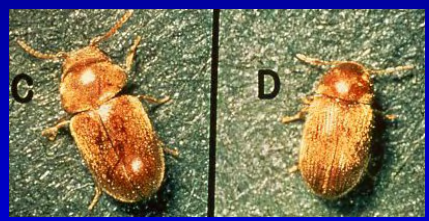
Application of Pheromones for Controlling Stored-Product Insects

Tom Phillips

Oklahoma State University

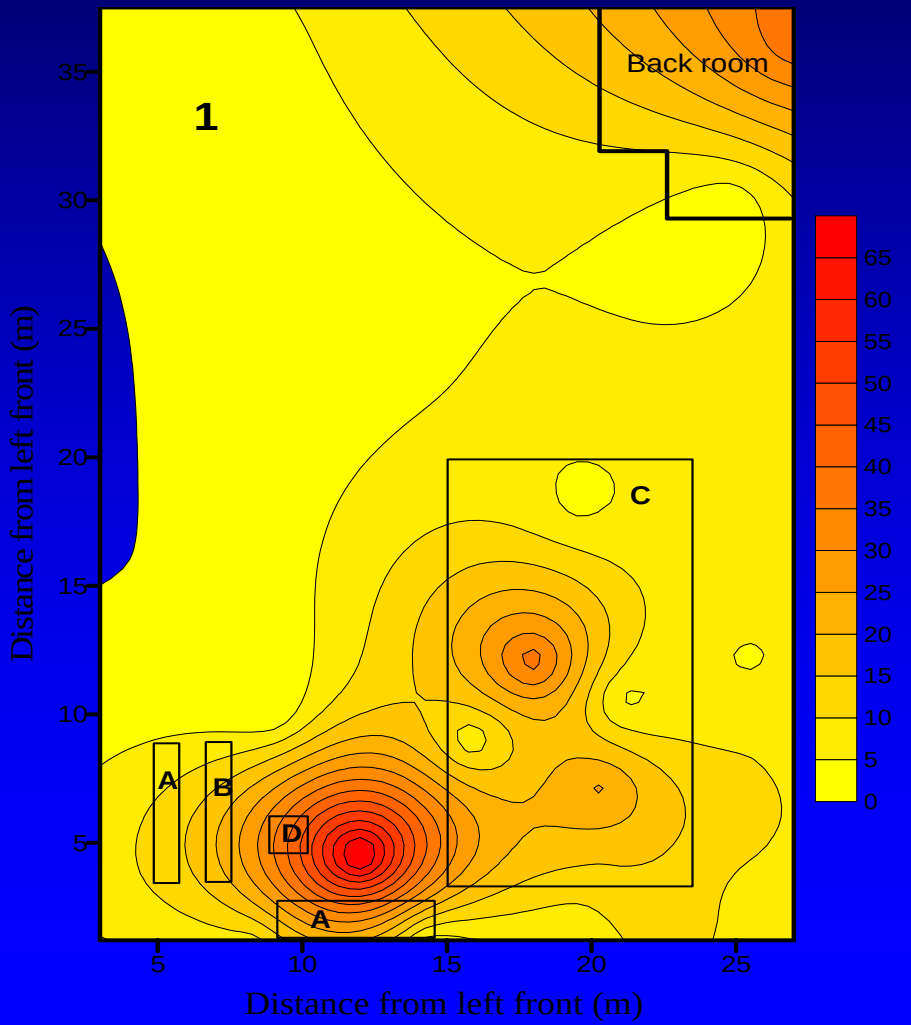
Pheromones for Stored Product Insects

- Pheromones known for > 40 species
- Lures available for 20 species; a few predominate
  - Indianmeal moth and other pyralids
  - Cigarette beetle
  - *Tribolium* flour beetles
  - Warehouse beetle and other dermestids
- Traps are for monitoring; widely used by pest control industry
- Used in food industry buildings with value-added products; not in grain storage
- Detect spatial and seasonal variation; trigger for management and control decisions

