 to 2011.

The GPPs of timothy grass, rice and Japanese radish plants were measured at six growth stages of these plants by pot cultivation experiments using soils in actual fields. The air and soil temperatures, soil moisture, and light intensity were controlled to simulate those in actual cultivation fields. While similar maximum GPPs at the saturated light level were found for timothy grass over the entire growth period, those of rice and Japanese radish plants decreased with the increased number of days after sowing.

To investigate the decomposition rate of soil organic matter in wetlands, mixtures of ^{13}C-labelled plants and wetland soil were packed into glass-fiber filter bags, and buried both in an actual wetland and a simulated wetland in the Closed Geosphere Experiment Facilities in FY 2010. In FY 2011, similar glass-fiber filter paper bags containing mixtures of ^{13}C-labelled plants and forest, paddy field, farmland or pasture soil were buried in each type of field. Concentrations of ^{13}C in fractions separated chemically from the materials in the bags in wetlands were measured at 14 d and 162 d after the burying. The ^{13}C concentration decreased in the order of base-soluble > acid-insoluble > acid-soluble > base-insoluble fractions.

To obtain temperature dependency of the decomposition rate of organic materials in soil, soil samples from forests, wetlands, paddy fields, farmlands and pastures were incubated in the laboratory at different temperatures (10, 20, and 30°C), and were measured for respired CO_2. All soil samples showed an increase in respired CO_2 with temperature. The incubation experimental study will continue until the end of FY 2012.

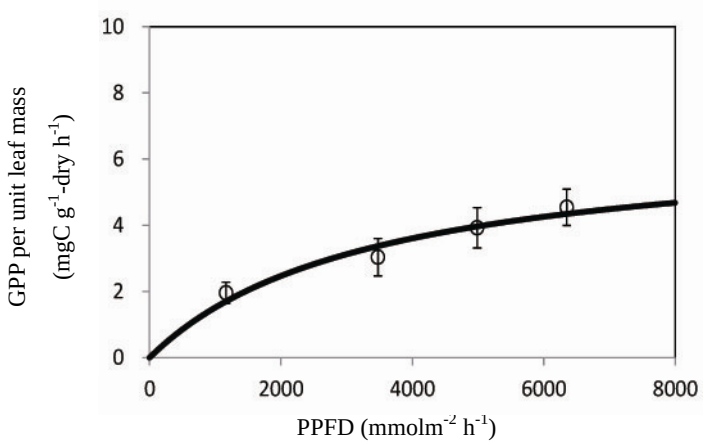

Fig. 1 Relationship between photosynthetic photon flux density (PPFD) and gross primary productivity (GPP) per unit leaf mass of rice plant at 74 d after sowing.