Risk vs. Reward: Can We Resolve Row Spacing and Seeding Rate Questions in Soybean?

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Today’s Soybean Production Systems are Dynamic

• Changes in row spacing
  – Growers have dropped small grains from their rotation
  – Row units vs drills
    • Accurate seeding rate
    • Uniform planting depth and emergence

• Changes in seeding rates
  – RR seed cost - 2007
    • List price – $30.99 to 33.99 vs. farm gate – $23.50 to 26.50

• Changes in planting date and environment
What Row Spacing Growers are Using

• What row spacing are growers planting?

<table>
<thead>
<tr>
<th>Row spacing</th>
<th>Seeding rate</th>
<th>Purdue rec’s (90*90)</th>
<th>% respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 21 in.</td>
<td>155,000</td>
<td>129,000</td>
<td>12%</td>
</tr>
<tr>
<td>11 ≥ x ≤ 20</td>
<td>180,000</td>
<td>160,000</td>
<td>31%</td>
</tr>
<tr>
<td>≤ 10 in.</td>
<td>198,000</td>
<td>196,000</td>
<td>57%</td>
</tr>
</tbody>
</table>

• 52% of Indiana growers with 1000+ acres are planting their soybeans in 15 inch rows

Conley and Santini, 2007; CM

IN and IL Row Spacing Changes

IN 2003
IN 2007
IL 2003
IL 2007

Percent of Growers

< 10 11 to 18 19 to 29 30 +

Row spacing

N = 180
### Soybean, Narrow vs. Wide Row Widths

#### Optimum Seeding Date, Full Season Varieties

<table>
<thead>
<tr>
<th>Location</th>
<th>Yield Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-LA</td>
<td>-5</td>
</tr>
<tr>
<td>2-KS</td>
<td>0</td>
</tr>
<tr>
<td>3-IL</td>
<td>5</td>
</tr>
<tr>
<td>4-NE</td>
<td>10</td>
</tr>
<tr>
<td>5-NE</td>
<td>15</td>
</tr>
<tr>
<td>6-NE</td>
<td>20</td>
</tr>
<tr>
<td>7-NE</td>
<td>25</td>
</tr>
<tr>
<td>8-IA</td>
<td>30</td>
</tr>
<tr>
<td>9-ON</td>
<td>35</td>
</tr>
<tr>
<td>10-MI</td>
<td>40</td>
</tr>
<tr>
<td>11-MI</td>
<td>45</td>
</tr>
<tr>
<td>12-MI</td>
<td>50</td>
</tr>
<tr>
<td>13-WI</td>
<td>55</td>
</tr>
<tr>
<td>14-WI</td>
<td>60</td>
</tr>
<tr>
<td>15-WI</td>
<td>65</td>
</tr>
<tr>
<td>16-MN</td>
<td>70</td>
</tr>
</tbody>
</table>


### Soybean, Narrow vs. Wide Row Widths

#### Late Seeding Date, Full and Short Season Varieties

<table>
<thead>
<tr>
<th>Location</th>
<th>Yield Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-AR</td>
<td>-20</td>
</tr>
<tr>
<td>2-AR</td>
<td>0</td>
</tr>
<tr>
<td>3-LA</td>
<td>20</td>
</tr>
<tr>
<td>4-KS</td>
<td>40</td>
</tr>
<tr>
<td>5-WI</td>
<td>60</td>
</tr>
</tbody>
</table>

IN Row Spacing Affect on Grain Yield

Conley et al. 2007

*Planting date did not affect row spacing response

Narrow vs. wide
9.3% difference

IN Row Spacing Affect on Grain Yield

Hanna et al. 2007

Means followed by the same letter within a column are not different (p < 0.05)

Narrow vs. wide
9.2% difference
Row Spacing Affect on Grain Yield

De Witt, Nevada, and Whiting, IA 2004-06

15 vs. 30 inch
6.7% difference

Grain yield (bu a⁻¹)

Source: P. Pedersen, 2007

Does Row Spacing Impact My Decision to Reduce My Soybean Seeding Rate

Soybean Yield Response to Row Spacing and Plant Population
12 Environments in 1999-2000

10" Rows
20" Rows
30" Rows

Source: Seth Naeve, Univ. Minn.
## Reasons for Differential Row Spacing Yield Response

- **Light interception and canopy development**
  - Affected by planting date and population
  - Plant height and photosynthetically-active radiance

- **Water availability**
  - In irrigated systems or when rainfall is sufficient narrow rows generally out-yield wide rows


## Weed Management Issues in Wider Rows

- **Weed control implications**
  - Weeds are the #1 IN soybean pest (Conley and Santini, 2007 CM)
  - Glyphosate resistance is a reality
  - Delayed canopy closure as row spacing increases

<table>
<thead>
<tr>
<th>Row Spacing</th>
<th>&lt; 5/5</th>
<th>5/6 to 5/15</th>
<th>5/16 to 5/25</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5</td>
<td>35</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>15</td>
<td>50</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>30</td>
<td>75</td>
<td>70</td>
<td>65</td>
</tr>
</tbody>
</table>

Source: Purdue Extension publication ID-179, *Corn & Soybean Field Guide*
Soybean Yield Loss Influenced by the Timing of Weed Removal and Row Spacing

[Graph showing the relationship between the timing of weed removal and soybean yield loss.]

