Measurement and Assessment of Field Emission Reductions from Soil Fumigation

Suduan Gao,* Ruijun Qin, Brad Hanson,
Dong Wang, Greg Brown, James Gerik

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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)


TriCal

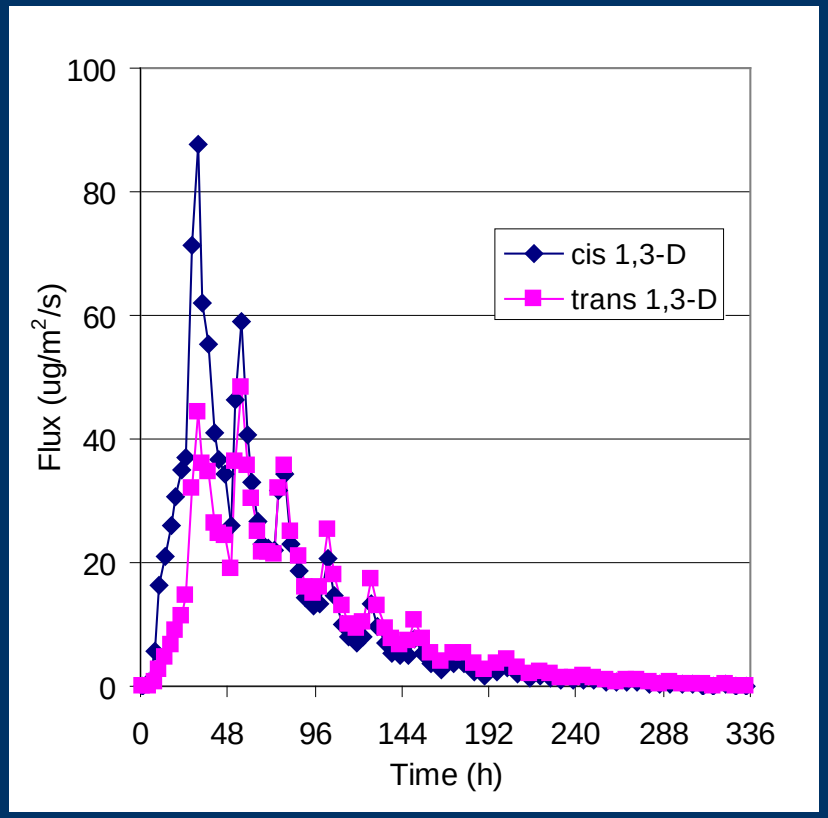

Dynamic chambers

Trials and Measurements

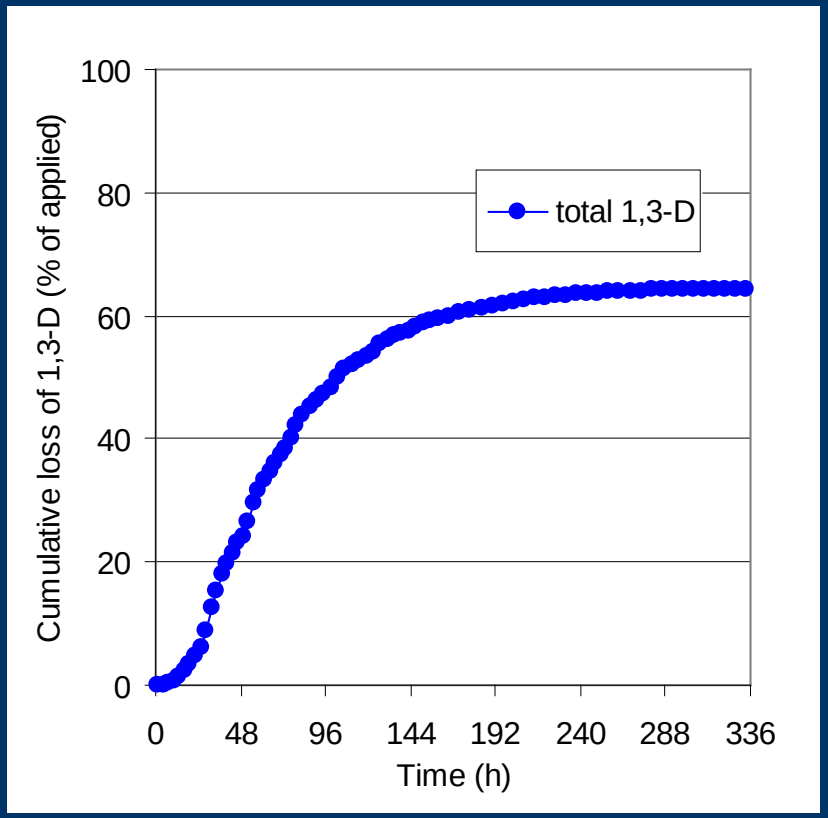
- One field trial each year for each industry sector in 2007 and 2008.
- Emission monitoring using dynamic flow-through flux chambers that give continuous measurements.
- Additional measurements:
  - Soil-gas concentration/distribution data.
  - Soil sample for residual fumigants in the end.
  - Soil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

