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Buried straw layer plus plastic mulching improves soil organic carbon fractions in an arid saline soil from Northwest China

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ABSTRACT

Salt stress has been increasingly constraining crop productivity in arid lands of the world and there is some evidence that a combination of straw layer burial and plastic film mulching alleviates salt stress and increases microflora diversity in a saline soil. However, their impacts on soil organic C (SOC), especially its active fraction are not well documented. We studied the combined effects of burying straw layer and plastic mulching on SOC, microbial biomass C (MBC) and dissolved organic C (DOC) using the following four treatments: deep ploughing with no plastic film mulching (CK); deep ploughing with plastic film mulching (PM); buried maize straw layer with no mulching (SL); and buried maize straw layer plus plastic film mulching (PM + SL). Compared with CK and PM, the PM + SL and SL treatments significantly enhanced the allocation of SOC to the 20–40 cm soil layer, due to an adequate supply of organic carbon from straw incorporation; the SOC value under PM + SL significantly decreased in the topsoil (0–20 cm) after 4 years, while that under CK and SL was little altered. After 4 years, the SOC under PM + SL and SL treatments increased by 5.84 and 10.78% ($P < 0.05$) in the 0–40 cm soil layer but that under PM decreased 6.79% ($P < 0.05$) while that under CK changed little. Although PM + SL and SL had much higher SOC at the 30–40 cm layer than CK and PM, the straw effect on soil layers greater than 40 cm was not significant. The increase in SOC within the entire 60 cm soil layer (from 5.01% in 2013 to 10.64% in 2014) under PM + SL was more pronounced. PM + SL also showed the highest contents of MBC and DOC due to the combined effect of plastic mulching and straw layer. The effect of straw burial on the MBC and DOC was more significant than that of plastic mulching, but the increase in MBC under PM + SL, SL and PM decreased with time, possibly because of the combined effects of water, heat and salinity as well as the increased stability of soil aggregates. The DOC under PM + SL and SL was basically stable compared with that under CK and PM. Significant positive correlations ($P < 0.01$) were observed between SOC and MBC and between SOC and DOC. Soil temperature and the difference in salt content at sowing and maturity had significant ($P < 0.01$) positive correlations with SOC and MBC, but soil water showed significant ($P < 0.01$) negative correlations with all the carbon fractions. Overall, the combined use of buried straw layer with plastic mulching could be a practical option for increasing the SOC in an arid saline soil.

1. Introduction

Different cultural practices may have different effects on the soil carbon (C) cycle, and these effects may vary with soil type and climatic conditions (Lal, 2004). Saline soils are widespread throughout the world and occupy about 400 million ha (FAO, 2008). About 20% of the world's irrigated land especially in arid and semi-arid regions, is salt-affected and/or irrigated with water containing elevated salt levels (Qadir et al., 2008). Saline soils have lower soil organic C (SOC) concentrations and crop yields than non-saline soils (Pankhurst et al., 2001). For example, the SOC concentration in surface arid saline soil is 5.8 g kg^{-1}, which is only 40% of that of other agricultural soils (Wang et al., 2004). The poor productivity of saline soil because of its large salt content, poor structure and porosity limits further C accumulation. The addition of organic materials such as farmyard manure, crop straw

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