Fumigant Emissions Reduction

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Introduction

- **Quantifying fumigant mass transfer through films is important for the development of practical management practices to reduce volatilization losses and enhance weed and pathogen control.**

SIF
Semi-impermeable film

Tri-extruded, low density polyethylene film

VIF
Virtually impermeable film

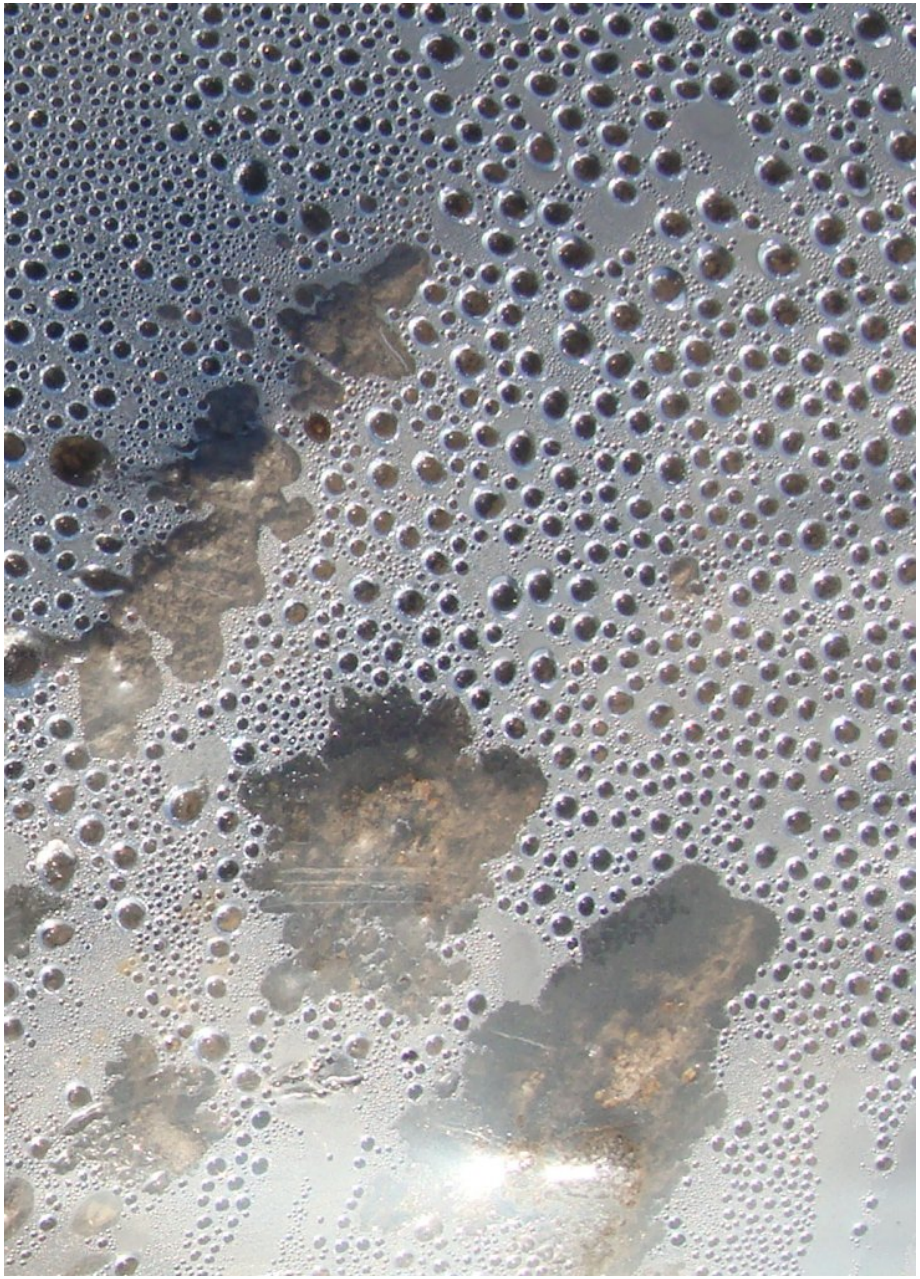
TIF
Totally impermeable film

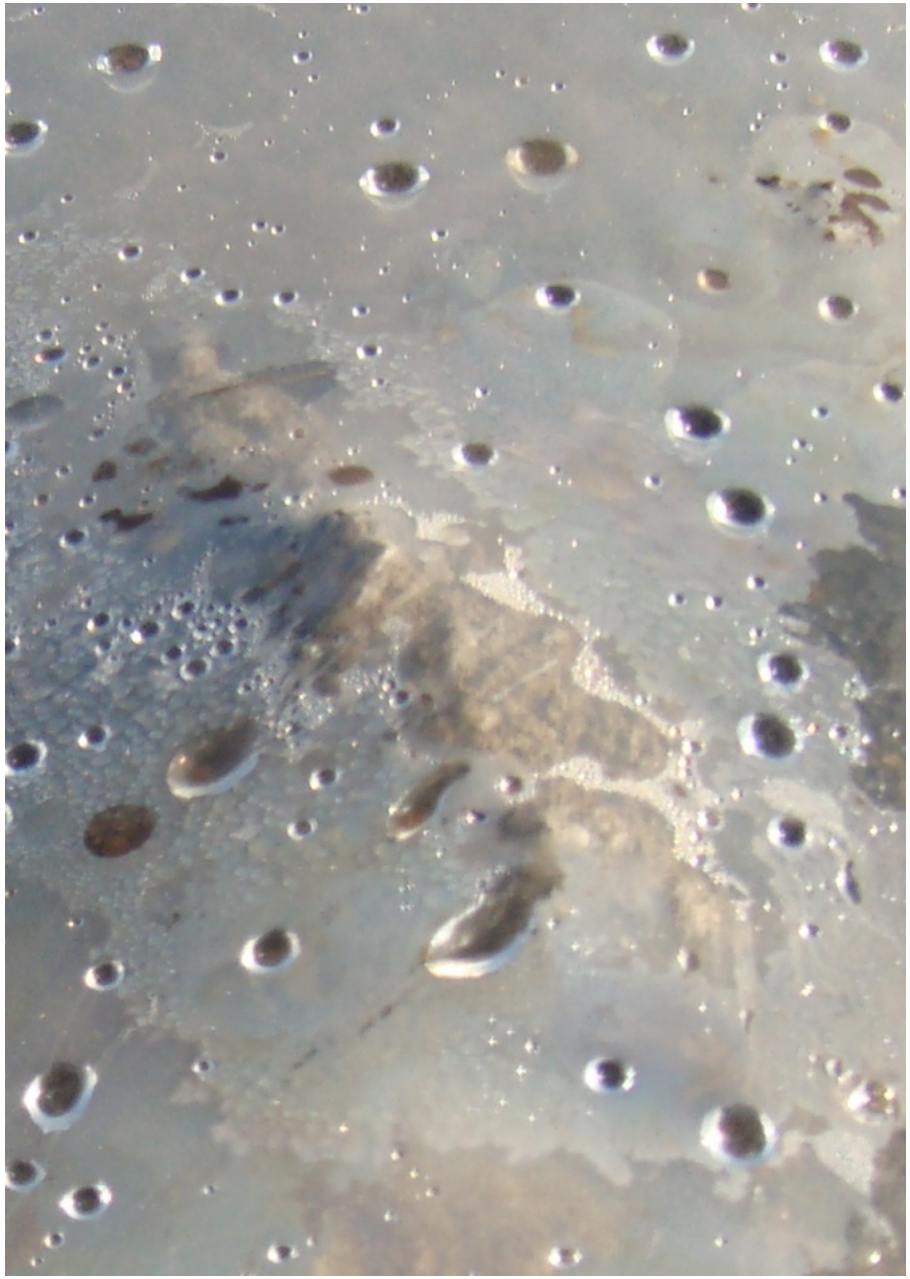
New film by Eval/Mitsui that was tested recently

The film is 1.38 mil multilayer with an EVAL™ resin


EVAL/MITSUI TIF

EVAL/MITSUI TIF





Objective

- **Collect permeability data *(mass transfer coefficients, MTC)* 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.**

Measuring Film Permeability

- **Four soil fumigants were tested:**

  methyl bromide (MB), iodomethane (IM), 1,3-Dichloropropene (1,3-D), and chloropicrin (CP).

