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東京農業大学

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Effects of adding Rice Husk Biochar in GHG Emission and Compost Quality during Cow Manure Composting

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Background

Agriculture is a major anthropogenic source of GHG emission and contributes 24% of total GHG emitted (IPCC, 2014). Livestock sector forms a significant part of agriculture and is responsible for major GHG emission. According to FAO, 2016, livestock manure contributes 23% to total GHG emitted in agricultural sector. N_2O, CO_2 and CH_4 are important GHG emitted during management of livestock manure. Biochar is a product of pyrolysis characterized with microscopic structure having large surface area and has affinity to absorb nutrients, ions etc. (Dünisch et al., 2007; Major et al., 2009), and has been applied in soil to mainatain soil fertility and reducing GHG emission (Van Zwieten et al., 2015).

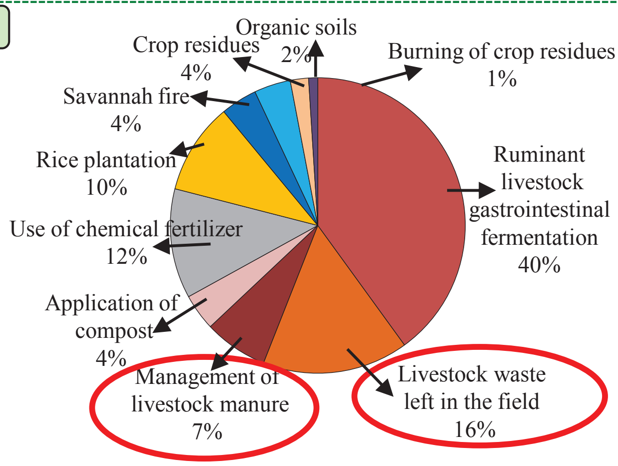

Fig. Major GHG contributor in agricultural sector. (FAO, 2016)

Objectives

Against the background of global warming, there is increased motivation in reducing GHG emissions. Therefore, this study focus to see the effects of adding rice husk biochar during cow manure composting in reducing GHG gases emission and better compost quality.

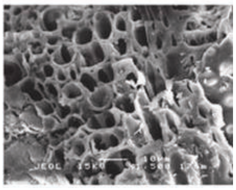

Fig. SEM image of rice husk biochar (Samsuri, 2016)

Methodology

Experimental setup

A composting experiment was conducted with 5%, 10% and 15% rice husk biochar added in cow manure for a period of 60 days.

Table Composition of treatments

Composition	Control	5% treatment	10% treatment	15% treatment
Cow manure (g)	3200	3200	3200	3200
Litter + rice straw (g) *	1800	1800	1800	1800
Rice husk bio-char (g) **		250	500	750

*Note: * represents weight in dry weight, ** represents oven dry weight*

Analytical methods

Total nitrogen……photo spectroscopy (Mihara and Ueno, 2000)

Organic carbon……C=0.580Ignition loss (Siriwattananon and Mihara, 2009)

Manure + litter + straw 5000 g + **Rice husk biochar 0 to 750 g**

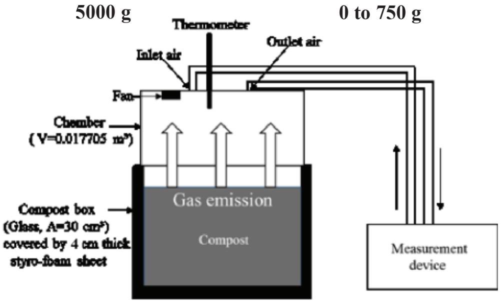

Fig. Schematic diagram of gas flux analysis

Gas flux calculation

$$F = \rho \times \frac{V}{A} \times \frac{\Delta C}{\Delta t} \times \frac{273}{T} \;\ldots\ldots\ldots Eq.\ 1$$

(Minamikawa et al., 2015)

