Mating disruption then, now and the future

Larry Gut

"Soft-path" pest control is much more management intensive than using broad-spectrum insecticides.

A sexy weapon ...

continued from page 12

against pests. At each of six sites, 10 acres will be treated with soft pesticides. It will be funded by the federal government as well as by the research commission.

The test growers haven't been picked yet, but Jay Brunner, the project's principal investigator, knows who he wants. "We're going after industry leaders, good adapters, good spokespersons for the industry," he says. "Down the road we'd like (growers) to be talking to their peers."

Meanwhile, a group of researchers

Lisa Jones

Entomologist Larry Gut checks a pheromone dispenser in an orchard

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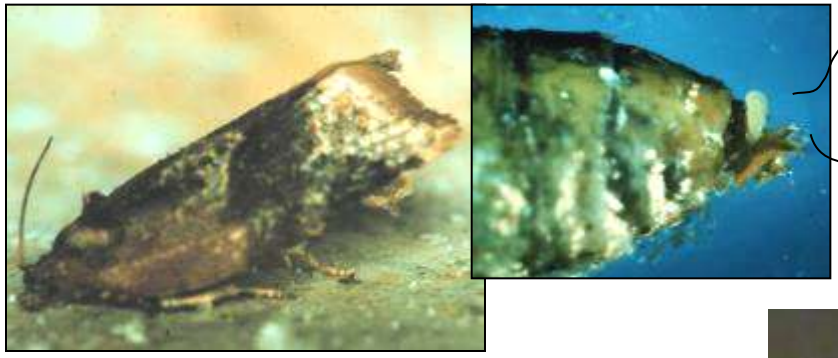
Mating disruption 101: "how males find females"

Wind



Pheromone plume

- Females release pheromone from specialized glands

- Antennal hairs sift pheromone molecules from the air
- Odorant stimulates receptor cells within antenna

gentle wind

eggs

Mating disruption is intended to stop this !!

In practice, mating disruption entails:

- Dispensing a large amount of sex pheromone within the crop

- Disturbing the normal behavior of male insects
- Interfering with mating
- And hence reducing the incidence of larvae

LUKASZ IS DOSED WITH PHEROMONE

Resistance is documented !

2009

2004-07

20 scientific papers, no babies
Evidence for mating disruption?

2002-03

A happy man

Early years of pheromone research

2001

In love with fruit flies ….. and Kirsten

For tree fruits

50yrs

40yrs

30yrs

20yrs

10yrs

1972-75
Early trials in Australia
– Rothschild

1978-79
Trials with Fiber technology
– Moffett and Westigard

1989
EPA reg. OFM MD
– Rice and Kirsch

1991
EPA reg. CM MD

1995-2002
AW Projects

USDA

- **680,000 ac MD in tree fruit crops**

1960 **1980** **2000** **Present**

Primary focus on:

Operational factors

- Technological

  pheromone delivery strategies,
  application parameters
  characteristics of the site

- Management considerations

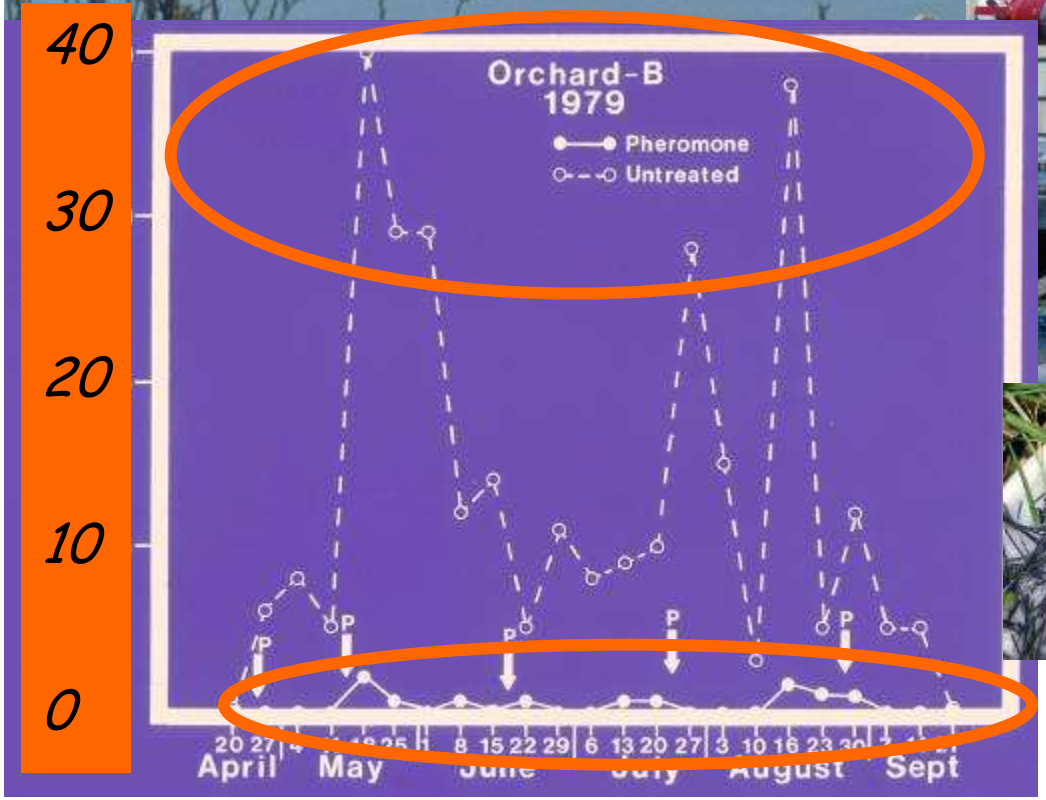
  supplemental controls
  monitoring

- Economics

  costs relative to other control options,
  compatible with current IPM programs,
  easy to use

Deliver the appropriate amount and blend of pheromone in a cost-effective manner

Advanced through trial-and-error



Pheromone bombs !

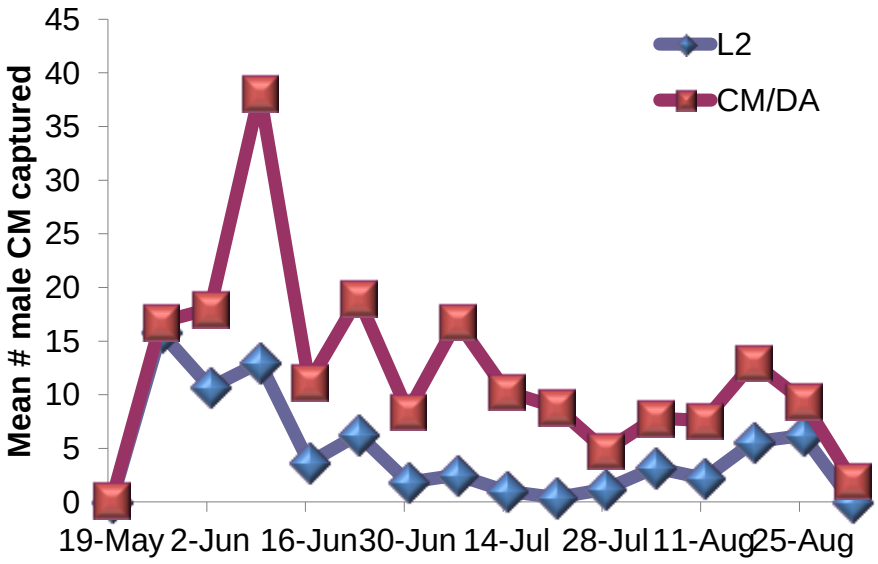
Areawide coverage is best:

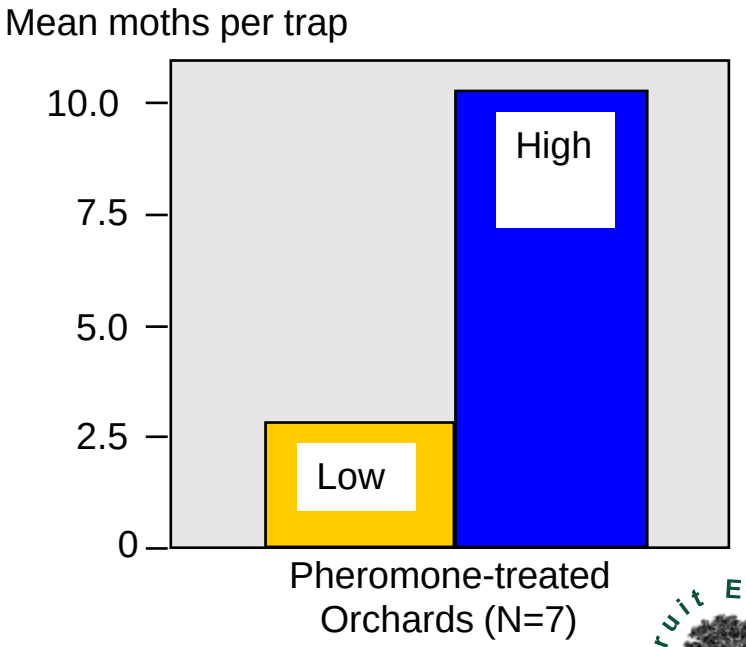
- Reduction in fruit injury

Monitoring in disrupted orchards

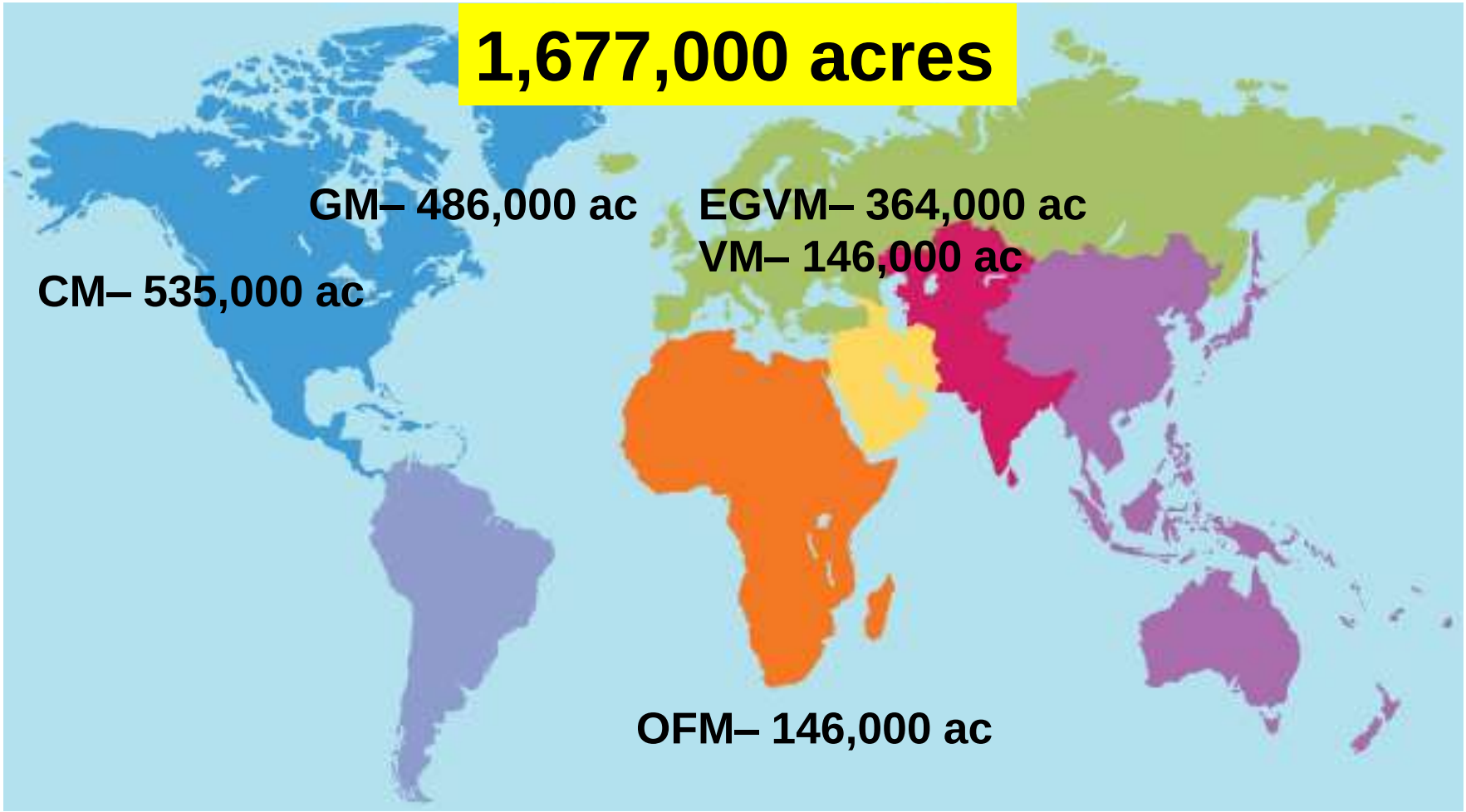
- For most species, use standard lure; catches should be near 0
  - For CM, use standard and “high-load” or CM/DA lures
  - Place traps in areas with history of pest pressure
  - Position traps at mid-canopy or high (CM) in the canopy

