Measurement and Assessment of Field Emission Reductions from Soil Fumigation

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This project supports emission monitoring for three PAW projects including industry sectors:

- Perennial nursery (PI: Brad Hanson)
- Grapevine orchards (PI: Dong Wang)
- Almond/stone fruits (PI: Greg Brown)

**Objective:**

To determine the effects of fumigation methods that are applicable for different commodities and various surface sealing treatments on fumigant emission reductions.

**Fumigants:**

- 1,3-dichloropropene (1,3-D) and chloropicrin (CP).
Emission Reduction Methods

• Application Methods:
  – Deep injection
  – Drip vs. shank
  – Local area treatment (strip shank; spot drip)

• Surface Treatment:
  – Plastic tarp (HDPE, VIF, SIF, TIF)
  – Irrigation (water seals; pre-irrigation)
  – Organic amendment (composted manure, green waste)
  – Chemical Treatment (thiosulfate)
Trials and Measurements

• One field trial each year for each industry sector in 2007 and 2008.
• Emission monitoring using dynamic flow-through flux chambers that give continuous measurements.
• Additional measurements:
  • Soil-gas concentration/distribution data.
  • Soil sample for residual fumigants in the end.
  • Soil moisture and temperature.
Data Collection for Emissions

Emission Flux

Cumulative Emission Loss
# Summary of cumulative emission loss

<table>
<thead>
<tr>
<th>Trial</th>
<th>Application methods</th>
<th>Treatment</th>
<th>2007 1,3-D emission loss (% of applied)</th>
<th>2008 1,3-D emission loss (% of applied)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perennial nurseries:</td>
<td>Standard Shank</td>
<td>Bare soil</td>
<td>84 (28)</td>
<td>42 (21)</td>
</tr>
<tr>
<td></td>
<td>(Telone II)</td>
<td>HDPE</td>
<td>38 (15)</td>
<td>22 (6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HDPE gluing strips</td>
<td>24 (14)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VIF</td>
<td>1 (3)</td>
<td>1 (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VIF gluing strips</td>
<td>2 (2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water seals</td>
<td>34 (7)</td>
<td></td>
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<tr>
<td></td>
<td>Bare soil</td>
<td></td>
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<td>HDPE</td>
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<td>VIF</td>
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<td></td>
<td>Water seals</td>
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<td></td>
<td></td>
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<tr>
<td>Buessing Shank:</td>
<td>Standard Shank</td>
<td>Bare soil</td>
<td>86 (28)</td>
<td>50 (22)</td>
</tr>
<tr>
<td></td>
<td>(Telone II)</td>
<td>HDPE</td>
<td>36 (5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VIF</td>
<td>5 (3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water seals</td>
<td>65 (12)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bare soil</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>HDPE</td>
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<td></td>
<td>VIF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water seals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vineyard:</td>
<td>Standard shank</td>
<td>Bare soil</td>
<td>89 (38)</td>
<td>69 (-)</td>
</tr>
<tr>
<td></td>
<td>(Telone C35)</td>
<td>VIF</td>
<td>19 (14)</td>
<td>3 (0)</td>
</tr>
<tr>
<td></td>
<td>Subsurface drip</td>
<td>Bare soil</td>
<td>50 (41)</td>
<td>29 (12)</td>
</tr>
<tr>
<td></td>
<td>(InLine)</td>
<td>VIF</td>
<td>8 (4)</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Almond/stonefruit:</td>
<td>Standard shank</td>
<td>Bare soil</td>
<td>77 (34)</td>
<td>92 (15)</td>
</tr>
<tr>
<td></td>
<td>(Telone C35)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spot-drip (InLine)</td>
<td>Cover crop</td>
<td>23 (31)</td>
<td>6 (7)</td>
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<tr>
<td></td>
<td></td>
<td>Without cover crop</td>
<td>2 (3)</td>
<td>18 (13)</td>
</tr>
</tbody>
</table>
2008 Perennial Nursery Trial
Treatments:

Standard shank (Telone II):
• bare soil (control)
• Water treatments
• High OM amendment (49 Mg ha\(^{-1}\))
• HDPE tarp (continuing and glue joint)
• VIF tarp (continuing and glue joint)
Average flux
Concerns on VIF tarp performance in field:
stretching and gluing
Table 1. Cumulative emission loss of 1,3-dichloropropene from 2008 field trial

<table>
<thead>
<tr>
<th>Treatment†</th>
<th>Emission loss (% of applied)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>42.4 (±17.0)</td>
</tr>
<tr>
<td>Manure at 49.4 Mg ha⁻¹</td>
<td>50.5 (±10)</td>
</tr>
<tr>
<td>Water seals</td>
<td>33.6 (±6.8)</td>
</tr>
<tr>
<td>HDPE (continuous sheet)</td>
<td>21.6 (±6.5)</td>
</tr>
<tr>
<td>HDPE (glue joints)</td>
<td>23.9 (±15.1)</td>
</tr>
<tr>
<td>VIF (continuous sheet)</td>
<td>1.4 (±1.0)</td>
</tr>
<tr>
<td>VIF (glue joint)</td>
<td>1.9 (±2.4)</td>
</tr>
</tbody>
</table>
Fumigant concentration under tarp

1,3-D air concentration under tarp (µg cm⁻³)

HDPE - Std shank
HDPE - Buessing shank
VIF - Std shank
VIF - Buessing shank

Date
10/3 10/5 10/7 10/9 10/11 10/13
Gaseous 1,3-dichloropropene in soil profile

a. Control
Application rate: 424 kg ha\textsuperscript{-1}

b. HDPE
Application rate: 408 kg ha\textsuperscript{-1}

c. VIF
Application rate: 236 kg ha\textsuperscript{-1}

d. Water seals
Application rate: 391 kg ha\textsuperscript{-1}
Emission flux & cumulative emission loss from September 2009 Strawberry Fumigation Trial (Ajwa, Segawa, Sullivan, Gao)
Summary

- Emission reduction by standard PE tarp, post-fumigation water treatments and organic amendment are limited and affected by specific soil and environmental conditions as well as how the treatments are applied:
  - Water seals: effective on reducing peak flux; not total emission loss; impact on efficacy in surface soils; water availability; low cost
  - HDPE tarp – appears effective with moist soil and/or low temperature
  - OM amendment: not always effective in the field
Summary (Continued)

- VIF has been proven to be the most promising technology to minimize emissions and maximize efficacy; can improve buffer zone; has the potential to use lower rates; but with high cost and concerns about surging emissions upon tarp removal.
• Spot-drip applications and strip-shank applications can result in lower emission loss by reducing fumigant-treated areas of a field (10 or 50%). Spot-drip further gave very low emissions as % of total applied (Wang et al. 2009).
Dynamic flux chamber update: modifications and field tests for accurate emission measurement from bare soil

Observations:

- Chamber flow rates of 1.25, 2.5 and 5 L/min did not affect emission loss.

- Collars of 6”, 12” under the chambers did not make difference in emission loss.

- A heating unit (hot-bottle) before flow meters was able to eliminate water condensation in both chamber flow and sample flow meters.

- The raised temperature did not affect fumigant stability.
Cumulative Fumigant Emission Loss from FULL Rate of Telone C35 & BARE Soil, Parlier Fumigation Trial, Oct. - Nov. 2009

Accumulated Emission Loss/Applied

Total Fumigant Emission Flux from FULL Rate of Telone C35 & BARE Soil Parlier Fumigation Trial, Oct. - Nov. 2009

Total Flux µg/(m²*sec)

Sample Flow (ml/min)

Chamber Flow (L/min)

Most recent update
Acknowledgements

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