B-51.2.3 Studies on CH_4 and N_2O emission from tropical arable land, and fertilizer management

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Total Budget for FY1998 4,000,000Yen

Abstract

The final goal of the research project is to estimate the amount of N_2O emitted from the tropical cultivated soils and to develop mitigation alternatives. Before this project, another project which had same goal, had been carried out from FY 1995 to FY 1997. In addition to the results of the former project, we clarified N_2O emission from upland fields' soil in Thailand through a year.

As hopeful mitigation alternatives, the effects of a controlled availability fertilizer and a chemical nitrogen fertilizer amended with a nitrification inhibitor (AM: 2-amino-4-chloro-6-methyl pyrimidine) on mitigation of nitrous oxide emission from soil were surveyed by pot. Those fertilizers reduced N_2O emission compared with urea.

Key Words Nitrous oxide, Greenhouse gas, Upland fields' soil, the Tropics, Mitigation alternatives

1. Introduction

Nitrous oxide (N_2O) concentration in the atmosphere is 311ppbv in 1992. It increased at 0.75ppbv per year from 1980 to 1990[1)]. It is said that this increase may contribute to the global warming from a few to 10 percent. According to IPCC, it is estimated that about 40 percent of N_2O sources are anthropogenic. It is estimated that cultivated soils share about 60 percent of the anthropogenic souces[1)]. Now, many symptoms of the global warming are appearing. So, it is necessary to estimate collect amount of N_2O emission from cultivated soils and to develop mitigation alternatives. However, such studies are quite few in Asia, so we need to promote these studies in this region.

2. Research Objective

The final goal of this research project is to estimate the amount of N_2O emitted from the tropical cultivated soils and to develop mitigation alternatives. Before this project, another project which had same goal was carried out from FY 1995 to FY 1997.

Experimental fields were prepared in Thailand and collaborative research with Thai researchers was done. In this year, remaining uncertain points were tried to clarify N_2O emission from upland fields' soils in Thailand through one year. Nitrous oxide emission from the beginning of rainy season to land preparation for corn was measured at two experimental sites (Khon Kaen and Nakhon Sawan). In addition, N_2O emission from ridge and furrow was measured through crop season.

About mitigation alternatives, a controlled availability fertilizer (coated urea) and a chemical nitrogen fertilizer amended with a nitrification inhibitor were tried. Such fertilizers were too expensive for farmers in developing countries at present. Even in developed countries, mitigation alternatives are not in practice so much. So, these fertilizers' effects on N_2O emission were surveyed by a pot experiment in Japan.

3. Method

3.1 Measurement of N_2O emission from upland soils in Thailand

Experimental fields were prepared at Khon Kaen and Nakhon Sawan. Khon Kaen's soil was acid sandy soil and Nakhon Sawan soil was calcareous clayey soil. Nitrous oxide emission from the beginning of rainy season to land preparation for corn was measured. In addition, the emission from ridge and furrow was measured through following crop season.

Two plots with an individual size of $36m^2$ were set up in triplicates at the two experimental sites (Figure 1). Nitrogen fertilizer was applied into ditch of one plot (75kg N /ha at Khon Kaen, 62.5kg N /ha at Nakhon Sawan). Nitrogen fertilizer was not applied into the other. Nitrous oxide flux was measured using a closed chamber[2] that had a cross sectional area of $0.144m^2$ (0.38m x 0.38m) and a height of 0.2m. Gas samples were taken at 0, 15, 30 minutes after the chamber were placed on the fields and were poured into vacuumed vials. The concentration of N_2O was determined using a gas chromatograph equipped with a ^{63}Ni electron capture detector. Nitrous oxide emission fluxes were calculated from the change in the concentration inside chambers.

3.2 Mitigation of N_2O emission by the use of a controlled availability fertilizer and a chemical fertilizer amended with a nitrification inhibitor

Pots that had an area of $0.05m^2$ and depth of 0.295m were filled with Andisol (Figure 2). Each fertilizer such as urea coated with polymer of olefin, a chemical nitrogen fertilizer amended with AM (2-amino-4-chloro-6-methyl pyrimidine) and urea were applied into the pots and sweet corn was cultivated. In addition to them, the pots without nitrogen fertilizer with sweet corn and the pots applied with controlled availability fertilizer without sweet corn were prepared. These pots were kept in a greenhouse and soil moisture contents were kept constant by irrigation several times per week. Nitrous oxide emission from those pots was measured by the closed chamber method, two or three times a week for 80 days.

