Potassium Placement Strategies for Optimum Nutrient Balance in Modern Corn Hybrids

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Presentation Overview

1. Modern Corn Hybrids (K uptake and partitioning)?

2. Nutrient Balance (K:N, and grain yield relationships to leaf concentrations)?

3. K placement considerations and strategies?
Study of Dekalb Corn Hybrids from 1967 to 2005 and Their Response Changes to Nitrogen and Plant Density Management (2013-2014)
Location:
ACRE (West Lafayette, IN)
PPAC (Wanatah, IN)

Years: 2013, 2014

N fertilizer rate: 55 kg ha\(^{-1}\); 220 kg ha\(^{-1}\)

Plant density:
54,000 plants ha\(^{-1}\)
79,000 plants ha\(^{-1}\)
104,000 plants ha\(^{-1}\)

Average Soil-Test P (0-20cm): 35
Average Soil-Test K (0-20 cm): 140
<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Commercial Release (yr)</th>
<th>Type of Cultivars</th>
<th>Cultivar Characteristics</th>
<th>Relative Maturity Days (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DKC61-69</td>
<td>2005</td>
<td>VT3</td>
<td>Corn rootworm, European corn borer and glyphosate resistant</td>
<td>111</td>
</tr>
<tr>
<td>DKC61-72</td>
<td>2005</td>
<td>RR2 (Roundup Ready™)</td>
<td>Glyphosate resistant</td>
<td>111</td>
</tr>
<tr>
<td>RX752</td>
<td>2003</td>
<td>VT3</td>
<td>Corn rootworm, European corn borer and glyphosate resistant</td>
<td>112</td>
</tr>
<tr>
<td>RX752RR2</td>
<td>2003</td>
<td>RR2 (Roundup Ready™)</td>
<td>Glyphosate resistant</td>
<td>112</td>
</tr>
<tr>
<td>RX730</td>
<td>1994</td>
<td>Conventional</td>
<td>Not resistant</td>
<td>111</td>
</tr>
<tr>
<td>DK636</td>
<td>1982</td>
<td>Conventional</td>
<td>Not resistant</td>
<td>113</td>
</tr>
<tr>
<td>XL72AA</td>
<td>1975</td>
<td>Conventional</td>
<td>Not resistant</td>
<td>115</td>
</tr>
<tr>
<td>XL45</td>
<td>1967</td>
<td>Conventional</td>
<td>Not resistant</td>
<td>115</td>
</tr>
</tbody>
</table>
Dekalb Hybrid Yield Gains from 1967 to 2005 at Two N Rates in Two Indiana Locations (2013-2014)

Source: Keru Chen et al., Field Crops Research, 2016
Whole-plant Sampling at Flowering and Maturity

1. Sampling from field; 2. Weighting fresh weight; 3. Select five sub-sample and separate sub-samples into leaf, stem (with husk), ear-shoot (R1); 4. Chopping; 5. Bagging; 6. Weighting all fresh weights
Corn Hybrid Era effect on Average Biomass at Flowering and Maturity (2013-2014)

Except for 1967 hybrid, no change in biomass at R1; Total Dry Matter at R6 increased ~80 kg ha\(^{-1}\) year\(^{-1}\)
Leaf versus Stem K concentrations at flowering

No Era trend in leaf or stem K concentrations at flowering
Hybrid Era Influence on Internal Plant K Distribution at Flowering and at Maturity

K uptake at flowering

- Leaf
- Stem
- Earshoot

K uptake at maturity

- Leaf
- Stem
- Kernel
- Cob

Tendency for more total K content retained in leaves at R6
Grain K concentrations at maturity

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kernel K concentration (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td></td>
<td>0.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>

No trend over time in grain K concentrations
Is high-yielding corn related to balanced nutrition?

