Potato, Tobacco, and Turf
Trial Findings
Potatoes

PROTASSIUM®
Potato Trials

- Tindall and Westerman (1991–Idaho) 3 year study
  - Greater yields vs. MOP
  - A Chloride–nitrate antagonism

- McDole (1978)
  - SOP resulted in higher specific gravities
  - Trend similar for four varieties

"The chloride form of potassium can actually reduce tuber growth and specific gravity. The sulfate form may be a better choice while at the same time decreasing blackspot bruise."

PGI March 1995–Bill Dean of WSU
Decreased Chloride

- Improves skin set
- Reduces bruising
- Prevents “shrink loss”
- Reduces disease incidence

![Effect of K source on Specific Gravity](image-url)

University of Wisconsin--Spooner 1994
Increased Specific Gravity in Idaho

Effect of K source on Specific Gravity

Russet Potatoes

Specific Gravity g/cm³

Potassium (K₂O Rate)
- AVG
- 500
- 250

1.072 1.074 1.076 1.078 1.08 1.082 1.084

McDole et al., 1978 - Idaho
## Chloride Removal by Crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Plant Part</th>
<th>Cl Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>Shoot</td>
<td>7.6 lb/ton</td>
</tr>
<tr>
<td>Barley</td>
<td>Grain</td>
<td>0.024 lb/bu</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Tuber</td>
<td>0.06 lb/cwt</td>
</tr>
<tr>
<td>Wheat</td>
<td>Grain</td>
<td>0.026 lb/bu</td>
</tr>
</tbody>
</table>
### Soil Chloride Levels 7 Months After Application

- **Willamette Valley Western Oregon**
- **Fertilizer applied October 2003**
- **Samples taken April 2004**

<table>
<thead>
<tr>
<th>Depth (Inches)</th>
<th>UTC</th>
<th>SOP 488#</th>
<th>KCI 475#</th>
<th>SOP 1468#</th>
<th>KCI 1486#</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>0.5</td>
<td>0.6</td>
<td>1.8</td>
<td>0.6</td>
<td>3.0</td>
</tr>
<tr>
<td>7.2</td>
<td>0.4</td>
<td>0.5</td>
<td>2.5</td>
<td>0.4</td>
<td>2.2</td>
</tr>
<tr>
<td>10.8</td>
<td>0.3</td>
<td>0.5</td>
<td>2.8</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>14.4</td>
<td>0.5</td>
<td>0.4</td>
<td>3.5</td>
<td>0.5</td>
<td>3.1</td>
</tr>
<tr>
<td>18.0</td>
<td>0.5</td>
<td>0.5</td>
<td>3.7</td>
<td>0.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

After 50 inches of rain there is still enough chloride in the top 14 inches of soil to hurt production.
Pasco, WA Potash Trial

• Results
  • SOP
    — Average specific gravities for the potassium sulfate was 1.080
    — Specific gravity incentive paid over $300 per acre
  • MOP
    — Average specific gravities for KCl (MOP) was 1.077

<table>
<thead>
<tr>
<th>Pasco, WA Potash Trial</th>
<th>Yield (tons)</th>
<th>Tons Out</th>
<th>Shrink</th>
<th>Final Yield (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOP</td>
<td>2172.69</td>
<td>36.82</td>
<td>154.82</td>
<td>34.2</td>
</tr>
<tr>
<td>MOP</td>
<td>2076.93</td>
<td>35.8</td>
<td>268.51</td>
<td>31.18</td>
</tr>
</tbody>
</table>
2005 Chipping Potato Trial

Location: Klamath Falls, OR
Variety: FL 1867
Vine Kill: West ½ September 14, 2005

