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# Outline

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Title: Isotopomeric analysis on the production and consumption processes of nitrous oxide accumulated in and emitted from Japanese tea field soil

(日本の茶園土壌において蓄積かつ放出される一酸化二窒素の生成および消滅過程に関するアイソトポマー解析)

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. Natural soils and agricultural soils are the biggest source of atmospheric $N_2O$. In the soils, $N_2O$ is produced through microbial processes, nitrification and denitrification. The high nitrogenous fertilizer application caused soil acidification and large $N_2O$ emission from Japanese tea field.

The soil $N_2O$ gas, $N_2O$ flux, soil, soil water, and rainwater samples were collected in 2011 and 2012. The concentrations and isotopemer ratios of $N_2O$ and inorganic nitrogen were analyzed to investigate the sources and sinks of $N_2O$ in Japanese tea field under conventional, lime nitrogen, and DCD (dicyandiamide) treatments.

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.

During the formation of $N_2O$ through denitrifier denitrification process, the fractions of O exchange between soil water and $N_2O$ precursors were approximately 80% and 77%, respectively, at 10 cm and 20 cm depth soils. 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 depth soil.

In the tea field, lime nitrogen effectively suppressed $N_2O$ emission by inhibiting nitrification process. The inhibition effect by lime nitrogen ($CaCN_2$) 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.