

Plastic Film Permeability to Fumigants

**Husein A. Ajwa and Wonsook Ha
University of California-Davis,
Salinas, CA**

Introduction

- Plastic tarp (film) is usually used to reduce fumigant volatilization losses from soil.
- Quantifying fumigant mass transfer through plastic films is important for the development of practical management practices to reduce volatilization losses and enhance weed and pathogen control.

VIF

Virtually impermeable film



VIF film is about 200 to 300 times less permeable to methyl bromide than HDPE

TIF

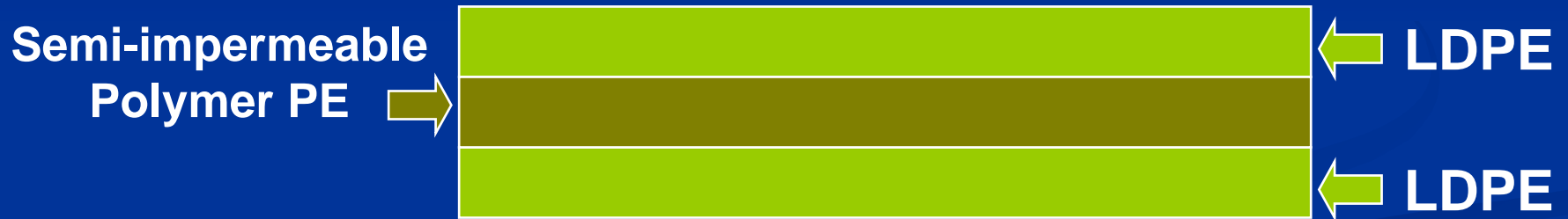
Totally impermeable film



New film by Eval/Mitsui that was tested recently
The film is 1.38 mil multilayer with an EVAL™ resin