CM/DA Improves Monitoring of seasonal flight





Worldwide use of MD



Species vary in sensitivity to disruption

RBLR PLR OBLR

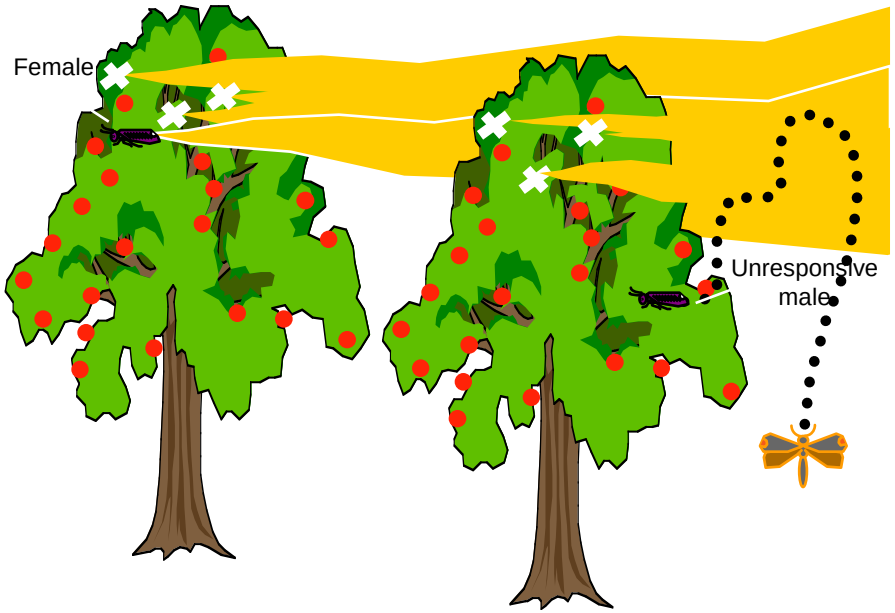
Easy → Difficult

Ease of disruption

- Achievable with various formulations
- Dosage required is less
- Trap shutdown is greater
- Fruit or tree protection is easier to achieve

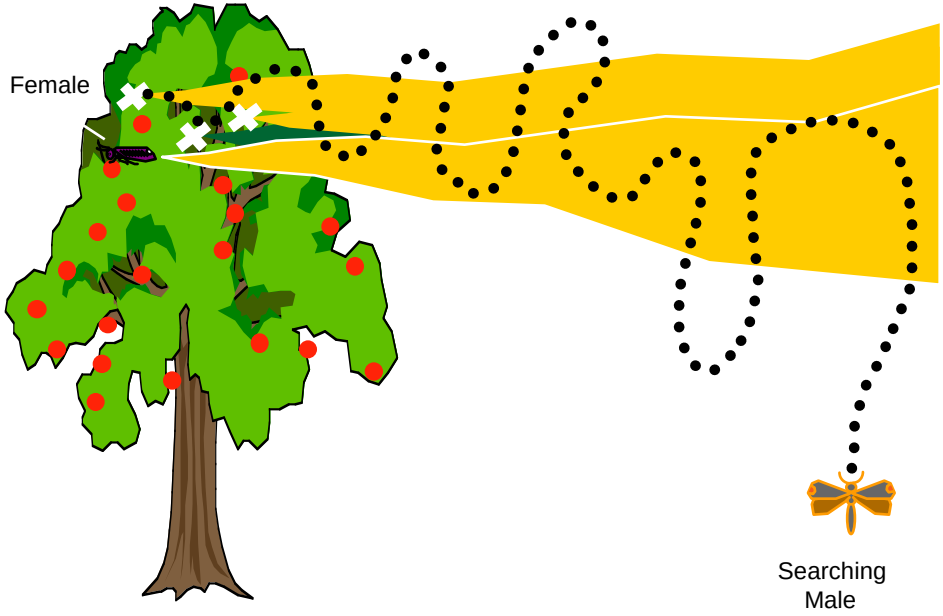
Knowing more about the specific way mating disruption is achieved should guide us

"Non-competitive"



Males ability to respond to pheromone is impaired

"Competitive"

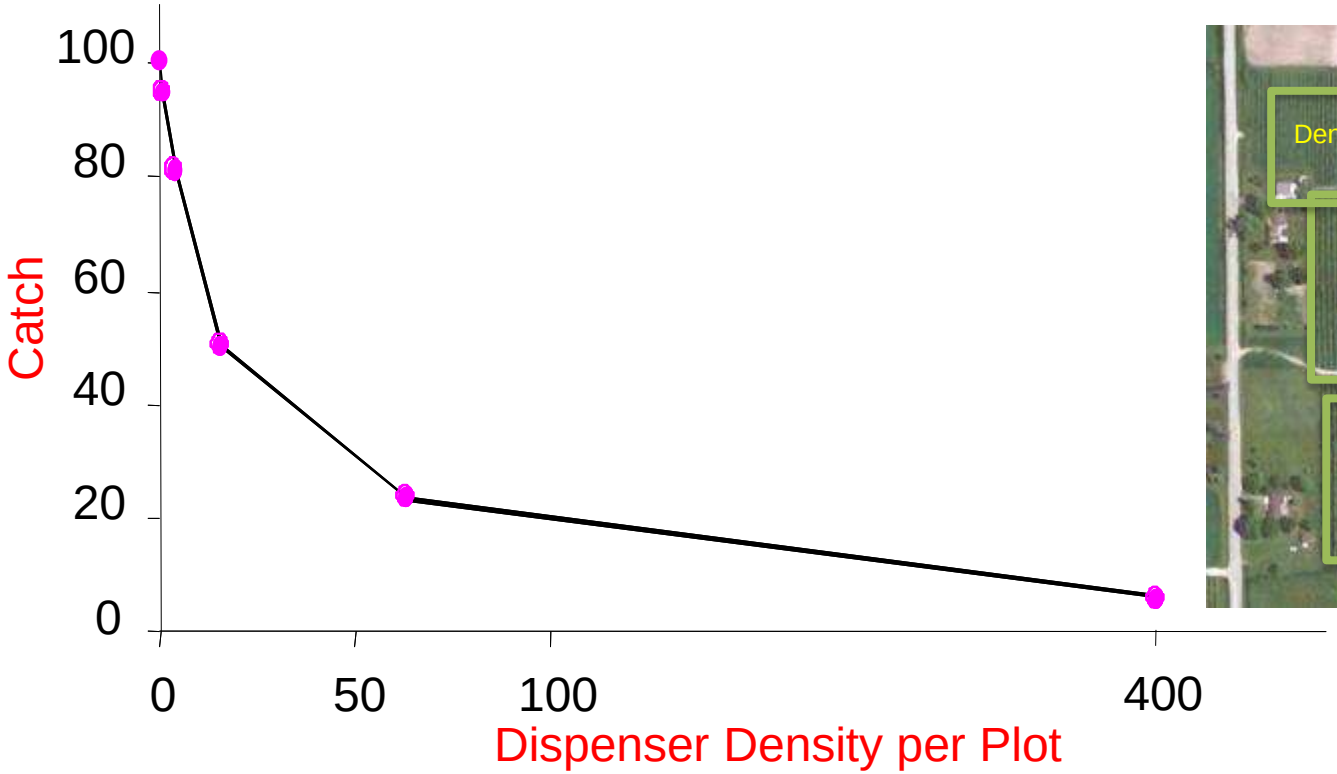


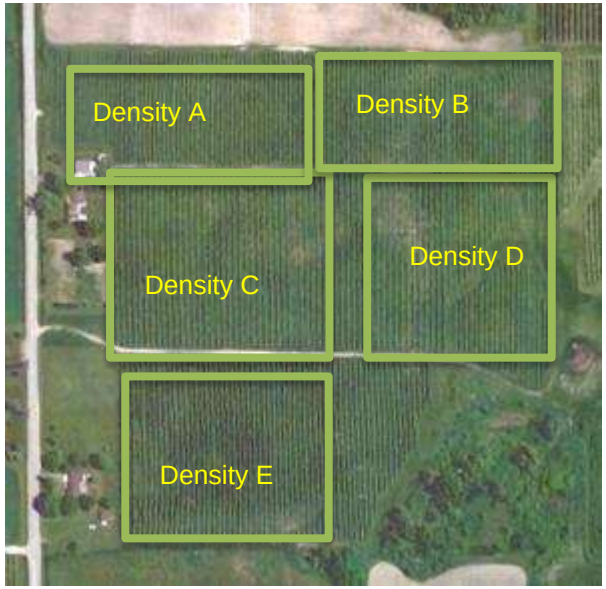
Males readily respond to pheromone

Dosage-response assays most telling means of identifying principal mechanism

MATING DISRUPTION

- Males not initially impaired → **COMPETITIVE DISRUPTION**
- M, F or signal impaired → **NON-COMPETITIVE DISRUPTION**

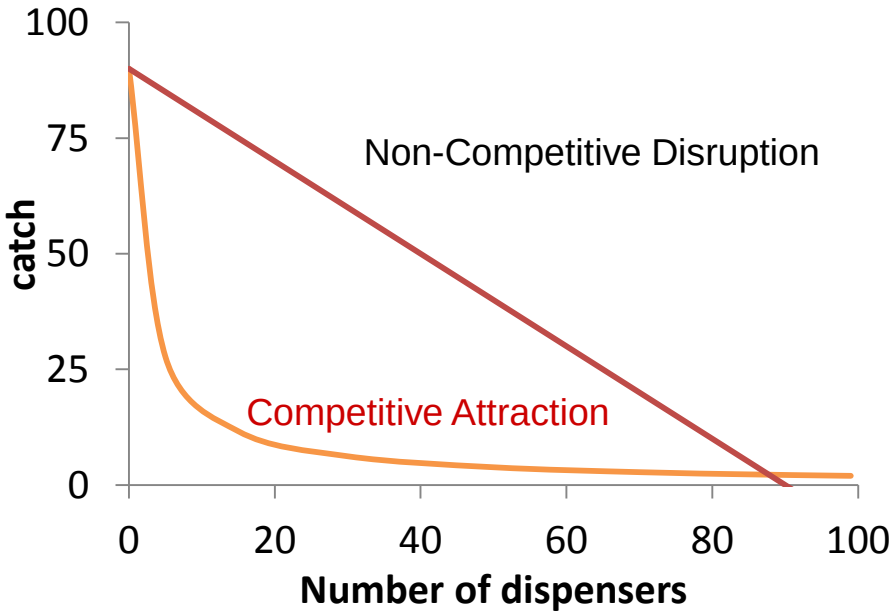




Differentiating the Mechanisms of Disruption

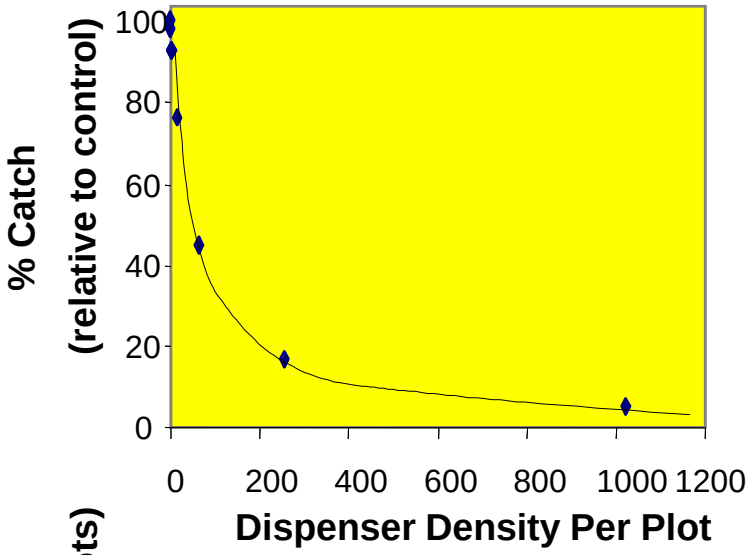
(Miller et. al. 2006. J. Chem. Ecol. 32:2089-2114)

