Minimize Emissions and Improve Efficacy of Soil Fumigations with Tarping of TIF

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Introduction

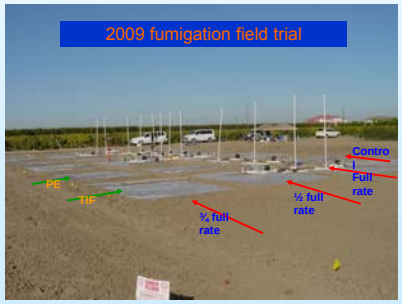
Soil fumigants continue to play a critical role in soil pest management in almonds. However, due to concerns about exposure risks and VOC air emissions, the use of soil fumigants is being ever more limited by environmental regulations. Emission reduction from soil fumigation is required in ozone nonattainment areas, which include the San Joaquin Valley where most almonds are grown. Management strategies that minimize emissions and improve pest control are the most desirable and tarping with low permeability film such as totally impermeable film (TIF) has this potential.

Objectives

- Demonstrate the potential of totally impermeable film (TIF) to improve soil fumigant distribution in soils.
- Determine the potential of using reduced fumigant application rates to achieve good efficacy under the TIF tarp.
- Determine fumigant persistence under the TIF tarp over time from different fumigant application rates and evaluate the waiting period between application and tarp-cutting to minimize potential exposure risks to workers and by-standers.

Field Trial, Fall 2009

- **Location:** USDA-ARS, Parlier, CA
- **Soil:** Hanford sandy loam (coarse-loamy, mixed, superactive, nonacid, thermic Typic Xerorthents**).**
- **Fumigation:** Shank injection using a Telone® rig - Telone C35 (61% 1,3-D, 33% CP and 6% inert ingredient**)** at 18" depth and 20" spacing between shanks.
- **Treatments:**
  - ➢Two tarps: standard polyethylene (PE or HDPE) (TriCal., Hollister, CA) and TIF (VaporSafe™, 1-mil thickness, clear, Raven Industries, Sioux Falls, SD).
  - ➢Fumigant application rates: full rate (605 kg ha^{-1} or 540 lb ac^{-1}), ¾ and ½ of full rate, and 0 (control). The ¾ rate was over applied resulting in no difference from the full rate in this trial.

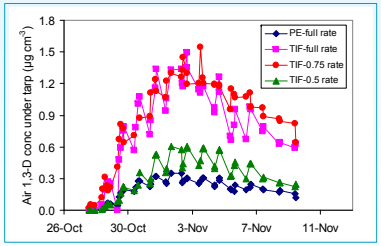


Hot glue technique for joining TIF sheets

Applications	
Target rate	Achieved
Full rate (48 g/ac)	103%
¾ rate	140%
½ rate	103%

Results

- **Air concentrations under tarp** show that the TIF retained much higher 1,3-D concentrations than standard PE. The ½ rate 1,3-D concentrations under the TIF was comparable to or higher than the full rate under the PE.



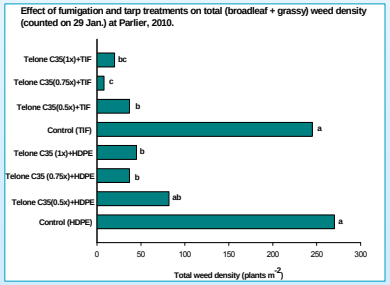
- **Nematode efficacy data** indicate that all fumigated treatments provided 100% control of citrus nematodes in buried bags (ave. 2588 live nematode in non-fumigated control). However, the ½ rate under both HDPE and TIF had some residential pin nematode survival.

Abbott efficacy (%) of different Telone C35 rates on pin (*Paratylenchus* spp.) and citrus (*Tylenchulus semipenetrans*) nematodes (Fall fumigation trial 2009). Average live nematodes in 100 cc soil in the non-fumigated control was 47±3 at 2 weeks and 4±2 at 12 weeks after fumigation for the pin nematode, and 2588 ±703 for the citrus nematode, respectively.

	Resident nematodes in soil		Nematodes in bags			
Treatment	Pin	Pin	Citrus	Citrus	Citrus	Citrus
	2 weeks after fum.[a]	16 weeks after fum.[b]	6 inches/ 15 cm[c]	1 foot/ 30 cm[c]	2 feet/ 60 cm[c]	3 feet/ 90 cm[c]
PE - ½ rate	98±1.3	100	100	100	100	100
PE - ¾ rate	100	100	100	100	100	100
PE - full rate	100	100	100	100	100	100
TIF - ½ rate	98±2.9	100	100	100	100	100
TIF - ¾ rate	100	100	100	100	100	100
TIF- full rate	100	100	100	100	100	100

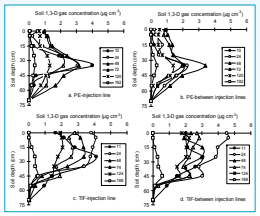
[a]Samples taken 1, 2, and 3 feet (30, 60, 90, and 120 cm) soil depth combined
[b]Composite samples taken from 0 to 2 feet (0 to 60) cm soil depth
[c]Samples taken 2 weeks after fumigation
± indicates standard deviation, N = 3

- **Native weed recovery** three months after fumigation show that all fumigated treatments has significantly lower weed population than the control. The ¾ (≈ full) rate under TIF had significantly lower weed density than all other treatments. Biomass showed a similar trend (data not shown).

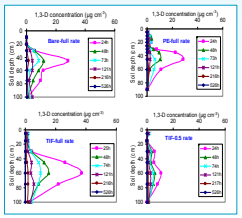


- **Gas fumigant distribution** in soil profile
  - ➢From a large field trial and shallow injection to 12" depth, TIF resulted in much higher 1,3-D concentrations and more uniform distribution than PE film (left graphs).
  - ➢From a small plot field trial and deep injection to 18" depth, TIF did not significantly improve 1,3-D concentration and distribution compared to the standard PE film, which may be partially due to small tarped areas (right graphs).

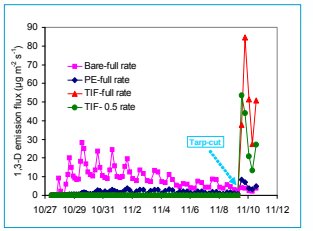
One acre tarped field; injection to 30 cm depth; deep ripping



A single sheet cover; injection to 45 cm depth; no deep ripping



- **Emission measurements** show TIF can significantly control emissions to extremely low. Due to its ability to retain fumigants, upon tarp-cutting, however, significant surge of emissions were observed from the TIF. This must be avoided to reduce potential exposure risks. Extending tarp-covering time and/or using lower fumigation rates are some of the solutions.



Continuing Research

- Another field trial was conducted in September 2010 focusing on testing correlation between application rates under TIF and efficacy control for nematodes, pathogens, and weeds. Gas concentrations were monitored especially at locations where pest samples were collected.

Fall 2010 fumigation trial overview

Placing pest bags and soil gas sampling tubing into soil

Summary

- TIF is proven to effectively reduce fumigant emissions by retaining fumigants under the tarp, but the tarp may need to remain in the field for a much longer period of time than standard PE to avoid the surge of emissions upon tarp-cutting.
- The potential of using lower rates under TIF for good efficacy has been shown and the specifics for perennials need to be determined
- On-going research is to collect field data to determine reduced fumigation rates under TIF and correlations with pest control.

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