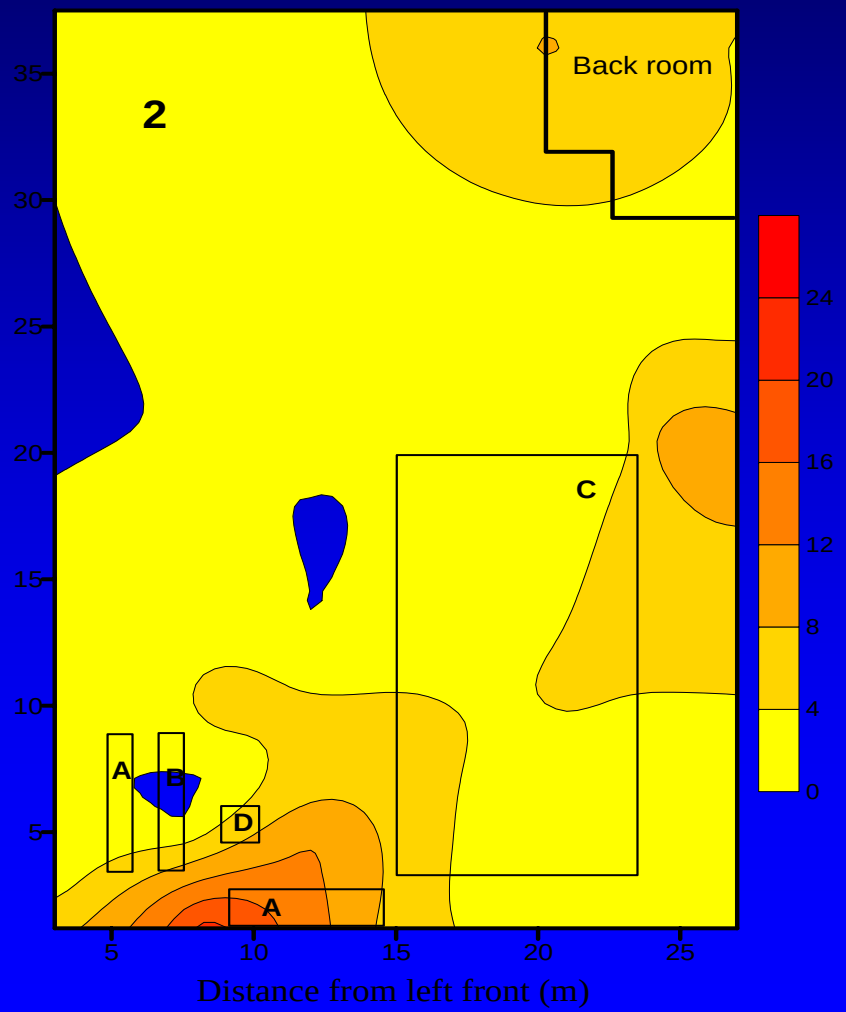


Spatial Analysis of Trap Captures

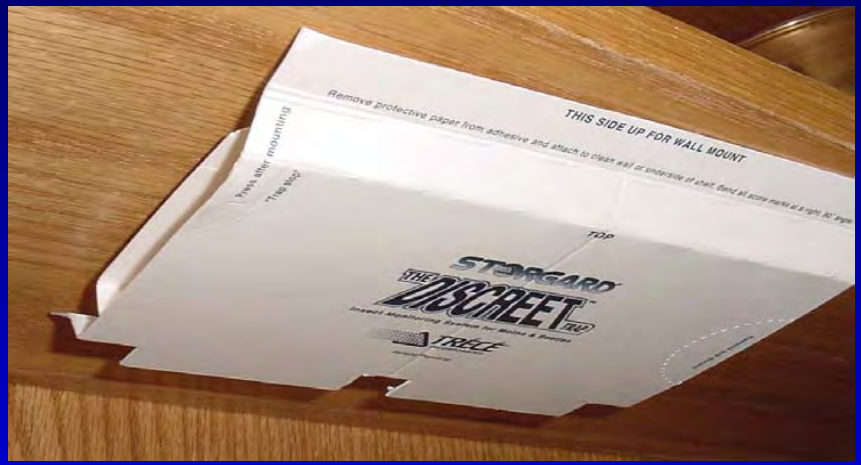
Beetles



Moths



Pheromone Traps



Can we control insects with pheromone traps?

- No, not usually
- Need to catch lots of females
- Most pheromone traps capture males (IMM, CB, WB)
- Mass-trapping of males could suppress populations under certain conditions
- Techniques to control stored product insects using sex pheromones to manipulate males

Pheromone-Based Control Techniques

- Mating Disruption
- Lure-and-Kill; Attracticide
- Examples from IMM research

What is Mating Disruption?

- Release high levels of synthetic pheromone
- Disrupts or alters mating behavior of males
- Males fail to mate female; females don’t lay fertile eggs; population goes to extinction
- Commercial scale trials with stored product moths recently completed

Chicken House A: 1472 m^3

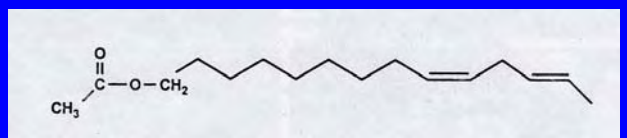
Chicken House B: 1880 m^3

MD Lure

1 lure per 80 cu m

Monitoring trap

2-3 live female
IMM in cage



"ZETA"

Oviposition Dish in Protective Cage

Food dishes were changed weekly, returned to the lab., incubated for 3 weeks, and larvae were heat-extracted and counted

Results: Traps Catches

Mean Weekly Trap Catch in MD vs Non-MD Houses

Non-MD 44.6 (SE 5.3)

MD 1.6 (SE 7.2)

$F_{1,43}=23.19$, $P<0.0001$

*****Significant "Trap Shut-down"******

Results: Larval Counts

Mean weekly larval counts for the 2 weeks before MD compared to the 4 weeks during MD at each house

Before MD **249.5 (SE 31.2)**

During MD **82.5 (SE 31.2)**

$F_{1,6} = 14.33$, $P=0.009$

*****Reproduction reduced; population suppressed*****

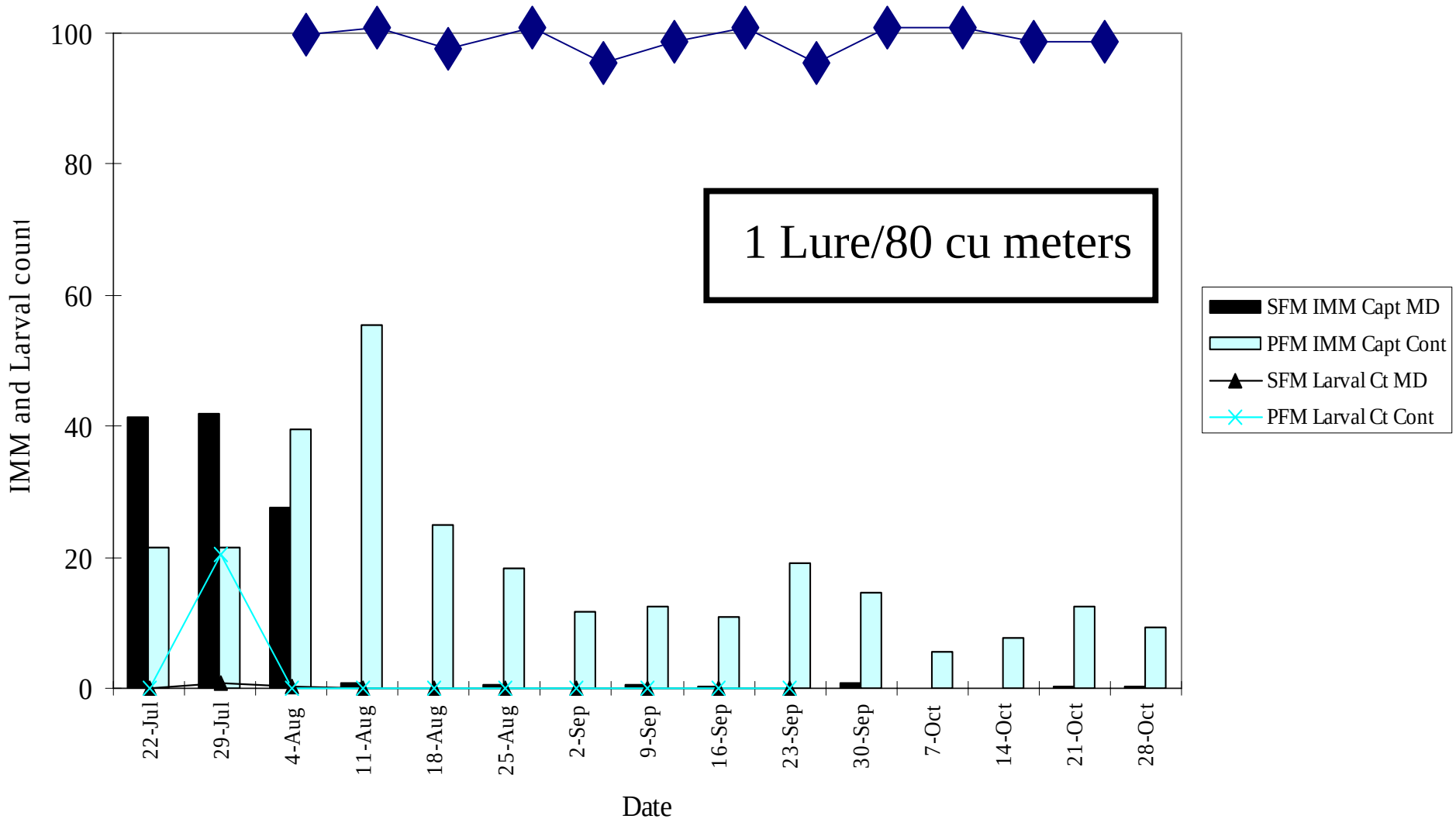
Demonstrating Mating Disruption in the "Real World"

