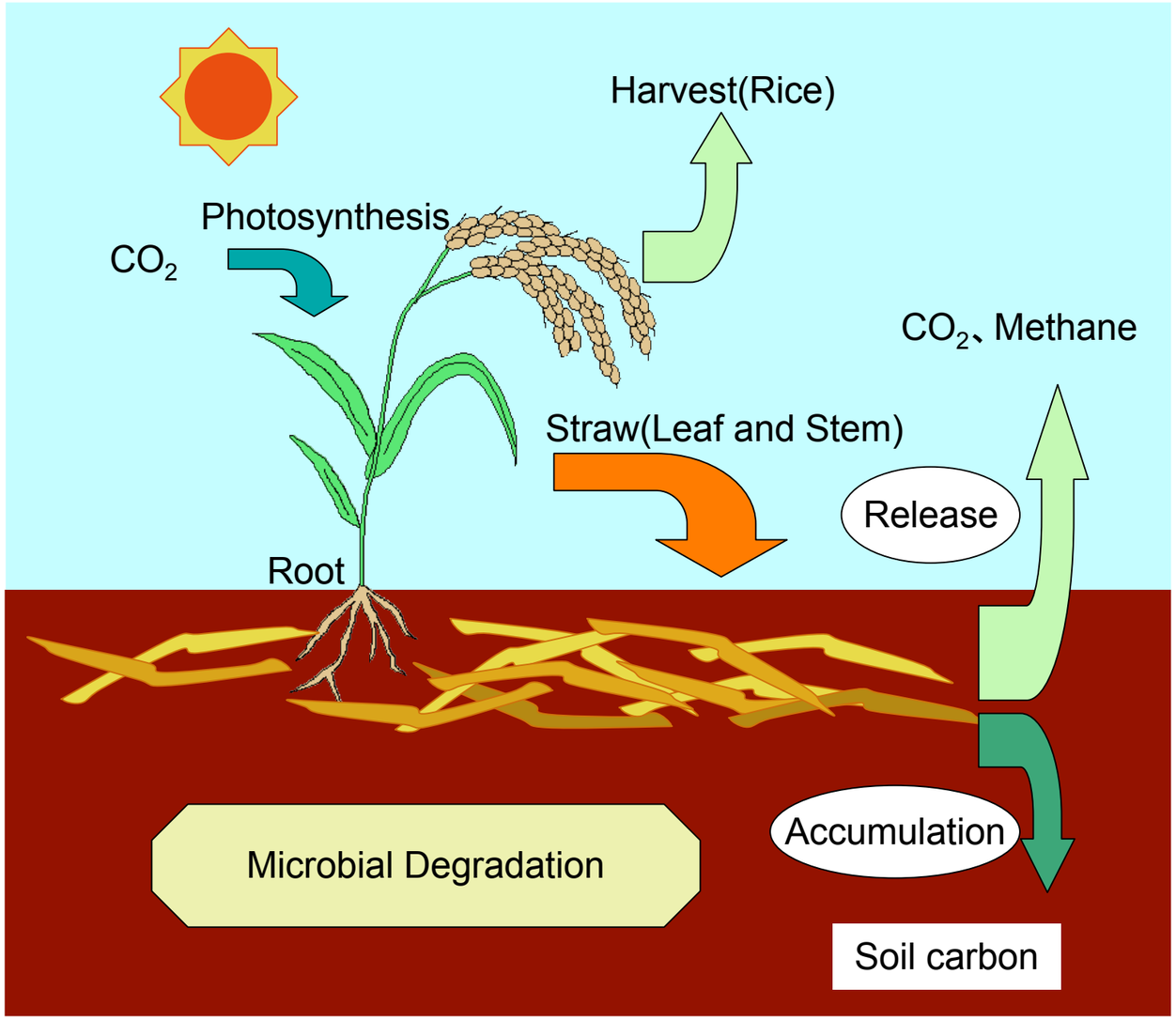
Introduction

Rice is the most important crop in Japan. Edible parts are less than half of total plant, and large amounts of plant residues are left in paddy in the forms of stubble and rice straw. Some rice straw (leaf and stem) is used as feed for cattle or compost with dung, or burn. In Aomori prefecture, the rice straw is buried to paddy under the prefectural guidance.

Rice straw consists of different biopolymers, including cellulose, hemicellulose and lignin and, in addition, contains inorganic components such as silica. The polysaccharides in the straw, in particular, may serve as substrates for the complex microbial community that degrades organic matter to CO_2 and CH_4. Although lignin should largely be recalcitrant in the absence of O_2, some components of this relatively complex biopolymer seem to be degraded in anoxic sediments and result in the formation of CH_4.

We investigated the degradation of three fractions of matured rice plant (stem, leaf and root) in paddy soil.

