学位論文内容の要旨

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学位論文題名

Effect of organic amendment on soil carbon dynamics in agricultural ecosystems

（農地土壌生態系における有機物投入が土壌炭素動態に及ぼす影響）

Soil carbon (C) contents and dynamics are important in the maintenance of agricultural soil health. Organic amendments (e.g. crop residue and organic manure) are known as materials to increase soil C in agricultural ecosystems. The degradation of organic amendments and physical disturbance of soils, performed by the faunal communities, can alter soil microbial community, and thus influence the rates of the C cycles. However, little is known about the soil biological community (i.e. soil fauna and microbes) interactions and soil C dynamics. Hence, the objectives of this research were (1) to investigate the effects of two types of earthworms on CO_2 emissions and microbial biomass during the organic material decomposition, (2) to quantify the interaction between soil C dynamics and microbial community changes after organic amendments in two agricultural soils in Zambia and (3) to determine the effects of organic amendments on above-ground ecosystems in two agricultural soils in Zambia

This first experiment measured the changes in CO_2 emissions and soil microbial biomass C (MBC) during the decomposition of barley grains, with and without the presence of one of two major species of earthworms (*Metaphire Hilgendorfi* and *Eisenia Fetida*). After 32 days incubation, *M. hilgendorfi* had a potential to accumulate MBC and nitrate-nitrogen (N), compared to *E. fetida*. The result suggested that the interaction between soil microbes and earthworm is influenced by the earthworm species, consequently influencing the soil C and N dynamics.

The second experiment focused on how organic amendments influence C dynamics and microbes in C depleted agricultural soils in Zambia. We conducted a field experiment using different organic amendments (e.g. cattle manure, poultry manure etc.) in two locations, characterized by a sandy loam soil and a loamy sand soil, in Zambia. A split-plot design was applied with crop types (cassava, maize, soybean and control (bare)) as

the main treatment and the soil amendment types (chemical fertilizer, cattle manure, poultry manure, maize residue, and control) as the subplot factors. The results indicate that in the loamy sand soil, organic amendments altered microbial activity, regarding diversity and abundance, but might not have a major impact regarding the C sequestration in the soil. Contrastingly, the effects of the organic amendments on microbial activities in the sandy loam soil were minor. Factors such as soil texture and moisture ranges controlled the impacts of organic amendments on soil C cycle and bacterial communities.

Finally, the third experiment investigated the changes in above-ground biomes after organic amendments in two different soils in Zambia (same treatments of second experiments). The results showed that the total number of soil fauna in each site was totally different; we found around 1000/200 individuals at sandy loam soils/sandy loam soils. Organic amendments had no significant effects on cassava and maize yields in sandy loam soils, whereas maize residue significantly increased soybean. Loamy sand soils had positive effects of organic amendments on crop yield except maize. Based on the results, organic amendments might have indirectly (soil fauna) influenced soil C dynamics in sandy loam soils, while directly influenced in loamy sand soils due to lack of C sources.

This study indicates that the response of organic amendments is markedly influenced by soil biological community. Those different response consequently influenced soil C dynamics and agricultural production. To maintain/increase soil C in agricultural systems, the factors affecting the soil biological community must be taken into account.