Micro-Nutrients
Major Effects

Calaveras Grape Growers Meeting
3 April 2009

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UCCE San Joaquin Co
<table>
<thead>
<tr>
<th>Deficiencies</th>
<th>Common</th>
<th>Infrequent</th>
<th>Rare</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>P</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Mg</td>
<td>Cu</td>
<td></td>
</tr>
<tr>
<td>Zn</td>
<td>Fe</td>
<td>Mo</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Mn</td>
<td>Ca</td>
<td></td>
</tr>
</tbody>
</table>
Excesses - Toxicity

N
B
Zn
Cl
Na
Mg (Serpentine)
Nutrient Demand Factors

- Soil
- Previous crop
- Inputs
- Irrigation
- Vineyard Practices
  - Cultivation
  - Cover Crops
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Symbol</th>
<th>Demand</th>
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<tbody>
<tr>
<td>Nitrogen</td>
<td>N</td>
<td>2.92</td>
</tr>
<tr>
<td>Potassium</td>
<td>K</td>
<td>4.94</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>P</td>
<td>0.56</td>
</tr>
<tr>
<td>Calcium</td>
<td>Ca</td>
<td>1.0</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg</td>
<td>0.2</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zn</td>
<td>0.0015</td>
</tr>
<tr>
<td>Boron</td>
<td>B</td>
<td>0.00065</td>
</tr>
</tbody>
</table>

5 TPA = 0.1 oz

= 0.05 oz
Actual Deficiency vs Induced

- Variety/Rootstock
- Antagonistic
- Water Quality
- Irrigation
- Soil pH
- Rainfall
- Biological
"Barnes Effect"

Drought-induced B deficiency
Chardonnay
Lime Induced Chlorosis
## Rootstock Tolerance to Calcareous Soils

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>% Active Lime in Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fercal</td>
<td>50+</td>
</tr>
<tr>
<td>41B, 333EM</td>
<td>40</td>
</tr>
<tr>
<td>161-49C</td>
<td>25</td>
</tr>
<tr>
<td>Kober 5BB, 420A, 140Ru, Borner</td>
<td>20</td>
</tr>
<tr>
<td>99R,110R,1103P,SO4</td>
<td>17</td>
</tr>
<tr>
<td>St George</td>
<td>14</td>
</tr>
<tr>
<td>Ganzin,1202C</td>
<td>13</td>
</tr>
<tr>
<td>3309C,1616C</td>
<td>11</td>
</tr>
<tr>
<td>4453M</td>
<td>10</td>
</tr>
<tr>
<td>101-14</td>
<td>9</td>
</tr>
<tr>
<td>Riparia Gloire, Castel 196-17</td>
<td>6</td>
</tr>
<tr>
<td>Schwarzmann</td>
<td>Med</td>
</tr>
<tr>
<td>Freedom</td>
<td>Med</td>
</tr>
<tr>
<td>Ramsey</td>
<td>Med</td>
</tr>
<tr>
<td>Dogridge</td>
<td>High</td>
</tr>
</tbody>
</table>
Rootstocks with Zinc Deficiency

- Dogridge
- Ramsey (Salt Creek)
- St. George
- Freedom
Availability of Micro-Nutrients

- Soil Parent Material
- pH
- Texture
  - Clay type and amount
  - O.M.
  - Competition
- Climate
  - Soil Temperature
  - Leaching
  - Weathering
- Soil pH
## Soil Types Associated with Micronutrient Deficiencies

<table>
<thead>
<tr>
<th>Texture/Type</th>
<th>pH &lt; 6</th>
<th>pH 6-7</th>
<th>pH &gt; 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy</td>
<td>Mo, Cu, Zn</td>
<td>Mn, Cu, Zn</td>
<td>Mn, B, Cu, Zn, Fe</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>Mo, Cu, Zn</td>
<td>Mn, B, Cu</td>
<td>Mn, B, Cu, Fe</td>
</tr>
<tr>
<td>Loam</td>
<td>Mo</td>
<td>Mn, B</td>
<td>Mn, B, Cu, Fe</td>
</tr>
<tr>
<td>Clay Loam</td>
<td>Mo</td>
<td>Mn</td>
<td>Mn, B</td>
</tr>
<tr>
<td>Clay Loam</td>
<td>Mo</td>
<td>-</td>
<td>Mn, B</td>
</tr>
<tr>
<td>Organic</td>
<td>Cu, Zn</td>
<td>Mn, Zn, Cu</td>
<td>Mn, Zn, Cu</td>
</tr>
</tbody>
</table>
Monitoring Nutrients

