European Journal of Soil Science

European Journal of Soil Science, 2018 doi: 10.1111/ejss.12688

Distinct changes in composition of soil organic matter with length of cropping time in subsoils of a Phaeozem and Chernozem

Y.-L. Zhang[a*], L.-J. Li[b*], S.-H. Yao[a], J.-D. Mao[c], K. Schmidt-Rohr[d], D. C. Olk[e], X.-Y. Cao[d], J.-F. Cui[f] & B. Zhang[a,b]

[a]*National Engineering Laboratory for Improving Quality of Arable Land, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing, 100081, China,* [b]*Key Laboratory of Mollisols Agroecology, National Field Observation and Research Station of Hailun Agroecosystems, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Harbin, 150081, China,* [c]*Department of Chemistry and Biochemistry, Old Dominion University, Norfolk, Virginia 23529, USA,* [d]*Department of Chemistry, Brandeis University, Waltham, Massachusetts 02453, USA,* [e]*USDA-ARS National Laboratory for Agriculture and the Environment, University Boulevard, Ames, Iowa 50011, USA, and* [f]*Department of Chemistry, Hach Hall, Iowa State University, Ames, Iowa 50011, USA*

Summary

Deeper soil horizons might provide an opportunity to enhance C sequestration because soil organic matter (SOM) at depth is assumed to be stable. However, it is unknown whether the stable composition of organic carbon in subsoils changes with the length of cropping time and the type of soil. The objectives of this study were to determine the effects on the chemical structures of SOM of cropping time after conversion from grassland to arable land under a Phaeozem and Chernozem in northeast China. Near-quantitative multiple cross-polarization (multiCP) ^{13}C nuclear magnetic resonance (NMR) spectroscopy was applied, and 11 types of carbon (C) functional groups were identified. Principal component analysis of these functional groups showed that the chemical composition of SOM was differentiated by soil type and depth. The Phaeozem and Chernozem profiles differed mainly in their relative proportions of aromatic C–C and $(CH_2)_n$ groups: the Phaeozem contained relatively more aromatic C–C, whereas the Chernozem contained relatively more $(CH_2)_n$ groups. The fused-ring aromatic C–C carbon was probably derived from char-like organic matter generated by burning of plant litter or from SOM humification, whereas the $(CH_2)_n$ groups were likely to be from plant- or microbially-derived residues. The main differences between top- and sub-soils were the occurrence of more protonated C in the topsoils and more non-protonated C in the subsoils. With increasing length of cropping time, aromatic C–C and C–O groups and COO/N–C=O groups increased, but $(CH_2)_n$ groups decreased in the Phaeozem subsoils and increased in the Chernozem subsoils. Our findings suggested that leaching and soil moisture might influence the origin, redistribution and transformation of the recalcitrant components of SOM in the soil profile, resulting in changes in SOM composition under different climates and soil types.

Highlights

- Characterization of chemical structures of soil organic matter (SOM) in soil profiles by solid-state ^{13}C NMR
- SOM composition varied between a Phaeozem and Chernozem and to a larger extent in the subsoils
- Fused-ring aromatics and $(CH_2)_n$ groups accumulated in subsoils of the Phaeozem and Chernozem, respectively
- SOM composition of subsoil changed probably with precipitation-controlled translocation or transformation

Correspondence: B. Zhang. E-mail: zhangbin01@caas.cn
*These authors contributed equally to this work.
Received 22 November 2017; revised version accepted 9 April 2018