Management of potassium in California rice systems

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Winter grower meetings
Jan 28 and Feb 5, 2013
Outline

• Cost of K fertilizer
• Why plant needs K
• Deficiency symptoms
• Plant demand for K
• K inputs and losses
• Results of 2012 study: K status of CA rice soils
Changes in fertilizer prices

Fertilizer prices 1960-2012 (USDA)

- Nitrogen solutions (30%)
- Urea 44-46% nitrogen
- Super-phosphate 44-46% phosphate
- Potassium chloride 60% potassium

Price increase since 2000 (%)

<table>
<thead>
<tr>
<th>Product</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>N solutions</td>
<td>185</td>
</tr>
<tr>
<td>Urea</td>
<td>177</td>
</tr>
<tr>
<td>Phosphate (P)</td>
<td>185</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>292</td>
</tr>
</tbody>
</table>
Why does rice need K?

• Plant regulation
  – Osmoregulation
  – Enzyme activation
  – Regulation of cell pH
  – Cellular cation-anion balance
  – Regulation of transpiration
  – Regulation of assimilate transport

• Whole plant level
  – K increases leaf area and chlorophyll content
  – Delays senescence
  – Increases #spikelet/panicle, % filled grains, and grain weight
    • Does not affect tillering
K deficiency

• Inadequate K results in:
  – An accumulation of sugars and amino acids that are suitable food sources for leaf diseases
• Adequate K improves a plant’s ability to tolerate adverse climatic conditions, lodging, insects, and diseases.
• Deficiency symptoms first occur in older leaves because K is a mobile nutrient.
Potassium deficiency symptoms

- Older leaf tips are yellowish brown
- Younger leaves can be short and droopy
- Rusty brown spots appear on tips of older leaves and then spreads to entire leaf.
- Symptoms tend to appear during later growth stages.
Aggregate Sheath Spot (AgSS) and plant K status

Linquist et al., (2008)
Aggregate Sheath Spot (AgSS) and K management

Linquist et al., (2008)
How much K does a plant take up?

- K concentration at harvest
  - Grain: 0.27%
  - Straw: 1.39%

- Plant uptake (assume a yield of 85 sacks)
  - Grain: 23 lb K/ac (28 lb K2O/ac)
  - Straw: 118 (142)
  - Total: 141 (169)
Inputs and Losses of K in rice systems

• Inputs
  – Fertilizer
  – Irrigation water

• Losses
  – Grain harvest
  – Straw removal (28/33 lb K/K2O per ton of straw)
  – Surface water runoff
2012 Field study

- Objective: Determine status of K in CA rice soils
- Study
  - 31 rice fields
  - Analyzed 3 checks in each (top, middle, bottom)
    - Soil K analysis
    - Leaf tissue K at heading
  - Inlet water analysis (two times)
  - Grower field history
    - Yields, K inputs, winter straw mgmt.
    - Develop a soil K budget
Summary information

- 14/31 fields had applied K fertilizer
  - Those that applied - 30 kg K\textsubscript{2}O/ha (27 lb/ac)
- No fields had straw removed regularly
- Variability between checks - not consistent
- Soil K
  - <100 ppm K: 8 fields all on east side of valley
- No relationship between soil K and K fertilizer input/output
- 4 groups of fields (adequate=100 ppm)
  1. (14) Adequate soil K – No K addition
  2. (9) Adequate soil K – K addition
  3. (1) Inadequate soil K – No K addition
  4. (6) Inadequate soil K – K addition
Soil and flag-leaf K values

Soil K (ppm)

Flag leaf K (%)

Legend:
- +K: Soil K values above the threshold.
- -K: Soil K values below the threshold.

Threshold levels:
- Soil K: 240 ppm
- Flag leaf K: 1.20%
Flag leaf K vs. soil K

Flag leaf vs soil K in sites NOT receiving K
Flag leaf K vs. soil K

Flag leaf vs soil K in sites NOT receiving K
Soil K by location
Water K inputs

- Water sources vary in K input
- Assuming only ET water (40")
  - Sac R = 13 lb K₂O/ac
  - Feather R and Sierra rivers = 8 lb K₂O/ac
Soil K vs. irrigation water

\[ y = 155.23x + 3.2486 \]
\[ R^2 = 0.3207 \]
Soil K vs. water and K balance

- No relationship between K balance and soil K.
- Suggests that K is not built up in the system.
Growing vs. winter season: K retention in rice fields

\[ y = 0.0066x - 4.9312 \quad R^2 = 0.6725 \]

\[ y = 0.0004x - 4.9088 \quad R^2 = 0.0459 \]
Summary

• East side of valley has greater the potential for K deficiency
  – Related to soil type and irrigation source.
• No observed effect of previous fertilizer history on soil K
  – Possibly due to effects of winter flood mgmt.
  – Should not attempt to “build-up” soil K
• Applications should be made based on soil test
• Straw removal has a large effect on K fertility management decisions
Deciding on need for K fertilizer

• Considerations
  – Soil K
    • Critical value is 60 ppm
    • Most CA soils above this value
    • Consider applying at least maintenance levels if soil K is below 100 ppm
  – K maintenance
    • Only remove grain
      – Apply 25-30 lb K2O/ac
    • Remove both grain and ½ straw
      – Apply 100 lb K2O/ac
What is this material?
Nutrients (lb) in 1 ton (2000 lb) of rice straw

- **N** 14 lb
- **P** 6 lb
- **K** 28 lb

- **Value (2012 fertilizer prices)**
  - $31.34
2013 study

• Continue 2012 study
• Focus on fields:
  – East side of Valley
  – Fields around Gridley
  – Fields without history of K fertilizer applications
  – Fields where straw is routinely removed
  – Fields with groundwater pumps
• Sign up in back if interested
2013 study

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THANK YOU