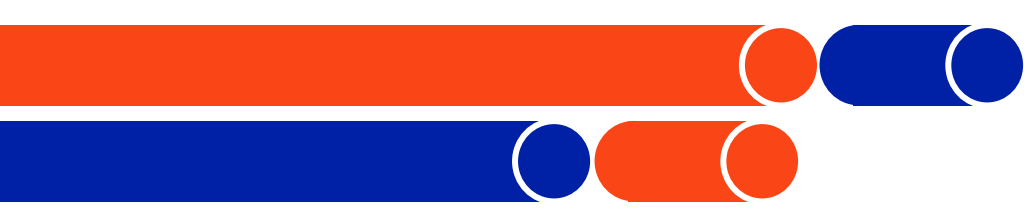


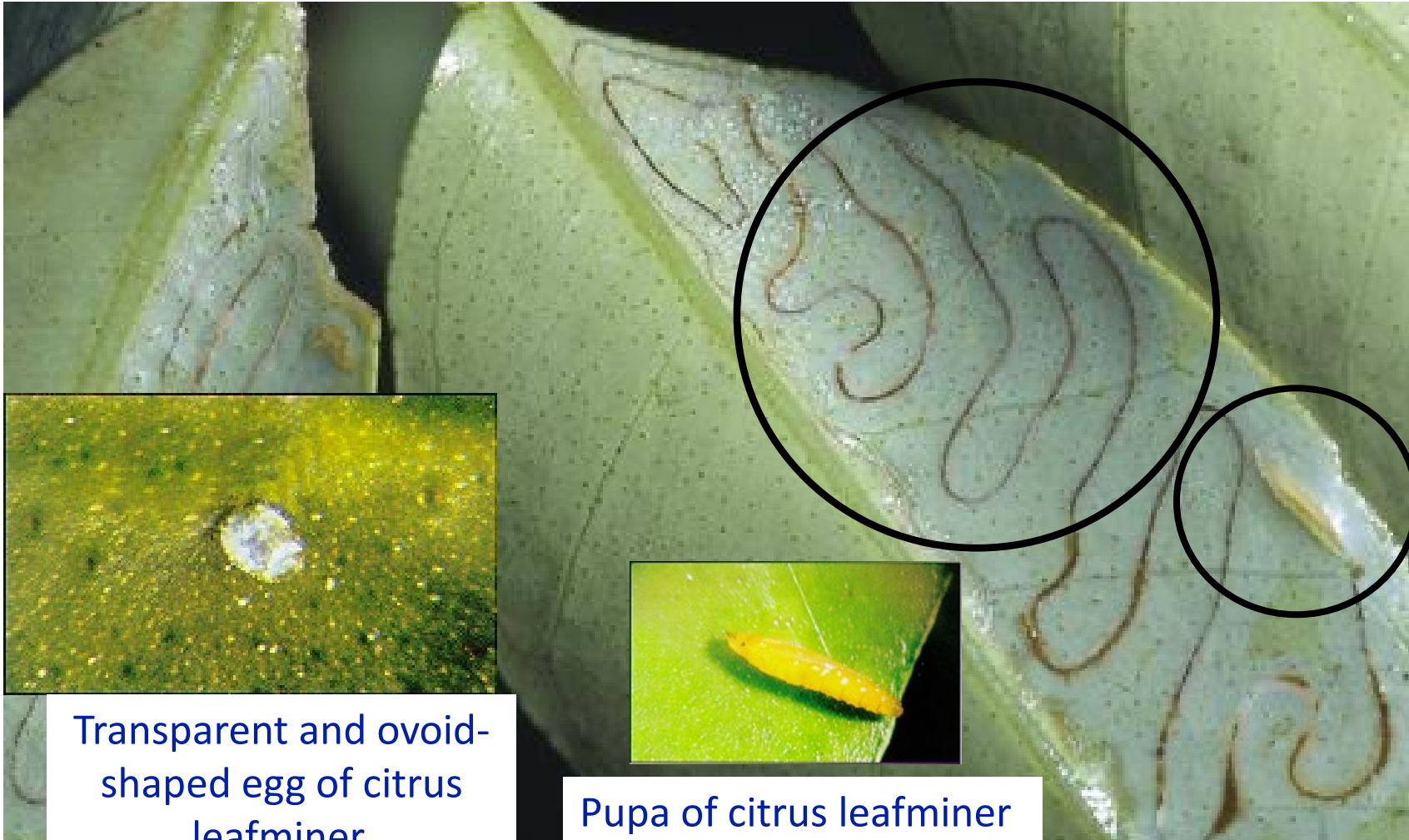


# CLM Research and Management

Lukasz Stelinski, UF/IFAS CREC



# Citrus Leafminer: A living infestation



Transparent and ovoid-shaped egg of citrus leafminer.