- 7.7 pH
- 3.6 % O.M
- N  160 units
- P  170 units
- K  155 units
- Zn 6 units

<table>
<thead>
<tr>
<th></th>
<th>Yield</th>
<th>&lt;1 oz</th>
<th>1-2oz</th>
<th>2-4oz</th>
<th>4-10oz</th>
<th>&gt;10oz</th>
<th>Sugars &amp; S.G.</th>
</tr>
</thead>
<tbody>
<tr>
<td>E ½ -KCl</td>
<td>461 cwt/A</td>
<td>6 tubers</td>
<td>11 tubers</td>
<td>48 tubers</td>
<td>52 tubers</td>
<td>3</td>
<td>Sucrose 301  S.G. 1.091</td>
</tr>
<tr>
<td>32 Acres</td>
<td></td>
<td></td>
<td>16.95 oz</td>
<td>142.55 oz</td>
<td>317.05 oz</td>
<td>31.5 oz</td>
<td></td>
</tr>
<tr>
<td>W ½ -SOP</td>
<td>535 cwt/A</td>
<td>6 tubers</td>
<td>10 tubers</td>
<td>43 tubers</td>
<td>70 tubers</td>
<td>3</td>
<td>Sucrose 260  S.G. 1.095</td>
</tr>
<tr>
<td>31 Acres</td>
<td></td>
<td></td>
<td>14.2 oz</td>
<td>127.8 oz</td>
<td>411.55 oz</td>
<td>36 oz</td>
<td></td>
</tr>
</tbody>
</table>

- 258 lbs KCl = 103 lbs Cl
- Eliminating 103 lbs of chloride positively affected yield
- SOP consistently raises specific gravity, even on chipping potato varieties
Effect of potassium source on tuber weight loss (while potatoes are in storage)
Colorado State University

- As tubers stayed longer in storage, the rate of sprout development significantly increased in tubers harvested from the MOP and control plots.
- The rate of sprout development had decreased by 50% in tubers harvested from the SOP plots.

Effect of potassium source on rate of tuber sprouting
**Colorado State University**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total</th>
<th>&gt;4 oz</th>
<th>4-16oz</th>
<th>4-10oz</th>
<th>&gt; 6 oz</th>
<th>6-16oz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>542 b</td>
<td>455 b</td>
<td>444 a</td>
<td>354 a</td>
<td>306 b</td>
<td>294 a</td>
</tr>
<tr>
<td>K$_2$SO$_4$ (liq)</td>
<td>480 d</td>
<td>368 d</td>
<td>359 b</td>
<td>304 b</td>
<td>244 c</td>
<td>234 c</td>
</tr>
<tr>
<td>K$_2$SO$_4$ (dry)</td>
<td>576 a</td>
<td>489 a</td>
<td>456 a</td>
<td>358 a</td>
<td>354 a</td>
<td>321 a</td>
</tr>
<tr>
<td>KCl (liq)</td>
<td>510 c</td>
<td>412 c</td>
<td>382 b</td>
<td>275 b</td>
<td>295 bc</td>
<td>264 b</td>
</tr>
<tr>
<td>KCl (dry)</td>
<td>517 c</td>
<td>400 c</td>
<td>388 b</td>
<td>298 b</td>
<td>273 c</td>
<td>261 bc</td>
</tr>
</tbody>
</table>

**Yield (cwt/acre)**
Yield of tubers > 2 inches in diameter and > 10 oz

Effect of source and form of potassium fertilizer application on tuber specific gravity of Rio Grande Russet
Colorado State University

- In general, no significant difference was observed in marketable tuber (>4, >6, >10 oz) yield among the treatments in 2010.

- The use of SOP significantly increased the yield of large marketable size (14–16 oz) tubers when compared to all other treatments.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total</th>
<th>&gt; 4 oz</th>
<th>&gt; 6 oz</th>
<th>&gt; 10 oz</th>
<th>14–16 oz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>563 ab</td>
<td>453 a</td>
<td>270 b</td>
<td>65 b</td>
<td>4 c</td>
</tr>
<tr>
<td>SOP (Dry)</td>
<td>540 b</td>
<td>435 a</td>
<td>284 ab</td>
<td>96 a</td>
<td>22 a</td>
</tr>
<tr>
<td>SOP (Liq)</td>
<td>585 a</td>
<td>438 a</td>
<td>294 ab</td>
<td>91 a</td>
<td>26 a</td>
</tr>
<tr>
<td>KCl (Dry)</td>
<td>581 a</td>
<td>444 a</td>
<td>290 ab</td>
<td>103 a</td>
<td>12 b</td>
</tr>
<tr>
<td>KCl (Liq)</td>
<td>552 b</td>
<td>435 a</td>
<td>304 a</td>
<td>91 a</td>
<td>13 b</td>
</tr>
</tbody>
</table>

Yield (cwt/acre)

Response of potato to source and form of potassium application, 2010
Summary and Conclusion

• Source and form of K fertilizer applied can influence potato tuber yield and quality.