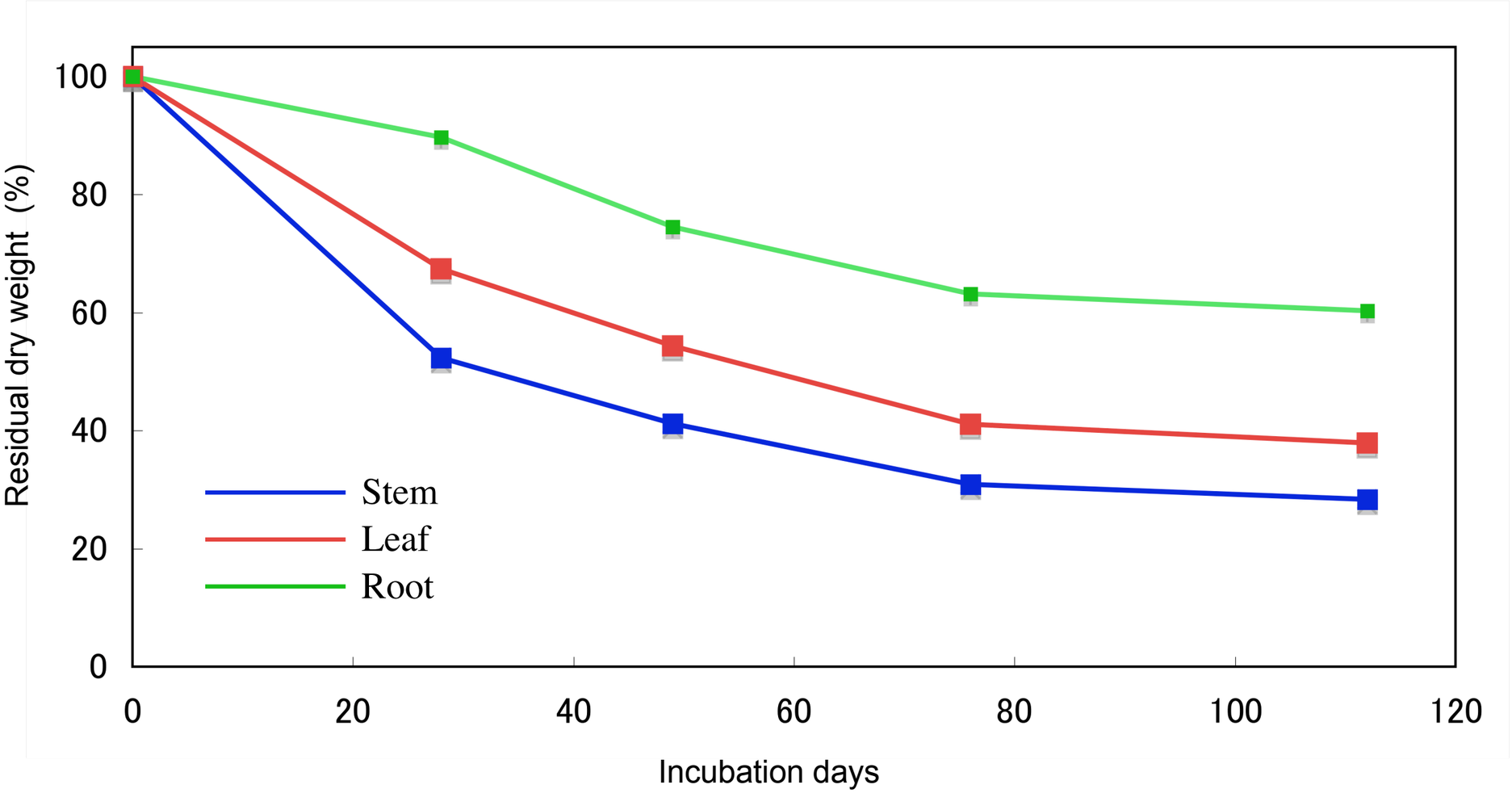
Carbon cycle of the paddy field



1 : Dry weight loss of rice plant

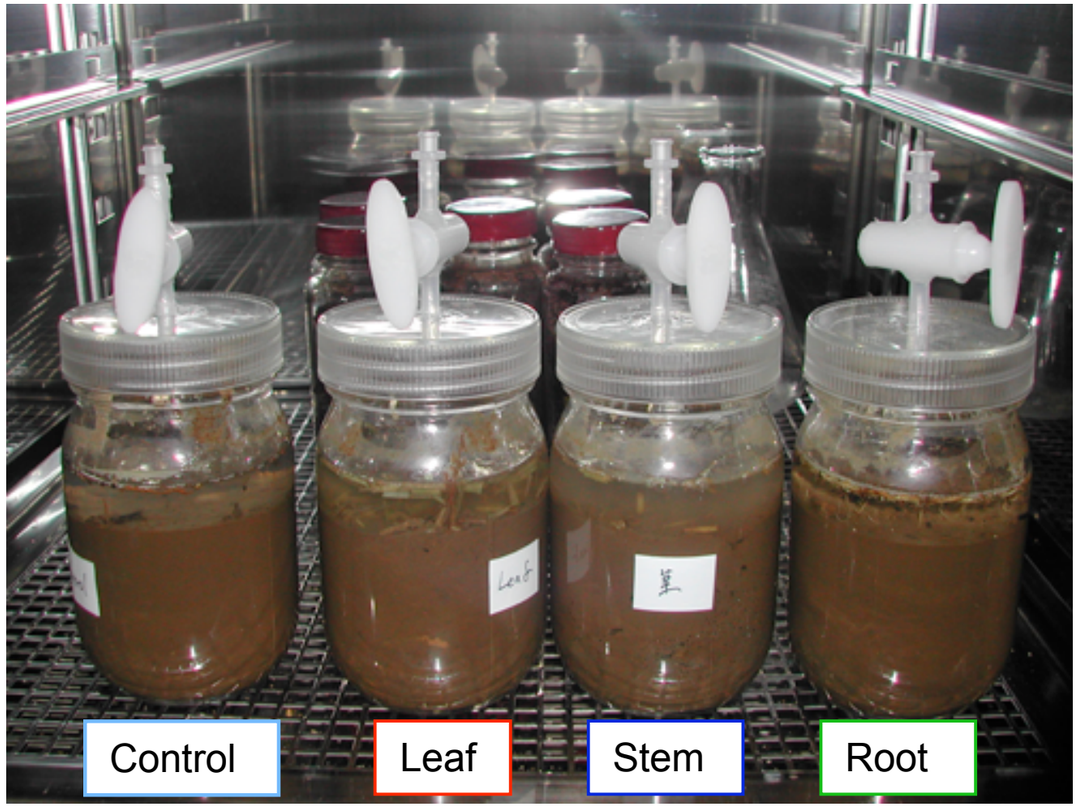
- To determine the loss of dry weights of three fractions due to degradation, 0.5g of each fraction was sealed in a nylon bag (mesh size 25μm) and buried in a glass bottle containing the mixture of 400 g soil and 130 ml water. The bottles were incubated at 30°C for 110 days

