AgBiotechnology and Oilseeds NDSU-COE

to

NDSU Bio Mass Conf
Sept 22 2009
Organization of Presentations

- Intro/overview (Wilson)
- Breeding (Mukles)
  - Organization and breeding plan..into the future
  - Results 2007 and 2008
  - Outlook
  - Future opportunities related to breeding
Partners, Collaborators and Supporters

- Bill Wilson and Phil McClean*, NDSU project leaders
- NDSU researchers and collaborators
  - Breeder:
    - Mukhlesur Rahman (University of Manitoba)
    - Marcelo Melani (previous breeder)
  - Pilot plant: Dennis Wiesenborn et al.
    - Darrin and Rachel
  - Regional research centers in
    - Minot, Carrington, Langdon, Prosper, Williston, Hettinger, Rugby
- Partners
  - Monsanto: Luke Bozeman*, project lead St. Louis
  - ADM: Velva Eric Mack and Tom Binder at Decatur
  - Future canola processor in ND
Goal: COE I and II

- **COE I:**
  - Improve genetics and processing for canola grown in ND (all existing breeding occurs outside ND)

- **COE II:** Expand to accelerate breeding
  - **Accelerate the breeding program**
    - Improving testing capabilities
    - Use of *molecular tools* in plant breeding
    - Gear up for seed release (commercialization)
Monsanto

- Provides Canola germplasm to NDSU

Processing collaborators

- Pilot scales testing of selected varieties and traits
- Provide information on desired traits

NDSU

- Develop germplasm for ND Canola
- Quality and technical testing
- Marketing and economics (3rd party studies)
- Agronomic initiatives (coordinate and expand)

Royalty sharing
NDSU/Monsanto

RESULTS

Canola: increased agronomic competitiveness
Increased supply of Canola
Increased oil content
Improved traits better suited for targeted end-uses
Activities during past 17 Months

• Research team in place in all areas
  – Breeding
  – Quality analysis
  – Economics and agbusiness
  – Field stations

• Canola breeding program
  – 2 full years of breeding efforts
    • ND Plots
    • ND Greenhouse work
    • Winter nurseries in Chile
Release Status—

• 3 lines identified for release
  – Announce in July 2009 for 2010 season

• Looking forward
  – Evaluating release of open pollinated and/or Hybrid lines
  – Numerous issues:
    • Access
    • Productivity gains
    • Patents, IP protection and royalties
    • Research agreement terms
    • Etc.
Canola Breeding team

Canola Breeder : Mukhlesur Rahman
Assistant Canola Breeder : Angela Sebelius
Research Specialist (GH & field) : Daniel Liene
Research Specialist (Pilot Plant) : Rachel Brudvik
Summer student : 3

Breeding cooperator

Monsanto
Pilot Plant (Dennis Wiesenborn)
NDSU research/extension centres (8 locations)
Plant pathologist (Dr. Luis Del Rio)
ND Canola Growers’ Association
10 locations: Prosper, Minot, Carrington, Langdon, Fargo, Casselton, Williston, Hettinger, Rugby, Winnipeg
Canola Breeding Objectives

**General scheme:** modified pedigree method with early generation testing

**Objectives:**

**Major objective:** Increase the competitiveness of production and processing of canola oils and biodiesel in ND

**Specific objectives:**

1- High seed yield
2- High oil content
3- Canola oil standards (00)
4- Low saturated fatty acids
5- Resistance to WM and blackleg
6- Resistance to lodging
# Breeding program on Schedule

<table>
<thead>
<tr>
<th>Season</th>
<th>Activities</th>
</tr>
</thead>
</table>
| **Summer (April – Aug)** | 1. Advance yield trial (7 locs)  
2. Early generation (F4) testing (3 Locs)  
3. Nursery trial-1 and bagging (F<sub>2</sub>-F<sub>3</sub>; BC<sub>1</sub>-BC<sub>1S</sub>)  
4. Nursery trial-2 and bagging (EGT : F<sub>4</sub> - F<sub>5</sub>)  
5. Nursery trial-3 and bagging (EGT : F<sub>6</sub> – F<sub>7</sub>)  
6. Disease (Blackleg + Sclerotinia) trial  
7. Breeder seeds increase  
8. Growers’ field trial  
9. Seed quality analysis and selection |
| **Winter – 1 (Sept – Jan)** | 1. Crossing, selfing and backcrossing in GH  
2. Generation advancement at WN Chile |
| **Winter – 2 (Jan – April)** | 1. Backcrossing and selfing (F<sub>2</sub> - F<sub>2</sub>)  
2. Data recording from WN Chile  
3. Seed quality analysis of WN lines |

Continue.............
## Performance of elite lines (Oil + oil yield)

