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N_2 production via aerobic pathways

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Extended Abstract

Compared to most studies on net N_2O production, relatively less was published on the N_2O consumption, however, previous studies observed continuous soil negative N_2O fluxes, especially in dry seasons. Goldberg et al. (2009) reported that drought turns a Central European Norway spruce forest soil from an N_2O source to a transient N_2O sink. Stewart et al. (2012) showed that N_2O flux from plant-soil system in polar deserts switch between sources and sinks under different light conditions.

Our work also confirmed that the farmland with dry and low nitrogen soil could be a N_2O sink (Wang et al. 2018). The study was conducted at the Taihang Mountain Ecosystem Experimental Station (37°53'N, 114°16'E) of the Chinese Academy of Sciences. Field measurements were conducted during the growing season, from March to October in 2012 and 2013, in an unfertilized and rainfed farmland planted with maize (Zea mays L.), which has not been fertilized since 1986. We simultaneously measured the soil surface N_2O emissions and the subsurface fluxes (0–115 cm) in situ by using a static chamber-based method (CM) and a concentration gradient-based method (GM) respectively, over a two-year period. Soil surface flux of N_2O was calculated on the basis of static chamber-based method; Subsoil flux of N_2O was estimated on the basis of soil gas concentration gradients using Fick's 1st law. Cumulative flux (c) of N_2O at soil surface measured using the chamber-based method were -179 mg N_2O m^{-2} and -107 mg N_2O m^{-2} during the observational period, respectively in 2012 and 2013. Cumulative flux (c) of N_2O using the concentration gradient-based method were -161 mg N_2O m^{-2} and -89 mg N_2O m^{-2} during the observational period, respectively in 2012 and 2013.

To further confirm what causes the N_2O sink under the dry and low nitrogen soil with aerobic condition, N_2O consumption and N_2 production were measured for 28 days in aerobic soil with soil moisture content ranging from 1% to 50% (wt/wt) and with N_2O addition, using a thermostatic, robotized incubation system. Under aerobic conditions (initial O_2 concentrations 21% O_2 v/v), N_2O consumption increased with increasing soil water content, but significant N_2O consumption and N_2

production was still measured at 2% moisture. The steady N_2O consumption measured in the field in Taihang Mountain was confirmed by the laboratory experiments, which confirmed that soil can take up N_2O from the atmosphere and reduce it to N_2 under dry and oxic conditions (Wu et al. 2013).

Does aerobic N_2O reduction (N_2 production) contribute to negative soil N_2O fluxes? The importance of di-nitrogen (N_2) production via aerobic pathways has been verified in a significant number of pure microbial strains. However, to date there are no reports confirming this *in situ*. To confirm that, we extracted micro-biota from three typical upland soils with variable properties and incubated them under aerobic and anaerobic conditions, with nitrate, to investigate whether N_2 production occurred via aerobic pathways and the relative importance of it when compared with the N_2 production via anaerobic pathways. Our results showed that N_2 can be produced in soil extracts under aerobic conditions, and that the N_2 produced via aerobic pathways equated to 29-51% of that produced via anaerobic pathways. Thus, N_2 production via aerobic pathways may play a significant role in soil nitrogen (N) cycling. Our results demonstrate that an O_2 deficit may not to be a requirement for converting reactive N back into inert N_2, and consequently this process may be more widespread in upland soils than currently thought (Qin et al. 2017).

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