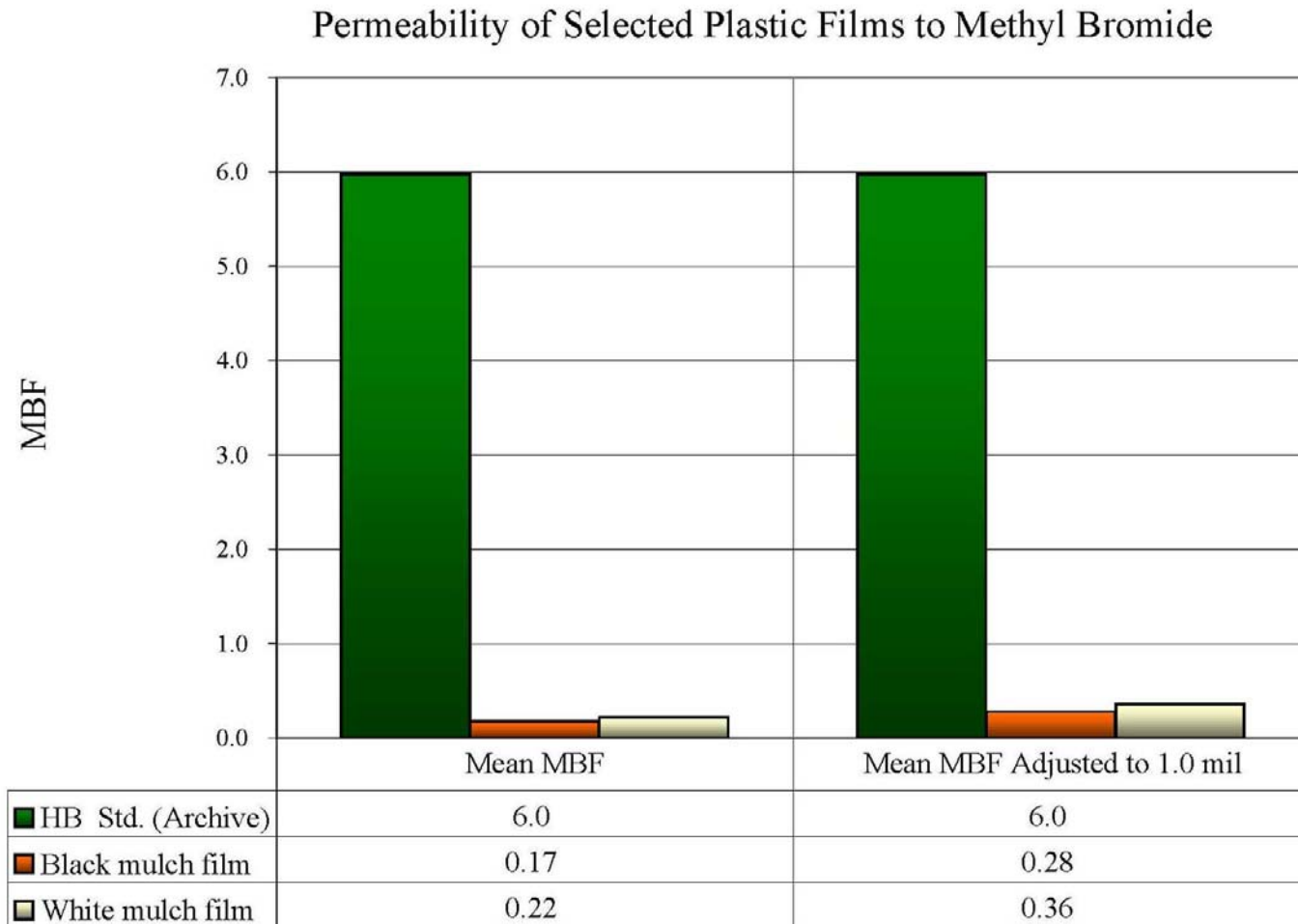
SIF

Semi-impermeable film



Tri-extruded, low density
polyethylene film

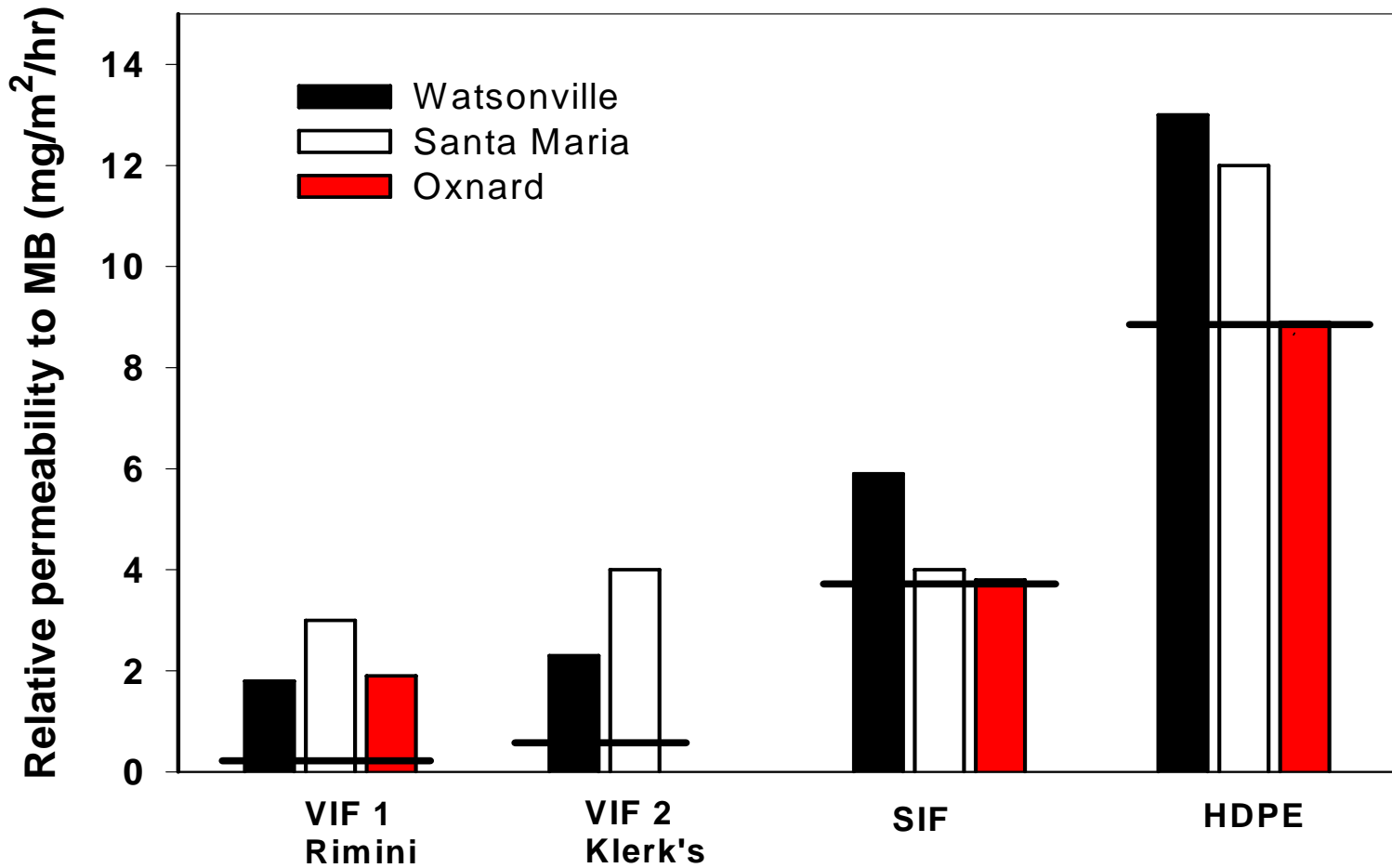
Relative Plastic Permeability



Tarping can change
film permeability



Film permeability after tarping



Objective

- The objective of this study was to determine film (tarpaulin) permeability to fumigants (as mass transfer coefficient, MTC) for commercial films used in strawberry and cutflower production systems.

Measuring Film Permeability

- Four soil fumigants were tested: methyl bromide (MB), iodomethane (IM), 1,3-Dichloropropene (1,3-D), and chloropicrin (CP).
- The permeability of commercial films to fumigant vapors was measured using static sealed chambers at $20 \pm 2^\circ\text{C}$.

Plastic Permeability Measurement

- Plastic film is mounted between two chambers.
- Fumigant is applied to the lower chamber.

