Starter Fertilizers: The Risk and The Rewards

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Some slides contributed from
Dr. Chad Godsey and Dr. Dave Mengel KSU
Concept of Starter Fertilizer

• Concentrate some fertilizer close to germinating seeds to:
  • Enhance early season growth
  • Enhance nutrient, N, P, K, ZN or S availability

• Issues
  • What nutrients are important?
  • What impact does soil test play on response?
  • Seedling safety?
  • Plant availability vs chemical availability?
Places Starter Fertilizer Pays

• Very early planting/low soil temperature
• Low soil test levels
• Low application rates
• High level of nutrient retention
• No-Till, cooler and wetter conditions under residue slow early growth of roots and shoots
• In No-till cooler soil temperature also slows mineralization of N and S enhancing starter response.
• Small Grains and Canola?
• My two cents
  • If you have other issues, pH weeds etc.
Soil Temperature at Planting Depth
Belleville 2004

Degrees F

40 45 50 55 60 65 70 75


Strip-till
No-till
Starter Fertilizer, the traditional use of band applications

With 11-52-0  No Starter  With 10-34-0
Concept of Band Application

• Under responsive conditions, concentrate the fertilizer to minimize soil-fertilizer contact.
  • Minimize “fixation” and create a zone of very high fertility that will increase availability.
  • Place in close proximity to germinating seeds to enhance early season availability.
Concept of Band Application and Starter Fertilizer

• Positives
  • Increases P or K levels in soil solution
  • Can position the fertility near the germinating seed
  • Can place the fertilizer in moisture to enhance availability in dry conditions
  • Efficient, both mechanical and nutrient

• Negatives
  • Limit the number of roots that can contact the nutrient and potentially limit nutrient uptake.
  • Potential for salt or ammonia injury to roots or seed in the band
  • Equipment cost and extra time
Different Types of Starter Fertilizer Band Applications

- 2” x 2” Starter
- Surface Dribble
- ‘Pop-up’ In-Furrow
Diffusion

- Diffusion: Movement of P and K from zones of higher concentration to zones of lower concentration
- P example:
  - Low-P soil: 0.006 in./d
  - High-P soil: 0.009 in./d
1999-2001 Grain Sorghum, Scandia, KS

<table>
<thead>
<tr>
<th>Starter, lb/a</th>
<th>Yield, bu/a</th>
<th>2 x 2</th>
<th>Dribble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check = 93 bu</td>
<td>104</td>
<td>101</td>
<td></td>
</tr>
<tr>
<td>0 30</td>
<td>111</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>30 0</td>
<td>116</td>
<td>111</td>
<td></td>
</tr>
<tr>
<td>15 30</td>
<td>127</td>
<td>118</td>
<td></td>
</tr>
<tr>
<td>30 30</td>
<td>127</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>45 30</td>
<td>117</td>
<td>112</td>
<td></td>
</tr>
</tbody>
</table>

Average: 117

P Soil Test = High
## Starter Effects on Corn Yield (bu/a)
3-year avg, NCK Experiment Field

<table>
<thead>
<tr>
<th>Starter</th>
<th>In-furrow</th>
<th>2x2</th>
<th>Dribble</th>
<th>Row Band</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-15-5</td>
<td>172</td>
<td>194</td>
<td>190</td>
<td>179</td>
</tr>
<tr>
<td>15-15-5</td>
<td>177</td>
<td>197</td>
<td>198</td>
<td>180</td>
</tr>
<tr>
<td>30-15-5</td>
<td>174</td>
<td>216</td>
<td>212</td>
<td>192</td>
</tr>
<tr>
<td>45-15-5</td>
<td>171</td>
<td>215</td>
<td>213</td>
<td>195</td>
</tr>
<tr>
<td>60-15-5</td>
<td>163</td>
<td>214</td>
<td>213</td>
<td>201</td>
</tr>
<tr>
<td>Average</td>
<td><strong>171</strong></td>
<td><strong>207</strong></td>
<td><strong>205</strong></td>
<td><strong>189</strong></td>
</tr>
</tbody>
</table>

No starter, 159
Plant Population

<table>
<thead>
<tr>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,000</td>
</tr>
<tr>
<td>22,000</td>
</tr>
<tr>
<td>24,000</td>
</tr>
<tr>
<td>26,000</td>
</tr>
<tr>
<td>28,000</td>
</tr>
<tr>
<td>30,000</td>
</tr>
<tr>
<td>32,000</td>
</tr>
<tr>
<td>34,000</td>
</tr>
</tbody>
</table>

