Evaluation of Sidedress Applications of Potassium and Nitrogen on Corn Grain Yield

Robert O. Miller, Colorado State University
Fort Collins, CO

Tim J. Smith, Crop Smith Inc.,
Monticello, IL

Craig Struve, Soil View,
Calumet, IA

February 15-16, 2016
Scottsdale, AZ
Plant nutrient content has been classified in five ranges as it relates to yield.

Corn ear leaf nutrients at growth stage VT represent a synopsis of plant nutrition at the end of the vegetative growth.
“Khan and Mulvaney see no value in soil testing for exchangeable K and instead recommend that producers periodically carry out their own strip trials.”

University of Illinois, October 28, 2013
AgProfessional.com/News
Lab Soil Test K: IA and MN

Observations 245,000 samples

Soil Test K
Mean 142 ppm

<table>
<thead>
<tr>
<th>STK ppm</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 120</td>
<td>17.3</td>
<td>16.4</td>
<td>24.8</td>
</tr>
<tr>
<td>&lt; 150</td>
<td>40.0</td>
<td>43.1</td>
<td>47.3</td>
</tr>
<tr>
<td>&lt; 180</td>
<td>61.3</td>
<td>63.6</td>
<td>69.4</td>
</tr>
</tbody>
</table>

Ave 64% of samples have K Rec

What Does Plant Analysis Show

Source: MVTL MN-IA, Mehlich 3 K

Miller et al, 2016
## Corn Ear Leaf Nutrients - IN

**Ear Leaf VT-R1 2518 samples, 6 years**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Deficiency Threshold</th>
<th>Percent of Samples Deficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (％)</td>
<td>&lt; 2.76</td>
<td>5.1</td>
</tr>
<tr>
<td>P (％)</td>
<td>&lt; 0.25</td>
<td>0.6</td>
</tr>
<tr>
<td>K (％)</td>
<td>&lt; 1.75</td>
<td>29.4</td>
</tr>
<tr>
<td>S (％)</td>
<td>&lt; 0.16</td>
<td>1.1</td>
</tr>
<tr>
<td>Zn (ppm)</td>
<td>&lt; 19</td>
<td>4.5</td>
</tr>
</tbody>
</table>

2. Data Ceres Solutions, Lafayette, IN, corn ear leaf VT-R2

Miller and Bower, 2016
# Corn Ear Leaf Nutrients - IN

## Ear Leaf VT-R1 2014, 281 samples

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Percent of Samples Nutrient Deficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$P$</td>
</tr>
<tr>
<td>Threshold</td>
<td>&lt; 0.28</td>
</tr>
</tbody>
</table>

| Low N Sites (％) | 5.7 | 11.4 | 20.1 | 16.1 | 23.8 | 9.5 |
| High N Sites (％) | 0.7 | 22.5 | 18.3 | 1.2 | 11.9 | 2.8 |

1 http://www.extension.purdue.edu/extmedia/nch/nch-46.html

2 Data Ceres Solutions, corn ear leaf VT-R2

Miller and Bower, 2016
Over four years K deficiency in Minnesota constituted 42.3 – 56.8% of ear leaf tissue samples, whereas N deficiency average was 33.5% of samples.

1 Source Winfield Solutions 2010-2014, Randy Brown, Tim Eyerich
2 http://www.extension.purdue.edu/extmedia/nch/nch-46.html
2011-2014 a study was conducted across 76 sites across six states to evaluate response to K. K was applied at 0, 50, 100 lbs/ac at growth stage V3 – V5, ranging 18,600 – 42,400 plts/ac, eight replications.

STK sampled at planting, corn ear leaves were sampled at VT, and grain yield and moisture determined based on 3/1000th acre of each plot at black layer.
**KR<sub>x</sub> Corn Yield Response**

