Effects of soil structure and nutrient status on N_2O production

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Introduction

Soil aggregates play an important role to effect biological processes to influence N_2O release from soil. Moreover, the type of N inputs to the fields may affect the N_2O emission in different ways, leading to different patterns of N_2O emissions from N fertilizers. The study of incubation was carried out to determine the effect of aggregate size, fertilizer management on N_2O production.

Materials and Methods

Experiment 1. Soil samples were taken from 0-20 cm horizon of each field managed by chemical fertilizer (F) and combination of chemical fertilizer and manure (FM) applications in Hokkaido (SZN, SHD) and FM in China (XJ). Air-dried soil samples were sieved with 2 and 4.5mm sieve. 20 g air-dried sample was pre-incubated in a 1.8 L glass jar at 20 ℃ for 2 days. Soil sample was moistened till field water capacity and then incubated again for 10 days (4 replicates). Gas concentrations of nitric oxide (NO), carbon dioxide (CO_2) and N_2O were measured every 2 days. Soil chemical properties were observed before and after incubation. **Experiment 2**. SHD and XJ soils were used before fertilization. Five treatments including control (CK), ammonium nitrate, charcoal, plant residue and cattle manure was selected as N source. Adding them to soil respectively with amount of 150 kg N ha^{-1} after determined the total N. Incubation process was same with experiment 1.

Results and Discussion

Experiment 1. Larger aggregates of all soils showed higher values of WEOC, MBC, NH_4^+-N and NO_3^--N, and higher productions of N_2O, compared to smaller aggregates. The high amount of MBC in larger aggregates induced higher decomposition of organic matter, resulting in greater N_2O productions and N mineralization. FM always showed the higher N_2O production than F due to soil mineralization stimulated by manure application. The N_2O production was higher in SZN soil than SHD. This might be ascribed to WEOC consumption were higher in SZN. The result of N_2O-N/NO-N showed that the N_2O production was derived from denitrification in SZN and XJ, but nitrification in SHD. The NO_3^--N concentration was significantly higher in XJ. Therefore, the highest N_2O production occurred in XJ due to denitrification which is enhanced by high NO_3^--N concentration. **Experiment 2.** In all samples, cumulative N_2O production increased with increasing WEOC consumption, which was highest in cattle manure, and followed by the plant residue, chemical fertilizer, CK and charcoal. Charcoal applied soils of both sites showed the lowest N_2O flux, it could be explained by the charcoal is able to changing microenvironment for the microbial growth due to adsorption. Especially in XJ. NO_3^--N concentration of charcoal was lower than CK, decreasing N_2O emission were partially caused by the ability of charcoal to adsorb NO_3^--N in the soil. Larger aggregates showed the higher N_2O flux due to mineralization, which was enhanced by WEOC consumption. It also showed the highest N_2O production happened in XJ because of high denitrification losses under high NO_3^--N concentration.

Conclusion

This study revealed that 1) larger aggregates of all treatments showed higher N_2O production than smaller aggregates because of association of higher amount of WEOC, MBC, NH_4^+-N and NO_3^--N which is enhanced by manure application; 2) highest N_2O production occurred in XJ owing to denitrification which is stimulated by high NO_3^--N concentration ; 3) The minimum N_2O production was found in charcoal applied soil due to adsorption on charcoal surface.