METHYL BROMIDE AND SULFURYL FLUORIDE EFFECTIVENESS AGAINST RED FLOUR BEETLE LIFE STAGES

Michelle Hartzer, Bhadriraju Subramanyam, Watcharapol Chayaprasert, Dirk. E. Maier, and Sara Savoldelli

Department of Grain Science and Industry

Kansas State University

Manhattan, KS 66506-2201, U.S.A.

Introduction

- MB phase-out and CEU nominations
- MB alternatives
  - Heat treatment
  - Sulfuryl fluoride (ProFume™)
- Side-by-side comparison of treatments difficult in the "real world"
  - Facilities treated with one of the three on major holidays
  - Cannot use live insects to gauge treatment efficacy
  - Lots of research on trapping to verify treatment effectiveness
- Side-by-side comparisons are necessary to evaluate cost-effectiveness of MB and alternatives

Hal Ross Flour Mill

- Opened in October 2006
- Can produce 400 cwt
- 380,000 cubic feet
- Can mill hard, soft and Duram wheat
- Excellent site for side-by-side comparisons of treatments
- Live insects can be used to compare treatments

MBT Grant 2008

- Multi-institutional, multi-authored project
  - K-State, Purdue, USDA-GMPRC
- Funded in 2008
- Evaluate methyl bromide, sulfuryl fluoride, and heat treatments in Hal Ross Flour Mill
  - Treatment time, 24 h
- Conduct bioassays using all life stages of the red flour beetle
- Determine cost-effectiveness
- Conduct workshops on each of the technologies

