Row Spacing Effects on Various Crops

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• Contributing Scientists: Dr. Guy Lafond & Bill May (AAFC)

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Row Spacing Challenges

• Commonly accepted that narrow row spacing gives the greatest potential grain yields for majority of crops under most circumstances.

• No-till combined w/retaining residues (i.e. taller stubble) & continuous cropping is also beneficial but creates seeding challenges.

• One solution has been to increase row spacing but there are limits as to the extent to which this can be done without compromising yield.

• Most research shows that spacing of at least 12” is possible without reducing yield for most crops; however, results can vary depending on crop management & environmental conditions.

• Challenging to avoid biases in row spacing research due to:
  • Soil disturbance
  • Fertilizer placement
  • Harvest area and managing edge effects.
Equipment
Equipment

10 inch spacing

14” cm Spacing

12” cm spacing

16” cm Spacing
Recent/Current Field Trials

- Since acquiring the described drill in 2009, IHARF & AAFC have been conducting row spacing research with a variety of crop types
  - Oat: 2009-2011 (SODC)
  - Canola: 2012-16 (SCDC)
  - Flax: 2014-2016 (ADOPT/SFDC)
  - Spring Wheat: 2013-2016 (AAFC)

- Row spacing treatments range from 10-24” (25-61 cm) & were combined with other factors such as side-banded N rate, seeding rate, weed control & fungicide applications
Row Spacing Effect on Banded Fertilizer Concentrations

- per 1 meter length of crop row
Row Spacing Effect on Banded Fertilizer Concentrations

- per 1 meter length of crop row
Oat Response to Row Spacing

Duration: 2009-11 (3 yr)
Treatments (20):
• 10, 12, 14 & 16” row spacing
• 18, 36, 53, 71 & 107 lb N/ac

Data Collected:
• Plant density
• Tiller frequency
• Panicle density
• Above-ground biomass
• Grain yield
• Grain quality

Tests of Fixed Effects:
Row spacing (R): 0.001
  R linear: <0.001
  R quad: ns
N Rate (N)*: ns
  N linear: ns
  N quad: ns
  R × N: ns
Year (Y): 0.003
  Y × R: ns
  Y × N: ns
  Y × R × N: ns
Oats: Effects on Grain Yield

Tests of Fixed Effects:
- Row spacing (R): <0.001
- R linear: <0.001
- R quad: ns
- N Rate (N): <0.001
- N linear: <0.001
- N quad: <0.001
- R × N: 0.006
- Year (Y): <0.001
- Y × R: 0.012
- Y × N: <0.001
- Y × R × N: ns
Oats: Effects on Grain Yield

Row Spacing $\times$ N Rate $\times$ Grain Yield

![Graph showing the relationship between row spacing, nitrogen rate, and grain yield. The graph includes data points for different nitrogen rates (18 lb N/ac, 36 lb N/ac, 53 lb N/ac, 71 lb N/ac, 107 lb N/ac) and row spacings. The Least Significant Difference (LSD) is 11.0.](image)
Oats: Effects on Grain Yield

Row Spacing × Year × Grain Yield

Yield (bu/ac) vs. Row Spacing (inches)

- 2009
- 2010
- 2011

LSD = 12.6
### Oats: Effects on Grain Quality

<table>
<thead>
<tr>
<th>Effect</th>
<th>Protein</th>
<th>Groat Yield</th>
<th>1000 seed wt</th>
<th>Test Weight</th>
<th>% Plump</th>
<th>% Thin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing (R)</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
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<tr>
<td>R linear</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>R quad</td>
<td>ns</td>
<td>ns</td>
<td>0.014</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
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<tr>
<td>N rate (N)</td>
<td>&lt;0.001</td>
<td>ns</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>N linear</td>
<td>&lt;0.001</td>
<td>ns</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>N quad</td>
<td>&lt;0.001</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>0.036</td>
<td>&lt;0.001</td>
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<tr>
<td>R × N</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Year (Y)</td>
<td>ns</td>
<td>0.001</td>
<td>&lt;0.001</td>
<td>0.001</td>
<td>0.002</td>
<td>ns</td>
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<tr>
<td>Y × R</td>
<td>ns</td>
<td>ns</td>
<td>0.006</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Y × N</td>
<td>&lt;0.001</td>
<td>ns</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Y × R × N</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>
Wheat Response to Row Spacing

Duration: 2013-16 (4 yr)