- Every building is different
- Every moth population is different
- Difficult to find identical control and treatment buildings; replicates highly variable
- Used paired buildings in many locations
- Assigned treated and untreated buildings
- Monitor moths in both building types from before treatment and through treatment period

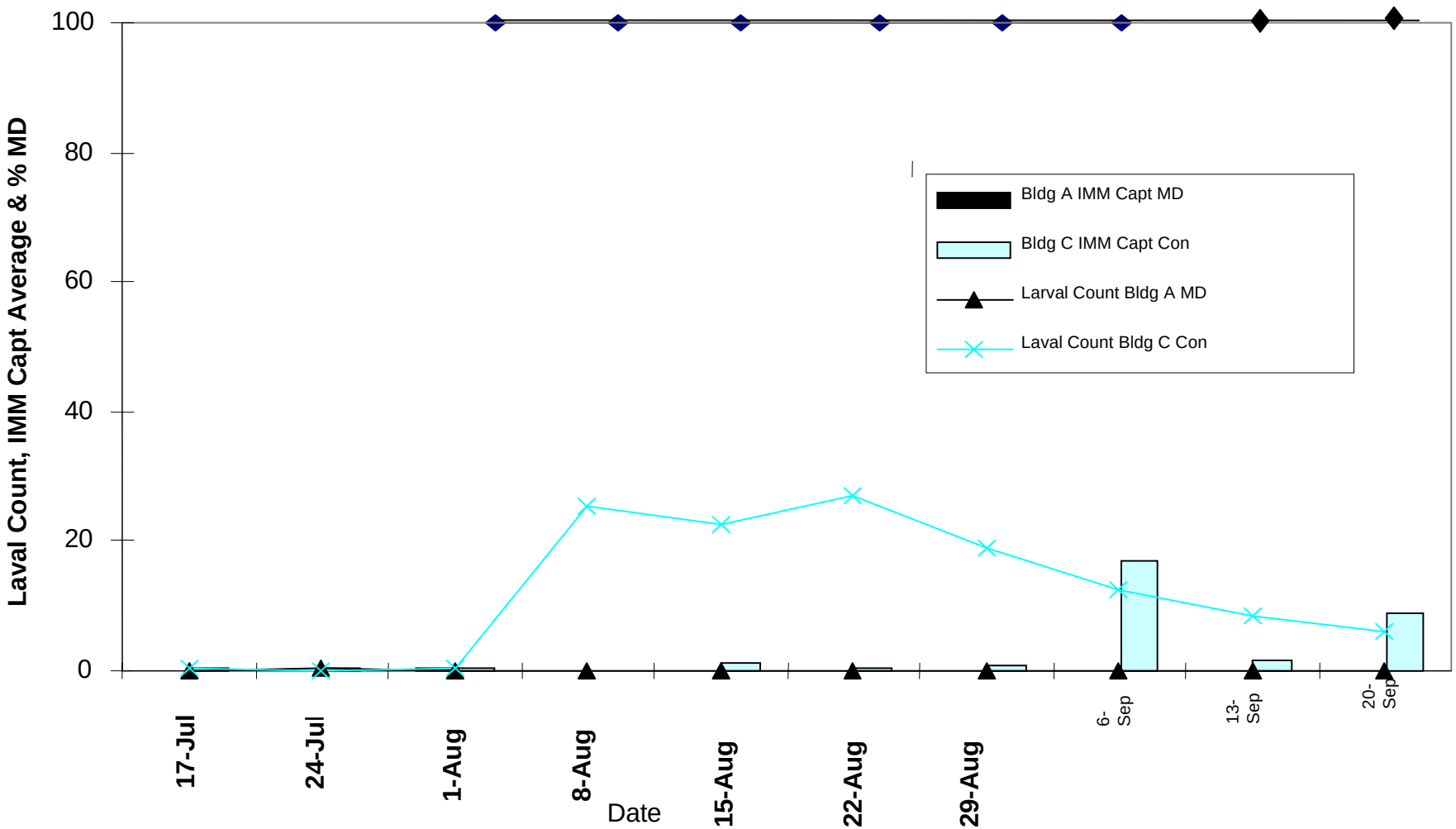
Examples of Sites

Placing Lures: 1 per 80 cu m in 2003

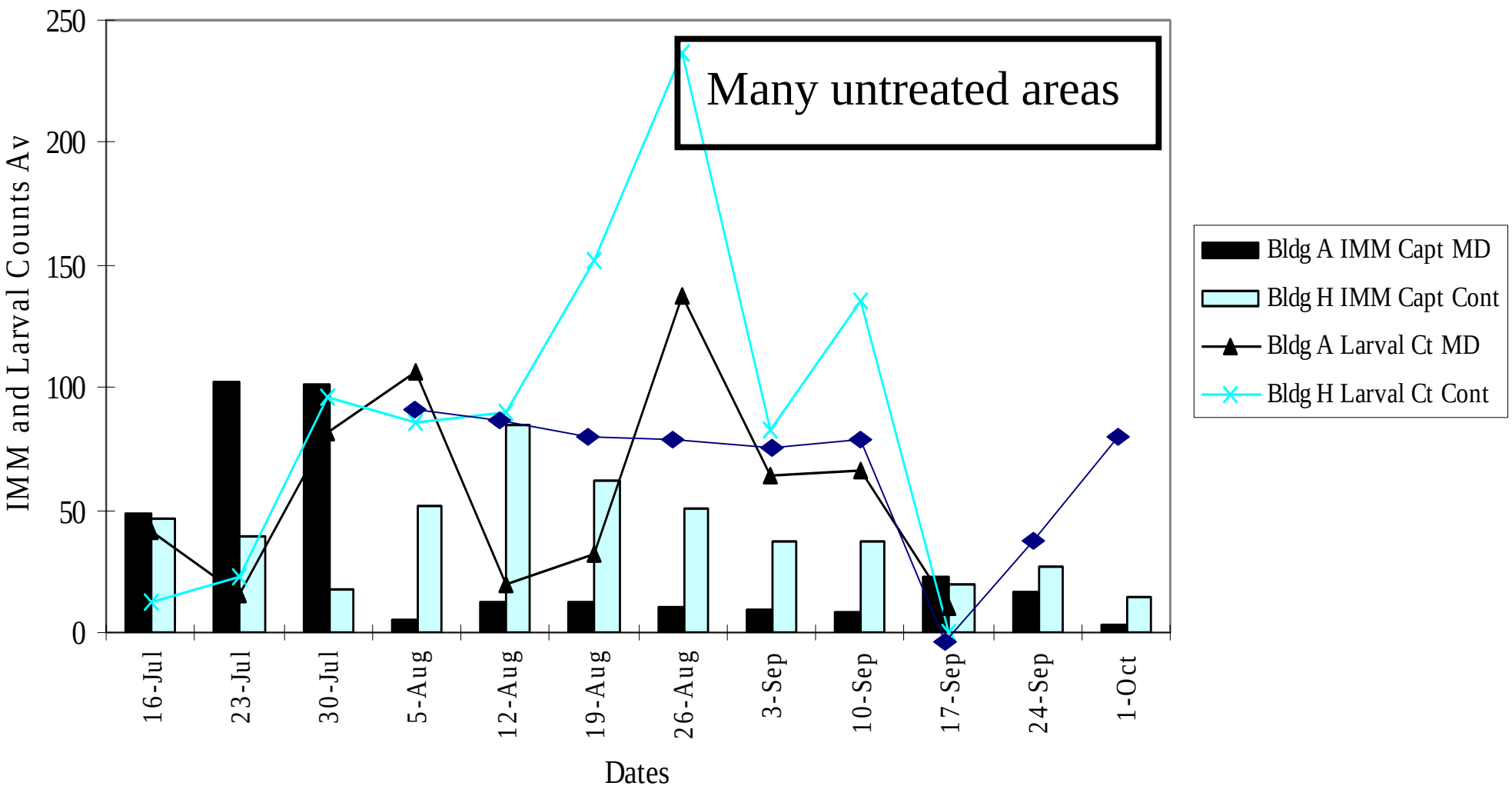
Mating Disruption in Oklahoma SFM and PFM Locations, 2003 IMM and Larval Counts MD installed in Aug 4, 2003



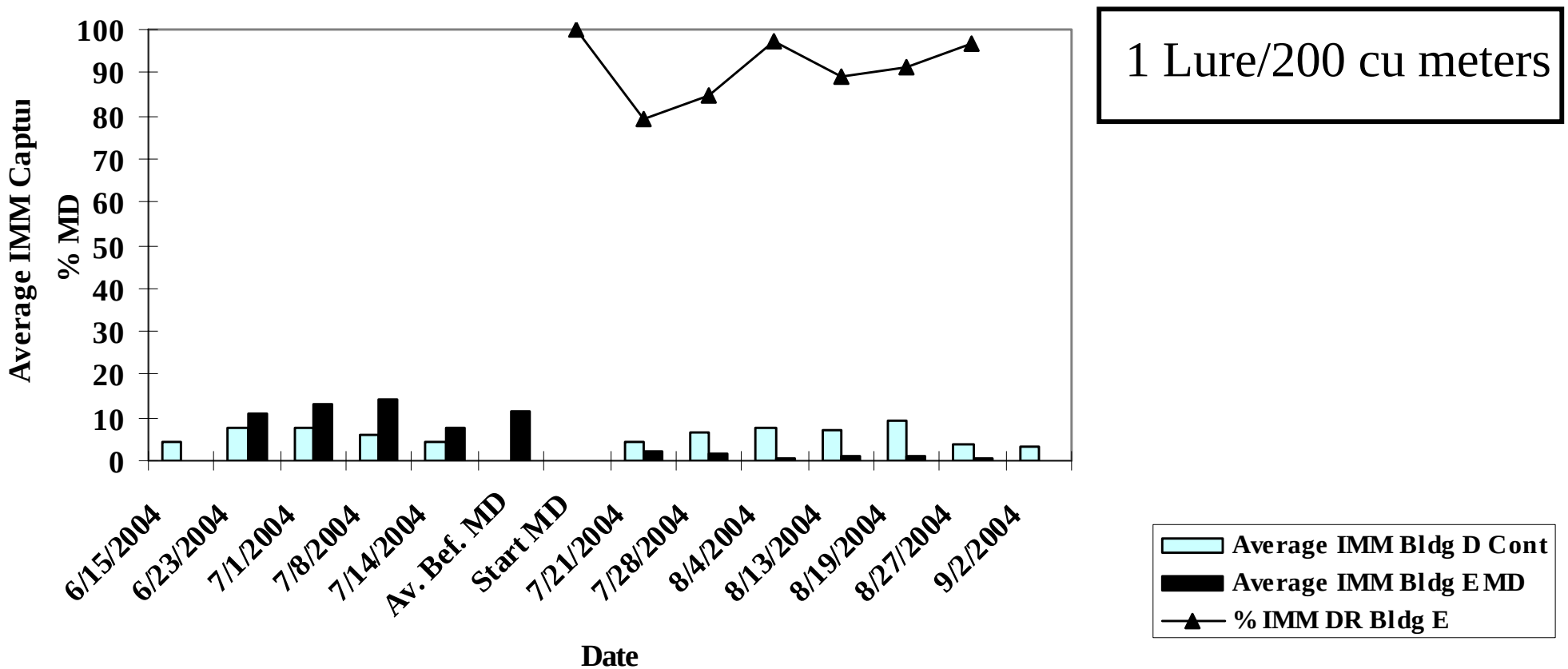
2003: Washington Bean Warehouses, 1 lure per 80 cu m, high and low



