Plant-Microbe Interfaces: Beneficial mycorrhization mediated by a lectin receptor-like kinase

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Project Goals: The goal of the Plant-Microbe Interfaces (PMI) SFA is to characterize and interpret the physical, molecular, and chemical interfaces between plants and microbes and determine their functional roles in biological and environmental systems. *Populus* and its associated microbial community serve as the experimental system for understanding the dynamic exchange of energy, information, and materials across this interface and its expression as functional properties at diverse spatial and temporal scales. To achieve this goal, we focus on 1) defining the bidirectional progression of molecular and cellular events involved in selecting and maintaining specific, mutualistic *Populus*-microbe interfaces, 2) defining the chemical environment and molecular signals that influence community structure and function, and 3) understanding the dynamic relationship and extrinsic stressors that shape microbiome composition and affect host performance.

Soil-borne microbes/fungi can establish mutualistic relationships with host plants, providing a large variety of nutritive and protective compounds in exchange for photosynthesized sugars. However, the molecular signals mediating the establishment of these beneficial relationships remain unclear. Our previous genetic mapping and whole-genome resequencing studies identified a gene deletion event of a lectin receptor-like kinase gene *PtLecRLK1* in *Populus* that was associated with poor root colonization by the ectomycorrhizal fungus *Laccaria bicolor.* By introducing *PtLecRLK1* into a perennial grass known to be a non-host of *L. bicolor*, switchgrass (*Panicum virgatum L.),* we found that the *L. bicolor* colonizes the *PtLecRLK1* transgenic switchgrass roots, which illustrates that introduction of *PtLecRLK1* has the potential to convert a non-host to a host of *L. bicolor*. Further transcriptomic and proteomic analyses on inoculated transgenic switchgrass root samples revealed genes/proteins overrepresented in the mutualistic interaction and underrepresented in the pathogenic defense pathway, consistent with the view that pathogenic defense response is downregulated during mutualistic interaction. Metabolomic profiling revealed that root colonization in the transgenic switchgrass was associated with an increase in N-containing metabolites and a decrease in organic acids, sugars, and phenolics, including hydroxycinnamate conjugates, which are often seen in the early steps of establishing mutualistic interactions in compatible partners. This work illustrates that *PtLecRLK1* is able to render a plant susceptible to colonization by the ectomycorrhizal fungus *L. bicolor* and sheds light on engineering mycorrhizal symbiosis into a non-host to enhance plant productivity and fitness on marginal lands.

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