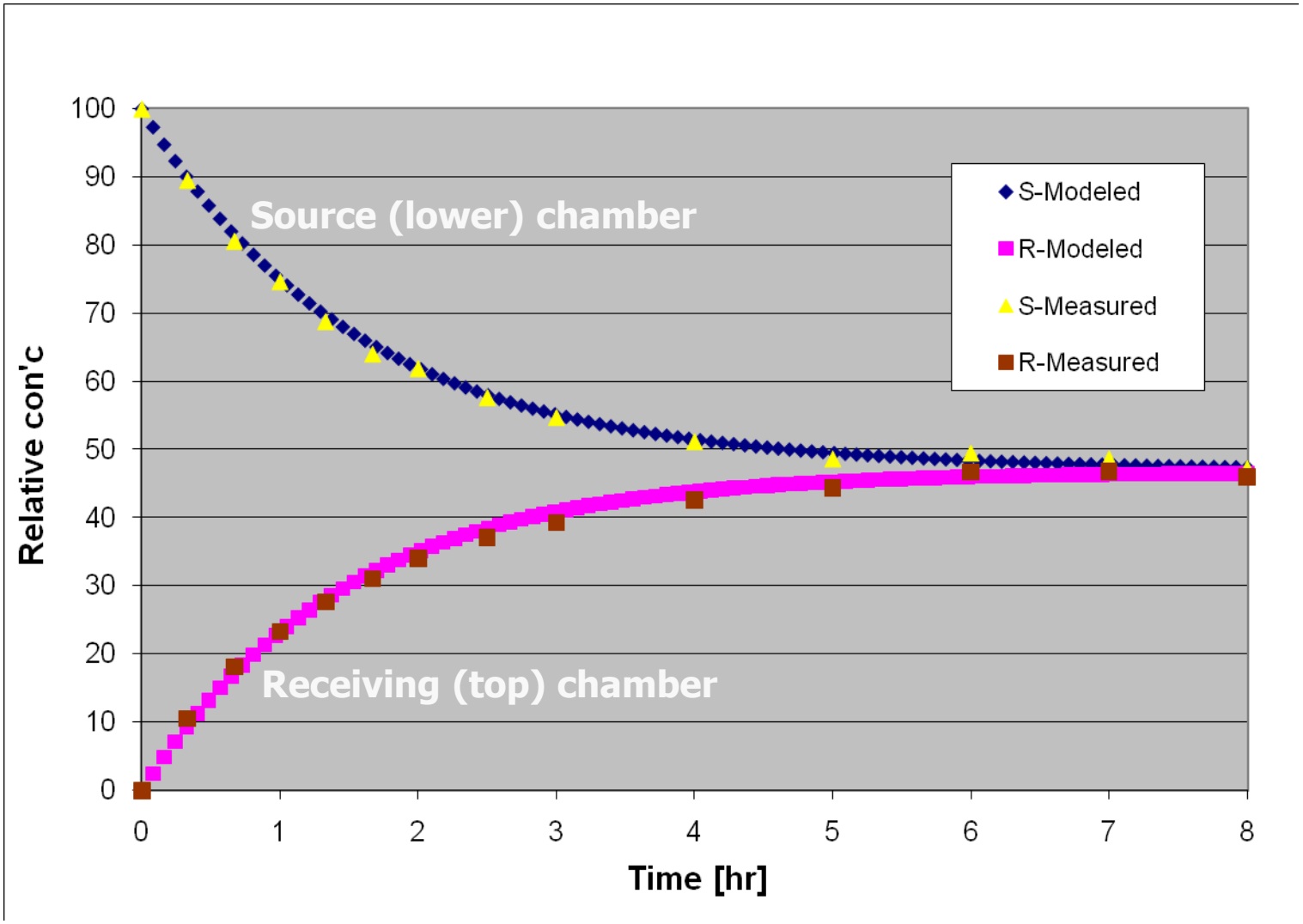
- **The permeability of commercial films to fumigant vapors was measured using static sealed chambers at 20 ± 2^{o}C.**

Plastic Permeability Measurement

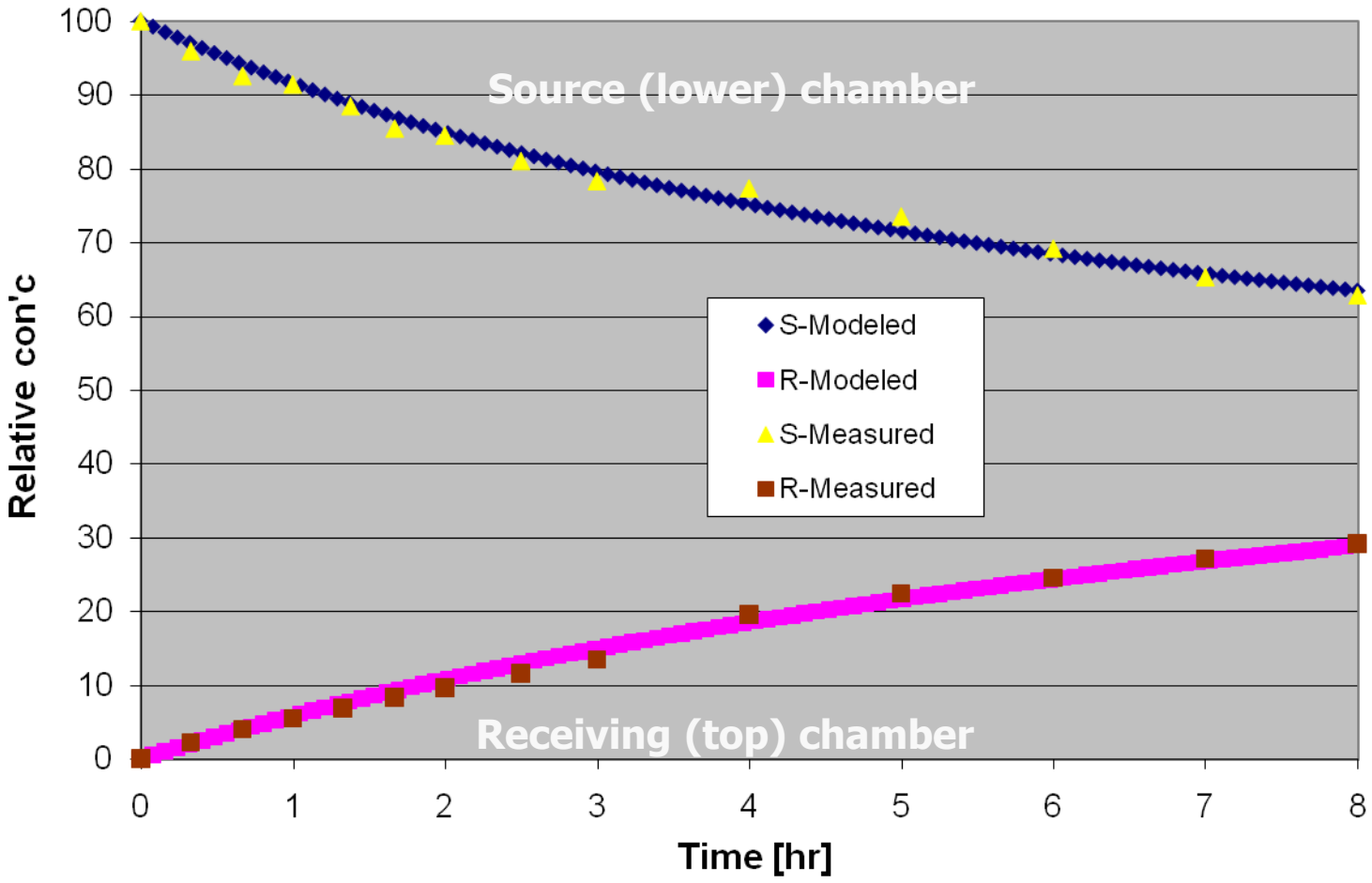
- **Plastic film is mounted between two chambers.**
- **Fumigant is applied to the lower chamber.**

