

Reduced rates of pheromone applications for control of codling moth (*Cydia pomonella*) in pear and walnut orchards

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Two approaches

- Reducing the number of point sources per acre to reduce labor costs (meso dispensers)
- Reducing the amount of pheromone required per acre to reduce material costs (meso and puffer trials) – D. Casado



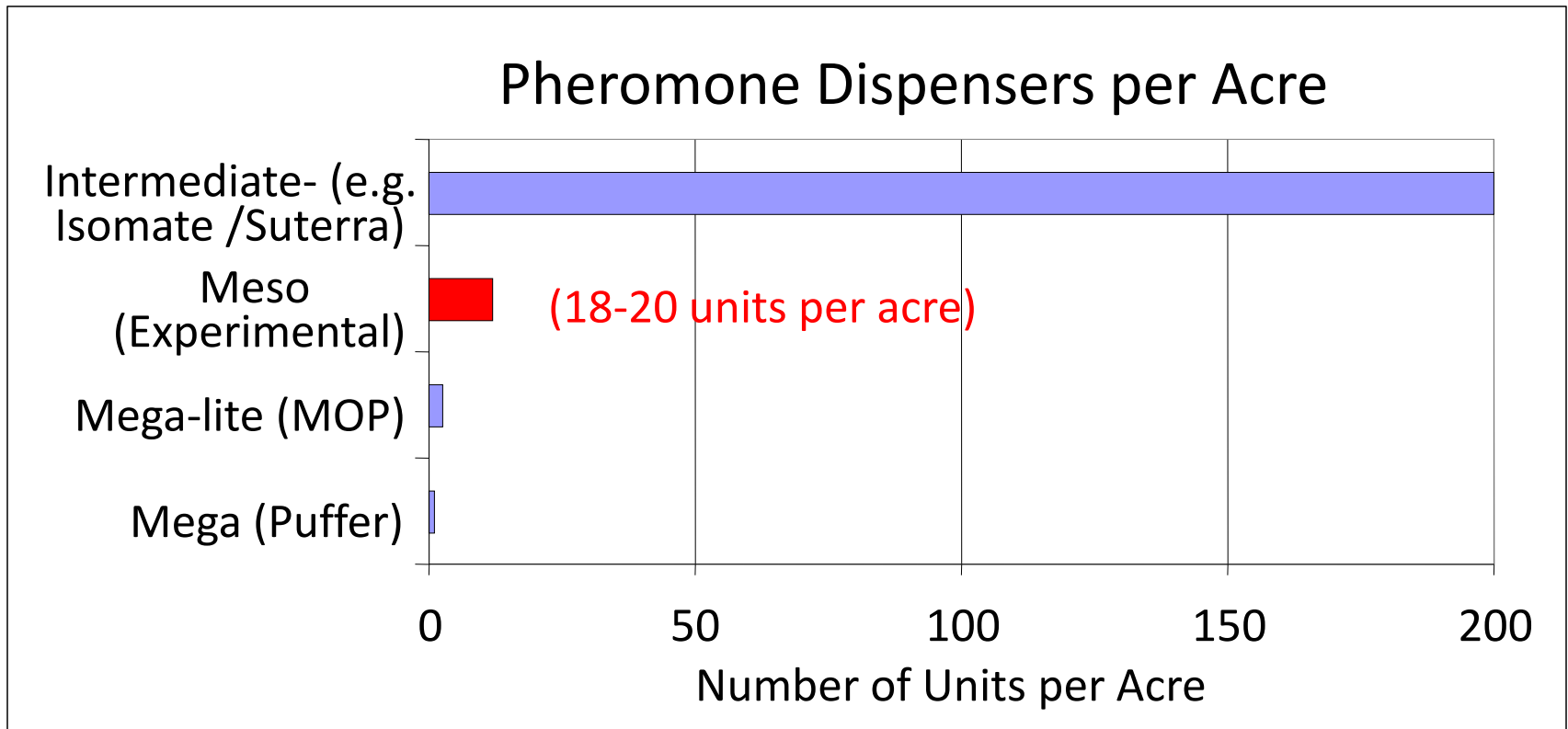
- Goal: To optimize pheromone mating disruption for codling moth for lower overall costs and lower labor requirements
 - Design a device that provides comparable control to current pheromone MD standard programs (CTT, Checkmate in US) using hand-applied dispensers
- 2009-10 field trial focus – Large block testing of “best” mesos from 2007 and 2008
 - Meso-emitter rate trials (walnuts only)
 - Meso-emitter large plot efficacy trials (walnuts and pears)

Conclusions – Starting at the End

- Meso emitters appear to provide control equal to the standard pheromone programs **IF** the same levels of pheromone per acre are used (20 Suterra Mesos and 40 Rings)
- At lower densities of codling moth, lower levels of pheromone should also work
- If verified with damage data, the amount of pheromone per acre in puffers can be reduced by 50% or more
- Reductions in labor (meso dispensers) and overall program costs (amount of pheromone) appear possible

Pheromone “Meso-emitter”

- Hand applied dispenser unit
- Reduced point sources: **18-20 units per acre** vs >160 per acre
- Higher emission rate per unit (vs Checkmate or Isomate)
- Initially keeping the amount of pheromone constant per acre



Current Meso-emitter Products

(Differ in Expected Total Pheromone per Acre)



Isomate "Ring" (2008)

* 2009 "ring" is a 5-C TT unit that separates to form a ring of 10 single tubes.
Deployed at 20-40 rings per acre.

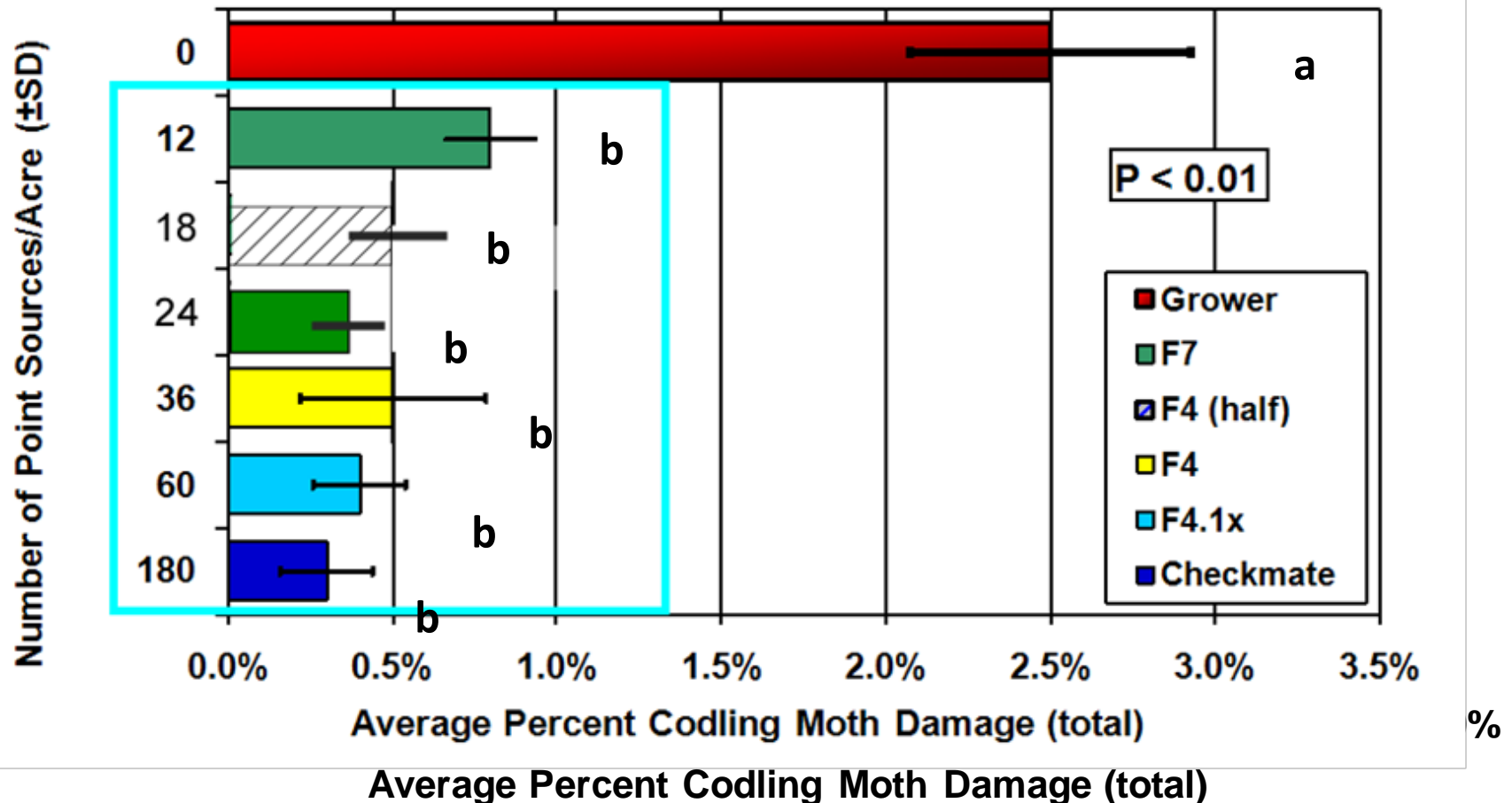


G037

CM XL1000
(for comparison)

Suterra membrane type dispensers.
G037 deployed at 18 units per acre.

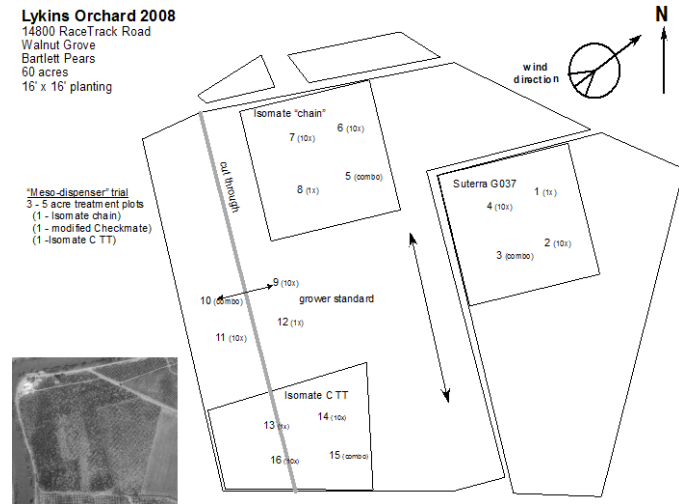
2007 Walnuts: Point Source Manipulation Total Codling Moth Damage at Harvest



Selected 20 units per acre as starting point from replicated 5 acre plot trial

2010 Meso-emitter Efficacy Trials

Lykins Orchard 2008
14800 RaceTrack Road
Walnut Grove
Bartlett Pears
60 acres
16' x 16' planting



Large plot meso plots in orchards expected to have high codling moth densities (1 Sacramento, 3 in Lake County)

Treatments:

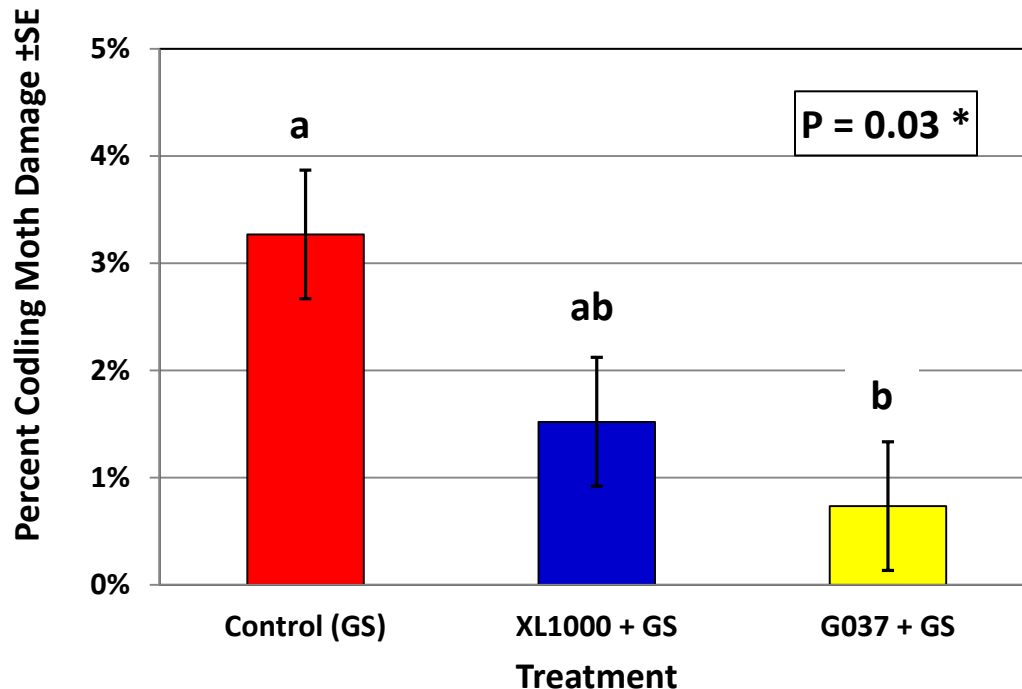
Meso Treatment (Suterra Meso or Pacific
Biocontrol Rings
Standard pheromone (Checkmate or CTT)
Controls (Untreated (3))

Assessments: Fruit Damage and Trap Suppression

Suterra Meso-emitter Efficacy 2009

Combined commodity data (n=8)

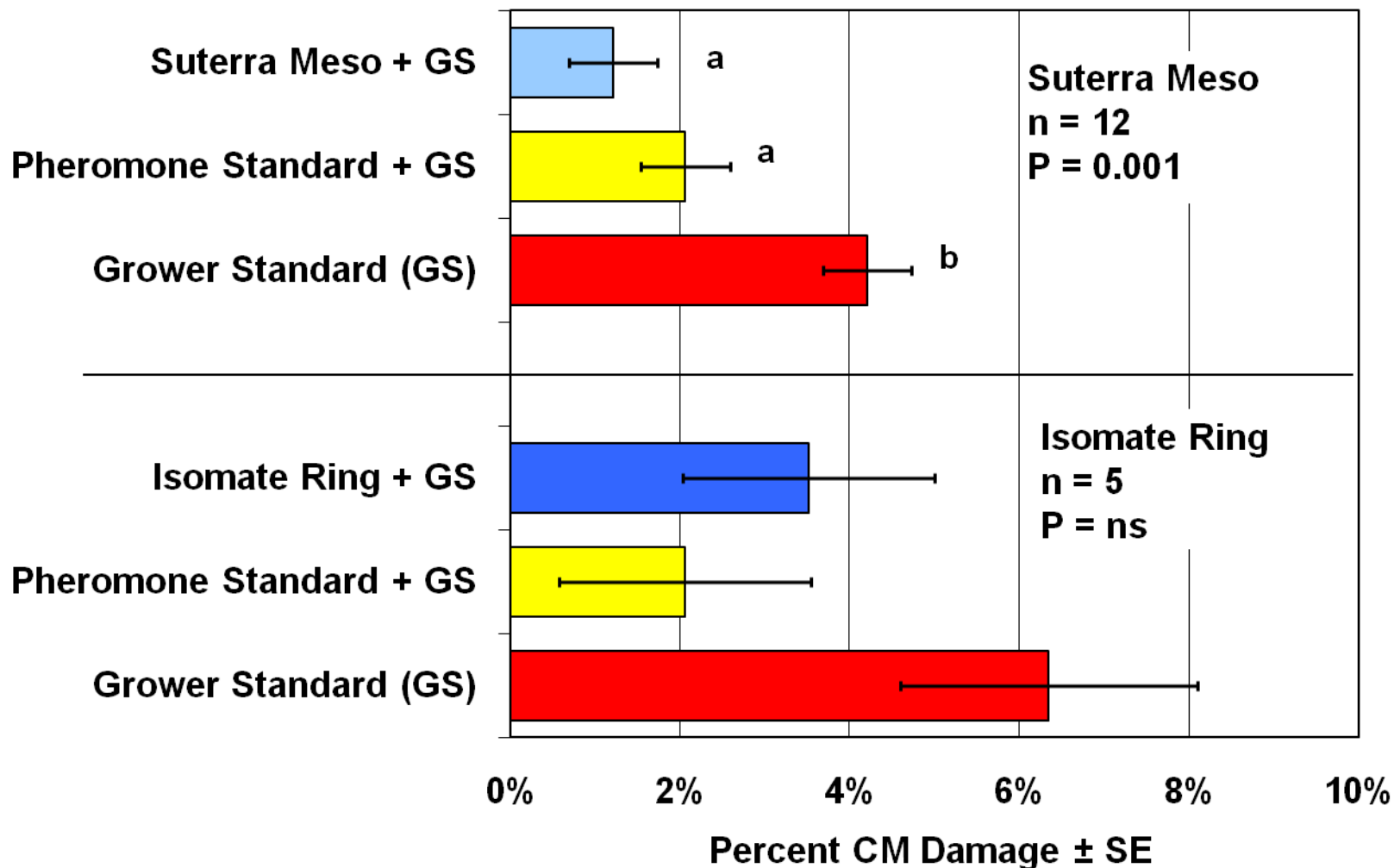
Pear and Walnut Combined Codling Moth Damage at Harvest 2009



- Damage was significantly suppressed by meso program compared to control
- No statistical difference between meso and standard pheromone programs
- Control plots were as follows
 - Pears – untreated controls
 - Walnuts - may have included insecticide treatments applied by the grower uniformly to both control and pheromone plots.
- Plots sizes varies, but ranged from 10-20 acres for meso plots

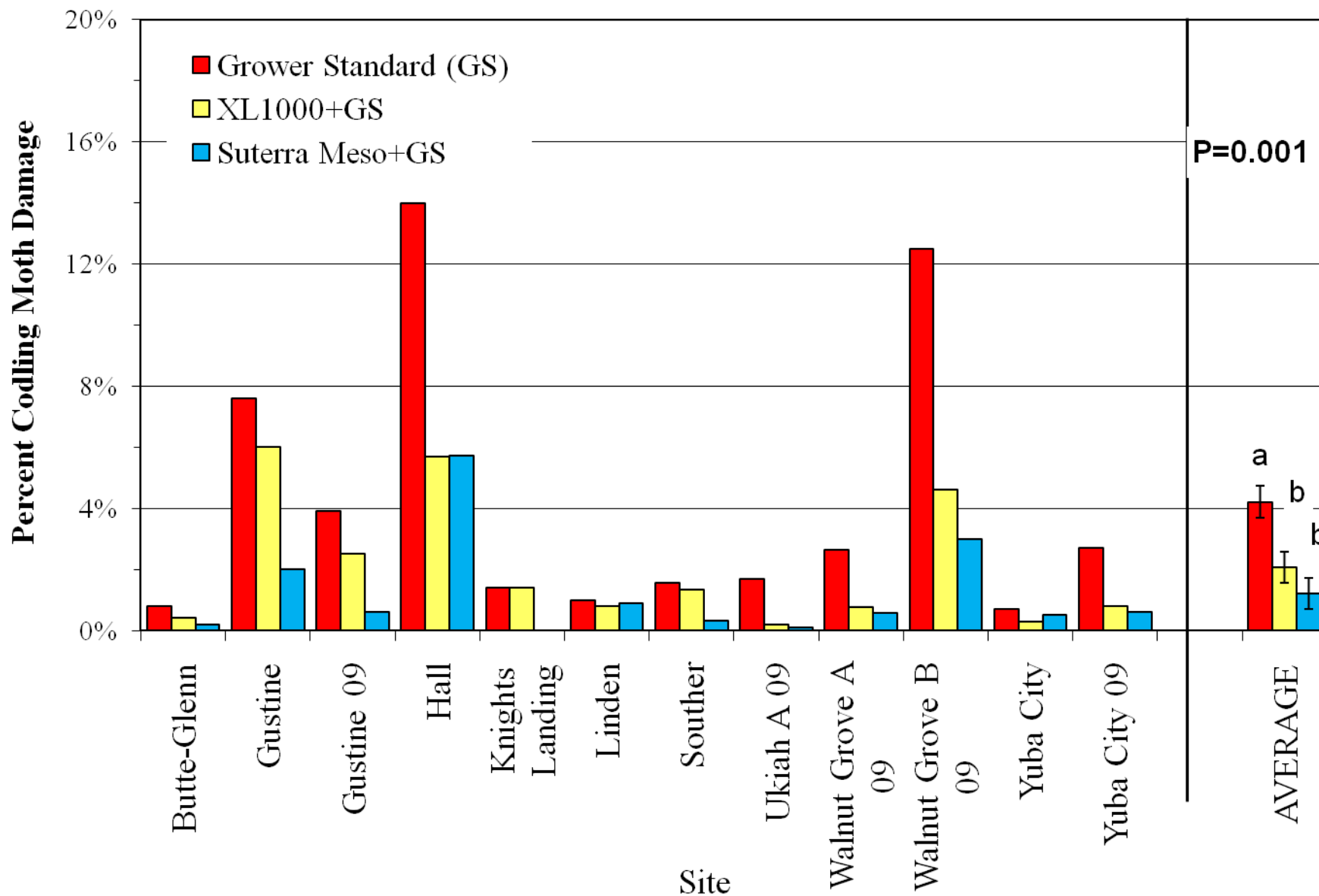
Blocks with 0% damage in all treatments excluded