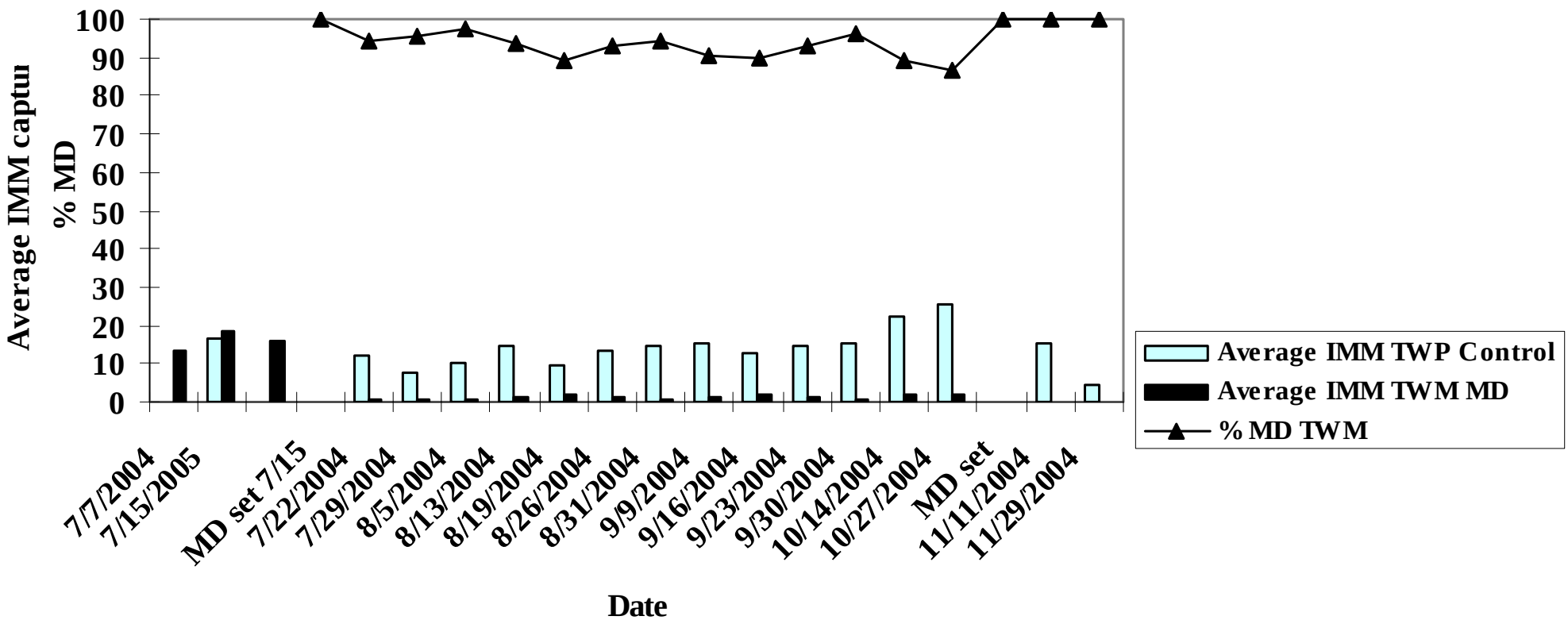
Mating Disruption Indiana Bean and Seed Plants IMM Capt, Larval Counts Av MD installed Aut 5, 2003 to Sept 30, 2003