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

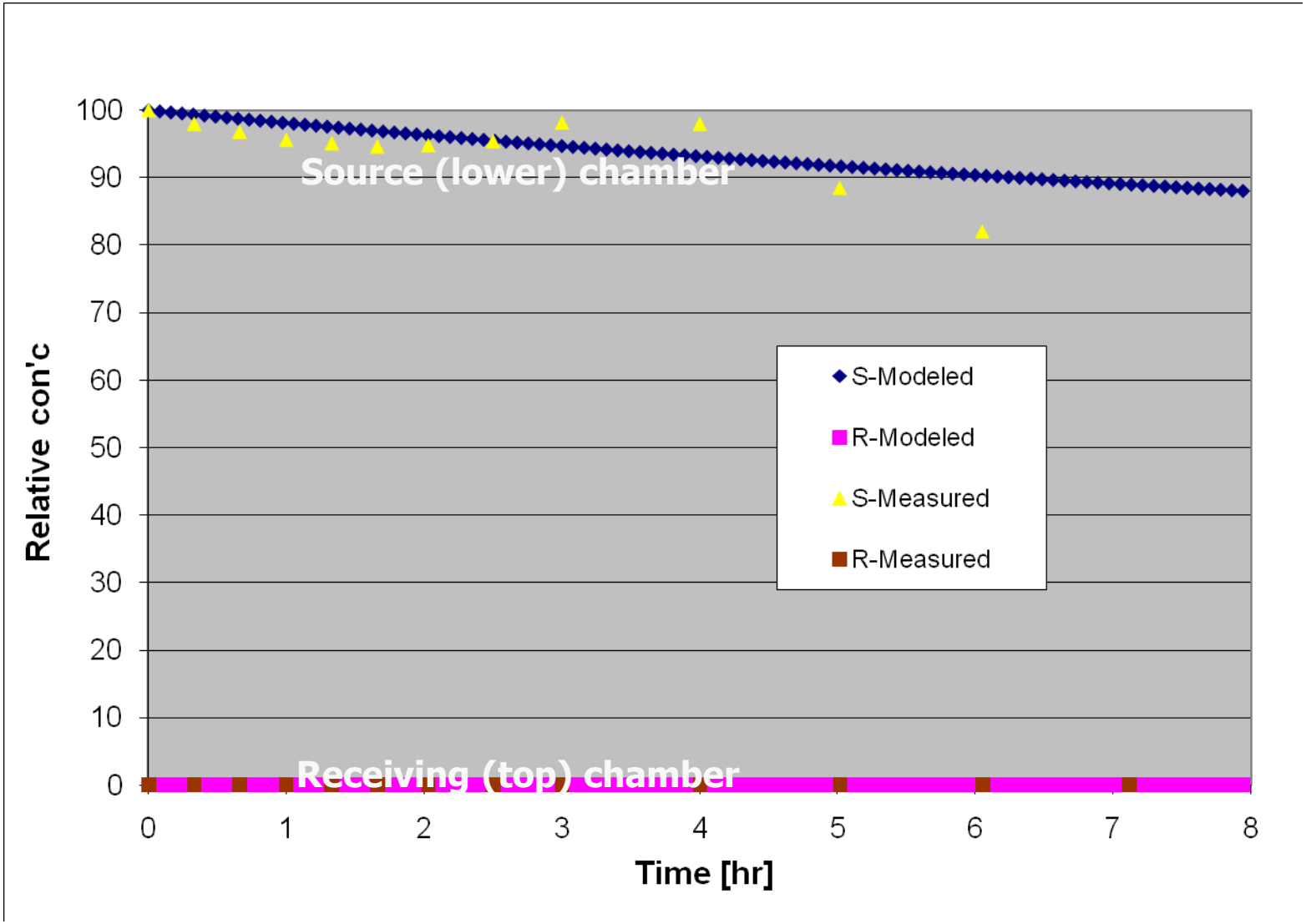
Diffusion of MB through standard LDPE



Diffusion of MB through metalized film



Diffusion of MB through Bromostop VIF



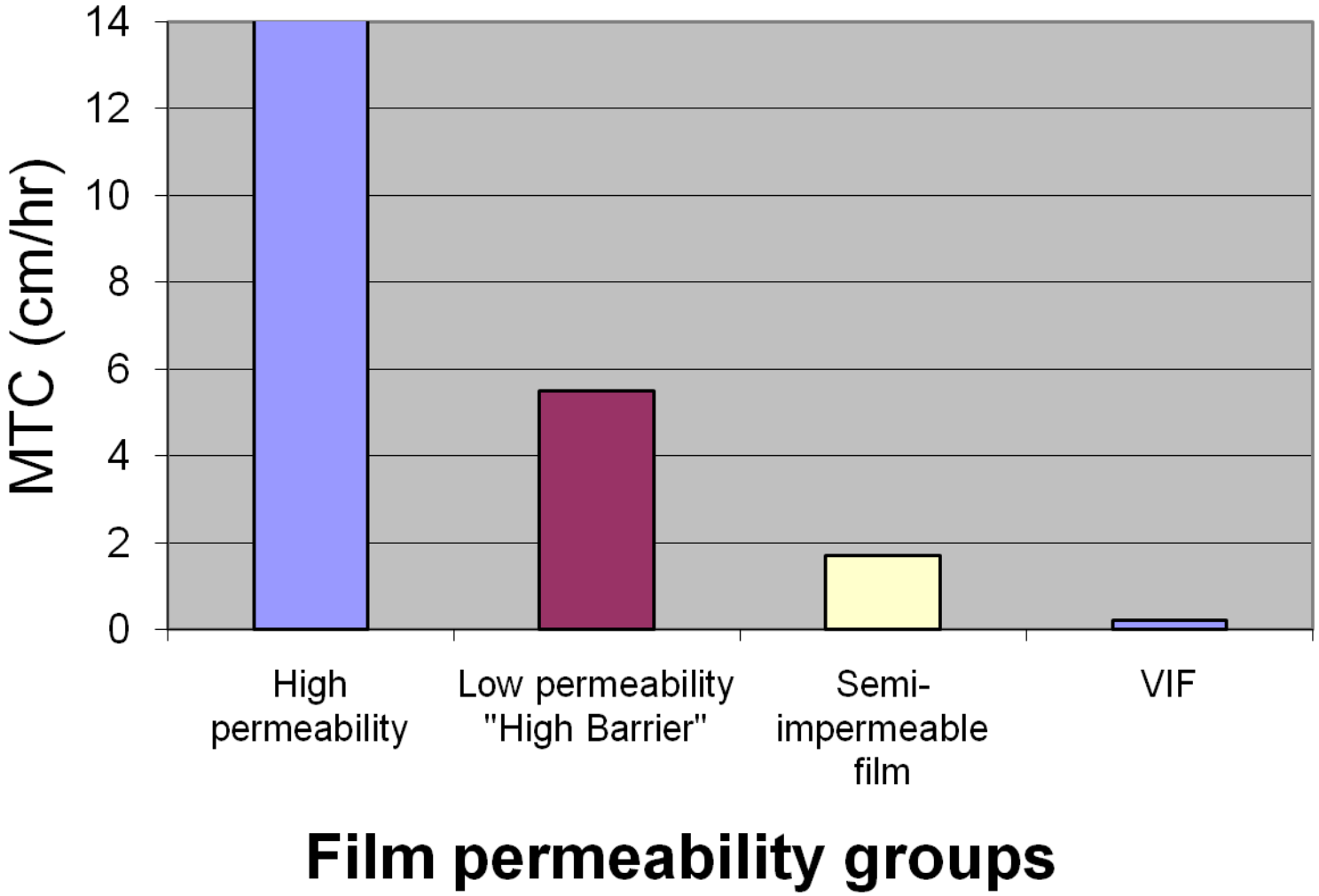
Mass Transfer Coefficients (cm/h)
(Before and After Tarping)

Film type	Methyl bromide		Iodomethane	
	Before	After	Before	After
Pliant embossed, 1.25 mil	4.33	4.55	3.79	4.51
PolyPak Std, 1.5 mil	4.50	5.67	0.93	1.11
PolyPak SIF, 2.0 mil	0.82	0.88	0.32	0.43
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 TIF, 1.38 mil	0.01	0.20	0.001	0.005

Mass Transfer Coefficients (cm/h) (Before and After Tarping)

Film type	Cis 1,3-D		Cis 1,3-D		Chloropicrin	
	Before	After	Before	After	Before	After
Pliant 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	5.15	5.65	1.49	1.70
PolyPak SIF, 2.0 mil	1.42	1.53	1.51	1.71	0.67	1.71
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	0.42	0.02	0.18
Eval/Mitsui TIF, 1.38 mil	0.00	0.02	0.001	0.07	0.001	0.01

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



SUMMARY

GAPs credit: 20% credit for every 10X reduction in MTC

- **low barrier film: 2 - 6 cm h^{-1}**
- **20% for SIF: 2 - 0.2 cm h^{-1}**
- **40% for VIF: < 0.2 cm h^{-1}**
- **60% for TIF: <0.02 cm h^{-1}**

CHLOROPICRIN AND METHYL BROMIDE EMISSIONS REDUCTION BY USING TOTALLY IMPERMEABLE FILM AND POTASSIUM THIOSULFATE

Aims

Obtain new peak and total emissions to:

- **Refine USEPA Risk Assessments and buffer zones**
- **Validate USEPA buffer zone reduction credits for TIF and KTS**
- **Refine CAL-EPA Risk Characterizations for MeBr and Chloropicrin**
- **Allow CDPR to revisit and lift "VIF" ban for MeBr**
- **Revise approved application methods in the VOC NAAs**
- **Support VOC emission reduction credits for TIF &KTS**