Dry weight loss of rice plant



- The loss of dry weight of stem and leaf was 70% and 30%, respectively, after incubation at 30°C for 120 days. Root was the most refractory to degradation, showing only 40% loss of dry weight.

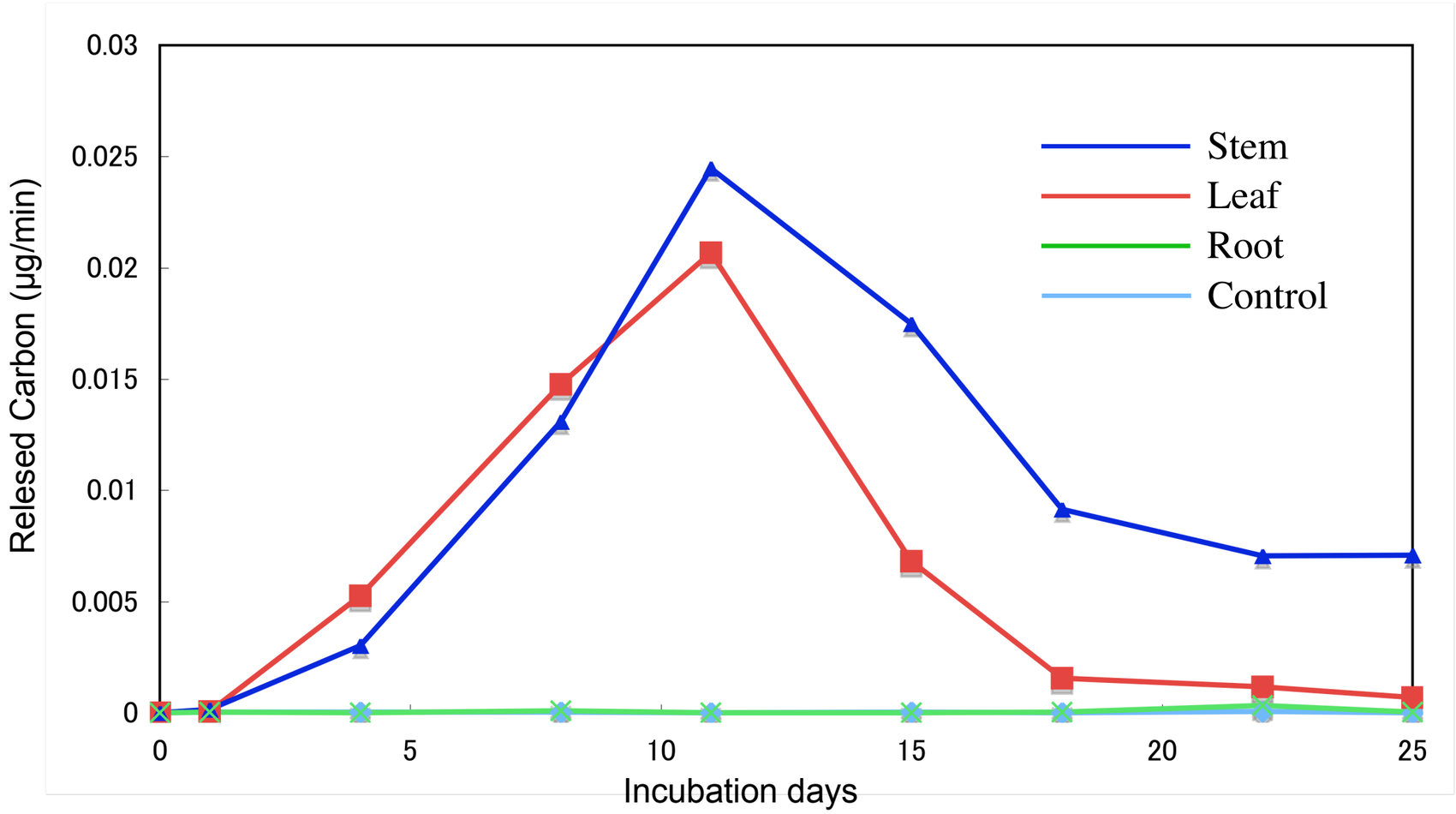
2 : Determination of dehydrogenase activity and the production of CO_2 and CH_4