<table>
<thead>
<tr>
<th>Lines</th>
<th>Seed yield (kg/ha)</th>
<th>Oil (%)</th>
<th>Oil (%) over ave. hybrids</th>
<th>Oil/acre (kg/ha)</th>
<th>Oil/acre over ave. hybrids</th>
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</thead>
<tbody>
<tr>
<td>662</td>
<td>2186</td>
<td>43.6</td>
<td>(+) 2.1</td>
<td>972</td>
<td>(+) 9.6</td>
</tr>
<tr>
<td>626</td>
<td>2062</td>
<td>42.3</td>
<td>(+) 0.8</td>
<td>889</td>
<td>(+) 0.2</td>
</tr>
<tr>
<td>685</td>
<td>2009</td>
<td>42.8</td>
<td>(+) 1.3</td>
<td>874</td>
<td>(-) 1.5</td>
</tr>
<tr>
<td>Ave. Hybrids</td>
<td>2099</td>
<td>41.5</td>
<td></td>
<td>887</td>
<td></td>
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</tbody>
</table>
### Performance of elite lines (disease reaction)

<table>
<thead>
<tr>
<th>Lines</th>
<th>BL incident</th>
<th>BL severity</th>
<th>SSR incident</th>
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<tbody>
<tr>
<td>NDSU-455</td>
<td>3</td>
<td>0.5</td>
<td>18</td>
</tr>
<tr>
<td>NDSU-662</td>
<td>8</td>
<td>1.5</td>
<td>24</td>
</tr>
<tr>
<td>NDSU-626</td>
<td>35</td>
<td>2.6</td>
<td>24</td>
</tr>
<tr>
<td>NDSU-416</td>
<td>47</td>
<td>3.1</td>
<td>8</td>
</tr>
<tr>
<td>Waster</td>
<td>36</td>
<td>3.2</td>
<td>25</td>
</tr>
<tr>
<td>DKL 38-25</td>
<td>30</td>
<td>3.2</td>
<td>35</td>
</tr>
<tr>
<td>Invigor 5550</td>
<td>38</td>
<td>3.2</td>
<td>45</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td><strong>3 - 52</strong></td>
<td><strong>0.5 - 5.0</strong></td>
<td><strong>8 - 53</strong></td>
</tr>
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</table>
## Important result to date (2006+2007+2008)

### Performance of elite lines (at growers’ field)

<table>
<thead>
<tr>
<th>NDSU lines &amp; Com Check</th>
<th>Seed yield (kg/ha)</th>
<th>Average Yield (kg/ha)</th>
<th>Yield over Check (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tom Borger (Langdon)</td>
<td>Ryan Pederson (Rolette)</td>
<td></td>
</tr>
<tr>
<td>NDSU 662</td>
<td>2560 (15.6%)</td>
<td>2165</td>
<td>2362 (+) 2.3</td>
</tr>
<tr>
<td>NDSU 685</td>
<td>2559 (15.6%)</td>
<td>2044</td>
<td>2307 (-) 0.001</td>
</tr>
<tr>
<td>NDSU 626</td>
<td>2596 (17.3%)</td>
<td>1883</td>
<td>2240 (-) 2.9</td>
</tr>
<tr>
<td>Dekalb 38-25</td>
<td>2214</td>
<td>2405</td>
<td>2309</td>
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Important result to date (2006+2007+2008)

New lines for the future

<table>
<thead>
<tr>
<th>2008 OP Rows</th>
<th>Yield (kg/ha)</th>
<th>Oil (%)</th>
<th>Oil (kg/ha)</th>
<th>Ave Hybrid (kg/ha)</th>
<th>Best Hybrid (kg/ha)</th>
<th>Over best hybrid</th>
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<tbody>
<tr>
<td>33101</td>
<td>3367</td>
<td>45.5</td>
<td>1511</td>
<td>1170</td>
<td>1305</td>
<td>+15.7</td>
</tr>
<tr>
<td>32028</td>
<td>2744</td>
<td>47.8</td>
<td>1312</td>
<td>1088</td>
<td>1163</td>
<td>+12.8</td>
</tr>
<tr>
<td>33186</td>
<td>3093</td>
<td>44.8</td>
<td>1380</td>
<td>1087</td>
<td>1233</td>
<td>+11.9</td>
</tr>
<tr>
<td>32656</td>
<td>3293</td>
<td>45.0</td>
<td>1483</td>
<td>1258</td>
<td>1407</td>
<td>+5.4</td>
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<tr>
<td>33107</td>
<td>3320</td>
<td>45.1</td>
<td>1448</td>
<td>1330</td>
<td>1375</td>
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<tr>
<td>32057</td>
<td>3036</td>
<td>45.9</td>
<td>1387</td>
<td>1214</td>
<td>1320</td>
<td>+5.1</td>
</tr>
<tr>
<td>33096</td>
<td>2753</td>
<td>46.2</td>
<td>1267</td>
<td>1150</td>
<td>1207</td>
<td>+5.0</td>
</tr>
<tr>
<td>33125</td>
<td>2875</td>
<td>44.4</td>
<td>1277</td>
<td>1196</td>
<td>1228</td>
<td>+4.0</td>
</tr>
<tr>
<td>33108</td>
<td>2695</td>
<td>46.7</td>
<td>1228</td>
<td>1177</td>
<td>1202</td>
<td>+2.2</td>
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<tr>
<td>33098</td>
<td>2932</td>
<td>46.8</td>
<td>1363</td>
<td>1240</td>
<td>1336</td>
<td>+2.0</td>
</tr>
<tr>
<td>Average</td>
<td>3010</td>
<td>45.8</td>
<td>1366</td>
<td>1192</td>
<td>1278</td>
<td></td>
</tr>
</tbody>
</table>