Pupa of citrus leafminer

- Damage heaviest during flush
- Direct damage greatest to young trees
- Reduced photosynthesis, tree growth
- Mines provide entry for pathogens

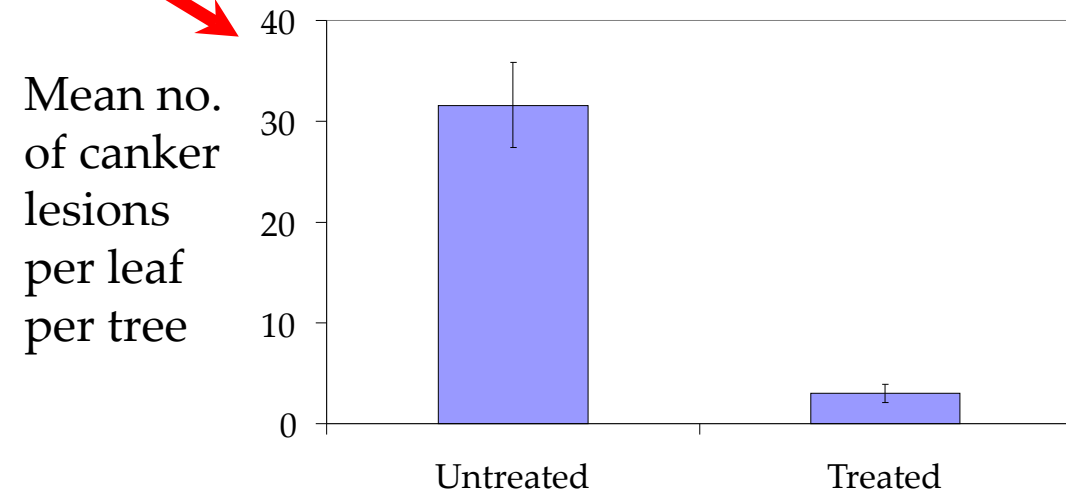
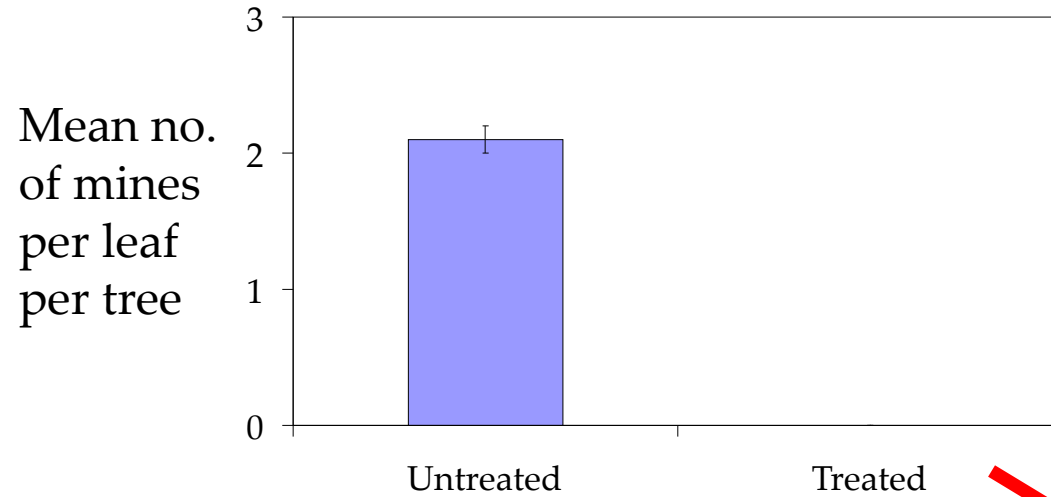