Data Collection for Emissions

Emission Flux



Cumulative Emission Loss



Summary of cumulative emission loss

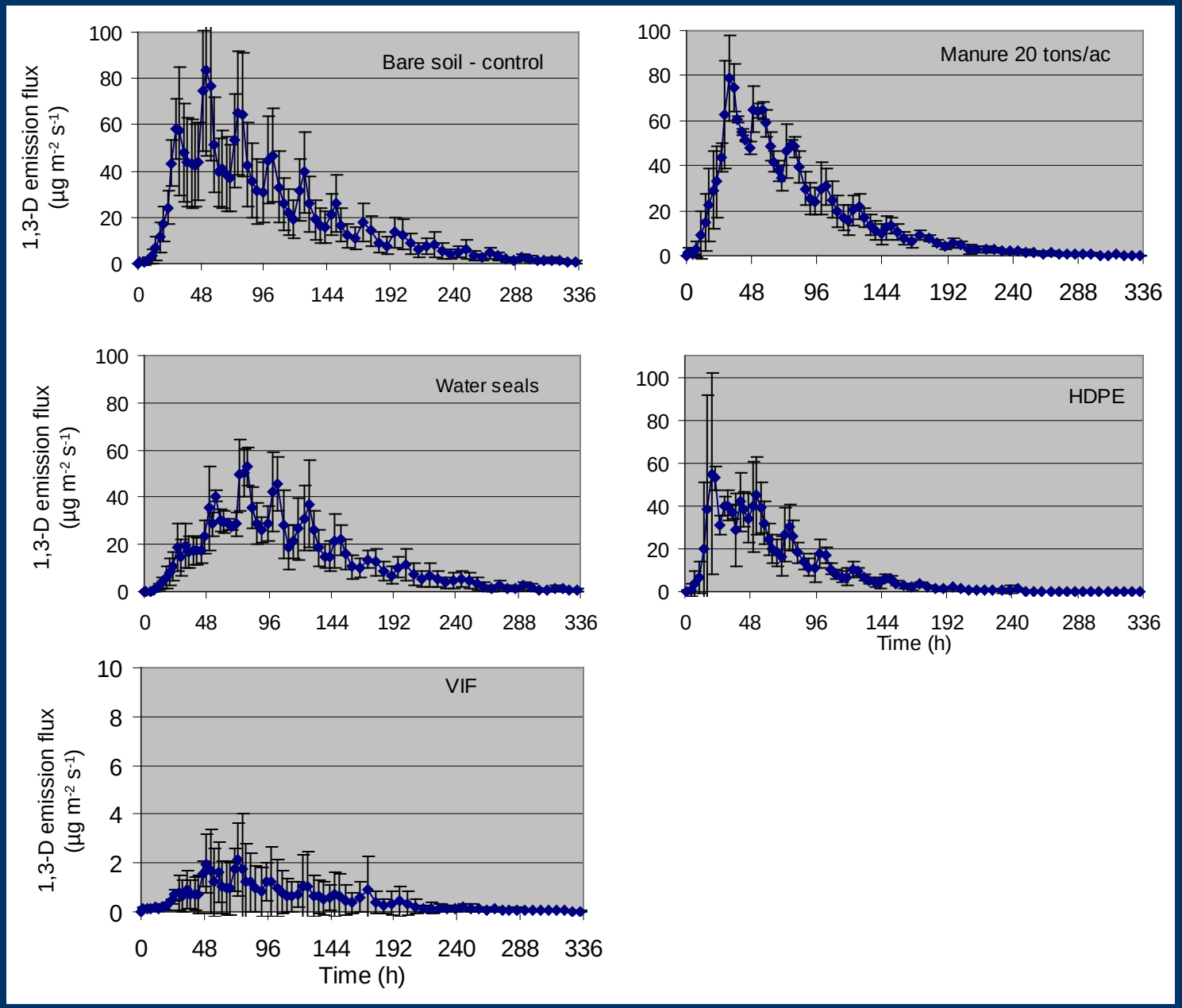
Trial	Application methods	Treatment	2007 1,3-D emission loss (% of applied)	2008 1,3-D emission loss (% of applied)
Perennial nurseries:	Standard Shank (Telone II)	Bare soil	84 (28)	42 (21)
		HDPE	38 (15)	22 (6)
		HDPE gluing strips		24 (14)
		VIF	1 (3)	1 (1)
		VIF gluing strips		2 (2)
		Water seals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

