Application of the CROPGRO-Soybean Model to Predict Soybean Yield

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Soybean production has increased tremendously in WI the last 20 years.
Yield goals are increasing year after year.
Few published studies have measured growth processes during the season to understand how high yields are achieved.
Objectives

- To determine current yield potential of soybean under various management systems
- To determine if growth pattern differs between older and newer cultivars under various management systems
- Analyze yield improvements among older and newer cultivars using the CROPGRO-soybean model
Materials and Methods

Studies in 1997-2000 for five different management systems

1. No-till
   - Irrigation
   - Silt Loam Soil

2. No-till
   - Irrigation

3. Conv. tillage
   - Irrigation

4. Conv. tillage

5. Conv. tillage
   - Irrigation
   - Sandy Loam
Materials and Methods

• Each management systems consisted of a RCBD in a split plot arrangement with 4 replications
  – Main plots
    • Two planting dates (early and late May)
  – Split plots
    • Three different cultivars (two new cultivars - DeKalb CX232 and Spansoy 250, and one old cultivar – Hardin)
Growth Measurements

• Triweekly
  – Plant density
  – Leaf area index
  – Lodging
  – Height
  – Biomass (leaf, stem, pod, and seed proportions)
  – Pod and seed counts
  – Growth and reproductive stages (V & R stage)
Environmental Measurements

• **Triweekly**
  - Soil moisture
  - (0-15, 15-30, 30-60, and 60-90 cm)

• **Daily**
  - Solar radiation
  - Precipitation
  - Soil temperature
  - Air temperature
CROPGRO – Soybean Model

“A mechanistic crop growth model that predicts daily photosynthesis, growth, and partitioning in response to daily weather inputs, soil traits, crop management, and genetic traits”
## Observed vs. Simulated Phenology

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>MG</th>
<th>R1</th>
<th>R3</th>
<th>R5</th>
<th>R7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardin</td>
<td>1.9</td>
<td>48.79</td>
<td>66.13</td>
<td>72.02</td>
<td>107.68</td>
</tr>
<tr>
<td>CX232</td>
<td>2.3</td>
<td>49.18</td>
<td>72.01</td>
<td>78.33</td>
<td>111.15</td>
</tr>
<tr>
<td>Spansoy 250</td>
<td>2.5</td>
<td>50.44</td>
<td>70.22</td>
<td>78.44</td>
<td>113.94</td>
</tr>
</tbody>
</table>

----------Days----------
Simulated Yields Across 34 Management Systems

<table>
<thead>
<tr>
<th></th>
<th>Hardin</th>
<th>CX232</th>
<th>Spansoy</th>
<th>LSD (0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pod yield (kg ha(^{-1}))</td>
<td>4991</td>
<td>5176</td>
<td>5036</td>
<td>134</td>
</tr>
<tr>
<td>Seed yield (kg ha(^{-1}))</td>
<td>3818</td>
<td>3887</td>
<td>3799</td>
<td>NS</td>
</tr>
<tr>
<td>Weight per seed (g; dry)</td>
<td>0.14</td>
<td>0.15</td>
<td>0.13</td>
<td>0.2</td>
</tr>
<tr>
<td>Seed no. (per m(^{2}))</td>
<td>2805</td>
<td>2655</td>
<td>2979</td>
<td>281</td>
</tr>
<tr>
<td>Seeds per pod</td>
<td>2.3</td>
<td>2.5</td>
<td>2.6</td>
<td>0.2</td>
</tr>
<tr>
<td>Max LAI (m(^{2}) m(^{-2}))</td>
<td>5.3</td>
<td>5.8</td>
<td>5.7</td>
<td>0.3</td>
</tr>
<tr>
<td>Biomass at R8 (kg ha(^{-1}))</td>
<td>6398</td>
<td>6876</td>
<td>7121</td>
<td>412</td>
</tr>
<tr>
<td>Seed HI (kg kg(^{-1}))</td>
<td>0.60</td>
<td>0.56</td>
<td>0.53</td>
<td>0.02</td>
</tr>
</tbody>
</table>
1998 CX232 (Arlington, Late, CT)

Days After Planting

Biomass (kg ha$^{-1}$)

Biomass
Pod
Grain
Leaf
Stem

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Seed HI - 2000 (Late, CT, Irrigated)

Days After Planting

Seed Harvest Index

0 20 40 60 80 100 120 140

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7

Hardin

CX232

Spansoy 250

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Biomass and Grain Yield, Sandy 1998

Days After Planting

Biomass (kg ha\(^{-1}\))

Biomass

Grain

CX232

Spansoy 250

Hardin

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CX232 Biomass and Grain Yield, 1999 (CT vs. NT)

Biomass (kg ha⁻¹)

Days After Planting

UW MADISON AGRONOMY
Summary

• CROPGRO-Soybean model could be used to quantify attainable soybean yields for the three cultivars in different management systems.

• Simulated yield responses for the three cultivars were variable and ranged from 39 to 85 bu acre\(^{-1}\) across years and management systems.
Summary

• New soybean cultivars for the Upper Midwest are associated with traits of:
  – Higher total canopy biomass and LAI
  – Lower seed harvest index
  – More seeds per pod
  – Higher leaf photosynthesis
  – Longer seed fill duration and pod addition
Acknowledgements

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