- **7.5"**
- **15"**
- **30"**


**Weed Management in GR Soybean**

- 26% of respondents indicated that they applied a preemergence herbicide to their soybean crop.

- 23% of growers indicated that they utilized a one pass weed control program.

- The percentage of growers utilizing a one trip weed control programs was 40% (99 or less), 34% (100 to 249), 20% (250 to 499), 13% (500 to 999), and 11% (1000+).

- One pass program produced a 5.8% yield loss compared to those growers with 2+ passes.

Source: Johnson et al. 2007. CM.
**Does Row Spacing Effect Spray Coverage?**

- Our studies showed no difference in spray penetration or total coverage between soybean planted in 7.5-, 15-, or 30-inch rows across locations and years.

- We recommend that growers base their soybean row spacing decisions on other factors, such as yield potential, equipment availability, or weed control.

Hanna et al. 2007

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**Do Wheel Tracks Affect Yield?**

- Sprayer wheel traffic from first flower (growth stage R1) through harvest can damage soybean plants and reduce yield if soybean stands are thin (<100,000 plants per acre) or late planted.

- Regardless of stand, plants could not compensate for wheel tracks made at R3 (early pod development) or R5 (early seed).

- Yield loss per acre is based on boom width.

Hanna et al. 2007
Summary – Row Spacing

- Yield response of narrow vs. wide rows in soybean is variable (0-18%)
  - Variability is water and light interception driven
  - (Average yield loss: 7%)

- Increased risk of yield loss due to weed competition

- Row spacing does not affect canopy penetration of foliar fungicides

- Wheel tracks from ground driven sprayers decrease grain yield in 7.5 and 15 inch row spacings when applied at R3 and R5 soybean
Common Grower Questions Related to Reduced Soybean Seeding Rate Systems

- What is the minimum I can plant and still achieve 100% yield potential?
- Should I select and plant a bush over an erect stem soybean variety?
  - Real or marketing/grower perception?
- What about maturity group response?
  - Should I adjust my seeding rate based on maturity group adaptiveness?

Current State Soybean Seeding Rec’s

<table>
<thead>
<tr>
<th>State</th>
<th>Germination</th>
<th>30”</th>
<th>15”</th>
<th>7.5”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iowa-seeds</td>
<td>90%</td>
<td>125 to 140</td>
<td>125 to 140</td>
<td>200*</td>
</tr>
<tr>
<td>Kentucky-plants</td>
<td>80%</td>
<td>111 to 139</td>
<td>139 to 167</td>
<td>119 to 179</td>
</tr>
<tr>
<td>Michigan-seeds</td>
<td>90%</td>
<td>122 to 157</td>
<td>139 to 174</td>
<td>175 to 280</td>
</tr>
<tr>
<td>Missouri-seeds</td>
<td>90%</td>
<td>140,000</td>
<td>175,000</td>
<td>200,000</td>
</tr>
<tr>
<td>Ohio-seeds</td>
<td>90*90%</td>
<td>129,000</td>
<td>160,000</td>
<td>196,000</td>
</tr>
<tr>
<td>Indiana-seeds</td>
<td>90*90%</td>
<td>129,000</td>
<td>160,000</td>
<td>196,000</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Old versus new
Maturity Group and Stem Phenotype Response to Decreased Soybean Populations

- **Northern:**
  - 2.8 and 3.6 M.G

- **Southern:**
  - 3.6 and 4.2

- **Plant populations**
  - 50,000 to 250,000

- **Erect vs. bushy beans**

- **8 site years; 4 varieties**

- **Drilled soybean (7.5")**

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Population Affect on Seed Mass

- Population affected seed mass at all N. locations

- Population did not affect seed mass at S. locations

- Seed mass was greater in early MG soybean varieties than full season
### 2005 -2006 Population Affect on Pod Number Plant⁻¹