UC Statewide IPM Program  
© 2005 Regents, University of California

# Association of injury with canker



# More leaf mines = More Canker

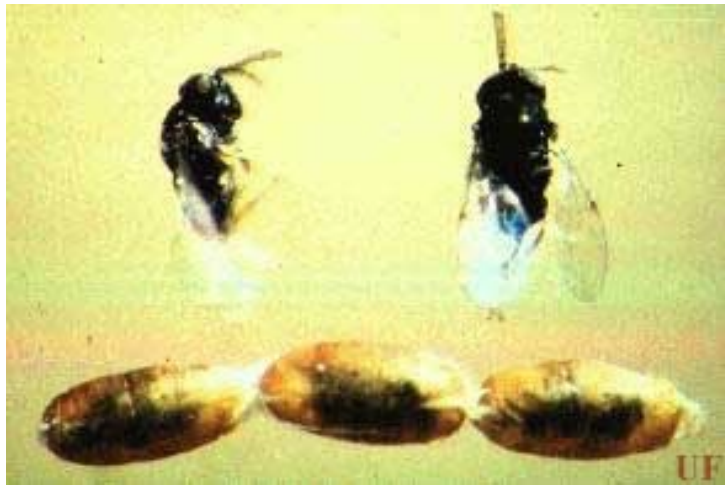


# Biological control of citrus leafminer

*Zagrammosoma multilineatum*,  
a native parasite  
of citrus leafminer



Green lacewing  
(*Chrysoperla  
rufilabris*), a  
predator of citrus  
leafminers



Adult females and pupae of *Ageniaspis citricola*

## Biological control: *Ageniaspis citricola*

- Imported 1994
- Parasitism ~100% in some areas
- *Ageniaspis citricola* was well established in FL

### IPM compatible

- Oil (3%), azadirachtin (+ 0.4% oil), and diflubenzuron (+ 0.4% oil)
- Avermectin + 0.4% oil was **not**





# Citrus peelminer: Another small moth in citrus

- This species is also a culprit affecting fresh fruit production
- Likes grapefruit in particular
- Chemical control strategies for this moth are the same as for leafminer





# Chemical Toolbox

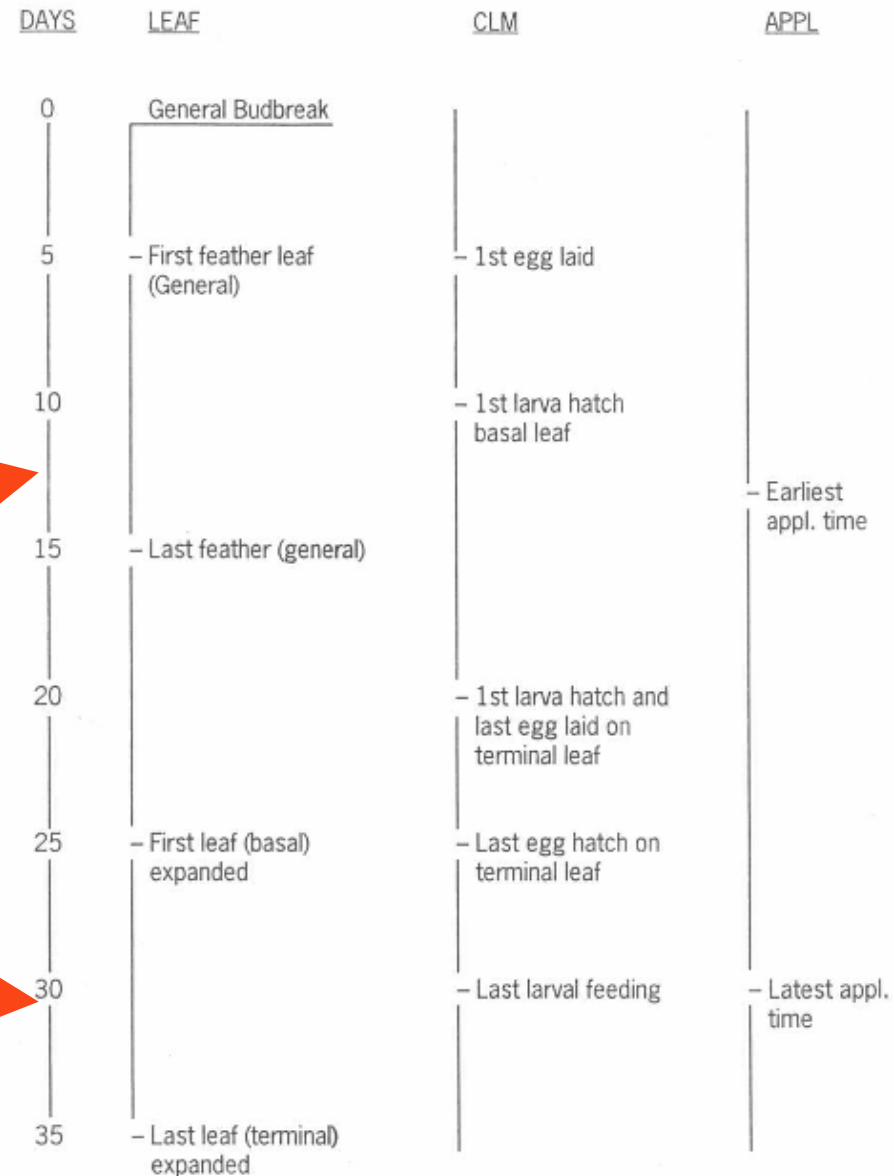
- Agri-Mek 0.15 EC
- Micromite
  - ACP immatures
- Delegate WG
- Admire Pro and 2F
- Platinum 75 SG
- Intrepid 2F
  - No effect on ACP
- Exirel
  - Good for ACP
- Agri-Flex
  - Good for ACP
- MalEx (Pheromone)
- Soil neonics for non-bearing trees