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

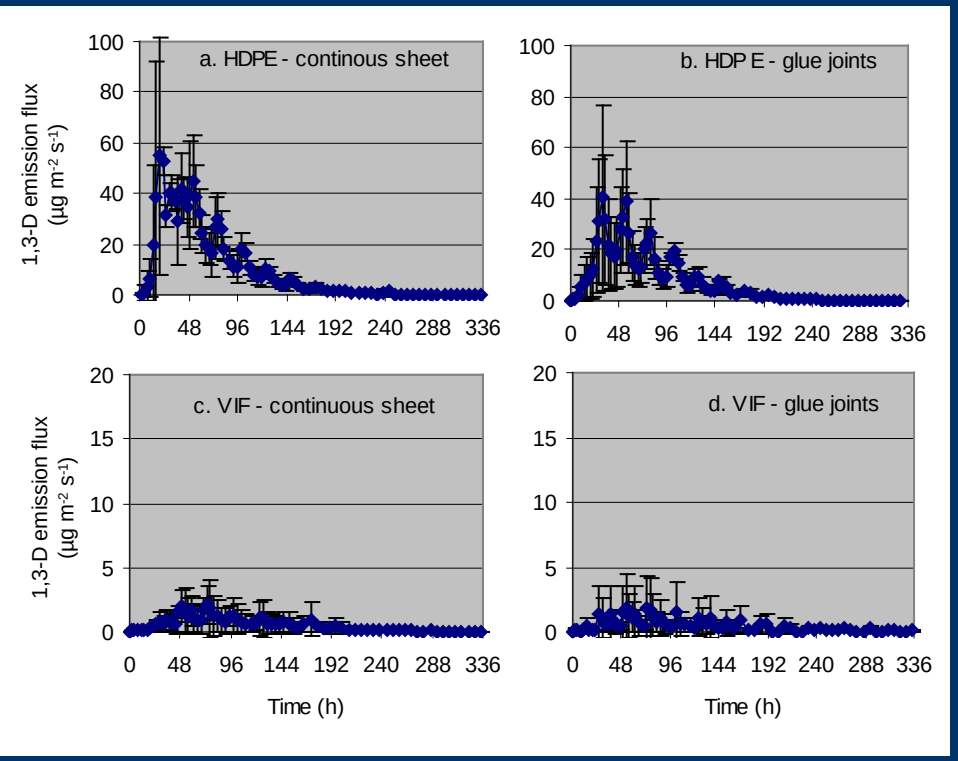
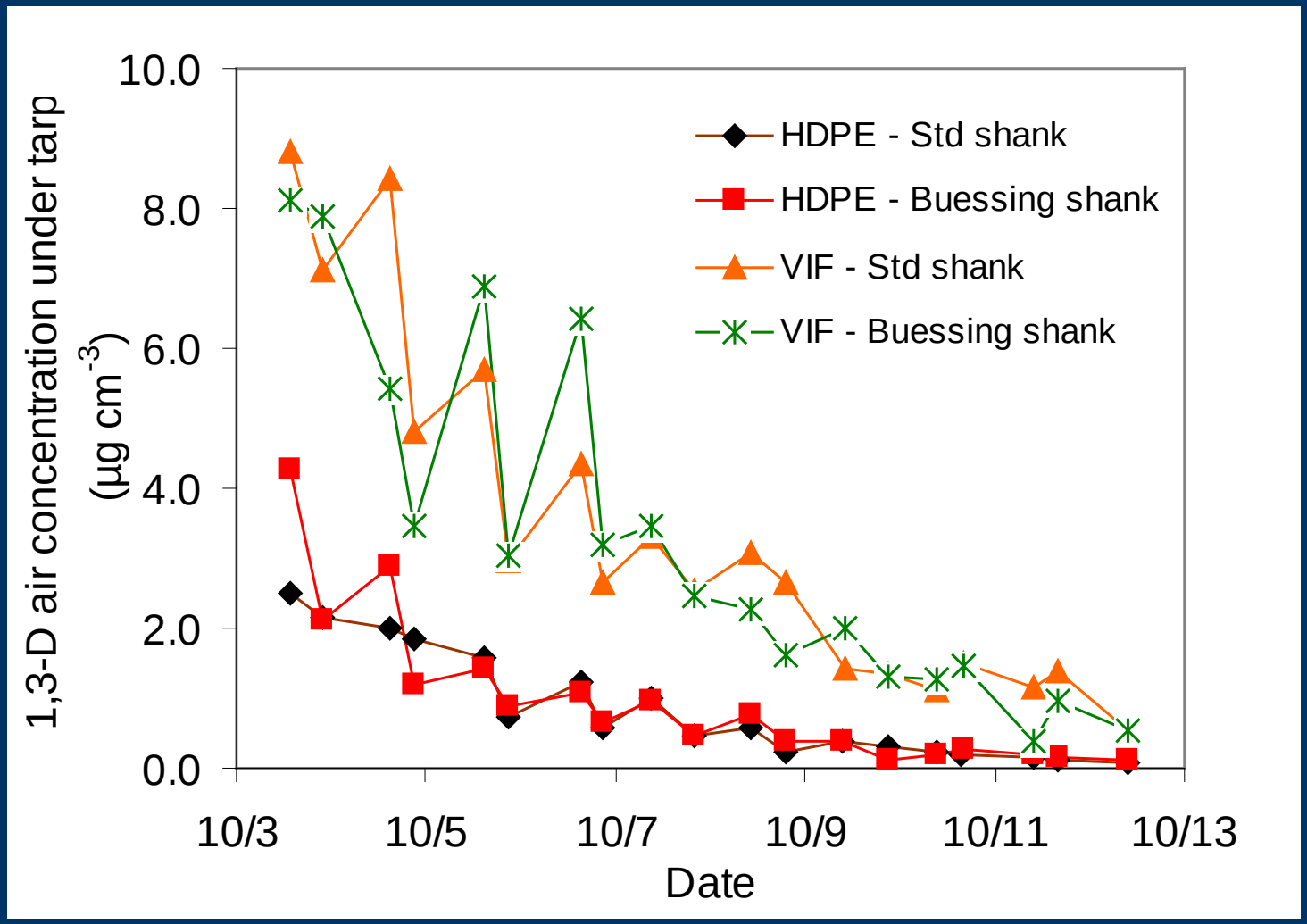


