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The response patterns of community traits of N_2O emission-related functional guilds to temperature across different arable soils under inorganic fertilization

Chang Yin [a], Fenliang Fan [a], Alin Song [a], Xiaoping Fan [b], Hong Ding [c], Wei Ran [d], Huizhen Qiu [e], Yongchao Liang [b, *]

[a] Key Laboratory of Plant Nutrition and Fertilizer, Ministry of Agriculture, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, China
[b] Key Laboratory of Environment Remediation and Ecological Health, Ministry of Education, College of Environmental & Resource Sciences, Zhejiang University, Hangzhou 310058, China
[c] Institute of Soil & Fertilizer, Fujian Academy of Agricultural Sciences, Fuzhou 350013, China
[d] College of Resources and Environment, Nanjing Agricultural University, Nanjing 210095, China
[e] College of Resources & Environment, Gansu Agricultural University, Lanzhou 730070, China

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ABSTRACT

Temperature is an important factor governing the community traits of N_2O-emission related functional guilds (mainly autotrophic ammonia oxidizers and heterotrophic denitrifiers) and their activities. However, there have been few attempts to explore the broad response patterns of these guilds to temperature changes across arable soils. For this, a temperature-controlled (15, 25 and 35 °C) microcosm experiment was conducted using three arable soils (Fujian, Gansu, and Jiangsu) in China under two different fertilizations (no fertilization control (CK) and inorganic fertilization (NPK)). In conjunction with the measurement of N_2O emission, the community structure and abundance of ammonia oxidizing archaea (AOA) and bacteria (AOB), as well as *nirS*- and *nirK*-denitrifiers were assessed using T-RFLP and quantitative PCR, respectively. The analysis of community traits indicated a consistent response pattern of AOAs to temperature in terms of guild abundance, and a consistent effect of inorganic fertilization on the abundance of AOBs, but soil-dependent response patterns to fertilization and temperature were found for *nirS*- and *nirK*-denitrifiers in terms of abundance and community structure. The correlation analysis suggested that AOAs possibly assumed a role in N_2O emission in all the tested soils, and *nirS*-denitrifiers probably participated in N_2O emission in both the Fujian and Gansu soil, while a considerable amount of N_2O emission in the Jiangsu soil might have been derived from heterotrophic nitrification.

1. Introduction

Temperature is a major factor governing microbial metabolism in general (Paul and Clark, 1989) and the emission of greenhouse gases in particular, such as those of CO_2, CH_4 and N_2O (Smith, 1997). Among these, N_2O is of particular interest due to both its net greenhouse effect per unit mass approximating to 300 times larger than that of CO_2 on a 100-year time span (Lashof and Ahuja, 1990), and its ability to deplete the ozone layer (Ravishankara et al., 2009). Meanwhile, ~50% of the global anthropogenic N_2O emission is derived from agricultural soil, thus the N_2O emission in agricultural soils is of significant environmental consequences (Mosier et al., 1998). As shown in previous experiments, temperature can impact N_2O emission in soils both directly and indirectly (Smith, 1997), and the sensitivity of N_2O emission to temperature varies among different soils, with both increases and declines in N_2O emission in response to temperature increases being reported (e.g. Focht and Verstraete, 1977; Maag and Vinther, 1996; Smith, 1997; Godde and Conrad, 1999; Dobbie and Smith, 2001; Avrahami and Bohannan, 2009). Most research suggests that N_2O emission is positively correlated with soil temperature.

The effect of temperature on N_2O emission has a profound microbial basis (Smith, 1997; Braker and Conrad, 2011; Butterbach-

* Corresponding author.
E-mail address: ycliang@zju.edu.cn (Y. Liang).

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