F is gas flux (mg m^{-2} hr^{-1}), ρ is density of gas (kg m^{-3}), A is surface area of compost box (m^2)
V is volume of air inside the chamber (m^3), $\Delta C/\Delta t$ is concentration change over time(10^{-6} m^3 m^{-3} hr^{-1})
T is average temperature inside the chamber (K)

Degradation rate

$$\left\{\frac{OM}{OM_0}\right\} = -kt \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; Eq.\ 2$$

(Haug, 1993, Kulcu and Yaldiz, 2004)

OM is mass of biodegradable organic matter at any time of composting, OM_0 is initial mass of biodegradable organic matter, t is time in day, k_t is reaction rate constant in $days^{-1}$

Results

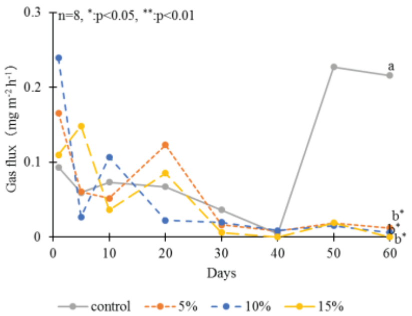

Fig. Periodic change in N_2O flux

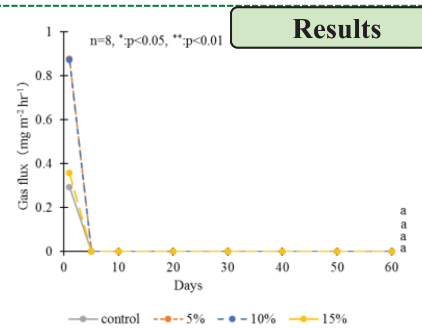

Fig. Periodic change in CH_4 flux

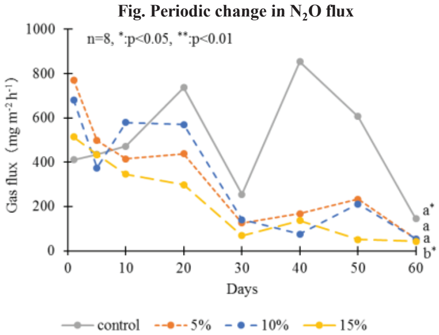

Fig. Periodic change in CO_2 flux

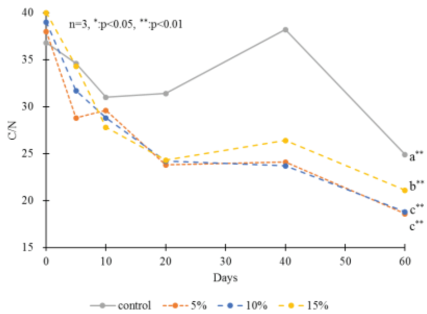

Fig. Periodic change in C/N ratio

Table Degradation rate at 5 and 60 days passed

Treatments	5 days k_t(d^{-1})	60 days k_t(d^{-1})
Control	0.013[a]	0.0045[a]
5%	0.032[b**]	0.0052[a]
10%	0.031[c**]	0.0056[a]
15%	0.034[d**]	0.0054[a]

n=3, *:p<0.05, **:p<0.01

Discussions

- Biochar's well developed pore structure and adsorption capacity reduced GHG emission of CO_2 and N_2O.
- Biochar addition provided necessary nutrient elements and habitat, facilitating growth of various microorganisms promoting degradation and maturity with a better C/N ratio.
- With increase in microbial activity, oxygen depleted, resulting in increased emission of CH_4 during early stages of composting in biochar added treatments.

Conclusions

This study was conducted to see the effects of adding rice husk biochar in different quantities to see its effect in GHG emission and final compost quality. In the given conditions, addition of biochar was effective in decreasing N_2O and CO_2 emission significantly. However, no significance difference was seen in CH_4 emission. On the other hand, compost quality with better degradation and C/N ratio was observed. Nevertheless, future investigation relating microbial community and structural characteristics of biochar are needed to understand mechanisms influencing composting process.