Introduction

- Avocados have few mineral deficiencies
- Surface feeder roots are efficient at recycling nutrients back into the tree
- Nitrogen should be applied every year, occasionally zinc and sometimes phosphorus, potassium and calcium (maybe)
- Leaf analysis is normally used to determine mineral deficiency or excess
- Liquid fertilizer injection is the normal way to apply fertilizers
A New Grower’s Quick Guide

• Hass avocados usually require 1.5 – 2.0 lbs actual nitrogen per tree per year

• Usually applied as a liquid fertilizer divided between 6 to 9 applications per year

• A hand-applied suggestion would be
  – 6 lbs triple 15 per tree in late February or early March (= 0.90 lbs actual N)
  – 3 lbs calcium nitrate (15.5-0-0) in June ( = 0.47 lbs actual N)
  – 3 lbs calcium nitrate (15.5-0-0) in June ( = 0.47 lbs actual N)
  – Total 1.83 lbs actual N/tree/year
Zinc

• Leaves are mottled, showing yellowing between the veins
• Small leaves
• Zinc sulfate can be
  – Applied by helicopter in May, 8 lbs/acre in 20 gallons water
  – Through the irrigation system
  – Or, hand applied around each tree every 3-5 years
Chloride Tip-Burn

• Not a mineral deficiency, but an excess of salinity due to
  – Saline irrigation water (wells or reclaimed water)
  – Poorly leached soils (salt accumulates in the root-zone)
  – Under-irrigation
  – Over application of manures and fertilizers
  – Water turned off during escrow
Required Mineral Nutrients

- 16 mineral nutrients
- C, H, O
- N, P, K (primary macro-nutrients)
- Ca, Mg, S (secondary macro-nutrients)
- Micro-nutrients...Zn, Fe, Mn, Cu, B, Mo, Cl
Wt.(lbs) Mineral Nutrients Removed in 10,000 lbs Avocados/Acre

- N: 35.6 lbs
- P: 5.4 lbs
- K: 60.4 lbs
- Ca: 0.8 lbs
- Mg: 3.3 lbs
- S: 3.5 lbs
- B: 0.04 lbs
- Fe: 0.09 lbs
- Zn: 0.04 lbs
- Mn: 0.02 lbs
- Cu: 0.01 lbs
Leaf Analysis

• Sampling
  – Leaves taken in August-October period
  – 5-7 month-old leaves sampled
  – Non-fruiting branches
  – Sample good blocks vs. poor blocks in separate samples
<table>
<thead>
<tr>
<th>Element</th>
<th>Unit</th>
<th>Low</th>
<th>Sufficient</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hass</td>
<td>%</td>
<td>&lt;1.8</td>
<td>2.0 - 2.2</td>
<td>&gt;2.2</td>
</tr>
<tr>
<td>Fuerte</td>
<td>%</td>
<td>&lt;1.6</td>
<td>1.6 - 2.0</td>
<td>&gt;2.0</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuerte</td>
<td>%</td>
<td>0.05 - 0.07</td>
<td>0.08 - 0.25</td>
<td>0.26 - 0.3</td>
</tr>
<tr>
<td>All Others</td>
<td>%</td>
<td>0.05 - 0.09</td>
<td>0.10 - 0.25</td>
<td>0.26 - 0.3</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>%</td>
<td>0.35 - 0.74</td>
<td>0.75 - 2.0</td>
<td>2.1 - 2.9</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>%</td>
<td>0.50 - 0.99</td>
<td>1.00 - 3.00</td>
<td>3.1 - 4.0</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>%</td>
<td>0.15 - 0.24</td>
<td>0.25 - 0.80</td>
<td>0.9 - 1.0</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>%</td>
<td>0.05 - 0.19</td>
<td>0.20 - 0.60</td>
<td>0.7 - 1.0</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>Ppm</td>
<td>20 - 49</td>
<td>50 - 100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>Ppm</td>
<td>20 - 49</td>
<td>50 - 200</td>
<td>&gt;200</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>Ppm</td>
<td>15 - 29</td>
<td>30 - 500</td>
<td>&gt;500</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>Ppm</td>
<td>&lt;20</td>
<td>30 - 150</td>
<td>&gt;150</td>
</tr>
</tbody>
</table>
Nitrogen

