EnvironmentAsia
The official journal published by the Thai Society of Higher Education Institutes on Environment

Available online at www.tshe.org/EA
EnvironmentAsia 1 (2008) 46-50

Influence of Distillery Slop on Methane Emission in Rice Paddies

Tasanee Thitakamol

Department of Environmental Science, Faculty of Science, Ramkhamhaeng University, Bangkapi, Bangkok 10240, Thailand

Abstract

Methane is a green house gas causing global warming. It is produced naturally during bio-fermentation under suitable anaerobic condition. When rice is grown in the tropics, there is some emission of methane. We studied the emission of methane during rice production in Thailand, in particular the effect of using of distillery slop on the rice fields. Release of methane was measured once a week for 18 weeks from plots using 4 different doses of distillery slop: 0, 125, 250 and 375 m^3/hectare, and 3 doses of chemical fertilizer: 0, 94 and 188 kg/hectare. The use of distillery slop did not significantly influence methane emission in the rice fields during any period of rice production. Furthermore, the measured quantities of methane were considerably lower than other sources of methane emission

Keywords: methane emission; distillery slop; rice

1. Introduction

Methane (CH_4) is a radiatively active trace gas constituting 12% of all the green house gases, while carbon dioxide (CO_2) amounts to 57%. However, methane has 25 times more infrared sorbing capability per molecule than carbon dioxide as a source of potential global warming (Rodhe, 1990), and the average life time in the troposphere is up to 10 years (Foley, 1990). Atmospheric methane concentration is currently increasing by approximately 0.5 % per year (Steele *et. al.*, 1992). Sources of methane include rice fields, cattle, landfill, and products from fossil energy. In agriculture, methane is produced from rice paddies which accounts for up to 20% of all methane produced in the earth (Foley, 1990). Previous estimates of global release rates of methane from rice paddies range from a low of 20 Tg per year to a high of 200 Tg per year. (Sass, 1992).

The area of Thailand is about 513,115 km^2 and rice paddies account for about 104,353 km^2, or about 20%. In this study we investigated the influence of distillery slop on methane emission in rice paddies in Khonkaen Province. The aim was to assess whether or not the utilization of distillery slop in rice paddies causes an increase in the emission of methane.

2. Materials and Methods

Materials

1. Rice seeds–Khao-Dawk Mali 105 produced at Khonkaen Rice Research Center, Khonkaen Province, Thailand.
2. Distillery slop - 16.2 m^3. was used for the experiment.
3. Chemical fertilizer 16-16-8, Hau-voir-kan-thai brand, produced by Thai Central Chemical Public Co., Ltd., Bangkok, Thailand.
4. Tools for farming.
5. Tools for gas collection, consisting of gas collecting chambers of which 36 measured 60 x 60 x 40 cm with two sides open. These chambers were installed right in the rice field of each plots as the base. Six other chambers measured 60 x 60 x 50 cm with two sides open, and another 6 chambers were of the same dimensions but with only one side open. To collect a gas sample, a syringe was used to suck gas from the chamber and then transferred to a vaccutainer.
6. Gas Chromatography (GC). To analyse the emission rate of methane, 3.cm^3. of methane sample was injected into GC. The 99.99% pure nitrogen was used as the carrier gas. The emission rate was read from the integrator, Chromatopac model C-R6A.
7. Standard methane – to be used as a standard for calibration of the chromatograph.

Table 1. Amounts of slop and fertilizer distributed to the different fields.

Treatment combination	Amount of slop (m^3./ ha)	Amount of fertilizer (kg/ ha)
T1	0	0
T2	0	94
T3	0	188
T4	125	0
T5	125	94
T6	125	188
T7	250	0
T8	250	94
T9	250	188
T10	375	0
T11	375	94
T12	375	188

2.2. Methods

Paddy fields were prepared and divided into 36 plots within 3 blocks, each comprising 24 m^2 as shown in Fig. 1. The amounts of slop and fertilizer distributed to the different fields are given in Table 1. These treatment combinations were randomly allocated in each experimental plot within each block as shown in Fig. 1. The growing of rice in the paddies may be divided into four periods, *viz.*, the pre-planting to panicle initiating period (the first 9 weeks), panicle initiating to panicle period (4 weeks), panicle to harvesting period (4 weeks) and post-harvesting period (1 weeks).

The rice was planted by hand with one kilogram of seeds on a seedbed field of 0.16 hactare. Then distillery slop was placed on all plots, except the control plots. Thereafter, natural water was pumped into the plots and mixed well. The plots were then left idle for 4 weeks. At hand planting, 3 seedlings were planted at a distance of 20 x 20 cm. Fertilizer was applied: 2/3 the amount at 35^{th} day and 1/3 at 70^{th} -80^{th} day after planting. Maintenance was carried out as well as water control and insecticide control when necessary. Every week for 18 weeks five samples of gas from each plot were collected and analyzed by gas chromatography for methane emission rate, making a total of 3,240 samples for a year of planting.

Statistical analysis was carried out using the Analysis of Variance method for the Factorial in Randomized Complete Block Design with IRRI STATISTICS VERSION 3.1 program.

