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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Nitrous oxide (N_2O) is a greenhouse gas in the troposphere and a potential destroyer of stratospheric ozone layer. N_2O concentration has risen rapidly from 1750 until now, and it will continue increasing in the future. Even atmospheric N_2O concentration is three magnitudes lower than CO_2 concentration; the radiative forcing of N_2O is stronger than that of CO_2. And the 100-year warming potential (GWP) of N_2O is 265 times higher than CO_2. Natural soils and agricultural soils are the biggest source of atmospheric N_2O. UV photolysis is the dominant stratospheric sink for N_2O. In the soils, N_2O is produced through microbial processes, nitrification and denitrification, and it is consumed by N_2O reduction through denitrification process. Nitrification is the oxidation of NH_3 into NO_3^- conducted by bacteria and archaea under aerobic condition. In this process, N_2O is produced as a byproduct of NH_2OH oxidation. Denitrification is the reduction of NO_3^- into N_2 conducted mainly by heterotrophic bacteria and fungi under anaerobic condition. N_2O is produced as the intermediate. In the Japanese tea field, the high nitrogenous fertilizer (including organic N and inorganic N) application caused soil acidification and large N_2O emission.

The soil N_2O gas, N_2O flux and soil were collected from Japanese tea field in 2011 and 2012. The concentrations and isotopemer ratios of N_2O and inorganic nitrogen were analyzed to investigate the N sources and sinks of N_2O in Japanese tea field under conventional treatment. Moreover, N_2O mitigation effects by lime nitrogen and dicyandiamide (DCD) treatments were also examined. Furthermore, soil water and rainwater samples were collected from Japanese tea field in 2012. The O isotope ratios of H_2O, N_2O, and NO_3^- were measured to determine the O source of N_2O in the tea field under conventional treatment.

The organic N and inorganic N fertilizers were the major N inputs in the Japanese tea field soil. Relatively smaller amount of N input was wet and dry deposition. Organic N fertilizers were converted to NH_4^+ through mineralization process in the soil. The NH_4^+ could convert to NO_3^- through nitrification process. According to the specific ^{15}N site preference (SP) values of bacterial nitrification, bacterial denitrifier-denitrification, nitrifier-denitrification, and fungal denitrification, it was suggested that bacterial denitrification was the

dominant process of N_2O production on most days in two parallel plots (Plot I and Plot II) under conventional treatment, irrespective of N_2O reduction occurring before or after mixing. However, on 31 May 2011 (after one of fertilizations) during which soil temperatures were 15.8°C to 17.9°C and water-filled pore space (WFPS) was 0.73 to 0.89 in the upper layer of Plot I and deeper layers of Plot II, and on 18 October 2012 during which soil temperatures were 19.7°C to 20.1°C and WFPS was 0.61 to 0.74 in Plot II, bacterial denitrification and bacterial nitrification (or fungal denitrification) contributed nearly equal shares on the produced N_2O. Moreover, on 4 October 2012 (35 cm depth; WPFS was 0.73) and 18 October 2012 (10 cm depth; soil temperature was 19.7°C and WFPS was 0.68) in Plot I, bacterial nitrification (or fungal denitrification) contributed more N_2O than bacterial denitrification.

In situ environment, precipitation was the sole water source. Part of soil water was replaced by precipitation. In nitrification and denitrification processes, H_2O and O_2 are the O sources. Isotopomeric analysis indicated that during the formation of N_2O through denitrifier denitrification process, and N_2O reduction could be negligible. The fractions of O exchange between soil water and N_2O precursors were approximately 80% and 77%, respectively, at 10 cm and 20 cm depths soil. The net ^{18}O isotope effects for denitrification (NO_3^- reduction to N_2O) were estimated as 35‰ and 33‰, respectively, at 10 cm and 20 cm depths soil.

In the Japanese tea field, lime nitrogen and DCD were applied to mitigate N_2O emission. Lime nitrogen effectively suppressed N_2O emission by inhibiting nitrification process. The inhibition effect by lime nitrogen could last for one month or shorter. The inhibition effect decreased with time. However, DCD treatment enhanced N_2O emission. The proportion of N_2O produced through bacterial nitrification process was ascended by DCD. Ineffective inhibition by DCD could be attributed to repeated application year by year. From 18 October to 2 November or to 8 November, N_2O flux decreased. As calculated using Rayleigh distribution equation, on 2 November or 8 November in conventional treatment, 33-35% of N_2O was consumed by N_2O reduction and 58-64% was consumed by diffusion. In lime nitrogen treatment, N_2O reduction consumed 34-82% of N_2O and diffusion consumed 1-57% of N_2O. In DCD treatment, 57-78% of N_2O was lost through N_2O reduction and 7-27% of N_2O was lost through diffusion.