- For the determination of dehydrogenase activity and the production of CO_2 and CH_4 accompanying with the degradation of polysaccharides in the plant, each fraction of 1.5g was sealed in a glass bottle with the soil-water mixture prepared as same as above. The bottles were incubated at 30°C for 30 days without shaking.

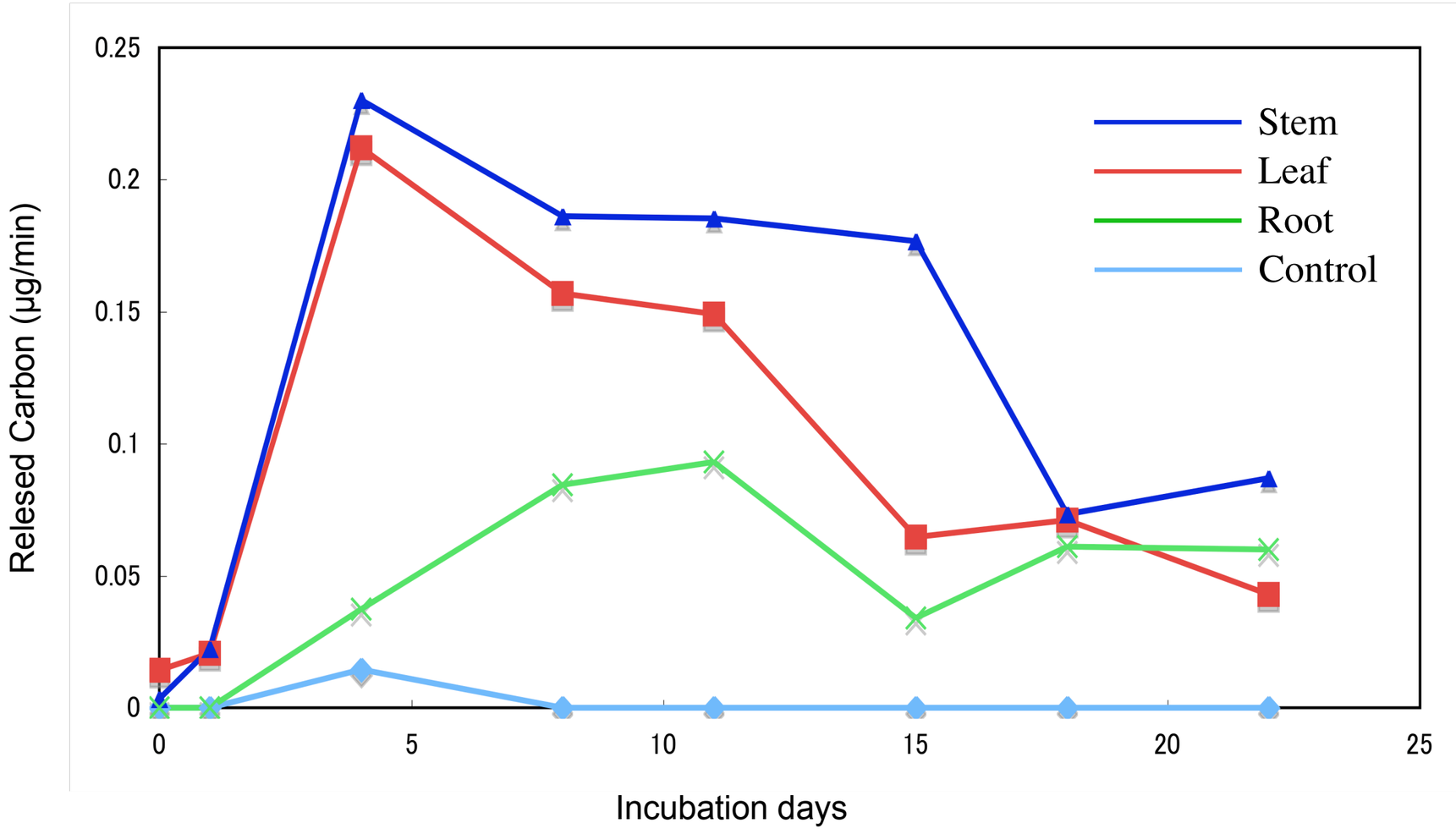
The gas produced was sampled by the syringe from sampling port and analyzed by the gas chromathography.

