Session Six
Postharvest quality, outturn

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Improving avocado fruit quality through tree nutrition

Present knowledge
Future challenge

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Or – how to keep on making money!!
Hypothesis, and the “Holy Grail”

“Few postharvest disorders of fruit (including diseases) are completely independent of pre-harvest factors” (van Rooyen and Bower 2003)

• Aim:
  – increase fruit robustness at harvest to withstand postharvest stresses
  – develop a prediction system to reduce disorders and get consistent outturn
So far!

Long history of Ca and quality in fruits

Diffuse discoloration (1-5) $\quad r = 0.83^{**}$

Anthracnose severity (1-5) $\quad r = 0.88^{**}$

Calcium concentration (mg kg$^{-1}$)

Individual, adjacent trees

Hofman, Vuthapanich, Whiley, Klieber, Simmons 2001
Other minerals

- Mg and K can also be related to fruit quality
  - More fruit Mg, better quality
  - Less fruit K, better quality
- Relationships not as strong as with Ca
- Most likely through interaction with Ca
Nitrogen

• Comparing fruit from high/low N sites
  – N strongly related to quality
    (van Rooyen and Bower 2003; Kruger et al 2004)

• Recommendations for fruit N in fruit
  – <1.7% in Dec, and <1% during Feb
    (Kruger et al 2004)

• Increased N applications
  – indications of increased rots
    (Willingham et al 2003)
Crop load

On-year good quality
Off-year reduced quality

Fruit yield per tree (kg)

Body rots (1-5)

Crop load (kg/m³ of canopy)

Body rots (% of flesh affected)

\[ r = 0.81^{**} \]

\[ r^2 = 0.18 \]
The nitrogen/crop load dilemma?

**Yield**
- Low yield
- Lower fruit N
- Larger fruit
- Lower Ca
- Lower quality

**Optimum N**
- High yield
- Smaller fruit
- Higher Ca
- Higher quality

**Quality**
- Not so good
- Good

**Nitrogen**
- Low yield
- Higher fruit N
- Larger fruit?
- Lower Ca
- Reduced quality
So!!

- When excess soil N common:
  - benefit in reducing fruit N

- When excess soil N not common (Australia?):
  - Negative effect of less N on fruit quality (through crop load)?

- What then?
  - Increase crop load
    - Genetics
    - Reduce plant stress (N, water etc)
  - Continue to focus on Ca
Challenges with Ca

- Correlations between fruit Ca and quality are common (using surveys), but...

- Challenging to manipulate fruit Ca and quality by fertiliser and other practices
## Ca effect on plant minerals

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ca concentration</th>
<th>Early December</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sap (mg/L)</td>
<td>Leaf (g/Kg)</td>
<td>Fruitlet flesh (g/Kg)</td>
</tr>
<tr>
<td>Control</td>
<td>14.2</td>
<td>14.3</td>
<td>1.56</td>
</tr>
<tr>
<td>6-MG</td>
<td>20.4</td>
<td>14.2</td>
<td>1.66</td>
</tr>
<tr>
<td>12-MG</td>
<td>18.3</td>
<td>15.2</td>
<td>1.59</td>
</tr>
<tr>
<td>12-G</td>
<td>15.7</td>
<td>14.3</td>
<td>1.47</td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td></td>
<td>0.11</td>
</tr>
</tbody>
</table>

Note: Values with different letters (a, b, ab) are significantly different at the 0.05 level.
## Ca effect in fruit quality

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ripening Time (days)</th>
<th>Flesh volume affected (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Body rots</td>
<td>Stem end rots</td>
</tr>
<tr>
<td>Control</td>
<td>12.2 ^{a}</td>
<td>9.3 ^{a}</td>
<td>4.3 ^{a}</td>
</tr>
<tr>
<td>6-MG</td>
<td>12.6 ^{b}</td>
<td>12.0 ^{b}</td>
<td>6.2 ^{b}</td>
</tr>
<tr>
<td>12-MG</td>
<td>12.3 ^{a}</td>
<td>10.1 ^{a}</td>
<td>5.5 ^{b}</td>
</tr>
<tr>
<td>12-G</td>
<td>12.4 ^{a}</td>
<td>10.6 ^{ab}</td>
<td>6.0 ^{b}</td>
</tr>
</tbody>
</table>

*No effect on flesh disorders*
## Ca/K interactions (seedlings)

<table>
<thead>
<tr>
<th>Soil treatment</th>
<th>Xylem sap (mg/L)</th>
<th>Leaf (g/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ca</td>
<td>K</td>
</tr>
<tr>
<td>Control</td>
<td>26 b</td>
<td>135 a</td>
</tr>
<tr>
<td>2 x Ca</td>
<td>26 b</td>
<td>158 a</td>
</tr>
<tr>
<td>4 x K</td>
<td>14 a</td>
<td>231 b</td>
</tr>
</tbody>
</table>
### Other considerations: Rootstock

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Xylem sap (mg/L)</th>
<th>Leaf (g/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ca</td>
<td>K</td>
</tr>
<tr>
<td>Reed</td>
<td>22</td>
<td>185 b</td>
</tr>
<tr>
<td>Smerdon</td>
<td>25</td>
<td>177 b</td>
</tr>
<tr>
<td>Toro Canyon</td>
<td>22</td>
<td>193 b</td>
</tr>
<tr>
<td>Velvick</td>
<td>19</td>
<td>144 a</td>
</tr>
</tbody>
</table>
## Rootstock effects

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Non-suberised root (g/Kg)</th>
<th>Leaf (g/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ca</td>
<td>K</td>
</tr>
<tr>
<td>Duke 7</td>
<td>2.22</td>
<td>9.69</td>
</tr>
<tr>
<td>Fuerte</td>
<td>1.71</td>
<td>10.18</td>
</tr>
<tr>
<td>Hass</td>
<td>1.54</td>
<td>9.98</td>
</tr>
<tr>
<td>Velvick</td>
<td>1.84</td>
<td>13.66</td>
</tr>
</tbody>
</table>

P value:
- Rootstock: 0.093
- Leaf: 0.001
- Non-suberised root: 0.093
- Ca: 0.001
Conclusions

• Nitrogen
  – Related to quality
  – Fruit concentration targets for acceptable quality
  – Data on interaction with crop load?
  – Not sure of relevance when excess N is uncommon

• Crop load
  – Aim to maximise crop load
  – Minimise stress by nutrition, water, genetics

• Ca/Mg/K
  – Current treatments having less impact on fruit Ca compared with survey results
  – Consider other factors
    • Genetics
    • Potassium
    • Other soil interactions
    • Crop load etc
Too many New Zealanders are using too few brain cells.