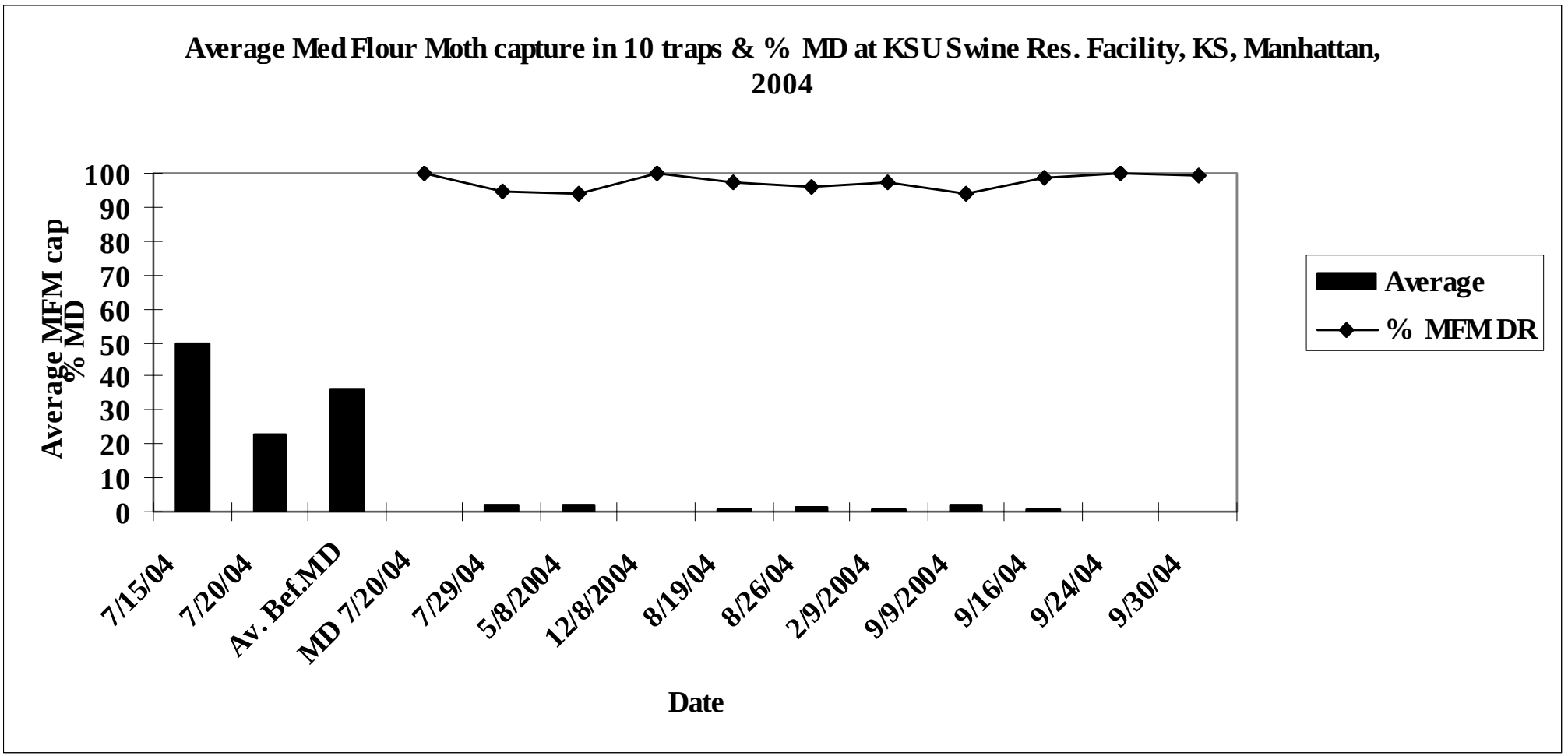
Average IMM capture in 16 traps & % MD at Bean Warehouse Building D Control 13,924 m3; Building E MD 8,562m3, Othello, WA 2004



Average IMM capture in 10 traps at Wells Bros. Feed Store Warehouse, Plano & IMM Capture & % MD at Wells Bros Feed Store Warehouse, 929 m3, Mckinney, TX (Dallas area) 2004



Mediterranean Flour Moths: One Case



***MFM can be disrupted by single-component lure!

2005 Results Summary

- Tested a simple protocol for deploying lures based on floor space only, regardless of ceiling height: 1 lure per 625 square feet appears effective
- Confirmed activity of MD lures against Mediterranean Flour Moth a second time
- Conducted successful tests with Almond Moth, *Cadra cautella*, in Hawaii
- Commercial partners have applied to EPA to secure primary and secondary registration

Lure-and-Kill for Indianmeal Moth

- Formulation combines sex pheromone with a targeted dose of insecticide
- Induce mass-killing of males; should be better than traps
- Screened several insecticide active ingredients; lab.-tested gel and panel formulations
- Field trials with panels in 2005