3. Results

Methane emission in the experimental plots (Tables 2, 3, 4, 5) show that application of distillery slop did not significantly affect methane emission during any period. This was the case also when various amounts of chemical fertilizer were used. However, the amount of methane emitted was different at each stage of the growth.

During the pre-planting to panicle initiating period, the emission rate averaged 140 mg/m^2/day and increasing to 215 mg/m^2/day during the panicle initiating to panicle period, then declining to 193 and 30 mg/m^2/day during the panicle to harvesting period and the post-harvesting period, respectively. Figure 2 shows the average emission rate of methane emission weekly and Fig. 3 illustrates the amount of total emission throughout planting season.

After scrutinizing the data of dosages and the amount of methane emission and comparing to the number of rice plants, weight of dry straw, and rice production (Table 6), it is found that the methane emission is positively correlated to the growth and the production of rice, in that application of distillery slop of not more than 125 m^3./hectare provides the maximum growth and rice production, whereas application of distillery slop not more than 125 m^3/hectare causes the maximum methane emission.

4. Discussion

Result of the analysis on the rate and amount of methane emission from rice paddy in the experimental plots indicates that methane emission is correlated to the rice plant growth and rice production. Thus,

Block 2	
T9	T4
T11	T3
T10	T6
T8	T5
T1	T7
T2	T12

Block 1	
T5	T8
T11	T4
T7	T12
T2	T9
T3	T10
T1	T6

Block 3	
T6	T1
T12	T8
T11	T7
T2	T4
T3	T10
T9	T5

Figure 1. Distribution of plots within the three blocks of soil.

Table 2. Methane emission rate(mg/m^2/day) during pre-planting to panicle initiating period.

Distillery slop dose (m^3/ hectare)	Chemical fertilizer (kg/hectare)			Average
	0	93.75	187.50	
0	187	150	154	164
125	110	138	154	134
250	91	129	136	119
375	145	125	161	144
Average	133 a	135 a	151 a	140

CV = 34.7% LSD (.05) 2-FxS = 82

Table 3. Methane emission rate(mg/m^2/day) during panicle initiating to panicle period.

Distillery slop dose (m^3 / hectare)	Chemical fertilizer (kg/hectare)			Average
	0	94	188	
0	231	221	249	233
125	267	204	205	225
250	157	213	250	207
375	176	207	204	195
Average	207 a	211 a	227 a	215

CV = 27.3% LSD (.05) 2-FxS = 100

Table 4. Methane emission rate(mg/m^2/day) during panicle to harvesting period.

Distillery slop dose (m^3 / hectare)	Chemical fertilizer (kg/hectare)			Average
	0	94	188	
0	183	180	184	182
125	152	201	220	191
250	179	164	267	203
375	211	159	216	195
Average	181 a	176 a	222 a	193

CV = 39.1% LSD (.05) 2-FxS = 128

Note: Average values within the same line are not significantly different

Table 5. Methane emission rate(mg/m^2/day) at post-harvesting period.

Distillery slop dose (m^3 / hectare)	Chemical fertilizer (kg/hectare)			Average
	0	94	188	
0	34.1	10.4	24.4	23.0
125	43.5	14.5	31.1	29.7
250	27.8	43.8	12.6	28.0
375	44.6	22.0	56.7	41.1
Average	37.5 a	22.7 a	31.2 a	30.4

CV = 67.9% LSD (.05) 2-FxS = 35.0

Note: Average values within the same line are not significantly different.

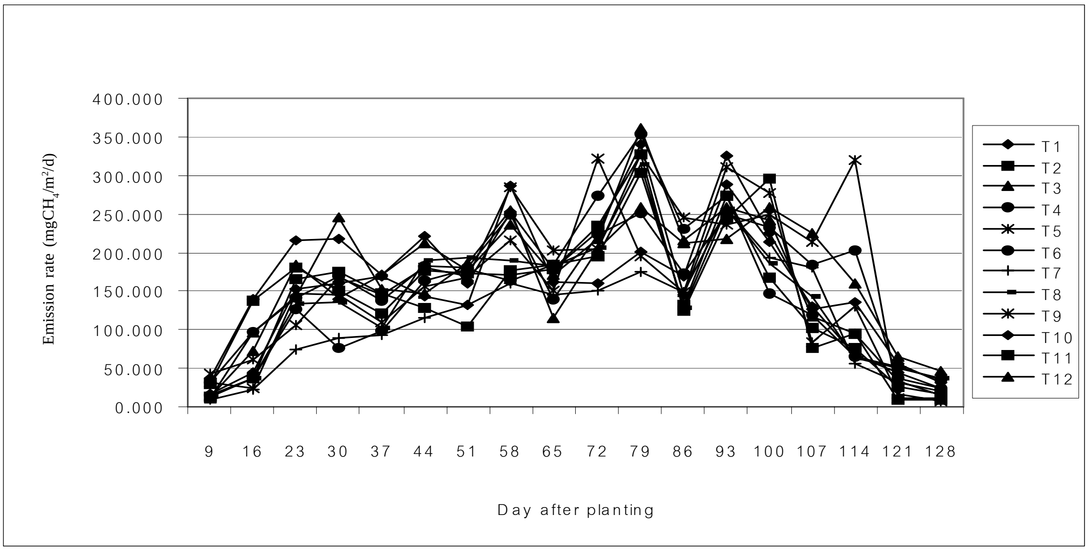

Figure 2. Average rates of methane emission based on weekly measurement throughout planting season.