Hybrid checks: Dekalb 72-55, IS 71-45
Important result to date (2006+2007+2008)

Crosses made

1. Winter canola x Spring canola

2. B. napus x B. juncea – to create canola type Juncea and new germplasm in Napus.

3. B. napus x B. rapa – to create new Napus germplasm.

4. B. napus (RR) x B. napus (non-RR) – to obtain favorable character from RR material to generate NDSU own germplasm.
Hybrid breeding

**Female line development**
- CMS line Female
- F1 -CMS
- Several generation backcross
- Desired female line (CMS)
- Canola with desired trait
- Canola with desired trait (B-line)

**Male line development**
- Pollinator R-line (P2)
- Male line development
  - Canola with desired trait
  - F1
  - 1. Several generation backcross with desire line
  - 2. Develop DH lines
  - 3. F2, F3, F4, F5 generations

**Maintainer**
- B-line (Isogenic of A-line)
- Maintain B-line (Iso. Line)

**CMS**
- A-line (P1)
- Maintain A-line (female line)

**Pollinator**
- R-line (P2)
- Maintain R-line (male Line)

**Commercial F1 hybrid**
- (for farmer)
- F1 hybrid

**Restorer Line**
- Male (R-line)

**Female lines**

**Male lines**
Correlation among Yield, Oil, Protein

<table>
<thead>
<tr>
<th></th>
<th>Oil</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>(+) 0.93**</td>
<td>(-) 0.92**</td>
</tr>
<tr>
<td>Oil</td>
<td></td>
<td>(-) 0.99**</td>
</tr>
</tbody>
</table>

N.B.: Correlations are based on average yield and oil content data for individual location.
Future Breeding

• Hybrid breeding (for increased and stabilized yield)
• Creating genetic diversity in *B. napus*:
  Spring rapeseed X Winter rapeseed
  Spring rapeseed X Semi-winter rapeseed (Chinese)
• High oil and protein content
  - Creating new germplasm
  - Development of YS *B. napus*
• Development of disease resistant cultivars
  - Blackleg, Sclerotinia stem rot disease etc.
• Adapted new Brassica species
  *B. juncea, B. carinata, B. rapa* (high protein, heat and stress tolerant)
Future Breeding

- Resynthesis of new *Brassica napus* using interspecific crosses
- Improved meal quality
  - Yellow seeded (YS) with low fibre with high protein
  - Low glucosinolate content
- Integration of DH technique (extreme homozygous, increase selection effi.) for inbred line development
- Integration of molecular markers and genomics into breeding program
- Mutation induction to create new germplasm
Breeding facilities

Combine with harvest master

Swather

6-row planter

Seed quality lab
Breeding facilities

Winter nursery - Chile
Crop tour – research field

Vice-president
Crop tour – research field

Executive director, NDCGA
Crop tour – Growers’ field

Tom Borgen (Langdon)
## Acknowledgements

### Funding:
- North Dakota State Government
- Cooperative State Research, Education, and Extension Service (CSREES)
- Northern Canola Growers Association

### Partnership:  Monsanto

### Collaborator:
- Pilot Plants, NDSU (Dennis Wiesenborn)
- NDSU Regional Research/Extension Centers
- ND Canola Growers Association
### Acknowledgements

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<td>Plant Pathology</td>
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<td>Pilot Plant, NDSU</td>
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<td>Rachel Brudvik</td>
<td>Pilot Plant, NDSU</td>
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<tr>
<td>Daniel Liene</td>
<td>Research specialist, COE</td>
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<tr>
<td>Blaine Schatz</td>
<td>Carrington Research Extension Center</td>
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<td>Angela Sebelius</td>
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<tr>
<td>Scott Halley</td>
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<tr>
<td>Neil Riveland</td>
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<tr>
<td>Eric Eriksmoen</td>
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Thank you