Soybean growth and maturity under varying environmental conditions in Manitoba

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Collaborators and Funding

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Funding from Manitoba Pulse Growers Association
Soybean Production in Canada

Cober and Morrison, 2013
Audience Question

How many years have you grown soybeans in Manitoba or provided production advice on growing soybeans in Manitoba?

a. Never
b. 1-year
c. 2 – 5 years
d. More than 5 years
e. More than 10 years
Soybean Harvested on the Prairies

MB and SK data from Statistics Canada, CANSIM Table 001-0010
AB data* estimated from Alberta Agriculture: 10-12k acres, 4-5k hectares
Manitoba Yields in Canadian Context

Data from Statistics Canada, CANSIM Table 001-0010
Objectives of Study

1. Relate crop heat units (CHU), precipitation and growing season length to the yield and quality of modern early-maturing soybean varieties grown in Manitoba

2. Relate calendar days, accumulated CHU, and photoperiod to growth-stage observations made
## Varieties

<table>
<thead>
<tr>
<th>Soybean</th>
<th>Crop Heat Units</th>
<th>Maturity Group</th>
<th>Manitoba Variety Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivar 1</td>
<td>2325</td>
<td>00.1</td>
<td>Short-season</td>
</tr>
<tr>
<td>Cultivar 2</td>
<td>2475</td>
<td>00.7</td>
<td>Long-season</td>
</tr>
<tr>
<td>Cultivar 3</td>
<td>2525</td>
<td>0.0</td>
<td>Long-season</td>
</tr>
</tbody>
</table>
## Sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Latitude (° N)</th>
<th>Elevation (m)</th>
<th>Normal $\sum$ Crop Heat Units, May 15 to Sept 15</th>
<th>Normal Precipitation (mm), May 15 to Sept 15</th>
<th>First Fall Frost, 50% risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arborg</td>
<td>50.90</td>
<td>229</td>
<td>2384</td>
<td>275</td>
<td>September 11</td>
</tr>
<tr>
<td>Beausejour</td>
<td>50.08</td>
<td>240</td>
<td>2496</td>
<td>295</td>
<td>September 21</td>
</tr>
<tr>
<td>Brandon</td>
<td>50.02</td>
<td>472</td>
<td>2316</td>
<td>258</td>
<td>September 14</td>
</tr>
<tr>
<td>Carberry</td>
<td>49.90</td>
<td>380</td>
<td>2316</td>
<td>258</td>
<td>September 15</td>
</tr>
<tr>
<td>Melita</td>
<td>49.27</td>
<td>440</td>
<td>2428</td>
<td>301</td>
<td>September 14</td>
</tr>
<tr>
<td>Morden</td>
<td>49.18</td>
<td>295</td>
<td>2635</td>
<td>280</td>
<td>September 23</td>
</tr>
<tr>
<td>Portage la Prairie</td>
<td>49.96</td>
<td>260</td>
<td>2513</td>
<td>290</td>
<td>September 24</td>
</tr>
<tr>
<td>Roblin</td>
<td>51.18</td>
<td>544</td>
<td>2162</td>
<td>251</td>
<td>September 8</td>
</tr>
</tbody>
</table>
## Planting Dates

<table>
<thead>
<tr>
<th>Site</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arborg</td>
<td>---</td>
<td>May 31</td>
<td>May 23</td>
</tr>
<tr>
<td>Beausejour</td>
<td>---</td>
<td>May 16</td>
<td>May 24</td>
</tr>
<tr>
<td>Brandon</td>
<td>May 26 ($T_{soil} = 12^\circ\text{C}$)</td>
<td>June 1 ($T_{soil} = 13^\circ\text{C}$)</td>
<td>May 22 ($T_{soil} = 11^\circ\text{C}$)</td>
</tr>
<tr>
<td>Carberry</td>
<td>May 26</td>
<td>May 16</td>
<td>May 22</td>
</tr>
<tr>
<td>Melita</td>
<td>---</td>
<td>May 16</td>
<td>May 15</td>
</tr>
<tr>
<td>Morden (zero-till)</td>
<td>May 20</td>
<td>May 16</td>
<td>May 16</td>
</tr>
<tr>
<td>Morden (conv. till)</td>
<td>May 26</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Portage la Prairie</td>
<td>June 13</td>
<td>May 17</td>
<td>June 5</td>
</tr>
<tr>
<td>Roblin</td>
<td>May 25</td>
<td>May 17</td>
<td>May 29</td>
</tr>
</tbody>
</table>
Audience Question