Treatments, 2009

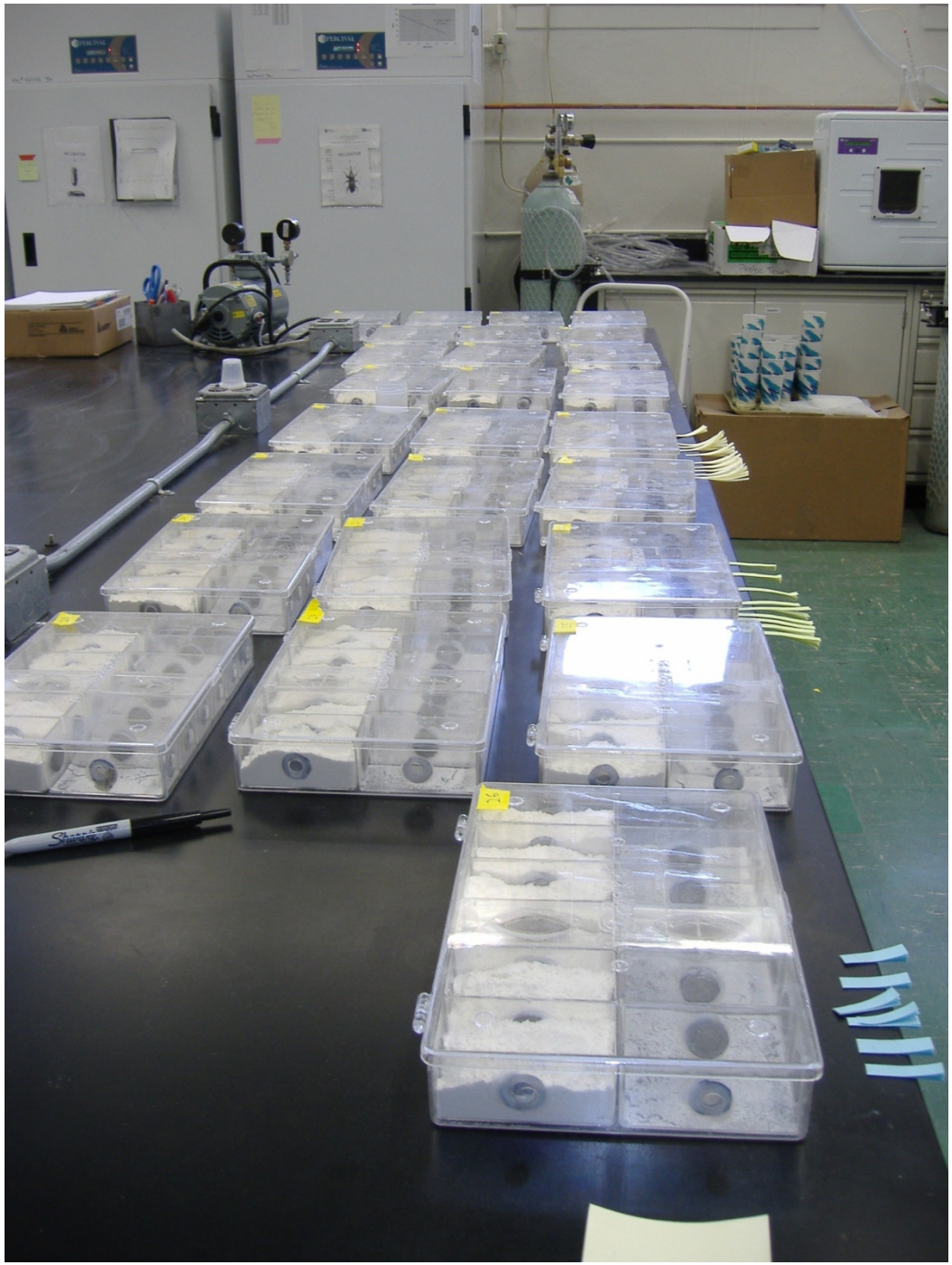
Spring

Methyl Bromide: May 6-7
Heat Treatment: May 13-14
Sulfuryl Fluoride: May 27-28