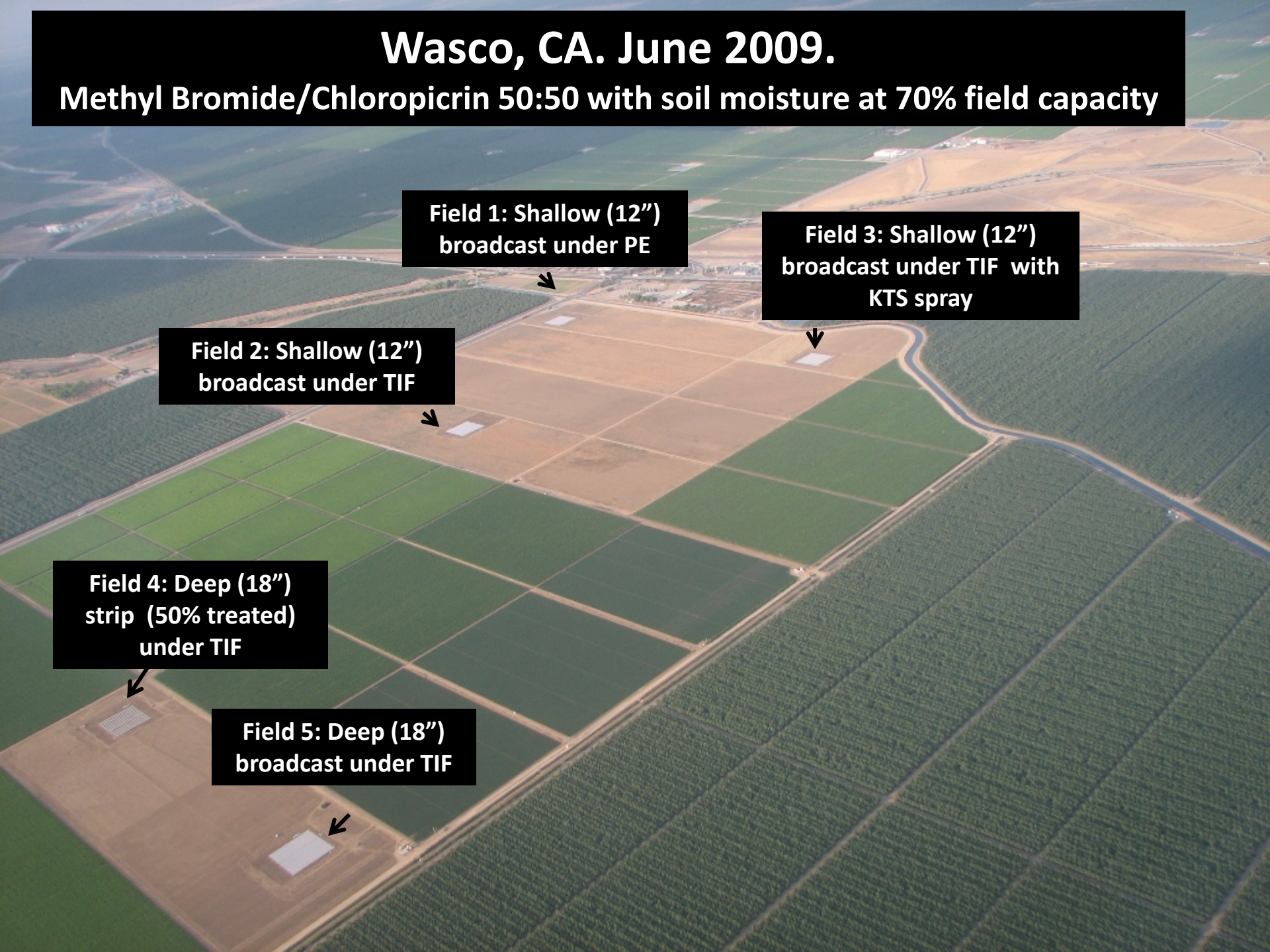
OBJECTIVES

- To evaluate chloropicrin and methyl bromide emissions from five shank application methods

- To provide scientific data to demonstrate emission reductions from the TIF (totally impermeable film), KTS (potassium thiosulfate), and fumigant GAPs (good agricultural practices)

Wasco, CA. June 2009.

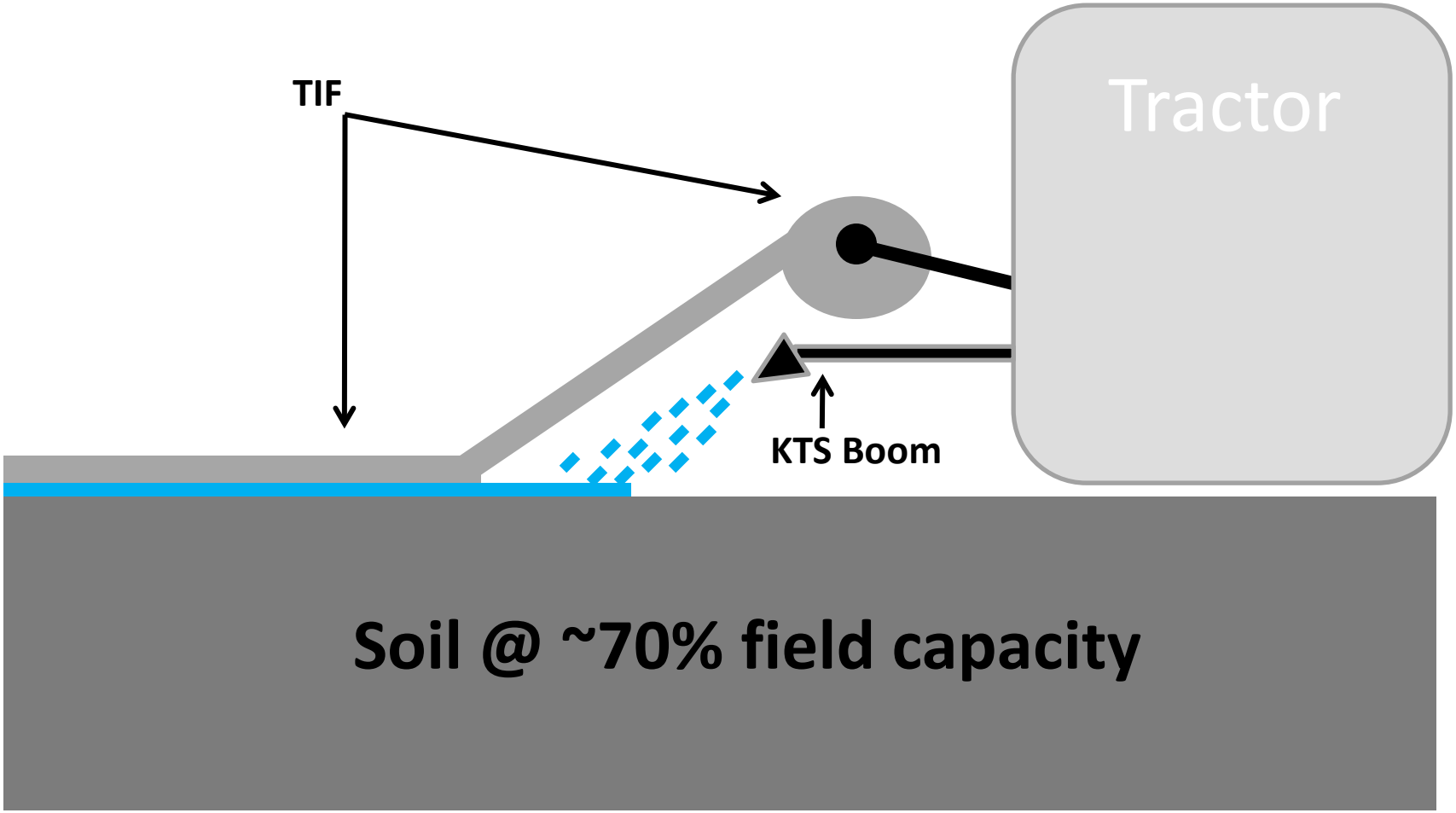
Methyl Bromide/Chloropicrin 50:50 with soil moisture at 70% field capacity