What is the best seedbed preparation for growing soybeans in Manitoba?

a. Direct-seeded, no cultivation
b. Light cultivation
c. Heavy cultivation
d. Burn previous crop residue, direct-seed
e. Burn previous crop residue, cultivate
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Arborg</td>
<td>-</td>
<td>-</td>
<td>Sept-14 (F)</td>
<td>106 R8 R8 R6</td>
<td>5-Oct (F)</td>
<td>135 R8 R8 R7</td>
</tr>
<tr>
<td>Beausejour</td>
<td>-</td>
<td>-</td>
<td>Sept-18 (F)</td>
<td>125 - - -</td>
<td>3-Oct (H)</td>
<td>132 R8 R8 R8</td>
</tr>
<tr>
<td>Brandon</td>
<td>Sept-14 (F)</td>
<td>111 R8 R7 R7</td>
<td>Sept-14 (F)</td>
<td>105 R7 R7 R7</td>
<td>21-Sept (F)</td>
<td>122 R8 R8 R7</td>
</tr>
<tr>
<td>Carberry</td>
<td>Sept-13 (F)</td>
<td>110 - - -</td>
<td>Sept-12 (H)</td>
<td>119 R8 R7 R7</td>
<td>5-Oct (F)</td>
<td>136 R8 R8 R7</td>
</tr>
<tr>
<td>Melita</td>
<td>-</td>
<td>-</td>
<td>Aug-30 (H)</td>
<td>106 R8 R8 R8</td>
<td>5-Oct (F)</td>
<td>144 R8 R8 R8</td>
</tr>
<tr>
<td>Morden (ZT)</td>
<td>Sept-27 (H)</td>
<td>130 R8 R8 R8</td>
<td>-</td>
<td>- - - -</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Morden (CT)</td>
<td>Sept-28 (H)</td>
<td>125 R8 R8 R8</td>
<td>Sept-11 (H)</td>
<td>118 R8 R8 R8</td>
<td>19-Sept (H)</td>
<td>128 R8 R8 R8</td>
</tr>
<tr>
<td>Portage la Prairie</td>
<td>Sept-30 (F)</td>
<td>109 - - -</td>
<td>Sept-23 (F)</td>
<td>129 - - -</td>
<td>20-Oct (F)</td>
<td>136 R8 R8 R8</td>
</tr>
<tr>
<td>Roblin</td>
<td>Sept-14 (F)</td>
<td>112 R8 R7 R7</td>
<td>Sept-21 (F)</td>
<td>127 R8 R8 R7</td>
<td>4-Oct (F)</td>
<td>128 R8 R8 R7</td>
</tr>
</tbody>
</table>
Impact of Frost and Degree of Maturity

- The oil content of all 3 soybean varieties harvested before the first fall frost was 1 to 1.5% higher than that of soybeans harvested after frost.

- For Cultivar 2 (2475 CHU, 00.7 MG), thousand seed weight was ~20 g greater for site-years where the crop was harvested at R8 vs. R7, although yield and other seed quality parameters (test weight, oil and protein content) were the same regardless of growth stage.

- For Cultivar 3 (2525 CHU, 0.0 MG), average yield was higher for site-years where the crop reached R8 (3126 ± 261 kg/ha; n = 8) than R7 (2322 ± 250 kg/ha; n = 10), but seed quality was not significantly different.
Relationship Between Crop Heat Units and Yield

### Cultivar 1 (CHU = 2325)
- Yield: 30 bu/acre
- Yield: 60 bu/acre

### Cultivar 2 (CHU = 2475)
- Yield: 30 bu/acre
- Yield: 60 bu/acre
Relationship Between Crop Heat Units and Yield

\[ y = 1.894x - 2064.9 \]
\[ R^2 = 0.3137 \]

Cultivar 1 (CHU = 2325)
Cultivar 2 (CHU = 2475)
Cultivar 3 (CHU = 2525)
Relationship Between CHU and Relative Yield

![Graph showing the relationship between crop heat units (CHU) and relative yield. The graph includes data points for two cultivars: Cultivar 1 (2325 CHU) and Cultivar 3 (2525 CHU).]
Relationship Between CHU and Relative Yield

![Graph showing the relationship between crop heat units (CHU) and relative yield across different cultivars.](image-url)

