Effects of different NH_4^+-N contents on N_2O and CO_2 emissions from manure compost-amended soil

*Thanuja Deepani Panangala Liyanage[1], Morihiro Maeda[1], Hiroaki Somura[1]

1. Okayama University

Nitrous oxide (N_2O) is a major greenhouse gas that causes global warming and stratospheric ozone depletion. Ammonium nitrogen (NH_4^+-N) content is considered as a key factor affecting N_2O emissions because ammonium oxidation by nitrifying microorganisms is a major process of N_2O emissions. Exact effects of NH_4^+-N on N_2O emissions are less examined and even available findings are contradictory. Some studies found strongly positive linear correlations between N_2O emissions and NH_4^+-N content, while others stated reductions in N_2O emissions with increasing NH_4^+-N content. Therefore, the present study aimed at investigating effects of different NH_4^+-N contents on N_2O and carbon dioxide (CO_2) emissions from manure compost amended soil.

Greenhouse soil was amended with two types of manure composts (Cattle compost, CC and Mixed compost was of cattle, poultry, and swine manure, MC) on 3% weight basis. The initial NH_4^+-N contents were adjusted at three levels of 160, 200, 400 mg/kg. The samples were aerobically incubated at 70% water holding capacity at 25˚C for 42 days. Emissions of N_2O and CO_2 (gas chromatography) and ammonium and nitrate N contents of soil were measured on days 0, 3, 7, 14, 21, 28, and 42.

The highest cumulative N_2O (200-420 mg kg^{-1}) and CO_2 (7-11 g kg^{-1}) emissions were observed in MC amended soils at each NH_4^+-N level. This is probably due to high total N, low C/N, and high mineral N of MC. The MC amended treatments with 160 mg/kg NH_4^+-N content showed peak emissions on day 7. In all the other treatments, N_2O emissions peaked on day 3 indicating that the nitrification process was enhanced by the addition of NH_4^+-N. The cumulative N_2O and CO_2 emissions in 400 mg/kg NH_4^+-N treatments were lower than those in 200 mg/kg NH_4^+-N treatments despite the addition of compost. Higher NH_4^+-N content would have suppressed the microbial activity probably due to enhanced osmotic effects. In both control and CC amended treatments, cumulative N_2O and CO_2 emissions increased with NH_4^+-N contents from 160 to 200 mg/kg, whereas they decreased in 400 mg/kg NH_4^+-N treatments. The variation of NO_3^--N content showed that the MC amended treatment with 160 mg/kg NH_4^+-N content was subjected to high denitrifying activity compared to the other treatments. With increasing NH_4^+-N content, the denitrifying activity seemed to decrease due to high osmotic potential. In conclusion, different types of compost have different amounts of N_2O and CO_2 emissions at each NH_4^+-N content. More NH_4^+-N suppressed microbial activities due to osmotic stress and therefore lower N_2O and CO_2 emissions were recorded. Content of NH_4^+-N can be a key factor in determination of N_2O emissions.

Keywords: Nitrous oxide , Carbon dioxide, Manure compost, Ammonium nitrogen, Microbial activity