- Soil
- Tissue
- Water
- Visual
- Yield History

- Timing
  - Bloom
  - Veraison
  - Pre-Harvest
  - Other?
Monitoring

Visual

Tissue Analysis
Visual Symptoms

- Shoot Growth
- Leaves
- Fruit
- Soil
Tissue Analysis

Affected By:

- Soil Type
- Rootstock
- Variety
- Trellis System
- Irrigation
- Time of Season
Tissue Analysis

- Petioles at bloom time
- Petioles at veraison
- Nitrogen monitoring not diagnostic
- Blades are good only if B is a problem
- Labs are all good but vary
- Keep part of dried samples
- No ideal ratios

= Comparison samples good anytime
Zinc (Zn) & Boron (B)

Shoots – zig zag, short internodes
shoot tip death

Leaves – mottled chlorosis
Zn early season young leaves
B later season to fall

Clusters – poor set and “shot berries”
Zinc Deficiency
Zinc

Small berries, wide range of size & round shape

Boron

Uniformity of small size, flattened pumpkin shape
Confusion from Symptom Overlap
Zn deficiency

GFLV
Chimera
GFLV “Yellow Mosaic”
Application Methods

- Soil
- Irrigation
- Foliar
- Timing
- Formulation
- Organic
Soil

- Effective +
- Cost Efficient +
- Long term +
- Slower -

- Band
- Place near water/active roots
- Formulation
  - Salts: ZnSO₄, ZnO
  - Chelates
  - Organic
Irrigation

- Effective +
- Less labor +
- Moderate term +
- Injector or solutionizer
- More management -

- Place near water/active roots
- Band

- Formulation
  - Salts ZnSO₄, Zn(NH₄)PO₄
  - Chelates
  - Mixture
Foliar Spray

- Convenient +
- Fast +
- Short term -
- More expensive -
- Timing important -

- Timing
  - Pre bloom
  - Post harvest

- Formulation
  - Salts
  - Basic
  - Oxides
  - Chelates
  - Organic?
Foliar Application Factors

- **Timing**
  - Pre bloom
  - Post harvest

- **Concentration** – dilute better

- **Spreader/Sticker**

- **Weather**
  - Temperature
  - Relative Humidity

- **Low biuret urea boost**

- **Formulation**
  - Sulfate salt Cheaper ZnSO₄
  - Basic Safer ZnCO₃
  - Oxides Less soluble ZnO
  - Chelates Expensive
  - Organic ? Costly and less effective)
Foliar Spray Summary

- **Timing**: 2-3 weeks
- **Formulations**: Basic, chelates, salts, oxides
- **Rates**: Low concentrations
- **Conditions**: Low Temps, High R.H., wind
# Materials

- **Solubor** \( \text{Na}_2\text{B}_8\text{O}_{13} \cdot 4\text{H}_2\text{O} \) 20.5%
- **Borax** \( \text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O} \) 11
- **Boric Acid** \( \text{H}_3\text{BO}_3 \) 17
- **Borate 48** \( \text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O} \) 14.9
- **Colemanite** \( \text{Ca}_2\text{B}_6\text{O}_{11} \cdot 5\text{H}_2\text{O} \) 10

- **Zinc Carbonate** \( \text{ZnCO}_3 \) 52%
- **Zinc Sulfate** \( \text{ZnSO}_4 \) 36
- **Zinc Oxide** \( \text{ZnO} \) 80
- **Zinc Chelates** - 9-14
- **Zinc lignosulfates** - 5-12
- **Zinc polyflavonoids** - 7-20
# Zinc Application Methods

<table>
<thead>
<tr>
<th></th>
<th>Material</th>
<th>Rate/Acre</th>
<th>Actual/Ac</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drip</strong></td>
<td>ZnSO4</td>
<td>50-150 lbs</td>
<td>18 – 54 lb</td>
<td>Early</td>
</tr>
<tr>
<td></td>
<td>Zn Chelate</td>
<td>3-9 gal</td>
<td>3 – 13.9</td>
<td></td>
</tr>
<tr>
<td><strong>Soil</strong></td>
<td>ZnSO4</td>
<td>50 -150</td>
<td>18 – 54 lb</td>
<td>Winter/Spring</td>
</tr>
<tr>
<td><strong>Foliar</strong></td>
<td>ZnCO3</td>
<td>5 lbs</td>
<td>2.9 lb</td>
<td>PreBloom</td>
</tr>
<tr>
<td></td>
<td>ZnSO4</td>
<td>1 -2 lb</td>
<td>0.4 -0.8 lb</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zn chelate</td>
<td>1 -2 gal</td>
<td>0.7 -1.4 lb</td>
<td></td>
</tr>
</tbody>
</table>
# Boron Application Methods

