I. Studies on Aerosol Puffers: Pheromone Load and Male Upwind Attraction

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II. Efficacy of Modified Pheromone Application Methods For Codling Moth Management in Walnuts

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I. Studies on Aerosol Puffers: Pheromone Load and Male Upwind Attraction

Goals:

- Increase efficiency and reduce cost of the pheromone mating disruption system
 - Examine reduced load puffer emissions on plumes
 - Compare active vs passive release systems
 - Evaluate attraction of CM males to a puffer

Pheromone rates (puffers)



Previous work suggested

- plume larger than deployment rate
- redundancy in amount of pheromone?
- reduced pheromone loads possible?



-Plume overlap: plot separation

-Patchy CM populations: Sterile Insect Releases (SIR)



Methods: Puffer load rates

- 1. Sites: 2 walnut, 2 pear
- 2. Trap grid of 56 to 72 traps (1x-baited)
- 3. 6 SIR releases per site: 400 males released 30-40 ft downwind of <u>each</u> trap
- 4. <u>Six</u> treatments (each site):
 - a) Control (no pheromone)
 - b) Puffer @ 10% standard load
 - c) Puffer @ 25% standard load
 - d) Puffer @ 50% standard load
 - e) Puffer @ 100% standard load
 - f) 40 Isomate CM-Rings (single point cluster)
- 5. Data analyses by geostatistical modeling: kriging surfaces and conditional simulation





Big Valley:

- Pear.

- 56 traps @ 7-8 feet.
- Size: 8.6 acres.

Burger:

- Pear.

- 64 traps @ 7-8 feet.
- Size: 11.9 acres.

Dondero:

- Walnut.
- 72 traps @ 12-15 feet.
- Size: 13.8 acres.

Podesta:

- Walnut.
- 72 traps @ 12-15 feet.
- Size: 15.2 acres.





Controls (no pheromone): - Homogeneous release, but not recapture

Reasons:

- Upwind movement
- Heterogeneity within and among orchards (canopy structure, etc.)





Pear – Big Valley



Walnut – Dondero



Walnut – Podesta



Average trap suppression (%) in 1,000 simulations





Conclusions

- 1. No clear rate response
- Lower rates of aerosol emissions may as effective as full 100% load (current standard)
 - a) Higher variation has been noted for the lower emission rates (1 and 10%)
- 3. Can a different implementation model be developed ?
 - a) improve performance
 - b) reduce overall costs
 - i. e.g. is 25% load rate possible?
 - ii. (cabinet cost remains constant)

Upwind movement of CM males

Hypothesis:

CM males are attracted upwind over long distances to puffers due to a "super-female effect".

- 2010 used a protein-marking technique \rightarrow results not clear
- 2011 long-distance movement with and without pheromone
 - Treatments: puffer vs no puffer (control)
 - compared trap capture of Sterile Males (SIR)



Experiment 2: Upwind movement



Methods: CM Male Movement

- 1. Site: 17-acre pear orchard (delta)
- 2. Traps (1x-baited):
 - 1. 6-trap cluster 500 ft upwind of SIR
- 3. SIR releases (6 total)
 - 1. 10,000 males /SIR, single point release
- 4. Two treatments (alternating in time):
 - a) Control (no pheromone) 3 replicates
 - b) full rate CM-Puffer 3 replicates
- 5. Data analysis
 - 1. Captures/day were log transformed: ln(x+1)
 - 2. Analyzed by linear mixed effects model:
 - 1. date and trap as random effects;
 - 2. puffer/no puffer as fixed effect.



Results: CM Male Movement

- 1. CM males move upwind
- 2. Captures similar puffer vs control
 - a) Puffer: ave = 2.14 males/trap/day
 - b) Control: ave = 1.68 males/trap/day
 - c) Higher variability in Puffer SE 1.0 vs. 0.32
- 3. No significant difference between treatmentsa) L-ratio= 0.481; df= 1; p= 0.488
- Results do not support long distance attraction towards puffers

Conclusions: Pheromone Load and Male Upwind Attraction

- Differences among puffer pheromone rates were low, but large variability observed across sites
 - <u>all</u> rates showed trap suppression in large areas
 - reduction of the pheromone load seems possible
 - efficacy trials warranted
- >passive emitters (rings) showed less trap suppression
 - aerosol and passive emissions may behave differently
- Long distance attraction of CM males towards puffers not observed in these trials

II. Efficacy of Modified Pheromone Application Methods For Codling Moth Management in Walnuts

2011 Projects

- Low emission-rate puffer (50% ai of standard Checkmate CM Puffer)
- New aerosol emitter (Isomate CM "Mist")
- Modified hand-applied dispensers (Suterra Meso or Isomate Ring)

50% ai Checkmate CM Puffer

- 1 unit per 2 acres
- Monitor CM flight Combo and 1x lures
- CM damage at harvest
- 3 trial sites





2011 Walnuts: 50%-Rate Suterra Puffer Average Season Total Trap Capture and Percent Shutdown of 1x Traps



Results: Trapping

- Two sites with strong CM populations
- 1x trap shutdown 100% in one site

Results: Damage (two sites evaluated)

• Damage reduced 22% and 75% from Grower Standards

Isomate CM Mist Sprayer

- Emissions similar to Checkmate Puffer
- 1 unit per acre
- Monitor CM flight Combo and 1x lures
- CM damage at harvest
- 2 trial sites



2011 Walnuts: Isomate CM Mist Trial Codling Moth Damage at Harvest

Average Season Total Trap Capture and Percent Shutdown of 1x Traps

2011 Walnuts: Isomate CM Mist Sprayer

Lure Type and Trial Site

N. Glenn

Combo[®] Lure

Riverbank

Results: Trapping

N. Glenn

1x Lure

Number of Codling Moth / Trap

0

Two sites with strong CM populations

Riverbank

• 1x trap shutdown 100%

Results: Damage

• Damage reduced @ 50% from Grower Std.

Modified hand-applied dispensers

Methods:

- Suterra Meso @ 18 units/acre
- Isomate Ring @ (2x20) units/acre
- Pheromone Standard @ 200 units/acre
- 6 trial sites (Welter, Grant, Pickel)
- Monitor CM flight Combo and 1x lures
- CM damage at harvest

Results : Trapping

- flight curve example at Waterford CA walnut site
- Very high CM population
- Combo-baited traps show widely dispersed population across treatments
- 1x-traps mostly shut down entire season



Modified hand-applied dispensers: trap totals

- Significant populations across most sites
- 1x traps in pheromone treatments shut down average >98.9%
- No observed difference between pheromone treatments



Modified hand-applied dispensers: Damage at Harvest

2011 Walnuts: Codling Moth Damage at Harvest Modified Dispenser Efficacy Trials (Suterra Membrane, Isomate Ring)



Modified hand-applied dispensers: Damage at Harvest (multiple years)



Increasing replication across years and sites continues to indicate the modified hand-applied dispensers offer similar control to traditional pheromone dispensers

Conclusions

- Initial trials of a 50% reduced load puffer indicate positive results (damage, 1x shutdown)
- Modified hand-applied dispensers offer viable pheromone option for walnut growers
 - Best use may be smaller blocks (<40 acre) or sites with dimensions not suitable for puffer applications
- > New products continue to be developed
- Growers will see more opportunities for pheromonebased management systems

General Comments

- Pheromone MD program has been developed which works when:
 - Combined with insecticides in early years
 - \succ Target population management \rightarrow long term goal
 - Isolation from outside sources
- Need a robust program to achieve broad adoption
- New competition in the aerosol based MD systems