- Nitrate is mobile in the soil and is absorbed readily into roots, leaches readily

- Ammonium is bound to the surfaces of soil particles and is not leached readily, slowly converts to nitrate

- Most fertilizers are a combination of nitrate and ammonium
Nitrogen Deficiency – General Yellowing of leaf and Reduction in Yield of Fuerte
Nitrogen Application Timing
research from Dr Carol Lovatt, UC Riverside

• Control trees: nitrogen was applied at 1.25 lb/tree/year, divided into 0.25 lbs in January, February, April, June, July, Nov.

• Treatments: the same but there was an extra 0.25 lb applied in each of these months

• The best yield occurred when the extra N was applied in April or in November (next slide for data)
## Four-year trial by Lovatt

<table>
<thead>
<tr>
<th>N applied</th>
<th>average fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>wt/tree of</td>
<td></td>
</tr>
<tr>
<td>Control trees (1.25 lbs/year)</td>
<td>128.7lb</td>
</tr>
<tr>
<td>Jan</td>
<td>extra 0.25 lb</td>
</tr>
<tr>
<td>Feb</td>
<td>extra 0.25 lb</td>
</tr>
<tr>
<td>April</td>
<td>extra 0.25 lb</td>
</tr>
<tr>
<td>June</td>
<td>extra 0.25 lb</td>
</tr>
<tr>
<td>Nov</td>
<td>extra 0.25 lb</td>
</tr>
</tbody>
</table>
Table 3  Amount of Actual Nitrogen per Tree per Year (Mature Grove)

<table>
<thead>
<tr>
<th>Spacing # Trees/</th>
<th>Actual N/acre (lbs)</th>
<th>Actual N/tree (lbs)</th>
<th>Triple 15 15-15-15</th>
<th>Ammonium Nitrate 34-0-0</th>
<th>Urea 46-0-0</th>
</tr>
</thead>
<tbody>
<tr>
<td>15' x 20'</td>
<td>145</td>
<td>200</td>
<td>1.4</td>
<td>9.3</td>
<td>4.1</td>
</tr>
<tr>
<td>20' x 20'</td>
<td>109</td>
<td>200</td>
<td>1.8</td>
<td>12.0</td>
<td>5.3</td>
</tr>
<tr>
<td>20' x 40'</td>
<td>54</td>
<td>200</td>
<td>3.7</td>
<td>24.7</td>
<td>10.9</td>
</tr>
</tbody>
</table>
Mulches and Manures

- High carbon mulches (wood chips and straw) decompose slowly, bacteria in the soil tie up nitrogen in order to decompose the mulches, these may require a nitrogen soil application to offset this problem.

- Manures are sources of nitrogen, but they vary from 1% N (horse manure) to 3% N (composted chicken manure) (more info on page 23).
Nitrogen Deficiency

• Lack of vegetative vigor
• Pale, green small leaves
• Reduced yields
• Premature defoliation
• Leaves with yellow veins (severe deficiency)

• Root rot has the same symptoms, how can you tell the difference?
Cover Crops for Organic Production

• Should be a legume that can fix N from the air
• Can they contribute in avocado production?
  – Should be turned under, but this can’t be done in avocado culture due to the shallowness of the roots
  – Too much shading on the ground to grow cover crops
Advantages of Fertigation

• Most groves have low volume irrigation systems
• Water is distributed uniformly, good fertilizer distribution
• Manager has flexibility in timing applications
• Less fertilizer needed because all of the fertilizer is applied to the wetted area, where the roots are located
• Labor costs are lowered
• On steep slopes, this is the only practical method of fertilizer application
Injection Equipment

• Differential pressure tanks (Batch Tanks)
• Venturi devices
• Positive displacement pumps

• Also needed:
  – Backflow prevention device
  – Tanks that can hold chemical fertilizers
Zinc

• Avocado has a small but essential requirement for zinc
• Leaf mottling between veins, small rounded fruit, shortened internodes
• Zinc deficiency can be a chronic problem in organic groves where high phosphorous manures are used
Zinc Deficiency
Zinc Deficiency
Boron Deficiency
Boron Deficiency