In-Furrow 2X2 Dribble Row Band

5-15-5
15-15-5
30-15-5
45-15-5
60-15-5
Starter Fertilizer on No-till Corn

![Bar graph showing population of corn plants per acre with different starter fertilizers and application methods. The graph compares populations for 0-0-0, In-furrow, and Over-row applications across different fertilizer rates.]
Starter Fertilizer on No-till Corn

![Graph showing the effect of different starter fertilizers on corn yield. The x-axis represents different starter fertilizers (0-0-0, '10-15-5, 20-15-5, 40-15-5, 50-15-5). The y-axis represents yield in bushels per acre (bu/a). There are three bars for each fertilizer type: 0-0-0, In-Furrow, and Over-row.]
## STARTER FERTILIZER ON NO-TILL SORGHUM

<table>
<thead>
<tr>
<th>Starter Placement</th>
<th>N</th>
<th>P$_{2}O_5$</th>
<th>Yield 2 yr avg</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>bu/a</td>
<td></td>
</tr>
<tr>
<td>2x2</td>
<td>0</td>
<td>0</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>30</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>0</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>30</td>
<td>119</td>
<td></td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>30</td>
<td>119</td>
<td></td>
</tr>
<tr>
<td>Over-row</td>
<td>0</td>
<td>30</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>0</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>30</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>30</td>
<td>106</td>
<td></td>
</tr>
</tbody>
</table>

LSD (.05) 6

N balanced at 140 lb/a with knifed UAN
Bray 1 P = 42 ppm
Gordon, Kansas State University
<table>
<thead>
<tr>
<th>P Applied, lb/a</th>
<th>Soybean Yield, bu/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 P</td>
<td>31</td>
</tr>
<tr>
<td>21</td>
<td>37.3</td>
</tr>
<tr>
<td>LSD 0.1</td>
<td>4</td>
</tr>
</tbody>
</table>

100 lb 7-21-7 applied 2x2 as starter fertilizer at planting
What about S and Micronutrients?

• General rule of thumb is if it sounds too good to be true it probably is.

• Soil test to determine needs
  • This especially works for Zn

• Soil pH will also determine needs

• Consider planting time and soil temperature
Starter fertilizer placed 2x2 on no-till dryland corn

<table>
<thead>
<tr>
<th>Starter Fertilizer</th>
<th>Plant Population</th>
<th>Grain Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000 2001</td>
<td>2000 2001</td>
</tr>
<tr>
<td>N P₂O₅ K₂O S</td>
<td>1000 plants/a</td>
<td>- - - bu/a - - -</td>
</tr>
<tr>
<td>0 0 0 0</td>
<td>20.7 23.7</td>
<td>105 72</td>
</tr>
<tr>
<td>30 30 10 0</td>
<td>17.9 22.7</td>
<td>119 86</td>
</tr>
<tr>
<td>30 30 10 10</td>
<td>18.0 23.7</td>
<td>132 91</td>
</tr>
<tr>
<td>60 30 10 0</td>
<td>20.1 23.2</td>
<td>120 83</td>
</tr>
<tr>
<td>90 30 10 0</td>
<td>20.8 22.5</td>
<td>142 85</td>
</tr>
<tr>
<td>120 30 10 0</td>
<td>20.3 22.7</td>
<td>128 88</td>
</tr>
<tr>
<td>LSD(0.10)</td>
<td>1.5 NS</td>
<td>15 6</td>
</tr>
</tbody>
</table>

Starter was placed 2 inches below and 2 inches to the side of seed row at planting.
Impact on Maturity

Figure 1. Images taken from two grain sorghum trials conducted in Oklahoma. Both trials were planted on the same day to the same cultivar. The image on the left was in a nitrogen management study that did not receive starter while the image on the right was taken in a herbicide study which received starter. Difference in maturity is evident.
Canola

- Phosphorus Response
- Winter Survival

![Graph showing the relationship between Phosphorus Response and Winter Survival with R² = 0.90.](image)
Perkins (Acidic soil)

Trt 1 Check 0N 0P
Trt 2. N Broadcast 0P
Trt 3. NP Broadcast
Trt 4. NP banded 15lbDAP
Trt 6. NP banded 45lbDAP
Trt 8. NP banded 75lbDAP
What portion of the applied P should be applied as starter fertilizer

• Is dependent on soil test values.
  • Low Soil test: High P rec should split.
    • Too much N with the P needed.
  • Med Soil test: Low P rec.
    • Starter primarily
  • High Soil test: No P rec
    • Some Starter only.
Corn Yield At Various Percentages Of Broadcast and Starter Applied P - Welch et al.

