PLASTIC FILM PERMEABILITY TO SOIL FUMIGANTS

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Plastic tarp (film) is usually used to reduce fumigant volatilization from soil. Several types of polyethylene (PE) films, virtually impermeable films (VIF), and semi-impermeable films (SIF) are being evaluated for their ability to reduce fumigant emissions. Quantifying fumigant mass transfer through films is important for the development of practical management practices to reduce fumigant volatilization losses from agricultural fields. The objective of this study was to evaluate fumigant flux through commercial tarps used for soil fumigation.

Methods

The mass transfer rates of 1,3-dichloropropene (1,3-D), chloropicrin (CP), iodomethane (IM), and methyl bromide (MB) through standard polyethylene tarp, virtually impermeable film (VIF), and other commercial films were determined under laboratory conditions using stainless steel permeability cells as described by Papiernik et al.(2001) and Ha and Ajwa (2006).

Results

The permeability of nine commercial films to 1,3-D, CP, IM, and MB vapors was measured using static sealed chambers at 22 ± 2^{o}C. Normalized concentration data to the initial concentration were utilized. Relative diffusion of fumigants across the film was used to calculate the mass transfer coefficient (MTC, cm h^{-1}) for various films. Table 1 summarizes the MTCs of MB, IM, cis and trans 1,3-D, and CP for selected commercial agricultural films. The MTC of MB was less than 0.2 cm h^{-1} for VIF, but large values were obtained for all other films. The MTC of IM was generally small for all films, except for the embossed high permeability film. Our MTC results for 1,3-D, CP, and IM indicate that films can be separated into four distinct groups: 1) high permeability film, 2) low permeability film, 3) impermeable film, and 4) virtually impermeable film. More data is being collected to set accurate ranges for the various films.

Reference:
Ha, W. and H.A. Ajwa. 2006. Plastic film permeability to soil fumigants *In:* Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. (Proceedings 49).

Papiernik, S. K., Yates, S. R., and Gan, J., 2001, An approach for estimating the permeability of agricultural films, Environmental Science and Technology, 35, 1240–1246.

Table 1. Mass transfer coefficients (cm h^{-1}) of methyl bromide (MB), iodomethane (IM), cis and trans 1,3-D, and chloropicrin (CP) for selected plastic films.

Film type	MB	IM	Cis 1,3-D	Trans 1,3-D	CP
High permeability tarp					
Pliant black embossed (1.25 mil)	4.57	4.11	18.12	18.94	10.95
Pliant white/black embossed (1.25 mil)	4.48	3.09	17.21	17.51	10.76
Low permeability tarp					
PolyPak black (1.5 mil)	4.95	0.46	3.80	5.28	1.60
Standard broadcast tarp (1.0 mil)	3.93	0.68	4.91	7.08	1.76
PolyPak clear SIF (2.0 mil)	0.82	0.42	3.31	4.42	1.50
Pliant metalized/stripe (1.3 mil)	3.52	0.55	3.84	5.68	1.67
Canslit “Shiny ” (1.3 mil)	2.61	0.50	4.82	6.02	2.24
Impermeable Film (micro-embossed)					
Pliant (1.25 mil)	3.60	0.02	1.17	2.28	0.22
C&B, micro-embossed (1.25 mil)	4.42	0.02	0.86	1.65	0.11
T&F, micro-embossed (1.25 mil)	3.05	0.04	1.18	1.51	0.21
Virtually Impermeable Film					
Bromostop black (1.38 mil)	0.01	0.02	0.16	0.32	0.05
Bromostop white/black (1.38 mil)	0.01	0.01	0.53	0.50	0.11
IPM clear (1.38 mil)	0.13	0.01	0.17	0.36	0.00
Mitsui Plastics (1.5 mil)	0.20	0.00	0.00	0.00	0.00