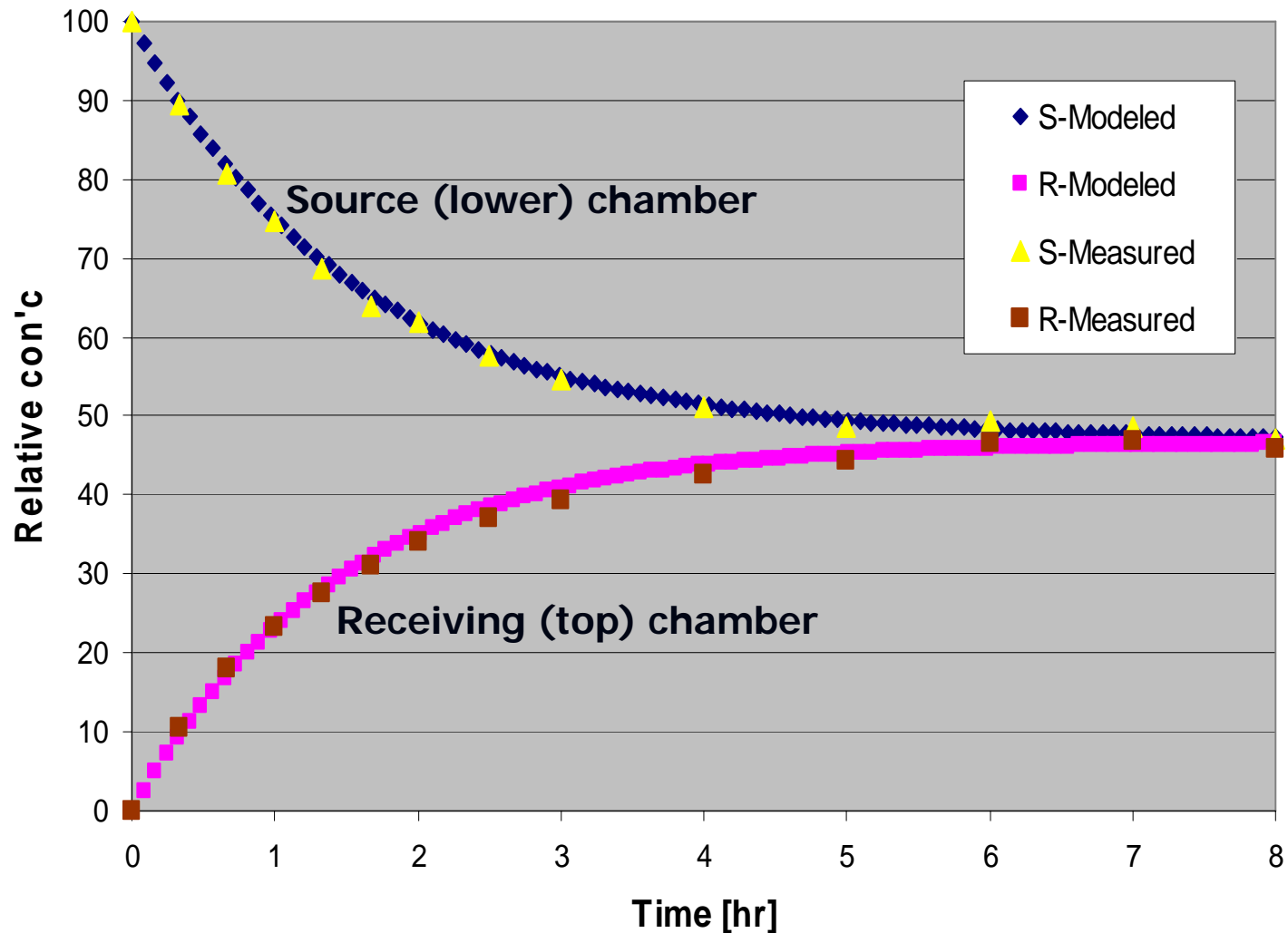


Plastic Permeability Measurement

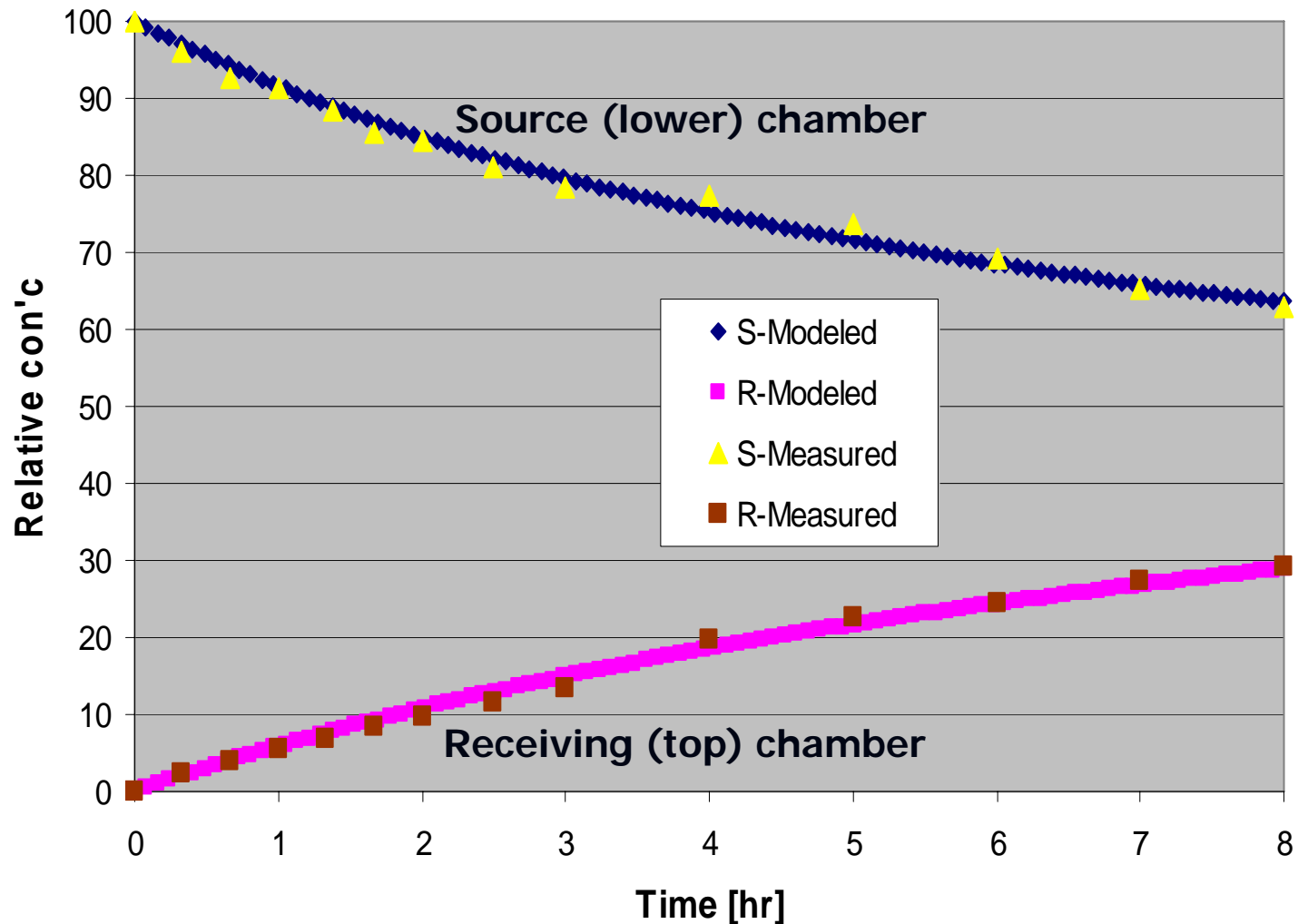
- Fumigant is measured by GC in both chambers.
- The Mass Transfer Coefficient (MTC) was calculated.



