Take a Stand: Optimize Plant Populations for Corn

Crop Pest Management Short Course
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Jeff Coulter - Extension Agronomist
coult077@umn.edu

http://z.umn.edu/corn
More plants needed in high-yield environments

• Eastern Dakotas (1998-2002): Optimum final stand increased by 740 plants/ac for every 10 bu/ac increase in yield level

• Illinois (1991-1994): Optimum final stand increased by 800 plants/ac for every 10 bu/ac increase in yield level

• Illinois (2005-2008): Optimum final stand increased by 940 plants/ac for every 10 bu/ac increase in yield level
### Cost of corn production (following soybean)

<table>
<thead>
<tr>
<th>Expense</th>
<th>Cost per acre*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed</td>
<td>$119 (14% of total)</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>$80 (10% of total)</td>
</tr>
<tr>
<td>Other nutrients, lime</td>
<td>$91</td>
</tr>
<tr>
<td>Pesticides</td>
<td>$20</td>
</tr>
<tr>
<td>Land, labor, equipment, insurance, interest, etc.</td>
<td>$524</td>
</tr>
<tr>
<td>Total</td>
<td>$834</td>
</tr>
</tbody>
</table>

*Input costs prior to discounts.

From Duffy, 2012 (*Estimated Costs of Crop Production in Iowa*)
Growers are adopting higher seeding rates

• Hybrids planted in the northern Corn Belt are earlier in maturity & more sink limited

• Optimum plant population tends to be higher in high-yield environments

• No or little yield penalty for too high of plant population

• High plant populations can capture potential yield increases in favorable growing seasons
Do high plant populations require more N?

- Optimum N fertilizer rate is not correlated with yield level

- Foliar symptoms of N deficiency are not uncommon at high plant populations with normal N rates

- In studies with high yields (>240 bu/ac) & high optimum populations (>35,000 plants/ac), N rates have exceeded university guidelines
Do high plant populations require more N?

• Avoiding N deficiency may partially offset the reduction in kernel weight that occurs with high plant populations
  – Could be especially important in the northern Corn Belt

• When corn is grown at high plant populations, yield increases with additional N have been inconsistent
  – Yield increased by up to 24 bu/ac in 4 of 10 site-years (IL, IN, NY, SD; 2005-2011)
  – Previous studies are highly confounded, creating uncertainty when attempting to make inferences to the Upper Midwest
Seeding rate x N rate study

<table>
<thead>
<tr>
<th>Location in 2012</th>
<th>Soil texture</th>
<th>Soil OM (%)</th>
<th>NO$_3$-N in top 2 feet (lb NO$_3$-N/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamberton</td>
<td>Loam</td>
<td>3.7</td>
<td>74</td>
</tr>
<tr>
<td>Waseca</td>
<td>Clay loam</td>
<td>6.0</td>
<td>144</td>
</tr>
<tr>
<td>Rochester</td>
<td>Silt loam</td>
<td>4.6</td>
<td>216</td>
</tr>
</tbody>
</table>

– Corn following soybean

– Soil fertility (excluding N) managed for 250+ bu/ac

– 15 lb S/ac preplant; 10-34-0 in-furrow at planting

– DKC53-78 RIB (103-day)
Seeding rate x N rate study

- 3 seeding rates (30,000; 36,000; 42,000 seeds/ac)
- 4 N fertilizer rates (65, 110, 155, 200 lb N/ac)
  - Split applications of N for enhanced efficiency

<table>
<thead>
<tr>
<th></th>
<th>N rates applied (lb N/ac)</th>
<th>Total</th>
<th>Starter</th>
<th>Preplant</th>
<th>Sidedress - V6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>65</td>
<td>5</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>110</td>
<td>5</td>
<td>65</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>155</td>
<td>5</td>
<td>110</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200</td>
<td>5</td>
<td>155</td>
<td>40</td>
</tr>
</tbody>
</table>
High seeding rates did not require more N at any location

- Lamberton, 2012
- Waseca, 2012
- Rochester, 2012
- Average of 3 locations

Corn grain yield (bu/ac)

N fertilizer rate (lb N/ac)
Highest yield with 36,000 or 42,000 seeds/ac

Data averaged across N rates

LSD (0.10)
Highest net return with 36,000 or 42,000 seeds/ac

Data averaged across N rates

$7.25/bu; $225/80,000 seeds; $0.50/lb N

LSD (0.10)
155 lb N/ac maximized yield at all locations

Data averaged across seeding rates

LSD (0.10)
Net returns mirrored yields, except at Rochester

Data averaged across seeding rates

$7.25/bu; $225/80,000 seeds; $0.50/lb N

LSD (0.10)
Yield was not increased with >32,000 plants/ac, even with high N fertility

W. Lafayette, IN (2005-2007), 2 hybrids/year (114-119 day RM)

From Boomsma et al., 2009 (Agronomy Journal)
Summary - seeding rate x N rate study

- Higher seeding rates never required more N
- Highest grain yield & net return with 36,000 or 42,000 seeds/ac
- Response to N varied among locations
- No advantage to N rates over 155 lb N/ac
Can higher plant populations offset yield losses from delayed planting?

