Carbon transformations in the rhizosphere: The critical role of microbial functional capacity

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Carbon cycling in the rhizosphere is a nexus of biophysical interactions between plant roots, microorganisms, and the soil organo-mineral matrix. Our research on how roots influence decomposition of soil organic matter in both simplified and complex microcosms uses geochemical characterization, molecular microbiology, isotope tracing and novel NanoSIMS-based imaging approaches to trace the fate of isotopically labelled root exudates and plant tissues. In the work presented here, we examined the effects of both live and dead *Avena fatua* roots (a common California annual grass) on decomposition in the rhizosphere. The presence of live roots consistently suppressed rates of ^{13}C-labeled root litter decomposition. The presence of live roots also significantly altered the abundance, composition and functional potential of microbial communities (assessed by both metagenomic and transcriptome sequencing). Planted soils had relatively more genes involved in low molecular weight compound degradation; unplanted soil microbes had more macromolecule degradation genes. Higher abundances of proV and proW genes (glycine betaine transport) in planted soils suggest microbes experience more severe water stress in planted soils. RNA-seq ans stable isotope probing analysis showed that living roots in the presence of decaying root material had differential effects on soil food webs and organisms participating in co-metabolism of exudates and decaying biomass. A conceptual model based on our recently collected data indicates that primary factor driving litter decomposition in the rhizosphere is microbial functional potential. Our results indicate that these microbial functional capacities differ in rhizosphere versus bulk soils, which may have implications for carbon stabilization in soil.