Fall

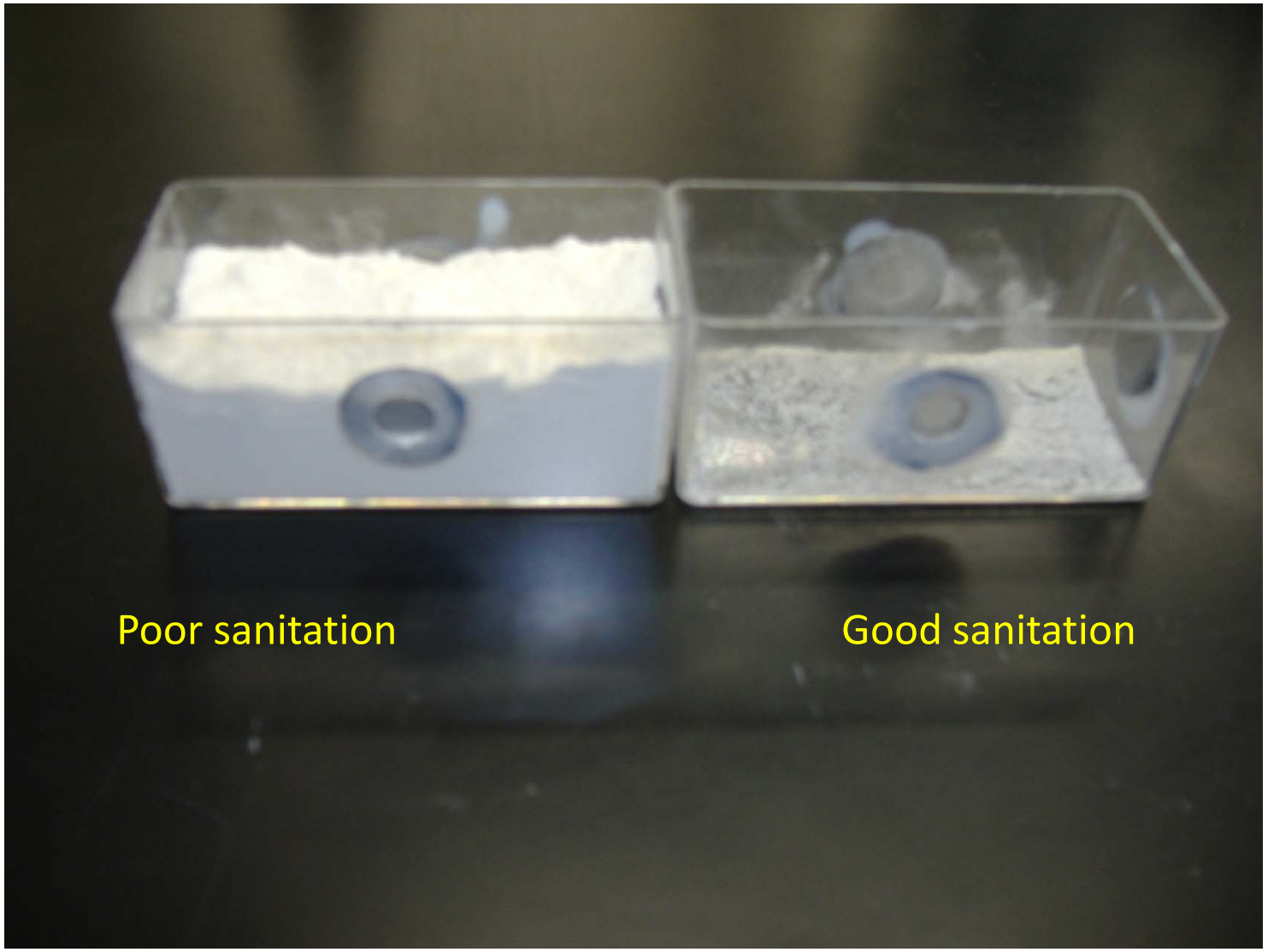
Methyl Bromide: August 11-12
Sulfuryl Fluoride: August 19-20
Heat Treatment: August 25-26