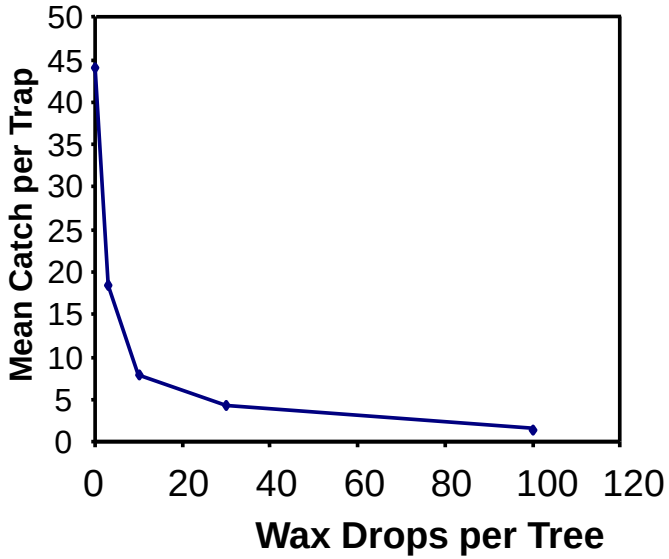
- Competitive Attraction
  - Simple probabilities
  - Each additional dispenser has diminishing impact upon population
  - Concave shape
- Non-Competitive Mechanisms
  - Each Dispenser has equal impact upon population
  - Negative linear slope

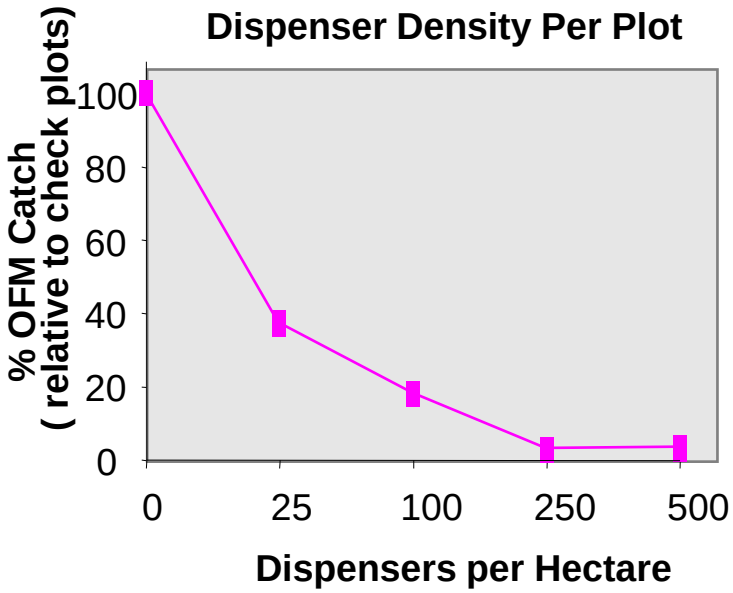


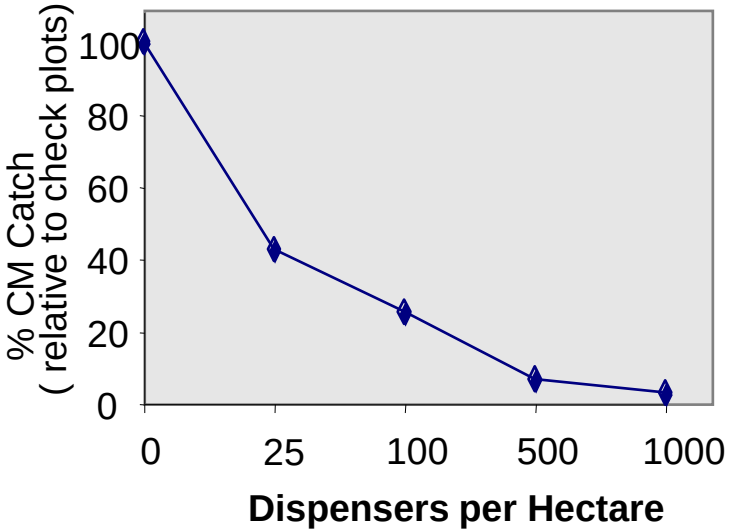
Plots generated from dosage response experiments most often fit competitive disruption profile

(Miller et. al. 2006. J. Chem. Ecol. 32:2115-2143)

