MEASUREMENT AND ASSESSMENT OF FIELD EMISSION REDUCTIONS

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Emission measurement has been an important component for the first two years of the Pacific Area-Wide (PAW) Pest Management Program for Integrated Methyl Bromide Alternatives. Dynamic Flux Chamber Systems with continuous and auto-sampling features were used for the emission sampling. Data collected as a part of this project has lead to several important conclusions. However, overestimation of cumulative emissions from bare soil has occasionally been observed and a number of methods for resolving this problem have been proposed and some were tested in the field. Reported here are emission data summaries from 2007 and 2008 field trials.

OBJECTIVES: This project was to support emission monitoring for three PAW projects (industry sectors including perennial nursery, almond/stone fruits and grapevine orchards) under the Pacific Area-Wide Pest Management Program. The objective was to determine the effects of various surface sealing techniques or treatments as well as fumigation methods that are applicable for different commodities on fumigant emissions. Fumigants studied thus far included mainly 1,3-dichloropropene (1,3-D) and chloropicrin (CP).

STUDY METHODS: Three field fumigation trials were conducted each year in 2007 and 2008 near Parlier at either USDA-ARS San Joaquin Valley Agricultural Sciences Center or University of California Kearney Agricultural Center. The soil was Hanford sandy loam (coarse-loamy, mixed, superactive, nonacid, thermic Typic Xerorthents). The trials were conducted in the months of August through November. The fields were usually cultivated to 75 cm depth and irrigated two weeks before fumigation to achieve adequate soil moisture conditions for fumigation. Each trial included efficacy studies by other scientists and only selected treatments were monitored for emissions as indicated in Table 1. All treatments were tested in three replicates.

Emission sampling in all field trials was carried out using dynamic flux chambers by trapping the fumigants on either charcoal (for 1,3-D only) or XAD (for both 1,3-D and CP) sampling tubes. Some information about these chambers was provided in Gao et al. (2008) The samples were extracted and analyzed for the fumigants following similar procedures reported earlier (e.g., Gao et al., 2009). Both emission flux and cumulative emission loss were computed. In addition, fumigant concentrations in the soil-gas phase, residual fumigant in soil, soil water content and soil temperature were measured either during or at the end of the field trial.

RESULTS**:** Data for cumulative emission loss are given in Table 1. Flux data (not given) usually correspond to cumulative emission loss with the exception that post-fumigation water treatment can affect flux dramatically. The results can be summarized as below:

1) Surface treatments are necessary for effectively minimizing fumigant emissions. Bare soils always gave the highest emission flux and cumulative emission loss for both broadcast shank

injections and subsurface drip applications. HDPE tarp reduced emissions compared to bare soils, which was most likely due to relatively moist surface soil conditions.

2) Buessing shank injecting fumigants to two depths (18” and 24”), i.e., with one deeper depth than the conventional shank (18”), did not result in lower emissions than the conventional shank in these trials. However, it illustrated some potential to improve fumigant distribution in soil profile (data not shown), thus may improve fumigation efficacy.

3) Post-fumigation water treatment (water seals) reduced emission flux more significantly than reducing total cumulative emission loss. Thus, water seals can reduce potential risk exposure concerns and help address buffer zone issues; but may not help much to reduce total VOC emissions depending on how much water and how many times of applications are used.

4) Several field trial data showed that VIF significantly reduced emissions on both flux and cumulative emission loss from both broadcast shank injection and drip application. The total emission loss was only a few percent of total applied. This film can retain more than twice as much fumigant concentrations under the tarp compared to HDPE. Difficulties of the film installation were occasionally observed in the field. Emission measurements over tarp gluing strips indicated little differences from non-gluing areas and had similarly large variations for both VIF and HDPE.

5) 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).

In summary, cumulative emission losses were much lower in VIF tarped treatments compared to HDPE tarp or water seals. Cumulative emission loss was generally lower in subsurface drip-spot (<30%) compared to broadcast subsurface drip (<50%) and shank injection (>50%) without tarp.

<u>REFERENCES</u>

Gao, S.; Wang, D.; Pflaum, T.; Qin, R.; Hanson, B.; Browne, G.; Ajwa, H.; Yates, S. 2008. Dynamic flux chamber systems for fumigant emission measurements. 22(1-4) *In* Proc. Ann. Int. Res. Conf. on MeBr Alternatives and Emission Reductions, 11-14 November, San Diego, CA, USA, Available at: http://www.mbao.org/2008/Proceedings/mbrpro08.html.

Gao, S., R. Qin, B.D. Hanson, N. Tharayil, T.J. Trout, D. Wang, and J. Gerik. 2009. Effects of manure and water applications on 1,3-dichloropropene and chloropicrin emission in a field trial. J. Agric. Food Chem. 57:5428−5434.

Wang, D**.,** G. Browne, S. Gao, B. Hanson, J. Gerik, R. Qin, N. Tharayil. 2009. Spot fumigation: fumigant gas dispersion and emission characteristics. Environ. Sci. Technol. 43:5783-5789.

Table 1. Emission loss measured with dynamic flux chamber system from application methods and surface sealing treatments in 2007 and 2008 field fumigation trials. Reported include the average of three replicates and standard deviation in parenthesis.

Trial	Application methods	Treatment	2007 emission loss (% of applied)	2008 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	6 (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)