University of Minnesota: Intermediate Wheatgrass Agronomics

Charles Frahm
November 28, 2016
Intermediate Wheatgrass at University of Minnesota

Groups Developing IWG
- Plant Breeding
- Genomics
- Economics
- **Agronomy**
- Food Science
Agronomy Collaborators at UMN

• UMN Agronomy Dept. faculty: Drs. Craig Sheaffer, Jim Anderson, Nancy Ehlke, M. Scotty Wells, Don Wyse

• UMN Postdocs: Drs. Jacob Jungers, Xiaofei Zhang

• UMN technicians: Kevin Betts, Brett Heim, Joshua Larson, Donn Vellekson

• Graduate Students: Charles Frahm and Kayla Altendorf
Forever Green Agriculture Initiative

• Develop perennial and winter annual species for commercial utilization
• Promote sustainable practices
• Improve condition of vital resources
• Provide economic opportunities to growers
Forever Green Crops

Winter Annuals
- Camelina
- Pennycress
- Cover crops (Hairy Vetch)

Perennials
- American Hazelnut
- Native plants
- Sunflower
- Intermediate Wheatgrass!!!
Intermediate Wheatgrass Agronomy

Maximizing grain yields
1. Optimum nitrogen fertilizer rates for grain yield
2. Optimum row spacing for grain yield
3. Optimum harvest timing and techniques for grain yield and quality
   1. When is the optimum time to harvest? How do we determine that time?
   2. Should Kernza be direct combined or swathed?

Economic Viability
1. Dual-use cropping system potential
Nitrogen Fertilizer

• Plays a role in nearly every plant process
  • New growth
  • Structural maintenance
  • Defense

• Nitrogen fertilizer promotes higher grain yields and biomass productivity in crops
Effect of N Source and Rate on IWG Yield

- Whole plot Treatments:
  - N source: Composted turkey manure and ammonium nitrate

- Split plot factor:
  - N rate: 0, 20, 40, 60, 80 kg N / ha

- Split-split plot factor:
  - Row spacing: 6” or 24” rows

Measured:
- Grain Yield
- Biomass (Straw) Yield
- Lodging
Perennials Improve Water Quality

Adapted by Jungers, 2016
Determine AONR for Kernza yield

Adapted from Jungers, 2015
Determine AONR for Kernza Grain Yield

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AONR (lb N a⁻¹)</td>
<td>Yield (lb N a⁻¹)</td>
<td>AONR (lb N a⁻¹)</td>
</tr>
<tr>
<td>South</td>
<td>54</td>
<td>857</td>
<td>NA</td>
</tr>
<tr>
<td>North</td>
<td>85</td>
<td>797</td>
<td>78</td>
</tr>
</tbody>
</table>
Nitrogen Fertilizer and Lodging

Adapted from Jungers 2016
Mature Lodged Grain
Lodging at Anthesis

June 20

July 25
Nitrogen Fertilizer and Lodging

Adapted from Jungers 2015
Intermediate Wheatgrass Agronomy

Maximizing grain yields
1. Optimum nitrogen fertilizer rates for grain yield
2. Optimum row spacing for grain yield
3. Optimum harvest timing and techniques for grain yield and quality
   1. When is the optimum time to harvest? How do we determine that time?
   2. Should Kernza be direct combined or swathed?

Economic Viability
1. Dual-use cropping system potential
Effect of row spacing on grain yield

• Whole plot treatments:
  – Row spacing: 6”, 12”, 18”, 24”, or 30” rows

• Split plot treatments:
  – Seed rate: 6 or 12 lbs PLS/acre

• Locations: Roseau and Lake of the Woods, MN
  • Planted September 2014
  • Harvested August 17-19, 2015

• Measured: Grain and Biomass Yield
Row Spacing (6, 12 & 24”)

St. Paul – April, 30
Row Spacing and Lodging

Adapted from Jungers 2015
Row Spacing and Lodging

--- 12-24" ---

+ N

---- 12-24" ----

Adapted from Jungers 2015
Effect of Row Spacing on Grain Yield
Effect of Row Spacing on Lodging

Higher incidence of lodging at narrow row spacing.
Intermediate Wheatgrass Agronomy

Maximizing grain yields

1. Optimum nitrogen fertilizer rates for grain yield
2. Optimum row spacing for grain yield
3. Optimum harvest timing and techniques for grain yield and quality
   1. When is the optimum time to harvest? How do we determine that time?
   2. Should Kernza be direct combined or swathed?

Economic Viability

1. Dual-use cropping system potential
Harvest Timing

- June 21, 2015
- July 27, 2015
- August 12, 2015
Harvest Timing

Changes in % moisture
Harvest Timing Methods

• Using 100 seeds from the 6” samples harvested at each plot

• Wet and dry weights.

• Goal is to determine physiological maturity

• 2 Locations (20 min proximity to campus)
  • St. Paul, MN
  • Rosemount, MN

• 14-20% moisture at harvest
Harvest Method

Swathing

Direct Combine
Intermediate Wheatgrass Agronomy

Maximizing grain yields
1. Optimum nitrogen fertilizer rates for grain yield
2. Optimum row spacing for grain yield
3. Optimum harvest timing and techniques for grain yield and quality
   1. When is the optimum time to harvest? How do we determine that time?
   2. Should Kernza be direct combined or swathed?

Economic Viability
1. Dual-use cropping system potential
Intermediate Wheatgrass Dual-Use Component

Sod-forming perennial grass

Was originally domesticated as a cool-season forage species.

Photo by: Lee DeHaan

Salina, KS
Dual-Use

• Intermediate Wheatgrass for Grain and Forage use

• Additional revenue stream for growers $$$

• High nutritive value forage

Grazing IWG as additional feed source
Seasonal Grain and Forage Opportunities

- **Spring**
  - Spring forage harvest (April)

- **Summer**
  - Summer grain harvest (Aug)

- **Fall**
  - Fall forage harvest (Oct)

- **Winter**
Effect of seasonal defoliation and row spacing on grain yield

Whole plot treatments: Hand Defoliation
   – Control – no defoliation
   – Spring cut (vegetative stage)
   – Fall cut (8 weeks after grain harvest)
   – Both spring and fall cutting

Split plot: Row spacing
   – Row spacing: 6” 12” or 24” rows

Measured
   • Grain Yield
   • Biomass Yield
   • Forage Quality
Effect of seasonal defoliation on grain yield

May 13, 2015
Fall Forage Yields

September 3, 2015

November 3, 2015
Average Forage Yield (ton/acre)

- Spring: 1.0 ton/acre
- Fall: 3.5 ton/acre
Forage Quality

• Relative feed value (RFV): index to assess quality, compare forage varieties, and price forages.
Grain Yield Persistence

Grain Yield (lb/acre)

- Control
- Fall
- Spring
- Spring & Fall

2015
2016
Future work

Agronomics:
• Effects of livestock grazing on IWG grain yields
• Crop Rotations that work with IWG
Grazing Study Initiated this Fall

- Minnesota
- Wisconsin
- Michigan
Rotational strip grazing. Weigh livestock before and after exposure to IWG. Assess forage quality.

Mob graze to measure effect on subsequent IWG grain yields.
Questions?

Funders:
- Minnesota Department of Agriculture
- Forever Green Initiative
- The Mallone Family Foundation and TLI Perennial Agriculture Program
- USDA NIFA