STUDIES ON CARBON AND NITROGEN DYNAMICS IN SUBMERGED RICE SOIL AS INFLUENCED BY ELEVATED ATMOSPHERIC CO_2 CONCENTRATION

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Abstract

Three level experiments were carried out to study the effects of elevated CO_2 on the carbon and nitrogen dynamics in submerged rice soil. The first experiment was carried out in the laboratory to understand the effect of elevated CO_2 and temperature on carbon and nitrogen dynamics, especially changes in microbial biomass and methane emission from submerged rice soil microcosms without rice plant using four closed chambers. Secondly, six computer-controlled greenhouse chambers (Climatrons) were used to determine biological nitrogen-fixation activity, methane oxidation and carbon mineralization as influenced by elevated CO_2. Lastly, I participated in the world's first rice FACE (free-air CO_2 enrichment) experiment in the field located at Shizukuishi, Iwate, Japan to elucidate the methane dynamics and nitrous oxide emission from rice soil as influenced by the enrichment of CO_2.

The results indicated that elevated CO_2 has an indirect effect on the carbon and nitrogen dynamics giving rise to a positive effect on roots of rice plant and algae growth on soil surface. Elevated CO_2 increased the chlorophyll-type compounds in surface soil and led to change in redox condition of the soil. Hence, the methane oxidation and nitrification were increased in the surface layer by elevated CO_2.

Effect of elevated CO_2 were found to be positive in terms of the size of microbial biomass C in soil through increasing algae growth and roots exudates and secretion, while the change in biomass N was not clear. The carbon and nitrogen mineralization of the soil was accelerated by elevated CO_2 due to the increasing soil microbial biomass and probably its faster turnover.

Elevated CO_2 and temperature accelerated methane production in the soil with added rice straw. However, it reduced the methane emission to the atmosphere in the ecosystem without rice plant or at the early period of rice cultivation, but increased that at the later stage of rice growth.

Finally, it is recognized that growing rice plant and algae in the soil ecosystem with elevated atmospheric CO_2 concentration act as a sink for carbon.