Methane production



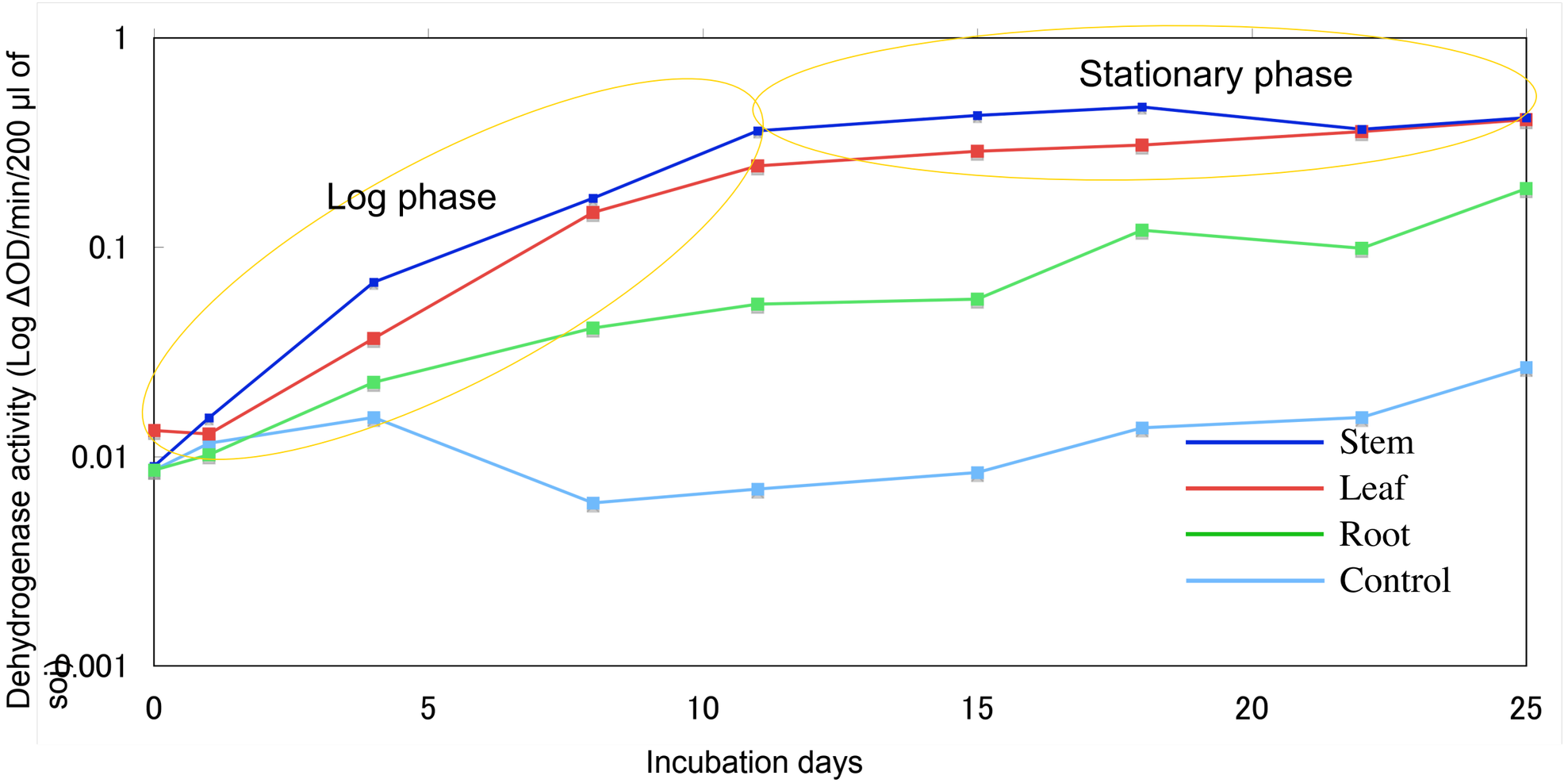
Methane production was measured by gas chromathography

