Research projects of counterparts funded at UNJA in 2021

Name	Counterpart	Title
Damris Muhammad, Nurzeni Fitri	**A05**	The effects of modified biochar on greenhouse gas emission from soils of palm oil plantations in Jambi

Background and Methods

The conversion of tropical rain forest to palm oil plantation not only causes above ground carbon loss but also carbon stock in the forest soils. Thus, the greenhouse gas emission from the converted land come not only from the decomposition of above ground biomass, but also from the carbon stock in the soils. However, the question of how to reduce the greenhouse gas (GHG) emission from soils to the atmosphere and how to stabilize the most unstable fraction of soil carbon in the form of dissolved organic carbon (DOC) in the soil is not well understood. Biochar as a pyrolysis product of organic wastes under limited oxygen environment (Oliveira *et al.*, 2018) was used and added to the soil of palm oil plantation in a lab incubation study, which then used to estimate and quantify the amount of GHG flux reduction and stabilisation of DOC in the palm oil plantation soils. The GHG emission were analyzed by HCl titration and DOC by UV-VIS spectrophotometer. The biochar was characterized using FTIR and SEM.

Objective

The objectives of this study were to estimate and quantify the GHG emission and DOC stabilisation in biochar-enriched soils of palm oil plantation, as a strategy to mitigate of GHG emission from palm oil plantation.

Approach

Ten soil samples (0–30 cm) were randomly collected from smallholder palm oil plantations in Muaro Jambi District. Samples were air dried and grained to pass 2 mm sieve. Approximately 750 g of soil was placed to a 1000-ml amber bottle and coffee husk biochar (5 and 10 % w/w) was added, with the water content was adjusted to 75 %. The weight of the mixture is recorded. The bottles were kept open for one week for conditioning and the weight was adjusted with water if necessary. Samples were stored in the dark for 10 weeks and the gas released from the bottles was collected in a 0.1 M NaOH solution. A small portion of the solid from the bottle was collected for DOC extraction. After collection of the gas and solids, the bottles were opened to ensure that oxygen was not a limiting factor of organic carbon mineralization. The soil samples in the bottle were re-weighted to ensure no loss of weight. This process is repeated for 10 weeks. The concentrations of CO_2 and DOC were determined by HCl titration and UV-VIS spectrophotometer, respectively. Soil properties such as pH, particle size distribution, minerals, total carbon content, water holding capacity, and density were also determined in this study. The biochar

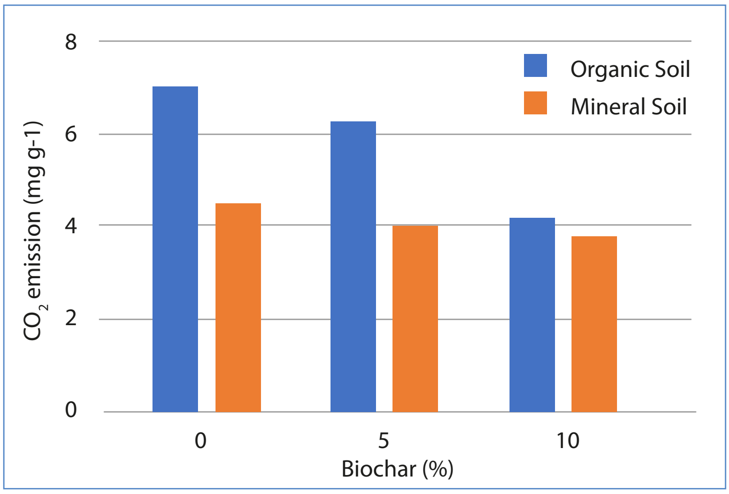

Figure 1. the effect of biochar addition to organic and mineral soils on the CO_2 gas emission

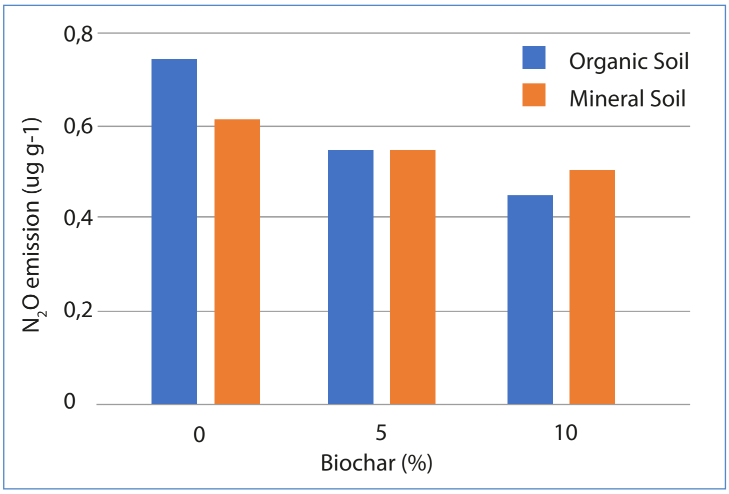

Figure 2. the effect of biochar amendment to organic and mineral soils on the N_2O gas emission measured at the 5th day of incubation

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used in this study was modified with acid (HNO_3), alkaline (KOH) and ethanol, and characterized by FTIR and SEM. All experiments were performed in triplicate.

Result

The effect of biochar amendment on CO_2 emission

Carbon dioxide emission from incubation of the biochar-enriched soil measured over 30 days are shown in figure 71. It shows that the addition of biochar to the soil affects CO_2 emission to the atmosphere. Both organic and mineral soils produced higher CO_2 emission compared to the control (without biochar addition), which was measured at the 5th day. The variation of biochar addition (5 % and 10 %) to the soils resulted in a decrease in CO_2 emission. Soil amended with 5 % biochar reduces CO_2 emission from organic soil (7.01 to 6.30 mg g-1) and mineral soil (4.50 to 4.00 mg g-1) by about 10 %. While the soil enriched with 10 % biochar resulted in a greater reduction in CO_2 emission.

The effect of biochar amendment on N_2O emission

Nitrous oxide (N_2O) emissions from biochar-enriched soil are shown in figure 72. It appears that the biochar-enriched soils affect the N_2O emission from the oil palm plantation measured over 30 days. The variations of biochar additions affect the N_2O emission released from the biochar-enriched soils. The control soil (without biochar addition) resulted in higher N_2O emissions for both organic and mineral soils measured at day 5 of incubation. The addition of 5 % and 10 % (w/w) biochar to the soil resulted in a decrease in N_2O emissions. The addition of 5 % biochar reduced N_2O emissions by 27 % and 10 % for organic and mineral soils, respectively. However, the 10 % addition did not result in a proportional reduction in N_2O emissions, as shown in figure 72. The 10 % addition measured on the 5th day of incubation reduced N_2O emissions by 40 % and 18 % for organic and mineral soil, respectively.

The addition of biochar to the organic and mineral soils of smallholders of palm oil plantation resulted in the decrease of greenhouse gas emission (CO_2 and N_2O) released from the studied soils in a laboratory experiment with 0 day of incubation. This approach appears to be promising strategy to mitigate greenhouse gas emissions from the palm oil plantation.

References

Oliveira RF, Patel AK, Jaisi DP, Adhikari S, Lu H and Khanal SK (2018) Review Environmental application of biochar: *Current status and perspectives*. Bioresource Technology.

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