2009-2010 Isomate Ring and Suterra Meso Trials Codling Moth Damage at Harvest



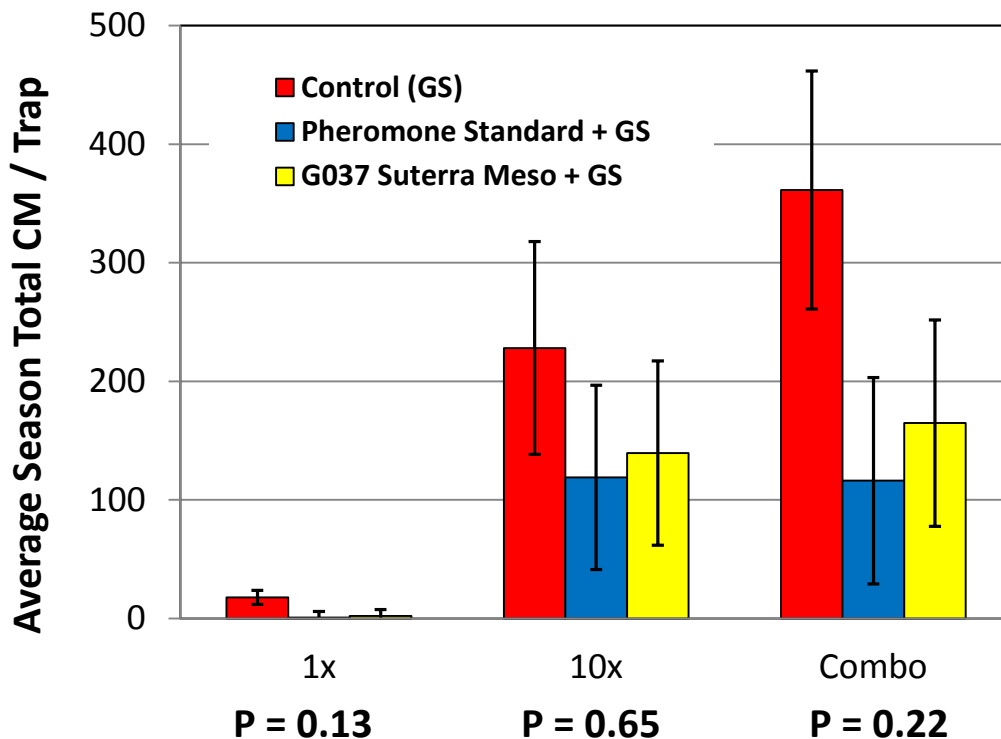
2009-2010 Suterra Meso Trials

Codling Moth Damage at Harvest (Pears & Walnuts)



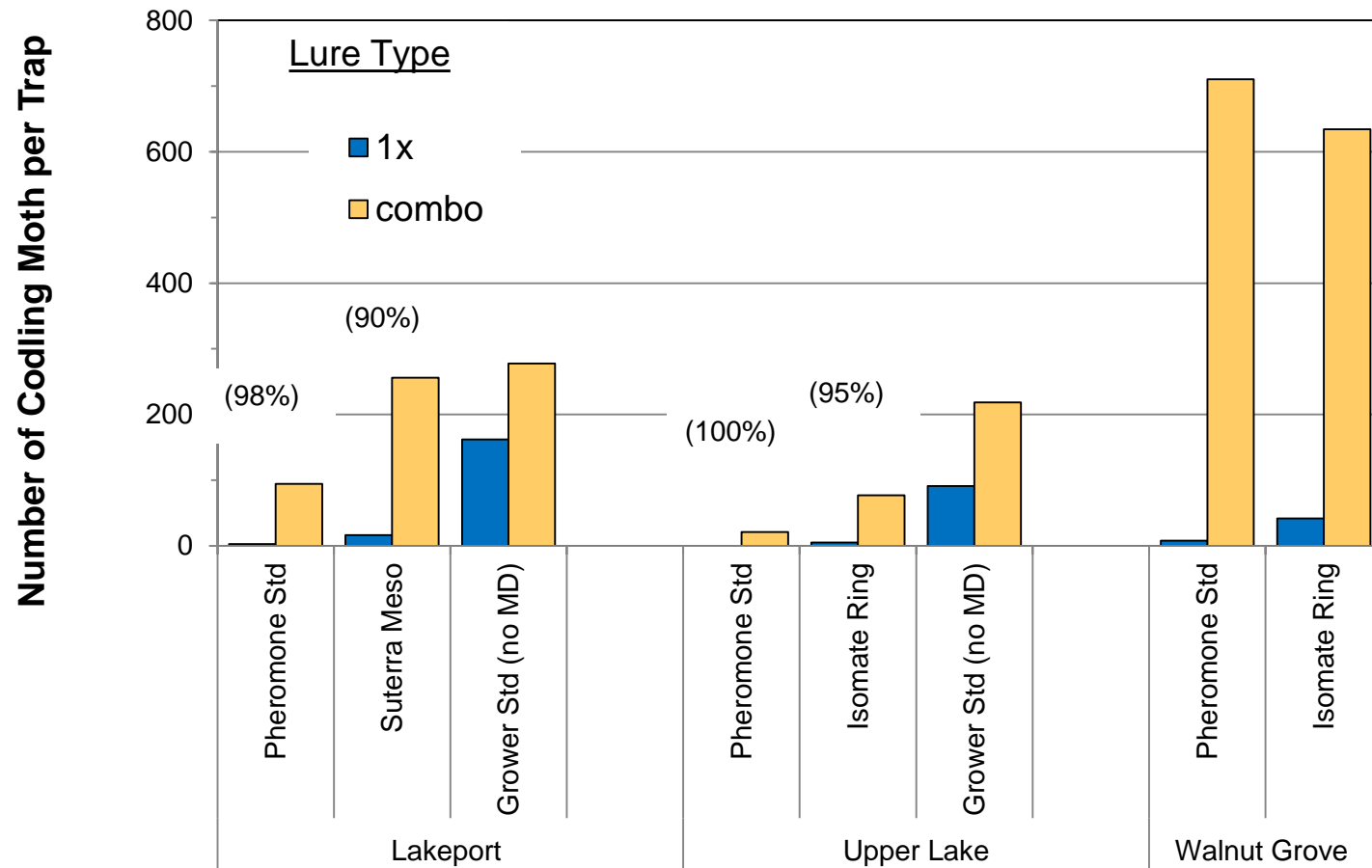
Pears: Trap Capture and Suppression 2009

2009 Pears: Season Total Trap Capture



- For each lure type higher numbers collected in untreated controls
- Lack of independence between plots indicated by low 1x counts in untreated controls
- No significance between plot treatments
- Even with large blocks, there is pheromone intrusion
- Meso treated plots will catch more moths (ca. 10-20%)

2010 Pears: Modified Dispenser Efficacy Trials Season Total Trap Capture

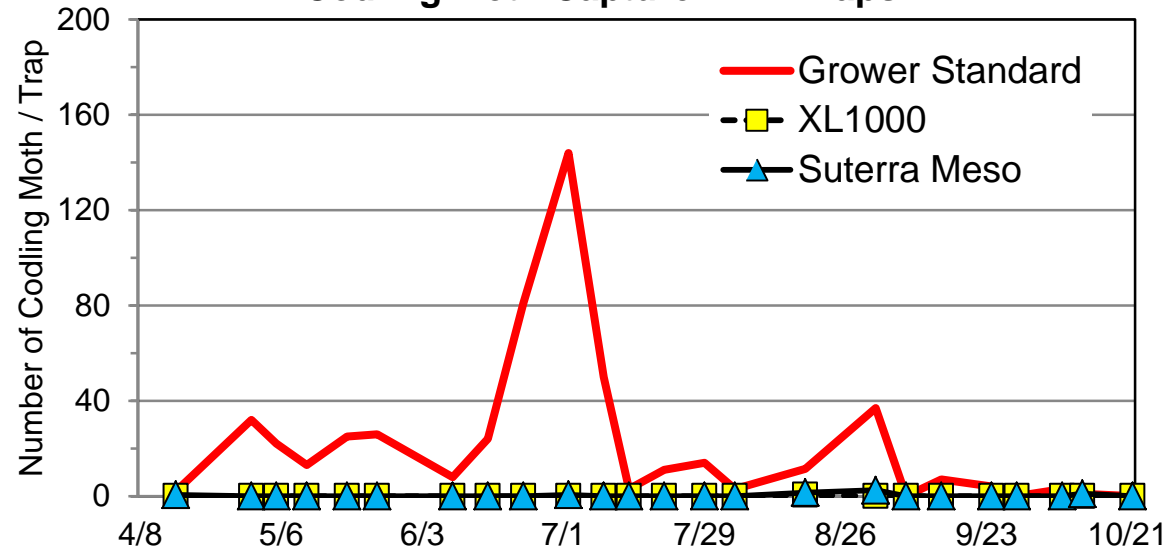


Trap Suppression in Walnuts

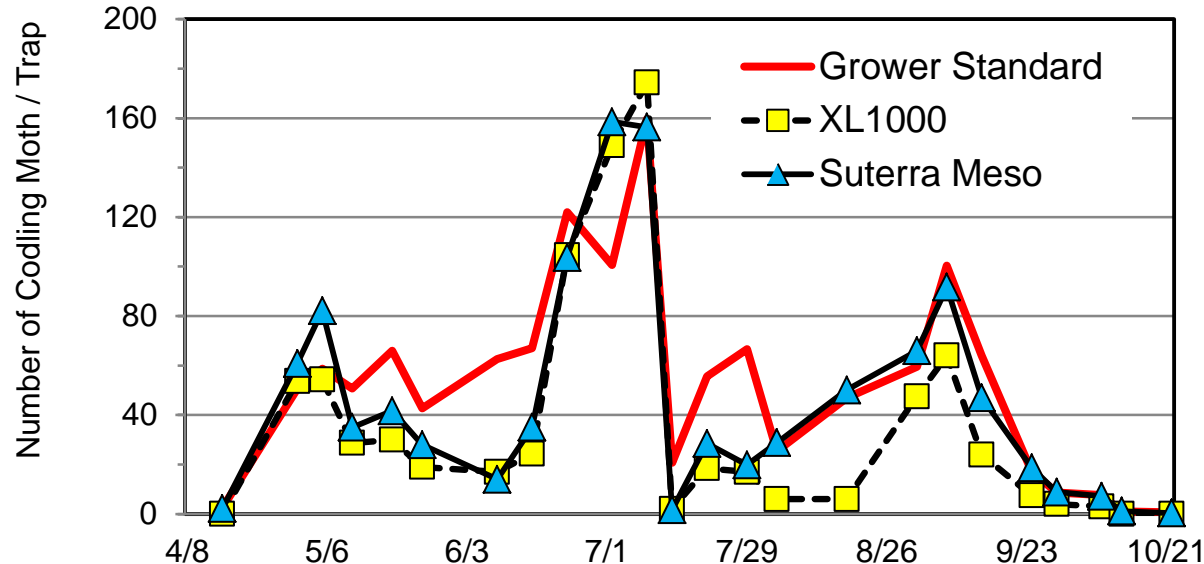
High pressure orchard in Gustine, CA

Whereas combo lure baited traps >1300 moths / season, 1X baited traps were suppressed 100%

