Starters: Value of N-P-K-S-Zn in Current Production Systems

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Impacts on US Corn Yields

- Blight -18%
- Wet spring, early frost -16%
- Drought -17%
- Drought -26%
- Drought -29%
- Flood
- Unusual Climate Events

Hatfield, 2010
Optimism of US Corn Production

Expect yields to continue to increase

US Corn Production

160 bu acre$^{-1}$
Goal: Capture Yield Potential
Days After Corn Planting

Above Ground Dry Weight, lbs/acre

Root Length, mi/acre

Grain wt portion = 9650 lbs
46% of total

Purdue Univ. Agronomy Research Center
soil supply of N, P, and/or other nutrients must increase

crop root system must take advantage
Soil Supply of Nutrients

- Root interception
- Mass flow
- Diffusion
Soil Nutrient Supply Zones

Mobile Nutrients

- NO$_3^-$
- SO$_4^{2-}$

Immobile Nutrients

- H$_2$PO$_4^-$
- K$^+$

Blaylock, 2003
Factors Affecting Root Growth

- soil water content
- soil temperature
- soil physical properties
Corn Root Growth in Saturated Soil

Kovar and Kuchenbuch, 1994
Midwest Corn

Graph showing the relationship between Soil Temperature (°C) and Root Growth Rate (cm s⁻¹ m⁻²).
## Optimum Soil Temperatures for Root Growth of Several Crop Species

<table>
<thead>
<tr>
<th>Crop</th>
<th>Optimum Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canola</td>
<td>73°F (23°C)</td>
</tr>
<tr>
<td>Corn</td>
<td>79°F (26°C)</td>
</tr>
<tr>
<td>Cotton</td>
<td>91°F (33°C)</td>
</tr>
<tr>
<td>Perennial Ryegrass</td>
<td>62°F (17°C)</td>
</tr>
<tr>
<td>Rice</td>
<td>87°F (31°C)</td>
</tr>
<tr>
<td>Soybean</td>
<td>77°F (25°C)</td>
</tr>
</tbody>
</table>

McMichael and Burke, 1996
Wheel Traffic = Compacted Soil

Photo by T.C. Kaspar, USDA-ARS
Response to Starter Fertilizer

- starter placement?
- starter composition?
Starter Placement Options

Figure 2a. Two-by-two placement.

Figure 2b. Below-seed placement.

Figure 2c. In-row or “pop-up” placement.

Figure 2d. Over-the-row banding.

Figure 2e. Surface-dribble placement.

Figure 2f. Banding under the row.

http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-29/
Pounds Actual $K \times 10^{-8}$ per inch$^2$

Karlen and Kovar, 2005
Starter Fertilizer Treatments (Iowa Corn)

Check
5 gal/A 10-34-0, in-furrow
8.7 gal/A 7-21-7, in-furrow
12 gal/A 10-34-0, surf. band
21 gal/A 7-21-7, surf. band
15-30-10; 0x0, 2x0
30-30-10; 0x0, 2x0
45-30-10; 0x0, 2x0
60-30-10; 0x0, 2x0
Effect of Starter Placement on Corn Grain Yields during Three Growing Seasons (Iowa)

Kovar, 2003
Effect of Starter Composition on Corn Grain Yields during Three Growing Seasons (Iowa)

Corn Yield, bu/A

Check 15-30-10 30-30-10 45-30-10 60-30-10

Kovar, 2003
Effect of Starter on Ridge-Till Corn Yields (Kansas)

Corn Yield, bu/A

In-Furrow  2x2  Dribble  Row Band

Gordon and Whitney, 2001
### Corn Grain Yield Response to In-Furrow Starter (Iowa)

<table>
<thead>
<tr>
<th>Site</th>
<th>Control</th>
<th>3-18-18&lt;sup&gt;+&lt;/sup&gt;</th>
<th>0-0-30&lt;sup&gt;+&lt;/sup&gt;</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>161a</td>
<td>182b</td>
<td>185b</td>
</tr>
<tr>
<td>2</td>
<td>159a</td>
<td>176c</td>
<td>171b</td>
</tr>
<tr>
<td>3</td>
<td>179</td>
<td>183</td>
<td>173</td>
</tr>
<tr>
<td>4</td>
<td>171a</td>
<td>172a</td>
<td>175a</td>
</tr>
<tr>
<td>5</td>
<td>169a</td>
<td>184b</td>
<td>184b</td>
</tr>
<tr>
<td>6</td>
<td>129a</td>
<td>147b</td>
<td>154b</td>
</tr>
</tbody>
</table>

<sup>+</sup>K applied at 15-22 lb K<sub>2</sub>O/Ac

Mallarino et al., 2010
Key Points

- Surface dribble (2x0) applications work as well as 2x2
- Starters with high N to P$_2$O$_5$ ratios (1:1 or greater) work well in high-residue systems
- Starter K alone seldom increases early corn growth or grain yield
Effect of 30 lb S/A on Corn Grain Yield

Kovar and Karlen, 2010
Sulfur Deficiency

http://www.sdstate.edu/ps/extension/soil-fert/corn-deficiency-photos.cfm
Micrograms $SO_4^-S$ per cm$^2$ Soil; 26 Days

Kovar and Grant, 2011
## Corn Grain Yield Response to Starter Placement and Composition (MN)

<table>
<thead>
<tr>
<th>Trmt</th>
<th>N+P₂O₅+K₂O+S</th>
<th>Placement</th>
<th>Source</th>
<th>Yield</th>
<th>lbs/Acre</th>
<th>bu/A</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>0+0+0+0+0</td>
<td>None</td>
<td>None</td>
<td>209</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6+20+0+0+0</td>
<td>in-furrow</td>
<td>APP</td>
<td>215</td>
<td>2x0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>20+20+6+4</td>
<td>2x0</td>
<td>APP+UAN+KTS</td>
<td>233</td>
<td>2x0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>20+20+6+4</td>
<td>2x2</td>
<td>APP+UAN+KTS</td>
<td>221</td>
<td>2x2</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>20+20+10+10</td>
<td>2x0</td>
<td>APP+UAN+KTS+ATS</td>
<td>231</td>
<td>2x0</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>20+20+10+10</td>
<td>2x2</td>
<td>APP+UAN+KTS+ATS</td>
<td>224</td>
<td>2x2</td>
<td></td>
</tr>
</tbody>
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Randall, 2008
Zinc Deficiency

http://www.sdstate.edu/ps/extension/soil-fert/corn-deficiency-photos.cfm
Key Points

- Sulfur responses becoming more common, S in starter has provided mixed results
- Starter S responses more likely in sandy or low organic matter soils, under cool soil temperatures
- Current research suggests that addition of Zn to starters will not provide a consistent yield response
Do hybrid differences affect the response to starters?
Starter Fertilizer x Hybrid Interaction (Florida)

- Surface band, 10 gal/A 10-34-0
- 28 hybrid varieties
- Positive response: 46%
- No response: 29%
- Negative response: 25%

Teare and Wright, 1990
Responsive hybrids have slow root growth rate, increased by starter.
- Root growth rate higher in non-responsive hybrids.
- Early-season shoot growth increased by 92% in response to starter.
- Response to N in starter was greater than response to P.

Rhoads and Wright, 1998
Know Your Fertilizer Rights

- Right Source
- Right Rate
- Right Time
- Right Place