Treatments (20):
- 10, 12, 14 & 16 row spacing
- 18, 36, 71, 107 & 142 lb N/ac

Data Collected:
- Plant density
- Head density
- Straw N
- Grain Yield
- 1000 seed weight
- Test weight
- Protein
Wheat: Effects on Grain Yield

INDIAN HEAD - 2013

Tests of Fixed Effects:
Row spacing (R): \( P = 0.010 \)
N Rate (N): \( P < 0.001 \)
R × N: \( P = 0.939 \)
Wheat: Effects on Grain Yield

INDIAN HEAD - 2014

Tests of Fixed Effects:

Row spacing (R): $P = 0.033$

N Rate (N): $P < 0.001$

$R \times N: P = 0.437$
SeedMaster Research Farm

HRSW 10” vs. 15” Row Spacing Trial

<table>
<thead>
<tr>
<th>Year</th>
<th>Spacing</th>
<th>Grade</th>
<th>Offer</th>
<th>Test Weight (lb/bu)</th>
<th>Protein (%)</th>
<th>Moisture (%)</th>
<th>Yield (bu/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>10&quot;</td>
<td>#2 Red</td>
<td></td>
<td>62.50</td>
<td>13.70</td>
<td>15.60</td>
<td>58.92</td>
</tr>
<tr>
<td>2014</td>
<td>10&quot;</td>
<td>#2 Red</td>
<td></td>
<td>61.70</td>
<td>13.60</td>
<td>13.10</td>
<td>55.70</td>
</tr>
<tr>
<td>2015</td>
<td>10&quot;</td>
<td>#2 Red</td>
<td></td>
<td>62.90</td>
<td>14.70</td>
<td>13.90</td>
<td>58.93</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 Year Average</td>
<td>62.37</td>
<td>14.00</td>
<td>14.20</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Spacing</th>
<th>Grade</th>
<th>Offer</th>
<th>Test Weight (lb/bu)</th>
<th>Protein (%)</th>
<th>Moisture (%)</th>
<th>Yield (bu/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>15&quot;</td>
<td>#2 Red</td>
<td></td>
<td>62.60</td>
<td>14.20</td>
<td>15.50</td>
<td>58.63</td>
</tr>
<tr>
<td>2014</td>
<td>15&quot;</td>
<td>#2 Red</td>
<td></td>
<td>61.80</td>
<td>13.60</td>
<td>13.10</td>
<td>54.10</td>
</tr>
<tr>
<td>2015</td>
<td>15&quot;</td>
<td>#2 Red</td>
<td></td>
<td>62.80</td>
<td>15.00</td>
<td>13.90</td>
<td>58.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 Year Average</td>
<td>62.40</td>
<td>14.27</td>
<td>14.17</td>
</tr>
</tbody>
</table>

Source: Owen Kinch
Flax Response to Row Spacing

Duration: 2014-16 (3 yr)

Treatments (10):
- 10, 12, 14, 16 & 24” row spacing
- With and without foliar fungicide

Data Collected:
- Plant density
- Maturity
- Lodging
- Seed yield
Lafond (1992) showed declining plant density, increased height and no effect on yield as row spacing increased from 4 to 12” (Can. J. Plant Sci. 93: 375-382)
Flax: Effects on Plant Density (IH-2014)

Overall F-test: $P = 0.034$ (RS)
Linear: $P = 0.030$
Quadratic: $P = 0.095$

Overall F-test: $P < 0.001$ (RS)
Linear: $P < 0.001$
Quadratic: $P = 0.052$
Flax: Effects on Seed Yield (IH-2014)

Yield (bu/ac) vs. Row Spacing (inches)

- Overall F-test: $P < 0.001$ (RS)
- Linear: $P < 0.001$
- Quadratic: $P = 0.876$

Key:
- a
- b
- ab
Flax: Effects on Seed Yield (IH-2015)

Overall F-test: $P < 0.001$ (RS)
Linear: $P < 0.001$
Quadratic: $P = 0.558$

Yield (bu/ac) vs. Row Spacing (inches) graph.
Row Spacing × Fungicide Effects on Flax Yield

- 2014-control
- 2014-fung
- 2015-control
- 2015-fung

R × F-2014: $P = 0.789$
R × F-2015: $P = 0.777$
Flax: Effects on Maturity (IH-2015)

