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Influence of Soil and Air Temperature on the Diel Change of Methane Emission in a Korean Paddy Soil incorporated with Rice Straw

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볏짚을 施用한 논土壤에서 土壤溫度 및 氣溫이 메탄排出의 日中變化에 미치는 影響

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ABSTRACT

Methane emission was measured every two hours for a whole day at heading stage of rice plantsby using a closed static chamber installed in NPK(11-70-80 kg/ha) plot and NPK+rice straw(5 ton/ha) plots. The effect of air and soil temperature on methane emission was studied.

In NPK plot the diel change of methane emission was synchronized better with soil temperature than air temperature because of abrupt rise of air temperature from 11 : 00 to 17 : 00 hours.

In NPK+rice straw plot diel methane emission showed proportionally increased with increase of soil temperature except for times from 11 : 00~17 : 00 hours when air temperature was very high, but showed a closer relation with change of air temperature.

It was suggested that the diel change of methane emission was closely related to that of air temperature where organic matter was abundant, while to that of soil temperature where organic matter was limited.

Key words : Methane emission, Paddy soil, Soil temperature, Air temperature, Rice straw, Diel change.

INTRODUCTION

There is considerable interest in factors which control fluxes of green house gas CH_4 into the atmosphere(Cicerone and Oremland 1988; Khalil and Rasmussen 1990). Methane emission measured from paddy fields showed two pecular characteristics such as diel change and seasonal change. Diel change of methane emission has been known to have relations to the change of soil temperature(Seiler et al. 1984; Holzapfel-Pschorn and Seiler 1986). It was reported that amount of methane emission was doubled when soil temperature increased from 20℃ to 25℃(Holzapfel-Pschorn and Seiler 1986) and also from 25℃ to 35℃ at 2 ㎝ of soil depth(Yagi and Minami 1993).

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Neverthless few approaches were made to study the effect of change of soil and air temperatures on the methane emission. The aim of this research was to study the effect of soil and air temperature on diel methane emission in rice paddy incorporated with or without rice straw.

MATERIALS AND METHODS

1. Cultivation of rice plant.

Rice seedlings(*Oryzae sativa* var. llpoombyeo) were transplanted both in NPK plot(N-P_2O_5-K_2O) : 110-70-80 kg/ha) and NPK+rice straw(5ton/ha) plot in Suwon, Korea in 1993. The properties of soil used and rice straw are described in a previous paper (Shin et al. 1995b).

2. Measurement of methane emission.

At heading stage of rice plants methane emission was measured every two hours for a whole day by using a closed static chamber(Shin and Kim 1994 ; Shin et al. 1995a). In brief, eight rice plants were transplanted in a polyacrylic plastic chamber of 60(L)×60(W)×100(H)cm. Gas samples were collected in 1ℓ Tedlar bags using a Personal air sampler(PAS, PAS-3000, Supelco Inc., USA). Flow rate of PAS was set 2ℓ/min. and inlet of PAS remained on for 5 seconds to remove the air in the stainless steel tubing of gas sampling port. A Tedlar bag was attatched to the outlet of PAS for 30 seconds and switch of PAS was turned off(samples at starting time). Two more samples were taken at 15 and 30 minutes after the start of sampling with the same procedure(samples at 15 and 30 minutes after start of sampling). Gas samples were analyzed using GC-FID (Varian Star 3400, USA) fitted with 6 port gas sampling valve(Valco Inc., Houston, Texas). PAS was connected to the outlet of gas sampling valve (GSV) and a Tedlar bag was attatched to the inlet of GSV. On/off valve of Tedlar bag was turned on and PAS was turned on for 15 to 20 seconds to fill the sample with gas sampling loop (GSV remained in load position). Pressure in the sampling loop of GSV was maintained at 760± 0.5 ㎜Hg using electronic mannometer(Modus MA2-050P, Modus Instrument Inc., USA) to inject the gas samples(GSV remained in inject position). Tedlar bags used for sampling in higher methane concentration such as rice straw applied plot were cleaned 2~3 times with clean air to avoid contamination. When measuring the methane flux, air and soil temperature at 5cm was simultaneously monitored.

RESULTS AND DISCUSSION

During monitoring the diel change of methane flux air temperature in the chamber ranged from 18.0 to 32.0℃ and soil temperature ranged from 20.8 to 24.5℃ at 5 ㎝ depth in NPK plot(Fig. 1). Methane emission followed with changes of soil temperature and also approximately followed the change of air temperature except for the period from 11 : 00 to 17 : 00 hours, when air temperature abruptly rose.

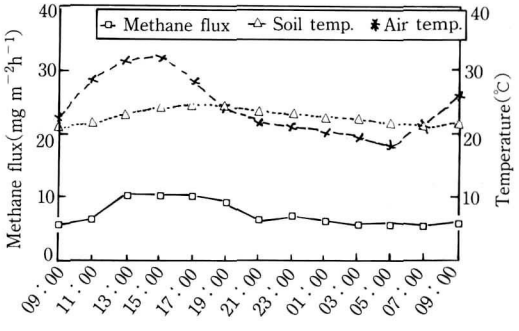

Fig. 1. Diel changes in methane flux, soil and air temperatures in NPK plot.

