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Mechanisms affecting root carbon decomposition and stabilisation at different soil depths

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The relationship between root litter addition and soil organic matter (SOM) formation in top- versus subsoils is unknown. The aim of this study was to investigate root litter decomposition and stabilisation in relation to microbial parameters in different soil depths. Our conceptual approach included incubation of 13C-labelled wheat roots at 30, 60 and 90 cm soil depth for 36 months under field conditions. Quantitative root carbon contribution to SOM was assessed, changes of bulk root chemistry studied by solid-state 13C NMR spectroscopy and lignin content and composition was assessed after CuO oxidation. Compound-specific isotope analysis allowed to investigate mineral interactions as SOM stabilisation mechanism spatially resolved at different soil depths. Microbial biomass and community structure was determined after DNA extraction.

After three years of incubation, similar amounts of root C were remaining at all soil depth. O-alkyl C most likely assigned to polysaccharides decreased at all soil depth compared to the initial root material. The degree of root litter decomposition assessed by the alkyl/O-alkyl ratio decreased with increasing soil depth, while aryl/O-alkyl ratio was highest at 60 cm depth. Root-derived lignin showed depth specific concentrations (30 < 90 < 60 cm). Its composition was soil depth independent suggesting that microbial communities in all three soil depths had similar degradation abilities. Microbial biomass C and fungi contribution increased after root litter addition. Their community structure changed after root litter addition and showed horizon specific dynamics. Stabilisation by mineral interactions was important throughout the soil profile but affected different compounds in top- and subsoil. We conclude that specific conditions of single soil horizons have to be taken into account if root C dynamics are to be fully understood.