Insect bioassays

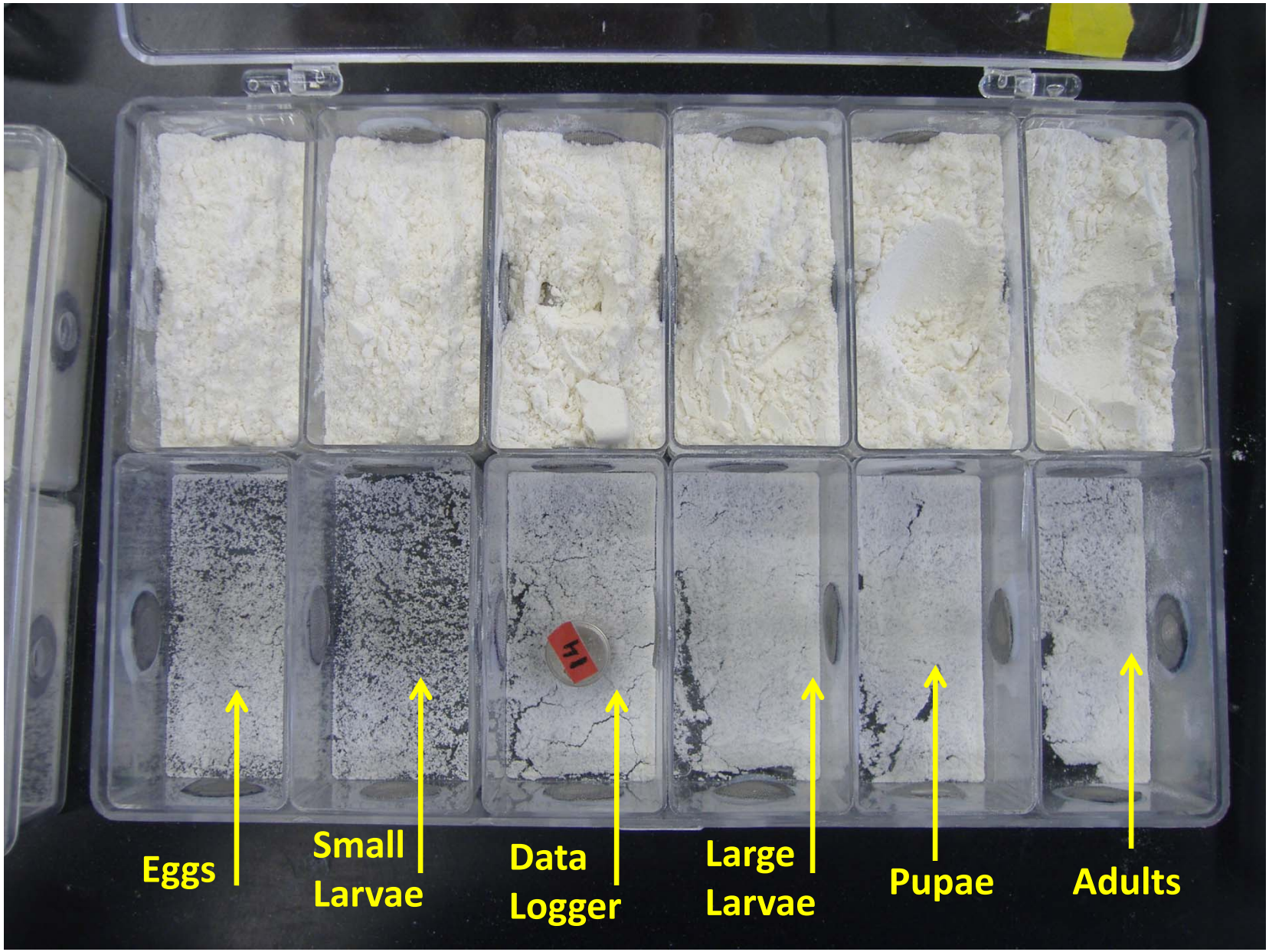


Components of the bioassay box

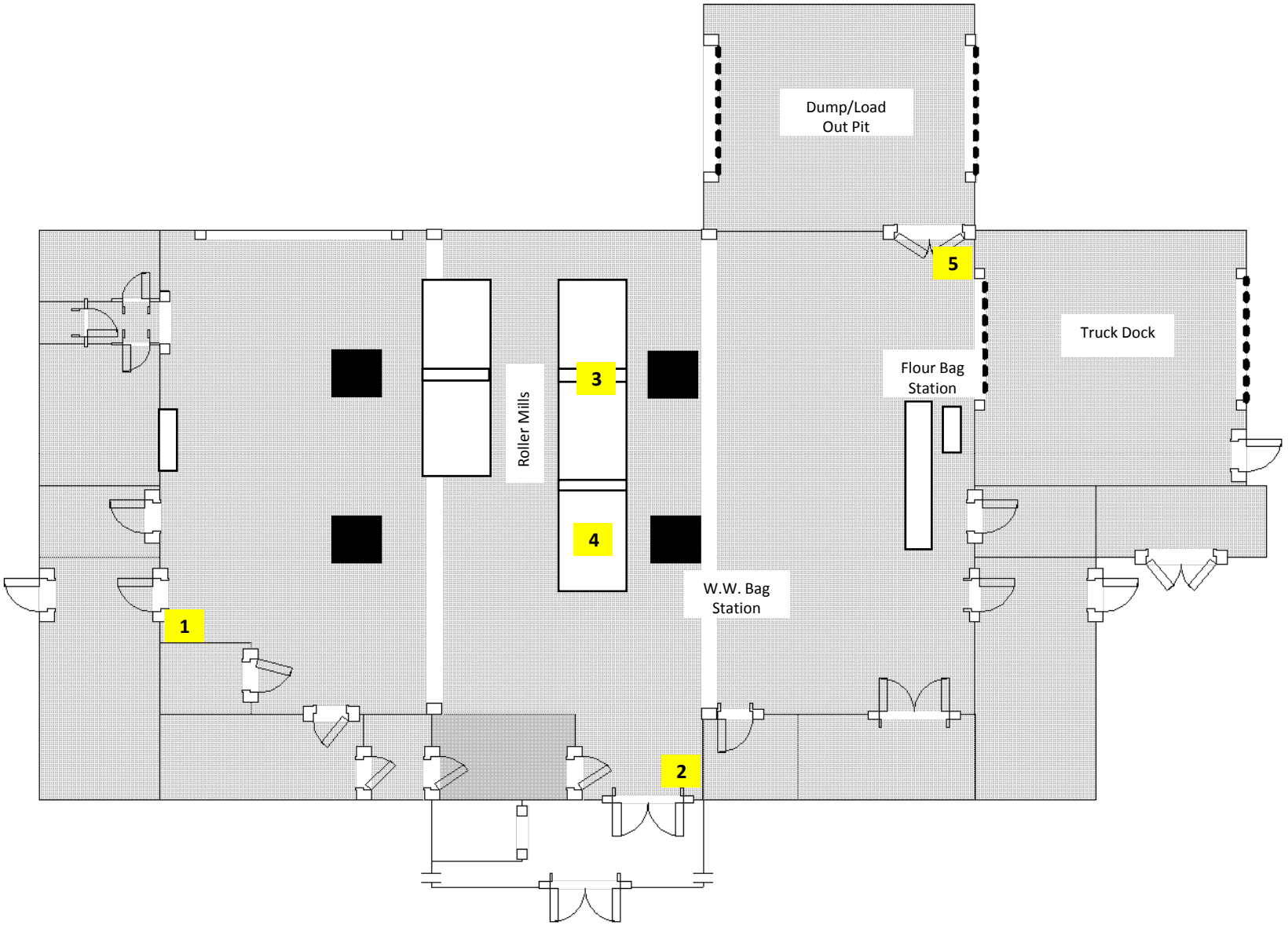
Sanitation levels simulated



The whole bioassay



First floor layout and box locations



Mill interior

25 boxes in the mill
1 control box in lab

Treatments

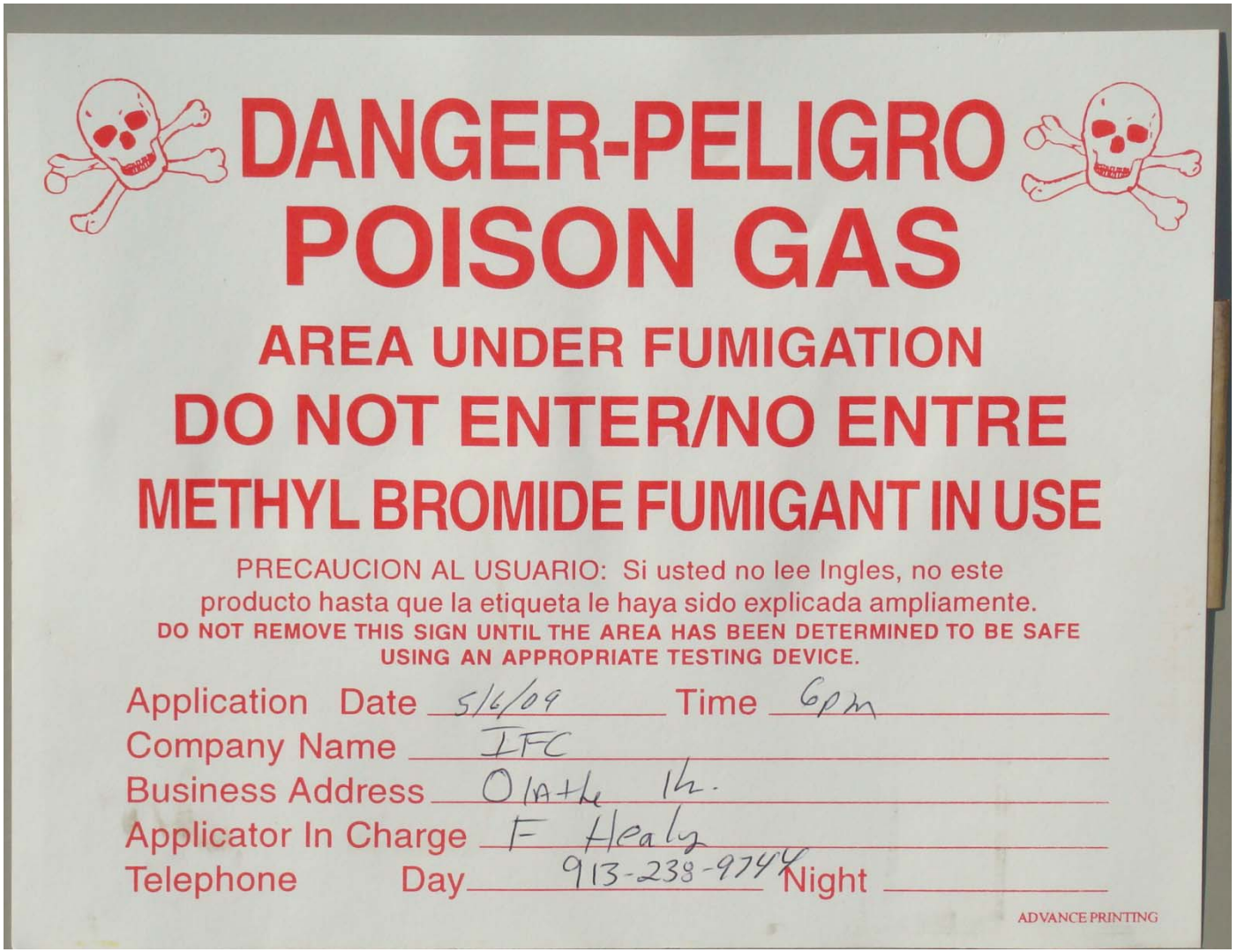
- May treatment
  - MB – 400 lbs
  - SF – 1250 lbs
- August
  - MB – 350 lbs
  - SF – 1125 lbs

Evaluating insect response

Adults: 24 hours
Pupae: 11 days
Large Larvae: 18 days
Small Larvae and Eggs: 45 days

Results

May treatments



Methyl bromide fumigation: % mortality of red flour beetle life stages (n = 1)