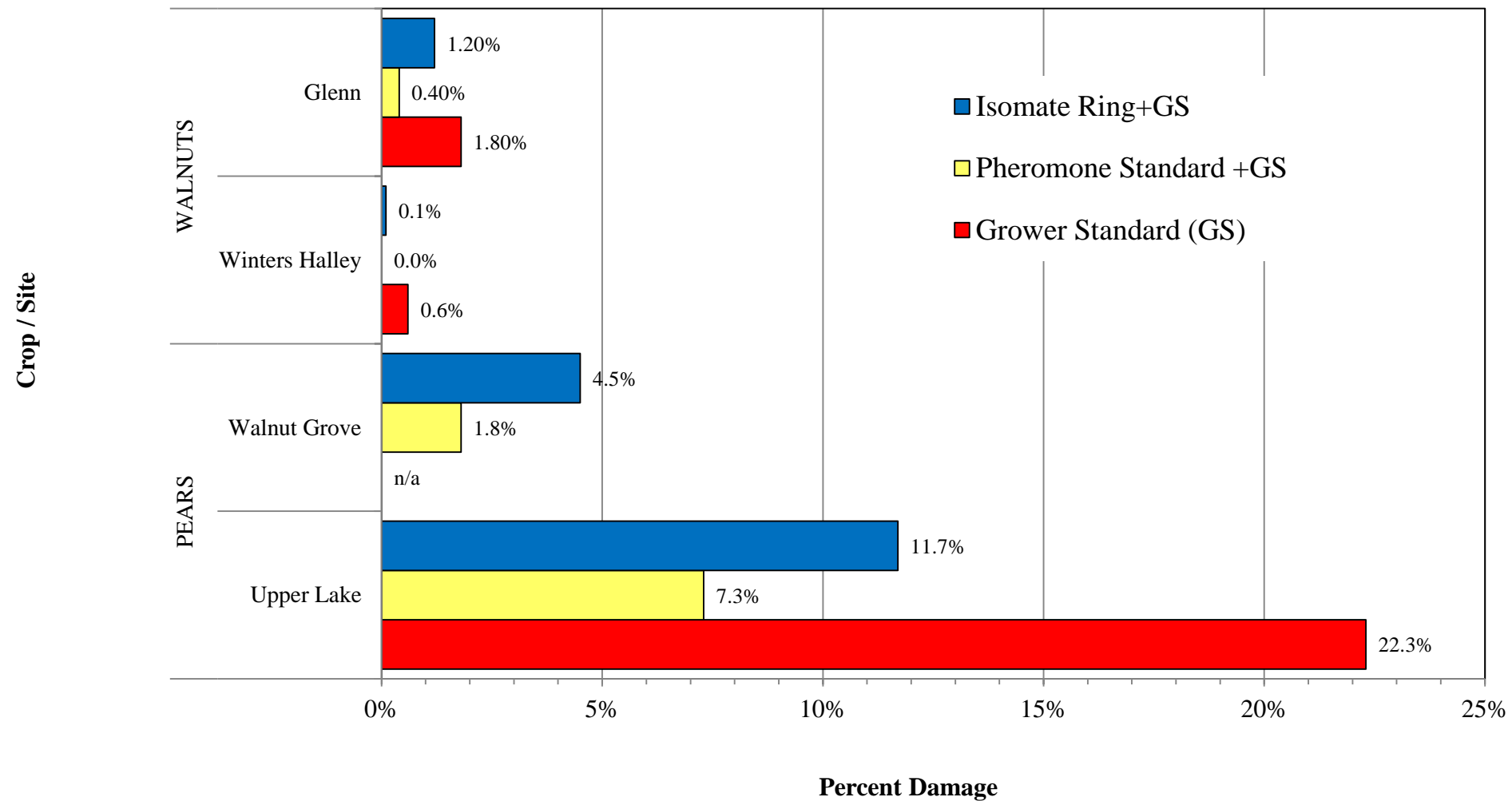
2010 Walnuts: Suterra Meso Trial - Gustine, CA
Codling Moth Capture in 1x Traps



2010 Walnuts: Suterra Meso Trial - Gustine, CA
Codling Moth Capture in Combo/DA Traps



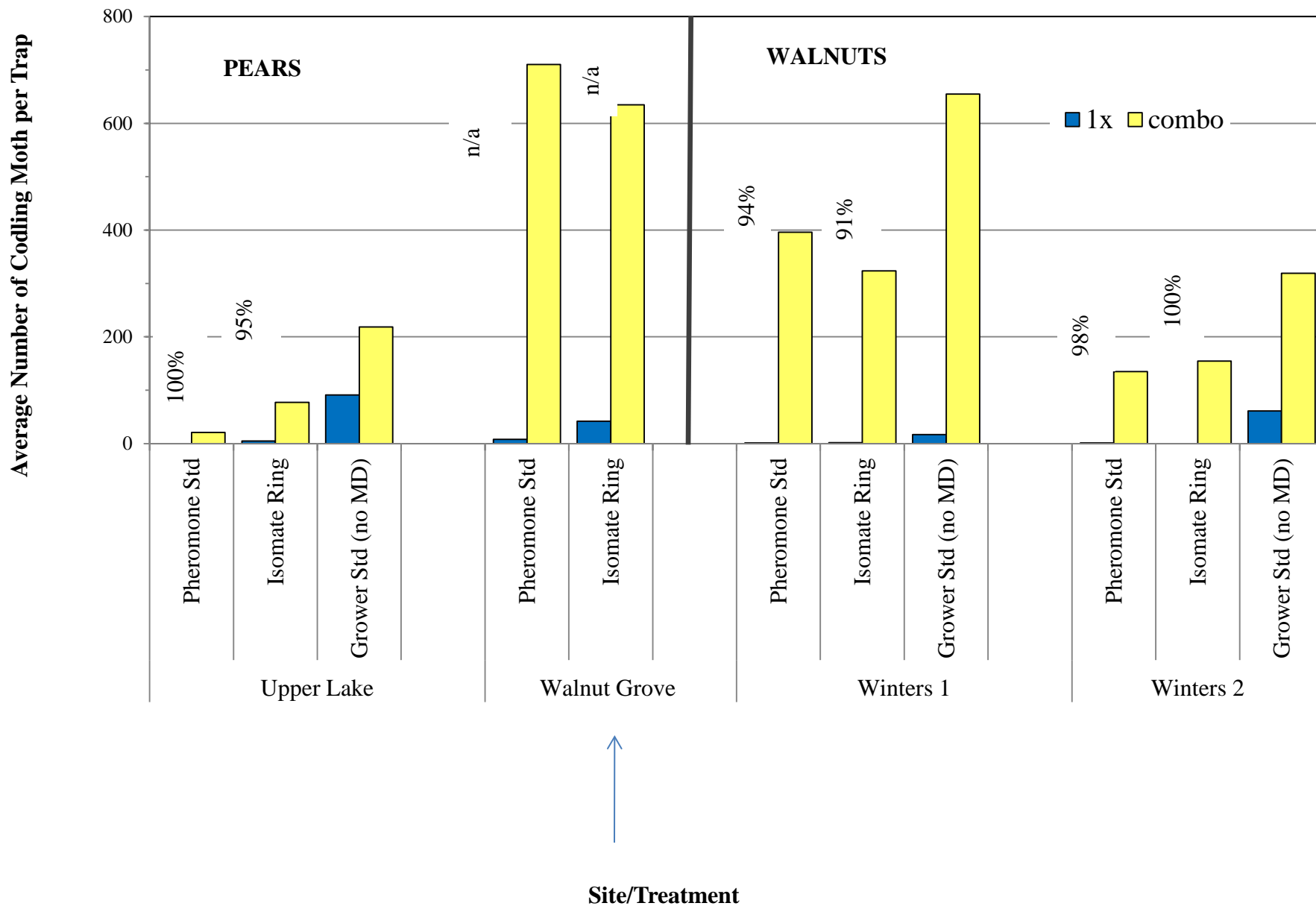
2010 Isomate Ring Efficacy Trials at 50% of Full Rate Codling Moth Damage at Harvest



Note: Only 50% AI per acre at 20 units per acre

2010 Walnuts and Pears: Isomate Ring Dispenser Trials

Season Total Trap Capture per Trap and 1x-Trap Suppression

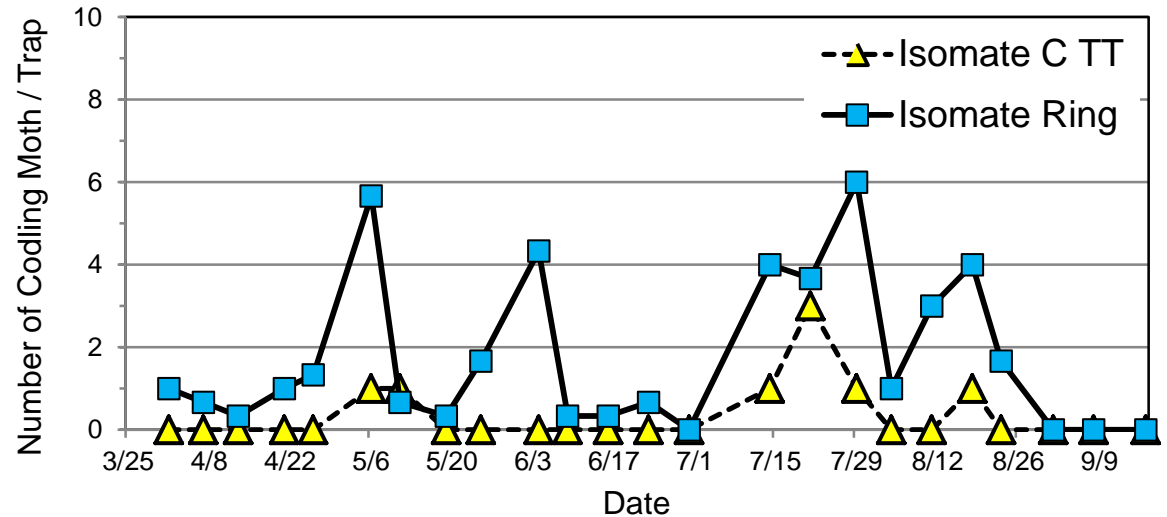


Trap Suppression in Pears using rings at 50% of Full Rate

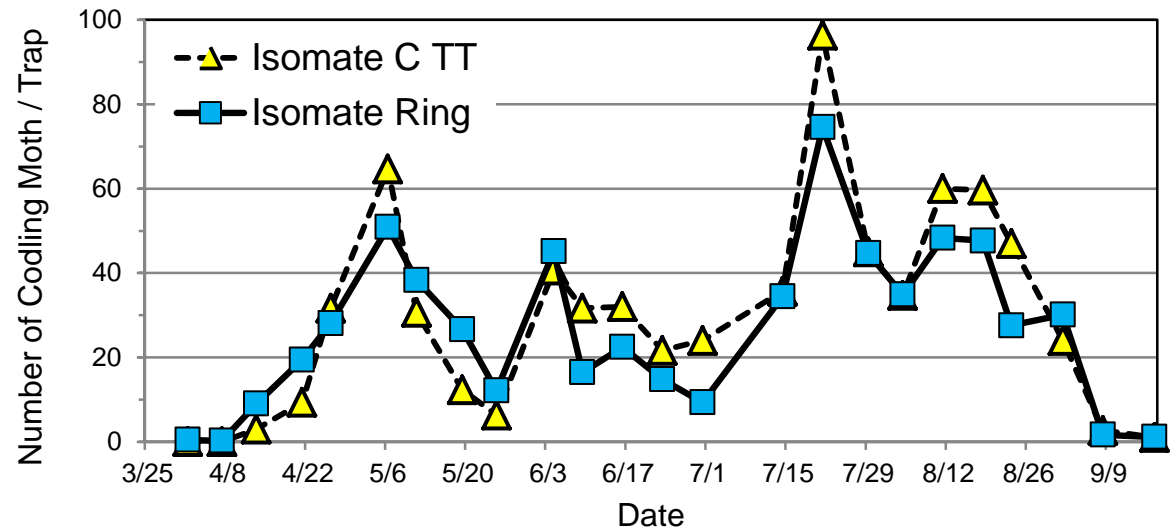
Consistent “breakthrough” in rings at 50% of full rate, but also in standard CTT

