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Microbial Ecology of the Plant Rhizosphere (PlantMicrobe)

December 2020

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U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
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◆ **Project Summary** The growth of bioenergy crops has the potential to help fulfill the nation's demand for energy. However, growing these crops on arable lands may lead to socioeconomic concerns. One proposed solution is to grow biofuel crops in nutrient poor soils that aren't well suited for food-crop growth. Therefore, in order to understand the impact of nutrient poor environments on plants, there is a need to investigate model plants and their rhizospheres in these environments using high throughput molecular analyses. Here the rhizosphere can be defined as the zone around underground portion of the plant that is influenced by the plant's roots, and can include chemical, biological, and physical influences.◆

Introduction and Project Description

The overarching goal of the PlantMicrobe project was to determine the structural, functional, and ecological properties of the rhizosphere, and how it is influenced by different plant accessions. Ultimately, how the rhizosphere is modulated by the plant's response to stress is an important scientific area of research and discovery. Here, "accessions" refers to slight differences between the genetic make-up of plants associated with the same species. In theory, these genetic differences can make some accessions more suitable to thrive in certain environments than others. The role the rhizosphere plays in this largely remains a mystery. Here, we studied how the rhizosphere responded to different *Setaria* species and accessions grown within a nutrient and carbon poor soil (marginal soil). Marginal soils are of interest for growing bioenergy related crops because they do not remove prime agricultural land from food production. In addition, evaluating how certain accessions and their rhizospheres respond to marginal soils can be important for predicting what may happen as a changing climate alters the soil environment. *Setaria* was selected because its DNA has been sequenced and because it represents a model plant for C4 photosynthesis. Many bioenergy crops are also classified by their ability to conduct C4 photosynthesis.

Results and Accomplishments

The first experiment tested the hypothesis that rhizospheres would respond differently in association to their *Setaria* host accessions subjected to nutrient stress. Here, a laboratory experiment was set up using a nutrient poor soil acquired from Eastern Washington. Three *Setaria* accessions and a separate *Setaria* species were grown in the soil and subjected to nutrient addition. Suitable controls were also included. Molecular measurements included the profiling of small molecule metabolites within roots, leaf, and rhizosphere. The characterization of different classes of soil organic matter, microbial composition, and bulk nitrogen and carbon was also undertaken. We successfully validated our hypothesis correlating plant response to differences in rhizosphere response based upon these measurements. In addition, we further proposed mechanisms by which plant exudates could account for these observed differences. Of interest, we proposed the concept of specific priming, where the exudates from plants prime surrounding microorganisms to mineralize specific organic compounds. This concept would explain some of the differences observed in soil organic matter composition between rhizospheres subjected to nutrient addition.

We conducted a larger field experiment in collaboration with Washington State University's irrigation research extension located in Prosser, WA. Here we evaluated the rhizospheres from ten different *Setaria* accessions exposed to water stress (drought). As with the laboratory experiment samples were collected for metabolomics, microbial, soil organic, bulk nitrogen and carbon measurement. In addition, samples were collected for proteomics analysis. Data was generated for most samples, with many samples archived. Final analysis was not able to be completed as the overall initiative funding this project was altered, limiting the completion of this experiment.

Field experiment evaluating rhizosphere response to drought for different *Setaria* accessions.

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