Methane (CH_4) Emission Produced from Utilization of Trichocompost Bio Urine and Bio Slurry on Sweet Corn (*Zea mays* L. Sacharata) Field

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ABSTRACT
The increase in greenhouse gases emissions (CH_4) in the atmosphere will contribute to an increase in global warming. The increase in methane gas (CH_4) is related to the solid and liquid waste of beef cattle which is not used optimally by some farmers, so it tends to contribute to the increase in methane gas (CH_4). Therefore, it is necessary to conduct a study to reduce methane (CH_4) emissions through processing the solid and liquid waste into trichocompost, bio urine, and bio slurry as a source of organic fertilizer for sweet corn (*Zea mays* L. Sacharata). This study aimed to examine the pattern of greenhouse gas (GHG) emissions in the form of methane gases (CH_4) through the use of trichocompost, bio urine, and bio slurry on sweet corn (*Zea mays* L. Sacharata). This study used a Randomized Block Design (RBD) design with 4 treatment groups with 4 replications, each test consisted of 2 (two) experimental units. The treatment consists of a combination of inorganic fertilizers (SP36, KCL, Urea) and organic fertilizers (trichocompost, biourine and bio slurry). The treatments were as follows: (1) 100% inorganic fertilizer (Io_{100}) (2) 75% inorganic fertilizer + 25% organic fertilizer ($Io_{75}O_{25}$), (3) 50% inorganic fertilizer + 50% organic fertilizer ($Io_{50}O_{50}$), (4) Inorganic Fertilizer 25% + 75% organic fertilizer ($Io_{25}O_{75}$). Observed variables: the pattern of flux methane gas (CH_4) after the first and second fertilization and the emission of methane gas (CH). The results showed that the highest CH_4 flux in the first fertilization resulted from $Io_{75}O_{25}$ treatment, while in the second fertilization; the highest CH_4 flux production wasproduced in Io_{100} application and the lowest at $Io_{25}O_{75}$. The lowest CH_4 emissions produced werebythe$Io_{25}O_{75}$ treatment. The results showed that the usage of inorganic fertilizers (N-P-K) 25%,50%, 75% replaced with organic fertilizers (Trichocompost, Bio urine and Bio slurry) based on beef cattle 75%, 50%, 25% on sweet corn field (*Zea mays* L. Sacharata) could reduce methane (CH_4) emissions around 75%, 38.68% and 21.68%.

Keywords: *Global warming, fertilizer, emission, manure, beef.*

1. INTRODUCTION

Global warming is a current crucial environmental issue caused by the increase of greenhouse gases in the atmosphere. Methane gas (CH_4) is the second biggest greenhouse gases contributor in the global warming. Various sectors which have been identified as the global warming factors are to include industry, livestock, and agriculture activities. Methane heating toward the atmosphere is increasing by 1% every year, and livestock also contributes to methane gas emission around 3% among the greenhouse gases total.

Livestock contributes 24.1% of the greenhouse gases total emissions. Emission resulting from this sector is coming from the livestock digestion activities and livestock waste management [1]. Among livestock commodities, cattle is contributing more methane gas (CH_4) compared to other ruminants. The highest methane emission contributor in Indonesia is coming from the livestock subsector, where 65.12% comes from ruminants or around 58.84% from total methane gas emission contributed only by livestock commodities [2. On the other side, the agriculture sector emitted around 14%of greenhouse gases on a global scale and 7% on a national scale [3]. The agriculture field is one of the significant methane gas emitters due to several activities in this are commonly utilizing inorganic fertilizers. Farmers tend to use chemical fertilizer (inorganic) in running their business. The usage of inorganic fertilizer in a long term will bring a severe impact, such as the increase of greenhouse gases (one of them is methane) that contribute to global warming [4].