<table>
<thead>
<tr>
<th>Seeding rate</th>
<th>ACRE</th>
<th>NEPAC</th>
<th>PPAC</th>
<th>SEPAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>50,000</td>
<td>81 a</td>
<td>55 a</td>
<td>109 a</td>
<td>75 a</td>
</tr>
<tr>
<td>100,000</td>
<td>45 b</td>
<td>35 b</td>
<td>66 b</td>
<td>55 a,b</td>
</tr>
<tr>
<td>150,000</td>
<td>39 b</td>
<td>25 c</td>
<td>43 c</td>
<td>44 b</td>
</tr>
<tr>
<td>200,000</td>
<td>37 b</td>
<td>22 c</td>
<td>35 d</td>
<td>43 b</td>
</tr>
<tr>
<td>250,000</td>
<td>36 b</td>
<td>21 c</td>
<td>30 d</td>
<td>38 b</td>
</tr>
</tbody>
</table>

Means within the same column and followed by the same letter are not considered different p < 0.05

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### Population Affect on Oil Content (ACRE 05-06)

![Graph showing oil content vs. seeding rate]
Summary Oil and Protein Content

- Oil content as not affected by population
- Oil content was affected by variety at ACRE
- Protein content varied among years, varieties, and locations
- In general protein content increased as population increased
Population Affect on Grain Yield (ACRE 05-06)

![Graph showing the relationship between seeding rate and grain yield for different cultivars with an R² value of 0.90.]

Population Affect on Grain Yield (NEPAC 05-06)

![Graph showing the relationship between seeding rate and grain yield for different cultivars with an R² value of 0.88.]
Population Affect on Grain Yield (PPAC 05-06)

- Seeding rate (1000 seeds ha\(^{-1}\))
  - 0 100 200 300 400 500 600 700
- Yield (kg ha\(^{-1}\))
  - 3000 3200 3400 3600 3800 4000 4200 4400 4600 4800 5000
- AG2801  D3640CR  AG3602  2702-4
- \(R^2 = 0.96\)

Population Affect on Grain Yield (SEPAC 05-06)

- Seeding rate (1000 seeds ha\(^{-1}\))
  - 0 100 200 300 400 500 600 700
- Yield (kg ha\(^{-1}\))
  - 3400 3600 3800 4000 4200 4400 4600 4800 5000 5200
- AG2801  D3640CR  434NRR  3832-4
- \(R^2 = 0.85\)
Summary Plant Populations

- Stem architecture (bushy vs. erect) did not affect soybean grain yield
- Soybean oil content was relatively stable among locations, varieties, and years
- Soybean protein content was variable
- Optimal seeding range was 100,000 to 150,000 plants a\(^{-1}\)
Planting Date Shift Over the Last Decade

• How has your average soybean planting date changed from 10 years ago? (1253 respondents)

<table>
<thead>
<tr>
<th>Planting date shift</th>
<th>Percent of growers</th>
</tr>
</thead>
<tbody>
<tr>
<td>One week earlier</td>
<td>28%</td>
</tr>
<tr>
<td>Two weeks earlier</td>
<td>32%</td>
</tr>
<tr>
<td>Three weeks earlier</td>
<td>7%</td>
</tr>
<tr>
<td>Later by one week</td>
<td>3%</td>
</tr>
<tr>
<td>Other</td>
<td>3%</td>
</tr>
<tr>
<td>No change</td>
<td>27%</td>
</tr>
</tbody>
</table>

Conley and Santini, 2007; CM

What is Driving this Shift?

• Rank the importance of the following factors for that have influenced your planting date? (1 to 5)

<table>
<thead>
<tr>
<th>Reason for shift</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield increase</td>
<td>1.9</td>
</tr>
<tr>
<td>Weather changes</td>
<td>2.0</td>
</tr>
<tr>
<td>Improved soybean varieties</td>
<td>2.1</td>
</tr>
<tr>
<td>Seed applied technology advances</td>
<td>2.5</td>
</tr>
<tr>
<td>Spread out work load</td>
<td>2.8</td>
</tr>
<tr>
<td>Industry re-plant programs</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Conley and Santini, 2007; CM
Location by Planting Date Affect on Soybean Yield

*Row spacing yield was similar across all planting dates*

<table>
<thead>
<tr>
<th>Variety</th>
<th>Planting Date</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG 2.8</td>
<td>20-Mar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MG 2.8</td>
<td>3-Apr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MG 3.2</td>
<td>17-Apr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MG 3.2</td>
<td>1-May</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MG 3.7</td>
<td>15-May</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MG 3.7</td>
<td>29-May</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MG 3.7</td>
<td>12-Jun</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Variety by Planting Date Affect on Soybean Yield

Planting Date Impact on Yield - Field Trial 2006, 2007, West Lafayette, IN
Changes in Soybean Flowering Characteristics, Node Number, and Grain Composition