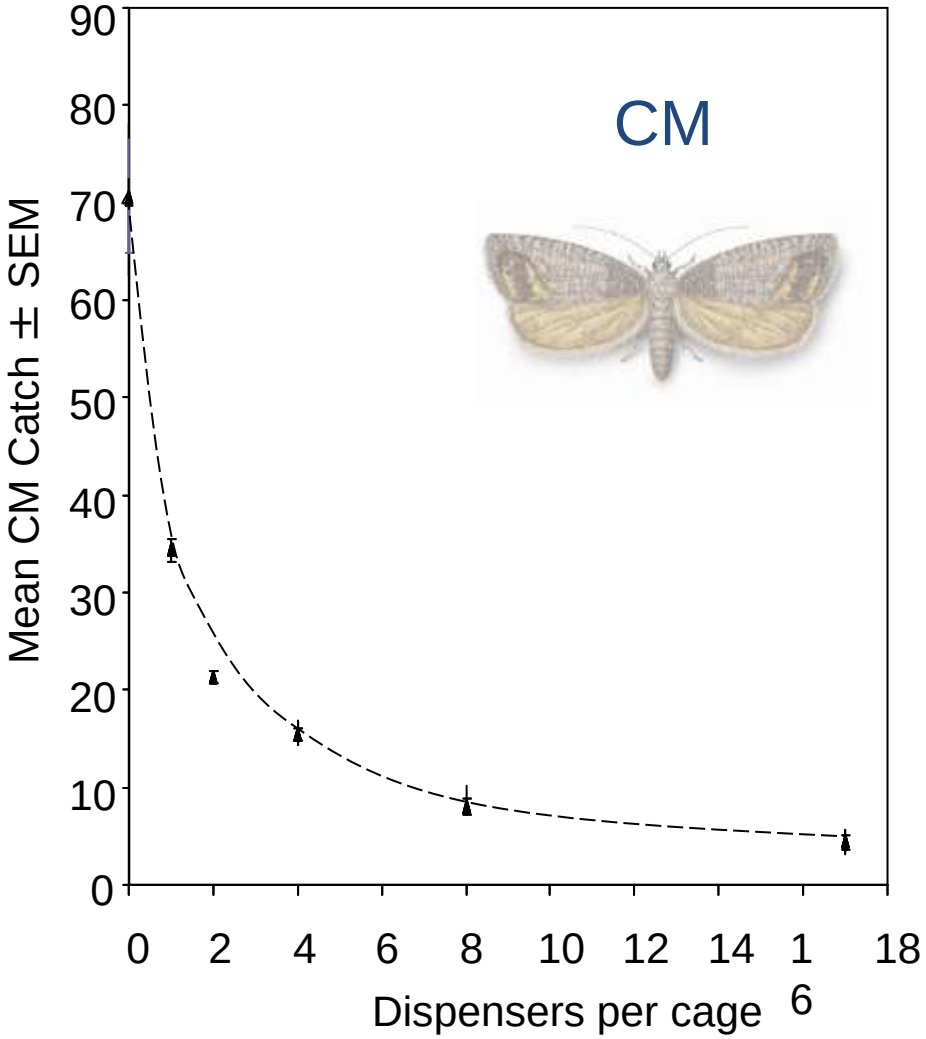


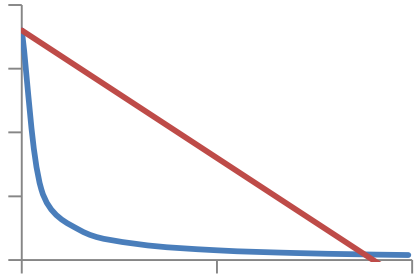


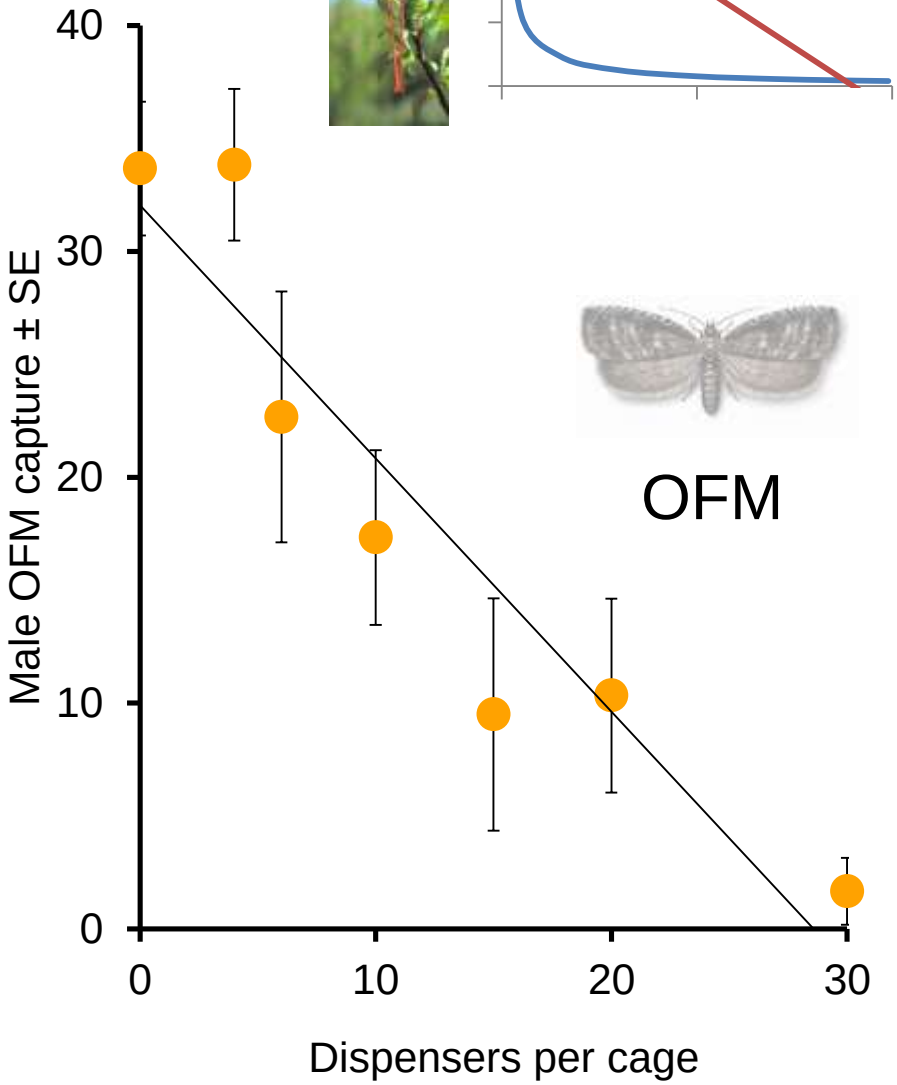




Dosage-response plots for high-releasing dispensers



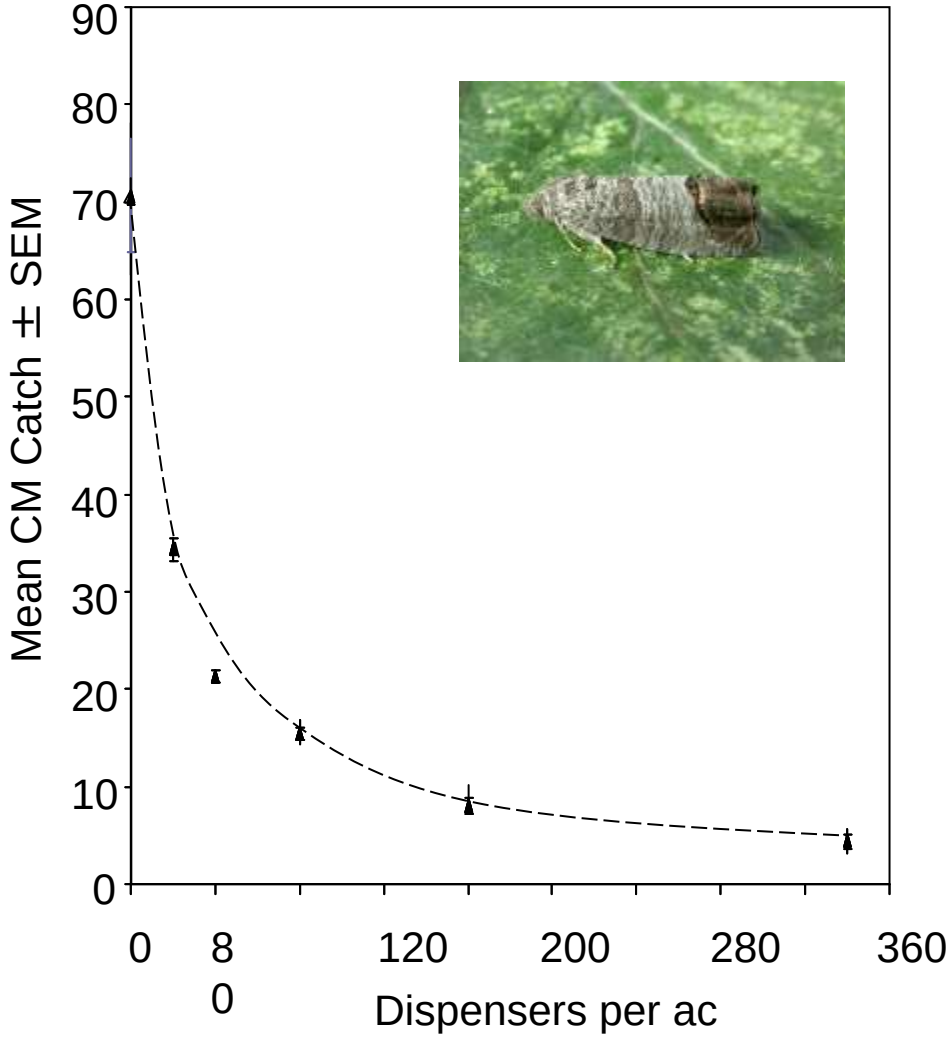




Why does pinpointing the principal disruption mechanism matter - Who cares?

Knowing the mechanism is competitive reveals:

- That it is a numbers game - the outcome is density dependent
- That the first few dispensers have the largest impact
- Achieving a high level of disruption may not be possible or practical

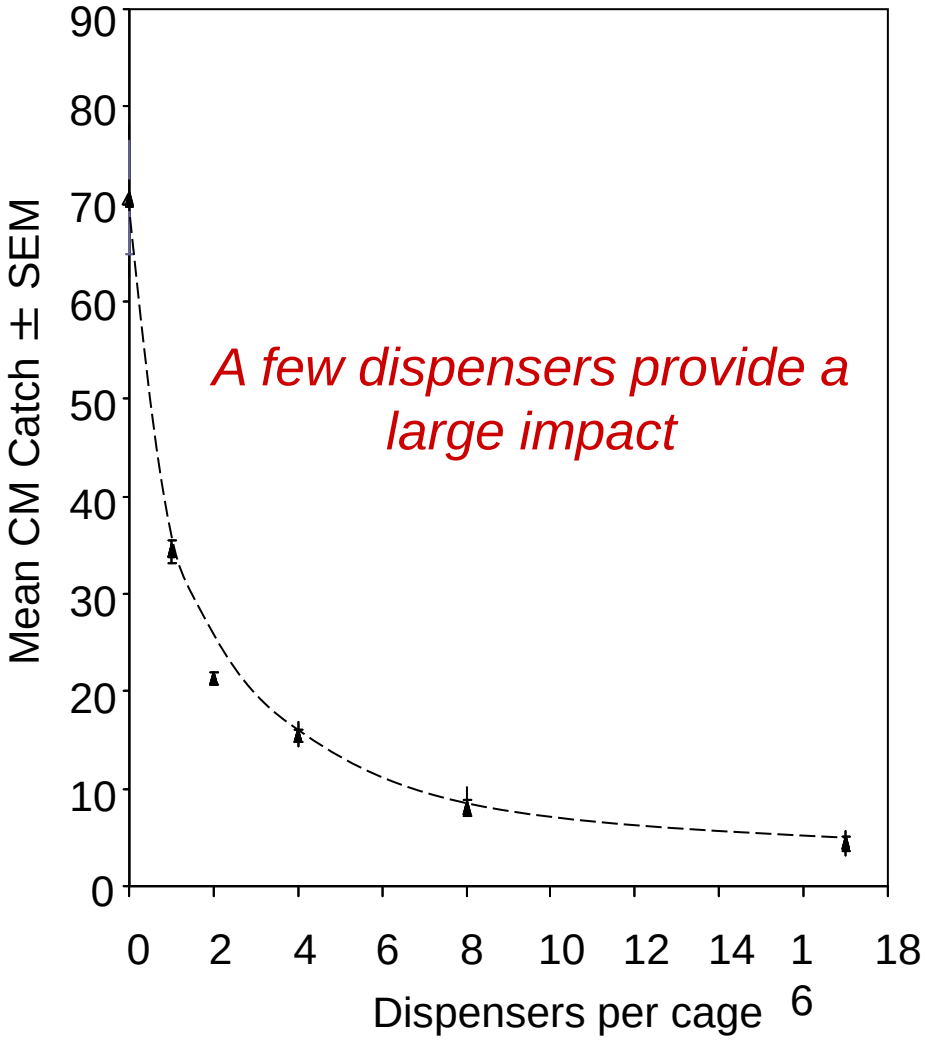


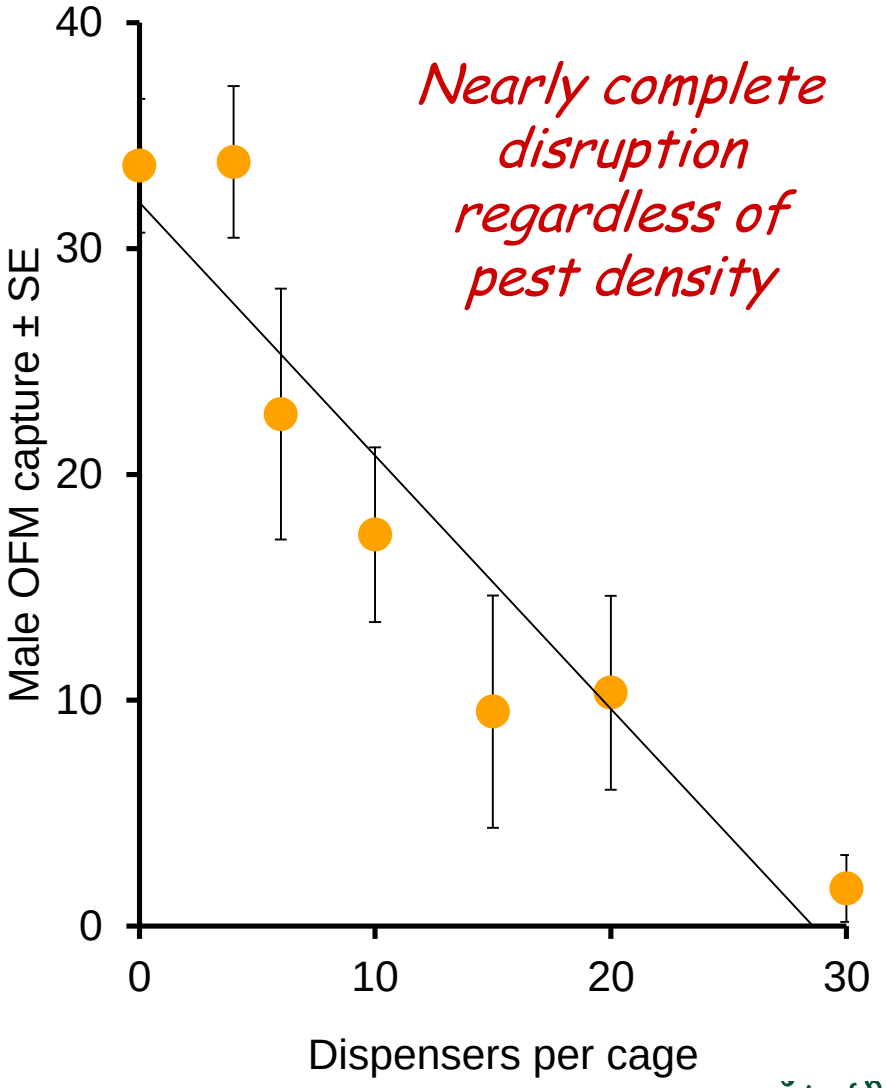
Why does pinpointing the principal disruption mechanism matter - Who cares?

Knowing the mechanism is non-competitive reveals:

- That the outcome is density independent
- Each dispenser has an equal impact
  - disruption may fail if pheromone distribution is inadequate due to low dispenser density
- A very high level of disruption can be achieved