The situation described above is discussed the cattle breeding system where it has been running conventionally. Solid and liquid waste produced by the cattle is yet to be utilized in an optimum way by the farmers. If these wastes are being stacked and abandoned, they will pollute the environment. These liquid and solid wastes can be processed into organic fertilizers such as trichocompost, bio urine, and bio slurry. Trichocompost is an organic fertilizer that contains antagonist fungus, Trichoderma sp. Trichoderma has been identified to inhibit pests and diseases in plants since it acts as an antagonistic biological agency in several pathogen plants. Other than Trichocompost, urine is also can be used to be organic fertilizer. In processing the urine, fermented technology is necessary where bacteria involvement is able to transform the chemical substance into the organic substrate so it can be implemented direct nutrition for the plants. While bio slury is a potential organic fertilizer that contains many nutrients for the plant's growth, such as Nitrogen (N), Phosphor (P), Kalium (K), Magnesium (Mg), and Sulfur (S). Other than mentioned nutrients, liquid bio slurry also consists of amino acid, auxin hormone, and also cytokines [5].

Based on the problem statements above, a research has been conducted to study the effect of cattle's liquid and solid waste utilization in the form of trichocompost, bio urine and bio slurry as the resources of organic fertilizer toward the methane gases (CH_4) on the cornfield (*Zea mays* L. Sacharata).

2. MATERIAL AND METHODS

2.1. Materials

The research was conducted in the Pudak Community Economic Zone (KEM), Kumpeh Ulu Village, Muaro Jambi Regency, Jambi Province. The materials used in this study were sweet corn seeds (Bonanza F1), processed solid and liquid beef cattle waste (Trichocompost, Bio urine and Bio slurry, SP36, KCL, urea, dolomite, and blank data).The equipment used in this study was CH_4 gas capture chamber (50cm x 30cm x 25cm), 10 ml syringe, aluminum foil paper, thermometer, septum rubber, bubble wrap, used box, and storage drum.

2.2. Research Method

2.2.1. Land Preparation

The sweet corn plantations prepared in this study were 0.25 ha, processed using a hand tractor, which was made into 16 pillows. The distance from one pillow to the next pillow was 100 cm with height of ± 10 cm,and each pillow had two rows of plants, designed in a Randomized Block Design (RBD), 4 treatments and 4 replications, and each test consisted of 2 experimental units, placement of treatments and the test was carried out randomly.

2.2.2. Planting

Corn seeds used in this research were Bonzana. Corn seeds were planted with a depth of 3 cm. The corn planting system used was the *legowo* row system. Each pillow had two rows of plants with a spacing of 25 cm x 50 cm. One corn seed was planted in each hole. If the seeds do not grow or die, they will be replaced with other corn seeds that are prepared at the reserve yard.

2.2.3. Fertilization

2.2.3.1. Inorganic Fertilizer

Inorganic fertilizers used in the study are urea (300 kg^{-1}ha dose), KCL (100 kg/ha dose), SP36 (200 kg/ha dose) and dolomite (2000 kg/ha dose). This inorganic fertilizer is applied with *making the planting hole* with a distance ± 5 cm in addition to the seeds. Inorganic fertilizer (KCL and SP36) is done at 14 DAPs, for urea fertilization wascarried out 2 times at 14 DAPs and 30 DAPs, while dolomite was given before planting by sowing.

2.2.3.2. Organic fertilizer

Organic fertilizers used were trichocompost (2,000 kg^{-1} ha dose), bio urine (100 kg^{-1} ha dose), and bio slurry (100 ltr^{-1} ha dose). Trichocompost was applied through a mixture of cow feces that had accumulated for 2 weeks and then coated with a mixture of sawdust with the addition of *Trichoderma* isolated in the food crop pest laboratory in Jambi Province. Trichocompost was applied by sprinkling on each seed. The application was done at the beginning of planting while bio urine and bio slurry was given at 14 DAPs and 30 DAPs. The applied biourine was beef cattle urine stored for 3 months and subsequently aerated. The bio slurryused was a product of biogas processing made from a mixture of cow's manure and water through an anaerobic process purchased from farmers. Biourine was applied first then followed by bio slurry by spraying each plant from the tips of the leaves until evenly distributed to the ground.

