European Journal of Soil Biology 74 (2016) 1–8

Contents lists available at ScienceDirect

European Journal of Soil Biology

journal homepage: http://www.elsevier.com/locate/ejsobi

Original article

Effect of biochar additions to soil on nitrogen leaching, microbial biomass and bacterial community structure

Nan Xu [a], Guangcai Tan [a], Hongyuan Wang [b, *], Xiapu Gai [b]

[a] Key Laboratory for Heavy Metal Pollution Control and Reutilization, School of Environment and Energy, Peking University Shenzhen Graduate School, Shenzhen 518055, China
[b] Key Laboratory of Nonpoint Source Pollution Control, Ministry of Agriculture, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, China

ARTICLE INFO

Article history:
Received 22 July 2015
Received in revised form
16 February 2016
Accepted 17 February 2016
Available online xxx

Handling Editor: C.C. Tebbe

Keywords:
Biochar
Nitrogen leaching
Microbial biomass
Bacterial community structure
High-throughput sequencing

ABSTRACT

Previous studies already demonstrated that biochar addition reduces nitrogen (N) leaching in soil, but little information is available about its effects on N leaching and bacterial community structure under the application of organic N. This study investigated the effects of corn-straw biochar under the application of urea (250 kg N ha^{-1}) in layered soil columns. The PCR-amplified partial 16S rRNA genes in soil were sequenced before and after biochar treatment in order to assess the change of bacterial diversity and community structure utilizing the Illumina technology. With the application of 2% (B2), 4% (B4) and 8% (B8) biochar (mass ratio), the cumulative amount of total leached nitrogen was reduced by 18.8%, 19.5% and 20.2%, respectively ($P < 0.05$). More than 90% of the total nitrogen leaching was in the form of nitrate, and increasing amount of biochar resulted in reduced amount of N leaching. The water holding capacity, microbial biomass, pH, electrical conductivity, net N mineralization and respiration rate of the soil were all increased under biochar treatments, except that the B8 treatment decreased soil respiration rate and net N mineralization in comparison with B4. Bacterial diversity increased in biochar-amended soil and was positively correlated with the addition ratio of biochar. Dominant phyla across all samples were *Proteobacteria*, *Acidobacteria*, *Chloroflexi*, *Bacteroidetes*, *Actinobacteria*, *Nitrospirae* and *Gemmatimonadetes*. The relative abundance of *Acidobacteria*, *Chloroflexi* and *Gemmatimonadetes* decreased under biochar treatments, while that of *Proteobacteria*, *Bacteroidetes* and *Actinobacteria* increased. Overall, biochar increased water holding capacity, enhanced microbial biomass and changed bacterial community structure of the soil which may all have contributed to the reduction of nitrogen leaching.

1. Introduction

Excessive and/or unbalanced application of nitrogen fertilizers has caused the translocation of nitrogen (N) from farmlands into aquatic systems. Nitrogen, especially in the form of nitrate, is easily soluble in soil pore water, and readily infiltrates beneath the active soil layer with crop root. The N leaching may deplete soil fertility, accelerate soil acidification and reduce crop yields [1]. Moreover, N leaching is regarded as a major contributor to the eutrophication of surface and ground water [2].

Recently, the interest in applying biochar in soil has grown, which is due to the dual benefits of biochar on both climate change mitigation and positive soil amendment [3,4]. Biochar is a solid carbon-rich organic material generated by heating biomass under condition of limited or no oxygen [5]. Previous studies already demonstrated that biochar addition reduces N leaching. This could be attributed to the increase of cation and anion exchange capacities (CEC, AEC) of soil by the biochar material [6,7]. Another reason could be the physical retention of available N dissolved in the soil solution, as the water holding capacity also increased in biochar-amended soil [6]. Although organic N, like urea, is widely used in agriculture, little information is available about the effect of biochar on N leaching and biological interactions under the application of organic N.

Soil amendment with biochar could modify physical and chemical properties of the habitat for microbial colonization, and therefore affect soil microbial activity and community structure [8,9]. Transformation of microbial communities can be associated

* Corresponding author.
E-mail address: wanghongyuan@caas.cn (H. Wang).

http://dx.doi.org/10.1016/j.ejsobi.2016.02.004
1164-5563/