• Dry formulate of potassium sulfate increased tuber yield and produced more bulky tubers compared to KCl.

• Tuber specific gravity was significantly improved by incorporating dry formulation of potassium sulfate in the soil before planting.

• The use of liquid KCl can result in more culls as a result of increased production of tuber external defects.

• In soils with high soil test K levels, dry formulations of potassium sulfate can be used to increase potato tuber yield and quality.
Pasco Potash Trial and 2005 Chipping Trial Insights

- Higher specific gravity
- More US #1’s
- More “payables”
- High processor bonus
- Improved russeting
- Less shrinkage in storage
Tobacco  
PROTASSIUM®
Flue Cured Tobacco & Potassium

- Good crop will remove
  - **90–200 lbs K₂O from the soil**
    - 180–400 lbs of Potassium Sulfate per acre
  - **Up to 20 lbs chloride from the soil**
    - Sufficient chloride present in soil
      - (90/.60=150*40=60 lbs Cl)
    - Use of MOP results in excess of 40 lbs Cl

Remember! Excess chloride interferes with nutrient uptake and plant development…
Effects of Excess Chloride on Tobacco

- Fat stems
- High levels of chloride in the leaves resulting in:
  - Mold and rot during curing and storage
  - Highly hygroscopic, causing discoloration during storage
  - Reduced burn rate and unpleasant flavors
  - Ultimately greatly reduced quality and usability of the cured leaf
Flue Cured Tobacco & Sulfur

• Deficiencies most likely on deep sandy soils with low organic matter
  • **Sulfur will leach over fall and winter with heavy rains**
    – Sulfur not as available in wet soils in spring
  • **20–30lbs S/acre recommended**
  • **90–200lbs K₂O from Potassium Sulfate will deliver 31-68lbs of Sulfur**
• Symptoms of sulfur deficiency
  • **Begin with yellowing in the buds**
  • **Leaves gradually pale from top to bottom**
    – Lower leaves do not burn up unless there is an N deficiency
• Results
  • **Decreased yield potential**
### Tobacco Trial

**Table 1. Soil analysis for the pot experiments (P₂O₅ Joret Hebert).**

<table>
<thead>
<tr>
<th>Clay</th>
<th>Silt</th>
<th>Sand</th>
<th>pH</th>
<th>O.M.</th>
<th>CEC</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>K/CEC</th>
<th>MgO</th>
<th>CaO</th>
<th>Cl</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>%</td>
<td>%</td>
<td>ppm</td>
<td>%</td>
<td>meq</td>
<td>ppm</td>
<td>%</td>
<td>ppm</td>
<td>%</td>
<td>%</td>
<td>ppm</td>
</tr>
<tr>
<td>Content</td>
<td>15.6</td>
<td>76.8</td>
<td>5.5</td>
<td>6.2</td>
<td>2.12</td>
<td>10.2</td>
<td>153</td>
<td>73</td>
<td>1.52</td>
<td>100</td>
<td>2.87</td>
</tr>
</tbody>
</table>

**Table 2. Quantities of fertilizers applied on the pot experiments.**

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Flue-cured</th>
<th>Air-cured</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>g pot⁻¹</td>
<td>kg ha⁻¹</td>
</tr>
<tr>
<td>KNO₃</td>
<td>17.61</td>
<td>80N+270K₂₀</td>
</tr>
<tr>
<td>K₂SO₄+urea</td>
<td>14.82+4.98</td>
<td>80N+270K₂₀</td>
</tr>
<tr>
<td>KCl+urea</td>
<td>12.64+4.98</td>
<td>80N+270K₂₀</td>
</tr>
<tr>
<td>K₂CO₃+urea</td>
<td>11.34+4.98</td>
<td>80N+270K₂₀</td>
</tr>
</tbody>
</table>

IPNI Effect of Potassium on the Production and Quality of Tobacco Leaves, *Marchand, M e-ic No. 24 Sept. 2010*
Tobacco – Dry Matter