Very high pressure observed in combos

2010 Pears: Isomate Ring Efficacy Trial, Walnut Grove, CA
Codling Moth Capture in 1x-Baited Traps



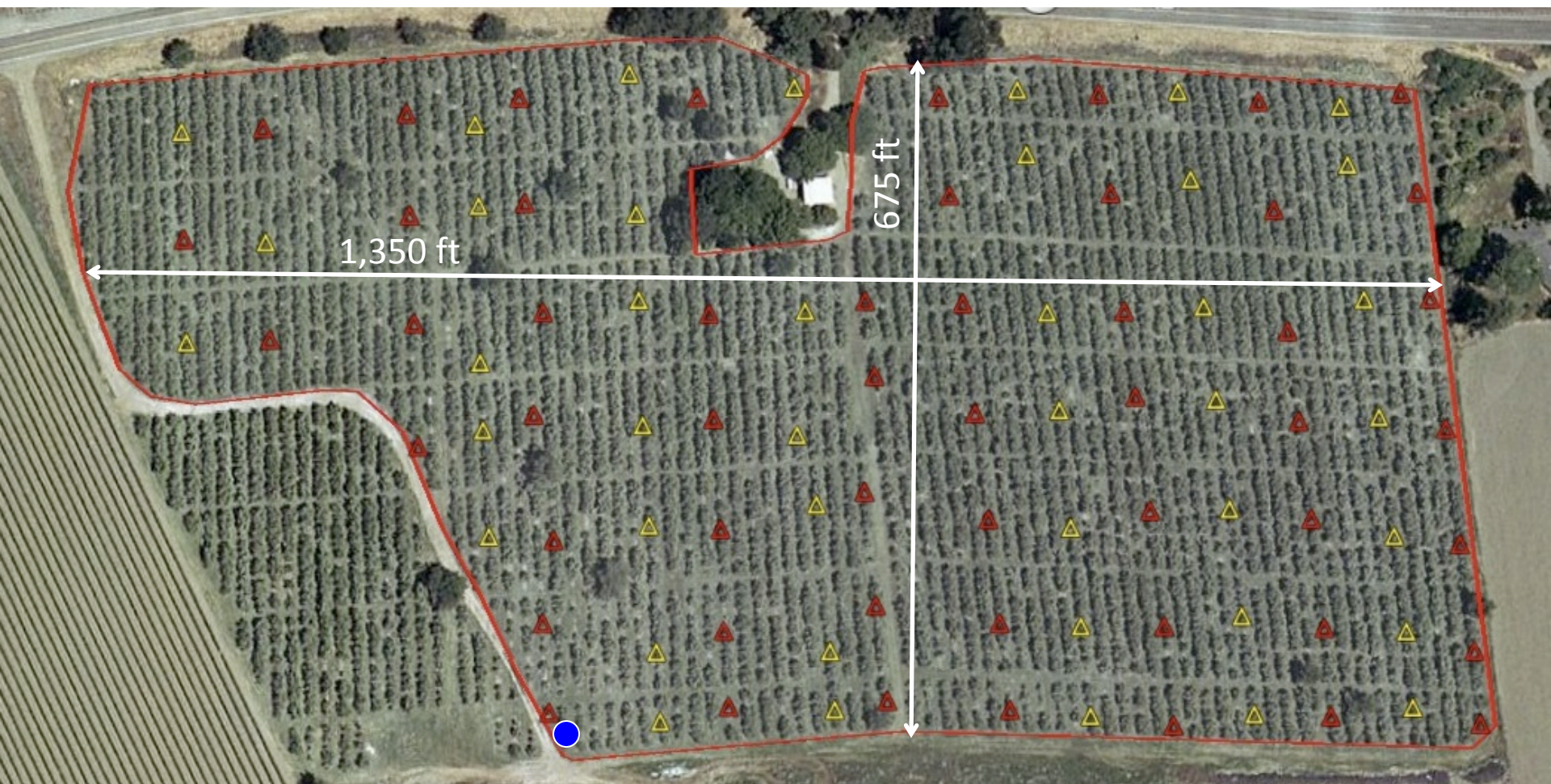
2010 Pears: Isomate Ring Efficacy Trial, Walnut Grove, CA
Codling Moth Capture in Combo-Baited Traps



Aerosol Delivery of Pheromones: Suterra “Puffers”



- Mechanical automatic devices
- Emit puffs of aerosol pheromone every 15 minutes for 12 hours a day
- High emission rate
- Low density (0.5-1 units/ac)
- Ease of application



- Pheromone puffer
- ▲ Pheromone-baited trap (53)
- △ Female-baited trap (40)

- Unfarmed (3 years) pear orchard
- 17 acres (7 ha) approx.
- Heavily infested by codling moth (20.4 ± 1.6 males/trap & night in early-June)

Lures

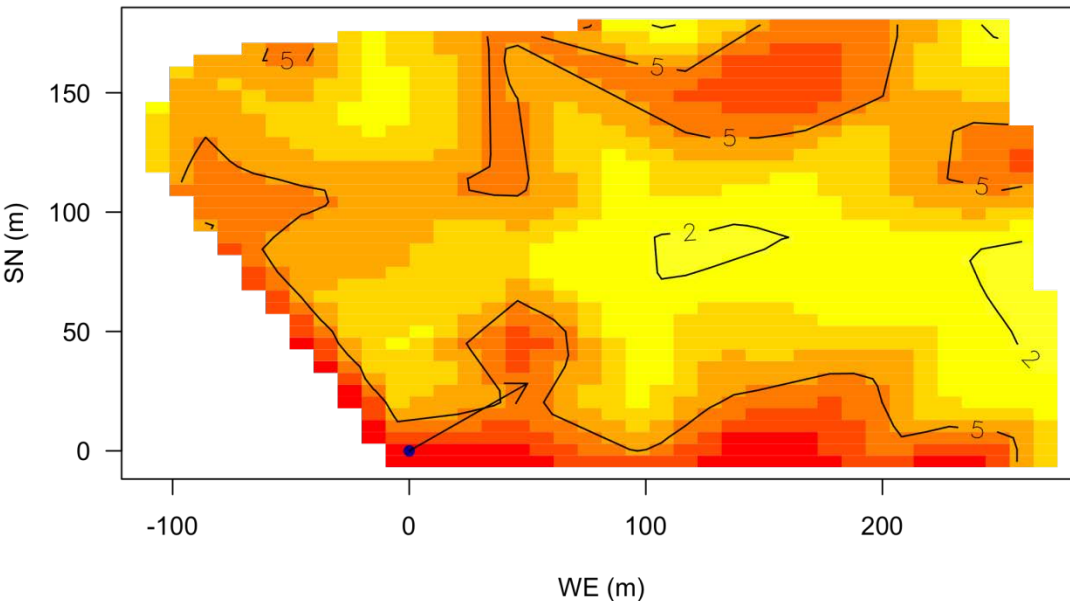
- Pheromone: 1 mg commercial lures
- Females:
 - 1 virgin female (< 24 h)
 - kept in a 4 x 4 x 4 cm³ aluminum cages
 - sugar water supplied daily



Data recorded

- Number of males/night
- Time to first capture (nights)
- Effectiveness (nights with captures/total nights)
- 2 complete replicates in 2009, 2-4 reps in 2010

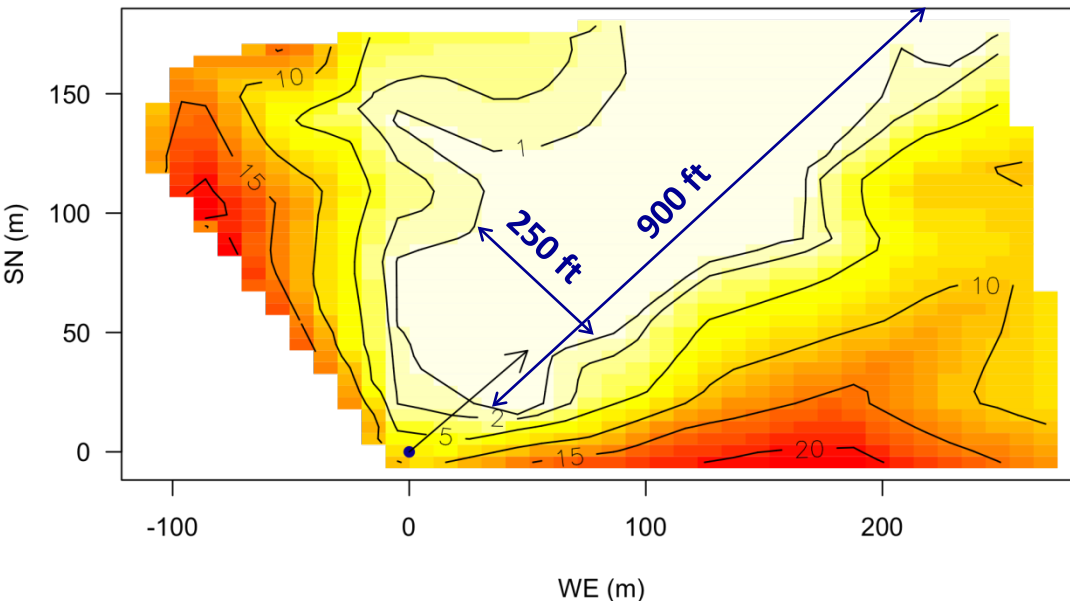
No puffer



Captures/night (pheromone)

- Captures in absence of puffer were reasonably uniform across the orchard (despite some hot-spots)
- In presence of the puffer a gradient of captures, perpendicular to the wind direction, was very apparent. Captures were totally suppressed up to 900 ft downwind.

