METHANE EMISSION FROM POWDER ORGANIC FERTILIZER AND GRANULE ORGANIC FERTILIZER IN PADDY FIELD

Sasidhorn Buddhawong[1*], Sivawan Phoolphundh[2], Sawanya Junbang[1] and Soydoa Vinitnantharat [1]

School of Energy, Environment and Materials[1], Faculty of Science[2],

King Mongkut's University of Technology Thonburi, Bangkok, Thailand

[*]sasidhorn.bud@kmutt.ac.th

ABSTRACT

This research aims to estimate the quantity of methane emission from paddy field from using powder organic fertilizer (P) and granule organic fertilizer (G) at Donkrabuang, Photharam District, Ratchaburi Province for being way in finding greenhouse gases releasing as data in applying for reducing greenhouse gases releasing from paddy field farming in Thailand. The study was divided into two parts. First part, there was an analytical of nutrient elements of powder organic fertilizer and granule organic fertilizer. Second part was comparative study of greenhouse gas emitted from the paddy field which was applied with powder organic fertilizer and granule organic.

It was found that powder organic fertilizer and granule organic fertilizer contains number of useful nutrients quantity and meets the standard criterion of organic fertilizer. Methane emission was measures in two paddy field area, which were planted with Thai rice "Ruang-Pra-Thew 123". One was applied with powder organic fertilizer and the other was applied with granule organic fertilizer. Gas emission sample were collected once a week during the period of rice growth using Static Box Technique and further analyzed with Gas Chromatography. Results of methane emission rate in rice field applied with powder organic fertilizer are in the range of 3.27 – 11.52 mg/m^2.h and gave rice production of 505.6 kilograms/rai. Whereas methane emission rate in rice field applied with granule organic fertilizer are in the range of 2.94 – 10.03 mg/m^2.h and gave rice production of 563.2 kilograms/rai.

1. INTRODUCTION

Rice production is one of the most important crops in Thailand. Since the globalization causes change in social and economy of the world and Asian country, life style of the people is also changed. Farmers in many places have changed their occupations, such as change from rice field to rubber tree, palm oil and other fruit productions. The rice field is decreased continuously, on the contrary to an increase of rice demand. As wetland rice fields have recently been identified as a major source of atmospheric methane. Although the potential for methane release from rice fields has long been noted (Harrison & Aiyer, 1913; Neue, H. 1993.). Of the wide variety of sources of atmospheric CH4, rice paddy fields are considered one of the most important. The Intergovernmental Panel on Climate Change (IPCC, 1996) estimated the global emission rate from paddy fields at 60 Tg/yr, with a range of 20 to 100 Tg/yr. This is about 5-20 per cent of the total emission from all anthropogenic sources. This figure is mainly based on field measurements of CH_4 fluxes from paddy fields in the United States, Spain, Italy, China, India, Australia, Japan and Thailand (IPCC, 1996). There were many studies of techniques increasing rice production with decreasing of methane emission. Fertilizer application techniques are also studied with expecting results of decrease of greenhouse gas emission. Therefore, this study focused on methane emission reduction with application of different type of organic fertilizer.

2. EXPERIMENT

2.1 Experimental Design

This research studied methane emission ratio in paddy fields using granules organic fertilizer compared to the powder organic fertilizer. The experimental rice fields were conducted at Donkrabuang, Photharam District, Ratchaburi Province. There are two experimental rice fields with dimension of 5 x 5 m^2. The rice, Leuang Pratew 123, was planted in the rice field during September 2, 2012 until November 23, 2012.

2.2 Application of organic fertilizer

Organic fertilizer used in this study was brought from Maesot, Tak Province. Ingredients of organic fertilizer are made of bagasse and excrete of bat. It was used as powder organic fertilizer (P) and was produced as granule organic fertilizer (G) by mixing with clay and extruded to granules. Rice cultivation was grown and watered in traditional locally way. The first experimental rice field was applied with powder organic fertilizer (P) and the second was applied with granule organic fertilizer (G).

