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RESEARCH ARTICLE

The efficiency of long-term straw return to sequester organic carbon in Northeast China's cropland

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Abstract

Black soil is one of the most precious soil resources on earth because it has abundant carbon stocks and a relatively high production capacity. However, decreasing organic matter after land reclamation, and the effects of long-term inputs of organic carbon have made it less fertile black soil in Northeast China. Straw return could be an effective method for improving soil organic carbon (SOC) sequestration in black soils. The objective of this study was to evaluate whether straw return effectively increases SOC sequestration. Long-term field experiments were conducted at three sites in Northeast China with varying latitudes and SOC densities. Study plots were subjected to three treatments: no fertilization (CK); inorganic fertilization (NPK); and NPK plus straw return (NPKS). The results showed that the SOC stocks resulting from NPKS treatment were 4.0 and 5.7% higher than those from NPK treatment at two sites, but straw return did not significantly affect the SOC stocks at the third site. Furthermore, at higher SOC densities, the NPKS treatment resulted in significantly higher soil carbon sequestration rates (CSR) than the NPK treatment. The equilibrium value of the CSR for the NPKS treatment equated to cultivation times of 17, 11, and 8 years at the different sites. Straw return did not significantly increase the SOC stocks in regions with low SOC densities, but did enhance the C pool in regions with high SOC densities. These results show that there is strong regional variation in the effects of straw return on the SOC stocks in black soil in Northeast China. Additional cultivations and fertilization practices should be used when straw return is considered as an approach for the long-term improvement of the soil organic carbon pool.

Keywords: soil organic carbon (SOC), SOC stock, straw return, soil sequestration rate, straw-C sequestration efficiency, black soil, long-term experiments

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1. Introduction

Soil contains the largest carbon (C) pool of the global terrestrial ecosystem. The total soil organic carbon (SOC) pool is approximately 1 500 Pg C, which is three times that of the atmospheric carbon pool (Song *et al.* 2014). Soil organic