CO_2 production



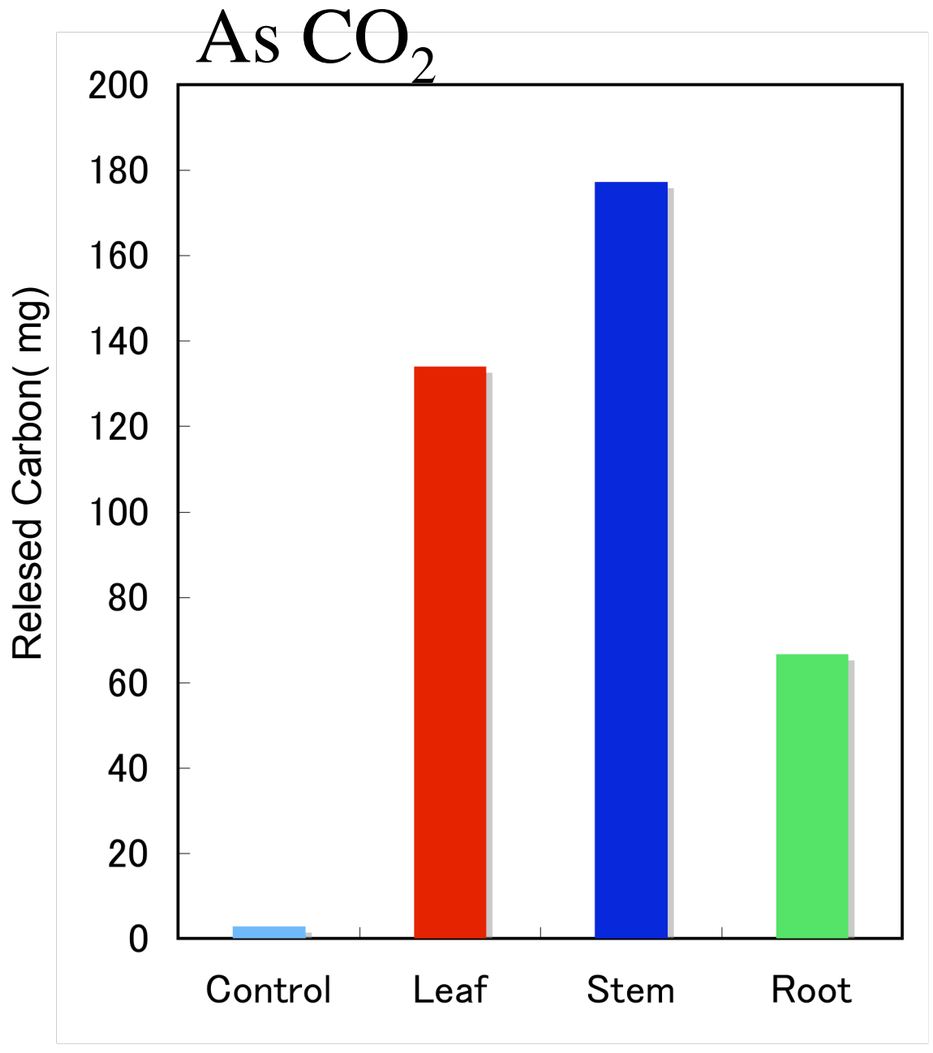
- CO_2 production was measured by gas chromathography