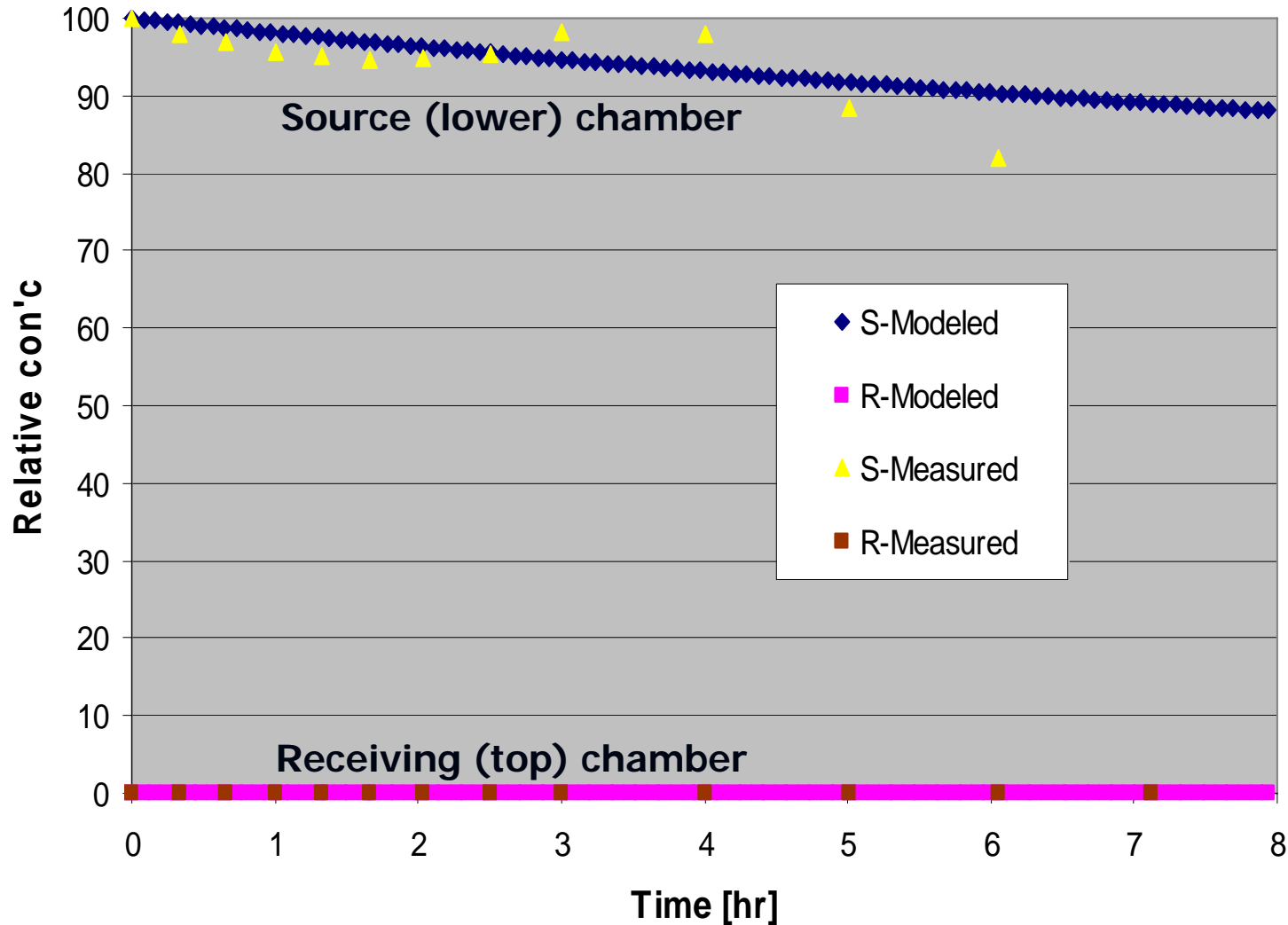
Diffusion of MB through standard LDPE



Diffusion of MB through metalized film



Diffusion of MB through Bromostop VIF



Mass Transfer Coefficients (cm/h) (High permeability film)

Film type	MB	IM	Cis 1,3-D	Trans 1,3-D	CP
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	10.75

Mass Transfer Coefficients (cm/h) (Low permeability film)

