Sticky Roots--Implications of Altered Rhizodeposition (Caused by Viral Infection) for Soil Carbon Processing in the Rhizosphere

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Project Abstract: Mineral-associated organic matter (MAOM) is a dominant component of total soil carbon that can be protected from decomposition for millennia. We are studying diverse mechanisms by which plant roots can dislodge organic matter (OM) from soil minerals, enabling its mineralization by microbes and potentially moving associated nutrients into actively cycling pools. The importance of MAOM dynamics has spurred its inclusion in DOE's ELM model, but currently without addition of the root influence on stability of MAOM.

In ESS project (DE-SC0021093), we are using a novel tool to perturb belowground root-microbe-mineral interactions: viral infection. Infection decreases root:shoot ratio, so shoot nutrient demand must be met by more intensive mining of soil per unit root. Further, phloem flow is increased by infection, and roots become "sticky", suggesting altered amounts and/or types of rhizodeposits in the rhizosphere. Using this tool, to date we have experimented with a simple one virus (Barley Yellow Dwarf Virus)–one plant (*Avena sativa*) system. In soil, infected plants exhibited reduced photosynthesis and plant biomass, and root:shoot ratio. Phloem contents of leaves sampled using aphid stylectomy and analyzed by GC-MS included sugars, organic acids, and amino acids. In batch experiments, ^{13}C-labeled MAOM sorbed to lab-synthesized minerals was mobilized by a suite of common root-derived and microbial metabolites (oxalic acid, glucose, and catechol), via distinct direct rapid (mineral dissolution) and indirect slower (microbial) mechanisms. Analysis by FTICR-MS of liquid gathered from around roots of infected and uninfected plants grown hydroponically (therefore with no water or nutrient limitations) suggested a shift toward amino sugars and carbohydrates with infection. Natural perturbations of belowground function (such as via viral infection of plants) will inform incorporation and sensitivity testing of vulnerability of MAOM to rhizodeposition within ELM, potentially with notable implications for long-term soil carbon storage and nutrient availability.