2.3. Intake of Methane Gas

Intake of CH_4 gaswas carried out in 2 stages: 3 days, 6 days, 9 days after the first fertilization (14 DAPs), and 3 days, 6 days, 9 days after the second fertilization (30 DAPs). Several stages of N_2O emission data collection include:

1. CH_4 gas capture chamber (50 cm x 30 cm x 25 cm) was placed between 2 (two) corn plants in the same pillow, this gas capture wasconductedin the morning.
2. Thermometer was installed to see the temperature-time when the gas capture process was done. The time used as a benchmark was 10, 20, 30, 40, and 50 minutes.
3. The capture of CH_4 gas was done by injection of 10 ml and the syringe surface closed using aluminum foil to prevent gas leakage.
4. The syringe containing the gas was immediately closed in order to ensure that the captured gas would not leak.
5. Gas concentration analysis was carried out in the Central Java Balingtan Pati laboratory using gas chromatography.

2.4. Research design

This study used a randomized block design (RBD), with 4 treatment groups with 4 replications, each group consisted of 2 experimental units. The treatments consisted of:

IO_{100}	:	100% Inorganic fertilizer (recommendation) (SP36 50 kg / 0.25 ha + KCL 25 kg / 0.25 ha + Urea 75 kg / 0.25 ha + Dolomite 500 kg / 0.25 ha
$IO_{75}O_{25}$	:	75% Inorganic Fertilizer + 25% Organic Fertilizer (Trichocompost) (SP36 37.5 kg / 0.25 ha + KCL 18.75 kg / 0.25 ha + Urea 56.25 kg / 0.25 ha + Trichocompost 500 kg / 0.25 ha)
$IO_{50}O_{50}$	:	50% Inorganic Fertilizer + 50% Organic Fertilizer (Trichocompost + Bio urine)
$IO_{25}O_{75}$	:	25% Inorganic Fertilizer + 75% Organic Fertilizer (Trichocompost + Bio urine + Bio slurry) (SP36 12.5 kg / 0.25 ha + KCL 6.25 kg / 0.25 ha + Urea 18.75 kg / 0.25 ha + Trichocompost 500 kg / 0.25 ha + Bio urine 25 L / 0.25 ha + Bio slurry 25 L / 0.25 ha

2.5. Variables Observed

The CH_4 gas flux in the first fertilization (kg $ha^{-1}day^{-1}$), N_2O gas flux pattern in the second fertilization ($kgha^{-1}day^{-1}$), N_2O gas emissions ($kgha^{-1}season^{-1}$).

3.6. Data analysis

The data obtained was calculated using the formula [6]:

$$E = dc/dt \times Vch/Ach \times mW/mV \times 273.2/(273.2 + T) \quad (1)$$

Description :

E	= N_2O gas emission (mg/ m^2/ day)
dc/dt	= Difference of N_2O per time given (ppm/minute)
Vch	= Box volum (m^3)
Ach	= Box are (m^2)
mW/mV	= Gas molecular weight / molecular volume constant N_2O (22.41 1)
T	= Average temperature during sampling (^{0}C)

The 273.2 value = Kelvin temperature constant

The flux data and greenhouse gas emissions (N_2O) obtained were analysed by Analysis of Variance (ANOVA), if there is difference between treatments then further test required using Duncan's test. Data processing used was the SAS (System Analysis Statistics) software.

3. RESULTS AND DISCUSSION

3.1. Methane Gas Flux Production Pattern (CH_4) in Fertilization I

Flux or rate of change of methane gas (CH_4) is described as the amount of methane gas (CH_4) emission produced daily on the corn plants which been fertilized using inorganic (urea, SP36, and KCL) and organic fertilizer (trichocompost, bio urine and bio slurry) which stated in (kg/ha/day). The methane gas flux pattern can be found in Figure 1.