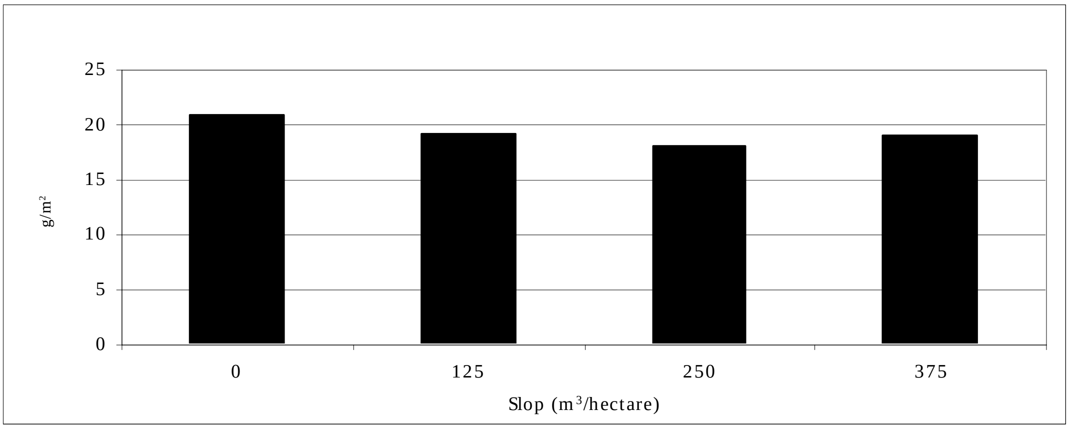

Figure 3. Amount of methane emitted throughout planting season.

applying not more than 125 cubic meter per hectare of distillery slop resulted in the highest plant growth and rice production. This was also the condition which resulted in the highest methane emission. However, the amount of methane emission measured in this experiment is relatively low compared to other sources of methane emissions. For example, Niwat *et.al.*,1999 has reported the amount of 20.1 g/m^2 methane emission throughout planting season. It is concluded that the application of distillery slop on rice paddies does not cause any significant increase of methane emission above the normal natural amount.

Table 6. Emission rate and amount of methane, number of plant, weight of dry straw and rice production.

Distillery slop dose (m^3/hectare)	Ave.rate of emission (mg/m^2/day)	Amount of gas emitted throughout planting season (g/m^2)	Number of* plant per m^2	Weight of* dry straw (kg/hectare)	Rice* Production (kg/hectare)
0	186	20.9	148	5,740	3,446
125	171	19.2	173	6,862	3,838
250	162	18.2	171	5,833	3,126
375	170	19.0	158	5,721	3,211
Average	172	19.3	163	6,039	3,405

* From Thitakamol and Kaewpinthong (2004)

References

Foley G. Global Warming: Who Is Taking The Heat?. The Panos Publications Ltd., UK. 1990.

Niwat C, Chitnucha, Pisit P, Laddawan K, Prayod C. An International Research Program on Methane Emissions from Rice Fields. P. 80-99. *In* Proc. of the 2542 Annual Technical Conference on Rice and Cereal in Temperate Zone. Prachinburi Rice Research Center, Department of Agriculture, Ministry of Agriculture and Cooperatives, Thailand. 1999.

Rodhe H. A Comparison of the Contribution of Various Gases to the Greenhouse Effect. *In* Science, 248, Stockholm University Press, Sweden. 1990;1217-19.

Sass RL. Short Summary Chapter for Methane. *In*: CH_4 and N_2O Global Emissions and Controls from Rice Fields and Other Agricultural and Industrial Sources. (Eds: Minami KY, Mosier A, Sass RL) Proceeding of an International Workshop: Methane and Nitrous Oxide Emission from Natural and Anthropogenic Sources and Their Reduction Research Plan, Tsukuba, Japan.1992;1-7.

Steele LP, Dlugokencky EJ, Lang PM, Tans PP, Martin RC, Masarie KA. Slowing Down of the Global Accumulation of Atmospheric Methane During the 1980s. *Nature* 1992; 358:313-16.

Thitakamol T, Kaewpinthong S. A Research Report on Utilization of Distillery Slop for the Rice Production in Khonkaen Province. Research report submitted to National Research Council of Thailand. Bangkok, Thailand. 2004.

Received 20 November 2007
Accepted 14 January 2008

Correspondence to
Mrs.Tasanee Thitakamol
Department of Environmental Science,
Faculty of Science, Ramkhamhaeng University,
Bangkapi, Bangkok, Thailand 10240.
Email: thitakamol_t@hotmail.com
Telephone: 6681-450-5474