Going with the Flow in the Rhizosphere Commodities Exchange

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More than half of the water that moves from soils to the atmosphere each year is transpired from leaves, and all of that water was first drawn into plants through the rhizospheres of innumerable plant roots. Around those roots, an active microbial and microfaunal community influences nutrient availability to plants and is fueled largely by carbon from roots. The result is a rhizosphere commodities exchange operating in the path of tremendous water flow, with diffusion and advection influencing availability of resources critical for microbial and plant growth. Water does not only flow into roots, however. Water can flow out of roots into dry soil, during “hydraulic redistribution” (HR) in seasonally-dry ecosystems. Our previous field work showed HR during drought in northern Utah nearly doubled decomposition and microbial release of N from soil organic matter in upper soil layers. Whether this stimulation was solely caused by the fleeting, nighttime, HR-linked enhancement of water availability in upper soil layers, or by the oscillation in soil water content driven by daytime transpiration and nighttime HR, or both, remains unclear.

We used a rhizosphere model with competitive cation exchange to investigate how diel plant water use affects competitive ion exchange and community interactions in the rhizosphere. Diel water flow promotes disequilibrium between dissolved and sorbed nutrient concentrations around plant roots, releasing cations from soil at distinct distances with clear diel dynamics. Adding a very simple representation of rhizosphere food web function suggests that oscillating local resource availabilities linked to oscillating water flow may drive enhanced biogeochemical function – increased nutrient availability to plants – that otherwise would not occur.