Geoderma 382 (2021) 114752

Contents lists available at ScienceDirect

Geoderma

journal homepage: www.elsevier.com/locate/geoderma

The stronger impact of inorganic nitrogen fertilization on soil bacterial community than organic fertilization in short-term condition

Meiling Zhang [a], Xin Zhang [a], Liyu Zhang [a], Li Zeng [a,b], Yao Liu [c], Xiubin Wang [a], Ping He [a], Shutian Li [a], Guoqing Liang [a], Wei Zhou [a], Chao Ai [a,*]

[a] *Ministry of Agriculture Key Laboratory of Plant Nutrition and Fertilizer, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, PR China*
[b] *College of Resources and Environment, Southwest University, Chongqing 400715, PR China*
[c] *National Center of Science and Technology Evaluation, MOST, Beijing 100081, PR China*

A R T I C L E I N F O

Handling Editor: Daniel Said-Pullicino

Keywords:
Short-term fertilization
Chemical N fertilization
Organic fertilization
Soil bacterial community

A B S T R A C T

Nitrogen (N) fertilization is a pivotal contributor to increasing crop yields. The substantial long-term effects of fertilization on soil microbial communities have been clearly verified. However, the short-term impacts of inorganic and organic fertilization are more stochastic and less deterministic in different agroecosystems, especially at a large spatial scale. Here, we examined the effect of 3 years of different fertilization strategies (i.e., no N fertilizer, inorganic N fertilization, and total or partial replacement of inorganic N by organic manure) on the soil bacterial community in three agroecosystem types spanning the middle temperate zone to the subtropical zone. The results showed that the main contribution to the changes in soil bacterial community structure were dominated by geographic location, which accounted for 61.60% of structural variation, while sampling season and fertilization practice explained 1.52% and 0.61%, respectively. Across three contrasting agroecosystem types, the inorganic N-alone application had greater impacts on the bacterial community structure than organic N fertilization, but the changes in composition were dependent on geographic location. Further, N fertilizer addition reduced soil bacterial network complexity and connectivity; specifically, some key module hubs belonging to non-dominant taxa were lost in N-fertilized upland soils, indicating reduced diversity and stability of the soil micro-ecosystem. Together, our results suggest that, when compared with the mild organic N source, the short-term stimulatory effect of chemical N fertilizer tended not to be beneficial for agroecosystem stability and sustainability.

1. Introduction

Fertilizer nitrogen (N) inputs have been a pivotal contributor to increasing crop yields and providing food for the growing global human population (Robertson and Vitousek, 2009). Currently, the anthropogenic N fixation rate has increased to 210 Tg per year of which 57% come through Haber-Bosch process for fertilizers. This huge artificial resource has resulted in near doubling of global N cycling over the last century (Fowler et al., 2013). The negative consequences of a large amount of N fertilizer application have become more clearly visible in recent years, such as biodiversity loss, environmental degradation and climate change (Edwards et al., 2015). These problems are prominent in China because approximately 35% of globally produced chemical fertilizer is consumed here. Therefore, the development of low-input and highly productive farming systems is becoming more important. Compound organic–inorganic fertilization is one alternative to partly or substantially replace chemical fertilization (Zhao et al., 2016).

Inorganic N fertilizer such as urea, which has the benefits of high and fast nutrient release, can quickly enhance crop growth and directly stimulate the microbial community (Li et al., 2019; Ramirez et al., 2010). In a systematic analysis of how global change disturbance impacted the microbial community, Allison and Martiny (2008) found that 84% of 38 studies showed a significant sensitivity of soil microbial community composition to chemical fertilization. The changes in ammonia nitrogen (NH_4^+-N) and pH induced by inorganic fertilization may be two of the most important factors affecting the structure and

* Corresponding author at: Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, No. 12, Zhongguancun South Street, Beijing 100081, PR China.
E-mail address: aichao@caas.cn (C. Ai).

https://doi.org/10.1016/j.geoderma.2020.114752
Received 4 June 2020; Received in revised form 14 August 2020; Accepted 21 September 2020