Practical ramifications



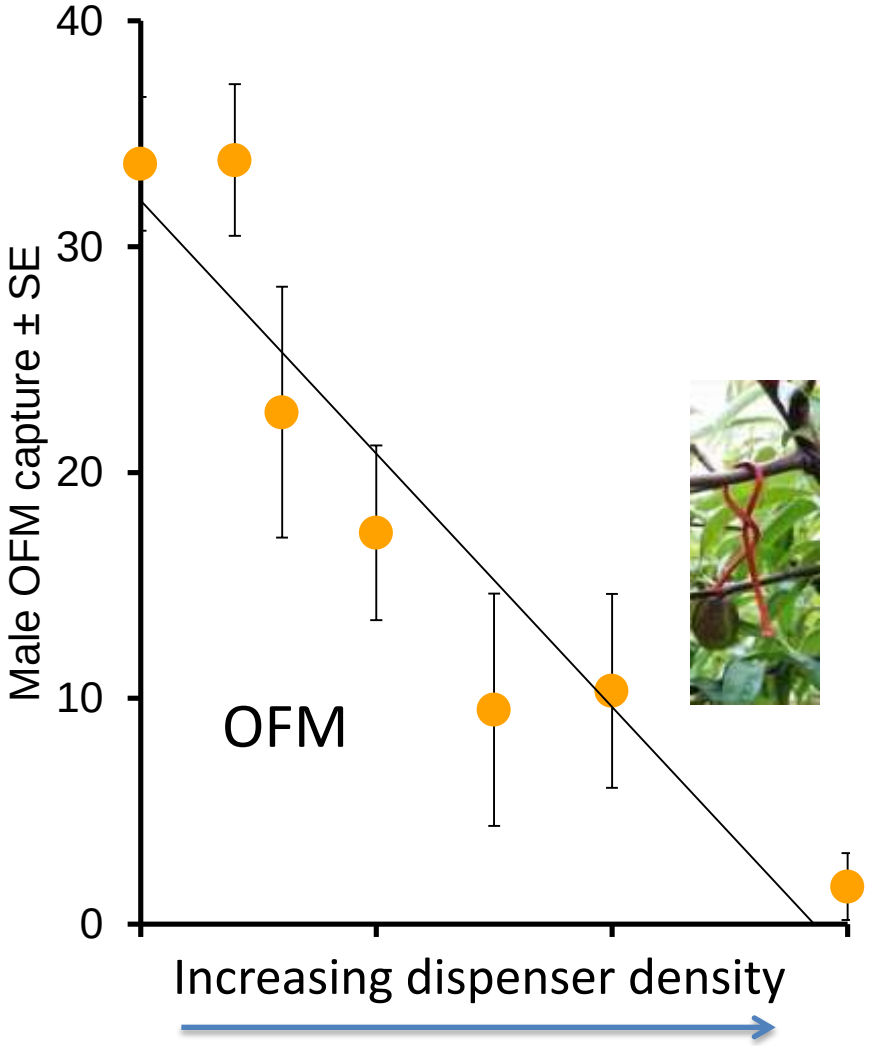


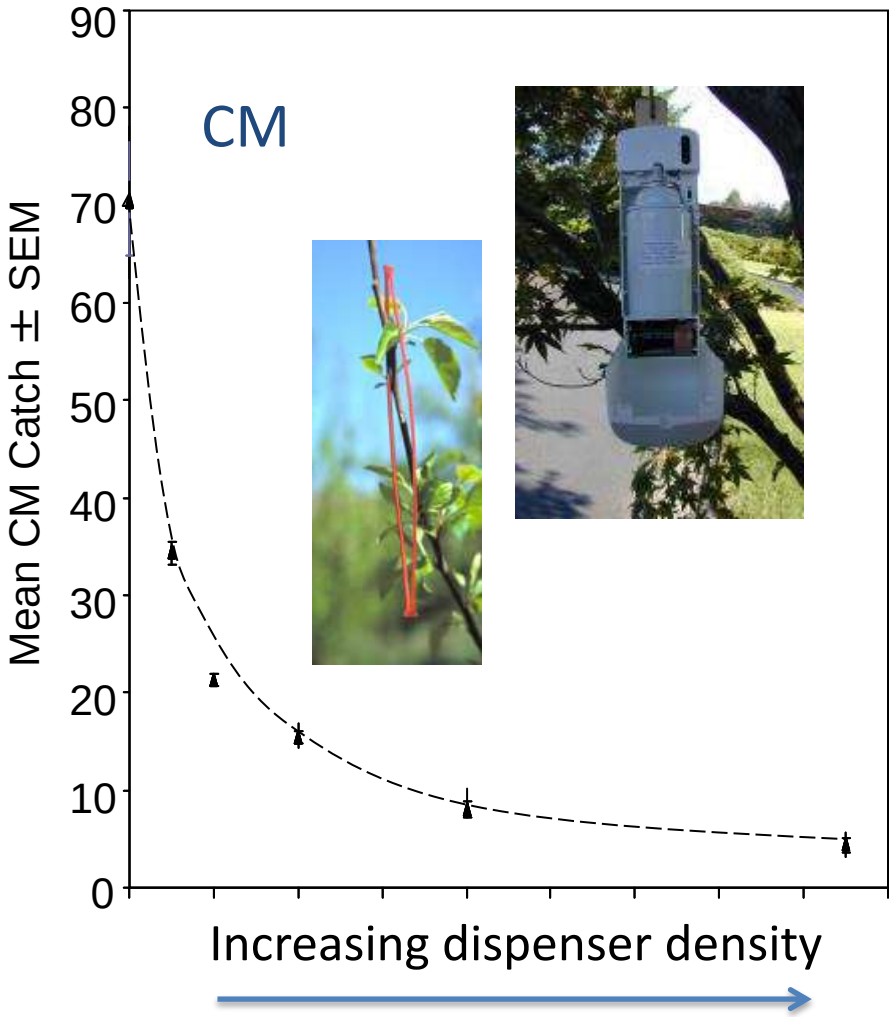
Practical ramifications

- It may be impossible to overwhelmingly suppress pest reproduction by mating disruption operating competitively, particularly when pest population densities are appreciable
  - ✓ Improve technology by optimizing release rates and application efficiency
  - ✓ Deploy fewer dispensers coupled with insecticides

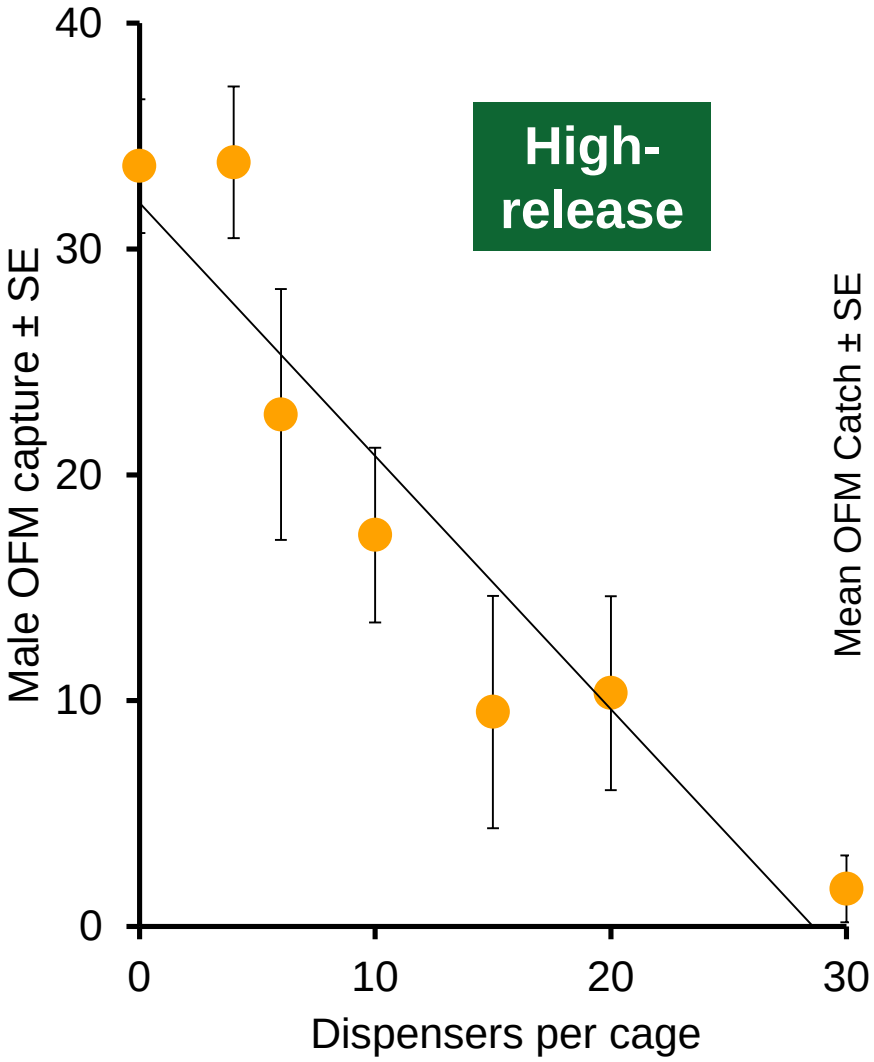
- The best opportunity for achieving high levels of control will be when mating disruption operates non-competitively
  - ✓ Determine the optimum dispenser release rate and deployment pattern required
  - ✓ Have realistic expectations, non-competitive disruption may not be possible for some species
  - ✓ Increase efforts to identify pests that are amenable to non-competitive disruption

Realistic expectations – OFM envy





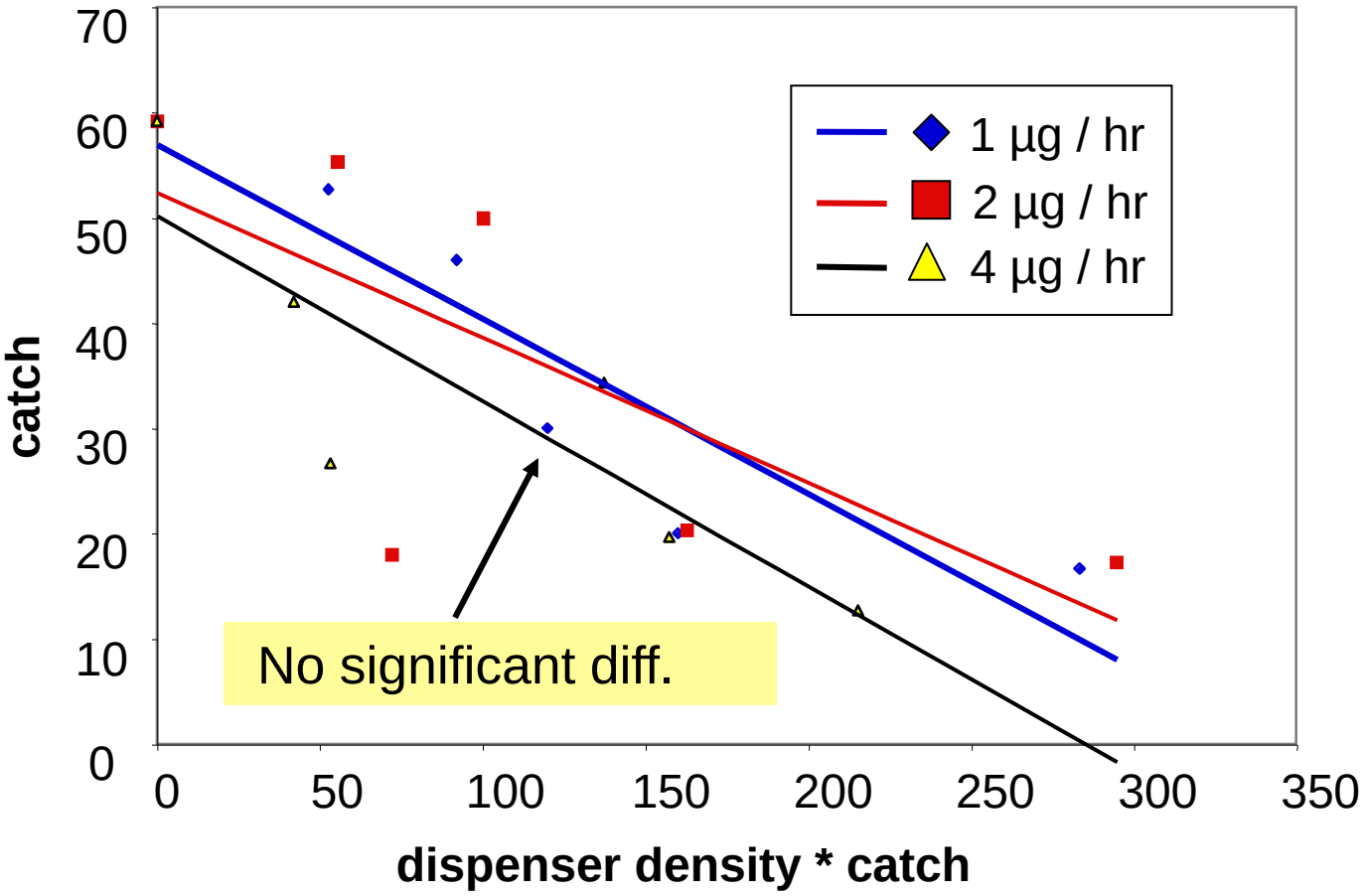
Flex-approach likely problematic for some pests



Can we reduce the amount of precious AI and not lose efficacy ?

Miller et al., 2009 Proc. Nat. Acad. Sci.