Box no. (Floor)	Eggs (Dust)	Eggs (2 cm)	Young larvae (Dust)	Young Larvae (2 cm)	Old larvae (Dust)	Old larvae (2 cm)	Pupae (Dust)	Pupae (2 cm)	Adults (Dust)	Adults (2 cm)	Gas Conc. (gh/m^3)
1(1F)	100	100	100	100	100	100	100	100	100	100	300
2 (1F)	100	100	100	100	100	100	100	100	100	100	309
3 (1F)	100	100	100	100	100	100	100	100	100	100	327
4 (1F)	100	100	100	100	100	100	100	100	100	100	303
5 (1F)	100	100	100	100	100	98	100	100	100	100	297
6 (2F)	100	100	100	100	100	96	100	100	100	100	300
7 (2F)	100	100	100	100	100	98	100	100	100	100	293
8 (2F)	100	100	100	100	100	100	100	100	100	100	291
9 (2F)	100	100	100	100	100	100	100	100	100	100	288
10 (2F)	100	100	100	100	100	100	100	100	100	100	287
11 (3F)	100	100	100	100	100	96	100	100	100	100	301
12 (3F)	100	100	100	100	100	100	100	100	100	100	302
13 (3F)	100	100	100	100	98	100	100	100	100	100	298
14 (3F)	100	100	100	100	100	100	100	100	100	100	316
15 (3F)	100	100	100	100	100	100	100	100	100	100	302

Methyl bromide fumigation: % mortality of red flour beetle life stages (*n* = 1)

Box no. (Floor) 99	Eggs (Dust)	Eggs (2 cm)	Young larvae (Dust)	Young Larvae (2 cm)	Old larvae (Dust)	Old larvae (2 cm)	Pupae (Dust)	Pupae (2 cm)	Adults (Dust)	Adults (2 cm)	Gas Conc. (gh/m^3)
16 (4F)	100	100	100	100	100	100	100	100	100	100	298
17 (4F)	100	100	100	100	100	100	100	100	100	100	296
18(4F)	100	100	100	100	100	100	100	100	100	100	309
19 (4F)	100	100	100	100	100	100	100	100	100	100	307
20 (4F)	100	100	100	100	96	100	100	100	100	100	301
21 (5F)	100	100	100	100	100	100	100	100	100	100	301
22 (5F)	100	100	100	100	100	100	100	100	100	100	294
23 (5F)	100	100	100	100	100	100	100	100	100	100	302
24 (5F)	100	100	100	100	100	100	100	100	100	100	300
25 (5F)	100	100	100	100	100	100	100	100	100	100	291
Average	100	100	100	100	99.8	99.5	100	100	100	100	299

Sulfuryl fluoride fumigation: % mortality of red flour beetle life stages (*n* = 1)

Box no. (Floor)	Eggs (Dust)	Eggs (2 cm)	Young larvae (Dust)	Young Larvae (2 cm)	Old larvae (Dust)	Old larvae (2 cm)	Pupae (Dust)	Pupae (2 cm)	Adults (Dust)	Adults (2 cm)	Gas Conc. (gh/m^3)
1(1F)	MV	70	100	100	100	100	100	100	100	100	1068
2 (1F)	60	62	100	100	100	100	100	100	100	100	1055
3 (1F)	70	74	100	100	100	100	100	100	100	100	1048
4 (1F)	80	70	100	100	100	100	100	100	100	100	1055
5 (1F)	68	42	100	100	100	100	100	100	100	100	1024
6 (2F)	74	60	100	100	100	100	100	100	100	100	998
7 (2F)	84	72	100	100	100	100	100	100	100	100	994
8 (2F)	98	82	100	100	100	100	100	100	100	100	998
9 (2F)	98	82	100	100	100	100	100	100	100	100	991
10 (2F)	70	80	100	100	100	100	100	100	100	100	996
11 (3F)	86	96	100	100	100	100	100	100	100	100	968
12 (3F)	92	84	100	100	100	100	100	100	100	100	978
13 (3F)	92	90	100	100	100	100	100	100	100	100	971
14 (3F)	100	96	100	100	100	100	100	100	100	100	1191
15 (3F)	94	88	100	100	100	100	100	100	100	100	983

Sulfuryl Fluoride Fumigation: % mortality of red flour beetle life stages (*n* = 1)