<table>
<thead>
<tr>
<th>2006-12 yrs</th>
<th>USA (10 Mg/ha)</th>
<th>WORLD (6 Mg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Points</td>
<td>253</td>
<td>341</td>
</tr>
<tr>
<td>N:P</td>
<td>4.9</td>
<td>5.3</td>
</tr>
<tr>
<td>N:K</td>
<td>1.1</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Source: Ciampitti and Vyn, 2014, Agron. J.
Timing and Source of N Uptake by Plants and Grain

Ciampitti et al., 2013 Agronomy Journal
Potassium Uptake in Growing Season Over Time in Corn at Three N Rates

Ciampitti et al., 2013 Agronomy Journal
Hybrid Era Impacts N to K ratios at Flowering and Maturity

Source: Chen and Vyn, unpublished
Ear-leaf K, N Relationships to Final Grain Yield in Indiana

Source: Kovacs and Vyn, unpublished
R1 Stage Ear-leaf N to K Ratio Relationship to Final Yield

Source: Kovacs and Vyn, unpublished
Long-Term Tillage/Rotation Study (1975-present)

Moldboard plowed

Chisel plowed

Fall Strip-Till
Long-term Tillage Influence on Soil-test P (ppm)

- **Fall Plow**: 40 ppm (0 to 10 cm), 50 ppm (10 to 20 cm)
- **Fall Chisel**: 40 ppm (0 to 10 cm), 30 ppm (10 to 20 cm)
- **Strip-till**: 40 ppm (0 to 10 cm), 30 ppm (10 to 20 cm)
- **No-till**: 20 ppm (0 to 10 cm), 30 ppm (10 to 20 cm)

Legend:
- **0 to 10 cm**
- **10 to 20 cm**
Long-term Tillage Influence on Soil-test K (ppm)

- **Fall Plow**
- **Fall Chisel**
- **Strip-till**
- **No-till**

Bar chart showing soil test K values for different tillage methods at 0 to 10 cm and 10 to 20 cm depths.
Stratification for P and K in Strip-till Corn and No-till Soybean Rotation with only Starter P (corn) and no Broadcast P or K in 4 Years

Source: Global Maize Trial, West Lafayette, 2014
Strip Tillage and Nutrient Placement Research
Tillage and K₂O Rate Consequences for In-row Soil-test K at 3 depth increments (West Lafayette, IN, 2016)

Source: Vyn, 2016, unpublished
K Source: Aspire (58% K₂O, 0.5% B)
Tillage and K₂O Rate Consequences for In-row Soil-test K at 3 depth increments (West Lafayette, IN, 2016)

- Fall Chisel, 130 K₂O
- Fall Chisel, 0 K₂O
- Spring Strip-Till 130 K₂O
- Spring Strip-Till, 0 K₂O
- No-Till, 130 K₂O
- No-Till, 0 K₂O

Source: Vyn, 2016, unpublished
K Source: Aspire (58% K₂O, 0.5% B)
Conclusions

• Modern hybrids take up more total K because they yield more, but uptake timing and distribution is little affected when planted at the same density.

• Optimum tissue K concentrations, and N to K nutrient balance ratios, vary with time in corn growth.

• Nutrient stratification in conservation-till can complicate soil exchangeable K availability. More placement/timing etc. research needed.
Acknowledgments

Funding:
- Indiana Corn Marketing Council
- Monsanto Company
- IPNI and 4R Research Fund
- The Mosaic Company

Equipment:
- John Deere Cropping Systems Unit
- Environmental Tillage Systems

Seed:
- Pioneer Hi-Bred, Int’l.
- Monsanto
- Dow AgroSciences
Dekalb Hybrid Yield Gains from 1967 to 2005 at Three Densities in Two Indiana Locations (2013-2014)

Source: Keru Chen et al., Field Crops Research, 2016
Plant Density Effects on biomass (averaged across 8 hybrids and 2 N rates)

Biomass at flowering

<table>
<thead>
<tr>
<th>Density</th>
<th>Leaf</th>
<th>Stem</th>
<th>Earshoot</th>
</tr>
</thead>
<tbody>
<tr>
<td>54,000</td>
<td>b</td>
<td>b</td>
<td>c</td>
</tr>
<tr>
<td>79,000</td>
<td>a</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>104,000</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
</tbody>
</table>

Biomass at maturity

<table>
<thead>
<tr>
<th>Density</th>
<th>Leaf</th>
<th>Stem</th>
<th>Grain</th>
<th>Cob</th>
</tr>
</thead>
<tbody>
<tr>
<td>54,000</td>
<td>c</td>
<td>b</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>79,000</td>
<td>b</td>
<td>a</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>104,000</td>
<td>a</td>
<td>a</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

(note: the scale is different for flowering and maturity)