学位論文の要旨

Abstract of Thesis

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学位論文題目 Title of Thesis（学位論文題目が英語の場合は和訳を付記）

Greenhouse gas emissions from agricultural soil amended with different types of compost in laboratory tests

室内実験における異なる堆肥を施用した農地土壌からの温室効果ガスの排出

学位論文の要旨 Abstract of Thesis

Agriculture is responsible for 10–14% of the total global anthropogenic greenhouse gas (GHG) emissions (Assouma et al. 2017, Robertson 2014). Replacement of chemical fertilizer with compost is recommendable for the recycling of organic waste. In addition, compost reduced the risk of nitrogen (N) leaching for a short period (Geng et al. 2019) but did not for a long period available (Maeda et al. 2003). Composting reforms organic waste into a valuable product for soil and plants (Evanylo et al. 2008). Compost with different methods and raw materials shows varying properties (Harada et al. 1993; Mori and Hojito 2015), which affects its decomposition processes and therefore GHG emissions. Mature compost is characterized by lower readily decomposable C content (Nasini et al. 2016), which may reduce GHG emissions after soil incorporation. Higher total N content in livestock waste compost may cause higher N_2O emissions than those in kitchen compost (Oguntade et al. 2019). Aeration to the composting processes has benefits in increasing organic matter decomposition (Bernal et al. 2009) while facultative heap (anaerobic) composting results in the slow degradation of organic matter (Kong et al. 2022). The effects of different types of compost on GHG emissions have not been clearly determined. Interactions between soil and compost also control GHG emissions. Recently, GHG emissions from soil were reported to be derived from both biotic and abiotic processes (Chen et al. 2021, Gu et al. 2016). Thus, the effect of compost application on GHG emissions has not been sufficiently discussed. Accordingly, the thesis was designed:

1) to evaluate the effect of compost ages and application rates on emissions of N_2O, CO_2, and CH_4 from kitchen compost-amended soil,

2) to investigate the effect of facultative heap compost application on N_2O, CO_2, and CH_4 emissions (Chapter 4), and

3) to determine the mechanisms of abiotic CO_2 and CH_4 emissions from compost-amended soil at different temperatures.

To achieve the above objectives, three laboratory experiments were conducted under aerobic conditions.

1) Aerobic kitchen waste compost at three different ages was mixed with soil at three application rates: 0%, 1%, and 2% (w/w) and incubated at 25°C for 28 days to determine N_2O, CO_2, and CH_4 emissions. Results showed that emissions of N_2O and CO_2 from compost-amended soil decreased with increasing compost ages. Mature compost application did not increase GHG emissions compared to soil only. Higher compost application rates reduced N_2O emission but increased CO_2 emission.

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Methane emission occurred even under aerobic conditions. These results suggested that GHG emissions were the lowest from soil receiving mature compost at 1% application rate.

2) Sandy clay loam or loamy sand soil treated with 0% or 2% of three different types of facultative heap compost was incubated at 30°C for 56 days to determine N_2O, CO_2, and CH_4 emissions. Loamy sand soil with higher total C and N, mineral N, and sand contents showed higher N_2O and CO_2 emissions and lower CH_4 than sandy clay loam soil. Emissions of N_2O from the soil amended with mature facultative heap compost were higher than those from the soil only. The application of immature facultative heap compost showed higher CO_2 and CH_4 emissions than the soil without compost.

3) Sterilized and non-sterilized soil only or soil mixed with 1% kitchen compost were incubated at 20, 30, and 35°C for 28 days to determine abiotic and biotic CO_2 and CH_4 emissions. Cumulative total emissions of CO_2 and CH_4 from the soil increased with temperature and compost application rates. Abiotic CH_4 emissions also increased with temperature, suggesting that thermal degradation is a possible pathway for abiotic CH_4 generation. Biotic CO_2 emissions from soil with or without compost at 30°C were higher than those at 20°C but were not significantly different between 30°C and 35°C.

This thesis proved that the use of mature aerobic kitchen compost does not increase GHG emissions from the soil but mature facultative heap compost led to higher N_2O emissions. In addition, we suggested that abiotic emissions of CO_2 and CH_4 may increase the global GHG budgets in future climate changes.