4. Results and discussion

4.1 Measurement of N_2O emission from upland soils in Thailand

Nitrous oxide flux at the beginning of rainy season was not different from that of following crop season at no-nitrogen plots both in Khon Kaen (Figure. 3) and Nakhon Sawan. It was expected that readily decomposable organic matter might accumulate in soil during dry season. N_2O emission might become large because soil micro organisms become active using such accumulated organic matter at the beginning of rainy season. However, the results showed such phenomenon is limited and N_2O flux was not significantly different from the following period as whole. The average N_2O flux from the very beginning of rainy season to the harvest at upland soil where nitrogen fertilizer was not applied was 12.2 $\mu gN_2O\text{-}N\ m^{-2}hr^{-1}$ at Khon Kaen and 8.6 $\mu gN_2O\text{-}N\ m^{-2}hr^{-1}$ at Nakhon Sawan. In corn production period, N_2O emission from furrow at the fertilized plot was smaller than that from ridge and larger than that from ridge of control (no-nitrogen) plot, both at the two sites.

Reliable estimation of the amount of N_2O emission from uplands' soil in tropical savanna become possible from the results of this study and the results of another study carried out from Japanese fiscal year 1995 to 1997 funded with Environmental Agency, Japan. The total amount of N_2O emission was divided into three parts.

① Nitrous oxide emission caused by nitrogen fertilizer application during the same rainy season when fertilizer was applied

② Nitrous oxide emission in rainy season except for ①

③ Nitrous oxide emission in dry season

4.2 Mitigation of N_2O emission by the use of a controlled availability fertilizer and a chemical fertilizer amended with a nitrification inhibitor

The order of total amount of emitted N_2O through 80days was urea > the coated urea (without sweet corn) > the coated urea > the chemical fertilizer amended with AM > no N (Figure. 4). Those amounts were different with 99% level of significance. It was concluded that AM reduced the ratio of nitrous oxide production through nitrification whenever plant grew or not. It was supposed that reduction of nitrous oxide emission caused by decrease of nitrite concentration in the soil. Controlled availability fertilizer decreased nitrous oxide emission from soil where sweet corn grew. Without plant, the effects of the controlled availability fertilizer on reducing nitrous oxide were limited.

5. Reference

1) IPCC:CLIMATE CHANGE 1994, p13, Cambridge University Press (1995)

2) Dojo kankyo bunsekihou hensyu iinkai hen: Dojo kankyou bunsekihou, p133-138, Hakuyusha, Tokyo (1997)

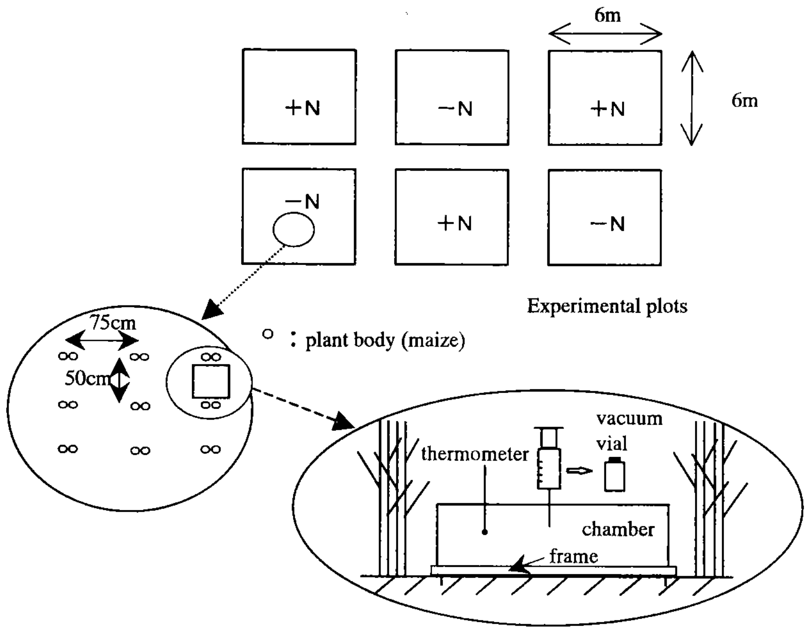

Figure 1. Schematic illustration of the experimental plots, the chamber and sampling system used for the experiment.