Box no. (Floor)	Eggs (Dust)	Eggs (2 cm)	Young larvae (Dust)	Young Larvae (2 cm)	Old larvae (Dust)	Old larvae (2 cm)	Pupae (Dust)	Pupae (2 cm)	Adults (Dust)	Adults (2 cm)	Gas Conc. (gh/m^3)
16 (4F)	88	82	100	100	100	100	100	100	100	100	1084
17 (4F)	94	88	100	100	100	100	100	100	100	100	1092
18(4F)	94	100	100	100	100	100	100	100	100	100	1070
19 (4F)	92	92	100	100	100	100	100	100	100	100	1111
20 (4F)	86	86	100	100	100	100	100	100	100	100	1086
21 (5F)	84	90	100	100	100	100	100	100	100	100	1074
22 (5F)	82	82	100	100	100	100	100	100	100	100	1050
23 (5F)	96	94	100	100	100	100	100	100	100	100	1103
24 (5F)	78	90	100	100	100	100	100	100	100	100	1072
25 (5F)	92	94	100	100	100	100	100	100	100	100	1072
Average	85.5	82	100	100	100	100	100	100	100	100	1030

Take Home Message: Temp too low!!!

Results

August treatments

Methyl bromide fumigation: % mortality of red flour beetle life stages (*n* = 1)

Box no. (Floor)	Eggs (Dust)	Eggs (2 cm)	Young larvae (Dust)	Young Larvae (2 cm)	Old larvae (Dust)	Old larvae (2 cm)	Pupae (Dust)	Pupae (2 cm)	Adults (Dust)	Adults (2 cm)	Gas Conc. (gh/m^3)
1(1F)	100	100	100	100	100	100	100	100	100	100	276
2 (1F)	100	100	100	100	100	100	100	100	100	100	273
3 (1F)	100	100	100	100	100	100	100	100	100	100	279
4 (1F)	100	100	100	100	100	100	100	100	100	100	277
5 (1F)	100	100	100	100	100	100	100	100	100	100	268
6 (2F)	100	100	100	100	100	100	100	100	100	100	268
7 (2F)	100	100	100	100	100	100	100	100	100	100	275
8 (2F)	100	100	100	100	100	100	100	100	100	100	287
9 (2F)	100	100	100	100	100	100	100	100	100	100	287
10 (2F)	100	100	100	100	100	100	100	100	100	100	285
11 (3F)	100	100	100	100	100	100	100	100	100	100	298
12 (3F)	100	100	100	100	100	100	100	100	100	100	316
13 (3F)	100	100	100	100	100	100	100	100	100	100	315
14 (3F)	100	100	100	100	98	98	100	100	100	100	318
15 (3F)	100	100	100	100	100	100	100	100	100	100	314

Methyl bromide fumigation: % mortality of red flour beetle life stages (*n* = 1)

Box no. (Floor)	Eggs (Dust)	Eggs (2 cm)	Young larvae (Dust)	Young Larvae (2 cm)	Old larvae (Dust)	Old larvae (2 cm)	Pupae (Dust)	Pupae (2 cm)	Adults (Dust)	Adults (2 cm)	Gas Conc. (gh/m^3)
16 (4F)	100	100	100	100	100	100	100	100	100	100	301
17 (4F)	100	100	100	100	100	100	100	100	100	100	300
18(4F)	100	100	100	100	100	98	100	100	100	100	303
19 (4F)	100	100	100	100	100	100	100	100	100	100	311
20 (4F)	100	100	100	100	100	100	100	100	100	100	303
21 (5F)	100	100	100	100	100	100	100	100	100	100	300
22 (5F)	100	100	100	100	100	100	100	100	100	100	ND
23 (5F)	100	100	100	100	100	100	100	100	100	100	303
24 (5F)	100	100	100	100	100	100	100	100	100	100	300
25 (5F)	100	100	100	100	100	100	100	100	100	100	299
Average	100	100	100	100	99.9	99.8	100	100	100	100	295.7

Sulfuryl fluoride fumigation: % mortality of red flour beetle life stages (*n* = 1)

Box no. (Floor)	Eggs (Dust)	Eggs (2 cm)	Young larvae (Dust)	Young Larvae (2 cm)	Old larvae (Dust)	Old larvae (2 cm)	Pupae (Dust)	Pupae (2 cm)	Adults (Dust)	Adults (2 cm)	Gas Conc. (gh/m^3)
1(1F)	100	100	100	100	100	98	100	100	100	100	836
2 (1F)	94	100	100	100	100	100	100	100	100	100	676
3 (1F)	98	100	100	100	100	100	100	100	100	100	848
4 (1F)	100	100	100	100	100	100	100	100	100	100	844
5 (1F)	100	100	100	100	100	100	100	100	100	100	829
6 (2F)	98	100	100	100	100	100	100	100	100	100	716
7 (2F)	100	100	100	100	100	100	100	100	100	100	748
8 (2F)	100	100	100	100	100	100	100	100	100	100	763
9 (2F)	100	100	100	100	100	100	100	100	100	100	751
10 (2F)	100	100	100	100	100	100	100	100	100	100	733
11 (3F)	100	100	100	100	100	100	100	100	100	100	814
12 (3F)	100	100	100	100	100	100	100	100	100	100	663
13 (3F)	100	100	100	100	100	100	100	100	100	100	793
14 (3F)	100	100	100	100	100	100	100	100	100	100	1003
15 (3F)	100	100	100	100	100	100	100	100	100	100	808

