Potassium (K) Tissue Demonstration project 2013

- Plant tissue testing for nutrient content has increased greatly past 5 years
- Many questions on how the soil conditions in the field can affect nutrient levels in plant tissue
- Potassium was the nutrient chosen for this project since it seems to be the first nutrient affected by changes in soil moisture level.
K Tissue Project Questions?

• What happens to the K tissue levels as crops grow through the growing season?
• What effect does soil moisture have on K tissue level.
• Will excessive K fertilizer application result in luxury uptake of K by the crop?
• Will the “Chloride” in the potash show up in the “Cl” tissue levels for all crops?
• What effect will K rate have on soil test levels after harvest?
K Tissue Project Method

- K fertilizer (0-0-60) applied and tilled into soil before planting
- Four Fields: wheat, corn, soybeans, sugarbeet
- K rates: 0, 50, 100, 200, 400 lb/a K$_2$O
- Tissue samples collected 2-3 times during growing season
- Soil samples collected after harvest
Sufficiency Range Interpretation

Determined by university Research

Increasing Nutrient Concentration in Plant

Deficient, Sufficient, Toxic

Increasing Yield/Growth
Sufficiency Range Interpretation

Seedling to maturity

Increasing Nutrient Level

Luxury Uptake

Sufficient Level

Deficient/ Low Level

Seedling to maturity
Wheat Tissue K levels
Tillering Stage (whole plant)

Tissue Potassium Level - %

Initial K soil Test level – 480 ppm,
K applied as lb/a K2O, Fertilizer tilled into soil before planting
Wheat K Tissue Levels
Boot Stage (upper Leaves)

Initial K soil Test level – 480 ppm,
K applied as lb/a K₂O, Fertilizer tilled into soil before planting
Wheat K Tissue Levels
Heading (Flag Leaf)

Initial K soil Test level – 480 ppm,
K applied as lb/a K2O, Fertilizer tilled into soil before planting

Sampled July 5 – soil pretty dry

Sufficient range
Wheat Field – K soil test 480 ppm

• Tillering Stage
  – K tissue levels high at all K fert rates (luxury consumption)

• Boot stage
  – K tissue levels in sufficiency range for all K fert rates

• Heading
  – K tissue levels at low end of sufficiency range for all K rates (sandy loam soil getting pretty dry)
Wheat “Cl” Tissue Levels

Plant Tissue Cl ppm – (All stages)

Sampled at tillering and boot stage

Initial Cl soil Test level – 20 lb/a (40 lb/a is critical level for wheat)
KCl (0-0-60) applied - Fertilizer tilled into soil before planting
Wheat – Chloride Uptake

- Wheat is sensitive to chloride
- Critical soil test level 40 lb/a (20 lb soil test)
- 39 lb/a Cl (50 lb/a K20) brought tissue level into the sufficient range at all stages
Corn K Tissue Levels
<12” stage - (whole plant)

Sandy Loam Soil – Tissue Sampled June 7

Sufficient range

Initial K soil Test level – 198 lb/a
K applied as lb/a K₂O, Fertilizer tilled into soil before planting
Corn K Tissue Levels
12” to tasseling (mature leaf)

Sampled June 27 – getting kind of dry by this time

Initial K soil Test level – 198 lb/a (high)
K applied as lb/a K2O, Fertilizer tilled into soil before planting
**Corn K Tissue Levels**

**Tasseling Stage (Mature Leaf)**

**Tissue Potassium level - %**

- Sampled July 22—Pretty dry by this time

- Sufficient range

**Initial K soil Test level – 198 lb/a**

K applied as lb/a K₂O, Fertilizer tilled into soil before planting
**Nutrient Uptake by Plants**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Root Interception</th>
<th>Mass Flow</th>
<th>Diffusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>&lt;1%</td>
<td>80%</td>
<td>19%</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>2%</td>
<td>5%</td>
<td>93%</td>
</tr>
<tr>
<td>Potassium</td>
<td>2%</td>
<td>18%</td>
<td>80%</td>
</tr>
</tbody>
</table>

Mass flow – Nutrient transported to the root surface by movement of water. (Mass flow decreases as soil moisture goes down)
Corn Field – K soil test 198 ppm

- Less than 12”
- K tissue levels remained in sufficient range at all K fert rates
- 12” to tasseling
  - K tissue level remained in sufficient range at all rates of K fertilizer
- Tasseling
  - K tissue level were below the sufficient range until the 100 lb/a rate (sandy loam soil getting pretty dry)
**Corn “CL” Tissue Level**

Chloride research on corn?