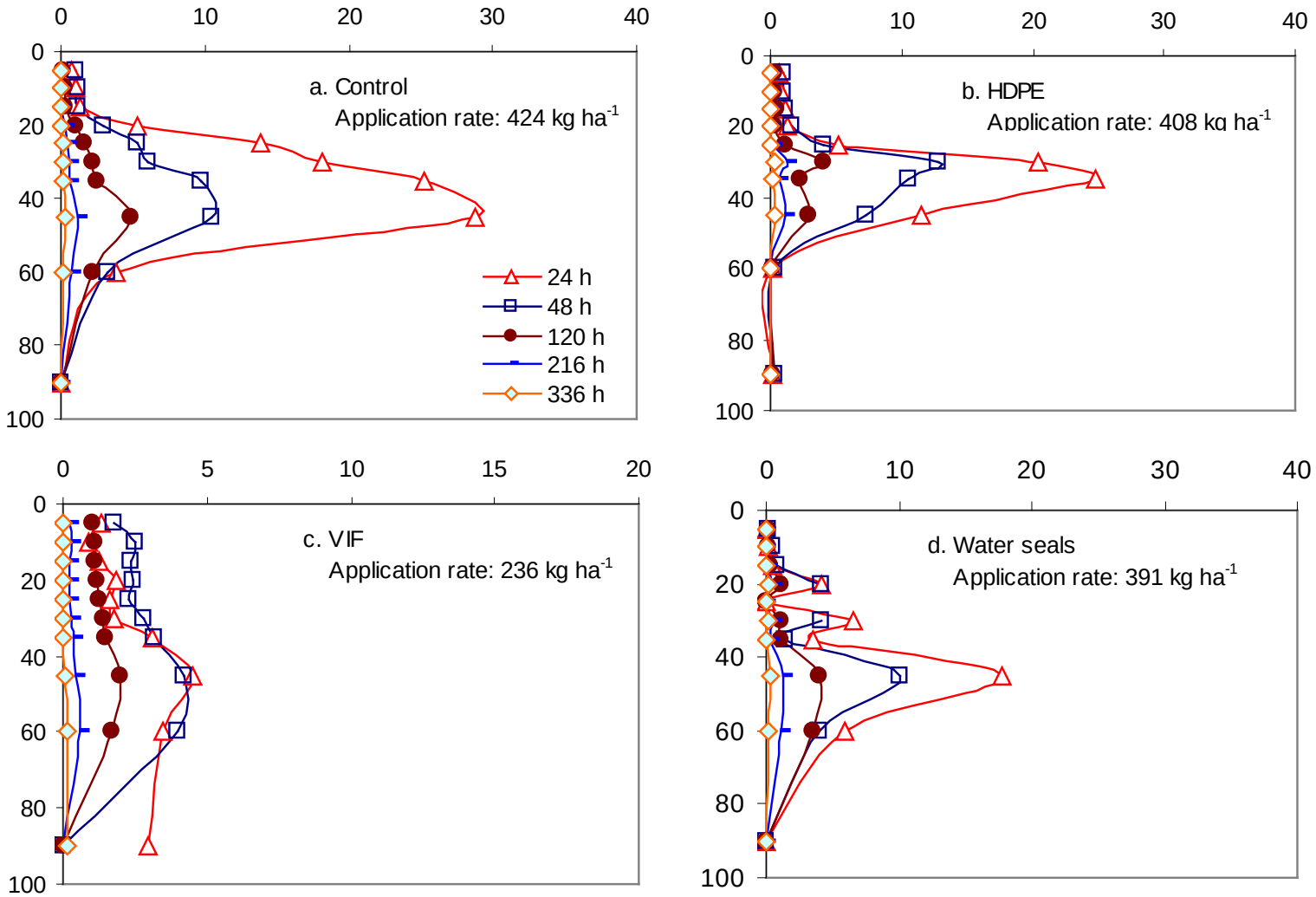
Table 1. Cumulative emission loss of 1,3-dichloropropene from 2008 field trial

