PRACTICAL NUTRITION MANAGEMENT FOR PISTACHIO

BEN THOMAS
Ben Thomas Consulting
PISTACHIO NUTRITION – SOME IMPORTANT DRIVERS

• Yield
• Nut quality
• Economics
• Tree establishment
• Early cropping
• Sustainability
• Biennial bearing
SOME BASIC PRINCIPLES

- Macronutrients and micronutrients
- How do plants take up nutrients?
  - Active roots. Roots need water and air to function.
  - Water is needed for nutrient uptake from soil
  - Nutrient mobility in soil
  - Foliar nutrient sprays
- Nutrient mobility in plants
  - Nutrient storage
  - Deficiency symptoms
  - Application method
- Potential yield determines fertiliser inputs
NUTRITION MANAGEMENT

• The 4 R’s of nutrition management
  – Applying the Right rate of the Right product at the Right time in the Right place.

• Determining which nutrients you need to apply

• Choosing a fertiliser

• Determining when to apply the fertiliser - timing

• Deciding on how you wish to apply the fertiliser
DECISION MAKING TOOLS

- **Visual assessment**
  - Deficiency or toxicity symptoms
  - Vigour and leaf colour

- **Soil analysis**
  - Indicates the amount of nutrient available to a plant in the soil

- **Plant analysis**
  - Measures the actual nutrient status of a tree at a particular point in time

- **Nutrient budgets**
  - Predicting nutrient requirements based on crop estimates
NITROGEN DEFICIENCY
COPPER DEFICIENCY
IRON DEFICIENCY
SALT BURN
SOIL ANALYSIS

• Soil analyses provide a measure of the amount of nutrient available to a plant in the soil.

• Each nutrient is present in the soil in various forms:
  – Soluble (in the soil solution)
  – Loosely held (exchangeable or slowly dissolving)
  – Tightly held (slowly exchangeable or very slowly dissolving)
  – Insoluble (component of soil minerals)

• Due to variation in the soil, you cannot take a soil sample from just anywhere in the orchard:
  – Adjust sampling to suit the question being asked.
USING SOIL ANALYSIS INFORMATION

• **Nutrient concentrations**
  – Know your analysis method

• **Soil pH**
  – Influences the form and availability of nutrient in soil (e.g. aluminium in acidic soils)
  – Nitrogen fertiliser use and acidification
  – Lime requirements

• **Sodicity and soil structural problems**
  – Gypsum requirements

• **Salinity**
  – Leaching irrigations, irrigation management
## Example Soil Analysis Data

<table>
<thead>
<tr>
<th>Element or Test</th>
<th>Topsoil</th>
<th>Subsurface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth - (cm)</td>
<td>0-15</td>
<td>15-30</td>
</tr>
<tr>
<td>pH&lt;sub&gt;calcium chloride&lt;/sub&gt;</td>
<td>6.2</td>
<td>7.1</td>
</tr>
<tr>
<td>Organic carbon - (%)</td>
<td>0.71</td>
<td>0.3</td>
</tr>
<tr>
<td>Colwell Phosphorus (P) - (mg/kg)</td>
<td>61</td>
<td>44</td>
</tr>
<tr>
<td>Colwell Potassium (K) - (mg/kg)</td>
<td>166</td>
<td>116</td>
</tr>
<tr>
<td>Extractable Sulfur (S) - (mg/kg)</td>
<td>36.9</td>
<td>47.4</td>
</tr>
<tr>
<td>Exchangeable Calcium (Ca) - (meq/100 g)</td>
<td>4.98</td>
<td>6.44</td>
</tr>
<tr>
<td>Exchangeable Magnesium (Mg) - (meq/100 g)</td>
<td>1.21</td>
<td>0.94</td>
</tr>
<tr>
<td>Exchangeable Potassium (K) - (meq/100g)</td>
<td>0.4</td>
<td>0.28</td>
</tr>
<tr>
<td>Exchangeable Sodium (Na) - (meq/100 g)</td>
<td>0.09</td>
<td>0.1</td>
</tr>
<tr>
<td>Cation exchange capacity - (meq/100 g)</td>
<td>6.7</td>
<td>7.8</td>
</tr>
<tr>
<td>Exchangeable sodium percentage</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>DTPA Extractable Copper (Cu) - (mg/kg)</td>
<td>2.4</td>
<td>3.1</td>
</tr>
<tr>
<td>DTPA Extractable Zinc (Zn) - (mg/kg)</td>
<td>2.5</td>
<td>2.6</td>
</tr>
<tr>
<td>DTPA Extractable Manganese (Mn) - (mg/kg)</td>
<td>23.2</td>
<td>17.6</td>
</tr>
<tr>
<td>DTPA Extractable Iron (Fe) - (mg/kg)</td>
<td>71.4</td>
<td>28.1</td>
</tr>
<tr>
<td>Extractable Boron (B) - (mg/kg)</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Extractable Aluminium (Al) - (mg/kg)</td>
<td>&lt; 0.20</td>
<td>&lt; 0.20</td>
</tr>
<tr>
<td>EC&lt;sub&gt;e&lt;/sub&gt; - (dS/m)</td>
<td>1.4</td>
<td>1.39</td>
</tr>
<tr>
<td>Chloride - (mg/kg)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Calcium Carbonate - (%)</td>
<td>&lt;0.3</td>
<td>0.44</td>
</tr>
</tbody>
</table>
PLANT ANALYSIS