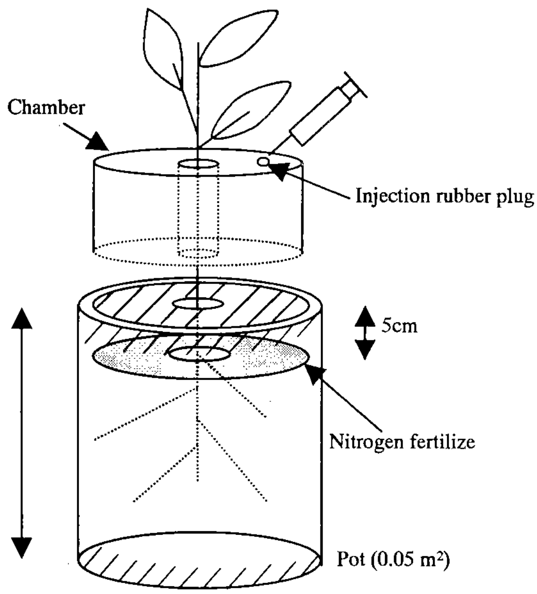

Figure 2. Pot and chamber for the experiment

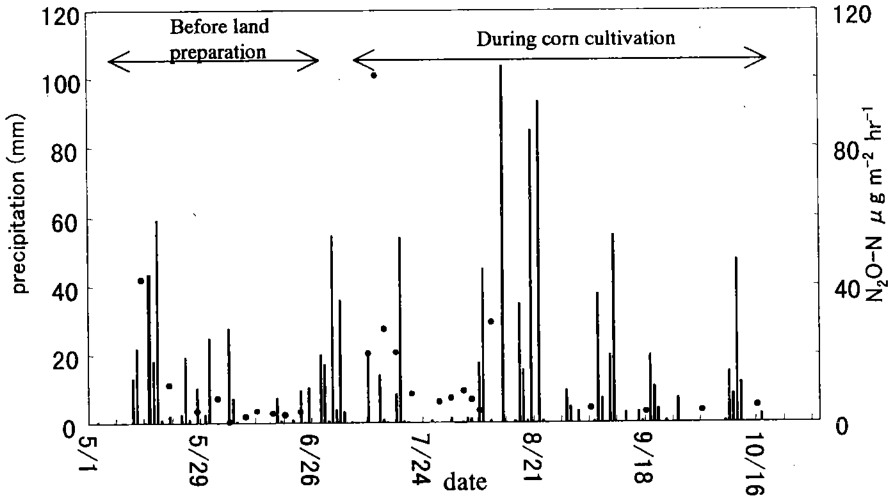

Figure 3. The change of nitrous oxide flux (dot) and precipitation (bar) at Khon kaen

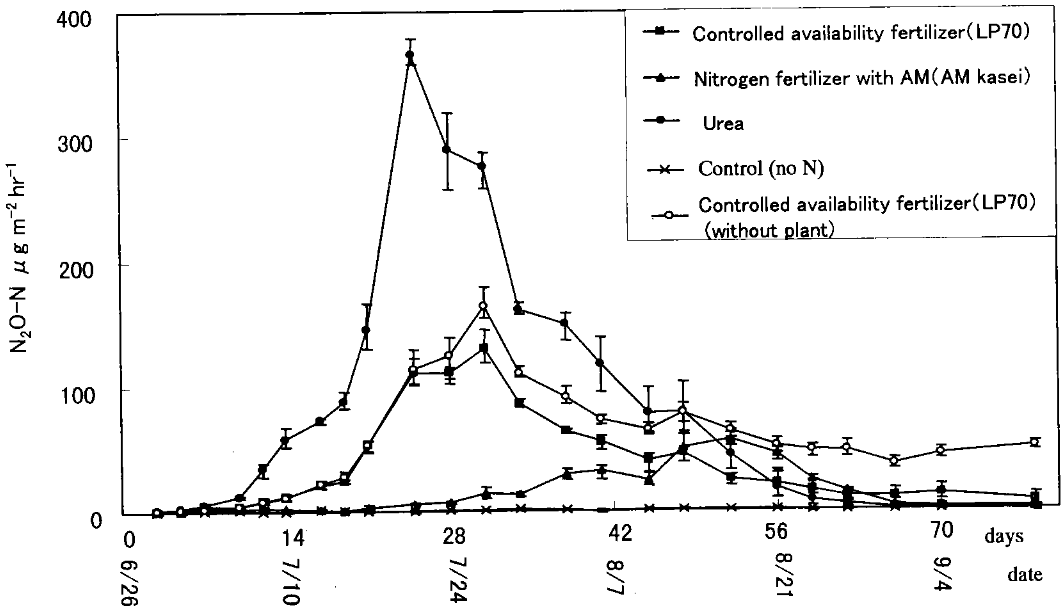

Figure 4. The change of nitrous oxide emission from pot soil applied with each nitrogen fertilizer

(Bar means the range of triplicates measurement.)