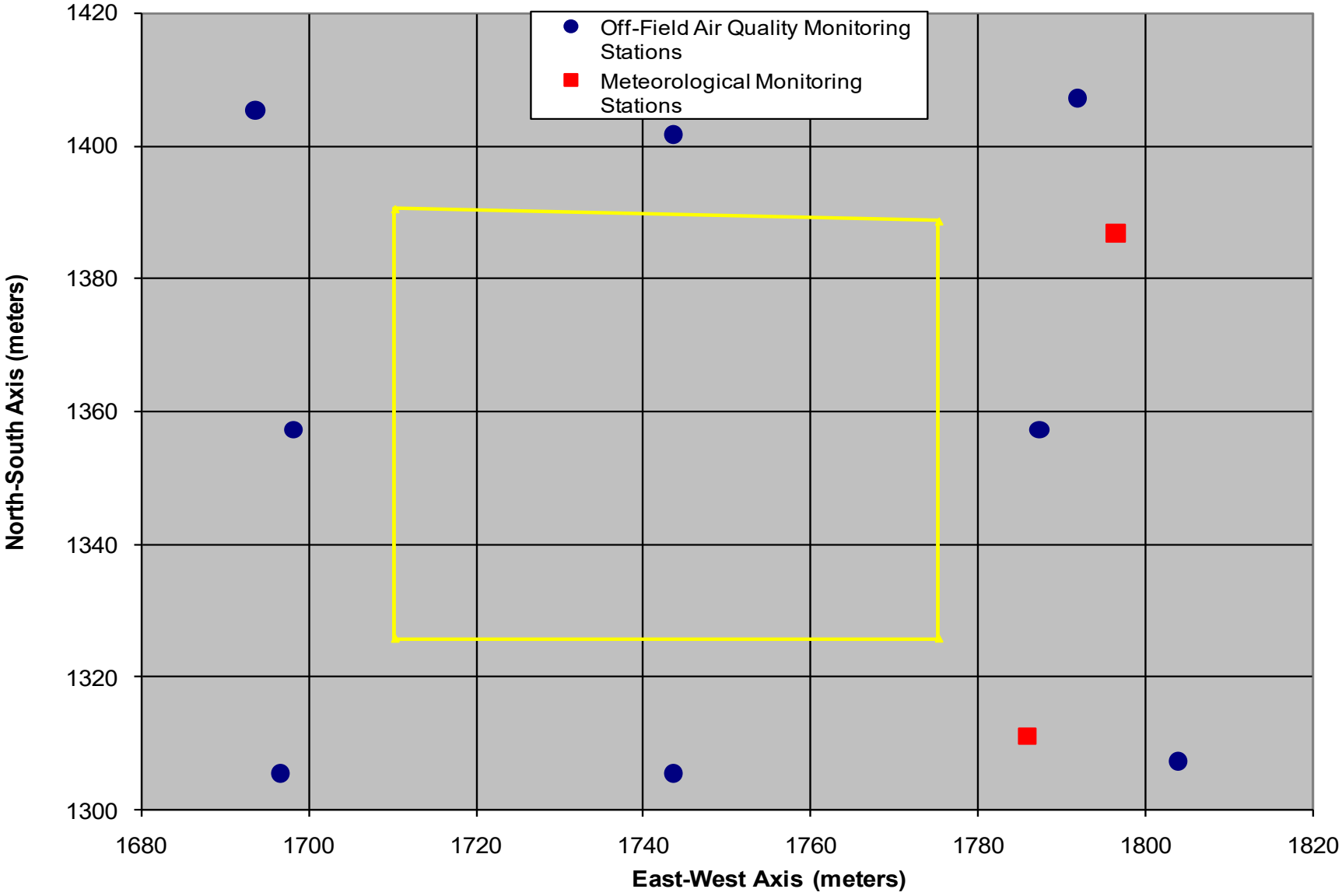


Application Methods and Rates for MB/PIC 50/50

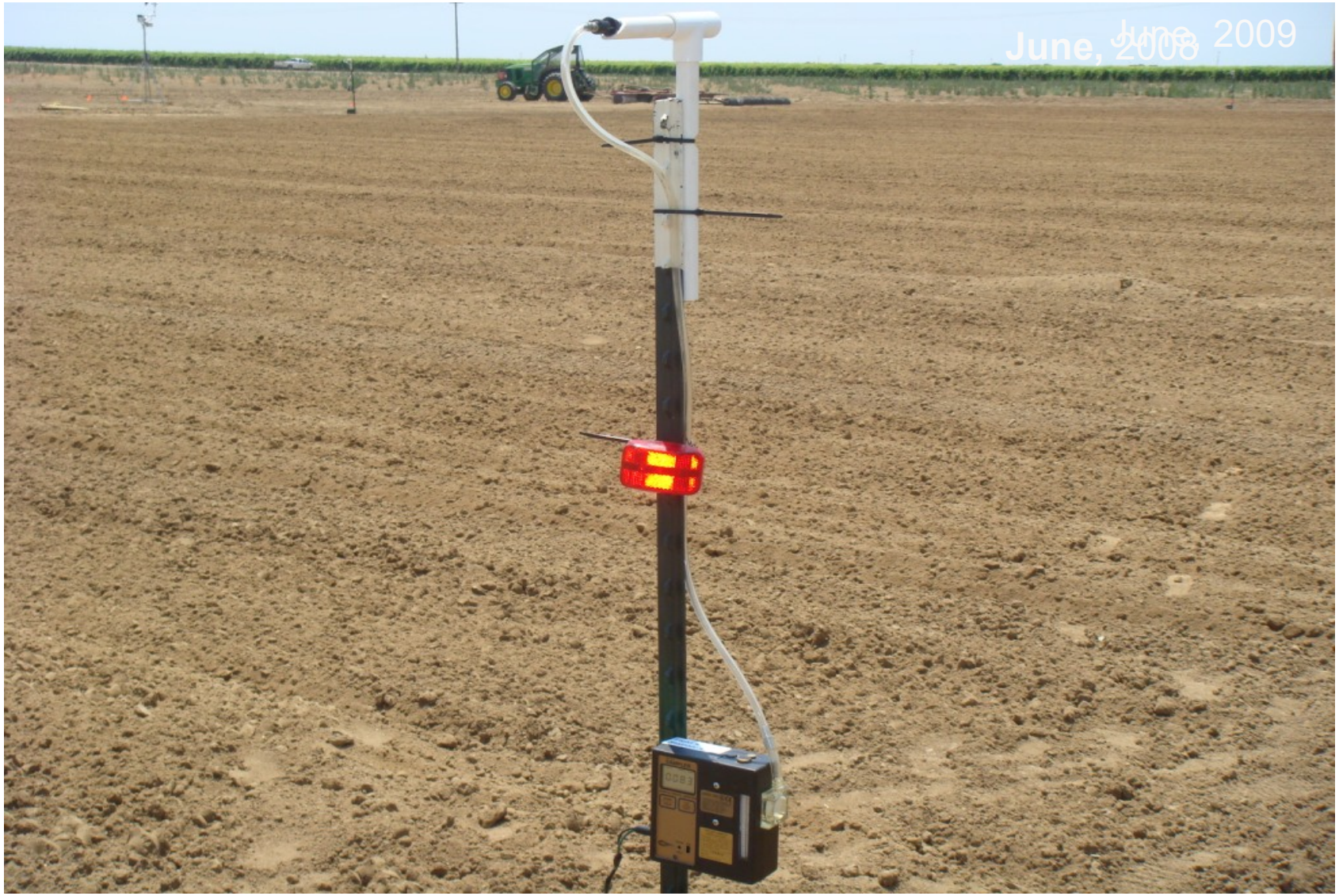
Field #	Application Method	Actual Application Rate (lbs/ac)
1	Broadcast, PE Tarped (~12” deep)	360
2	Broadcast, TIF Tarped (~12” deep)	360
3	Broadcast, TIF plus KTS Tarped (~12” deep)	360
4	Strip, TIF Tarped Deep (~18” deep)	180
5	Broadcast, TIF Tarped Deep (~18” deep)	360

Application of Potassium Thiosulfate (KTS) to Soil Surface immediately before Tarping



