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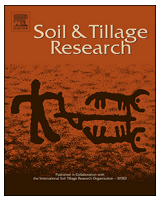

Changes in soil organic carbon and microbial community under varying straw incorporation strategies

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ABSTRACT

Straw return is a popular management strategy to improve soil organic carbon (SOC) and change soil microbial community structure in agro-ecosystems. In the North China plain, the average straw incorporation rate is 6000–10,000 kg ha^{-1}, however, effective utilization of maize straw is difficult because of its large amount and volume. A four-year (2014–2017) experiment was conducted to investigate the effects of different forms of maize straw on subsoil SOC fractions and microbial communities under deep-buried (30–40 cm) management in a typic Agrosol in Liaohe plain. Six treatments were established: no straw (CK, 0 kg ha^{-1}), whole straw (WS, 6000 kg ha^{-1}), chopped straw (CS, 6000 kg ha^{-1}), pelletized straw (PS, 6000 kg ha^{-1}), straw biochar (BC, 2010 kg ha^{-1}) and straw ash (SA, 960 kg ha^{-1}). Soil organic carbon, dissolved organic carbon (DOC), microbial biomass carbon (MBC), and bacterial and fungal diversity and abundance were analysed by chemical and molecular methods. Compared with CK, the five treatments significantly increased the SOC pool by 1.4–4.8 % in the 0–20 cm soil depth and 3.2–14.2 % in the 20–40 cm depth, with the highest increase under CS. Both CS and WS significantly increased the DOC and MBC, with higher DOC/SOC and MBC/SOC ratios. Notably, straw incorporation showed greater effects on DOC and MBC and a higher increase in SOC fractions in the 20–40 cm depth. Principal component analysis and similarity analysis showed that the different forms of straw incorporation caused significant variations in microbial community structure in the subsoil layer. The BC and SA significantly increased the diversity of soil microorganisms, while CS and WS altered the relative abundance of the dominant bacterial phyla *Acidobacteria*, *Nitrospirae*, *Proteobacteria*, *Verrucomicrobia* and dominant fungal phyla *Ascomycota*, *Morttierellomycota*, *Glomeromycota*, which increased with increases in SOC fractions. Our results showed that regulation of C-related microbial abundance in the subsoil was more conducive to improving SOC fractions than simply improving soil microbial diversity. Since chopped straw significantly increased the abundance of C-related microflora and SOC fractions, it should be the optimal form of incorporation in deep-buried straw management.

1. Introduction

Soil organic carbon (SOC) accounts for about 60 % of soil organic matter, and it plays an important role in improving soil fertility and sustaining soil productivity (Chen et al., 2017). Studies have suggested that with an increase in SOC by 1 g kg^{-1}, crop yield in summer maize and winter wheat rotation can increase by about 500 kg ha^{-1} in the North China (Qiu et al., 2009). Dissolved organic C (DOC) and microbial biomass C (MBC) are two important SOC fractions which are more sensitive to short-term changes in agricultural soil ecosystems. Dissolved organic C is widely known to play a critical role in several soil processes and can affect the mobility and availability of soil nutrients such as nitrogen (N), phosphorus (P) and sulphur (S) (Kaiser et al., 2001; Kalbitz et al., 2000). Microbial biomass C is more sensitive than SOC and DOC under sustainable cropping systems (Anderson and Domsch, 1989), especially under different tillage management practices (Franzluebbers et al., 1995; Salinas-García et al., 1997). Therefore, grasping the changes of DOC and MBC will help us to better observe the dynamics of SOC, so as to guide soil carbon sequestration and crop production.

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