LITERATURE REVIEW

POTENTIAL PHYTOSANITARY TREATMENTS FOR EXPORT LOGS

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Context

• 1980s were the “high-water mark” for fumigant R&D

• Followed by a marked reduction in new fumigant development and associated research
  – Loss of ethylene dibromide - 1984
  – Increased environmental and worker safety concerns
  – Increased costs to register new chemicals
  – Increased public pressure to decrease dependence on toxic compounds
  – Decreased commercial interest in new fumigants
    • decreased scientific interest in pursuing fumigant research
Context

• MBTOC alternatives

• NZ EPA Reassessment decision
  – Possible alternatives

• STIMBR required a review
  – Potential phytosanitary treatments
  – Specific to export *Pinus radiata* logs
  – Excluded methyl bromide and phoshine
Primary goal

• Find at least two fumigants
  – Potential viable alternatives
  – Further research

• Reviewed thirty three fumigants
  – 15 major fumigants
  – 18 minor fumigants
# Major fumigants

- Reviewed 15 significant candidates

<table>
<thead>
<tr>
<th>Carbonyl sulphide</th>
<th>Chloropicrin</th>
<th>Dichlorvos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimethyl disulphide</td>
<td>Ethanedinitrile</td>
<td>Ethyl formate</td>
</tr>
<tr>
<td>Ethylene dioxide</td>
<td>Hydrogen cyanide</td>
<td>Methyl bromide</td>
</tr>
<tr>
<td>Methyl iodide</td>
<td>Methylisothiocyanate</td>
<td>Nitric oxide</td>
</tr>
<tr>
<td>Ozone</td>
<td>Phosphine</td>
<td>Sulfuryl fluoride</td>
</tr>
</tbody>
</table>
## Minor fumigants

Reviewed 18 candidates:

<table>
<thead>
<tr>
<th>Acetaldehyde</th>
<th>Acrylonitrile</th>
<th>Azobenzene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon bisulphide</td>
<td>Carbon monoxide</td>
<td>Dichloronitroethane</td>
</tr>
<tr>
<td>Ethylene chlorobromide</td>
<td>Methyl allyl chloride</td>
<td>Methyl chloroform</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>Naphthalene</td>
<td>Nicotine</td>
</tr>
<tr>
<td>Methyl formate</td>
<td>Paradichlorobenzene</td>
<td>Propylene dichloride</td>
</tr>
<tr>
<td>Sulphur dioxide</td>
<td>Tetrachloroethane</td>
<td></td>
</tr>
</tbody>
</table>
Secondary goal

• In-depth review of potential non-chemical treatments and methods including

  – Controlled and modified atmospheres

  – Energy treatments
    • Irradiation
    • Microwave
    • Electric current
    • Infrared

  – Physical treatments
    • Cold / heat
    • Pressure / vacuum,
    • Other alternatives
      – debarking of logs
      – pest management systems
      – systems approaches.
Considerations

• Review - specific to treatments against forest species associated with *Pinus radiata*

• New Zealand does not have any nematode or pathogen issues of quarantine importance with export logs
Considerations

Treatment schedules specify treatment parameters that must be followed to ensure treatment efficacy and quarantine security for example:

- **Fumigation schedules** specify the fumigant concentration, the temperatures at which the fumigation must be carried out, and the duration the treated material must be exposed to the fumigant.

- **Physical treatment schedules** such as cold or heat treatments, specify the temperatures that must be used and the treatment time or duration for which the material must be subjected to the specified temperature.

- **Energy treatments** such as irradiation, specify the amount of radiation energy that must be absorbed at the center of the treated material.
Fumigants - evaluation parameters

- Physical and chemical properties
- Mode of insecticidal action
- Availability
- Environmental credentials
- Health and safety requirements.
- Potential synergistic combinations based on mode of action
- Enhancing treatments that can be incorporated at operational scale evaluated for potential benefits, e.g., heat, modified oxygen (O2) and carbon dioxide (CO2).
# Review findings

## Non-chemical options

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debarking</td>
<td>More expensive</td>
<td>Study completed; all potential alternative chemical or non-chemical methods must be compared with debarking</td>
</tr>
<tr>
<td></td>
<td>logistically challenging</td>
<td></td>
</tr>
<tr>
<td>Heat - hot water or steam</td>
<td>Very expensive and logistically challenging</td>
<td>No research in progress; may have niche potential</td>
</tr>
<tr>
<td>Heat - Joule heating</td>
<td>Concept proven</td>
<td>Niche potential</td>
</tr>
<tr>
<td>Microwave</td>
<td>Expensive, but possible</td>
<td>Approved for use on wood packaging internationally but unlikely for logs</td>
</tr>
<tr>
<td>Irradiation</td>
<td></td>
<td>May have niche potential</td>
</tr>
<tr>
<td>Water soaking</td>
<td>Untested</td>
<td>Logistically difficult; considered and discounted</td>
</tr>
<tr>
<td>Integrated pest</td>
<td>Initial research completed</td>
<td>Already used in horticulture; may only support a decreased need for fumigation during periods of insect inactivity; will require pest monitoring programs</td>
</tr>
<tr>
<td>management</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Review findings - fumigants

- **NO NEW PREVIOUSLY UNKNOWN FUMIGANTS**

- **NO “SILVER BULLETS”**
## Review findings – FUMIGANTS

### Chemical options

<table>
<thead>
<tr>
<th>Fumigant</th>
<th>Compared with methyl bromide</th>
<th>Status and/or comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonyl sulphide</td>
<td>Less toxic</td>
<td>Considered, but less effective</td>
</tr>
<tr>
<td>Ethyl formate</td>
<td>Less toxic</td>
<td>Being tested for horticultural crops but unsuitable for logs</td>
</tr>
<tr>
<td>Methyl iodide</td>
<td>Toxic and carcinogenic</td>
<td></td>
</tr>
<tr>
<td>Methylisothiocyanate</td>
<td>More toxic</td>
<td>Considered and discounted</td>
</tr>
<tr>
<td>Sulfuryl fluoride</td>
<td>A green house gas</td>
<td>A distant second to EDN if no other fumigants are available for logs</td>
</tr>
<tr>
<td>Ethanedinitrile</td>
<td>Equivalent toxicity</td>
<td>Promising for sawn timber and logs</td>
</tr>
</tbody>
</table>
Review findings

Except for ethanedinitrile, the review found no additional viable fumigant alternatives to methyl bromide.
Ethanedinitrile - EDN
A potential alternative phytosanitary treatment for logs

• Techno-economic study completed

• Confirmed no significant technical issues to prevent pursuing EDN as an alternative export log phytosanitary treatment

• EDN efficacy data for three forest insect species is being developed