Is Soil-Test Potassium Meaningful for Crop Production and Soil Fertility Management in Arkansas?

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Symposium--Soil Potassium Tests and Their Relationship to Plant Availability and Native Mineralogy

UofA
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RESEARCH & EXTENSION
University of Arkansas System
Background

• The validity of the soil-testing process for K has been challenged!

• Opportunity to evaluate or increase awareness of the strengths and weaknesses of soil-test K tool
  – Soil-test-based recommendations generally assumed to be accurate
### Background

<table>
<thead>
<tr>
<th>State Response Info</th>
<th>Calibration Information Date (as of 1994)</th>
<th>Date Recommendations Established</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>51-70</td>
<td>71-80</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATL (17)</td>
<td>77(^{13})</td>
<td>35(^{6})</td>
</tr>
<tr>
<td>MW (12)</td>
<td>100(^{12})</td>
<td>92(^{11})</td>
</tr>
<tr>
<td>SC (8)</td>
<td>88(^{7})</td>
<td>63(^{5})</td>
</tr>
<tr>
<td>W (13)</td>
<td>54(^{7})</td>
<td>54(^{7})</td>
</tr>
<tr>
<td><strong>USA</strong></td>
<td>78(^{39})</td>
<td>56(^{28})</td>
</tr>
</tbody>
</table>

Superscripted values in columns 2 & 3 are total number of 50 states that responded to survey; ? Indicates states responded but had no answers to questions.
Fundamental questions to be answered from soil-testing research?

• Are crop growth measurements significantly correlated with soil-nutrient availability indices?
  – What about the calibration step?

• How does soil-test K and relative crop yield respond to K fertilization across time?

• Can we improve the accuracy of soil-test-based K recommendations?
## How Good is the Correlation?

<table>
<thead>
<tr>
<th>Crop – Growth Measure</th>
<th>Model</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice Yield</td>
<td>LP</td>
<td>0.63</td>
</tr>
<tr>
<td>Soybean (irrigated) Yield</td>
<td>LP</td>
<td>0.76</td>
</tr>
<tr>
<td>Bermudagrass Yield</td>
<td>Q</td>
<td>0.81</td>
</tr>
<tr>
<td>Rice Tissue</td>
<td>L</td>
<td>0.77</td>
</tr>
<tr>
<td>Rice Tissue</td>
<td>L</td>
<td>0.81</td>
</tr>
<tr>
<td>Soybean (irrigated) Tissue</td>
<td>L</td>
<td>0.73</td>
</tr>
<tr>
<td>Bermudagrass Uptake</td>
<td>L</td>
<td>0.86</td>
</tr>
</tbody>
</table>
Correlation/Calibration Combined

Irrigated Soybean
(SSSAJ 74:1642-1651)

\[ r^2 = 0.70 \]

Flood-irrigated rice
(SSSAJ 71:1192-1201)

\[ r^2 = 0.54 \]
Observations on the Process of Correlation

- $R^2$ values are in part due to the process of identifying influential and outlying data points
- Critical soil-test K values for rice and soybean are comparable...
- Field observations often verify results
  - Bermudagrass example in photo
# Accuracy of Soil-Test K for Soybean Recommendations

<table>
<thead>
<tr>
<th>Soil Test K</th>
<th>Sites</th>
<th>Success</th>
<th>False +</th>
<th>False -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>#</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Suboptimal</td>
<td>6</td>
<td>33</td>
<td>67</td>
<td>0</td>
</tr>
<tr>
<td>Medium</td>
<td>3</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Optimal</td>
<td>7</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>† Total</td>
<td>16</td>
<td>78</td>
<td>22</td>
<td>0</td>
</tr>
</tbody>
</table>

†Total percentages calculated as a weighted total of the number of sites in each soil-test level

Matt Fryer Thesis Research (ongoing project)

Session 163-4 Monday, November 3, 2014: 2:00 PM
Soil-Test K Response Across Time
Long-term Trial

• Overall trend is for soil-test K to decline 3 ppm yr\(^{-1}\)

• Annual mean K
  – Initial 80 ppm
  – Range 35 to 103 ppm
  – Annual change/fluctuation ranged from -48 to +22 ppm

Source: Long-term K trial at PTRS (unpublished data, Slaton)
Yield Decline from Insufficient K Fertilization Across Time

- General trend is for relative yield to decline by 1.9% per year when no K fertilizer is applied.
- Trend for yield decline was consistent until ~2008.
  - $n=9$, $r^2 = 0.81$, & slope = -4.3

[Graph showing yield decline over time with equation % Max Yield = 92.5 - 1.88x ($r^2 = 0.46$) and yield trend for 112-150 kg K ha$^{-1}$ yr$^{-1}$]

Source: Long-term K trial at PTRS (unpublished data, Slaton)
Relative Crop Yield Response to Soil-Test K (no K fertilizer)

- Poor relationship between relative crop yield (poor by crop or with crops combined as shown)
- Each point is the % relative yield of crop receiving no K fertilizer regressed against soil-test K

Source: Long-term K trial at PTRS (unpublished data, Slaton)
Change in Soil-test K Across Time
Bermudagrass

- Annual decline in soil-test K was non-linear after 5-years of hay harvest
- A low plateau was reached after ~3rd cropping year
- K declined linearly the first 4 years
  - -22.1 ppm K yr\(^{-1}\)

Each data point represents a replicate (n = 5) that received no K fertilizer for each year of trial

Captina silt loam, Bermudagrass Hay

Linear slope -22.1
STK (ppm) = 133 - 22.1x (X_0 = 3.6 yr)

r^2 = 0.85

Source: 5-yr K trial at AAREC (unpublished data, Slaton)
K Balance and $\Delta$ Soil-Test K
Bermudagrass Hay System

$\Delta STK = 8.7 + 0.559x$ ($r^2 = 0.52$)

Slaton et al. (2014) unpublished data (0-10 cm depth)
Summary and Conclusions

• Soil-test K has utility for making K management decisions

• The concepts of soil testing are apparent in correlation and calibration relationships

• Validation efforts support current soil-test K interpretation
Summary

• Evaluate new and validate existing soil-test K concepts/practices
• Update aged correlation & calibration information used for crop fertilization
• Examine K removal and residue-K cycling in cropping systems
• Examine new soil-test methods and sampling strategies
Questions??

• Thanks to the symposium coordinators for the invitation to present in this symposium.

• Research Funded by Arkansas Rice Check-off, Soybean Check-off, and Fertilizer Tonnage Fee Programs.