Suppression Evaluation

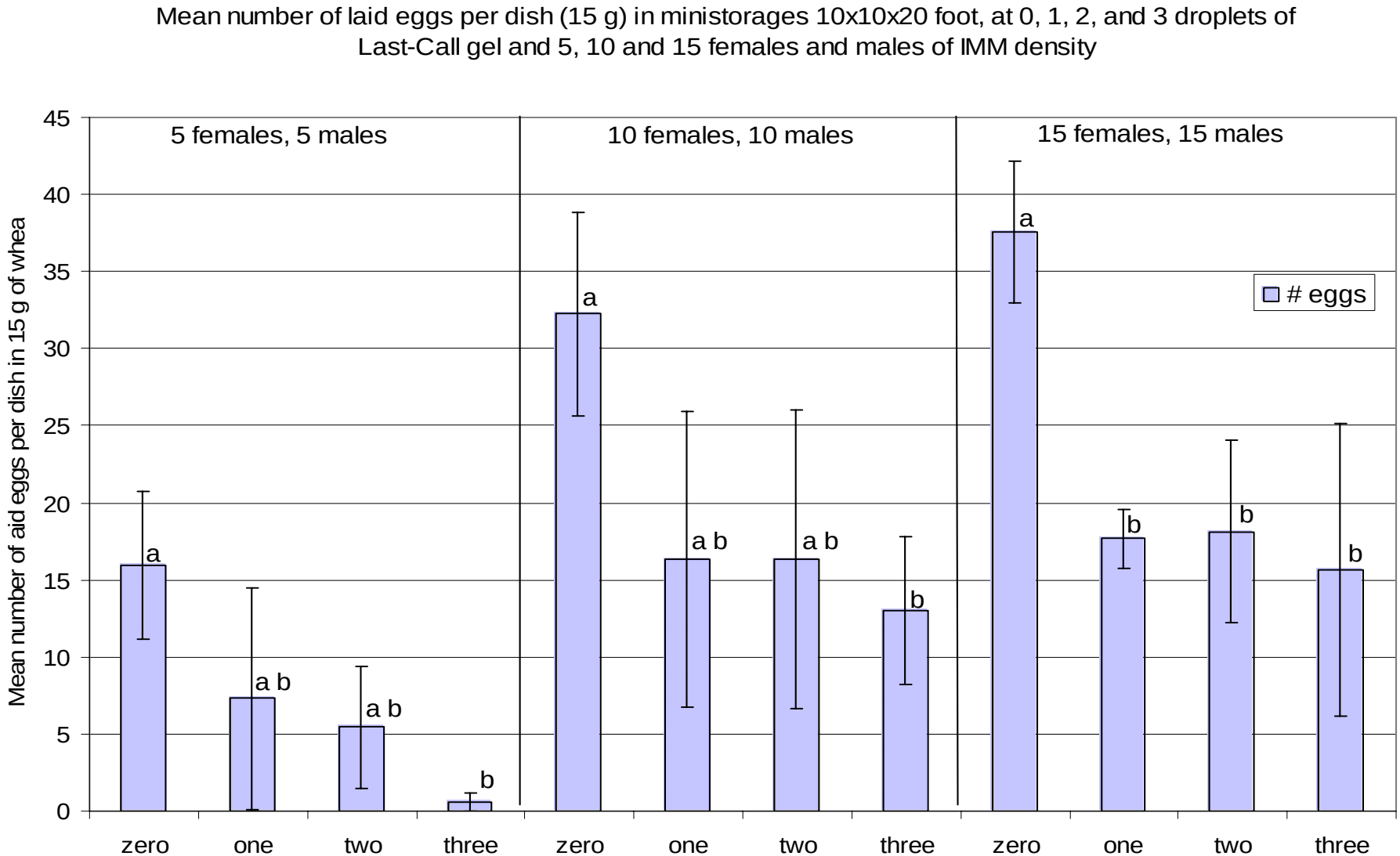
Attracticide: Last Call gel

- 4 Mini-storage rooms, 10 X 10 X 20 ft, as simulated warehouses
- Set up on Mondays and pick up on Fridays
- 25 ± 4 °C and 40-60 RH

- Treatments of 0, 1, 2, or 3 droplets (50 mg per droplet) assigned to the rooms; randomized and repeat for 4 weeks

- Density of 5, 10 and 15 moths per room tested in 3 studies

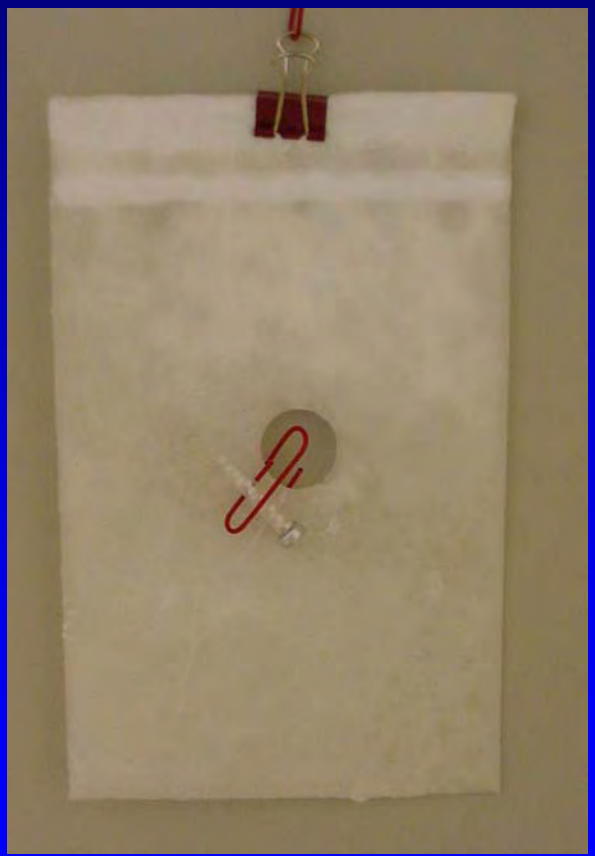
- Males monitored with traps, reproduction monitored by oviposition in dishes of grain



Unfortunately, the residual activity of gel was less than 8 weeks.