- Early planted, early maturity group soybean cultivars are producing flowers in May
- Increased node number
- Modified grain composition
- Decreased seed size

Robinson et al. 2006

Does Planting Date Impact My Decision to Reduce My Soybean Seeding Rate

Population effects on soybean yield across planting dates

Source: Seth Naeve, Univ. Minn.
### Defining Planting Date Responses in N. Illinois*

**2001-2003 University of Illinois**

*Source: E. Nafziger University of Illinois*

<table>
<thead>
<tr>
<th>Seed rate†</th>
<th>Planting date</th>
<th>000/acre</th>
<th>Early April</th>
<th>Late April</th>
<th>Early May</th>
<th>Late May</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td></td>
<td>38.7</td>
<td>45.8</td>
<td>46.6</td>
<td>43.5</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>41.9</td>
<td>48.3</td>
<td>47.6</td>
<td>46.5</td>
<td></td>
</tr>
<tr>
<td>175</td>
<td></td>
<td>43.8</td>
<td>48.7</td>
<td>48.3</td>
<td>46.5</td>
<td></td>
</tr>
<tr>
<td>225</td>
<td></td>
<td>45.3</td>
<td>48.9</td>
<td>48.9</td>
<td>46.6</td>
<td></td>
</tr>
</tbody>
</table>

* Soybean yield averaged over nine environments in Northern Illinois.
† Seeding rates are expressed as viable seeds per acre.

### Defining Planting Date Responses in S. Illinois*

**2001-2003 University of Illinois**

*Source: E. Nafziger University of Illinois*

<table>
<thead>
<tr>
<th>Seed rate†</th>
<th>Planting date</th>
<th>000/acre</th>
<th>Mid-April</th>
<th>Early May</th>
<th>Late May</th>
<th>Early June</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td></td>
<td>30.4</td>
<td>33.7</td>
<td>35.9</td>
<td>30.6</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>29.3</td>
<td>33.7</td>
<td>35.3</td>
<td>32.8</td>
<td></td>
</tr>
<tr>
<td>175</td>
<td></td>
<td>32.3</td>
<td>34.6</td>
<td>36.3</td>
<td>32.4</td>
<td></td>
</tr>
<tr>
<td>225</td>
<td></td>
<td>32.9</td>
<td>35.4</td>
<td>34.6</td>
<td>33.7</td>
<td></td>
</tr>
</tbody>
</table>

* Soybean yield averaged over four environments in Southern Illinois.
† Seeding rates are expressed as viable seeds per acre.
Defining Planting Date Responses in Illinois

“In Northern Illinois….Planting in early April reduced yield by about 10 percent, and planting in late May reduced yield by about 5 percent; these results suggest that planting “too early” tends to reduce yield more than planting late.”

“It pays to wait to plant, but if planting is earlier than ideal, it pays to add extra seed.”

Source: E. Nafziger
University of Illinois

Defining Planting Date Responses in Illinois
2001-2003 University of Illinois CMRA Project

“In Northern Illinois….Optimum planting rates for planting in the optimum window were about 150,000 to 160,000 viable seeds per acre, but this rose to above 200,000 per acre if planting was earlier than the optimum time.”

“Still it appears that planting rate should be between 150,000 to 175,000 viable seeds per acre in Southern Illinois.”

Source: E. Nafziger
University of Illinois
Should Yield Environment Affect Seeding Rate

Economic Analysis for a High Yield Field

Source: J. Beuerlein, Ohio State
Should Yield Environment Affect Seeding Rate

![Graph showing the relationship between seeding rate and yield in a moderate yield environment. The graph illustrates that higher seeding rates are associated with lower yields, and the optimal seeding rate varies depending on the yield environment.]

Source: J. Beuerlein, Ohio State

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Economic Analysis for a Medium Yield Field

![Graph showing the economic analysis for a medium yield field. The graph illustrates the relationship between seeding rate, profit, and seed cost. The maximum profit occurs at a specific seeding rate, and the profit decreases as the seeding rate increases.]

Source: J. Beuerlein, Ohio State
**Should Yield Environment Affect Seeding Rate**

![Graph showing the relationship between seeding rate and yield/harvest population in low yield environments.]

Source: J. Beuerlein, Ohio State

**Economic Analysis for a Low Yield Field**

![Graph showing the relationship between seed cost and profit/yield/cost in a low yield environment.]

Source: J. Beuerlein, Ohio State
Conclusions

• 7.5 and 15 inch rows still out-yield 30 inch rows under optimal conditions

• Early planting pays if you seed the correct maturity group soybean

• All you need is 100,000 plants a\(^{-1}\) in moderate to high yield fields