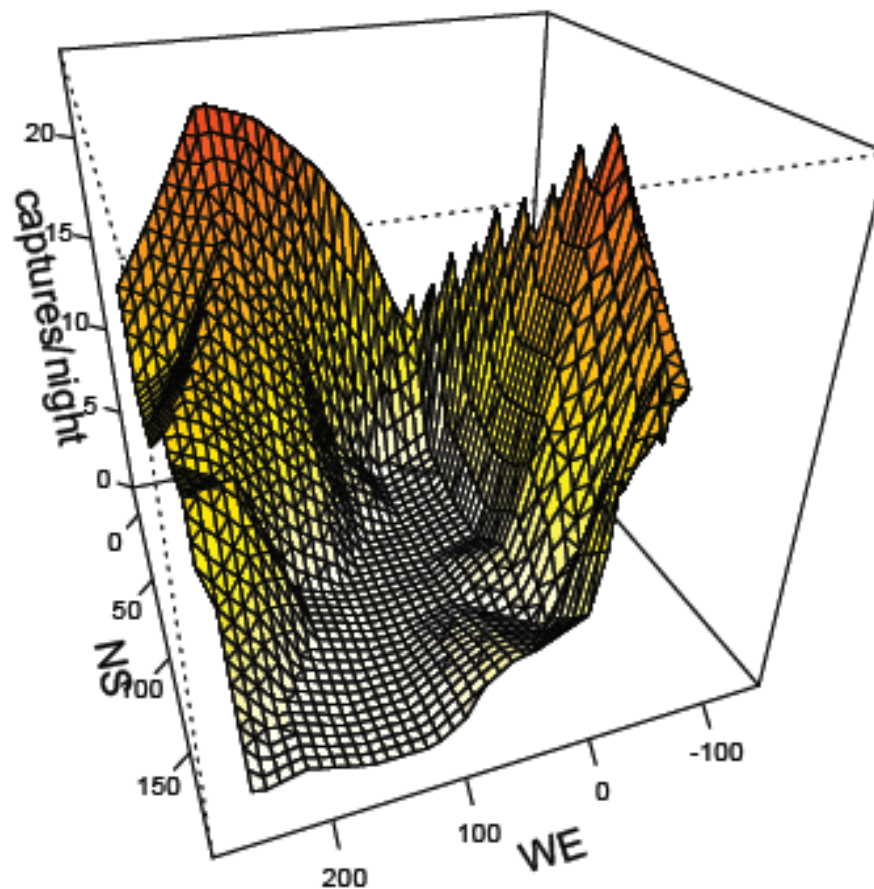
With puffer



- Smaller values without puffer due to timing of the control (late in season)

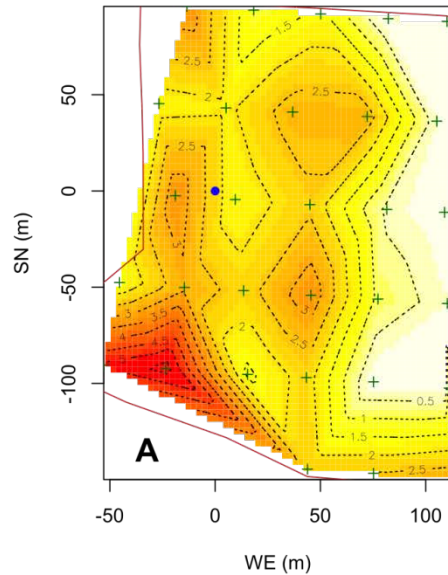
Plume cutting a swath through codling moth flight

pheromone lures, July 23rd to 31st (captures/night)

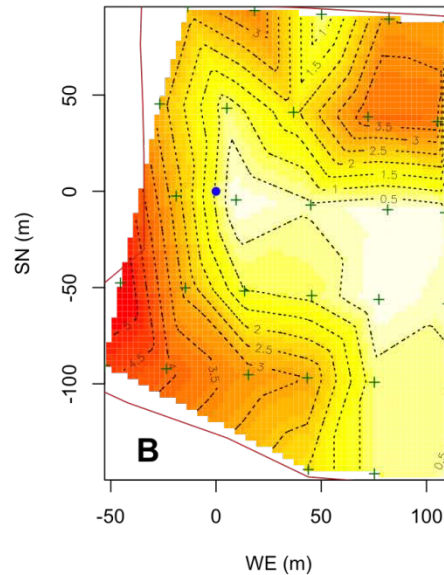


Rate Effects on Plume Size and Shape on Wild CM Males in Pears

1%



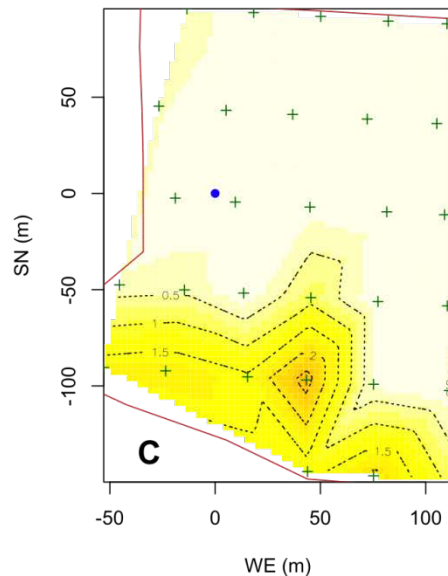
10%



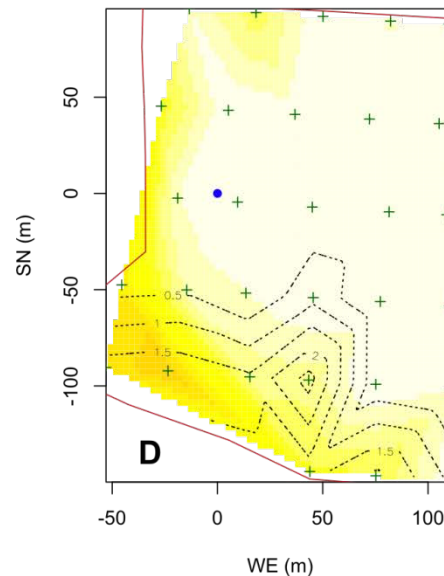
No clear plume
observed with 1%
ai per puff

Smaller, more
narrow plume
with 10% ai per
puff

50%

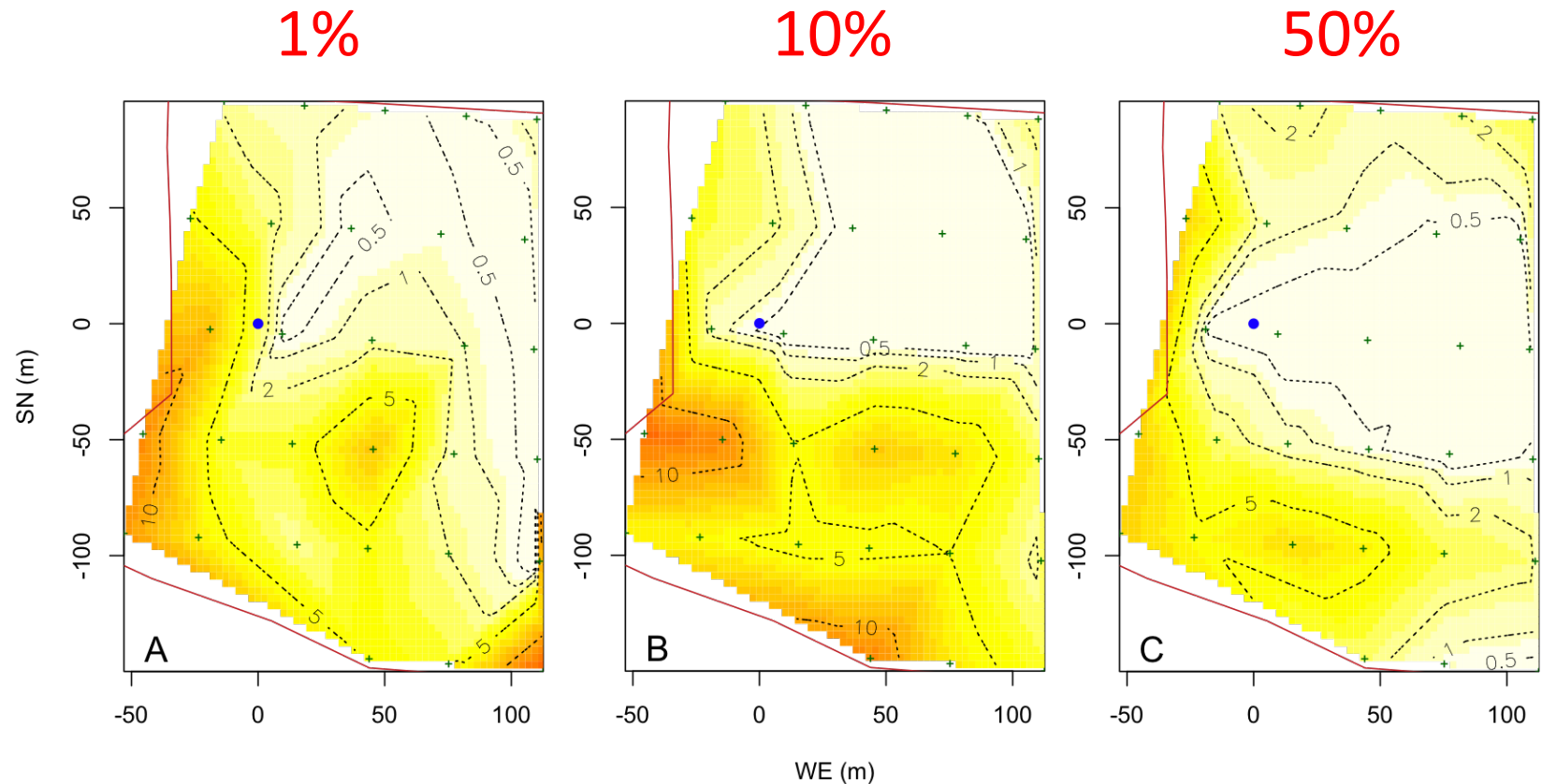


100%



50% and 100%
rates with roughly
similar plume size
and shapes

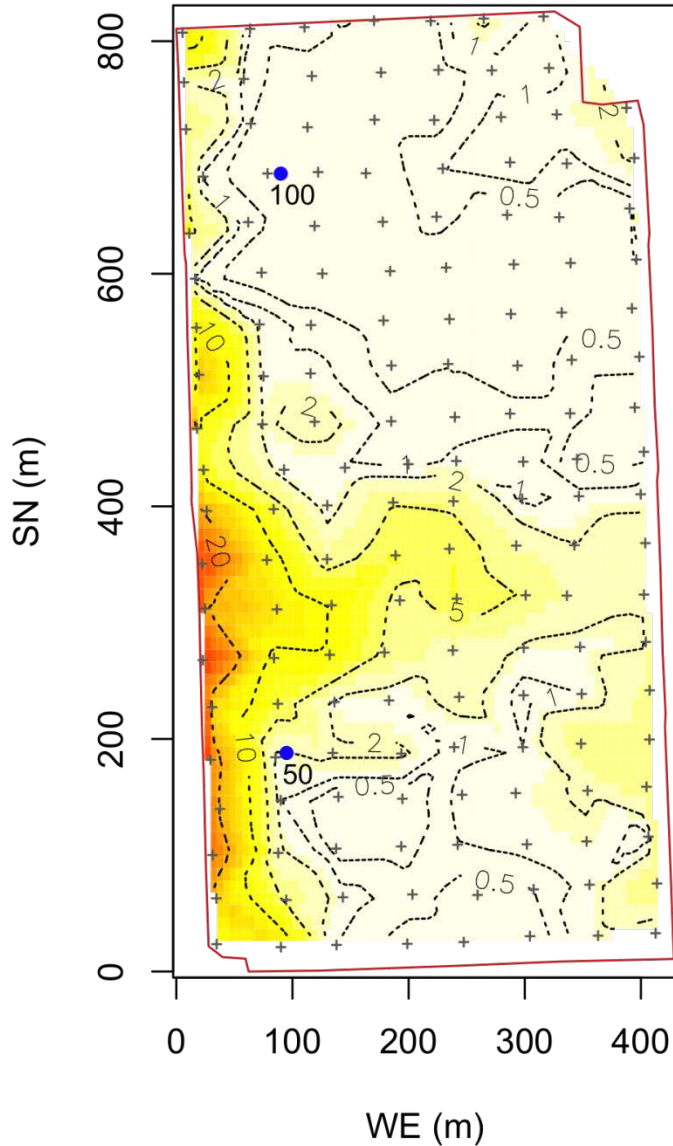
Effects of Rates on Sterile CM Males in Walnuts



