Potassium Effects on Yield, Grain Quality, Lodging, and Stalk Strength

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Road Map

- Yield
- Grain quality
- Lodging and stalk strength
- Tissue testing
- Disease
Rice Production Requirements

• Flood entire field in 3-5 days
• Maintain flood for 90 day growing season
• Drain and dry field for harvest in 17 days
• Dry and handle grain properly
Fertilizing Rice

• P&K
  – Soil applied
  – Pre-plant
• N-Urea
  – 2/3 Pre-flood @ 1\textsuperscript{st} tiller
  – 1/3 Mid-season @ Internode elongation
P and K Removal for Rice & Soybeans

• Rice
  – P$_2$O$_5$  0.28 lb/bu
  – K$_2$O  0.18 lb/bu
  180 bu rice crop: 50P-32K

• Soybeans
  – P$_2$O$_5$  0.90 lb/bu
  – K$_2$O  1.50 lb/bu
  60 bu soybean crop: 54P-90K
Rice Production Systems

- Dry-seeded, delayed flood
- Water-seeded
- Dry-seeded, furrow irrigated
- Dry-seeded, center pivot irrigated
Rice Production in Missouri.

- 1997
  - 95,000 acres
  - 110 bu/acre
  - Mostly tall varieties

- 2015
  - 180,000 acres
  - 156 bu/acre
  - 70% Semi-dwarf
  - 30% Hybrid
Rice Soils of the Missouri Bootheel

- Silt loams west of Crowley’s Ridge
  - Long history of rice production
  - Silt-loam over clay subsoil. CEC = 12-18
  - K fertility must be maintained
- Clay soils east of Crowley’s Ridge
  - Shorter history of rice production
  - Heavy clays CEC= 20-35
  - Still have native high K fertility
Potassium and Rice Production

- Potassium deficiency in rice
  - Yellowing of leaf tips, begins with lower leaves
- Decreased disease resistance
- Increased lodging
- Decreased yields
Potassium and Rice Yields

MU Soil test critical level for K in rice:
120 + 5XCEC given in lb/acre K₂O

<table>
<thead>
<tr>
<th>% of soil test rec K applied</th>
<th>Rice yield Bu/acre</th>
<th>3-year average % relative yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>114 123 116</td>
<td>78</td>
</tr>
<tr>
<td>50%</td>
<td>138 134 141</td>
<td>91</td>
</tr>
<tr>
<td>75%</td>
<td>149 134 140</td>
<td>94</td>
</tr>
<tr>
<td>100%</td>
<td>161 138 154</td>
<td>100</td>
</tr>
</tbody>
</table>

But rice is grown in rotation with soybeans. The MU soil test critical level for soybeans is: 220 + 5XCEC
Potassium and Grain Quality

- 60% of world rice production is utilized as direct human consumption
- Premium product is an intact grain with a pearly while translucent color
- Husk and bran sequentially removed. Remaining rice is weighed: head rice. Broken grains removed remaining rice weighed: whole rice
- Expressed as: %head/%whole
- Additional penalties for chalky or discolored grains

“If your head + whole can’t be 125 Y’all ain’t gunna be happy”
# Potassium and Grain Quality

<table>
<thead>
<tr>
<th>% of soil test rec K applied</th>
<th>Milling quality %Head/%Whole</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>50/61</td>
<td>66/73</td>
<td>60/71</td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td>55/62</td>
<td>68/75</td>
<td>67/73</td>
<td></td>
</tr>
<tr>
<td>75%</td>
<td>56/63</td>
<td>69/75</td>
<td>69/73</td>
<td></td>
</tr>
<tr>
<td>100%</td>
<td>57/63</td>
<td>69/76</td>
<td>69/75</td>
<td></td>
</tr>
</tbody>
</table>

In 2010 we weren’t happy!
Pre-plant Potassium and Lodging

• We have not seen a consistent relationship between pre-plant K and lodging
• But..........
Mid-Season K and Lodging

- Rice Variety *Baldo*
  - Specialty rice for the western Asian market
  - Very susceptible to lodging
Measuring stalk strength

- Lower 12 inches of stalk collected at harvest.

- Stalk placed with 3’ of base exposed at table edge. Held in place with padded book.

- Cup suspended by string from exposed end.

- Weights progressively added until stalk failed, weight recorded.

- Individual stalks analyzed for K content
Potassium and Stalk Strength

\[ y = 0.0113x - 0.4203 \]

\[ R^2 = 0.4158 \]
## Stalk Strength and Lodging

### 2010 data

<table>
<thead>
<tr>
<th>% of soil test rec K applied</th>
<th>Stalk breaking strength (g)</th>
<th>Lodging (%)</th>
<th>Yield Bu/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>70</td>
<td>30</td>
<td>114</td>
</tr>
<tr>
<td>50%</td>
<td>108</td>
<td>25</td>
<td>138</td>
</tr>
<tr>
<td>75%</td>
<td>125</td>
<td>20</td>
<td>149</td>
</tr>
<tr>
<td>100%</td>
<td>140</td>
<td>18</td>
<td>161</td>
</tr>
</tbody>
</table>
Measuring K Levels in Rice Tissue

Correlation of yield with tissue K for different rice plant parts at 10% heading:

<table>
<thead>
<tr>
<th>Plant Part</th>
<th>r^2 value 2002</th>
<th>r^2 value 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole plant</td>
<td>0.25</td>
<td>0.32</td>
</tr>
<tr>
<td>Flag leaf</td>
<td>0.07</td>
<td>0.06</td>
</tr>
<tr>
<td>Lowest leaf</td>
<td>0.45</td>
<td>0.39</td>
</tr>
<tr>
<td>Stem</td>
<td>0.31</td>
<td>0.41</td>
</tr>
<tr>
<td>Head</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
Measuring K Levels in Rice Tissue: Cardy Meter

- 8 inches of basal rice stalks collected at 3 growth stages
- Samples frozen to rupture plant cells. ½ of sample cut into 2 inch lengths. Compressed to release sap.
- K content of sap measured with Cardy meter. Second ½ sample K measured with traditional methods.
Measuring K Levels in Rice Tissue: Cardy Meter

- Comparison of traditional method of K determination with Cardy meter at R1 growth stage
- Differences is absolute levels due to sap vrs tissue comparison.
# Potassium and Rice Disease

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sheath blight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check</td>
<td>8</td>
</tr>
<tr>
<td>PP K</td>
<td>3</td>
</tr>
<tr>
<td>PF K</td>
<td>2</td>
</tr>
<tr>
<td>PP P</td>
<td>6</td>
</tr>
<tr>
<td>PF P</td>
<td>7</td>
</tr>
</tbody>
</table>
Conclusions:

- Proper Potassium nutrition is critical for maximum profitable rice production.
  - Maintains high yields
  - Maximizes milling quality
  - Can reduce lodging
  - Helps prevent disease pressure
Questions?
We Could Not Have Done it Without:

- The Missouri Rice Merchandising and Research Council - Your check off $ at work!
- The Missouri Fertilizer and Lime Board - Your tariff $ at work!
- South East Missouri State University
- The International Plant Nutrition Institute
- The Potassium Nitrate Association
- The Helena Chemical Company
- The Mosiac Company
- Rosen’s Inc
- TIMAC Agro USA
- AgXplore International