Film type	MB	IM	Cis 1,3-D	Trans 1,3-D	CP
PolyPak Std (1.5 mil)	4.95	0.46	3.80	5.28	1.60
PolyPak SIF (2.0 mil)	0.82	0.42	1.42	1.50	0.67
Metalized /stripe (1.3 mil)	3.53	0.55	3.84	5.68	1.67
Metalized /shiny (1.3 mil)	2.61	0.50	4.82	6.02	2.24

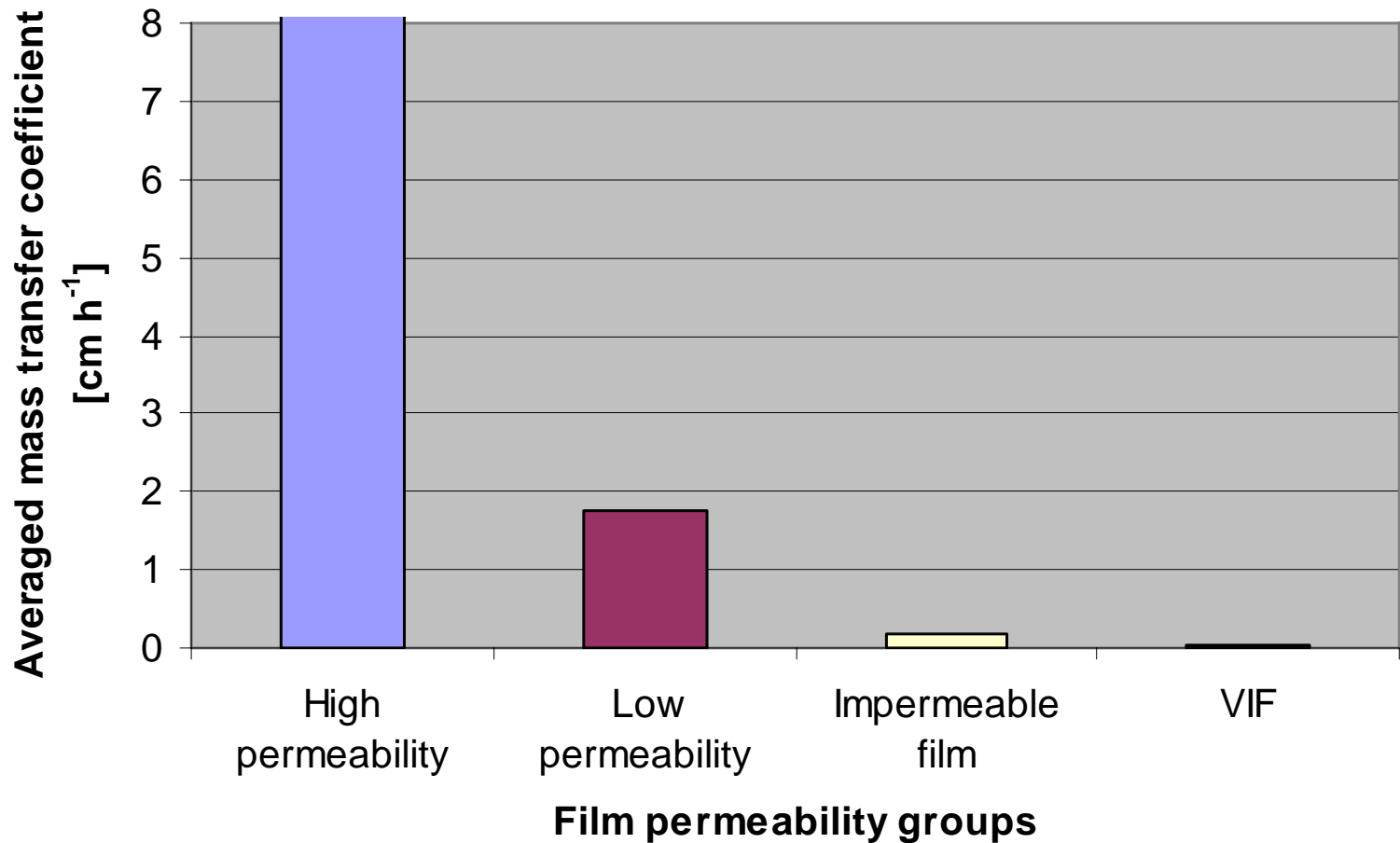
Mass Transfer Coefficients (cm/h) (Impermeable film)

Film type	MB	IM	Cis 1,3-D	Trans 1,3-D	CP
Pliant (B-A) (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

