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Changes in mineral-associated carbon and nitrogen by long-term fertilization and sequestration potential with various cropping across China dry croplands

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A B S T R A C T

Mineral-associated organic carbon (MOC) and mineral-associated nitrogen (MN) are the major pools of total soil organic carbon (TSOC) and total nitrogen (TN) stocks. Thus, it is important to understand the impact of agricultural practices on MOC and MN stocks and capacities. The present study aimed to explore how the application of various fertilizers and crop rotation affect MOC and MN, and how improved management practices sequester carbon and nitrogen as MOC and MN to mitigate climate change. Twenty-one long-term experiments across China dry croplands with various soil types and crop rotations were involved to investigate the effects of the application of various fertilizers on MOC and MN. Results showed that mineral fertilizers combined with manure significantly increased TSOC (62 %) and TN (57 %), and MOC (33 %) and MN (32 %) concentrations, respectively, resulting in decreased ratios of MOC/TSOC (0.59) and MN/TN (0.47). Moreover, mineral fertilizers with straw significantly increased MOC/TSOC ratio, but had no effects on MN/TN ratio compared with mineral fertilizer application (0.72 − 0.77). Significantly positive linear correlations were observed between MOC (MN) concentrations and the mass proportion of fine soil particles (< 20 μm). Further analysis suggested that TN, TSOC, crop rotation (e.g., wheat-maize, wheat-soybean, maize-soybean, maize-rape, and maize monoculture), and fine soil particle content were the key regulating factors, which accounted for about72 % of the variations of MOC and MN concentration. Boundary line analysis suggested that MOC and MN had the potential to increase by 48 % and 39 %, respectively. In conclusion, main dry croplands in China might sequester an additional 527 Tg for MOC and 37 Tg for MN with appropriate crop rotation and manure application.

1. Introduction

Developing strategies for soil organic matter accumulation in agricultural soil not only benefits crop productivity and mitigation of greenhouse gas emissions (Bremer et al., 2011), but also is critical for the structural stability of soils (Cai et al., 2016a; Gregorich et al., 2006). Soil organic matter stabilization has been attributed to three possible mechanisms: the molecular characteristics (recalcitrance) of soil organic matter; the spatial inaccessibility of soil organic matter through the formation of aggregates; and the association of soil organic matter with fine soil particles (< 20 μm), i.e. with minerals. Mineral-associated organic carbon (MOC) and mineral-associated nitrogen (MN) are generally regarded as highly stable with a relatively long turnover time and insensitive to changes in management practices (Balesdent et al., 1998; Gregorich et al., 2006). The MOC and MN also represent approximately 63–82 % of the total soil organic carbon (TSOC) and total nitrogen (TN) in most soils, therefore serve as an important and stable pool of soil organic matter (Cai et al., 2016a).

With regards to arable soil, MOC and MN concentrations are greatly influenced by soil texture, management practices, and climate conditions (Arrouays et al., 2006; Cai et al., 2016a). Exogenous carbon (C) and nitrogen (N) inputs are stabilized by soil microbes into soil mineral

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