Treatment†	Emission loss (% of applied)
Control	42.4 (±17.0)
Manure at 49.4 Mg ha^{-1}	50.5 (±10)
Water seals	33.6 (±6.8)
HDPE (continuous sheet)	21.6 (±6.5)
HDPE (glue joints)	23.9 (±15.1)
VIF (continuous sheet)	1.4 (±1.0)
VIF (glue joint)	1.9 (±2.4)

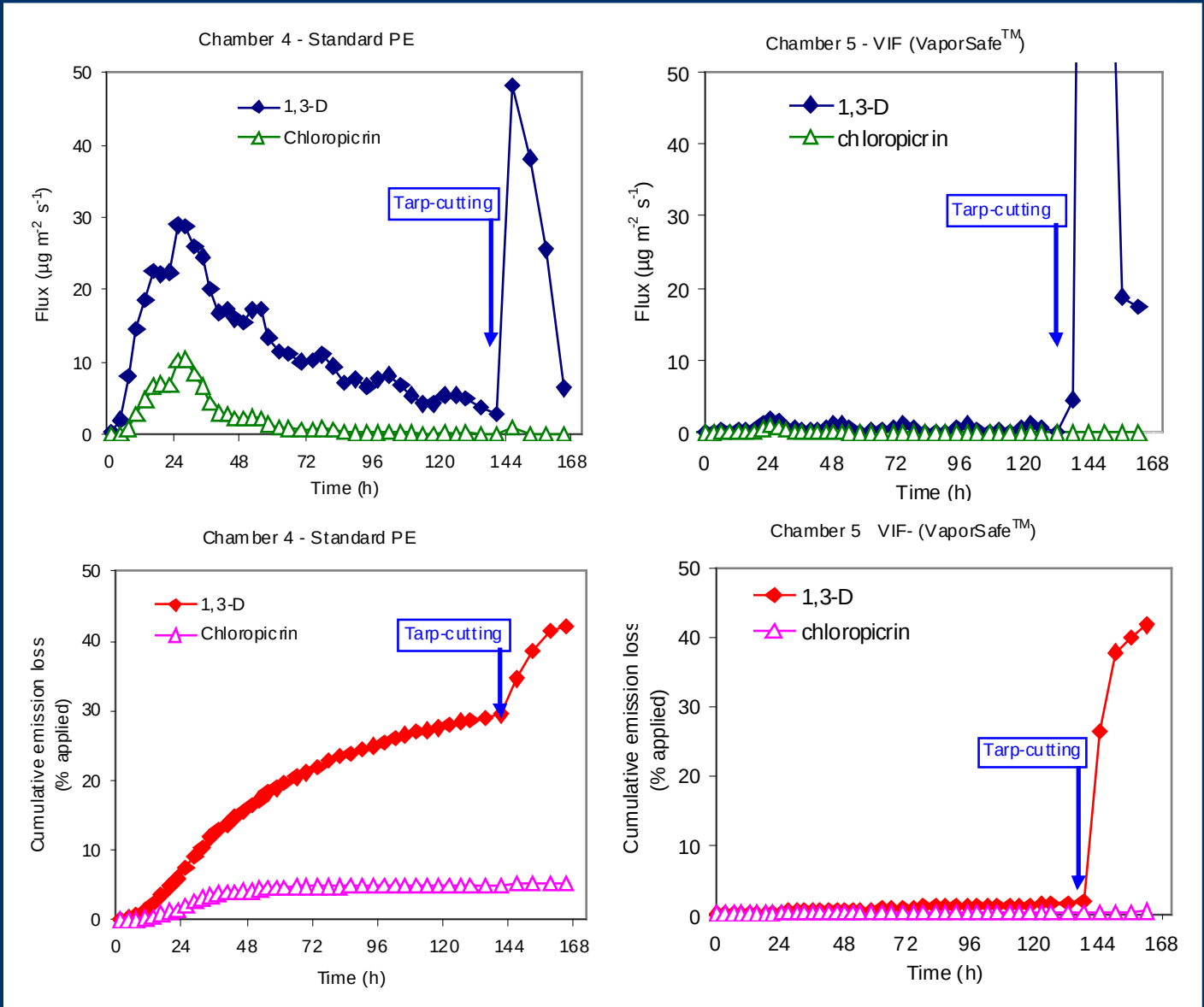
Fumigant concentration under tarp



Gaseous 1,3-dichloropropnene in soil profile