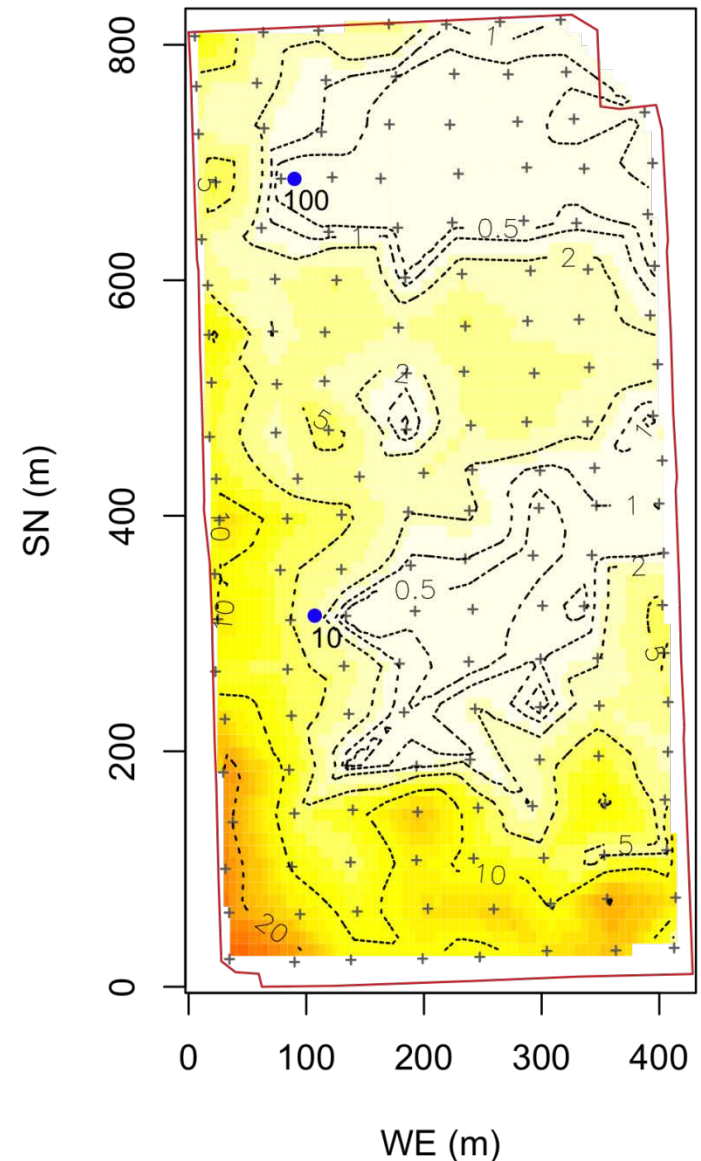
Relatively small plume with 1% ai per puff with little clear distinction between 10 and 50% plume

Paired Rate Contrasts

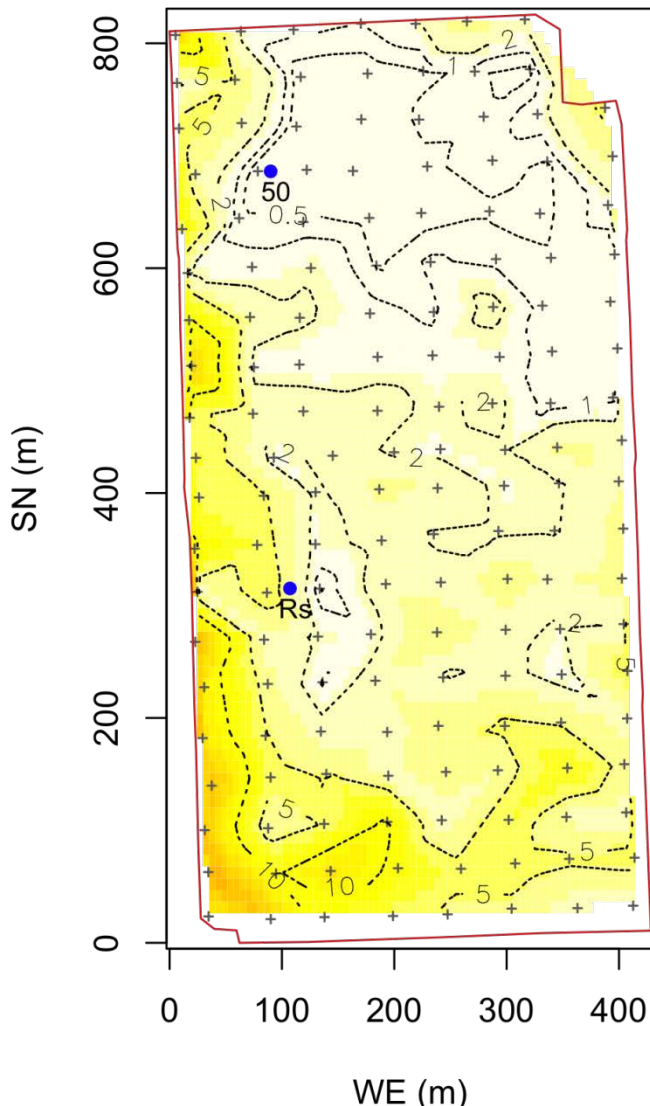
50 vs 100%



10 vs 100%



Passive Versus Active Release



Puffer with 50% ai pheromone load compared to aggregated 10-unit “Pacific Biocontrol Ring” dispenser that were estimated to release at the same overall rate per day

Contrasts the effect of delivery mechanism (intermittent aerosol bursts versus continuous diffusion from reservoir system)

SECONDARY EMISSION OF PHEROMONE FROM PUFFER-EXPOSED LEAVES

- **Objective: test attraction of codling moth males to leaves exposed to a puffer plume**

Pheromones have been shown to bind to surfaces (e.g. glass, leaves,...)

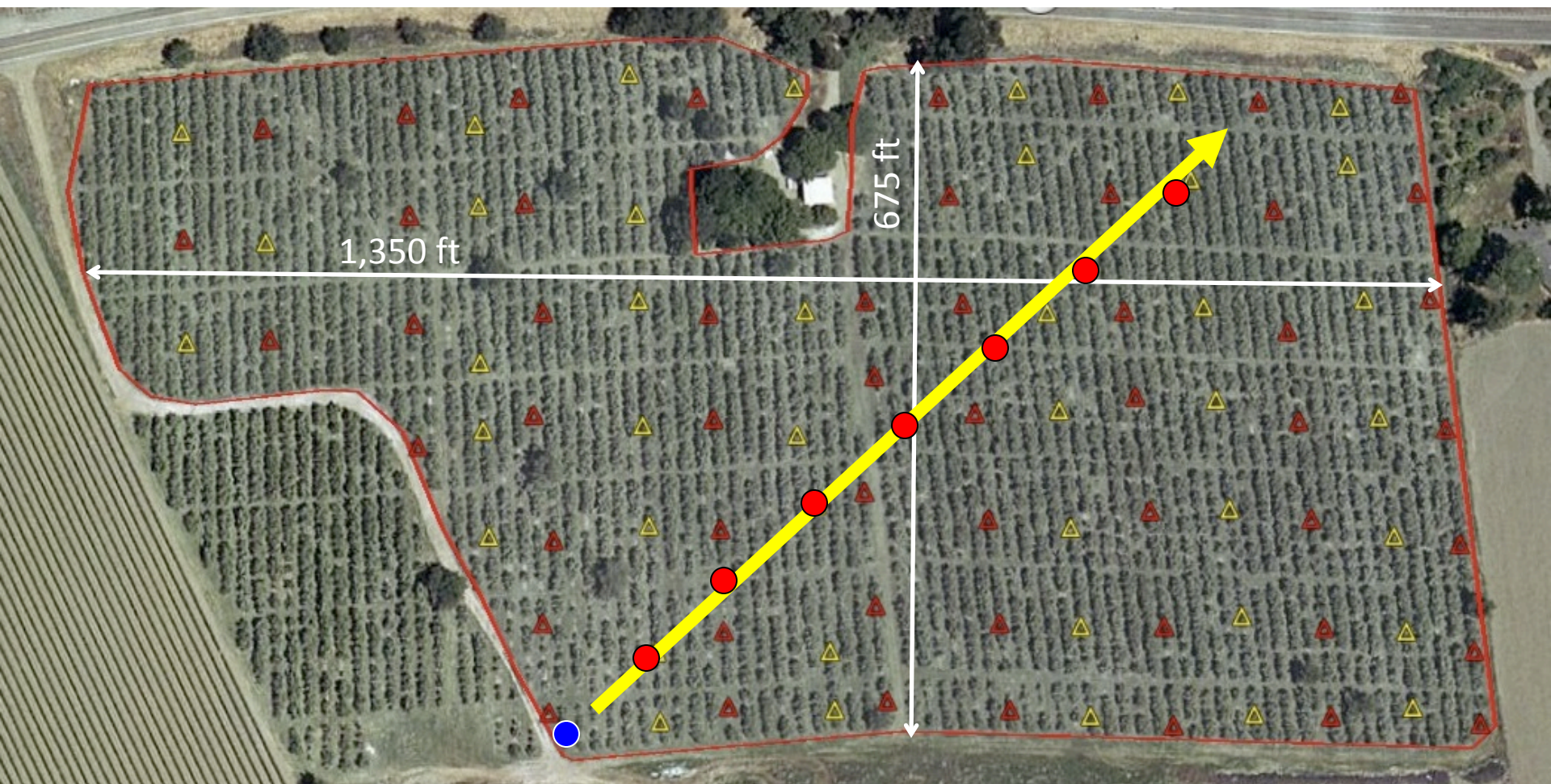
For other insects, Lobesia, LBAM, pea moth, pheromones bind and are released later

Residual plume images for codling moth suggested secondary release

Do puffers impregnate the orchard such that the orchard becomes the emitter

Approach

- CM puffer run at standard settings in walnut and pear orchards
- Leaves collected after one week at different **horizontal** distances downwind from puffer and frozen
 - Distances of collection: <1, 17, 50, 100, 135 and 170 m
- In walnuts only, a **vertical** transect run at multiple distances from dispenser
- Replicates of 15 to 20 codling moth males were exposed to leaf samples in the wind tunnel
- Males were flown one-by-one, allowed a 3 minute response time



● Pheromone puffer

▲ Pheromone-baited trap (53)