- **Less than 12”**
- **12” to tasseling**

Initial Cl soil Test level – 25 lb/a

KCl applied as (0-0-60) - Fertilizer tilled into soil before planting
Corn – Cl uptake – 20 lb/a soil test

- Corn is somewhat sensitive to chloride
- Critical soil test level? (40 lb/a – wheat)
- Did not see increased uptake of Cl until tasseling stage (early season moisture may have moved chloride below the root zone early in the season)
**Soybean K Tissue level**

*Soybean less than 6” tall (whole plant)*

![Graph showing tissue potassium levels in soybeans](graph.png)

- **Sandy Loam Soil – Tissue Sampled July 5**
- **Initial K soil Test level – 130 ppm (medium to High)**
- **K applied as lb/a K₂O, Fertilizer tilled into soil before planting**
Initial K soil Test level – 130 ppm
K applied as lb/a K₂O, Fertilizer tilled into soil before planting
Soybean Field – K soil test 130 ppm

- Less than 6” (whole plant)
- K tissue levels remained in sufficient range at all K fert rates
- Early Bloom (recently mature leaf)
  - 50 lb/a K₂O rate and higher was required to bring tissue K level into the sufficient range.
  - K soil level may have been limiting
  - Soil moisture was pretty low at this time.
Soybean “Cl” Tissue Levels
K Tissue Project 2013

Plant Tissue Chloride Level % – (All stages)

Tissue Samples taken <6” and early bloom

Initial Cl soil Test level – 10 lb/a
K applied as lb/a K₂O, Fertilizer tilled into soil before planting
Soybean – Cl uptake – 20 lb/a soil test

• Soybean is not sensitive to low chloride levels in the soil
• Tissue chloride levels at any rate of K fertilizer were very low.
## Chloride (Cl⁻) – Mobile
### Harvest time soil test level

<table>
<thead>
<tr>
<th>Rate Cl lb/a</th>
<th>Soybean Site</th>
<th>Corn Site</th>
<th>Wheat Site</th>
<th>Sugarbeet Site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cl lb/a 0-24”</td>
<td>Cl lb/a 0-24”</td>
<td>Cl lb/a 0-24”</td>
<td>Cl lb/a 0-24”</td>
</tr>
<tr>
<td>Check</td>
<td>4lb</td>
<td>20lb</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td>39 lb/a</td>
<td>8 lb</td>
<td>20 lb</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>78 lb/a</td>
<td>4 lb</td>
<td>20 lb</td>
<td>56</td>
<td>52</td>
</tr>
<tr>
<td>156 lb/a</td>
<td>4 lb</td>
<td>24 lb</td>
<td>36</td>
<td>52</td>
</tr>
<tr>
<td>313 lb/a</td>
<td>16 lb</td>
<td>20 lb</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>Soil Text</td>
<td>Sandy loam</td>
<td>Sandy loam</td>
<td>Silt Loam</td>
<td>Clay Loam</td>
</tr>
</tbody>
</table>
1.8-3 lb/a K2O required to increase soil test 1 ppm (based on 400 lb/a K2O rate)
Potassium (K) Tissue Demonstration Project

- Tissue levels were affected by K soil test level
- Dry soil conditions seemed to decrease the K tissue level regardless of K fertilizer applied
- High soil K levels resulted in luxury uptake by wheat early in the season but not later
- Chloride uptake increased with higher rates on wheat and corn but not for soybeans.
High K Rates Affect on soil test levels

- Soil K levels increased as the K fertilizer rates increased
- The soil test level increased at different rates, depending on the initial K soil test level
- The calculated K% (base saturation) was changed very little, even with 400 lb/a K2O (666 lb 0-0-60 applied)
### K% on Base Saturation
*(what happened when high rates of K fertilizer applied?)*

<table>
<thead>
<tr>
<th>Rate K2O lb/a</th>
<th>K Soil Test ppm</th>
<th>K% calculated Base Saturation %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check</td>
<td>320</td>
<td>3.3%</td>
</tr>
<tr>
<td>50 lb/a</td>
<td>335</td>
<td>3.4%</td>
</tr>
<tr>
<td>100 lb/a</td>
<td>368</td>
<td>3.6%</td>
</tr>
<tr>
<td>200 lb/a</td>
<td>428</td>
<td>4.2%</td>
</tr>
<tr>
<td>400 lb/a</td>
<td>512</td>
<td>4.7%</td>
</tr>
</tbody>
</table>

Salts 0.3-0.5 (low), carbonates 0.5% to 1.5% (low), pH 7.7 topsoil, 8.0 subsoil