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.

Summary (Continued)

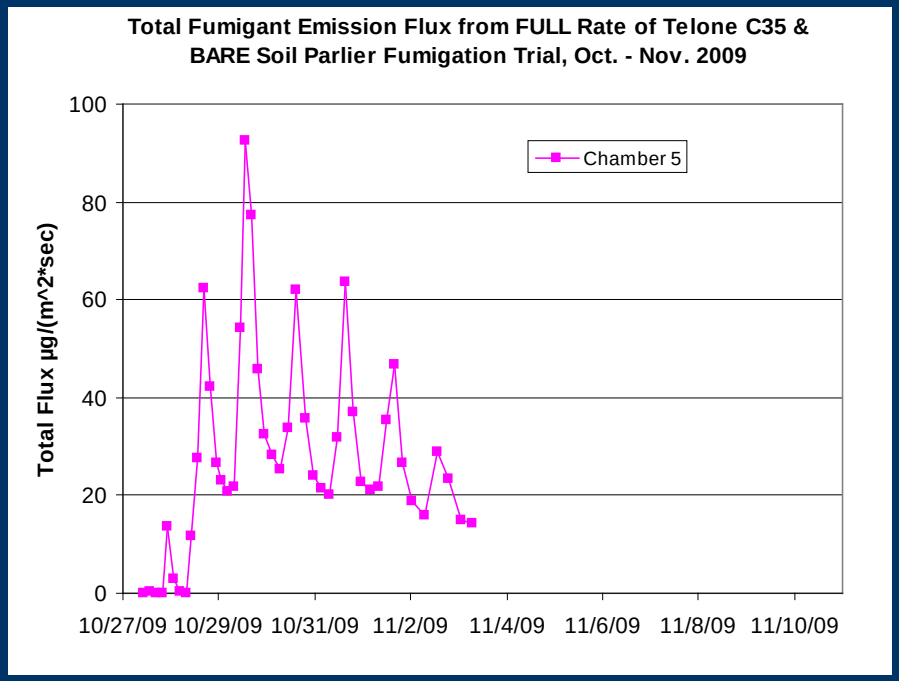
- Spot-drip applications and strip-shank applications can result in lower emission loss by reducing fumigant-treated areas of a field (10 or 50%). Spot-drip further gave very low emissions as % of total applied (Wang et al. 2009).

