Low-dose methyl bromide fumigation as a quarantine treatment against fruit flies

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Market Access Protocols

- Commodities that are hosts of fruit flies need protocols to access markets that have quarantine barriers to trade
- Fruit flies pose a major quarantine risk to many trading partners
- Horticultural industries need disinfestation treatments
  - Effective against the pest
  - Maintain fruit quality
  - Fit smoothly into (multiple) transport and handling systems
    - (air-freight/sea-freight)
  - Are cost effective
**Treatment technology**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Description</th>
<th>Temperature</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold storage</td>
<td>Cool the fruit</td>
<td>1 - 3°C</td>
<td>12 - 21 days</td>
</tr>
<tr>
<td>Vapour heat</td>
<td>Heat the fruit</td>
<td>47°C</td>
<td>15 min</td>
</tr>
<tr>
<td>Irradiation</td>
<td>Gamma/e-beam/X-ray</td>
<td>150 – 400 Gy</td>
<td>Same day</td>
</tr>
<tr>
<td>MB fumigation</td>
<td>32-48 g/m³ MB</td>
<td>32-48 g/m³</td>
<td>Same day</td>
</tr>
<tr>
<td></td>
<td>at 11-21°C</td>
<td>MB</td>
<td>32-48 g/m³</td>
</tr>
</tbody>
</table>

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Capsicums

- In-line flood-spray with dimethoate since 1994
- 2011 postharvest use on capsicums suspended by APVMA
- **Heat** – required efficacy levels cause fruit damage
- **Cold** – 12 days too long, quality issues
- **Irradiation** – thrips, vectors
- **Traditional MB** (40g/m³ at 17°C for 2 h)
## What is low-dose methyl bromide?

### A traditional treatment schedule

<table>
<thead>
<tr>
<th>Flesh Temp (°C)</th>
<th>Conc MB (g/m³) (°C)</th>
<th>Time (h)</th>
<th>CT product g h /m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥32</td>
<td>16</td>
<td>2</td>
<td>32</td>
</tr>
<tr>
<td>26 - 31</td>
<td>24</td>
<td>2</td>
<td>48</td>
</tr>
<tr>
<td>21 - 25</td>
<td>32</td>
<td>2</td>
<td>64</td>
</tr>
<tr>
<td>15 - 20</td>
<td>40</td>
<td>2</td>
<td>80</td>
</tr>
<tr>
<td>10 - 14</td>
<td>48</td>
<td>2</td>
<td>96</td>
</tr>
<tr>
<td>5 - 10</td>
<td>56</td>
<td>2</td>
<td>112</td>
</tr>
</tbody>
</table>

- Historically most treatments conducted for a treatment duration of 2 hours.

### Insects:
- $80 \text{ g h/m}^3 = 40 \text{ g/m}^3 \times 2 \text{ hours}$
- $80 \text{ g h/m}^3 = 20 \text{ g/m}^3 \times 4 \text{ hours}$

### Fruit:
- Less damage from lower concentrations

### Low-dose fumigation:
- Lower concentration of MB applied over a longer treatment time
  - Same mortality effect on the insect
  - Less injury to the fruit
  - Less MB used
What did we do?
Did it work?

- We are not trying to determine the most tolerant stage or the most tolerant species
- Instead conducting multiple confirmatory trials against all lifestages
- ≥ 99.99% mortality (95% confidence)

Mortality of Qfly in Capsicums after methyl bromide fumigation with 18g/m³ at 18°C for 5 h

<table>
<thead>
<tr>
<th>Lifestage</th>
<th>Number of survivors</th>
<th>Total no. of insects treated</th>
<th>Corrected mortality* (95% confidence)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>0</td>
<td>35,551</td>
<td>99.99157</td>
</tr>
<tr>
<td>First instar larvae</td>
<td>0</td>
<td>53,720</td>
<td>99.99442</td>
</tr>
<tr>
<td>Second instar larvae</td>
<td>0</td>
<td>40,371</td>
<td>99.99258</td>
</tr>
<tr>
<td>Third instar larvae</td>
<td>0</td>
<td>43,901</td>
<td>99.99318</td>
</tr>
</tbody>
</table>

*Couey and Chew (1986)
What about the quality?

Traditional MB
40g/m³ at 17°C for 2 h

“It appears that capsicums are, at best, marginally tolerant of fumigation with methyl bromide.” (Jessup 1994, NSW DPI)

- Damage was on the surface of the fruit.
- Some pitting in the form of sunken, water-soaked lesions, slight shrivelling, softening and rot development.
- The lesions formed on the fumigated fruit at about 4 days at 17°C after fumigation.

Low dose MB
18g/m³ at 18°C for 5 h

CONTROL   TREATED

- After 10 days at 6°C followed by 6 days holding at 10°C
- **Quality parameters:** weight loss, total soluble solids, skin colour, skin quality, skin wrinkling, skin pitting, severity and incidence of rots.
- **No significant difference between control and treated fruit.**
### Outcomes

#### Traditional schedule:

<table>
<thead>
<tr>
<th>Flesh Temp (°C)</th>
<th>MB (g/m³)</th>
<th>Duration (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥32</td>
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</tr>
<tr>
<td>5 - 10</td>
<td>56</td>
<td>2</td>
</tr>
</tbody>
</table>

#### Current research: low-dose MB

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Flesh Temp (°C)</th>
<th>MB (g/m³)</th>
<th>Duration (h)</th>
<th>Survivors</th>
<th>CT product (g h m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capsicum</td>
<td>18</td>
<td>18</td>
<td>5</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>Nectarine</td>
<td>18</td>
<td>18</td>
<td>5.5</td>
<td>0</td>
<td>99</td>
</tr>
<tr>
<td>Peach</td>
<td>18</td>
<td>18</td>
<td>5.5</td>
<td>0</td>
<td>99</td>
</tr>
</tbody>
</table>
What have we accomplished

• First low-dose MB export protocol
  – **Nectarines** to China, May 2016
  – First shipments occurred last summer

• Protocols in negotiation
  – DAWR conducting protocol negotiation with NZ with **capsicum** data
  – DAWR conducting protocol negotiation with Thailand and USA with **nectarine** and **peach** data.

• New project to expand low-dose methyl bromide fumigation for industries where airfreight protocols are required, or not other options:
  – Pumpkin, mangoes, plum, strawberry, apple, table grape, pear

• Collaborating with WA scientists to generate equivalent data on Medfly.
Acknowledgements

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