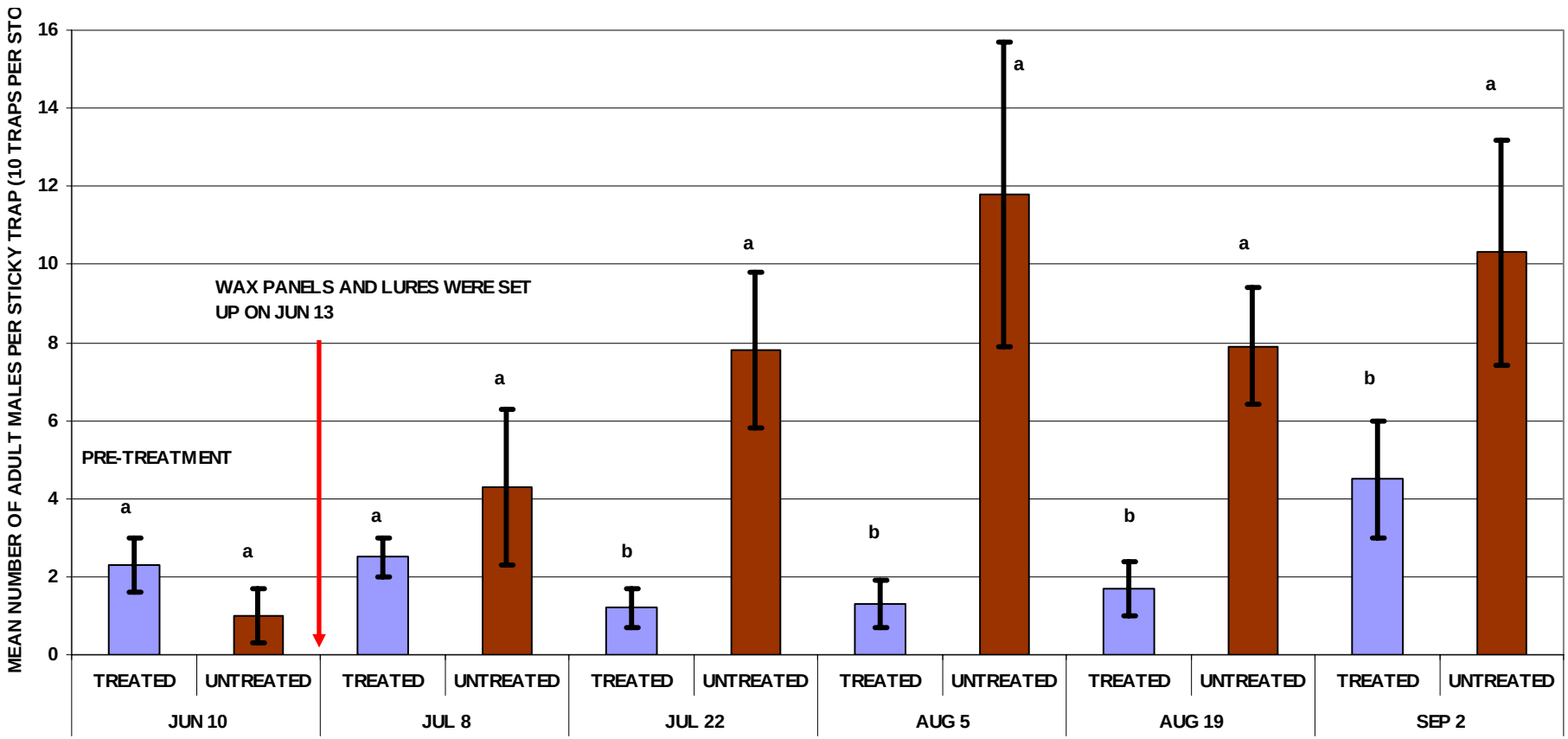
Wax Panels as Killing Surfaces

- Panels impregnated with permethrin
- Surface of 12 x 20 cm
- Use regular trap lure
- Active for 3+ months
- Field studies in 2005

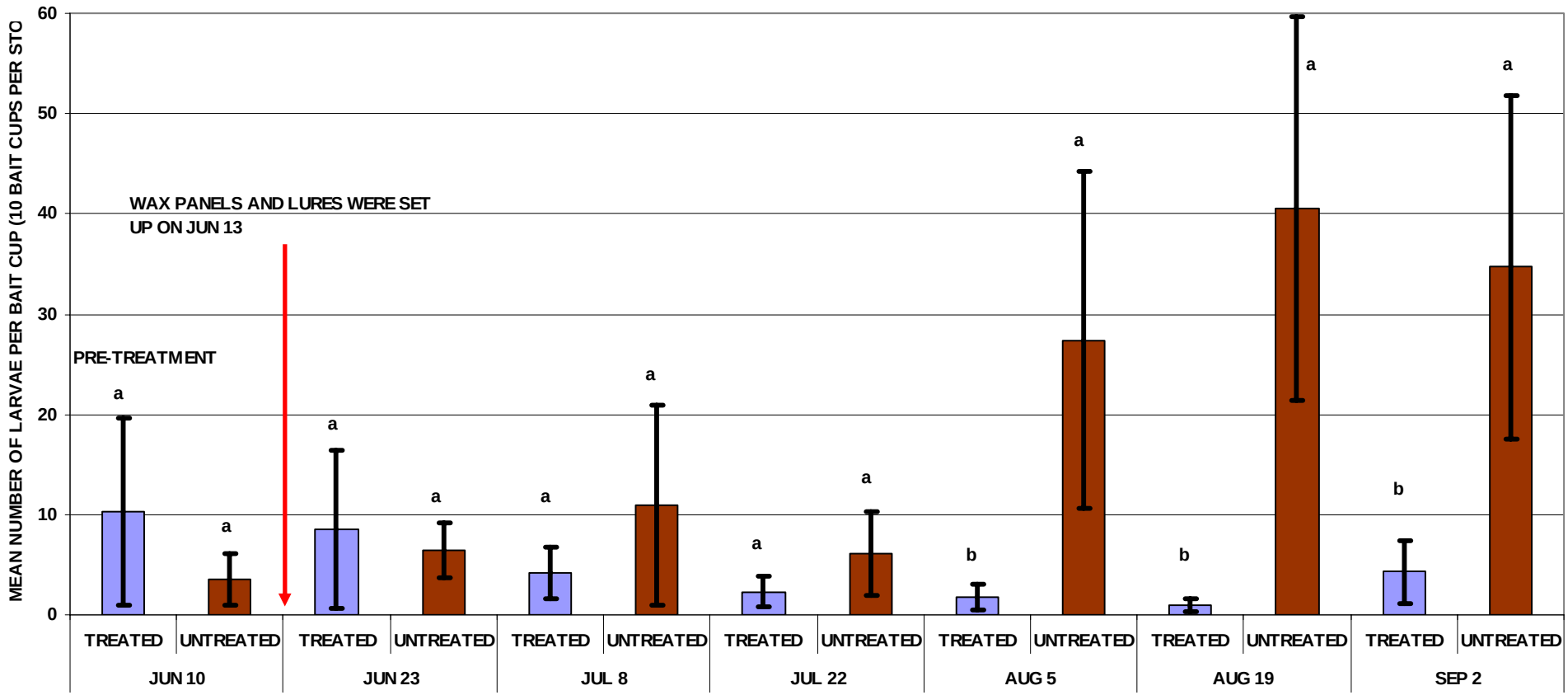


Small Pet Stores and Grocery Stores

MEAN NUMBER OF ADULT MALES OF IMM PER STICKY TRAP IN AN ATTRACTICIDE STUDY WITH WAX PANEL (SUTERRA, OR.) IN PET FOOD AND GROCERY STORES AT DALLAS, TX. 2005.



MEAN NUMBER OF IMM LARVAE PER BAIT CUP IN AN ATTRACTICIDE STUDY WITH WAX PANELS (SUTERRA, OR) IN PET AND GROCERY STORES (8) AT DALLAS, TX. 2005.



Summary

- Pheromone traps are widely used for monitoring SPIs in food plants, warehouses and retail outlets
- Mating Disruption and lure-and-Kill for moths shows great promise, and registration is imminent
- Species specificity of control may be OK
- Demand for pheromone-based controls could be high in low input and organic systems

Acknowledgements

Charlie Konemann
Manuel Campos
Stacy Sanders
Industry and University Cooperators

Funding: Whitmire Micro-Gen
USDA **R**isk **A**voidance and **M**itigation **P**rogram
USDA NRI Bio-based Pest Management

Thank You!

tom.phillips@okstate.edu