Public Abstract

First Name:Michael

Middle Name:Joseph William

Last Name:Maw

Adviser's First Name:Felix

Adviser's Last Name:Fritschi

Co-Adviser's First Name:

Co-Adviser's Last Name:

Graduation Term:FS 2016

Department:Plant, Insect and Microbial Sciences

Degree:PhD

Title:Managing High Biomass Sorghum for Optimum Ethanol Yield in Missouri

High Biomass Sorghum (HBS) has potential for production as a biofuel feedstock in Missouri, but little is known of the crop's yield and appropriate nitrogen (N) management for optimizing ethanol yields, especially in a low-input cropping system on marginal lands. This dissertation is a collection of four studies examining the potential for HBS to be adopted as a biofuel feedstock for ethanol production in the Midwestern U.S. The first study tested the effects of five N fertilizer rates (0, 56, 112, 168, 224 kg N ha⁻¹) on the production of two HBS hybrids (ES 5200 and ES 5201) over two years in central Missouri. Yield of HBS was greatest at 56 kg N ha⁻¹ and above, but NRE and NUE decreased at higher N rates. The second study determined the corresponding HBS leaf and stem concentration and contents of 11 macro- and micronutrients from the first study above. Response to N fertilizer rate was controlled by differences between years in rainfall. Reduced DM in the second year resulted in increased concentrations, but less elemental uptake and a resultant delayed N response demonstrate the strong link between nutrient uptake and plant growth following the precipitation. The third study included comparing the long-term yields (2010-2014) of HBS to maize and sweet sorghum at two marginal sites in Missouri with minimal inputs and each crop in rotation with soybeans. Theoretical ethanol yields of sweet sorghum and HBS were similar and greater than maize at both locations. Drought severely limited yields of all three crop rotations, but HBS was the most stable in yield across the five years. Study four involved collecting soil cores from each of the crop plots in study three in 2010, 2011, and 2014 to understand the impact of HBS, compared to maize and sweet sorghum, on soil organic carbon (SOC) concentration and stock, as well as the labile soil carbon fraction (AC). Concentrations of SOC and AC within all crop plots decreased over the first two years at both sites, but after five years the SOC concentrations returned to levels similar to initial 2010 levels, suggesting beneficial effects from the biofuel feedstocks, while the AC concentrations decreased. Due to the occurrence of drought during the study, the findings have relevance for evaluating land management impacts on SOC in a changing climate.

High biomass sorghum is a high-yielding biomass feedstock that shows promise for production in Missouri, especially on marginal lands. Even moderate rates of N fertilizer have the potential to positively increase DM and theoretical ethanol yield in adequate rainfall years. However, intensive nutrient management may prove necessary with continual DM removal. The short-term trend of HBS stemming SOC loss compared to maize production on marginal sites, provides support for continued research into the potential for HBS production in Missouri.