The Contribution of Alternative Nitrogenases to Nitrogen Fixation in Switchgrass Rhizospheres on Marginal Lands

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Project URL:

http://rhizosphere.msu.edu

Project Goals (applicable to the MMPRNT project):

1) What is the Impact of the Rhizosphere Microbiome on Switchgrass Nitrogen Status?
2) Does the Chemistry and Rate of Root Exudation Influence Rhizosphere Nitrogen Transformations?
3 How are Switchgrass Functional Traits Influenced by Nitrogen Availability and Microbiome Interactions?
4) Are Plant-Rhizosphere Linkages Generalizable Across Temporal and Spatial Scales?

Abstract text (specific to this investigation):

The productivity of switchgrass, a common biofuel crop, is limited by nitrogen (N) availability in marginal land cropping systems. Free-living diazotrophs, naturally-occurring microorganisms capable of biological N fixation, have the potential to increase switchgrass productivity without fertilizer N inputs by increasing reactive N availability in rhizosphere soils. Classical nitrogenase enzymes require Molybdenum (Mo) to function; this element could therefore limit observed rates of soil biological N fixation in Mo-depleted soils. However, alternative nitrogenase enzymes which operate without Mo, can be expressed by some free-living diazotrophs as well. In this study we investigated the role that alternative nitrogenases play in biological N fixation in the rhizosphere of switchgrass grown without fertilizer N inputs in marginal land cropping systems. Recent work by Bellenger *et al.* (2014) has shown that the activity of alternative nitrogenase enzymes can be investigated by measuring the ratio between observed rates of acetylene reduction and $^{15}N_2$ incorporation, two commonly-used assays for nitrogenase activity in soil. We measured both $^{15}N_2$ incorporation and acetylene reduction in soils collected from switchgrass rhizospheres in three marginal land sites in Michigan, which were established as part of the Great Lakes Bioenergy Research Center Marginal Land Experiment. We found evidence for substantial alternative nitrogenase activity in soils collected from a single site (Lux Arbor), but not in soils from other sites tested. Ongoing research is investigating the edaphic factors that favor biological N fixation by alternative nitrogenases in the switchgrass rhizosphere. Furthermore, we are investigating the abundance of free-living diazotrophs and the genetic capacity of these organisms to express alternative nitrogenase enzymes across sites using quantitative PCR.

References:

Bellenger JP, Xu Y, Zhang X, Morel FMM, Kraepiel AML. (2014). Possible contribution of alternative nitrogenases to nitrogen fixation by asymbiotic N_2-fixing bacteria in soils. *Soil Biology & Biochemistry* **69:** 413-420.

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