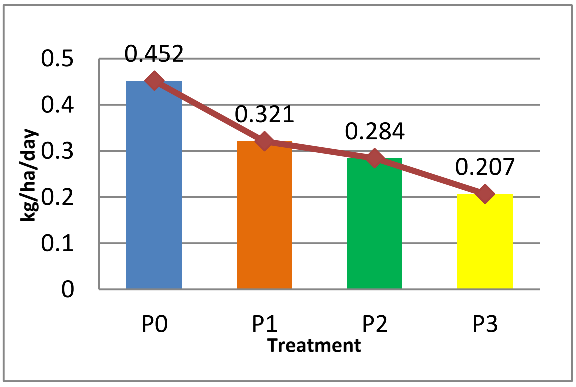

Figure 1. Methane Flux Graphic in Fertilization 1

In Fertilization I, there was an alteration in methane gas flux value after adding trichocompost, bio urine, and bio slurry. From the observation, the methane gas flux was experiencing a decline. In the P1 treatment (inorganic fertilizer 75% and organic fertilizer 25%), a declined pattern was observed. The addition of organic fertilizer (trichocompost) at 25% is able to reduce the methane gas, followed by P2 treatment (inorganic fertilizer 50% and organic fertilizer 50%) and P3 (inorganic fertilizer 25% organic fertilizer 75%) which have a lower methane gas flux compared to treatment P0 (100% inorganic fertilizer).

Field condition during Fertilization I was one of the factors that affecting the methane gas flux production pattern. Suryadi [7] explained in his study where a dry field planted with corn, peanut, and cassava had a very low total methane gas flux compared to those produced in the logged field (anaerobic). Moreover, the methanogen bacteria activities in dry field were minimal, and only able to act in an anaerobic environment.

3.2. Methane Gas Flux Production Pattern (CH4) in Fertilization II

Methane gas flux pattern in Fertilization II in cornfield can be observed in Figure 2.

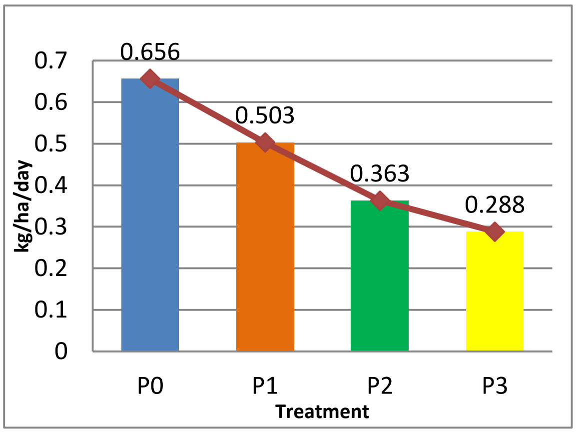

Figure 2 Flux Graphic in Fertilization II

In Fertilization II, the methane gas flux production pattern was equal to that of the Fertilization I. However, the methane gas flux value produced in Fertilization II experience and increase compared to Fertilization I. This was expected because the fertilizer has been decomposed in the Fertilization II. Other than that, Fertilization II was conducted during raining season; hence the field condition was already wet, and referring to this condition, it was expected become one of the influential factors in methane gas production. Based on Wihardjaka and Harsanti [8] on the anaerobic field condition, methane gas producing bacteria, known as methanogen, grows significantly on the wetlands. Suryadi [7] (2012) mentioned that methane gas production is closely related to methanogen bacteria activities, which require organic substances and ananareob environment. The interaction between them created a suitable condition for the methanogen bacteria activities. The continuous inundation process created anaerobic conditions that were very suitable for methanogenic bacteria as a producer of methane gas (CH_4). The increase in methane gas (CH_4) in agricultural land is caused by the increased availability of water from rain fall [9].

3.3. Methane Gas (CH4) Emission

Methane gas (CH_4) emission was the total accumulation of methane gas produced in a field in each planting season or stated in (kg/ha/season). Total methane gas emission served in Table 1.