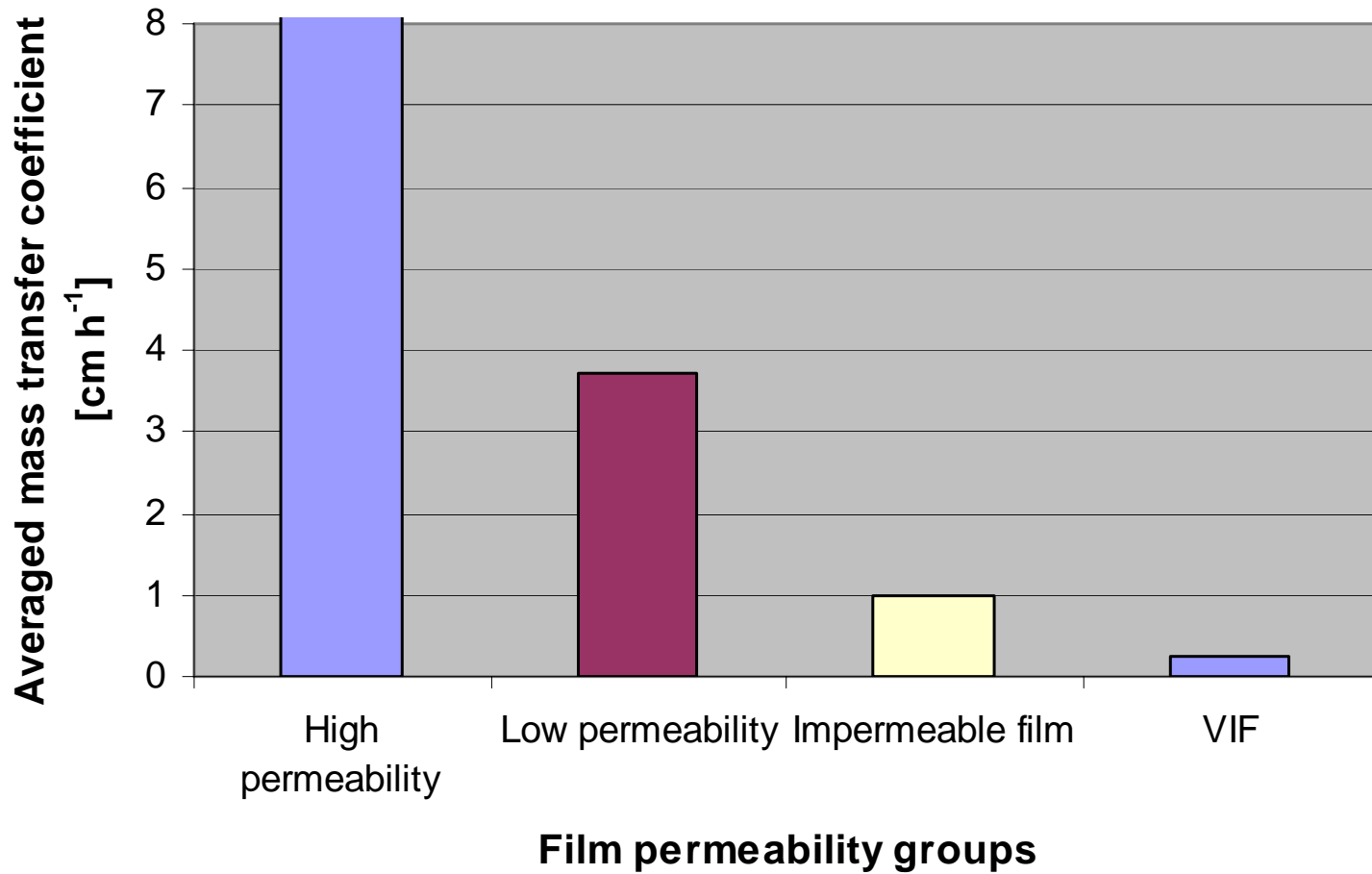
Mass Transfer Coefficients (cm/h) (Virtually impermeable film)

Film type	MB	IM	Cis 1,3-D	Trans 1,3-D	CP
IPM clear VIF (1.38 mil)	0.13	0.01	0.17	0.36	0.001
Bromostop VIF (1.38 mil)	0.18	0.02	0.16	0.32	0.05
Eval/Mitsui film (1.38 mil) TIF	0.20	$< 10^{-13}$	$< 10^{-13}$	$< 10^{-13}$	$< 10^{-13}$

