Project Title: Improving the sustainability of bioenergy crops through arbuscular mycorrhization

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Project Goals

Arbuscular mycorrhization (AM) is the most beneficial symbiosis between microbes and bioenergy crops. The goal of our project is to characterize the signals and the genes controlling the establishment of AM in bioenergy crops. The specific objectives are:

1. Identify plant genes controlling AM in monocots and analyze their regulation by biotic and abiotic stresses.
2. Test the plant responses to AM signals and the influence of stresses on these responses.

Availability of water and nutrients is a major constraint for crop productivity and sustainable agriculture. Over the last decades, there has been an excessive dependence on chemical fertilizers with major economic, ecological and heath consequences. Taking better advantage of plant-microbe symbioses like arbuscular mycorrhization (AM) seems a reasonable alternative to improve crop yields and the sustainability of our agricultural systems. All the major bioenergy crops can form associations with AM fungi that improve their acquisition of water and nutrients (especially phosphorus). AM is the most efficient symbiosis between soil microbes and bioenergy crops. On a global level, AM symbiosis contributes significantly to phosphate, nitrogen and carbon cycling. Therefore, improving the efficiency and the development of AM associations especially under sub-optimal conditions has a tremendous potential for improving the sustainability of biofuel production. Our goal is to characterize the signals and the genes controlling the establishment of AM in energy crops. We developed a high-throughput screening of maize mutants affected in AM symbiosis. We screened more than 4000 lines of mutagenized population of B73 and identified six mutants which are unable to establish AM. The absence of AM in these mutants was confirmed by microscopy. These mutants have been self-fertilized to produce M3 progenies for further phenotypic characterization and crossed to a polymorphic parent for positional cloning. The screening of additional maize lines is ongoing. In order to characterize the signals produced by AM fungi, we developed an easy procedure to collect such diffusible signals in germinating spore exudates (GSE); these stimulate plant growth in monocots (maize, rice) and eudicots (alfalfa). They also induce expression of AM-specific genes through several genetic pathways and this induction is negatively regulated by the stress hormone, ethylene. In order to analyze the GSE-induced early responses in maize at the transcript level and their regulation by ethylene, microarray experiments were performed. Data analysis indicates that these signals induce gene expression in maize and ethylene inhibits this gene expression.