Table 1. Methane Gas Emission (CH_4)

Treatment	Average Methane Gas Emission (CH_4) (kg/ha/season)
P0	42.06 ± 6.95^{a}
P1	32.94 ± 3.72^{ab}
P2	25.75 ± 13.71^{bc}
P3	13.64 ± 6.57^{c}

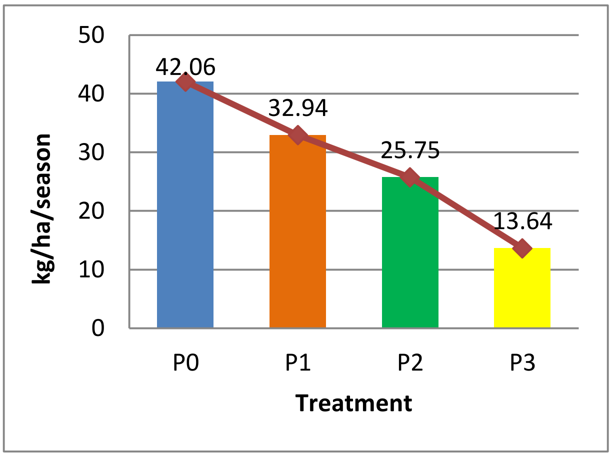

Figure 3 Methane Gas (CH_4) Emission.

The addition of trichocompost, bio urine, and bio slurry on cornfield showed a significant real impact ($P<0.05$) on the methane gas emission (CH_4). Table 1showed that methane gas emission on the P2 and P3 treatment were showing a real different compared to P0 ($P<0.05$), while P1 was not significantly different or relatively similar with P0, P2, and P3 ($P>0.05$). Methane emission graphic pattern can be seen in Figure 3. It described that similar methane gas production flux pattern produced in Fertilization I and Fertilization II.

The highest methane gas emissions shown in P0 treatment (100% inorganic fertilizer around 42.06 kg/ha/season). This was expected due to the addition of dolomite on cornfield that would affect the chemical reaction in the soil, such as the increase of soil pH. Tani [4] explained that the application of dolomite in soy and corn plants increased the greenhouse gas emission, where one of it was methane. This was due to dolomite $CaCO_3MgCO_3$, which contained nutrients such as Ca and Mg. The addition of dolomite could increase the Ca and Mg contents and increase the soil pH. Greenhouse gas emission tends to increase the soil pH.

Methane gas emission (CH_4) produced in the P1, P2, and P3 treatment were lower compared to P0 treatment. This can be observed in Figure 3. The methane gas emission pattern tends to decline after adding organic fertilizer, such as compost, bio urine, and bio slurry. This was suitable with the studies that Tani [4] conducted, where it has been explained that a lower greenhouse gas emission observed was due to methane treated with bio slurry where the cattle waste that being utilized through bio digester has been fermented and part of ammoniac gas produced from the faeces were transformed into burning gas. Hence only small part left out in the bio slurry. Livestock waste processed to biogas through bio digester could reduce methane emission and carbon dioxide (CO_2).

Methane gas emission could be influenced by several factors, such as soil, microbes, environmental characteristic, and etc. Environmental factors and soil conditions include the organic substance contents and humidity to affect the methane production [10]. Methane release variation from one ecosystem was affected by the plant type cultivation, microbe community, soil characteristic, and the interaction. Understanding the relations between soil, microbes' characteristic, and methane on various types of cultivation was important to be the basic of understanding the involvement of mechanisms that run on methane production. Methane gas is normally formed by methanogen bacteria's activity of methanogen on the anaerobic environment [11]. In addition to the anaerobic environment, the formation of methane (CH_4) is also influenced by temperature; both air temperature and soil temperature [12].

4. CONCLUSION

Application of beef cattle waste (Trichocompost, bio urine, and bio slurry) as organic fertilizer on sweet corn (*Zea mays* L. Sacharata) by 25%, 50%, and 75% can reduce methane gas (CH_4) emission by 21.68%, 38.68%, and75%.

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