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***SOIL-PLANT INTERACTIONS: CHEMICAL, PHYSICAL AND BIOLOGICAL PROCESSES***

**NON-TECHNICAL SUMMARY:** Soils are the foundation from which plants grow. Soils and plants, together with soil organisms, form the basis for terrestrial ecosystems in general, and US agriculture and urban development in particular. The objective of this project is to investigate processes and mechanisms in the soil-plant system and to determine how soil-plant interactions affect agricultural, urban, and natural ecosystems. We investigate physical, chemical, and biological processes, both from a foundational as well as an applied perspective. Soil-plant interactions studied in this project include heat and water flow, solute and particle transport, plant-water uptake, nutrient availability and management, rhizosphere microbiology, root physiology and genetics, and metal biogeochemistry and bioavailability. Our investigations of soil-plant interactions range from fundamental studies at the molecular scale (metal biochemistry, root genomics), to the rhizosphere scale (root water and nutrient uptake, particle transport, rhizosphere microbiome), and to the field scale (plant nutrient uptake, nutrient and water management). Better understanding of soil-plant interactions is essential to maintain healthy soils and sustainable agricultural and urban systems.

**OBJECTIVES:** This proposal focuses on chemical, physical, and biological processes that take place in the root zone and rhizosphere environment where soils and plants interact. Our long-term goal is to support US agriculture by providing scientifically sound recommendations for sustainable soil management. Such recommendations have to be based on a thorough understanding of chemical, physical, and biological processes and mechanisms that take place in the root zone and rhizosphere.Given these needs, the specific objectives of this project are:To identify and quantify mechanisms of flow and transport of water, energy, solutes, and colloids in the root zone and rhizosphere.To determine the role of the soil microbiome on metal and nutrient biogeochemistry.To determine how root growth and development as well and phenotypically plastic root traits impact crop health and productivity.To develop management strategies to optimize water and nutrient supply, delivery, and uptake by plants while minimizing availability and uptake of toxic substances and particles.

**APPROACH:** Our methods include an array of physical, chemical, biological, physiological, and genetic tools to assess soil-plant interactions. Specific methods include a suite of microscopic analyses, spectroscopy, x-ray analysis, digital root imaging, microbiological techniques, and

molecular techniques. We will also carry out extensive field experiments and trials. Greenhouse and laboratory studies examining potential soil properties and amendments will be developed. We will deliver our research results through presentations at scientific meetings, peer-reviewed journal articles, and extension activities.

**KEYWORDS:** soil-plant system; rhizosphere; water flow; plant water uptake; nutrient efficiency; rhizosphere microbiology; root physiology and genetics; metal beogeochemistry; nutrient management; water management; microbiome

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