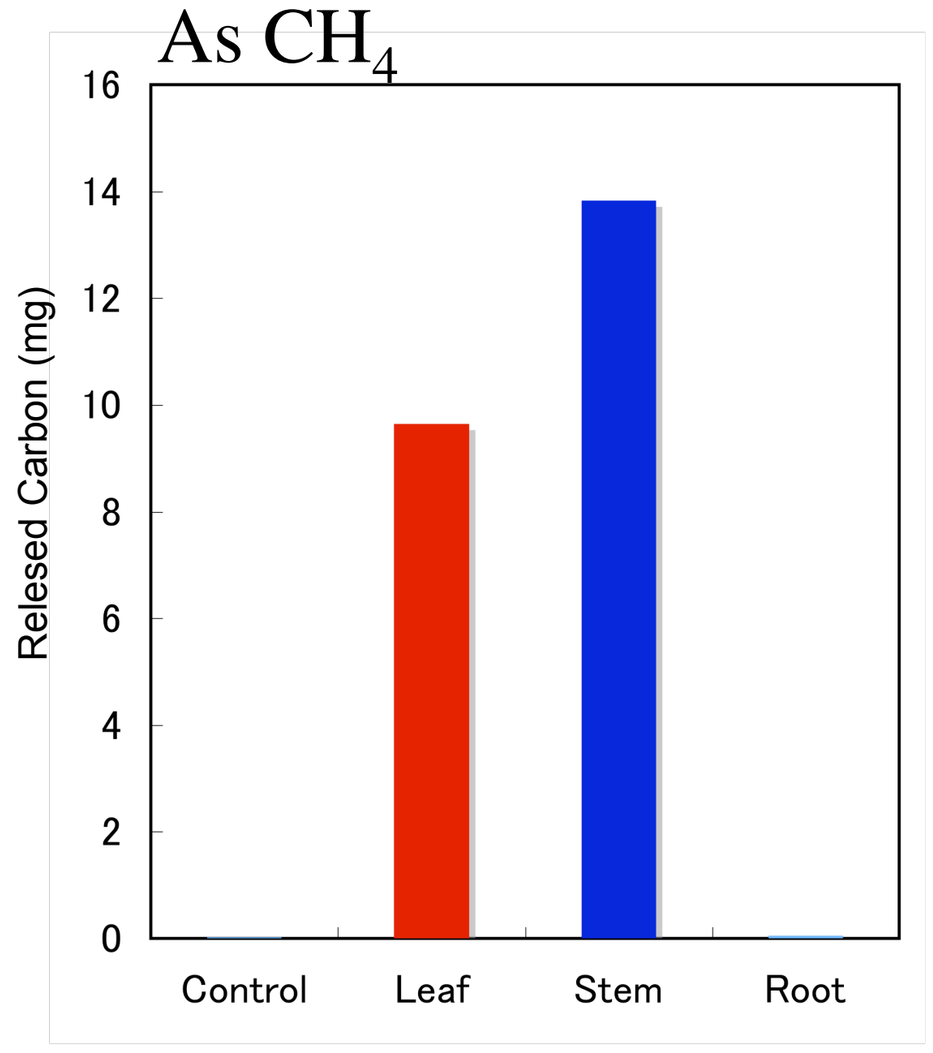
Microbial activity



- The dehydriogenase activity was analyzed as microbial activity by using TCT as the substrate. The microbial activity was higher in the bottle containing stem and leaf, in which the microbial population reached the stationary state at the 11th day during the period of incubation. In the bottle containing root, though microbial activity kept slowly increasing throughout the period of incubation.

