"Sticky Roots" – Rhizodeposition and the fate of mineral-associated soil carbon

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Mineral-associated organic matter (MAOM) is a dominant component of total soil carbon. Once bound to reactive soil minerals, that organic matter can be protected for millennia. In previous lab experiments, however, we have shown that individual compounds commonly released by roots can mobilize MAOM off minerals via direct and indirect mechanisms, making it vulnerable to microbial attack. We are exploring the mechanisms underlying root-induced mobilization of MAOM, and the longer-term, larger-scale implications of that mobilization.

Experimentation: We have developed a tool to manipulate rhizodeposition: controlled viral infection of plants. Barley Yellow Dwarf Virus (BYDV) attacks a broad range of grasses and increases phloem flow, potentially spurring increased delivery of phloem contents to the rhizosphere. We are testing effects of that virus-altered rhizosphere chemistry on MAOM mobilization by exposing plants (*Avena sativa*) to aphids, some carrying BYDV, and some not. **(Result 1)** When infected and uninfected plants were grown from a young age in nutrient replete conditions hydroponically, the solutes in hydroponic liquid around infected vs. uninfected roots differed (as assayed by FTICR-MS). When those solutes were added to nonsterile soil laced with ferrihydrite loaded with ^{13}C-glucose (as a surrogate for MAOM), ~75% more MAOM mobilization and mineralization (as evidenced by $^{13}CO_2$ release) was driven per unit root biomass by solutes gathered around infected plant roots. **(Result 2)** When oats were grown hydroponically to large size, then half were infected with BYDV, virus-infected plants exhibited slightly reduced median leaf number ~10 days after infection. By ~2.5 weeks, virus infection drove ~20% *increase* in DOC in hydroponic solution around roots of infected plants, despite the reduced median leaf number. **(Result 3)** When young BYDV-infected and uninfected oats were grown in soil, plant biomass, photosynthetic rates, and root:shoot ratios were reduced by infection. Amplicon sequencing revealed infection-linked alteration of microbial community composition. **(Activity 4)** We are now conducting a capstone greenhouse soil experiment using BYDV-infected and uninfected *Avena*, testing two hypotheses: Viral infection will intensify ^{13}C-MAOM mobilization and mineralization at root surfaces in soil, but reduced root biomass in infected plants may result in a reduction of whole soil column mineralization of ^{13}C-MAOM.

Modeling: Using *ecosys*, we will test the hypothesis that root-induced MAOM mobilization and mineralization, resulting in entrainment of nutrients (N and P) into actively cycling pools, drives a positive feedback spurring enhanced plant productivity, rhizodeposition, and soil carbon storage in the longer term.