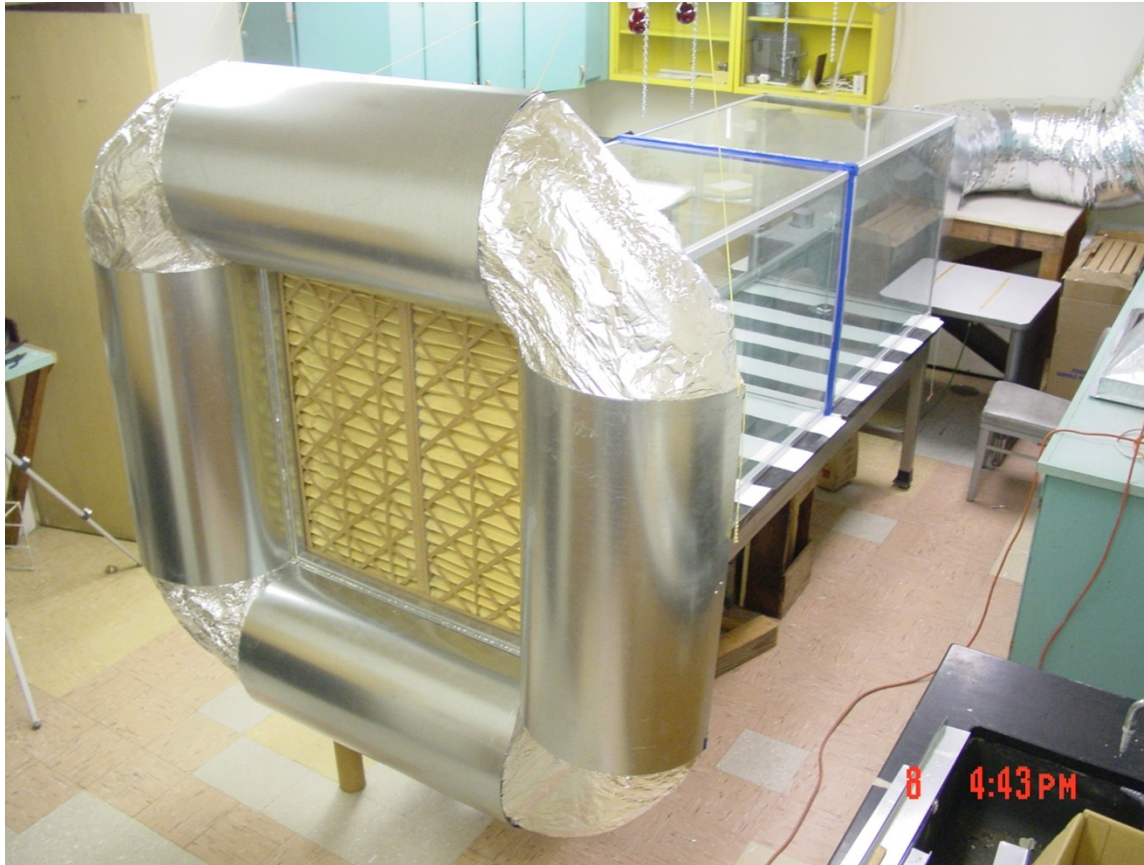
△ Female-baited trap (40)

- Unfarmed (3 years) pear orchard

- 17 acres (7 ha) approx.

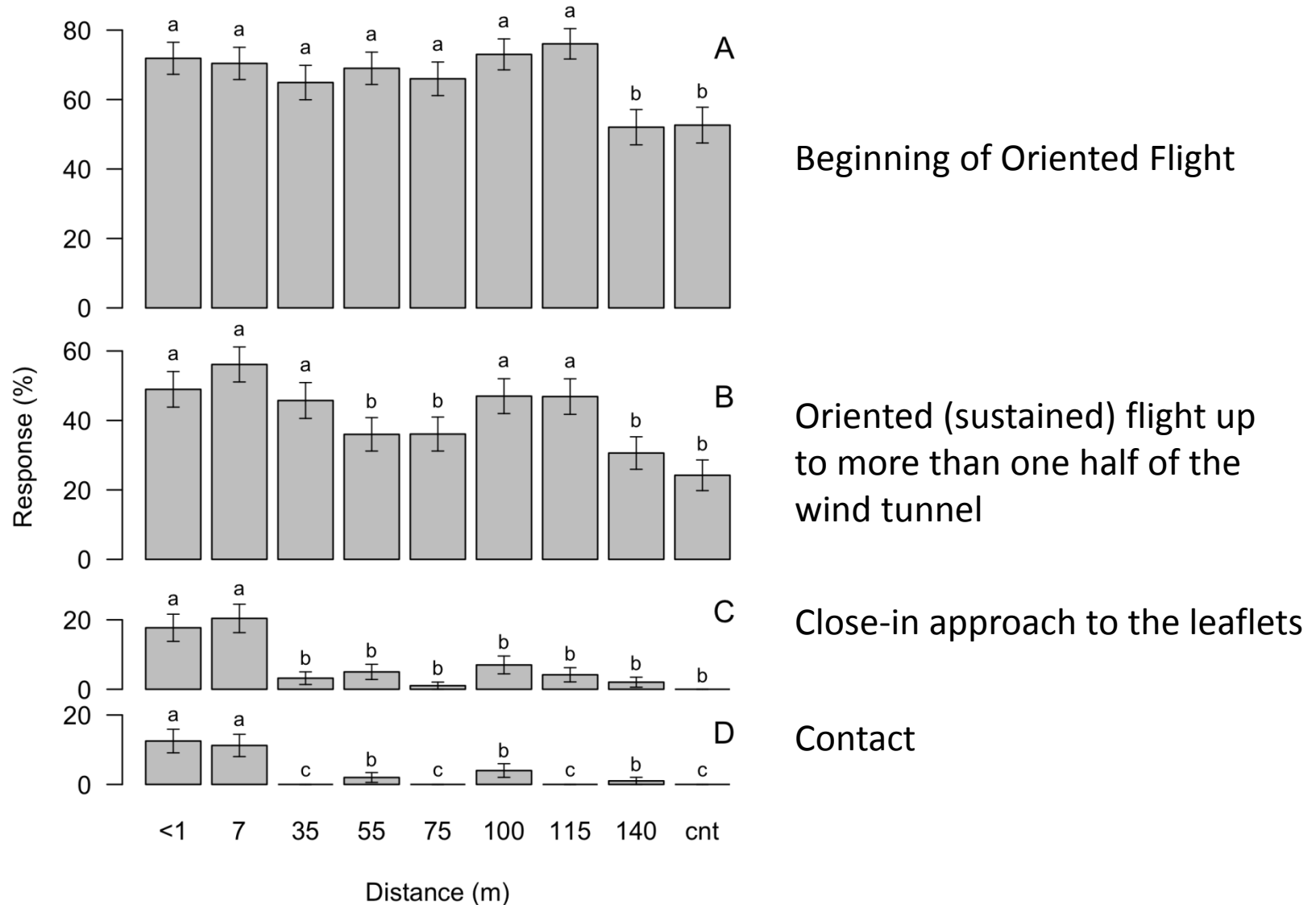
- Heavily infested by codling moth (20.4 ± 1.6 males/trap & night in early-June)

Moth Flight Wind Tunnel



- Room air is filtered as it is pulled into the tunnel.
- Odor source placed at “upwind” position in tunnel
- Moths placed at downwind end of tunnel

Secondary Release from Pear Foliage Relative to Distance from Puffer

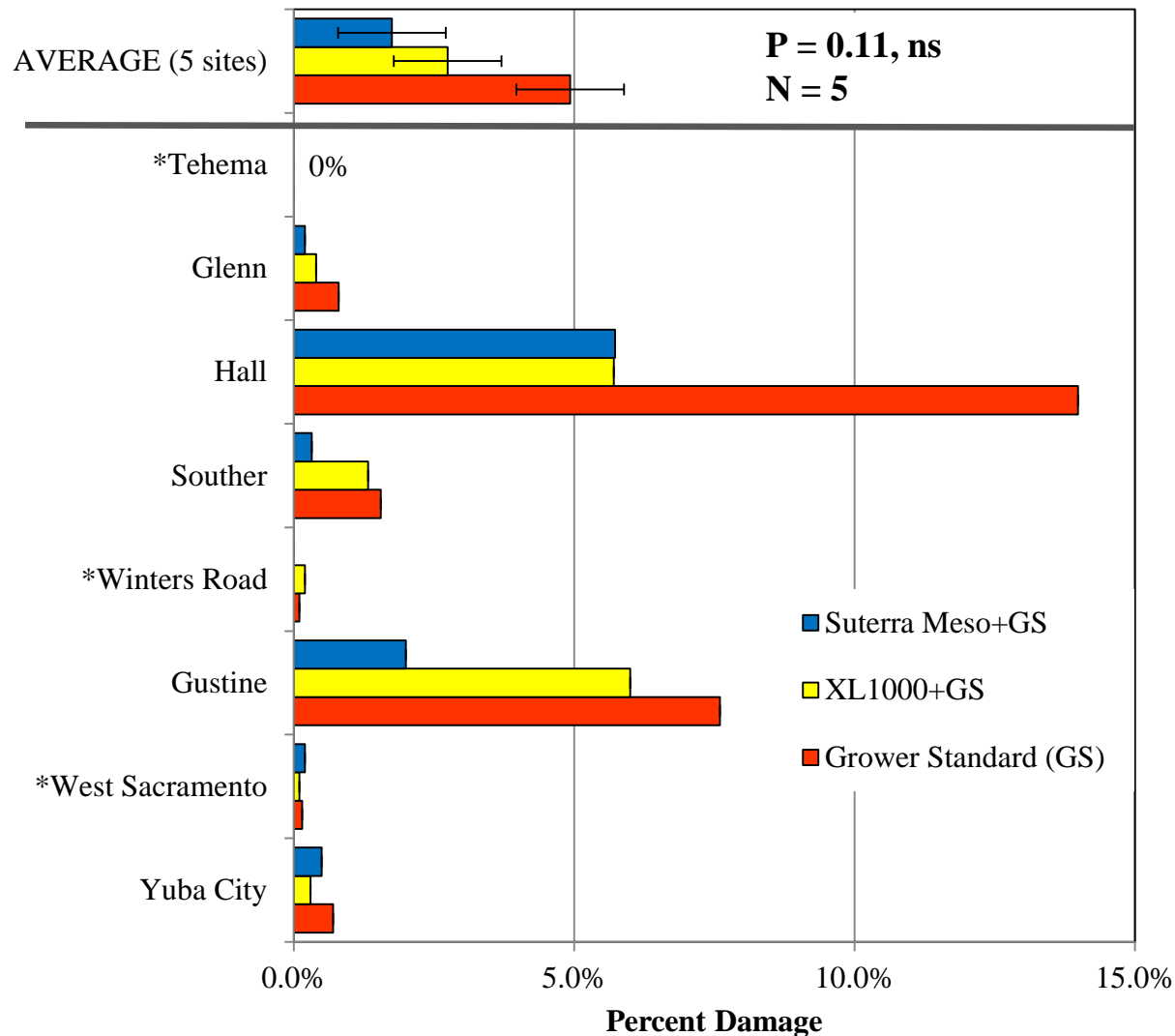




Meso Dispensers at full rates appear to be viable alternatives for control of codling moth in larger mature walnut and pear tree canopies

Opportunities for reducing the amount of pheromone per puff exist

2010 Walnuts: Suterra Meso Trial Codling Moth Damage at Harvest



Same general pattern
observed in 2010, but not
statistically different

Pressures were quite good
in a lot of the orchards

*sites with less than 0.5% damage in
Grower Standard were excluded from analysis

