Biogeochemical Profiling of Transient Microenvironments at the Root-Soil Interface

MARIELA GARCIA ARREDONDO[1], ZOE CARDON[2], MORRIS JONES[1], MALAK TFAILY[3], AND MARCO KEILUWEIT[1*]

[1]University of Massachusetts Amherst; mgarciaarred@umass.edu
[2]Marine Biological Laboratory; zcardon@mbl.edu
[1]University of Massachusetts Amherst; morrisjones@umass.edu
[3]PNNL Environmental Molecular Science Lab; malak.tfaily@pnnl.gov
[1]University of Massachusetts Amherst; keiluweit@umass.edu
(*correspondence: keiluweit@umass.edu)

Understanding the role of root-soil interactions in nutrient and organic matter (OM) cycling is critical for projecting climate change impacts on soil fertility and carbon storage. Roots and associated microbes release an array of reactive rhizodeposits into the surrounding soil environment. These chelators, acids, and reductants facilitate mineral dissolution and promote nutrient and OM availability. Both quantity and quality of rhizodeposition is highly variable as roots grow and mature, creating dynamic microenvironments with rapidly changing geochemical conditions and microbial activity. Here, we aimed to define the spatial and temporal dynamics of microenvironents along single roots and their impact on nutrient and OM availability. To accomplish this objective, we combined in-situ electrochemical microsensors with micro-dialysis probes to examine variations in critical geochemical parameters ([O_2], Eh, pH) in relation to changes in quantity and quality of dissolved OM and nutrients at the root-soil surface. Continuous, high-resolution profiling of growing and maturing *Vicia faba* roots over 6 days revealed clear diel cycles, but even more dramatic changes along transects from root tip, to uptake zone, and mature suberized zones. Root tips showed higher concentrations of organic acids, resulting in a sharp decline in pH and an increase in dissolved Fe, Mn and OM concentrations. As roots matured, concentrations of organic reductants increased, leading to declines in Eh and [O_2] as well as an increase in the abundance of microbial metabolites. Our results revealed transient microenvironments along individual roots and suggest that nutrient and OM mobilization strategies vary in both space and time. This *in-situ* microsensor approach opens novel opportunities for identifying coupled biogeochemicall processes at the root-soil surface and their impact on fertility and carbon storage in soils.