Overall F-test: P < 0.001 (RS)
Linear: P < 0.001
Quadratic: P = 0.558

Maturity (days) vs. Row Spacing (inches)
Flax at Varying Row Spacing (IH-2015)
Soybean Response to Row Spacing

Duration: 2014-17 (4 yr)

Treatments (15):
- 10, 12, 14, 16 & 24” row spacing
- 40, 50 & 60 seeds/m$^2$ (162-243k seeds/ac)

Data Collected:
- Plant density
- Maturity
- Pod clearance
- Seed yield
- 1000 seed weight
Soybeans: Effects on Emergence (IH-2014)

Row Spacing × Plant Density

- Emergence (plants/m²)
- Row spacing (inches)
- Spacing: $P = 0.014$
- Linear: $P = 0.008$
- Quad: $P = 0.152$

Seed Rate × Plant Density

- Seed Rate: $P < 0.001$
- RS × SR: $P = 0.679$

Seed Rate (1000 seeds/ac)
Soybeans: Effects on Emergence (IH-2015)

Row Spacing × Plant Density

- Spacing: $P = 0.024$
- Linear: $P = 0.021$
- Quad: $P = 0.357$

Seed Rate × Plant Density

- Seed Rate: $P < 0.001$
- RS × SR: $P = 0.532$

Emergence (plants/m²)

Row spacing (inches)

Seed Rate (1000 seeds/ac)
Soybeans: Effects on Seed Yield (IH-2014)

**Row Spacing × Seed Yield**

- Spacing: $P < 0.001$
- Linear: $P < 0.001$
- Quad: $P < 0.001$

**Seed Rate × Seed Yield**

- Seed Rate: $P < 0.001$
- RS × SR: $P = 0.148$
Soybeans: Effects on Seed Yield (IH-2015)

**Row Spacing x Seed Yield**

- **Spacing:** $P = 0.001$
- **Linear:** $P < 0.001$
- **Quad:** $P = 0.007$

**Seed Rate x Seed Yield**

- **Seed Rate:** $P < 0.001$
- **RS x SR:** $P = 0.047$
Soybeans: Effects on Seed Yield (IH-2015)

Row Spacing × Seeding Rate × Yield

RS × SR: \( P = 0.047 \)

Yield (bu/ac)

Seed Rate (1000 seeds/ac)
Soybeans: Effects on Maturity (IH-2015)

Row Spacing × Maturity

- Spacing: $P = 0.147$
- Linear: $P = 0.053$
- Quad: $P = 0.662$

Seed Rate × Maturity

- Seed Rate: $P < 0.001$
- RS × SR: $P = 0.358$
Canola Response to Row Spacing

Duration: 2013-16 (4 yr)
Treatments (20, 20 & 10):
- 10, 12, 14, 16 & 24” row spacing (all trials)
- 0, 45, 90, 134 lb N/ac
- 30, 60, 90 & 120 seeds/m² (1.1-5.3 lb/ac)
- No in-crop herbicide & herbicide applied

Data Collected:
- Plant density
- Flower dates
- Crop & weed biomass
- Maturity
- Seed yield
- 1000 seed weight
- Green Count
Canola: RS Effects on Emergence
2013-15 (RS × NR)

Effect | 2013  | 2014  | 2015  
-------- | ------ | ------ | ------ 
RS      | <0.001 | 0.046 | <0.001 
NR      | <0.001 | <0.001 | <0.001 
RS × NR | 0.095  | 0.016 | 0.106  
RS lin  | <0.001 | 0.004 | <0.001 
RS quad | 0.832  | 0.983 | 0.475  

----- p-value ------
Row Spacing x N Rate Interactions (Indian Head 2014)

RS × NR: P = 0.016

Emergence (plants/m²)

Nitrogen Rate (lb N/ac)
Canola: RS Effects on Yield 2013-15 (RS × NR)

Row Spacing × Seed Yield

<table>
<thead>
<tr>
<th>Effect</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS</td>
<td>0.024</td>
<td>0.195</td>
<td>0.009</td>
</tr>
<tr>
<td>NR</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RS × NR</td>
<td>&lt;0.001</td>
<td>0.391</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RS lin</td>
<td>0.061</td>
<td>0.195</td>
<td>0.001</td>
</tr>
<tr>
<td>RS quad</td>
<td>&lt;0.001</td>
<td>0.063</td>
<td>0.169</td>
</tr>
</tbody>
</table>
Row Spacing x N Rate Interactions (Indian Head 2013)