**Krx Project Yield Results 2012**
Six Iowa sites

<table>
<thead>
<tr>
<th>Site</th>
<th>STK</th>
<th>Check</th>
<th>+K</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>City / State</td>
<td>ppm</td>
<td>bu/ac</td>
<td>ppm</td>
<td>ppm</td>
</tr>
<tr>
<td>Pocahontas, IA</td>
<td>163</td>
<td>172</td>
<td>165</td>
<td>- 7</td>
</tr>
<tr>
<td>Palo Alto, IA</td>
<td>196</td>
<td>152</td>
<td>185</td>
<td>+ 33*</td>
</tr>
<tr>
<td>Calhoun, IA</td>
<td>126</td>
<td>166</td>
<td>171</td>
<td>+ 5</td>
</tr>
<tr>
<td>Wright, IA</td>
<td>135</td>
<td>155</td>
<td>175</td>
<td>+ 21*</td>
</tr>
<tr>
<td>Cherokee, IA</td>
<td>290</td>
<td>211</td>
<td>227</td>
<td>+ 9 *</td>
</tr>
<tr>
<td>Hardin, IA</td>
<td>147</td>
<td>204</td>
<td>216</td>
<td>+ 12*</td>
</tr>
</tbody>
</table>

* Yield significant at the 0.10 level, corn 15.5% moisture. STK 0-6” Depth

K increased yield on soils STK - 200 ppm

K effect on ear size

Check

139

+ K

167

Miller, 2016
KR<sub>X</sub> Corn Yield vs STK 3 years

A K application<sup>1</sup> of 50 lbs/ac improved grain yield at twenty-seven of sixty locations.

Probability of yield response

- STK 75 to 150 - 58%
- STK 150 to 200 - 56%
- STK 200 to 300 - 38%
- STK 300 to 600 - 20%

Ave yield increase 11 bu/ac

<sup>1</sup>Yield increase to application of 50 lbs/ac K at V4-V6.
2015 research expanded to include population component and N x K treatments. Four populations 26k, 32k, 38k and 44k plants per acre at four sites: WI, IA, IL and CO. Fertilizer treatments consisted of side dress N, K and N x K, six replications.

Additional studies were conducted at five locations evaluating K sources and in combination with N and B, applied side dress at V4-V5, eight replications. Ear leaves were sampled at VT-R1.
Population and Yield Response

Four plant populations, three sites

Yield max occurred between 32k and 38k

No response to applied K across population, yield increase to N, and NxK.

Significant loss of stalks with ears with increasing population, 16% loss at 44k population, vs 6.2% at 26k, WI and IA sites.

1 Yields average overall all treatments, corn 15.5% moisture, six replications

2 Illinois site, 44k treatment impacted by herbicide overspray.

Miller, 2016
**KR<sub>x</sub>: N x K Corn Yield Response**

**KR<sub>x</sub> Project Dodgeville, WI 2015**

Fertilizer: UAN 32 and K acetate (Nachurs); applied spoke wheel injector at V3-V4 growth stage, 2-3" depth, 4" both sides of row, eight replications. Soil STK 182 ppm.

* Yield significant at the 0.10 level, corn 15.5% moisture.
### KR<sub>x</sub>: N x K Corn Yield Response

Grain Yield Response to N and K (two sources)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Iowa Sutherland</th>
<th>Wisconsin Dodgeville</th>
<th>Illinois Farmer City</th>
</tr>
</thead>
<tbody>
<tr>
<td>STK (ppm)</td>
<td>192</td>
<td>178</td>
<td>154</td>
</tr>
<tr>
<td>Check</td>
<td>194.1 *</td>
<td>219.0 *</td>
<td>183.2 *</td>
</tr>
<tr>
<td>50 K&lt;sub&gt;ac&lt;/sub&gt;</td>
<td>205.9 *</td>
<td>230.6 *</td>
<td>187.4 *</td>
</tr>
<tr>
<td>50 N</td>
<td>217.1 *</td>
<td>229.6 *</td>
<td>200.2 *</td>
</tr>
<tr>
<td>50 N + 50 K&lt;sub&gt;ac&lt;/sub&gt;</td>
<td>212.1 *</td>
<td>239.2 *</td>
<td>195.4 *</td>
</tr>
<tr>
<td>50 N + 50 K&lt;sub&gt;KCl&lt;/sub&gt;</td>
<td>204.1 *</td>
<td>240.5 *</td>
<td>203.8 *</td>
</tr>
</tbody>
</table>

1 Significant at p 0.1 level, 8 reps

Miller et al, 2016
**KRx K Corn Yield Response**

Grain yield response to K at three sites, to application of K sulfate applied at V4-V5 using spoke wheel injector.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Wisconsin Site</th>
<th>Illinois Site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield</td>
<td>Delta $^2$</td>
</tr>
<tr>
<td>(K lbs/ac)</td>
<td>(bu/ac)</td>
<td></td>
</tr>
<tr>
<td>Check</td>
<td>203.4</td>
<td>-</td>
</tr>
<tr>
<td>50 K$_{SO_4}$</td>
<td>216.7</td>
<td>+ 13.3*</td>
</tr>
<tr>
<td>50 K$_{SO_4}$ + B$^1$</td>
<td>215.2</td>
<td>+ 11.8*</td>
</tr>
<tr>
<td>25 K$_{SO_4}$ 2X</td>
<td>217.6</td>
<td>+ 14.2*</td>
</tr>
</tbody>
</table>