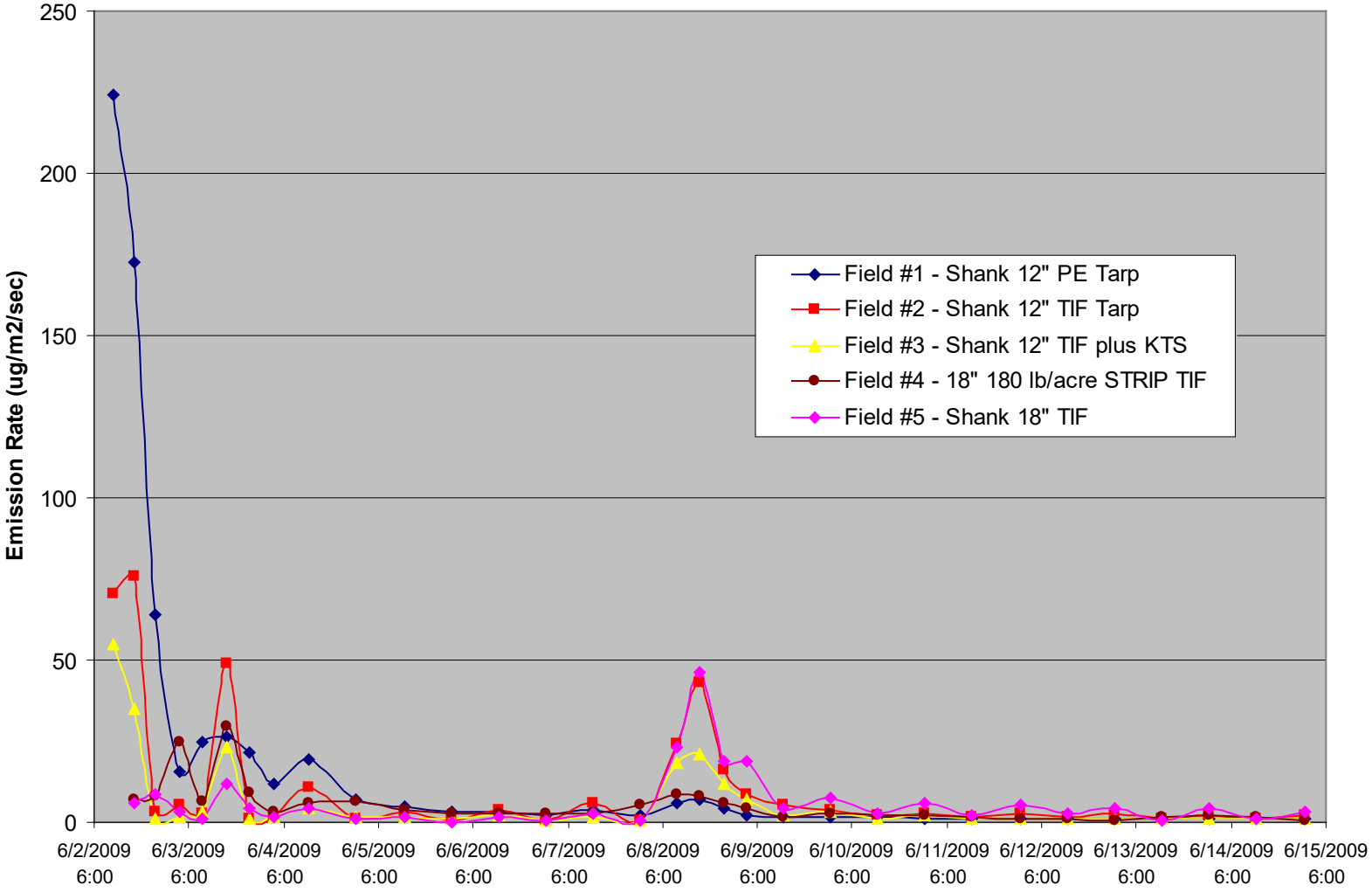


Field layout showing locations of the monitoring stations

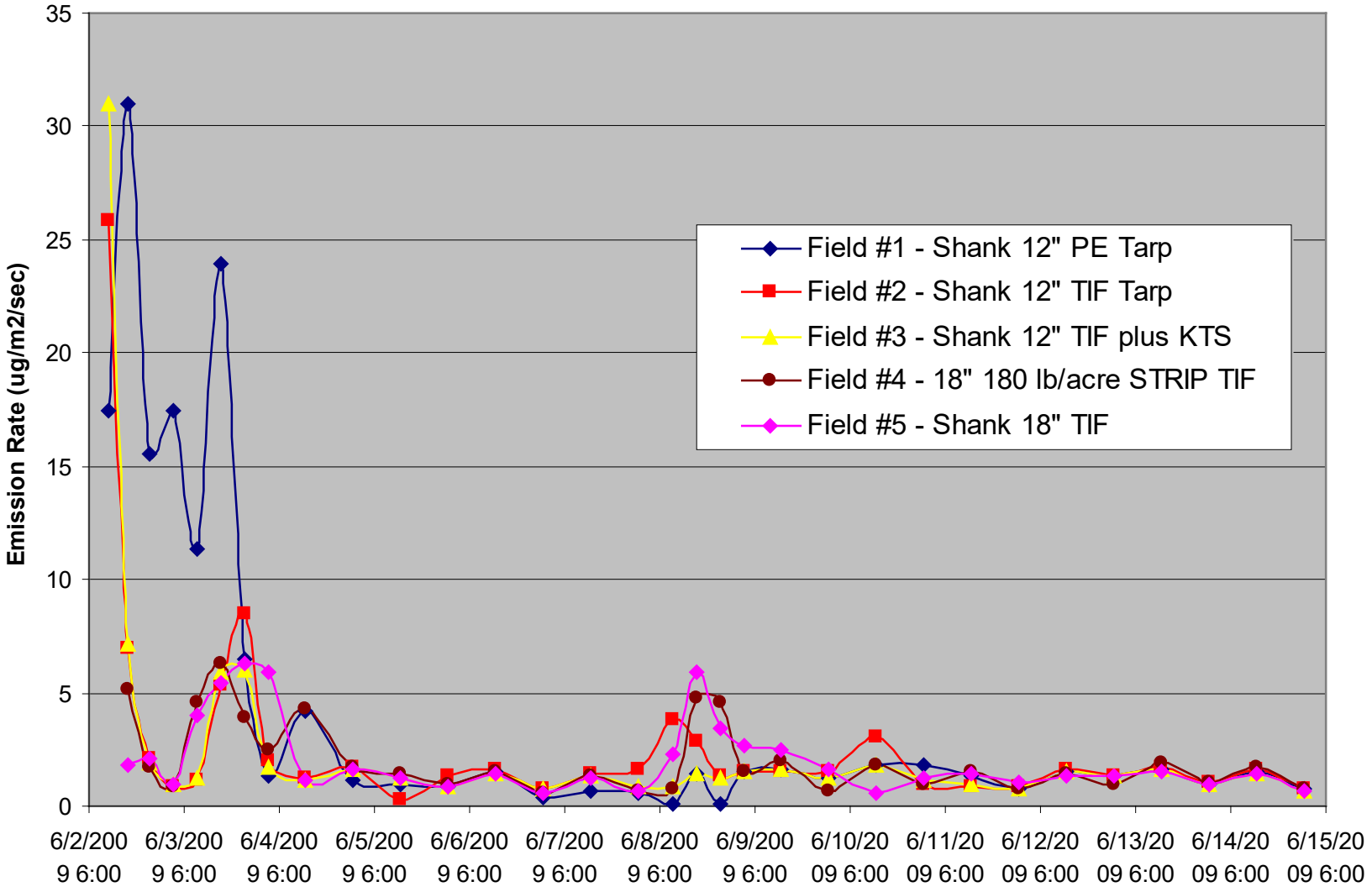


Off-site air sampler

Methyl Bromide Emission Rates at the Methyl Bromide/Chloropicrin Summer 2009 Field Trial in Wasco, California



Chloropicrin Emission Rates at the Methyl Bromide/Chloropicrin Summer 2009 Field Trial in Wasco, California

