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Soil organic carbon dynamics under long-term fertilizations in arable land of northern China

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Abstract. Soil carbon sequestration is a complex process influenced by agricultural practices, climate and soil conditions. This paper reports a study of long-term fertilization impacts on soil organic carbon (SOC) dynamic from six long-term experiments. The experiment sites are located from warm-temperate zone with a double-cropping system of corn (*Zea mays* L.) – wheat (*Triticum Aestivium* L.) rotation, to mild-temperate zones with mono-cropping systems of continuous corn, or a three-year rotation of corn-wheat-wheat. Mineral fertilizer applications result in an increasing trend in SOC except in the arid and semi-arid areas with the mono-cropping systems. Additional manure application is important to maintain SOC level in the arid and semi-arid areas. Carbon conversion rate is significant lower in the warm-temperate zone with double cropping system (6.8%–7.7%) than that in the mild-temperate areas with mono-cropping systems (15.8%–31.0%). The conversion rate is significantly correlated with annual precipitation and active accumulative temperature, i.e., higher conversion rate under lower precipitation and/or temperature conditions. Moreover, soil high in clay content has higher conversion rate than soils low in clay content. Soil carbon sequestration rate ranges from 0.07 to 1.461 t ha^{-1} year^{-1} in the upland of northern China. There is significantly linear correlation between soil carbon sequestration and carbon input at most sites, indicating that these soils are not carbon-saturated thus have potential to migrate more CO_2 from atmosphere.

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1 Introduction

Soil organic carbon (SOC) is an important index of soil fertility because of its relationship to crop productivity (Vinther et al., 2004; Pan et al., 2009). For instance, declining SOC levels often leads to decreased crop productivity (Dominy et al., 2002; Lal, 2006). Thus, maintaining SOC level is essential for agricultural sustainability. The concept of sustainable agricultural production emphasizes the importance of SOC management for food security and environment protection (Buyanovsky and Wagner, 1998; Pan et al., 2009). Because of the potential of agro-ecosystems to absorb a large amount of atmospheric carbon dioxide through soil carbon sequestration, SOC management is recognized as a "win-win strategy" (Smith et al., 1999; Lal, 2002), and has been put forward as one of the mitigating options for global climate change (Post et al., 2004). Particularly, it is estimated that, in China, the potential of soil carbon sequestration may offset more than 10% of the annual fossil fuel emissions (Lal, 2004).

Soil carbon sequestration is a complex process that is influenced by many factors, such as agricultural practice, and climatic and soil conditions. A number of studies indicate that SOC levels increase under practices of balanced fertilization, organic amendments, cropping rotations, conservative tillage (e.g., no-till), and reduced fallow (Su et al., 2006; Bhattacharyya et al., 2007; Purakayastha et al., 2008; Gong et al., 2009; Tong et al., 2009). Particularly, there is evidence of improved soil fertility and increased carbon sequestration in Chinese croplands due to extensive applications of balanced fertilization over the past 20 years, especially with additional organic materials and/or incorporation of crop residue (Huang and Sun, 2006).

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