<table>
<thead>
<tr>
<th></th>
<th>Material</th>
<th>Rate/Acre</th>
<th>Actual/Ac</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Drip</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solubor</td>
<td>0.5 lb</td>
<td>0.1 lb</td>
<td>Early</td>
</tr>
<tr>
<td></td>
<td>2-4X</td>
<td>1-2 lbs</td>
<td>0.2-0.4 lb</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Soil</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solubor</td>
<td>5 lbs</td>
<td>1.0 lbs</td>
<td>Fall/Winter Broadcast</td>
</tr>
<tr>
<td></td>
<td>maximum</td>
<td>20 lbs</td>
<td>4.0 lbs</td>
<td>Fall/Winter Berm</td>
</tr>
<tr>
<td></td>
<td>Solubor</td>
<td>5-10 lb</td>
<td>1-2 lbs</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Foliar</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solubor</td>
<td>1-2 lbs</td>
<td>0.2 -0.4 lb</td>
<td>PreBloom</td>
</tr>
<tr>
<td></td>
<td>maximum</td>
<td>5 lbs</td>
<td>1.0 lbs</td>
<td>per year</td>
</tr>
</tbody>
</table>
## Cost Comparison for Zinc

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount/Ac</th>
<th>Actual</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drip</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZnSO₄ 36%</td>
<td>100 lb</td>
<td>36</td>
<td>50</td>
</tr>
<tr>
<td>Zn EDTA 6.5%</td>
<td>6 gal</td>
<td>4</td>
<td>72</td>
</tr>
<tr>
<td><strong>Foliar</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZnCO₃ 52%</td>
<td>5 lb</td>
<td>2.6</td>
<td>20 *</td>
</tr>
</tbody>
</table>

* Material $5
  Application $15
Other Micro Nutrients

- Fe – almost always a pH related soil problem
- Mn – similar to zinc, often in poorly drained areas & wet years
- Cu – similar to excess boron or nitrogen, rare
- Mo – poor set & berry growth, sandy soils, rare
  - Combination formulations helpful for long term, but... $
- S – mimics nitrogen
- Ca – serpentine soils, almost exclusively
Phosphorus

PHOSPHORUS DEFICIENT GRAPE

Image courtesy of Potash & Phosphate Institute
Phosphorus Deficiency in California

- New viticultural areas and soil sites
  ✓ Enabled by drip irrigation
- Mostly hillsides of north coast and Sierra Nevada
- Low pH
- High iron
Phosphorus Deficiency
Cabernet Sauvignon
<table>
<thead>
<tr>
<th>Phosphorus Critical Values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Petiole Levels (% P)</strong></td>
</tr>
<tr>
<td>Deficient</td>
</tr>
<tr>
<td>Questionable</td>
</tr>
<tr>
<td>Adequate</td>
</tr>
<tr>
<td>Cushion</td>
</tr>
</tbody>
</table>
### Phosphorus Status and Rootstocks

<table>
<thead>
<tr>
<th>HIGH</th>
<th>MEDIUM</th>
<th>LOW</th>
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</thead>
<tbody>
<tr>
<td>110R</td>
<td>Harmony</td>
<td>420A</td>
</tr>
<tr>
<td>1103P</td>
<td>5C</td>
<td>101-14Mgt</td>
</tr>
<tr>
<td>Ramsey</td>
<td>5BB</td>
<td>3309C</td>
</tr>
<tr>
<td>Freedom</td>
<td>039-16</td>
<td>Schwarzmann</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Phosphorus Deficiency Correction

Rates:
0.33 lb. P/vine under drippers, 3 years
0.66 lb. P/vine unnecessary

Materials:
Single or Treble superphosphate
Ammonium phosphate
Summary

• Monitoring
  – Observe
  – Keep Records
  – Know soil type (map)
  – Tissue Analysis petioles at bloom (veraison) - blades B, Na, Cl as diagnostic

• Correction Method
  – Drip
  – Foliar
  – Soil

• Timing
• Formulations
• Rates
  – Dilute concentrations

• Conditions
  – Temperature
  – Relative Humidity

• Winery feedback from juice analysis - communication

“Best thing to put on your vineyard is your shadow” anonymous
Happy Harvest 2009