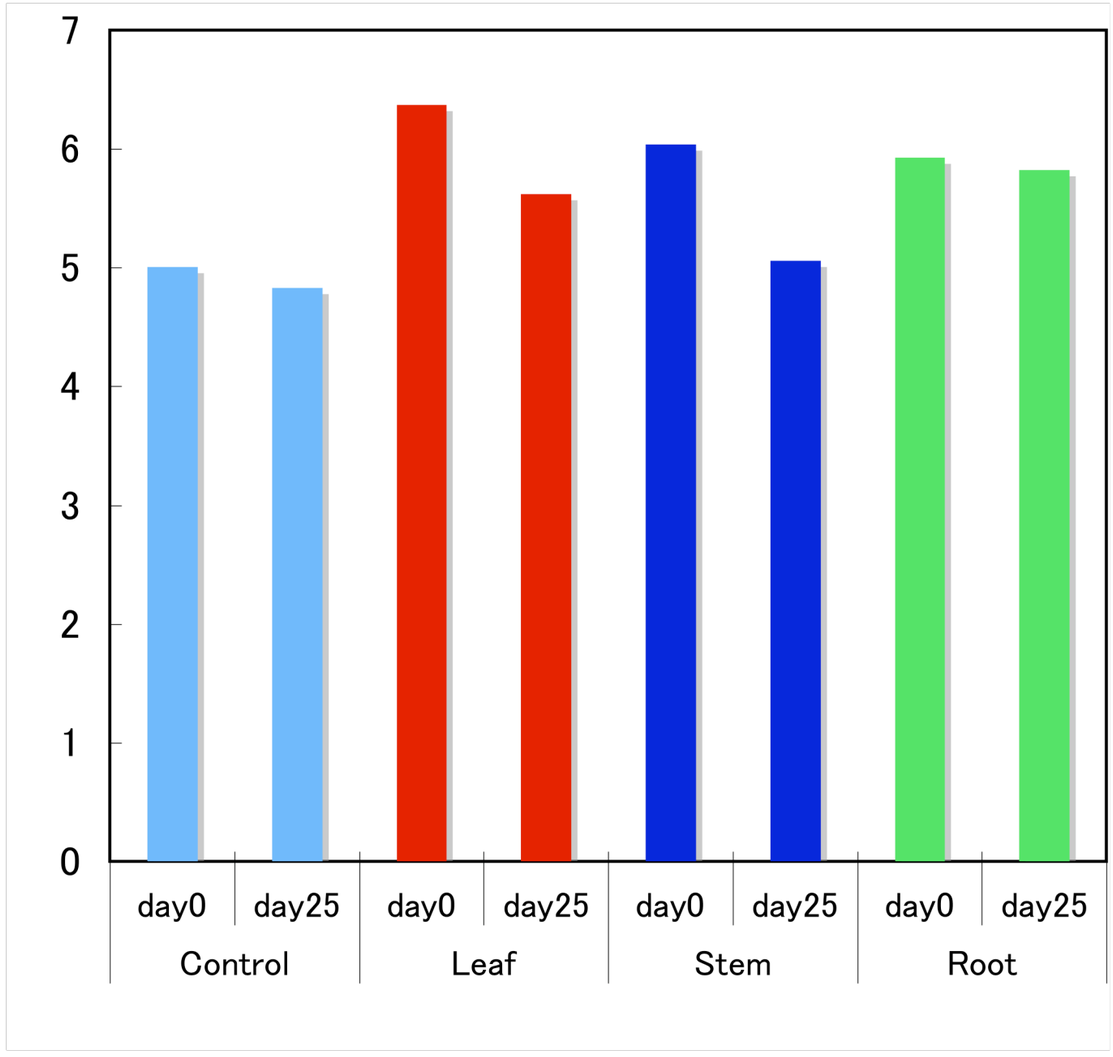
Total amount of released carbon





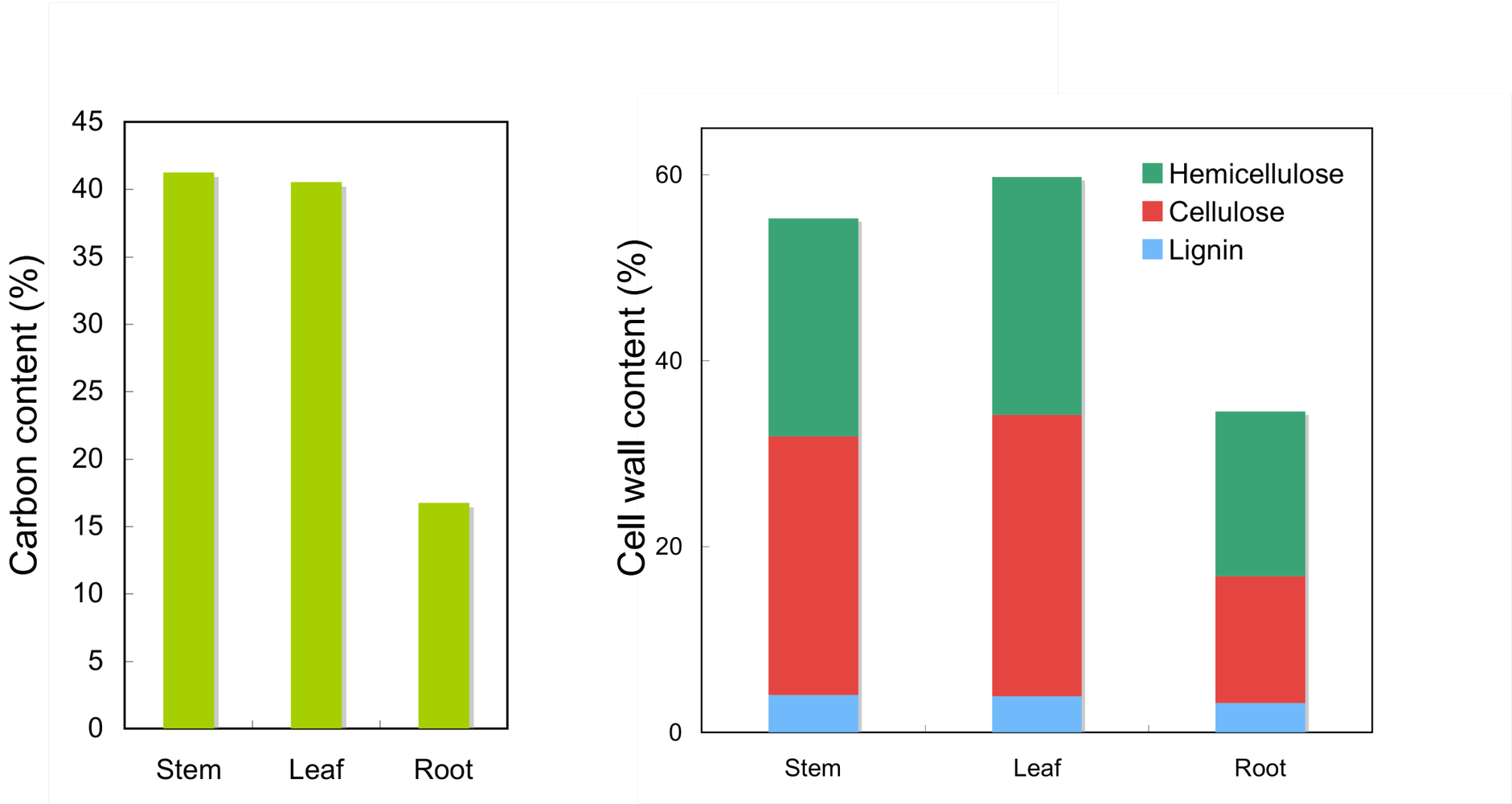
The total released carbon as the gas between the experiment days (25 d) was 191 mgC from the soil including stem, 144 mgC from leaf and 66.8mgC from root.

Changes of total carbon amount of the soil



- The total carbon amounts of the soil were analyzed. The total carbon of the bottle including stem or leaf were decreased.

Carbon content and composition of the rice straw and root



- Carbon content of root was the lowest in three fractions. But, lignin content of the root was almost same as stem or leaf. This is the reason why root was most refractory to degradation.

Conclusion

We investigated the degradation of three fractions of matured rice plant (stem, leaf and root) in paddy soil. The results obtained two experiments showed that stem and leaf are relatively easily degraded to CO_2 and methane by microorganisms in the paddy soil. Root was the most refractory to degradation.

The carbon content of the root was the lowest in three fractions. But, lignin content of the root was almost same as stem or leaf. This is the reason why the root was most refractory to degradation.

An experiment is currently underway to clarify the fraction-specific changes in the composition of organic matter due to degradation of rice plant, in which composition and carbon contents of gas released from paddy soil will be determined using C-13 enriched rice straw buried in the paddy field.

The study was conducted under contract with Aomori Prefectural Government, Japan.

Methanogenic degradation of rice plant buried in paddy soil

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