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Roots bridge water to nutrients: a novel approach on nutrient loss reduction

Jing Yan and Teamrat Ghezzehei
University of California, Merced, Merced, United States (taghezzehei@ucmerced.edu)

While its small volume and narrow region compared to bulk soil, the rhizosphere regulates numerous processes that determine physical structure, nutrient distribution, and biodiversity of soils. One of the most important and distinct functions of the rhizosphere is the capacity of roots to bridge and redistribute soil water from wet soil layers to drier layers. This process was identified and defined as hydraulic lift or hydraulic redistribution, a passive process driven by gradients in water potentials and it has attracted much research attention due to its important role in global water circulation and agriculture security. However, while previous studies mostly focused on the hydrological or physiological impacts of hydraulic redistribution, limited research has been conducted to elucidate its role in nutrient cycling and uptake. In this study, we aim to test the possibility of utilizing hydraulic redistribution to facilitate the nutrient movement and uptake from resource segregated zone. Our overarching hypothesis is that plants can extract nutrients from the drier but nutrient-rich regions by supplying sufficient amounts of water from the wet but nutrient-deficient regions. To test our hypothesis, we designed split-root systems of tomatoes with unequal supply of water and nutrients in different root compartments. More specifically, we transplanted tomato seedlings into sand or soil mediums, and grew them under conditions with alternate 12-h lightness and darkness. We continuously monitored the temperature, water and nutrient content of soils in these separated compartments. The above and below ground biomass were also quantified to evaluate the impacts on the plant growth. The results were compared to a control with evenly supply of water and nutrients to assess the plant growth, nutrient leaching and uptake without hydraulic redistribution.