Zanesville Soil – Low Yield, Low Fertility
Corn Yield At Various Percentages Of Broadcast and Starter Applied P - Welch et al.

Elliott Soil – High Productivity, low fertility
Corn Yield At Various Percentages Of Broadcast and Starter Applied P - Welch et al.

Muscatine Soil – Very High Productivity, High fertility
Band vs Broadcast to enhance efficiency

• Going beyond starter effect, at low soil test P or K levels banding pays well at low rates
• At higher rates a combination of banding and broadcasting gives better performance
  • Banding/ enhances chemical availability to limited roots on seedlings and enhances early growth
  • Broadcasting increases the number of roots which
  • Can utilize the fertilizer later and increases yield
Considerations

- Not all fertilizers are created equal
- Not all soils are equal
- Not all Seeds are created equal.

The general sequence of salt tolerance of common crops is: **barley > wheat > grain sorghum >> corn >soybean.**

Soil texture can also influence the salt effect.

<table>
<thead>
<tr>
<th>Placement (distance from seed)</th>
<th>Sandy Soils</th>
<th>Loamy Soils</th>
<th>Clayey Soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>In direct contact</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>¼ - ½ inch</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>1 – 2 inches</td>
<td>20</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>&gt;2 inches</td>
<td>25+</td>
<td>38+</td>
<td>50+</td>
</tr>
</tbody>
</table>

Safe levels of fertilizer salt (N + K2O in lbs/acre) to apply in corn production as a function of soil texture and placement (adopted from Dr. Jessica Davis, Colorado State University).
Row Spacing is a Big driver!!!!

Salt Index - N + K₂O
Suggested Maximum Rates of Fertilizer to be Applied Directly With Seed
(Corn and Small Grains)

<table>
<thead>
<tr>
<th>Row Spacing in Inches</th>
<th>Pounds N + K₂O* (No urea or UAN)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium to Fine Textured Soils</td>
</tr>
<tr>
<td>40</td>
<td>6</td>
</tr>
<tr>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>6-8</td>
<td>30</td>
</tr>
</tbody>
</table>

Reduce salt rates 30% for grain sorghum.
No seed-placed fertilizer is recommended for soybeans, sunflowers, field beans, or sugar beets.
There is an App for that, Soon

- Input
  - Crop
  - Row width
  - Product (s)
- Output
  - Maximum rate or critical rate
Placement of fertilizers in relation to seed

- Fertilizer salts, primarily N and K, can injure seedlings
- Never place urea with seed
- In 30” rows, a maximum of 6-10 pounds of N plus K per acre can be used
- No starter fertilizer applied in direct seed contact for soybean and cotton
- 2x2 placement allows much more flexibility
Summary

- Starter fertilizer is a useful tool at low soil test levels:
  - To overcome high levels of fixation
  - To maximize early season availability to seedlings
- There are also potential limits and problems
  - Roots have a finite capacity to absorb nutrients which can limit uptake from bands
  - Fertilizer salts and ammonia can damage roots
- Cost - dribble is probably cheaper but in ideal world prefer 2x2.
- Sulfur and other micronutrients may pay if some environmental factor(s) affect plant root development and/or S mineralization rates.
- On-farm research to determine if they pay.
Conclusions:

• Band placement is a useful tool at low soil test levels:
  • To overcome high levels of chemical fixation
  • To maximize early season availability to seedlings
• There are limits on how much nutrient can be utilized from a band
  • Roots have a finite capacity to absorb nutrients
• In No-till corn and grain sorghum don’t overlook the importance of early N.
  • Consider “spiking” additional N to apply 20-30 lbs N per acre, especially in wide C:N residues
• Starter fertilizer banding greatly enhances the availability of Zn and Fe, allowing the use of lower rates
• In Wheat and Canola don’t overlook the importance of N+P
Thank you!!!

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Presentation available @
www.npk.okstate.edu

Twitter: @OSU_NPK

YouTube Channel: OSUNPK

Blog www.osunpk.com
No-till 2 x2 unit
Surface Band

For Pop-up, move hose forward into seed furrow