Air and soil temperature in the chamber of rice straw-amended plot ranged from 18.0 to 32.0℃ and from 21.1 to 24.5℃, respectively. Diel change of methane emission showed little relations with

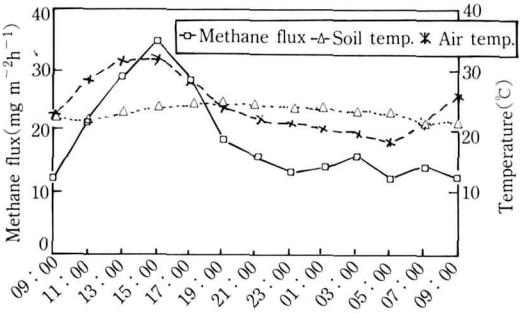

Fig. 2. Diel changes in methane flux, soil and air temperatures in rice straw-amended plot.

change of soil temperature, but showed a closer relationship with change of air temperature, as methane emission incresased during the times from 11 : 00 to 17 : 00 hours when air temperature abruptly increased(Fig. 2).

Methane emission in NPK plot showed linear regression with soil temperature which was expressed as $Y=-22.05+1.28X$ with 0.83 of highly significant correlation coefficient(Fig. 3). On the relationship between soil temperature and methane

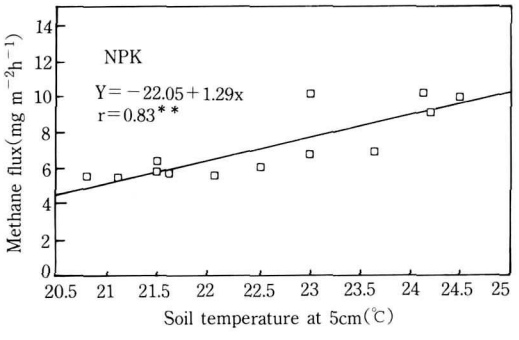

Fig. 3. Relationship between soil temperature and methane flux in flooded NPK plot.

emission, it was reported that methane emission was doubled when the soil temperature in depth of 1~15cm rose from 20℃ to 25℃(Schütz et al. 1989). And also from 25℃ to 35℃ at 2㎝ in soil depth(Yagi and Minami 1993).

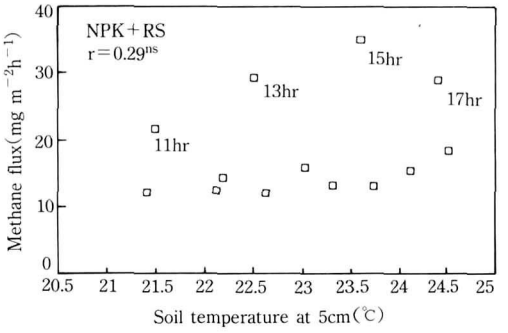

Fig. 4. Relationship between soil temperature and methane flux in rice straw-amended plot.

When whole data were used for computation methane emission was not correlated significant($r=0.29^{**}$), as methane emission between 11 : 00 and 17 : 00 hours was higher(Fig. 4).

Comparing Fig. 3 and Fig. 4, it could be considered that methane emission proportionally increased with increase of soil temperature except for mid of daytime when air tempearture was high and physiological process was vigorous.

Relations between air temperature and methane emission in NPK plot and NPK+rice straw plot are expressed as linear regressions $Y=-16.05+1.44X$($r=0.87^{**}$) and $Y=0.66+0.32X$($r=0.77^{**}$), respectively(Fig. 5).

More methane was emitted during the period from 11 : 00 to 17 : 00 hours under the condition of high temperature. Methane emission to the atmosphere was more vigorous in rice straw-amended plot where abundant organic substrate for methane production was present than in NPK plot where organic substrate was limited.

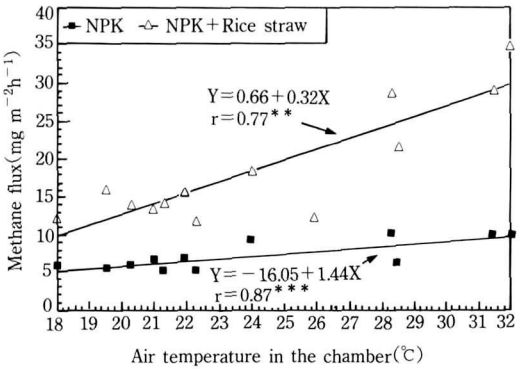

Fig. 5. Relationships between air temperature and methane flux in the chamber under flooded rice field.

This suggests that the diel change of methane be related to air temperature and availability organic matter in the soil besides the soil temperature.

Neue et al.(1994) found no change in methane flux and diel emission pattern when rice plants were cut in the water and diel change of methane flux was monitored They concluded that diel methane emission didn't depend on the metabolism of rice plants, but rather on the change of soil temperature at 2cm in soil depth with 7℃ difference. The difference of soil temperature at 5 cm in soil depth was 3.5℃ in our measurement which was lower than theirs.

摘　　要

볏짚을 사용한 구(볏짚 5톤+NPK : 110-70-80kg/ha)와 볏짚을 사용하지 아니한 구(NPK : 110-70-80 kg/ha)에서 벼의 출수기에 2시간 간격으로 메탄 배출량을 24시간 측정하고 地溫과 氣溫의 變化에 따른 相關關係를 고찰하였다.

1. 볏짚을 사용하지 아니한 三要素區에서는 메탄배출은 地溫의 변화와 상응하게 변화하나 기온 상승이 급격한 오전 11시부터 오후 5시까지는 메탄배출량이 기온상승에 부응하는 증가경향을 보이지 않았다.

2. 볏짚을 시용한 三要素區에서는 메탄 배출의 일변화 양상이 지온의 변화와는 상관이 적고 기온이 상승하는 오전 11시～오후 5시에 매탄배출량이 급격히 증가하여 기온의 변화와 상관이 깊어 보였다.

3. 메탄 배출에는 地溫 외에도 氣溫과 메탄생성의 基質이 되는 有機物의 存在가 중요함이 인정되었다.

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