Miscanthus x giganteus Biomass Yield Response to Nitrogen Fertility in Southern IL

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Stakeholders: Grover Webb & J.B. Gates
Miscanthus x giganteus

• Sterile rhizomatous perennial C4 grass (Lewandowski, 2000).
• High biomass yield potential
• Cross (naturally occurring hybrid) between Miscanthus sinensis and Miscanthus sacchariflorus (Hodkinson & Renoize, 2001).
• Introduced into Europe in 1935 from Japan (Hodkinson et al. 2002) and investigated for its bioenergy feedstock potential.
• US researchers have begun investigating miscanthus, yet relatively little US based information is available.
Does MxG need Nitrogen?

• Studies have varied in their determinations. Few studies have been done in North America.

• Optimizing nitrogen input improves the overall efficiency and cost effective biomass feedstock production and system sustainability.

• Optimal nitrogen input will vary based on region and soil fertility. Therefore, a site specific recommendation should be made for a region.
Effects of Nitrogen on Biomass

Ercoli et al., 1999. Favorable response up to 200 kg N ha⁻¹ (179 lb acre⁻¹).
Effects of Nitrogen on Biomass

1993-2006 Rothamsted biomass yields

Source: modified from Christian et al., 2008
Hypothesis

Nitrogen fertilization will not have positive impact on growth and biomass production of MxG in DSAC.
Objectives

• General Objective: optimization of N fertility for MxG biomass production at DSAC.

• Specific Objective:
  – Determine the effect of N Fertilization
    1. On plant growth
    2. On biomass yield
    3. On soil N removal
    4. On feedstock composition including cellulose, hemicellulose, lignin, and ash.
Materials and Methods

• In June 2009, MxG was planted at DSAC.
• The plots are randomized with 5 replications.
• Plots size is 25 ft x 30 ft. Total area 125 ft x 150 ft.
• Applied N rates are as followed: 0, 50, 100, 150, and 200 N lbs/ac.
• Height data taken weekly.
• SPAD Data taken monthly.
• Sub-samples taken in the Summer & Winter.
• Total biomass production assessed in Fall.
• Biomass N and feedstock quality will be determined in Lee’s Lab.
Dixon Springs Miscanthus N Rates, Height Measurements

Growth Data
200 N lbs/acre v. 0 N lbs/acre
SPAD Visual
Dixon Springs Miscanthus N Rates, SPAD readings 5/26/11

The graph shows the SPAD (soil plant analysis development) data for Dixon Springs Miscanthus at different N (nitrogen) application rates (lb/acre) over three dates: 5/26/11, 7/7/11, and 8/1/11. The SPAD values increase with higher N rates for each date. The data trends indicate a positive correlation between N rate and SPAD readings.
Identification of Anticipated Outcomes and Deliverables

• The optimum N rate will be assessed by corresponding the allotted nitrogen to the maximum growth rate and biomass yield.
  – Thus far, the optimum N rate has been 100 N lbs/acre. The growth rates of the 100, 150 and 200 N lbs/acre plots are consistent with one another. Therefore, 100 N lbs/acre is the favorable application rate because it increases efficiency and sustainability.

• Growth rate and biomass yield data can be used in economic analysis to determine the cost benefit of applying Nitrogen to MxG grown in soils of comparable fertility within Southern IL.
  – This is crucial to the establishment of MxG as a viable feedstock for Southern IL because it contributes to determining potential profit. Thus allowing farmers to make a thorough decision in selecting MxG as a Feedstock.
Three representative plants were selected from each plot. Data was collected for:

- Kilogram/plant
- Gram/tiller
- Tiller number/plant
- Leaf number/tiller
- Tiller diameter
- Height

Each trait followed the same trend. Maximum efficiency was reached at 100 N lbs/acre.
Sub-Sample Data

Kilogram per Plant

Nitrogen Rate

<table>
<thead>
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<th>Mass (kilograms)</th>
<th>0 N</th>
<th>50 N</th>
<th>100 N</th>
<th>150 N</th>
<th>200 N</th>
</tr>
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<td>3.00</td>
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Nitrogen Rate

- 0 N
- 50 N
- 100 N
- 150 N
- 200 N
Biomass vs. Tiller Number has a $R^2$ of 0.689
Biomass vs. Tiller Mass has a $R^2$ of 0.549
Combining these two characteristics gave an $R^2$ value of 0.98.
This allows extremely high accuracy in predicting biomass yields.
100 N lbs/acre is consistently the nitrogen rate yielding the most efficient productivity.
Sub-Sample Data Significance

• When the confidence value was set at 1% (\(\alpha = .01\)), each one of the data categories had significant correlation to nitrogen rate.
  – When the confidence value was changed to 0.01%, kg/tiller, g/tiller, leaf number, and height.
The optimum N rate will be assessed by corresponding the allotted nitrogen to the maximum growth rate and biomass yield.

- Thus far, the optimum N rate has been 100 N lbs/acre. The growth rates of the 100, 150 and 200 N lbs/acre plots are consistent with one another. Therefore, 100 N lbs/acre is the favorable application rate because it increases efficiency and sustainability.

- However, SPAD data indicates a potential variation in growth rate’s between the 100 N, 150 N and 200 N rates before the end of vegetative growth stage. For definite results, further analysis will have to be conducted throughout the remainder of the growth period.

Growth rate and biomass yield data can be used in economic analysis to determine the cost benefit of applying Nitrogen to MxG grown in soils of comparable fertility within Southern IL.

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