Similar levels of disruption are achieved using Isomate CM Flex® dispensers releasing pheromone across a range of rates



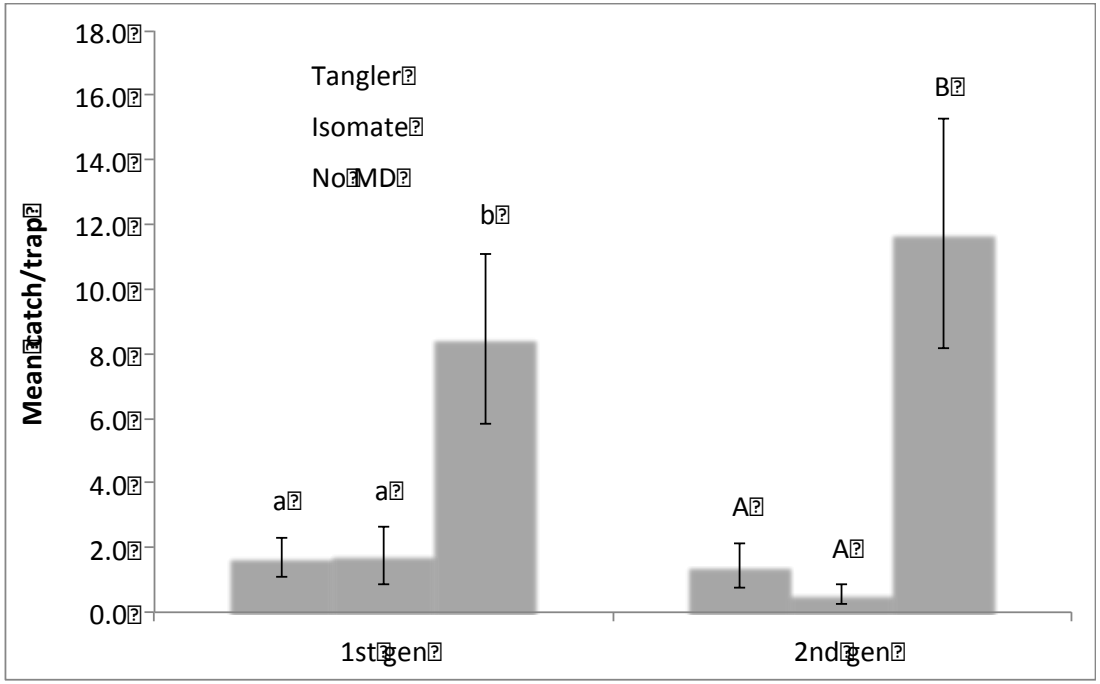
Flex 25
Flex 50
Flex 100

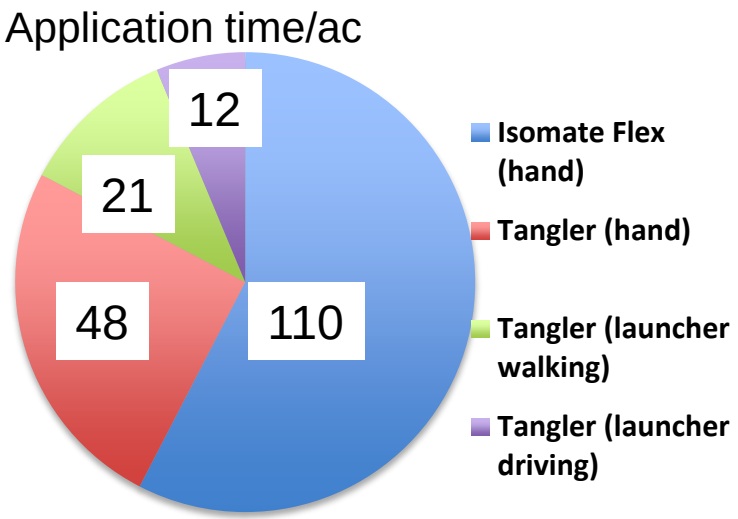
On-farm trials (2 ha plots) confirm that the amount of pheromone released from Isomate CM Flex can be substantially reduced without compromising efficacy

Reducing application rate

Data courtesy of Brunner et al., WSU

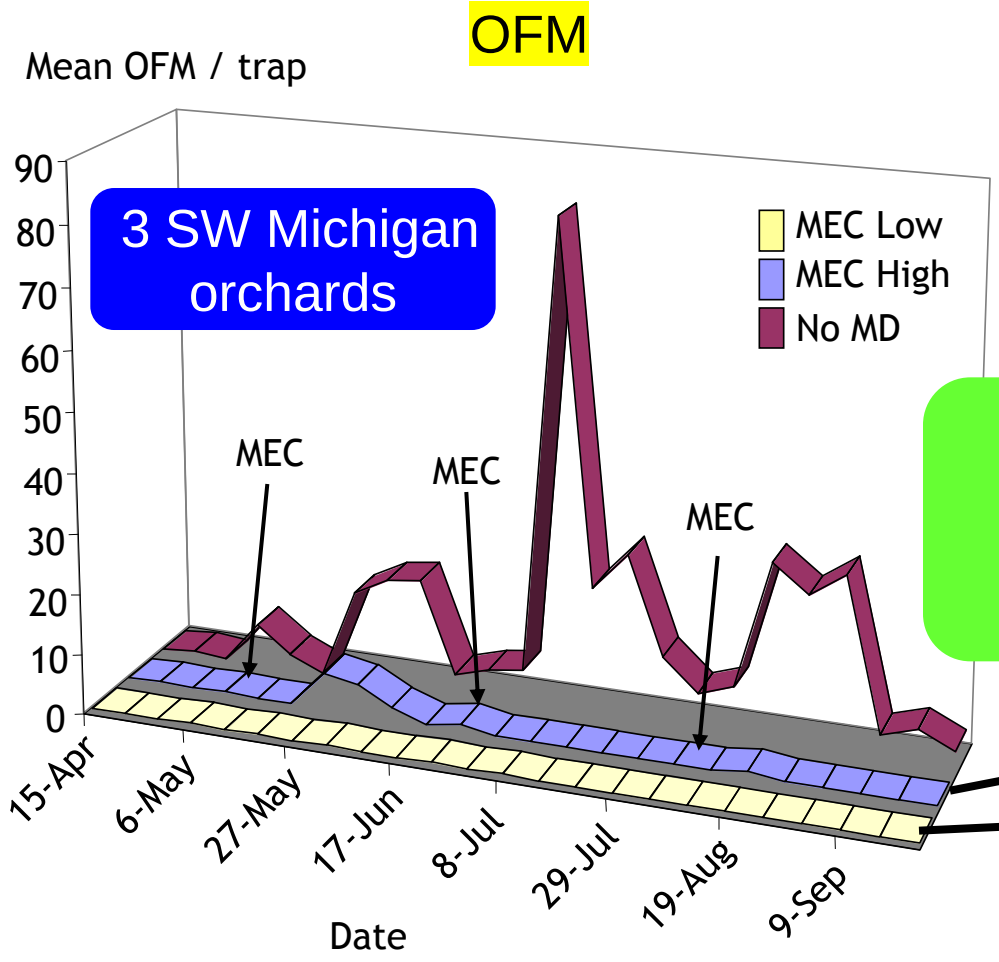
Reduced application costs
The Tangler®





Tangler™ CM

Sprayable pheromone



Low Rate Frequent Application (LRFA) is a GOOD approach

Weekly applications of 2-4 oz/ac

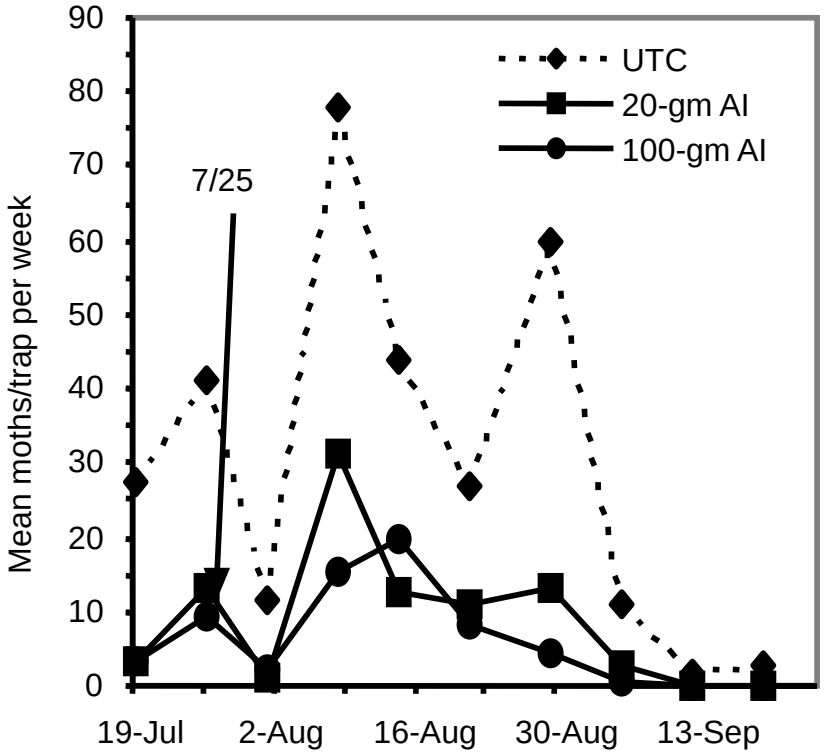
45 gm ai/acre per season

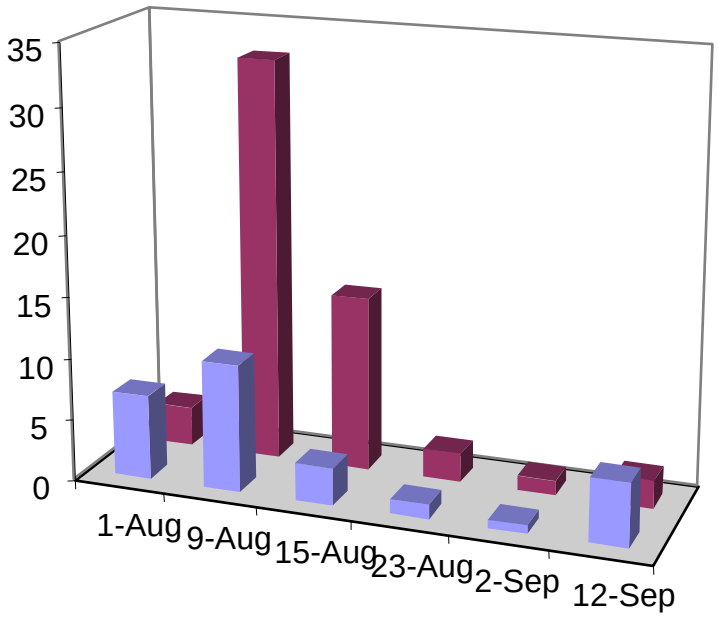
20 gm ai/acre per season

MEC sprayable formulations for CM

Airblast unsatisfactory

Low volume approach is the most efficacious





- Even then, we consistently achieve:
  only ca. 70% disruption for 2-3 weeks

Another approach to using sprayable pheromone

- Single application targeting peak flight

- 1-2 applications targeting summer generations

Apr May June July Aug Sep Oct

Multispecies disruption

- Single application of a dual-species dispenser, e.g., CM/OFM
  - *Must compromise on application density*

    CM - 300-400
    OFM - 100-200
  - *Deployment at the CM rate of 400/ac results over-treating for OFM by 200-300 dispensers/ac*

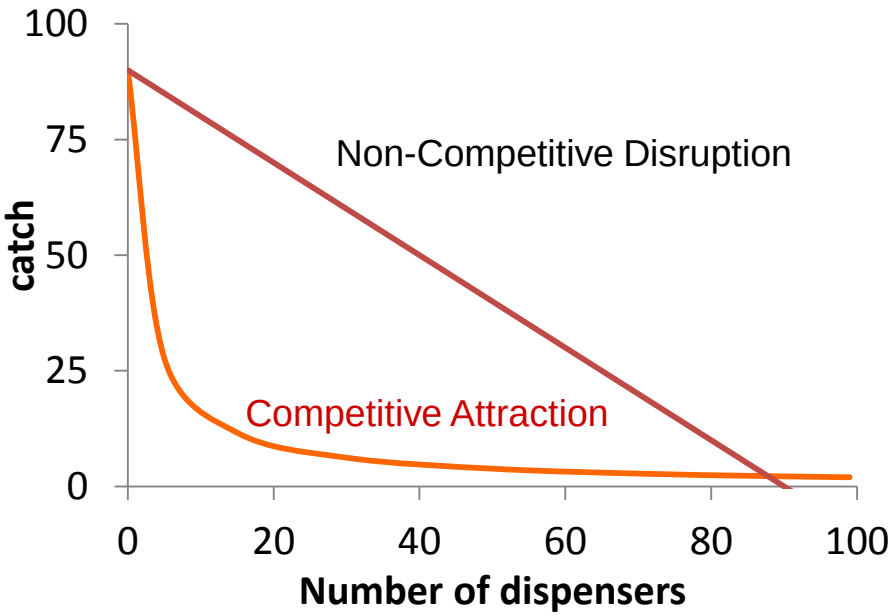
- More economical approach:

  CM/OFM dual @ 100-200/ac
  CM @ 100-300/ac

Is non-competitive, high-level, disruption possible for some species ?