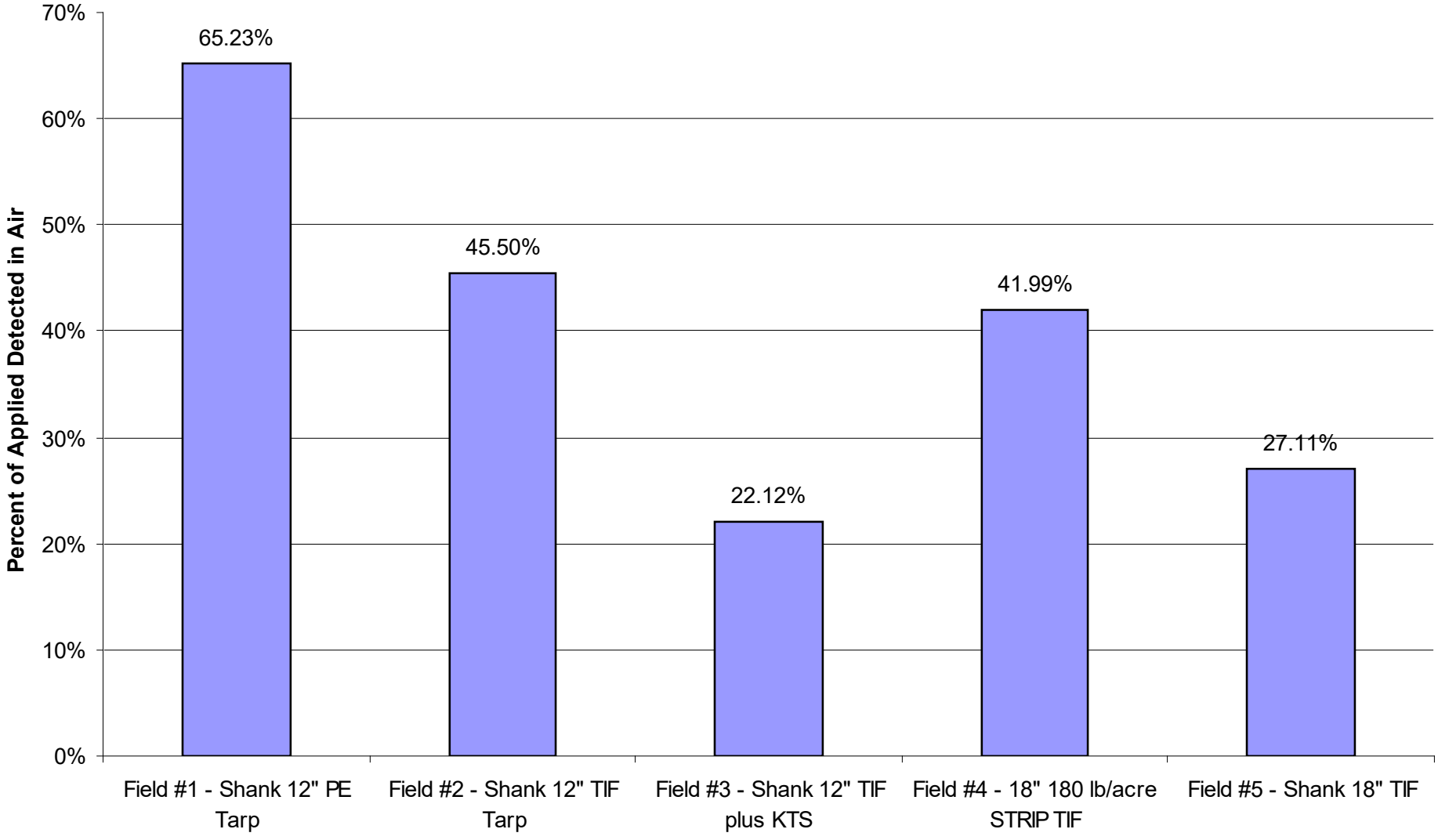


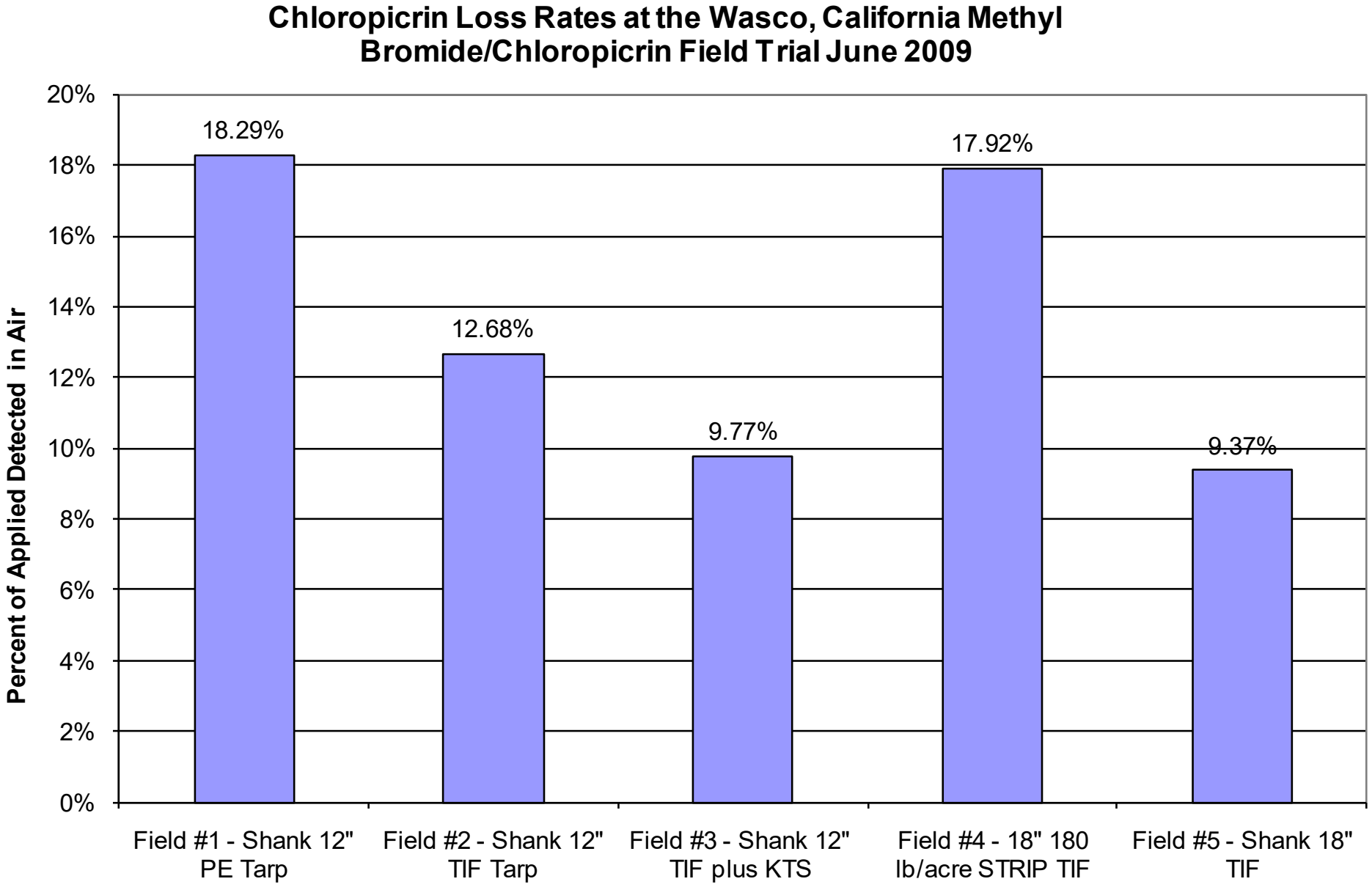
24-hr Average Peak Methyl Bromide Concentration (ug/m2/sec) and Percent Emissions Reduction Relative to PE Shallow Broadcast (Field 1)

Treatment	24-hr ave MB conc.	% Reduction
Field 1: PE	119.2	0
Field 2: TIF	38.8	67.4
Field 3: TIF + KTS	23.2	80.5
Field 4: Deep Strip TIF	17.5	85.3
Field 5: Deep Broadcast TIF	26.9	77.4

24-hr Average Peak Chloropicrin Concentration (ug/m2/sec) and Percent Emissions Reduction Relative to PE Shallow Broadcast (Field 1)

Treatment	24-hr ave Pic conc.	% Reduction
Field 1: PE	20.4	0
Field 2: TIF	8.9	56.1
Field 3: TIF + KTS	10.2	49.7
Field 4: Deep Strip TIF	2.6	87.3
Field 5: Deep Broadcast TIF	1.6	92.2


Methyl Bromide Loss Rates at the Wasco, California Methyl Bromide/Chloropicrin Field Trial June 2009
Percent of Applied Detected in Air
70%
60%
50%
40%
30%
20%
10%
0%
65.23%
45.50%
22.12%
41.99%
27.11%
Field #1 - Shank 12" PE Tarp
Field #2 - Shank 12" TIF Tarp
Field #3 - Shank 12" TIF plus KTS
Field #4 - 18" 180 lb/acre STRIP TIF
Field #5 - Shank 18" TIF


Chloropicrin Loss Rates at the Wasco, California Methyl Bromide/Chloropicrin Field Trial June 2009
Percent of Applied Detected in Air
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
18.29%
12.68%
9.77%
17.92%
9.37%
Field #1 - Shank 12" PE Tarp
Field #2 - Shank 12" TIF Tarp
Field #3 - Shank 12" TIF plus KTS
Field #4 - 18" 180 lb/acre STRIP TIF
Field #5 - Shank 18" TIF