Late May (left) vs. Late April (right)

Late April (left) vs. Mid-May (right)
1) Response to plant population similar for all planting dates

2) On average, yield maximized at 32,800 plants/ac or higher

102-day hybrid
Narrow rows may reduce plant-to-plant competition and increase yield, especially with higher populations in some environments.

- 44,000 plants/acre
- 30-inch rows

- 44,000 plants/acre
- 20-inch rows
1) No difference in yield between row widths
2) Response to plant population similar for both row widths
3) On average, yield maximized at 34,300 plants/ac or higher

Avg. of 3 hybrids; corn on corn
1) Yield was 7 and 14% higher with the 101- & 105-day hybrids when compared to the 95-day hybrid

2) Response to plant population was similar for all hybrids

3) On average, yield maximized at 34,300 plants/ac or higher
Twin-row study

- Welcome, MN (2010-2012)
- Wilmont, MN (2010-2011)
- Following soybean
- Field-scale trials
- Soil fertility managed for high yields
- 30-inch rows vs. 22-/8-inch twin rows
- 33,000; 38,000; 43,000 seeds/ac
- DKC48-37 (98-day RM)
30-inch rows

22-/8-inch twin rows

Photos from Liz Stahl (Univ. of Minnesota)
Statistically significant differences occurred in just 1 of 5 site-years (Wilmont, MN – 2010)

Data from Liz Stahl (Univ. of Minnesota)
Across 5 site-years, yield was statistically higher (6 bu/ac; 3%) with 43,000 seeds/ac in twin-rows.
Row width x hybrid x population study

- 5 site-years in northwestern MN (2009-2011)
- Planted after soybean or wheat
- 2 row widths (22-inch vs. 30-inch)
- 3 hybrids:
  - 80-day RM
  - 85-day RM
  - 89-day RM
- Each hybrid x row width at 6 plant populations
Key findings:

1) Highest yield with the 89-day hybrid

2) Optimum final stand similar among hybrids

Avg. of 2 row widths
Key findings:

1) Advantage to 22” rows at >33,000 plants/ac

2) Optimum final stand was higher for 22” rows
**Optimum seeding rates – northwestern MN**  
*(averaged over 3 hybrids & 5 site-years)*

<table>
<thead>
<tr>
<th>Seed cost ($/80,000)</th>
<th>Corn price ($/bu)</th>
<th>Optimum seeding rates*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>30-inch rows</td>
</tr>
<tr>
<td>225</td>
<td>7.25</td>
<td>37,100 to 39,500</td>
</tr>
<tr>
<td>275</td>
<td>7.25</td>
<td>36,100 to 38,500</td>
</tr>
</tbody>
</table>

Optimum rates in both scenarios above =  
37,100 to 38,500 \hspace{2cm} 40,500 to 42,100

*Assumes 5% over-seeding.*
Summary – northwestern MN study

- Hybrids responded similarly to population & row width

- With narrow rows, optimum seeding rates were 3,500 seeds/ac higher & maximum yields were 4-5% higher

- Optimum seeding rates were exceptionally high. However, moderate increases to existing seeding rates in this region will likely increase yield & net return for many growers, especially if they use narrow rows
Corn brand x seeding rate study

- Elbow Lake, MN - 2012

- Following soybean

- Soil fertility managed for high yields

- 30,000; 35,000; 40,000; 45,000 seeds/ac

- 6 corn brands of similar relative maturity
  - Channel 196-06 VT3 PRO (96-day)
  - Croplan 3390 VT3 PRO (93-day)
  - DEKALB DKC46-20 (96-day)
  - Pioneer P9630AM1 (96-day)
  - NK N38U 3000GT (97-day)
  - Wensman 7268 VT3 (96-day)
LSD (0.10)
For the 4 responsive brands, average yield was maximized with 40,000 seeds/ac.
Summary – brand x seeding rate study

• Choice of brand was more important than choice of seeding rate
  – Differences among brands at a given seeding rate ranged from 21-32 bu/ac (avg. = 24 bu/ac)
  – Differences among seeding rates for a given brand ranged from 9-31 bu/ac (avg. = 19 bu/ac)