• Plant analysis measures the actual nutrient status of a tree at a particular point in time

• Compromises are involved when we choose a single sampling time and a single plant part
  – Mobile nutrients or nutrients that build up during the life of the leaf would be best assessed in older leaves
  – Immobile nutrients would be best assessed in younger leaves or shoot tips

• What do I sample?
  – It is important to collect leaf or plant tissue samples of the correct age and type so that the results can be compared to known standards.
NUTRIENT RESPONSE CURVE

Yield (% of maximum)

- Deficient Zone
- Marginal Zone
- Adequate Zone
- Marginal Zone
- Toxic Zone

90% Maximum Yield

Critical Concentrations

Deficiency  Toxicity

Nutrient concentration in plant
USING PLANT ANALYSIS INFORMATION

- Plant analysis provides a snapshot of the nutrient status at a particular point in time
- With regular sampling, plant analysis is an excellent monitoring tool
- Biennial bearing
- Correct sampling is critical
- High values can reflect contamination with foliar sprays
### Example Leaf Analysis Data

<table>
<thead>
<tr>
<th>Traditional Standards</th>
<th>2.5 - 2.9%</th>
<th>No standards</th>
<th>0.14 - 0.17%</th>
<th>2.0 - 2.2%</th>
<th>1.3 - 4.0%</th>
<th>No standards</th>
<th>&lt; 0.1 - 0.3%</th>
<th>10 - 15 mg/kg</th>
<th>30 - 80 mg/kg</th>
<th>6 - 10 mg/kg</th>
<th>No standards</th>
<th>120 - 250 mg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suggested Working Range*</td>
<td>2.2 - 2.5%</td>
<td>No standards</td>
<td>0.14 - 0.17%</td>
<td>1.8 - 2.2%</td>
<td>1.3 - 4.0%</td>
<td>No standards</td>
<td>&lt; 0.1 - 0.3%</td>
<td>10 - 15 mg/kg</td>
<td>30 - 80 mg/kg</td>
<td>6 - 10 mg/kg</td>
<td>No standards</td>
<td>120 - 250 mg/kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>Date</th>
<th>Test Variation</th>
<th>N (%)</th>
<th>NO₃-N (mg/kg)</th>
<th>P (%)</th>
<th>K (%)</th>
<th>Ca (%)</th>
<th>Mg (%)</th>
<th>S (%)</th>
<th>Na (%)</th>
<th>Cl (mg/kg)</th>
<th>Zn (mg/kg)</th>
<th>Mn (mg/kg)</th>
<th>Cu (mg/kg)</th>
<th>Fe (mg/kg)</th>
<th>B (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block A</td>
<td>23/02/2015</td>
<td>Pistachio</td>
<td>2.27</td>
<td>140</td>
<td>0.12</td>
<td>1.9</td>
<td>2.86</td>
<td>0.52</td>
<td>0.14</td>
<td>0.02</td>
<td>0.36</td>
<td>155</td>
<td>168</td>
<td>89</td>
<td>109</td>
<td>139</td>
</tr>
<tr>
<td>Block B</td>
<td>23/02/2015</td>
<td>Pistachio</td>
<td>2.45</td>
<td>173</td>
<td>0.15</td>
<td>1.89</td>
<td>2.8</td>
<td>0.56</td>
<td>0.14</td>
<td>0.03</td>
<td>0.45</td>
<td>85</td>
<td>328</td>
<td>62</td>
<td>84</td>
<td>153</td>
</tr>
<tr>
<td>Block C</td>
<td>23/02/2015</td>
<td>Pistachio</td>
<td>2.36</td>
<td>228</td>
<td>0.13</td>
<td>2.31</td>
<td>2.89</td>
<td>0.49</td>
<td>0.14</td>
<td>0.03</td>
<td>0.44</td>
<td>109</td>
<td>207</td>
<td>84</td>
<td>116</td>
<td>213</td>
</tr>
</tbody>
</table>

