USE OF FOLIAR APPLICATIONS OF PHOSPHONATE FUNGICIDE TO CONTROL PHYTOPHTHORA ROOT ROT IN AVOCADOS

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• Phytophthora root rot is a significant root disease of avocados growing in all states of Australia and throughout New Zealand

• Infection causes a decline in tree health with an associated loss in yield and fruit quality
In 1987 a 20% formulation of mono-dipotassium phosphonate (Fosject®) was registered for trunk injection or as a 0.1% foliar spray to control Phytophthora root rot.
• Good commercial control has been achieved with 1-2 trunk-injection treatments/year

• The 0.1% foliar spray has not given good control of root rot in mature, fruiting trees

• Increased labour costs have made trunk-injection an expensive management procedure
• The development of new technology for phosphonate application was commissioned by the Australian avocado industry in 1997

• Soil application through fertigation

• Foliar application with formulations of increased concentrations
Soil application was discarded due to:

- Leaching
- Rapid oxidation \((\text{PO}_3 \rightarrow \text{PO}_4)\)
- Potential increased phosphonate tolerance
Tolerance of *P. cinnamomomi* to Phosphonic Acid

Source: Duvenhage (1994); Weinert *et al.* (1997)
In this paper we describe results from research into foliar application of new formulations of Phosphonate fungicide
The research into foliar-applied phosphonate has examined:

- Phytotoxicity
- Efficacy
- Fruit residues
- Withholding periods
- Application methodology
- Phosphonate storage
Experimental Sites

- Pemberton
- Childers Duranbah
- Commercial orchards
- Hass
Experimental Treatments

- Foliar 0.1% phosphonate
- Foliar 0.5% phosphonate with pH adjusted
- Foliar 1.0% phosphonate with pH adjusted
- Trunk-injected phosphonate (20 & 40%)
Phytotoxicity

- Previous problems with foliar-applied Aliette®
- Higher concentrations of product being evaluated
- Suitability for use as a tank-mix with other pesticides
Phytotoxicity

- 0.5% safer than 1.0%
- Tank mix at pH 7.2
- No surfactant or stickers
- No copper hydroxide
- Do not apply as a tank mix with other pesticides
Efficacy

• Improvement in tree health (0 -10 scale)

• Phosphonic acid root concentration (20-50 mg/kg$_{fw}$)
### Tree & Root Health after PO₃ Sprays (1999)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Root mass (1-3)</th>
<th>% healthy roots</th>
<th>Tree health (0-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>1.7</td>
<td>50.0</td>
<td>2.8</td>
</tr>
<tr>
<td>Worm casts</td>
<td>1.3</td>
<td>74.5</td>
<td>3.8</td>
</tr>
<tr>
<td>PO₃ at 0.1%</td>
<td>2.3</td>
<td>73.0</td>
<td>2.0</td>
</tr>
<tr>
<td>PO₃ at 0.5%</td>
<td>2.5</td>
<td>91.0</td>
<td>1.6</td>
</tr>
<tr>
<td>PO₃ at 1.0%</td>
<td>2.3</td>
<td>90.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Injected PO₃</td>
<td>2.5</td>
<td>85.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Duranbah (1999)
**Improvement in Tree Health Following Foliar Phosphonate**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Health Improvement (0-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-2.8&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>PO&lt;sub&gt;3&lt;/sub&gt; @ 0.1%</td>
<td>-0.4&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>PO&lt;sub&gt;3&lt;/sub&gt; @ 0.25% + Bion</td>
<td>1.6&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>PO&lt;sub&gt;3&lt;/sub&gt; @ 0.5%</td>
<td>1.6&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>PO&lt;sub&gt;3&lt;/sub&gt; @ 0.5% + Bion</td>
<td>1.0&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>PO&lt;sub&gt;3&lt;/sub&gt; @ 1.0%</td>
<td>1.6&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Trunk-injected PO&lt;sub&gt;3&lt;/sub&gt; @ 20%</td>
<td>1.2&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*Childers (1999/00)*
### Root PO$_3$ Conc. 2 & 4 Weeks after Spraying