3. ANALYSIS

3.1 Methane emission analysis

Methane flux measurements were carried out once a week. The initial methane sampling was conducted on the duration rice age of 60-142 days. The static box techniques were used to trap gas emitted from plant and from soil. The static box was made of acrylic with dimension of 0.3 m width x 0.3 m length x 1.0 m height. There is a drilling the hole for thermometer to measure the temperature. Gas samples were taken through a sampling port fitted at the side of the chamber by using 10 ml tight plastic syringes at the time of 0, 5, 10 and 15 minute after placement of static box. At the time period of each gas flux sampling, plant height, depth of water, and height of static box all sides were recorded. Then, gas samples were analyzed for methane concentration with a Gas Chromatograph (Shimadzu model GC 14 B) with a unibead-C column equipped with Flame Ionization Detector (FID). The chromatographic operating conditions used for the gas samples determination were as follows; column temperature:100ºC, Injection temperature:120ºC, FID detector temperature:300ºC, Carrier gas (He) flow:65 ml min^{-1}, Injection:0.5 ml.

3.2 Organic fertilizer

Both powder organic fertilizer (P) and granule organic fertilizer (G) were analyzed for their components according to the official methods of analysis of fertilizer standard (Horwitz, W. & Latimer, G.E., 2005). Conductivity, pH, organic matter content (Walkley and Black), total nitrogen (Kjeldahl method), available phosphorus (Bray II), available potassium (Flam photometer), calcium and magnesium (Atomic absorption spectrophotometer).

4. RESULTS

4.1 Component of organic fertilizers

Results of macronutrients and micronutrients concentrations in the organic fertilizer were varied as shown in Table 1. These fertilizer contained available nutrients and met the fertilizer standard concentration. Their nutrient and C/N ration of both P and G were not significantly different, but they were different in the size and character.

Table 1 Component of powder organic fertilizer (P) and granule organic fertilizer (G) compared to the standard.

Parameters	P	G	S
Moisture content (%)	13.28	4.04	<35
pH	7.63	6.42	5.5-8.5
Conductivity (ds/m)	3.20	5.23	<6
Organic matter (%)	20.99	20.94	>1.5
Total N (%)	1.66	1.31	>1
C/N ratio	12.64	15.98	≤ 20:1
Available P (% P_2O_5)	2.91	4.90	>0.5
Available K (% K_2O)	0.95	2.16	>0.5
Ca	2.82	29.21	-
Mg	0.63	1.68	-

4.2 Methane emissions from rice fields

According to the rice growth period in the rice field applied with organic fertilizer, CH_4 emission was found in the 3 growth period. The first CH_4 emission was found at the vegetative growth of rice age of day 60 (Fig.1). The rice field G (Granules organic fertilizer) emitted the strongest methane emission at 66 days (10.03 mg/m^2/h). It was higher than what found in the rice field P (Organic fertilizer powder), which showed the strongest methane emission at day 73 with value of only 7.00 mg/m^2/h. Higher values of methane may come from the high organic carbon in the soil and was used by bacterial growth resulting in an increase of methane gas.

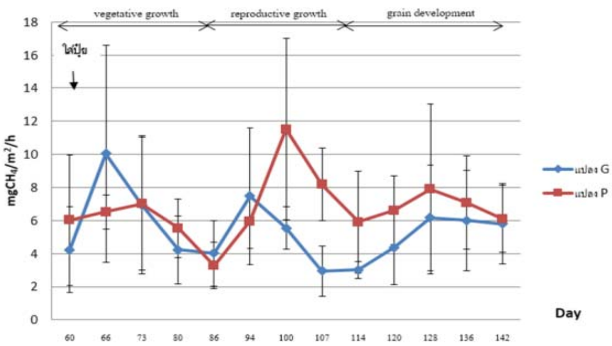

Fig. 1 (a) Methane emission in three different rice growth periods (vegetative growth, reproductive growth, grain development) in the rice field applied with powder organic fertilizer (P) and granule organic fertilizer (G)

