Energy Crop Biomass Yields at 3 Sites in Illinois

Miscanthus and Switchgrass – the Formative Years

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Dudley Smith Initiative
Outline

- Miscanthus Research at UIUC – a look back
- Biomass production from 3 and 4 year old stands of Miscanthus and switchgrass at 3 sites in Illinois
M. x g at UIUC

1988
M.xg comes to UIUC turf farm

1999
Steve Long comes to UIUC

2001
C-FAR internal project - “feasibility”

2003
C-FAR Special Research Initiative

2007+
!!!!

???
A few simple questions
The C-FAR internal project (2001-2003) asked:
1. Does Miscanthus × giganteus grow in Illinois?
2. Does it produce more biomass than native switchgrass in Illinois?
Which Grass to Use?

No side-by-side field trials in the peer-reviewed literature

USA - Switchgrass (*Panicum virgatum* L.)

Europe - Miscanthus (*Miscanthus x giganteus* Greef et Deu.)
A few simple questions
The C-FAR internal project (2001-2003) asked:

1. Does Miscanthus x giganteus grow in Illinois?
2. Does it produce more biomass than native switchgrass in Illinois?
3. Does actual Miscanthus productivity agree with modeled projections of biomass yield?
Projected Miscanthus Yields in Illinois

- Agro-climatic computer model (Clifton-Brown, et al. 2004)
- Projects maximum seasonal biomass (before senescence)
- IL State Water Survey climatic data
- 27-44 tons ha\(^{-1}\) yr\(^{-1}\)

Heaton et al. 2004
Mitigation and Adaptation Strategies for Global Change 9: 433-451
Field Testing of Model Projections

- 2002
- 3 Sites: North, Central, South
- Switchgrass seeded (>13 kg PLS/ha)
- Miscanthus hand planted (1-3 tillers/plant, 50-75 cm tall)
How Might Yields Compare?

A desk study

- Surveyed all relevant peer-reviewed literature (174 Observations)
- Evaluated mature yields of Miscanthus and switchgrass
- Related to rainfall/irrigation, N fertilizer and growing degree days
Survey Says:
Miscanthus yields approximately 2x more biomass than switchgrass over a range of thermal time, rainfall and nutrient conditions.
Illinois Field Trials

• Established in 2002
• 3 Sites: North, Central, South
• Switchgrass Cave-in-Rock (>13 kg PLS/ha)
• Miscanthus hand planted (1-3 tillers/plant, 50-75 cm tall)
Biomass Measurements
2003-2005

Biomass Sampled 5 times during season: June, August, October, December, February
Used for Nitrogen analysis
Tiller growth

- Miscanthus
- Switchgrass

Tillers m⁻² and Tiller Ht (cm)

- May
- June
- July
- August
- September

Tiller growth study by Julian Day
2004 Biomass

North

Central

South

Total Dry Matter (t/ha)

June August October December February

North

Miscanthus

Switchgrass

Projected biomass

Central

South

Projected biomass
Surprising Findings – N cycling

Months 2004/5

N in plant components (kg ha⁻¹)

Miscanthus x giganteus

- Stem
- Live Leaf
- Inflorescence
- Dead Leaf
- Litter

Months: M, J, J, A, S, O, N, D, J, F, M, A
Surprising Findings – N cycling

*Panicum virgatum*

N in plant components (kg ha⁻¹)

- Stem
- Live Leaf
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- Dead Leaf
- Litter

Months 2004/5

0 100 200 300 400

MJ JASON DJFM

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How does *Miscanthus* produce so much biomass with so little N input (Results from Urbana 2004/5)?

<table>
<thead>
<tr>
<th>Season</th>
<th>Mineral nutrients</th>
<th>Translocation from rhizomes to growing shoot</th>
<th>Translocation to rhizome as shoot senesces</th>
<th>C harvested in Shoots, N retained in roots, Rhizomes &amp; litter</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPRING/SUMMER</td>
<td>370 kg(N) ha⁻¹</td>
<td>? kg(N) ha⁻¹</td>
<td>100+ kg(N) ha⁻¹</td>
<td>328+ kg(N) ha⁻¹</td>
</tr>
<tr>
<td>FALL</td>
<td>270 kg(N) ha⁻¹</td>
<td></td>
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<tr>
<td>WINTER</td>
<td>42 kg(N) ha⁻¹</td>
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<td></td>
</tr>
</tbody>
</table>

$C/N = 38$

$C/N = 482$

370 kg(N) ha⁻¹

270 kg(N) ha⁻¹

42 kg(N) ha⁻¹

Miscanthus
Conclusions from C-FAR Internal Project

- Miscanthus is a feasible and very promising biomass crop in Illinois

- Miscanthus produced 2-4x more biomass than Cave-in-Rock switchgrass over 3 locations and 3 years
Conclusions from C-FAR Internal Project cont.

- Miscanthus appears broadly adapted to Illinois and beyond
- Long term research should be maintained and expanded to understand yield and environmental sustainability over time
Coming Attractions...
The Agro-Energy Energy Horizon
Thank you

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