<table>
<thead>
<tr>
<th>Treatments PO$_3$conc. (mg/kg)</th>
<th>2 weeks</th>
<th>4 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>0.6b</td>
<td>0.7c</td>
</tr>
<tr>
<td>PO$_3$ at 0.1%</td>
<td>5.3b</td>
<td>9.0c</td>
</tr>
<tr>
<td>PO$_3$ at 0.5%</td>
<td>26.8a</td>
<td>38.3ab</td>
</tr>
<tr>
<td>PO$_3$ at 1.0%</td>
<td>37.7a</td>
<td>50.9a</td>
</tr>
<tr>
<td>Injected PO$_3$ not treated</td>
<td>31.6b</td>
<td></td>
</tr>
</tbody>
</table>

Trunk injection is 138% more efficient than spray application

Maleny (1999)
Effect of Phosphonate on Hass Yield

Pemberton (1999/00)
Fruit Residues

- Maximum Residue Level (MRL) for avocados in Australia is 100 mg/kg - it varies between countries.

- Fruit residues are influenced by:
  - Time of application.
Fruit Residues

Time of Application

Phosphonic acid conc. (mg/kg)

3-5 mm

1/3 grown

Mature

3rd Nov 30th Jan 16th July

Foliar application
Fruit Residues

- Maximum Residue Level (MRL) for avocados in Australia is 100 mg/kg

- Fruit residues are influenced by:
  - Time of application
  - Crop load
Mean Phosphonic Acid Residue in Fruit
52.8 mg/kg
Withholding Period

- Requirement of NRA
- Establishes minimum time between treatment and harvest
Mature Fruit PO₃ Concentration after Spraying Phosphonate
Mature Fruit PO₃ Concentration after Spraying Phosphonate
Application Methodology

High volume (1500 L/ha)

Low volume (600 L/ha)
High vs Low Volume Application Rate

- **High** = 60 g/tree
- **Low** = 25 g/tree

*Root phosphonic acid conc. (mg/kg)*

**Application rate**

- High
- Low
- Low x 2
Application Methodology

Treatment Timing

Growth

Spring Summer Autumn Winter
Application Methodology

Treatment Timing

Growth

Spring Summer Autumn Winter
Phosphonic acid is phytotoxic to pollen germination and growth. More than 400 mg/kg PA in flowers reduces the number of pollen tubes reaching the ovaries. Yield reduction may occur.
Crop Load Affects Root Phosphonic Acid Concentration

Yield (kg/tree)
Root phosphonic acid conc. (mg/kg)

\[ r^2 = 0.98 \]

Maleny (1999)
Phosphonate Storage

• Claims made that phosphonate deteriorated in storage after 90 days
• Phosphonate oxidises from PO$_3$ to PO$_4$
• Investigated stability of phosphonate in sealed containers that were filled or half-filled and stored for 6 months
Phosphononate Storage

PO$_3$ Conc. (mg/kg)

Days

0  191

Full seal
Half seal
Conclusions

- Foliar applied phosphonate at 0.5% a.i. will give commercial control of Phytophthora root rot in mature trees.
- Application frequency will vary depending on numerous factors and may be managed through monitoring phosphonic acid in roots.
Conclusions

- To reduce the risk of phytotoxicity
  - Don’t add wetting agent or spreader
  - Use copper oxychloride for anthracnose control
  - The tank solution should be adjusted to pH 7.2
  - Don’t mix with other pesticides
Conclusions

• Spring and summer flush maturity are the two most effective treatment times.

• It is the number of grams of product applied per tree that is critical in providing protection.

• Phosphonate fungicide is a stable product provided it is stored in a sealed container.
Acknowledgments

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