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Sticky Roots--Implications of Widespread Viral Infection of Plants for Soil Carbon Processing in the Rhizosphere

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One way that plants strongly influence soil properties is through rhizodeposition, in which exudates diffuse from roots, additional secretions are actively released, and root cells are sloughed into the soil. The core objective of this project is to test whether rhizodeposition can destabilize soil organic matter (SOM) association with minerals, making that SOM more vulnerable to microbial attack.

Mineral associations preserve very large soil carbon pools in terrestrial ecosystems, and DOE's newly developed E3SM Land Model (ELM) includes a representation of that soil carbon preservation. However, the potential vulnerability of SOM–mineral associations to effects of rhizodeposition is not yet represented in ELM. In a novel approach, we are exploring whether plant virus infection can serve as a tool to intensify rhizodeposition, and therefore intensify dissolution of SOM from minerals. Viral infection is widespread in terrestrial ecosystems; 25- 70% of plants have virus infection, yet the influence of such infection on root traits and terrestrial soil carbon dynamics remains largely unexplored.

We are using two plant hosts--the annual *Avena sativa* (oats) and the genetically tractable, model grass *Brachypodium distachyon*—and the broad host range virus Barley Yellow Dwarf Virus (BYDV). BYDV infects at least 150 grass species in agricultural and natural ecosystems, and in previous experiments, roots of oats infected with BYDV had extraordinarily sticky roots, suggesting that infection enhanced rhizodeposition. Uninfected and infected individuals of each host species are being grown individually in replicate "rhizoboxes" (rectangular pots equipped with sensors) for: (1) sampling of organic compounds inside phloem before they diffuse out to soil (using aphid stylectomy); (2) biogeochemical profiling around roots (using Eh and pH sensors, and, sampling of dissolved organic compounds in soil solution); (3) imaging of regions around root supporting extensive microbial growth using living, luminescent microbial biosensors; and (4) incubation and subsequent quantification of mineral- SOM associations in the presence of uninfected vs. infected plant roots. Mechanistic understanding derived from these data will inform future development and application of ELM. If our experiments indicate that high rates of rhizodeposition support a large, active microbial population driving SOM-mineral dissociation, then future research combining experimentation and modeling should explore the strength and larger-scale significance of that cascade of processes. And if viral infection does lead to "sticky roots", our understanding of the potential importance of prevalent virus infection in terrestrial landscapes will be transformed.