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Effects of different long-term tillage systems on the composition of organic matter by ^{13}C CP/TOSS NMR in physical fractions in the Loess Plateau of China

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ABSTRACT

The adoption of conservation tillage is promising for soil management system in the Loess Plateau of China; however, how conservation tillage influences the molecular structure contributes and long-term stabilization of soil organic matter (SOM) is still not clear in this area. In this study, experimental plots were continually cultivated with winter wheat (*Triticum aestivum* L.) and soil samples were collected in September 2009 and September 2015, 10 and 16 years after the experiment was initiated, respectively. Four treatments were applied: reduced tillage (RT), no tillage (NT), sub-soiling (SS) and conventional tillage (CT). Soil samples were physically fractionated into five fractions: free light fraction (FLF), occluded light fraction (OLF), coarse sand particulate organic matter (c-POM), fine sand particulate organic matter (f-POM) and mineral associated organic matter + silt + clay (m-SOM). The soil organic carbon (SOC) stocks were analysed in SOM fractions and bulk soil (BS). Solid state ^{13}C cross polarization/total sideband suppression nuclear magnetic resonance (^{13}C CP/TOSS NMR) spectroscopy was applied to determine the abundance of different forms of carbon (C) (carboxyl C, O/N-alkyl C, aromatic C and alkyl C) in the soil physical fractions.

The SOC stocks in the 0–30 cm layer were influenced by the tillage systems. Although there were no significant differences in SOC stocks among these four treatments in the 0–10 and 10–20 cm layers in first 10 years, after 16 years, the SOC stocks were highest in the SS and NT treatments in the 0–10 cm layer. As the duration of the experiment increased from 2009 to 2015, the SOC content of m-SOM-C fraction under RT and CT also increased. As determined by ^{13}C NMR, in the light fractions (FLF to OLF), the abundance of aromatic C increased when the abundance of O/N-alkyl C declined and there was a higher aromatic C/O/N-alkyl C ratio. A gradual increase in the abundance of alkyl C of heavy fractions was accompanied by a decrease in aromatic C, which might be due to the microbial by-products deposited on mineral surface in the soils. In addition, a higher SOM preservation were shown in conservation tillage (NT and SS) by our NMR data. Particular interesting were the results of the light and c-POM fractions, in which conservation tillage showed a higher abundance of O/N-alkyl C and a lower aromatic C/O/N-alkyl C ratio in these two fractions compared with conventional tillage (RT and CT).However, these changes were not evident in the heavy fractions. The changes in the chemical structures of the light and c-POM fractions were possibly due to the retention of crop residues and low levels of soil disturbance. In conclusion, long-term conservation tillage affected the fractions and the chemical functional groups of SOM and could be ideal to preserve SOC in the Loess Plateau.

1. Introduction

Soils play a pivotal role in the global carbon (C) cycle and act as a C sink in the terrestrial ecosystem (Post et al., 1982; Assefa et al., 2017). Worldwide, soils are estimated to store approximately 3150 Pg of C and hold more than three times more C than the atmosphere (Sabine et al.,

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