1 Wolf Trax Boron DDP at 0.6 lbs per acre of product (18.5% B).

2 Significant at p 0.1 level, 8 reps.

Miller, et al, 2016
Corn Ear Leaf VT-R1 K vs Mg

64 KRx sites, across 7 states 2011-2015.

\[ R^2 = 0.325 \]

![Graph showing Ear Leaf Mg VT-R1 (%) vs Ear Leaf K VT-R1 (%).](image)

\[ Mg:K = 0.16 \]

<table>
<thead>
<tr>
<th>Variable Average</th>
<th>Cluster (^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low K</td>
</tr>
<tr>
<td>Yield (bu/ac)</td>
<td>159</td>
</tr>
<tr>
<td>N %</td>
<td>2.92</td>
</tr>
<tr>
<td>K %</td>
<td>1.48</td>
</tr>
<tr>
<td>Mg %</td>
<td>0.42</td>
</tr>
<tr>
<td>Mg:K</td>
<td>0.29</td>
</tr>
<tr>
<td>N:K</td>
<td>1.99</td>
</tr>
</tbody>
</table>

\(^3\) Clusters based on 12 sites each.

1. Each site represents the mean of 4 check plots, across 7 states.
2. Mg:K > 0.16 K deficient, Elwali, 1984 Agron J.
Leaf Nutrition vs Grain Yield 2014

Parsing maize grain yield\(^1\) by ear leaf ratios, shows 83% of yield is explained by leaf N, N:Mg > 10 (green) at ten sites. Six sites with N:Mg < 10 (red), averaged 44 bu/ac lower yields.

\[ y = -68x^2 + 500x - 673 \]
\[ R^2 = 0.83 \]

\[ y = -68x^2 + 500x - 673 \]
\[ R^2 = 0.6818 \]

<table>
<thead>
<tr>
<th>Analysis</th>
<th>N:Mg Ratio</th>
<th>N %</th>
<th>K %</th>
<th>Mg</th>
<th>Mg:K</th>
<th>N:Mg</th>
<th>Yield (bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10</td>
<td>2.90</td>
<td>1.65</td>
<td>0.35</td>
<td>0.22</td>
<td>8.1</td>
<td>204</td>
<td></td>
</tr>
<tr>
<td>&gt; 10</td>
<td>2.95</td>
<td>2.02</td>
<td>0.23</td>
<td>0.12</td>
<td>13.3</td>
<td>159</td>
<td></td>
</tr>
</tbody>
</table>

\(^3\) Mean results based on N:Mg Ratio.

\(^1\) 2014 KRx control plot grain yields 16 sites, 4 states, 8 replications.

\(^2\) Sites vary in hybrids, tillage, soil types and crop history.
Results show side dress K response at 46% of 76 research sites, yield response 8 – 33 bu/ac in Midwest.

Optimum population was between 32k and 38k per acre at three locations. N x K treatment increased grain yields STK at 4 of 5 sites 2015. Response was anion independent.

Five years of data show grain yields are optimum when ear leaf K > 1.9%, ratios Mg:K < 0.15 and N:Mg ratios > 10. Sites outside these leaf ranges show significant limitations on yield.

Additional Research is planned for 2016 in IN, IL, IA WI and MN.

Miller et al, 2015
Sponsors

Acknowledgements

Tommy Roach, Nachurs, TX
Nick Koshnick, Climate Corp, CA
Robert Beck, Winfield Solutions, IL
Mark David, Compass Minerals, ID
Tom McGraw, MISS, IA retired
Betsy Bower, Ceres Solutions, IN
Larry May, Lincoln, NE
Tim Eyrich, Agri-Trend, SC
Jodi Jaynes, Sure-Tech Laboratories, IN
Jim Fredericks, Ag Source Lab, IA
Mike Lindaman, Ag Source – LGI Lab, IA
Ray Ward, Ward Laboratories, NE
Thank you for your time and attention