



The Rhizosphere Microbiome as the Second Plant Genome

Rodrigo Mendes

(Embrapa Environment, Brazil)

The rhizosphere microbiome plays a pivotal role in plant physiology, development, and health. It functions as an extension of the plant host genome, mediating key interactions with the surrounding environment. This dynamic, multitrophic community assembles through host-driven selection processes, including root exudation, forming a first line of defense against environmental stresses. When challenged by soil-borne pathogens, plants can activate a “cry for help” response, recruiting beneficial microorganisms to reinforce their defenses and suppress disease. In disease-suppressive soils, attempts by soil-borne pathogens to infect roots are often thwarted by specific microbial consortia that compete for resources and niches or activate antagonistic functions. Metagenomic and metatranscriptomic analyses have shown that fungal invasion can reshape rhizosphere communities by inducing stress responses in beneficial bacteria—such as Oxalobacteraceae, Burkholderiaceae, and Sphingomonadaceae—thereby triggering protective traits. By decoding these complex microbial dialogues and multitrophic dynamics, we can begin to rationally redirect rhizosphere microbiomes to favor organisms that enhance plant growth, resilience, and health, offering powerful strategies for sustainable crop protection and productivity. Notably, recent findings suggest that domestication and modern breeding may have unintentionally eroded the plant’s capacity to engage with beneficial rhizosphere microbes. This opens a path toward rewilding elite cultivars to restore and exploit natural microbial partnerships shaped throughout the course of plant evolution and agricultural history. Notably, recent findings suggest that domestication and modern breeding may have unintentionally eroded the plant’s capacity to engage with beneficial rhizosphere microbes. This opens a promising path toward “rewilding” elite cultivars by reintroducing traits lost during domestication and breeding to restore and enhance natural microbial partnerships shaped throughout plant-microbiome coevolution.