IPNI Effect of Potassium on the Production and Quality of Tobacco Leaves, Marchand, M e-ifc No. 24 Sept. 2010

Fig. 1. Dry matter production of flue-cured and air-cured tobacco leaves with different sources of K fertilizers.
**Tobacco – Leaf N Concentration**

*Fig. 2. N concentration (percent in DM) in flue-cured and air-cured tobacco leaves with different sources of K fertilizers.*

IPNI Effect of Potassium on the Production and Quality of Tobacco Leaves, *Marchand, Me-ic No. 24 Sept. 2010*
Tobacco – Leaf Chloride Concentrations

Fig. 5. Chloride concentration (percent in DM) in flue-cured and air-cured tobacco leaves with different forms of K fertilizers.

IPNI Effect of Potassium on the Production and Quality of Tobacco Leaves, Marchand, M e-ific No. 24 Sept. 2010
## Why is Protassium+ Important for Turf?

### Protassium+ Enhances Turf:
- Quality
- Rooting
- Hardiness

### Protassium+ Promotes Turf:
- Growth
- Uptake of water
- Disease resistance
- Wear Tolerance
Potassium Deficiency Symptoms

- Low K on Bentgrass & Bluegrass appear as
  - Leaves initially appear as droopy
  - Moderate yellowing on intervienal areas especially tips of older leaves
  - Rolling and withering of leave tips

- Low K fosters disease
  - Thin cell walls
  - Breakdown of cells
  - Accumulation of unused nitrates, phosphates and sugars
Increased Need for Sulfur on Turf

- Decreased sulfur emissions to the atmosphere
- Reduce use of SCU
- Increased amount of clipping removal
- Decreased use of sulfur containing fungicides and insecticides
- Increased awareness of soils deficient in sulfur
- Declining organic matter levels
The following slides include...
The Evaluation of Protassium+ Water Sequestration vs. MOP in Kentucky Bluegrass to a Standard Fertility Program in a Greenhouse Environment
Clipping Averages

![Clipping Averages Graph]

*Work Conducted By Arise Research & Discovery, Inc. 2008*
Chlorophyll

![Graph showing chlorophyll levels across different treatments and dates.](image-url)
Plant Health

![Plant Health Graph](image_url)
Plant Color

![Plant Color Chart]

Treatment

Work Conducted By Arie Research & Discovery, Inc. 2008

Protassium®
High Chloride Risks

- Leaf and “Tip burn”
- Poor seed germination
- Nutritional imbalances
- Stunted root and shoot growth

| Salt Index | Salt Index | Salt Index/Unit of $K_2O$
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium Fertilizers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOP (Potassium Chloride-60%)</td>
<td>116.2</td>
<td>1.936 ($K_2O$)</td>
</tr>
<tr>
<td>Sodium Nitrate</td>
<td>100</td>
<td>6.06 (N)</td>
</tr>
<tr>
<td>Potassium Nitrate</td>
<td>73.6</td>
<td>1.58 ($K_2O$)</td>
</tr>
<tr>
<td>SOP (Potassium Sulfate)</td>
<td>46.1</td>
<td>0.88 ($K_2O$)</td>
</tr>
<tr>
<td>K–MAG (Sulfate of Potash Magnesia)</td>
<td>43.2</td>
<td>1.96 ($K_2O$)</td>
</tr>
</tbody>
</table>

Remember! The Salt Index gives an indication of relative effect of a fertilizer on soil solution....
Why Protassium+?

- Quality
- Particle Sizes

<table>
<thead>
<tr>
<th>Protassium+</th>
<th>Particle Size (SGN)</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turf Gran</td>
<td>220</td>
<td>Roughs &amp; Fairways</td>
</tr>
<tr>
<td>Mini Gran</td>
<td>140</td>
<td>Fairways &amp; Tees</td>
</tr>
<tr>
<td>Greensgrade</td>
<td>90</td>
<td>Greens</td>
</tr>
<tr>
<td>Soluble Fines</td>
<td>10</td>
<td>Fairways, Tees &amp; Greens</td>
</tr>
</tbody>
</table>
Questions?