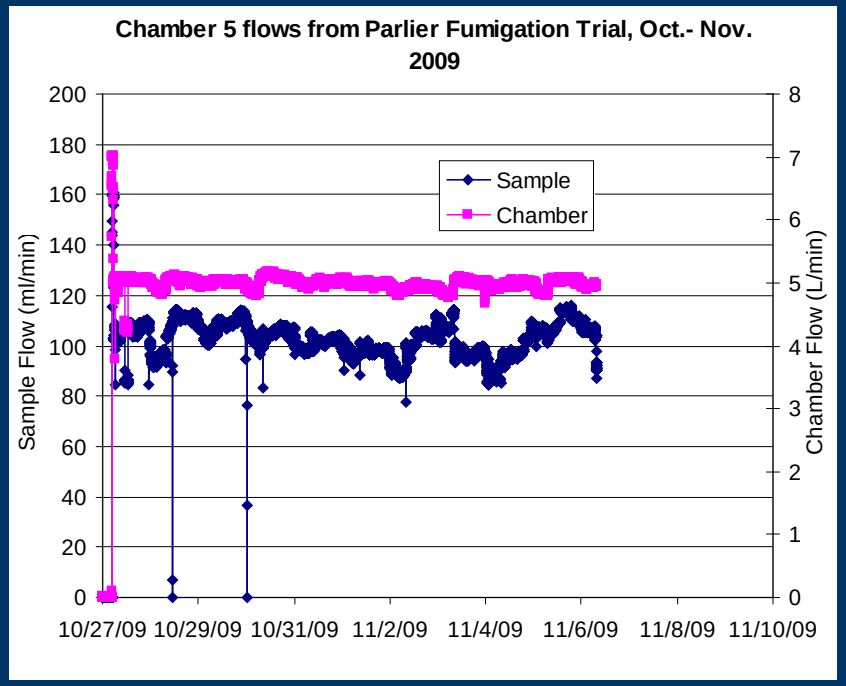
Dynamic flux chamber update: modifications and field tests for accurate emission measurement from bare soil

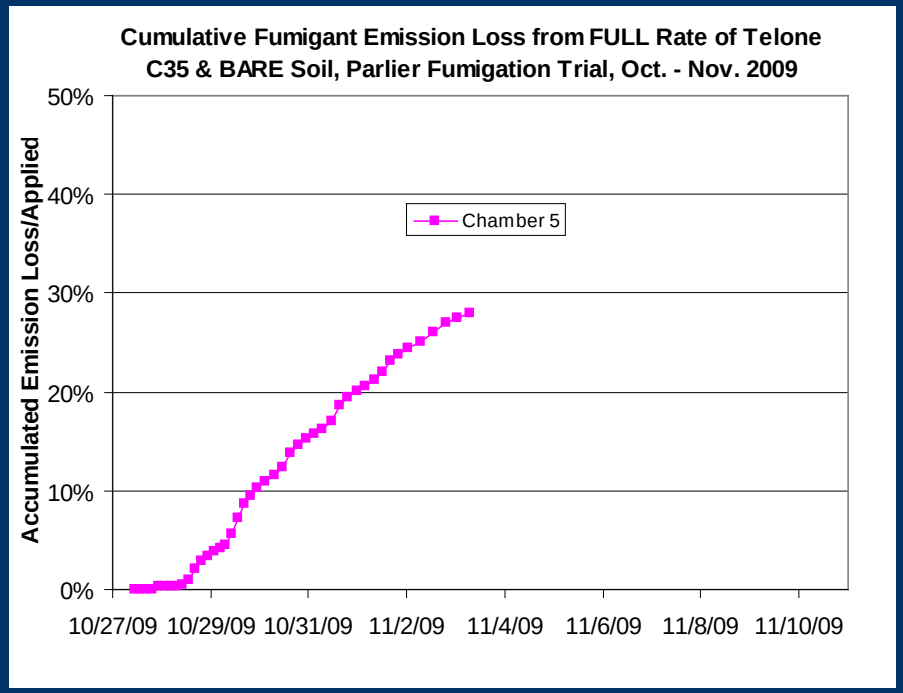
Observations:

- 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.

Most recent update







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