TESTING FILM PERMEABILITY TO FUMIGANTS UNDER LABORATORY AND FIELD CONDITIONS

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Plastic films are commonly used to tarp the soil surface to reduce fumigant volatilization losses. Some of the commercial films, however, are relatively permeable to fumigant vapors and a large proportion of the applied fumigant mass escapes to the atmosphere. The use of low permeability films, such as virtually impermeable films (VIF), semi-impermeable film (SIF), and metalized film, rather than standard polyethylene (PE) films can reduce fumigant emissions to the atmosphere and may improve fumigant performance. To develop realistic management practices that minimize fumigant flux to the atmosphere, film permeability must be assessed. The key to measuring the permeability of the films is to test them after field tarping. Film types and properties vary widely among manufacturers and the label does not accurately characterize film performance in the field. For example, VIF has been shown to have extremely low permeability under laboratory conditions (before tarping), but its permeability changes significantly under field conditions (after tarping). This may be due to a breakdown in the VIF properties under field conditions during tarping (i.e., stretching and cracking of the low permeability layer). In a bedded drip-fumigation system, fumigant flux from standard high barrier film was 3 to 5 times greater than flux from VIF, and 2 times greater than flux from SIF. Therefore, the use of generic terms to describe film permeability can be misleading, and there is a need to establish accurate film permeability values that can be used to set standards for film performance and to minimize atmospheric emissions of alternative fumigants.

The objectives of this research are to: 1) collect permeability data for commercial films that are being used by strawberry and cut flower growers before and after tarping to document changes in film properties under different cultural practices and various soil and environmental conditions; 2) coordinate with other researchers to verify and test the two permeability measurement methods to ensure the accuracy of measurements obtained with the newly developed mass transfer coefficient method; 3) implement a stakeholder outreach plan to foster the adoption of permeability standards that will minimize fumigant emissions; and 4) provide researchers and growers with testing and extension services to determine film permeability for the alternative fumigants.

Methods

We estimated film permeability for commercial tarps using the permeability cells for various fumigants before and after tarping by using a micro-gas chromatograph as described by Ha and Ajwa (2006).

More than 20 film samples were collected from commercial fields and strawberry and cut flower research plots. These films were characterized and archived. The permeability of several fumigants (1,3-dichloropropene, chloropicrin, iodomethane, and methyl bromide) were determined before and after tarping.

Results

Tables 1 and 2 show results for some of these samples. The average change in permeability for the standard tarp, SIF, and Blockade was < 10%. The average change in permeability for the VIF and TIF was 79% and 95%, respectively. For most fumigants, however, TIF permeability after tarping was less than the permeability of VIF before tarping.

Table 1. Mass transfer coefficient (cm/hr) of methyl bromide and iodomethane before and after bed tarping.

Film type	Methyl bromide		Iodomethane	
	Before	After	Before	After
Pliant black embossed, 1.25 mil	4.33	4.55	3.79	4.51
PolyPak Std, 1.5 mil	4.50	4.67	0.93	1.11
PolyPak SIF, 2.0 mil	0.82	0.88	0.32	0.43
Micro-embossed (Blockade), 1.25 mil)	2.34	2.71	0.02	0.03
Bromostop VIF (1.38 mil)	0.09	0.44	0.02	0.08
Eval/Mitsui film (1.38 mil)	0.011	0.20	0.001	0.005

Table 2. Mass transfer coefficient (cm/hr) of 1,3-dichloropropene and chloropicrin before and after bed tarping.

Film type	Cis 1,3-D		Trans 1,3-D		Chloropicrin	
	Before	After	Before	After	Before	After
Pliant black embossed, 1.25 mil	14.61	16.38	17.32	18.22	9.04	9.98
PolyPak Std, 1.5 mil	3.23	3.79	5.16	5.65	1.49	1.70
PolyPak SIF, 2.0 mil	1.42	1.53	1.51	1.71	0.67	0.72
Micro-embossed (Blockade), 1.25 mil)	0.86	0.88	1.65	1.74	0.11	0.17
Bromostop VIF (1.38 mil)	0.07	0.27	0.09	0.41	0.02	0.18
Eval/Mitsui film (1.38 mil)	0.001	0.02	0.001	0.07	0.001	0.01

References:

Ha, W., and H.A. Ajwa 2006. Plastic film permeability to soil fumigants. Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. Orlando, FL. Abstract 49, 1-3.