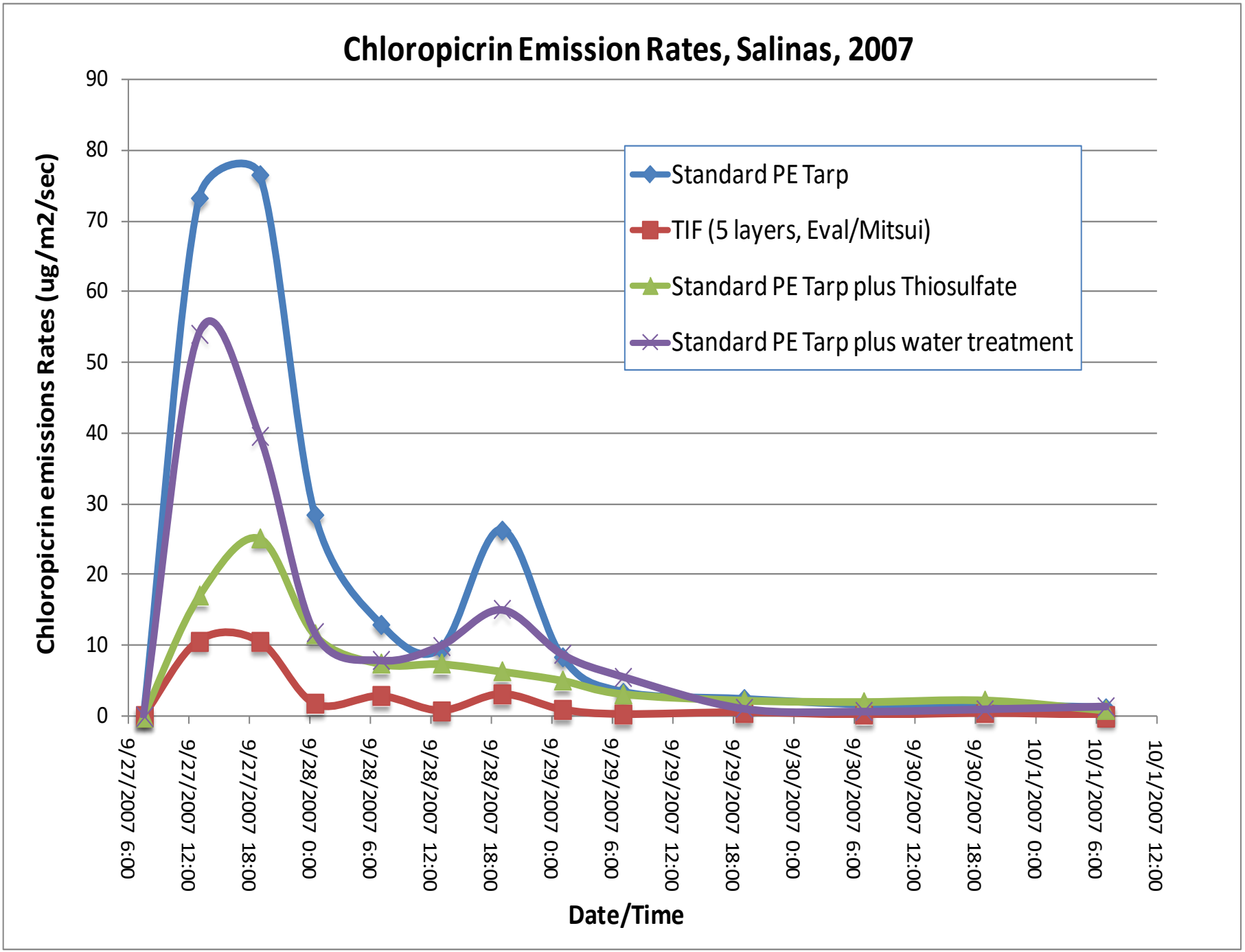
SUMMARY

- TIF tarp reduced chloropicrin and methyl bromide peak (24-hr) emissions by 56 and 67%, respectively, compared to PE tarp. This confirms the USEPA buffer zone reduction credit for TIF (60% by USEPA).
- TIF+KTS reduced peak chloropicrin and methyl bromide emissions by 50 and 80%, respectively, compared to PE tarp.
- Deep injection under TIF reduced MB peak emissions an additional 10%, and chloropicrin by 36%, compared to shallow injection under TIF.
- For shallow broadcast applications, TIF and TIF+KTS reduced total MB emissions by 30% and 66%, respectively. Regarding chloropicrin, 30 and 46% reductions, respectively, were achieved.
- For deep injection under TIF, the broadcast method had 48% (chloropicrin) and 35% (methyl bromide) lower emissions than the strip method.

Chloropicrin Drip Studies

Emission reduction with TIF and potassium thiosulfate

Field #	Tarp material	Water seal	Potassium Thiosulfate
1	Standard LDPE	No	No
2	TIF (Eval/Mitsui)	No	No
3	Standard LDPE	Yes	Yes
4	Standard LDPE	Yes	No


Chloropicrin Emission Rates, Salinas, 2007
Chloropicrin emissions Rates (ug/m2/sec)
90
80
70
60
50
40
30
20
10
0
Standard PE Tarp
TIF (5 layers, Eval/Mitsui)
Standard PE Tarp plus Thiosulfate
Standard PE Tarp plus water treatment
9/27/2007 6:00
9/27/2007 12:00
9/27/2007 18:00
9/28/2007 0:00
9/28/2007 6:00
9/28/2007 12:00
9/28/2007 18:00
9/29/2007 0:00
9/29/2007 6:00
9/29/2007 12:00
9/29/2007 18:00
9/30/2007 0:00
9/30/2007 6:00
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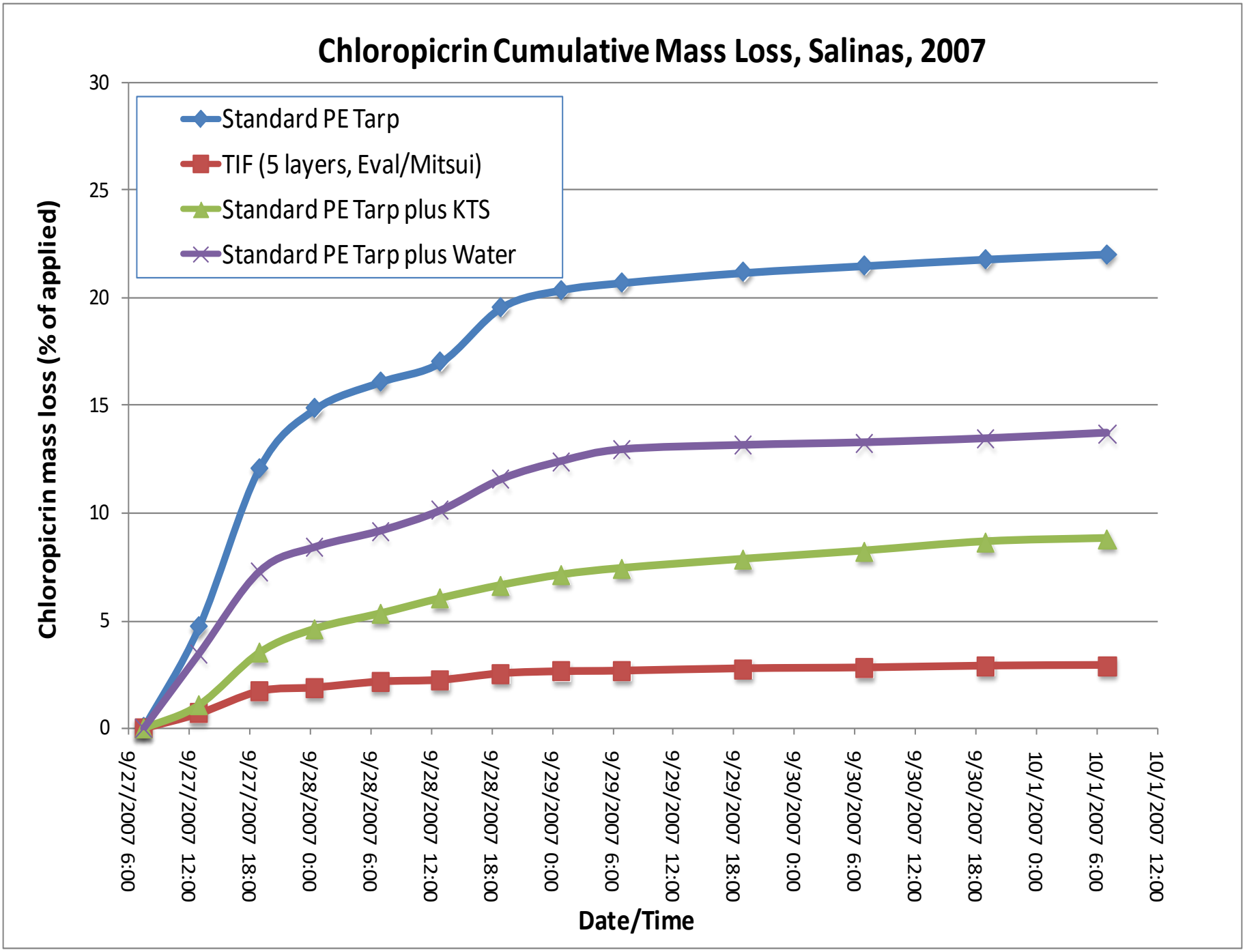
Chloropicrin Cumulative Mass Loss, Salinas, 2007
Standard PE Tarp
TIF (5 layers, Eval/Mitsui)
Standard PE Tarp plus KTS
Standard PE Tarp plus Water
Chloropicrin mass loss (% of applied)
30
25
20
15
10
5
0
9/27/2007 6:00
9/27/2007 12:00
9/27/2007 18:00
9/28/2007 0:00
9/28/2007 6:00
9/28/2007 12:00
9/28/2007 18:00
9/29/2007 0:00
9/29/2007 6:00
9/29/2007 12:00
9/29/2007 18:00
9/30/2007 0:00
9/30/2007 6:00
9/30/2007 12:00
9/30/2007 18:00
10/1/2007 0:00
10/1/2007 6:00
10/1/2007 12:00
Date/Time

SUMMARY

- **TIF (5 layers) reduced chloropicrin emission rates by more than 80% relative to standard LDPE tarp.**
- **K-thiosulfate/water treatment reduced chloropicrin emission rates by 65%.**
- **Water treatment alone reduced chloropicrin emission rates by 25%.**

With these data,

- **USEPA can revise mitigation measures (buffer zones) based on new data.**
- **CDPR can revise mitigation measures (buffer zones), lift VIF ban, revise VOC emissions estimates and approved method in NAAs, give growers VOC allocation relief, etc.**


Thank
you