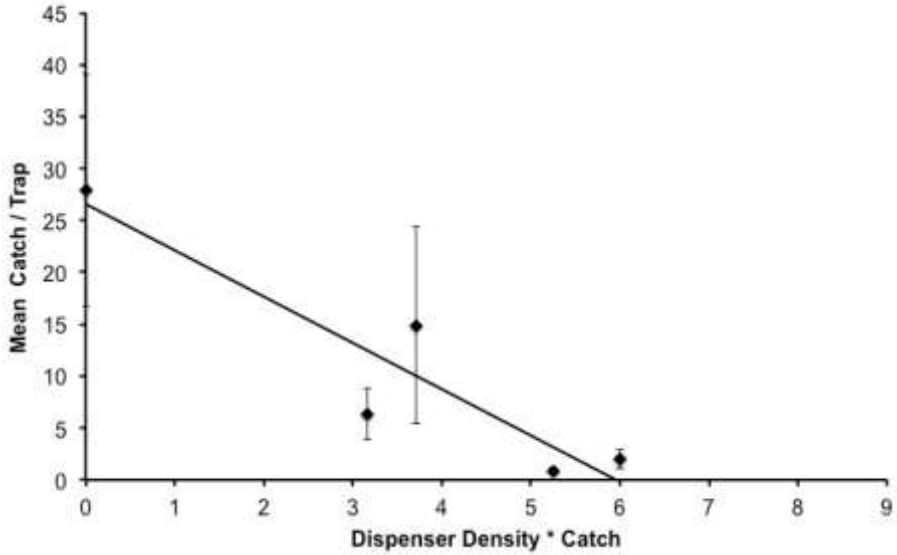
Aerosol emitters

Meso-dispensers



Graphical analysis reveals that AE's disrupt CM competitively

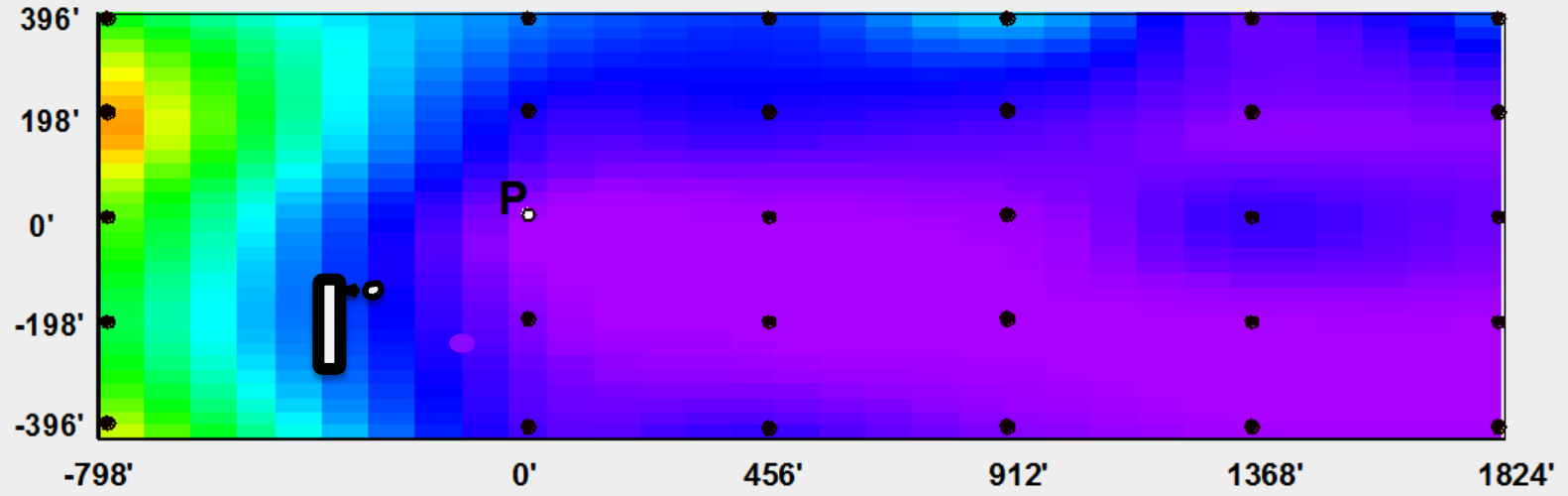
McGhee et al. 2014. Pest Manag. Sci. 70:1859-1862



Mean Catch / Trap

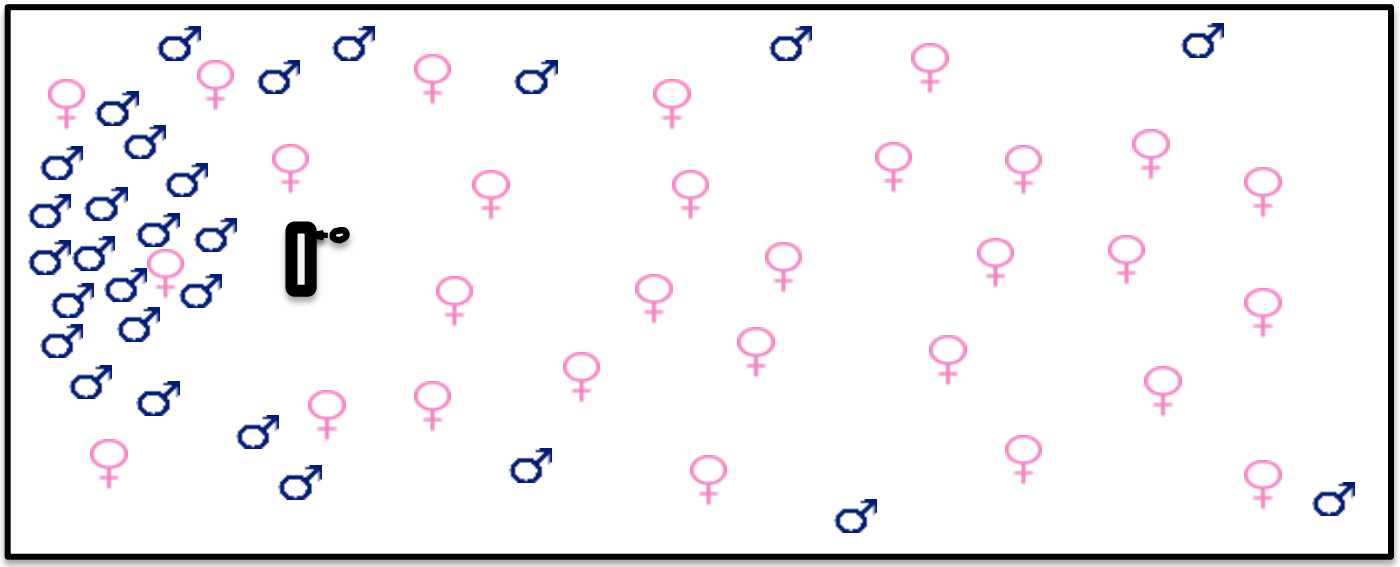
Dispensers / Ac

Low catch Interpreted as huge plume and males deactivated downwind

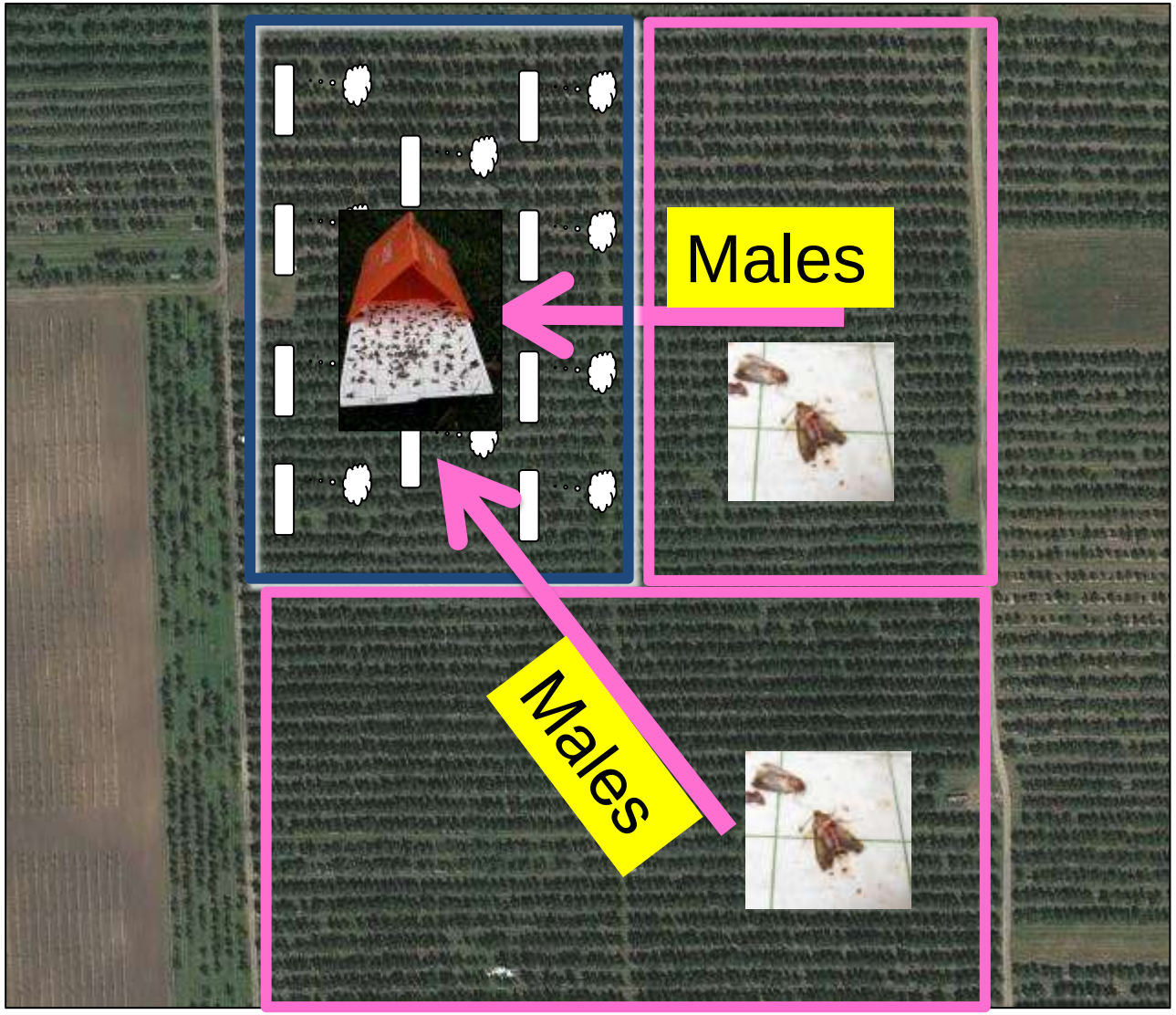


More likely, males move upwind towards the emitter

bypassing traps and females



Be aware of effects on adjacent orchards



Optimum dispenser density

If we need <u>at least</u> one AE/acre

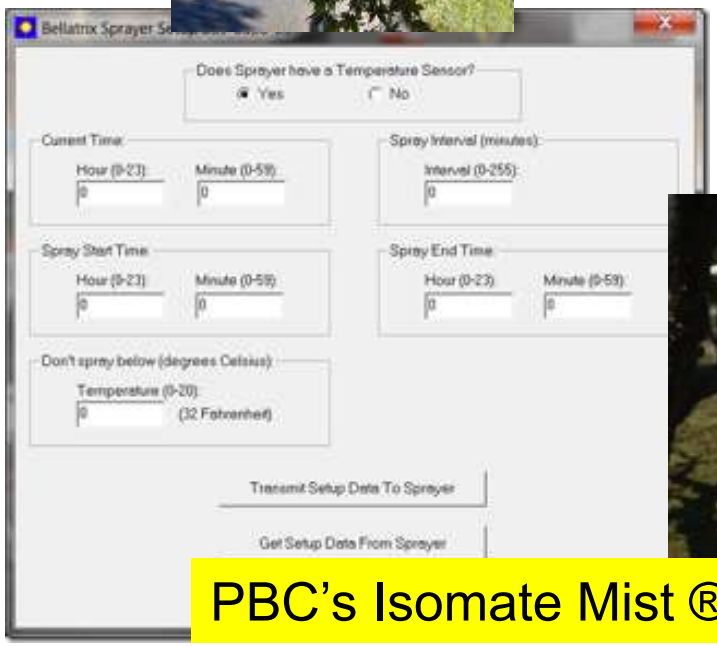
How can we do this economically?

