On-Farm Evaluation of Within-Row Plant Spacing Uniformity

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Within-Row Plant Spacing Uniformity: Measuring a flea on top of an elephant?
Effect of Plant Spacing Uniformity

- Erbach et al. (1972) No benefit up to 6” SD (IA)
- Krall et al. (1977) 3.4 Bu/ac/in SD improvement (KS)
- Johnson & Mulvaney (1980) No benefit (IL)
- Daynard et al. (1983, 1981, 1979) No benefit (ON)
- Vanderliep (1988) Yield decreased if SD >2.4” (KS)
- Nielsen (2001) 2.5 Bu/ac/in SD above 2” (1.2 to 4.5) (IN)
- Lauer (2001) Little benefit at same population (WI)
- Liu et al. (2001) Temporal variation more important than spatial var. (ON)
On-Farm Evaluation of Within-Row Plant Spacing Uniformity

Objectives:

• Determine the relationship between within-row plant spacing standard deviation and corn grain yield from field-length strip plots (2000).

• Develop a spatial analysis tool to document the influence of within-row plant spacing uniformity on individual plant yield (2001).
Split-Planter Study - 2000

- Half the meters on corn planter serviced
- Half left unadjusted
- One or more passes planted in field
- Establish paired strips with different plant spacing standard deviation

Planter Meter Comparison

- Adjusted
- Unadjusted
2000 Test Locations - 96 sites

- Red sites reported plant spacing and yield data
- Blue sites reported only plant spacing data
Experimental Procedures

- Plant spacing measurements taken for 30 consecutive plants in four random areas of both strips
- Grain yield measured in both strips
- Compare improvement in yield with improvement in plant spacing standard deviation
Yield Increases With Improved Spacing

$y = 4.0612x + 0.6193. \quad R^2 = 0.408.$

Improvement in Standard Deviation Due to Cal. (in.)
Components of Plant Spacing Std. Dev.

Aggregate Field Average Std. Dev.

Misplaced Plants

Effect 0 to -4.1 Bu/ac/in on Yield

Missing Plants

- (variable)

Extra Plants

+ or -
On-Farm Research - 2001

- Individual plant response to within-row spacing
- Individual ear sampling in commercial fields
- Determine grain yield per acre for individual plants
<table>
<thead>
<tr>
<th>Location</th>
<th>Hybrid</th>
<th>CRM</th>
<th>Yield Level Bu/ac</th>
<th>No. of Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missouri</td>
<td>34B28</td>
<td>109</td>
<td>102</td>
<td>884</td>
</tr>
<tr>
<td>Iowa 1</td>
<td>34B24</td>
<td>110</td>
<td>139</td>
<td>2,127</td>
</tr>
<tr>
<td>Iowa 2</td>
<td>33G30</td>
<td>112</td>
<td>162</td>
<td>1,560</td>
</tr>
<tr>
<td>Minnesota</td>
<td>35R58</td>
<td>105</td>
<td>193</td>
<td>1,450</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>6,021</strong></td>
<td></td>
</tr>
</tbody>
</table>
Within-Row Distance Occupied by Plant (WRPD)
Area Occupied by an Individual Plant (WRPA)

WRPA = Within-Row Plant Distance $\times$ Row Width
Plant Spacing Analysis
30,000 Plants/acre

Distance to Neighbor A (inches)

Distance to Neighbor B (inches)

Ideal Spacing = 6.96”
**Plant Spacing Signature**

30,000 Plants/acre

- **Distance to Neighbor B (inches)**
- **Distance to Neighbor A (inches)**

- **Ideal**
- **Double**
- **Skip**
- **D1S**
- **D2S**
- **D3S**
- **D4S**

- **4+ Skips**
- **3 Skips**
- **3 Skips**

**Triple**
Plant Spacing Signature

Distance to Neighbor A (inches)

Distance to Neighbor B (inches)

Ideal

Distance to Neighbor A (inches)
Individual Plant Yield Response to Within-Row Plant Spacing - Iowa

Distance to Neighbor A (inches)

Distance to Neighbor B (inches)

0”, 7” Spacing

21”, 7” Spacing

Individual Plant Yield Bu/ ac

Legend:
- 0 to 10 Bu/ac
- 10 to 12 Bu/ac
- 12 to 14 Bu/ac
- 14 to 16 Bu/ac
- 16 to 18 Bu/ac
- 18 to 20 Bu/ac
- 20 to 22 Bu/ac