The second phase of reproductive growth, methane was found at the rice age of day 94. It is suitable for the growth of the bacteria to produce methane. [1] After that, the methane emission was decreased at the rice age of 107-114 days, which is in the period of development of rice grain. During this period, nutrients in soil was used up and decreased because there was no additional of organic fertilizer. Therefore, bacterial in soil produced less energy and the growth rate was decreased, which resulted in decreasing of methane production. An

emission of methane was increased again at the rice age of 120-128 days because the root exudates of rice, that released organic substances into the soil (Schutz et al.1989 (b), Butterbach-Bahl et al. 1997).
At the last growth phase-grain development, methane emission was reduced due to a period of rice growing until the readily for harvest (rice age of 128-142 day). There were because methane production in paddy field is proportional to the amount of organic food is microbial, therefore, the nutrients in soil was reduced. Due to cultivation management with no filling organic matter after the age of 60 days if rice, the precursor in the process of methane production was decreased and also resulted in decreasing of methane production.

4.2 Rice production

Grain yield of rice after harvest in field experiment G and P is shown in Table 2. Considering the yield of rice, it was found that the rice yield from the field applied with granules organic fertilizer was 563.2 Kg /Rai and with powder organic fertilizer was 505.6 Kg /Rai. There is no significant different in the rice yield managed with different organic fertilization methods.

Table 2 Rice production in the rice field applied with granule organic fertilizer (G) and powder organic fertilizer (P)

Rice field	Rice production (Kg/Rai*)
G	563.2
P	505.6

*Rai is a Thai measurement system. 1 Rai equals to 3.95 Acres.

CONCLUSION

Organic fertilizer in the form of powder organic fertilizer (P) and granule organic fertilizer (G) contains number of useful nutrients quantity and meets the standard criterion of organic fertilizer. Methane emission in the rice fields occurred in the field applied with powder organic fertilizer are in the range of 3.27 – 11.52 $mg/m^2.h$ and rice production was 505.6 kilograms/rai. Methane emission rate in rice field applied with granule organic fertilizer are in the range of 2.94 – 10.03 $mg/m^2.h$ and gave rice production of 563.2 kilograms/rai. It is useful in developing the management the ways of rice cultivation in order to reduce of methane emission from rice fields to the atmosphere.

REFERENCES

Butterbach-Bahl, K., Papen, H. and Rannenberg. H. Impact of gas transport through rice cultivars on methane emission from rice paddy fields. *Plant, Cell and Environment*, Vol. 20, pp.1175-1183, 1997.

Harrison, W. H., and P. A. S. Aiyer, The gases of swamp rice soil.1. Their composition and relationship to the crop. Memoires Department of Agriculture India Chemistry Series., vol. 5, no.3, pp. 65-104, 1913.

Horwitz, W. and Latimer, G.E. (eds.) Official method of analysis of AOAC international. 18th Ed., AOAC International Inc., Gaithersberg, MD, 2005.

IPCC, Guidelines for National Greenhouse Gas Inventories: Reference Manual, 1993.

Neue, H. Methane emission from rice fields: Wetland rice fields may make a major contribution to global warming. *BioScience*, vol.43, no.7, pp. 466-73, 1993.

Schutz H., Seiler W. and Conrad R. Processes involved in formation and emission of methane in rice paddies, *Biogeochem*, Vol. 7, pp. 33-35 1989b.

The National Institute of Agro-environmental Sciences. Official methods of analysis of fertilizers. 130 pp, 1987.

Sasidhorn Buddhawong received the Dr.rer.nat. (1978), M.E. (2004), in Chemistry from The University of Leipzig, Germany.

She is an Assistant Professor, Division of Environmental Technology, School of Energy, Environment and Materials. Her Current interests include bio-remediation, phytoremediation, waste treatment and utilization.

Sivawan Phoolphundh received the Dr.-Ing. (1997) degree in Environmental engineering from Karlsruhe University, Germany.

She is an Assistant Professor, Department of Microbiology, KMUTT. Her Current interests include biological wastes treatment, utilization and management; and clean technology.

Soydoa Vinitnantharat received the Ph.D. (1999) degree in Environmental Technology and Management from Asian Institute of Technology.

She is an Associate Professor, Division of Environmental Technology, School of Energy, Environment and Materials, KMUTT. Her Current interests include municipal and industrial waste treatment and utilization (Biological treatment, Adsorption).