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Plant-microbe-mineral interactions within a soil profile

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Abstract

The rhizosphere microbiome is critical to plant performance and soil biogeochemical cycling with important global carbon cycle feedback, including plant growth, stress tolerance, and carbon metabolism. Our research aims to determine how the rhizosphere of perennial plants influences microbial structure and function throughout the soil profile and the implications of plant-microbe-mineral interactions on carbon cycling. We conducted our research in a marginal soil, using a multi-omics approach to determine the structure and function of the rhizosphere microbiome, including relationships with abiotic soil properties. Plant inputs influenced the soil microbiome composition and significantly increased the relative abundance of multiple taxa. Although rhizosphere effects on community members were more pronounced than soil depth, we found significant shifts in metabolic signatures throughout the soil profile. On average, the surface soil had significantly higher levels of trehalose and several sugar alcohols known to be produced in response to water, heat, and salt stress. The surface soil also had significantly higher levels of linoleic acid, which was negatively correlated to calcium concentrations and positively correlated to concentrations of soil organic matter and metal micronutrients. In contrast, the deep calcareous soil horizon contained significantly higher levels of organic acids. Soil calcium concentrations were positively correlated with benzoic acid and lactic acid concentrations, suggesting enhanced dissolution of inorganic C. Together these results illustrate the importance of plant-microbe-mineral interactions in generating and retaining organic and inorganic forms of C throughout the soil profile and provide important considerations for managing the rhizosphere to support sustainable biomass production.