Color Scale:
- Dark Green: 0 to 40 Bu/ac
- Light Green: 40 to 80 Bu/ac
- Yellow: 80 to 120 Bu/ac
- Orange: 120 to 160 Bu/ac
- Red: 160 to 200 Bu/ac
Individual Plant Yield With Increasing Gap Size

<table>
<thead>
<tr>
<th>Distance to Neighboring Plants (inches)</th>
<th>Individual Plant Yield (Bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Missouri</td>
</tr>
<tr>
<td>10</td>
<td>Iowa - 1</td>
</tr>
<tr>
<td>15</td>
<td>Iowa - 2</td>
</tr>
<tr>
<td>20</td>
<td>Minnesota</td>
</tr>
</tbody>
</table>

Plant A
- 7
- 7
- 7
- 7
- 7
- 7
- 7
- 7
- 7

Plant B
- 0
- 3
- 6
- 9
- 12
- 15
- 18
- 21
Individual Plant Yield Response to Within-Row Plant Spacing - Iowa

- 7”, 7” Spacing
- 0”, 14” Spacing
Individual Plant Yield @ WRPD = 7 inches

- Missouri
- Iowa - 1
- Iowa - 2
- Minnesota

Nearest Distance to Neighboring Plants (inches): 0, 2, 4, 6, 7

Furthest Distance to Neighboring Plants (inches): 14, 13, 12, 11, 10, 9, 8, 7

Individual Plant Yield (Bu/ac)

Distance to Neighboring Plants (inches)
## Potential Yield Improvement Due to Improved Spacing

<table>
<thead>
<tr>
<th>Location</th>
<th>Ave. Spacing</th>
<th>Original Spacing</th>
<th>Perfect Spacing</th>
<th>Yield Improv.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S.D.</td>
<td>S.D.</td>
<td>S.D.</td>
<td>Bu/ac/in</td>
</tr>
<tr>
<td>Missouri</td>
<td>10.8 in.</td>
<td>6.9 in.</td>
<td>0 in.</td>
<td>1.1 Bu/ac/in</td>
</tr>
<tr>
<td>Iowa 1</td>
<td>6.2 in.</td>
<td>3.2 in.</td>
<td>0 in.</td>
<td>6.1 Bu/ac/in</td>
</tr>
<tr>
<td>Iowa 2</td>
<td>7.1 in.</td>
<td>3.6 in.</td>
<td>0 in.</td>
<td>2.9 Bu/ac/in</td>
</tr>
<tr>
<td>Minnesota</td>
<td>7.1 in.</td>
<td>3.8 in.</td>
<td>0 in.</td>
<td>3.3 Bu/ac/in</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>--</strong></td>
<td><strong>4.4 in.</strong></td>
<td><strong>0 in.</strong></td>
<td><strong>3.4 Bu/ac/in</strong></td>
</tr>
</tbody>
</table>

Average yield: 149 Bu/ac

Average yield improvement: 3.4 Bu/ac/in
Summary and Conclusions

- On-farm strip tests revealed a positive relationship between yield and improved WRPS standard deviation.

- Summarized individual plant yields under wide variation in growing season stress, yield levels, hybrid genetics and plant spacing.

- **Plant Spacing Analysis** is a useful way to examine plant spacing X yield in corn fields (2D - Plant Spacing Signature, and 3D - Yield Maps).

- Grain yields improved with increasing plant spacing uniformity at all four sites (ave. = 3.4 Bu/ ac/ in.).

- Perfect spacing was not needed to achieve maximum yield at a given plant density.
• There was no evidence for increased barrenness with closely-spaced plants at any location.

• Plants growing next to gaps were the least productive plants (per unit area) despite high “ear-flex” ratings for all of the hybrids used.
What About Planter Calibration?

- Cost of new planter: $50,000
- Annual cost of seed corn: $28,200 (assuming 600 acres)
- Cost of calibrating a 12-row planter: $300
- Typical savings due to improved plant spacing (3.4 Bu/ac for 1” of S.D. improvement): $4,080
- Break-even for calibration: 0.5 Bu/ac