Title: Elucidation of the Roles of Diazotrophic Endophyte Communities in Promoting Productivity and Resilience of *Populus* through Systems Biology Approaches

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Project Goals: The overall project goal is to move toward an understanding of the holobiont, how plants and the microbial community within them interact in ways that promote the productivity of the whole. Integration of the plant physiology data with the molecular plant-microbe interactions (multi-omics) data from greenhouse and field experiments will allow us to develop a systems-level understanding of the genetic and molecular basis for diazotrophic endophytic mutualism in *Populus*. This deeper level of understanding of the plant responses will guide construction of microbial communities in order to optimize the impacts of bioinoculants for environmental sustainability of bioenergy crops.

Abstract text: Poplar trees are important feedstocks for bioenergy and ecosystem services, but more efficient and resilient growth is essential for sustainability. In their native habitat of rocky riverbanks, poplar trees host a diverse assembly of micro-organisms that help them to survive in this harsh environment. Some of the micro-organisms which make up the poplar microbiome can help poplar grow by providing the required nutrients of nitrogen and available phosphorus, which are lacking in the rock and sand dominated riversides. In addition to increasing nutrient acquisition, the micro-organisms can also promote plant tolerance to other environmental stresses including drought. Previously we demonstrated that adding micro-organisms from the wild poplar microbiome to a wide variety of other plants increased the health and growth of these plants under a variety of conditions. Since the start of this newly funded project in autumn 2020, we have isolated additional nitrogen-fixing endophyte strains and are optimizing the microbial consortia that will serve as the bio-inoculants. A suitable field site in a nutrient- and water-limited is being prepared for the spring planting of inoculated poplar plants. Using systems biology approaches at both lab and field scales, we will identify the metabolic and physiological impacts of the bio-inoculants on the host plant under nutrient stress and water limitation. We will then integrate the plant physiology data with the molecular plant-microbe interactions data to develop a systems-level understanding of the genetic and molecular basis for diazotrophic (nitrogen-fixing) endophytic mutualisms. This deeper level of understanding of the plant responses will guide construction of microbial communities that best prime plant pathways for enduring abiotic stresses to optimize the impacts of bioinoculants for environmental and economic sustainability of bioenergy crops.

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