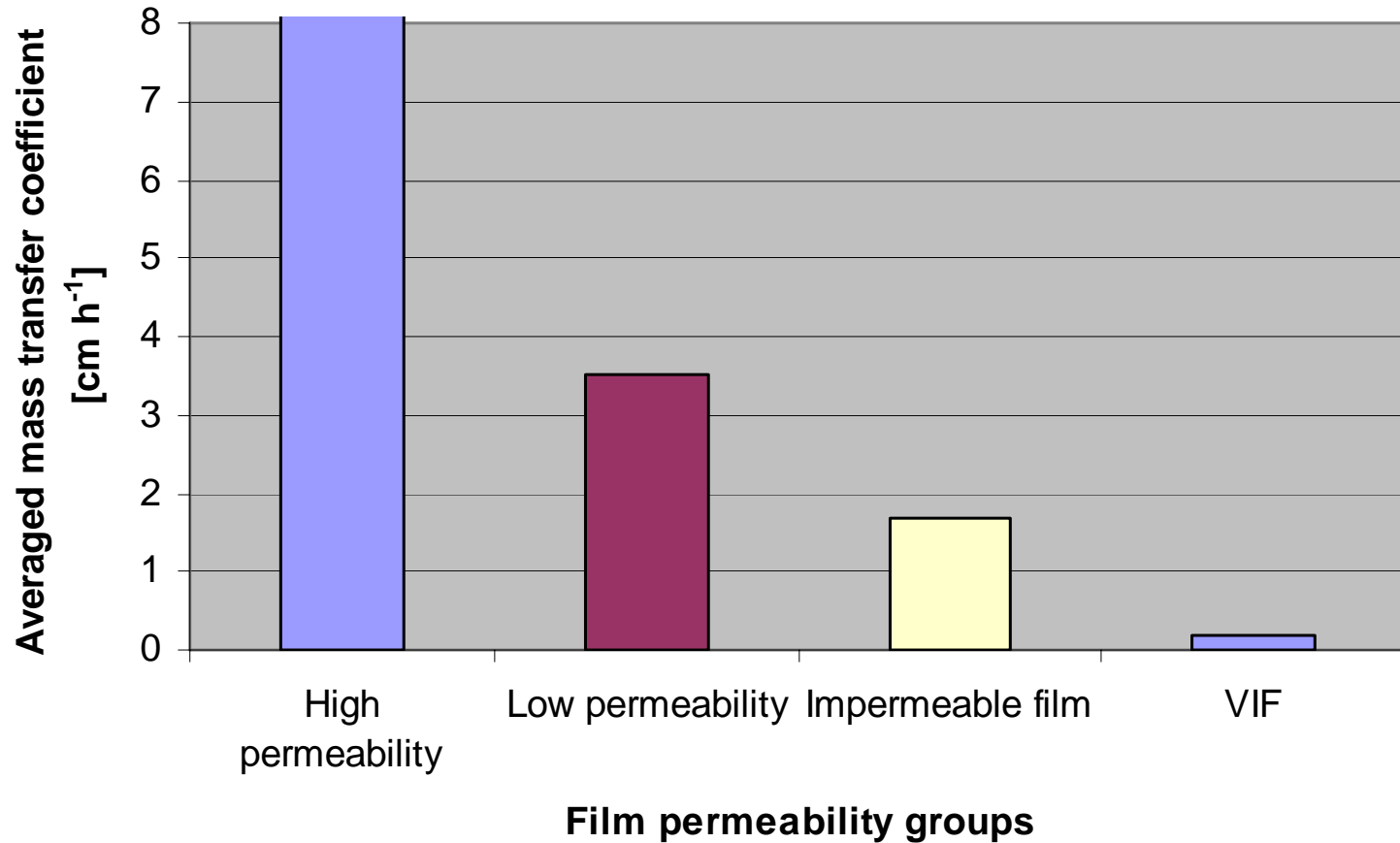
Average Mass Transfer Coefficient for CP



Average Mass Transfer Coefficient for 1,3-D, and CP



Average Mass Transfer Coefficient for MB, 1,3-D, and CP



SUMMARY

- The average mass transfer coefficient (MTC) of IM was generally small for all films, except for the embossed high permeability film.
- The average MTCs of all other fumigants were:
 - $> 4 \text{ cm h}^{-1}$ for high permeability film
 - $< 4.0 \text{ cm h}^{-1}$ for low permeability film
 - $< 2.0 \text{ cm h}^{-1}$ for impermeable film, and
 - $< 0.2 \text{ cm h}^{-1}$ for VIF.

Thank you very much

Acknowledgements

- California Strawberry Commission
- USDA-ARS, PAW program
- USDA-CSREES
- PolyPak
- TriCal
- Mark Lauman
- Bruno Rimini
- Eval/Mitsui