*Values high*  
*Values marginally high*  
*Values adequate*  
*Values marginally low*  
*Values low*

* - Suggested working ranges based on data from 5th Pistachio Production Manual, Bob Beede website, Beede & Karlsen and Brown.
• Predicting fertiliser requirements based on target yields, nutrient content of pistachio fruit and nutrient recovery

• Requires nutrient content of whole pistachio fruit (hull, shell and kernel)

• Need to allow for vegetative growth and efficiency of uptake

• Retrospective nutrient budgets – an excellent review tool
NUTRITION MANAGEMENT

• The 4 R’s of nutrition management
  – Applying the **Right** rate of the **Right** product at the **Right** time in the **Right** place.

• Determining which nutrients you need to apply

• Choosing a fertiliser

• Determining when to apply the fertiliser - timing

• Deciding on how you wish to apply the fertiliser
CHOOSING A FERTILISER - SOME CONSIDERATIONS

- Price - Calculate the cost of actual nutrient in a fertiliser
- Single element vs. multi-element fertilisers
- Liquid, soluble solid, solid fertilisers
- Risk of leaching or loss to atmosphere
- Soil acidification
- In some circumstances, a more expensive form of fertiliser should be used
  - EDDHA-chelated iron in calcareous soils
NUTRITION MANAGEMENT

• The 4 R’s of nutrition management
  – Applying the Right rate of the Right product at the Right time in the Right place.

• Determining which nutrients you need to apply
• Choosing a fertiliser
• Determining when to apply the fertiliser - timing
• Deciding on how you wish to apply the fertiliser
TIMING

• Critical growth stages
  – Late dormant boron foliar nutrient sprays
  – Zinc and copper foliar nutrient sprays
  – Nutrient uptake patterns

• Soil temperature

• Rain events

• Fertigation and leaching
### PISTACHIO NUTRIENT UPTAKE PATTERNS

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Season</th>
<th>Nutrient uptake (g/tree)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Spring flush</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>On</td>
<td>243</td>
</tr>
<tr>
<td></td>
<td>Off</td>
<td>317</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>On</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Off</td>
<td>26</td>
</tr>
<tr>
<td>Potassium</td>
<td>On</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Off</td>
<td>3</td>
</tr>
</tbody>
</table>

Adapted from Rosecrance et al. 1996  *Tree Physiology* **16**, 949-956
FERTILISER APPLICATION METHODS

• **Fertigation**
  – Targeted application to roots
  – Nutrients rapidly available

• **Foliar nutrient sprays**
  – Targeted and timing specific application

• **Banded or broadcast**
  – Does not require irrigation
  – Aiming to boost soil reserves
  – Requires rain to wash into soil
PUTTING IT ALL TOGETHER

• Develop nitrogen, phosphorus and potassium fertiliser budgets based on target yields and nutrient uptake patterns

• Use visual assessments of vigour and crop load during the season and adjust fertiliser budgets accordingly

• Apply boron and zinc (and copper if required) foliar nutrient sprays at appropriate times

• Use regular soil analysis to check soil nutrient reserves, pH, sodicity and salinity

• Use leaf analysis in January to monitor the actual nutrient status of the trees

• Using actual yields, review the fertiliser program with retrospective nutrient budgets
• **Preplant applications**
  – Phosphorus fertiliser
  – Organic matter
  – Lime and gypsum

• **Nitrogen fertiliser**
  – Small but frequent applications
  – Aim is strong establishment of the trees in preparation for budding
  – Some loss is inevitable as not all drippers are feeding the young trees

• **Foliar nutrient sprays**
  – Zinc and manganese
  – Copper!