Reduce the cost of the dispenser (AE)

Release rate based on matching that of reservoir dispensers deployed at 1000/ha

Current use parameters

- ca 70 gm codlemone / unit
- Sprayed every 15 minutes
- 12 hour cycle (0500-1500 hr)



PBC's Isomate Mist ®

Other options

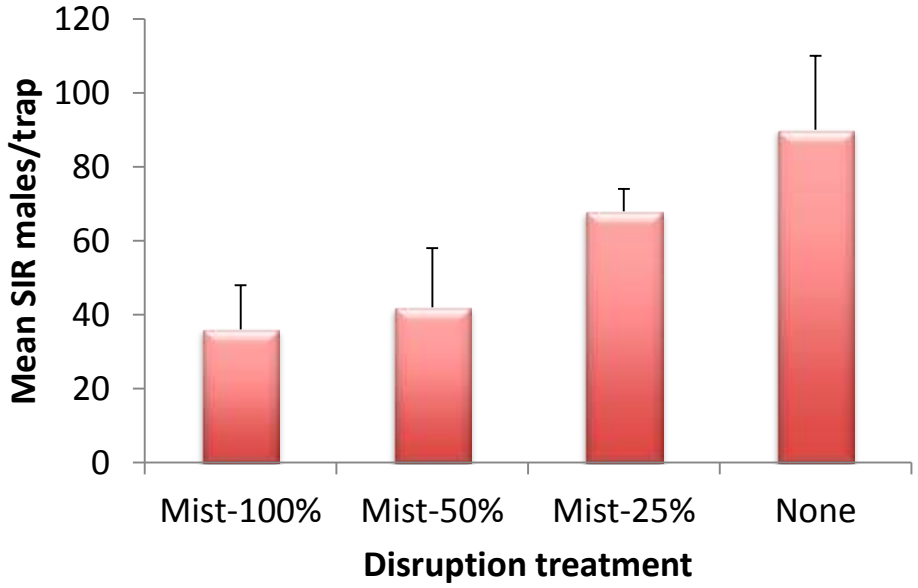
- Reduce loading rate
- Reduce ON cycling time
- Reduce spray interval

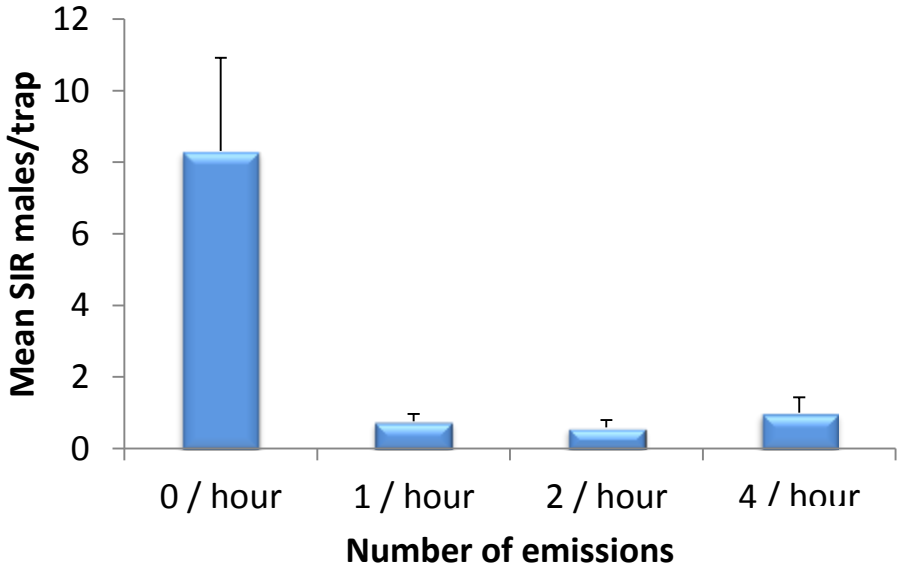
Optimize release rate to reduce cost

Release rate based on matching that of reservoir dispensers deployed at 1000/ha

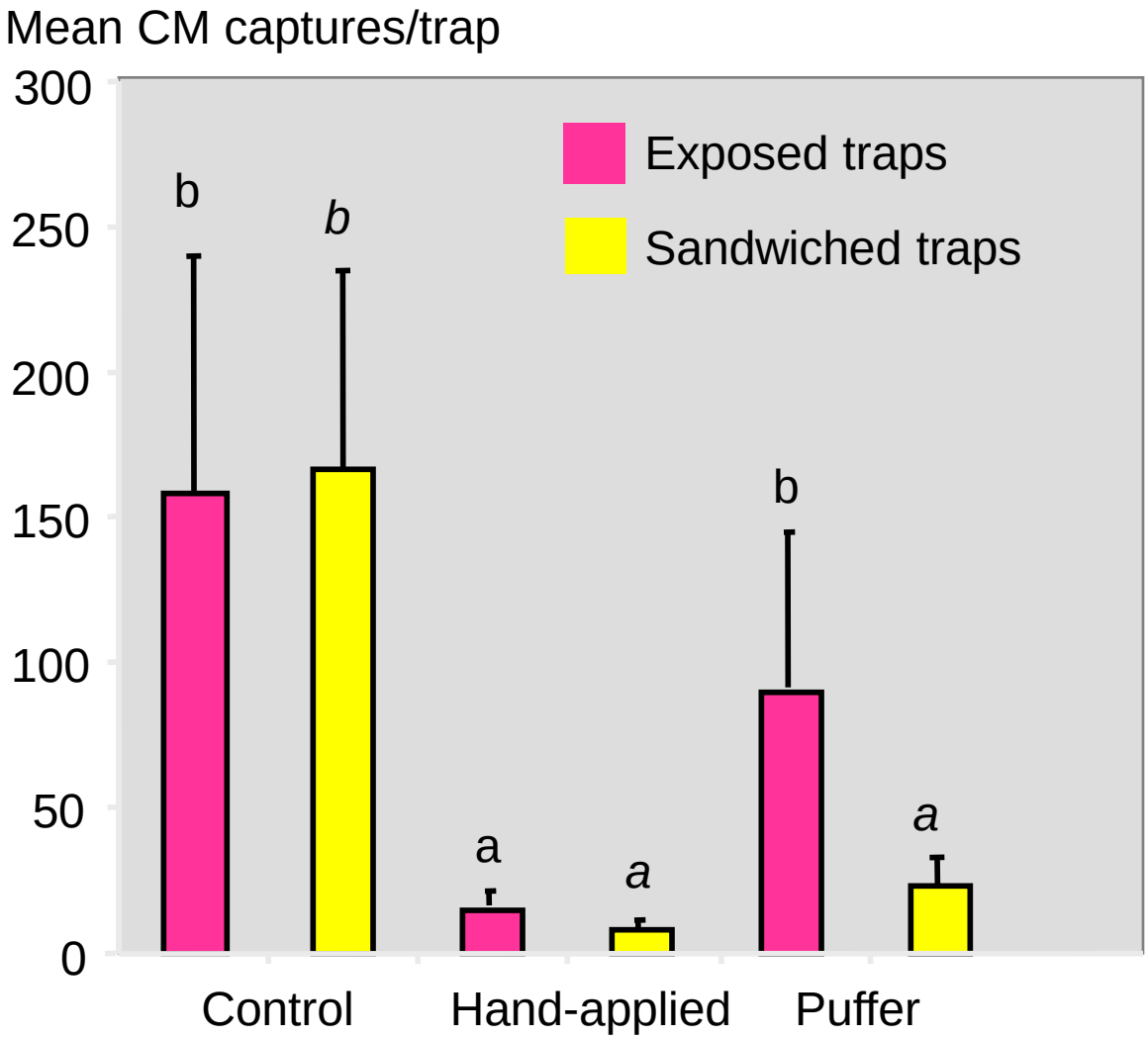
Current use parameters

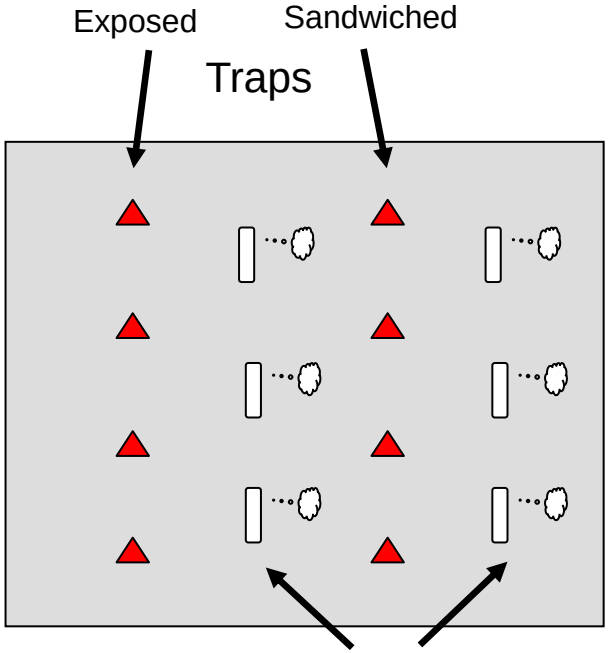
- ca 70 gm codlemone / unit
- Sprayed every 15 minutes
- 12 hour cycle (0500-1500 hr)





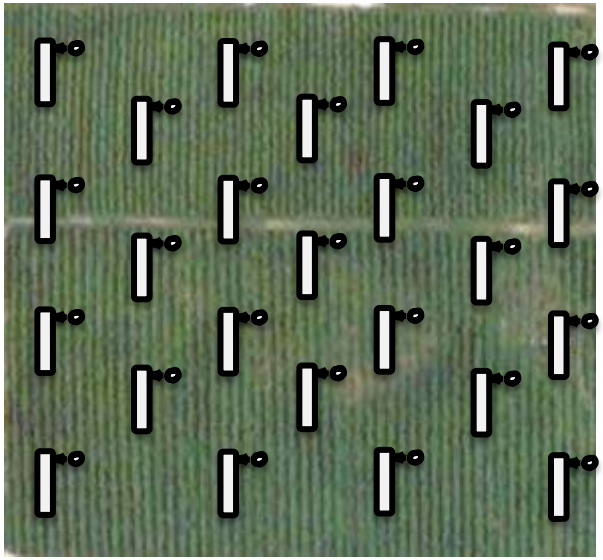
Aerosol emitters: Edges are problematic

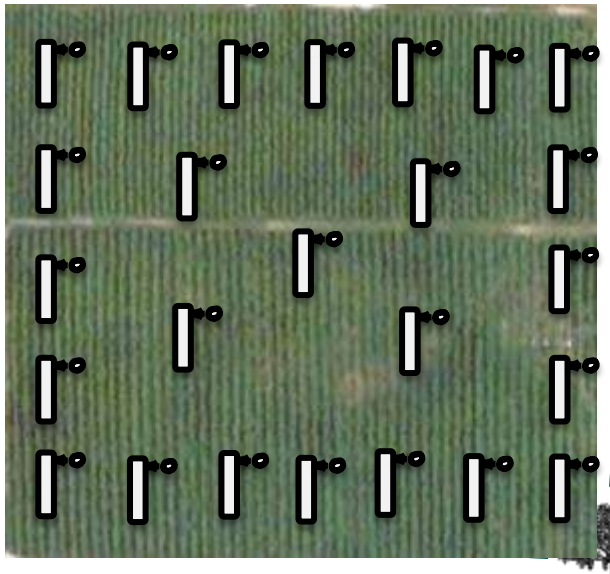




Deployment options

- Grid pattern
- Primarily along edges
- Supplemental insecticides along perimeters





Pete tests puffers

Resistance recorded

Andrew is born

2004

2000-03

Moves to MI
…….. with his wife, Gayle

1999

Leads a dozen pheromone projects,
No children
Evidence for mating disruption?

Thanks to the many who have contributed to these efforts

Jim Miller

Peter McGhee

Lukasz Stelinski

grower cooperators

Mike Reinke

pheromone industry

ShinEtsu

Suterra®

SCENTRY

Funding provided by:
• USDA-AFRI
• MI Apple Res. Comm.
• WA Tree Fruit Res. Comm.
• MSU and Project GREEEN
• Industry supported