• For the 4 responsive brands, average yield was maximized with 40,000 seeds/ac

• No clear yield penalty for too high of seeding rate
Silage hybrids selected for tonnage & quality. How high should we push their populations?
Silage hybrid under irrigation with a high population – Sartell, MN
Tonnage is important, but not if it is low quality & cows are limited by intake.
Brown midrib (BMR) silage hybrids have increased fiber digestibility & dry matter intake

• BMR corn first discovered in St. Paul, MN in 1924

• BMR corn has a naturally occurring gene that reduces lignin levels in stalks (by up to 39%) & leaves. Lignin is the part of fiber that is not digestible

• BMR plants have brown coloration on the leaf midrib, stalk rind, & stalk pith

Photo by Dave Hanson
Non-BMR

BMR

Photo from Jon Erickson (Mycogen)
BMR (left) vs. non-BMR (right)

Photos from Jon Erickson (Mycogen)
Silage hybrid type x seeding rate study

- Corn following corn
- La Crescent, Rochester, Melrose, & Ottertail, MN
- Ottertail site was irrigated
- Fertility managed for high yield
- 5 gal/acre 10-34-0 in-furrow
Silage hybrid type x seeding rate study

• 3 seeding rates (35,000; 40,000; 45,000 seeds/ac)

• 2 southern locations (Rochester & La Crescent)
  – BMR = 109-day Mycogen F2F626
  – BMR = 109-day Mycogen F2F665
  – Silage specific = 110-day Mycogen TMF2Q717
  – Silage specific = 110-day Mycogen TMF2H699

• 2 central locations (Melrose & Ottertail)
  – BMR = 105-day Mycogen F2F569
  – BMR = 99-day Mycogen F2F488
  – Silage specific = 101-day Mycogen TMF2L533
  – Silage specific = 98-day Mycogen TMF2R522
• Higher yields at southern locations
• Limited differences in silage quality among locations
• NDFD not affected by seeding rate, but averaged 4.0 percentage points higher with BMR hybrids

<table>
<thead>
<tr>
<th>Location</th>
<th>Silage yield (tons/ac at 65%)</th>
<th>Milk/ton (lb/ton dry matter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>La Crescent</td>
<td>34.0</td>
<td>3,630</td>
</tr>
<tr>
<td>Rochester</td>
<td>32.2</td>
<td>3,500</td>
</tr>
<tr>
<td>Melrose</td>
<td>23.3</td>
<td>3,650</td>
</tr>
<tr>
<td>Ottertail</td>
<td>21.9</td>
<td>3,670</td>
</tr>
</tbody>
</table>
1) BMR hybrids had 11% lower yield & 2% lower milk/ton

2) For both hybrid types, high seeding rates increased silage yield by 7-12%, but did not affect milk/ton
1) BMR hybrids had equal silage yield & 2% higher milk/ton

2) For both hybrid types, high seeding rates did not affect silage yield or milk/ton

Rochester, MN - 2012
Data averaged across 2 brands for each hybrid type
1) BMR hybrids had equal silage yield & milk/ton

2) High seeding rates did not affect silage yield for either hybrid type, but reduced milk/ton for silage specific hybrids
1) BMR hybrids had 7% lower silage yield & equal milk/ton

2) For both hybrid types, high seeding rates increased silage yield by 6-12%, but reduced milk/ton

Ottertail, MN – 2012
Data averaged across 2 brands for each hybrid type

LSD (0.10)
Summary – silage hybrid type x seeding rate study

- NDFD averaged 4.0 percentage points higher with BMR hybrids than silage-specific hybrids

- Silage yields were 7-11% lower with BMR hybrids at 2 of 4 locations

- Response to seeding rate did not differ with hybrid type

- High seeding rates increased silage yield by 6-12% at 2 of 4 locations, but reduced milk/ton by 2-3% at 2 of 4 locations
Take home points

• High yields do not require high populations, but often have required at least 32,000 plants/ac in southern MN

• High seeding rates do not require higher N rates

• Optimum final stand does not differ with planting date in southern MN

• In southern MN, row width has little effect on corn yield or optimum final stand

• In northwestern MN, optimum populations are higher, especially in narrow rows
• Optimum seeding rate differs somewhat among hybrids, but choosing the right hybrid affects yield more

• Optimum seeding rates are a little higher for silage corn

• High seeding rates do not always increase silage yield, but they can reduce quality

• BMR hybrids performed well & were not that different from silage hybrids in their response to seeding rate

• Consider on-farm test strips before making large changes to seeding rates
Thanks!

http://z.umn.edu/corn