- **Crop Heat Units (CHU):**
  - Cultivar 1: 2325 CHU
  - Cultivar 2: 2475 CHU
  - Cultivar 3: 2525 CHU

- **Relative Yield:**
  - Data points for each cultivar are scattered across the graph, indicating a range of relative yields at different CHU levels.
Relationship Between CHU < 2300 and Yield

- Cultivar 1 (2325 CHU)
- Cultivar 2 (2475 CHU)
- Cultivar 3 (2525 CHU)
Relationship Between CHU < 2300 and Yield

Roblin 2011

Crop Heat Units

Yield (kg/ha)

- Cultivar 1 (2325 CHU)
- Cultivar 2 (2475 CHU)
- Cultivar 3 (2525 CHU)
Relationship between Precipitation and Yield

\[ y = 4.3594x + 1714.4 \]

\[ R^2 = 0.2384 \]

Yield (kg/ha) vs. Precipitation (mm)

- **Cultivar 1 (CHU = 2325)**
- **Cultivar 2 (CHU = 2475)**
- **Cultivar 3 (CHU = 2525)**
Influence of Climate on Seed Quality

- Found significant positive correlations between accumulated CHU and thousand seed weight for Cultivar 2 and Cultivar 3

- Found significant positive correlation between cumulative precipitation and thousand seed weight for Cultivar 1

- Significant positive correlations between total precipitation and protein content were found for all 3 soybean varieties studied
Role of Photoperiod?

Daylight + Civil Twilight (hours)

- Roblin
- Brandon
- Morden

- 1-May
- 22-May
- 12-Jun
- 3-Jul
- 24-Jul
- 14-Aug
- 4-Sep
- 25-Sep
Morden vs. Roblin is significantly different (p = 0.035) for Cultivar 3 only

Brandon vs. Roblin & Morden vs. Roblin significantly different for Cultivar 3 only
Cultivar 1
2325CHU
0.1MG

Cultivar 2
2475CHU
0.7MG

Cultivar 3
2525CHU
0.0MG
Cultivar 1
2325CHU
00.1MG

Cultivar 2
2475CHU
00.7MG

Cultivar 3
2525CHU
0.0MG

Brandon
\[ y = 20.835x \]
\[ R^2 = 0.9957 \]

Morden
\[ y = 24.656x \]
\[ R^2 = 0.9783 \]

Roblin
\[ y = 20.613x \]
\[ R^2 = 0.9967 \]
Conclusions

- Confirms previous and parallel findings that it is possible to achieve reasonable soybean yields in Manitoba with adequate quality under thermal regimes of apparently sub-optimal cumulative crop heat units.

- Strengthens and validates recent moves away from exclusively utilizing crop heat units for rating the suitability of different soybean varieties in Canada to using maturity grouping.

- Highlights importance of achieving (uniform) emergence as early as possible in the season.
DETERMINATION OF CLIMATICALLY SUITABLE AREAS FOR SOYBEAN
\textit{(Glycine max (L.) Merr.)} PRODUCTION IN MANITOBA

R. B. BURNETT, G. W. FALK, and C. F. SHAYKEWICH,

\textit{Department of Soil Science, University of Manitoba, Winnipeg, Man. R3T 2N2.}
\textit{Received 6 July 1984, accepted 1 Mar. 1985.}


Fig. 2. Probability of maturing Maple Presto before the first killing frost in the autumn.
Currently, recommendations for soybean production in Manitoba are made on the basis of corn heat unit accumulation. Originally, Brown (1962) developed this system for establishing climatic requirements of soybeans. In Manitoba, Maple Presto is believed to require 2300 corn heat units to mature, while McCall is believed to require 2500. Corn heat units from planting to maturity were calculated for all station years used in this study where maturity was reached. For Maple Presto the values ranged from 1728 to 2065 with a mean of 1890. The figures for McCall ranged from 1936 to 2493 with a mean of 2220. The wide range of values casts doubt on the usefulness of this method of soybean zonation.

Conclusions

- Results from the study provided some information regarding the impacts of timing of harvest on soybean yield and quality, and the potential effects of crop stage at harvest for different varieties.

- Regional variety trials, such as the Western Manitoba Soybean Adaptation Trial, provide an additional source of information regarding the relative performance of cultivars in non-traditional soybean production areas on the Prairies, and provide a useful reference for growers in these regions.