RS x NR: P < 0.001

Seed Yield (bu/ac) vs Nitrogen Rate (lb N/ac)

- 10"
- 12"
- 14"
- 16"
- 24"

Poly. (10"")
Poly. (12"")
Poly. (14"")
Poly. (24"")
Row Spacing x N Rate Interactions (Indian Head 2015)

RS × NR: P < 0.001

Nitrogen Rate (lb N/ac)

Seed Yield (bu/ac)
Canola: SR Effects on Emergence 2013-15 (RS × SR)

Seed Rate × Plant Density

Emergence (plants/m²)

Seed Rate (seeds/m²)

<table>
<thead>
<tr>
<th>Effect</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS</td>
<td>&lt;0.001</td>
<td>0.046</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SR</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RS × SR</td>
<td>0.095</td>
<td>0.016</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SR lin</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SR quad</td>
<td>0.241</td>
<td>0.155</td>
<td>0.046</td>
</tr>
</tbody>
</table>
Row Spacing x Seed Rate Interactions (Indian Head 2014)

$\text{RS} \times \text{SR}: P = 0.016$

Emergence (plants/m$^2$) vs. Seed Rate (seeds/m$^2$) for different row spacings (10" to 24") and seed rates.

- Linear (10")
- Linear (12")
- Linear (14")
- Linear (16")
- Linear (24")
Row Spacing x Seed Rate Interactions (Indian Head 2015)

RS × SR: \( P < 0.001 \)
Canola: SR Effects on Yield 2013-15 (RS × SR)

Seed Rate × Yield

<table>
<thead>
<tr>
<th>Effect</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS</td>
<td>0.002</td>
<td>0.216</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SR</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RS × SR</td>
<td>0.748</td>
<td>0.807</td>
<td>0.072</td>
</tr>
<tr>
<td>SR lin</td>
<td>&lt;0.001</td>
<td>0.054</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SR quad</td>
<td>&lt;0.001</td>
<td>0.884</td>
<td>0.031</td>
</tr>
</tbody>
</table>
**Canola: RS Effects on Weed Biomass 2013-15 (RS × HERB)**

**Row Spacing × Weed Biomass**

<table>
<thead>
<tr>
<th>Effect</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS</td>
<td>0.440</td>
<td>0.546</td>
<td>0.011</td>
</tr>
<tr>
<td>HERB</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RS × HERB</td>
<td>0.657</td>
<td>0.594</td>
<td>0.012</td>
</tr>
<tr>
<td>SR lin</td>
<td>0.131</td>
<td>0.760</td>
<td>0.001</td>
</tr>
<tr>
<td>SR quad</td>
<td>0.316</td>
<td>0.482</td>
<td>0.176</td>
</tr>
</tbody>
</table>
Row Spacing x Herbicide Interactions (Indian Head 2015)

RS × HERB: $P = 0.010$

Weed Biomass (kg/ha) vs. Seed Rate (seeds/m²)

- Control
- Sprayed

Seed Rate (seeds/m²): 8, 10, 12, 14, 16, 18, 20, 22, 24, 26

Weed Biomass (kg/ha): 550, 450, 350, 250, 150, 50, -50
Take-home Messages

- Research at various stages, however crops types vary in their ability to compensate for wider row spacing (work required on pea, lentil, faba bean & other cereals)
  - **MOST SENSITIVE:** FLAX > WHEAT ≥ OATS > SOYBEANS > CANOLA :LEAST SENSITIVE
- Plausible that sound agronomic management (i.e. timely & thorough weed removal) is more critical with wider row spacing
- Delays in maturity are minor & less than those caused by increased fertility or reduced plant populations
- Seedling mortality increases with row spacing but still able to achieve adequate plant populations & no detrimental effects on grain quality observed
- While yield variability increased with wider row spacing but this may be offset by:
  - Reduced equipment cost, fuel consumption & horsepower requirements (per acre)
  - Reduce or eliminate tillage operations (including heavy harrowing) or other undesirable practices such as burning and seed under more challenging conditions
  - More timely seeding to due reduced land preparation requirements and/or larger drills
  - Improved soil & water conservation due to reduced disturbance & enhanced residues
  - Better suited for inter-row seeding resulting in improved seed-placement & further improvements in water conservation
THANK YOU

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Website: www.iharf.ca

IHARF Soil & Crop Management Seminar
(February 3 2016)

IHARF Crop Management Field Day (July 19 2016)