Sulfuryl Fluoride Fumigation: % mortality of red flour beetle life stages (*n* = 1)

Box no. (Floor)	Eggs (Dust)	Eggs (2 cm)	Young larvae (Dust)	Young Larvae (2 cm)	Old larvae (Dust)	Old larvae (2 cm)	Pupae (Dust)	Pupae (2 cm)	Adults (Dust)	Adults (2 cm)	Gas Conc. (gh/m^3)
16 (4F)	100	100	100	100	100	100	100	100	100	100	734
17 (4F)	100	100	100	100	100	100	100	100	100	100	762
18(4F)	100	100	100	100	100	100	100	100	100	100	765
19 (4F)	100	100	100	100	100	100	100	100	100	100	769
20 (4F)	100	100	100	100	100	100	100	100	100	100	747
21 (5F)	100	100	100	100	100	100	100	100	100	100	690
22 (5F)	100	100	100	100	100	100	100	100	100	100	678
23 (5F)	100	100	100	100	100	100	100	100	100	100	715
24 (5F)	100	100	100	100	100	100	100	100	100	100	689
25 (5F)	100	100	100	100	100	100	100	100	100	100	672
Average	99.6	100	100	100	100	99.8	100	100	100	100	766.7

Workshops

- May 13-15, 2009
  - Hands-on workshop on heat treatment
  - Weblink: http://www.ksre.ksu.edu/grsc_subi/Heat_Workshop_09_slides.htm
- August 19-21, 2009
  - Hands-on workshop on sulfuryl fluoride fumigation
  - Weblink: http://www.ksre.ksu.edu/grsc_subi/Conference/Workshop_SF_2009/index_old.htm

Acknowledgments

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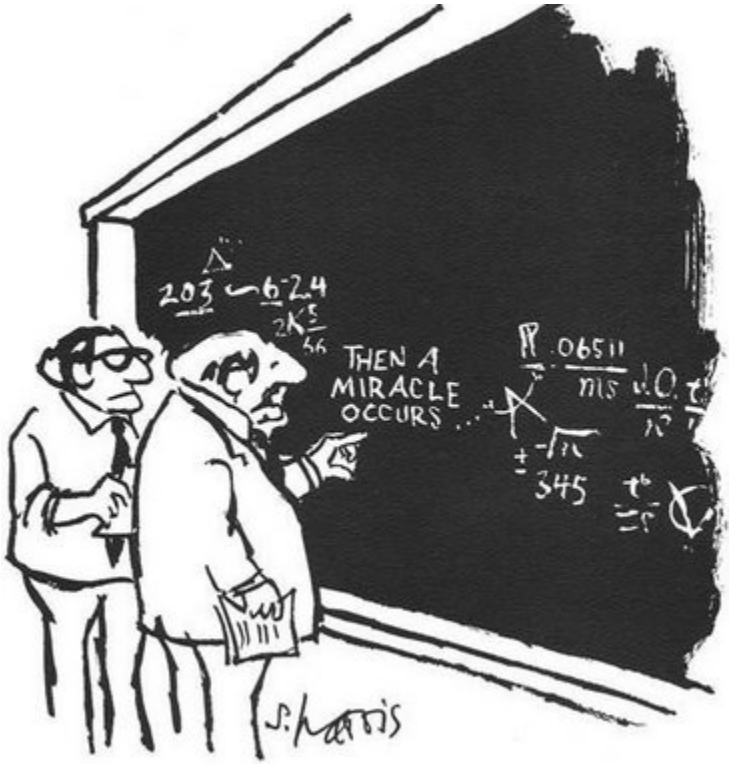
- Temp-Air, Burnsville, MN
- Dow AgroSciences
- Chemtura
- Propane Research and Education Council, Washington, D.C.
- Pest-Heat, Aston, PA

Questions?



"I think you should be more explicit here in step two."