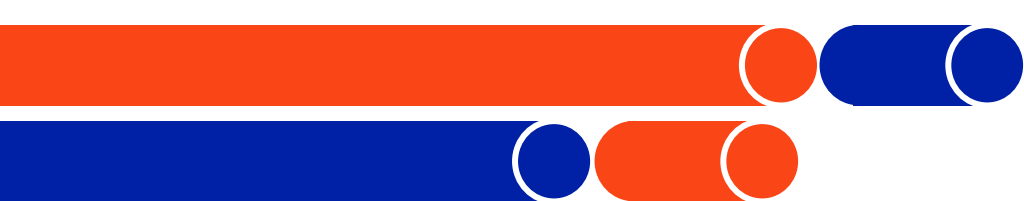
# Timing of application for leafminer control

## --FOLIAR APPLICATIONS--

13 days from general budbreak is earliest time for application

Last potential date for leafminer application is 31 days after budbreak





## Timing of soil applications of systemic neonicotinoids and cyantraniliprole (Verimark) for small, non-bearing trees

- Soil-applied systemic insecticides are a good option
- These can be applied before leaf flush (10-14 d) because it takes time for the concentration of insecticide to build up
- The duration of control with these (up to 8 week) is often longer than with foliar sprays

# Citrus leafminer pheromone



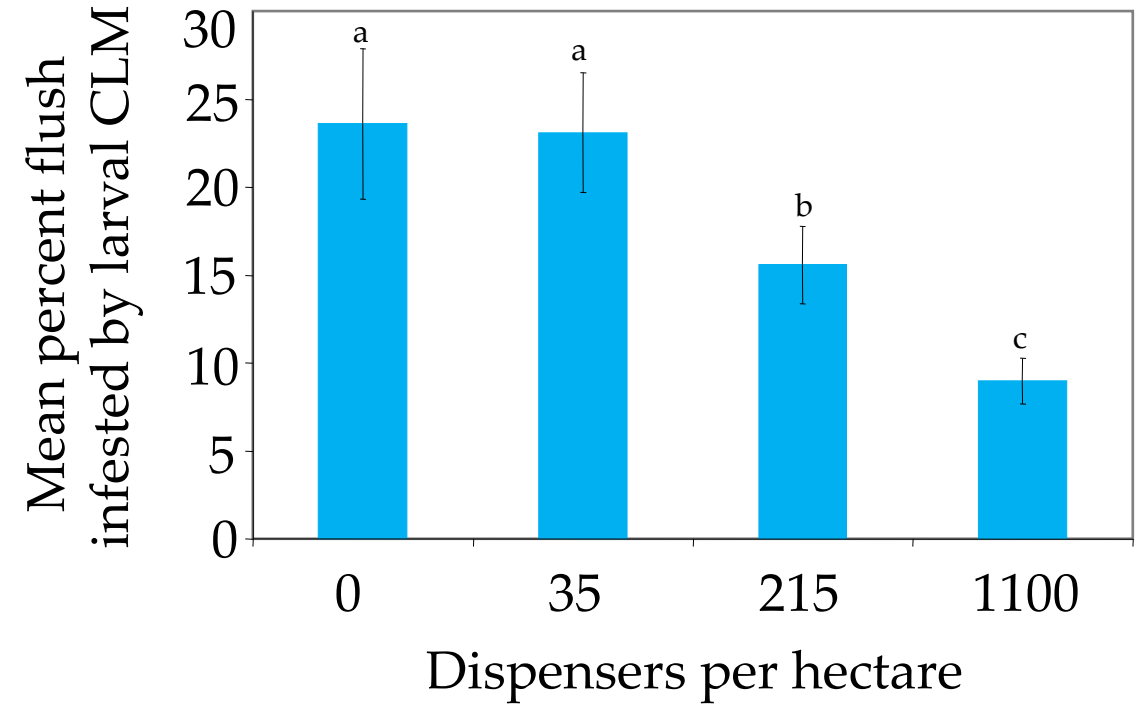
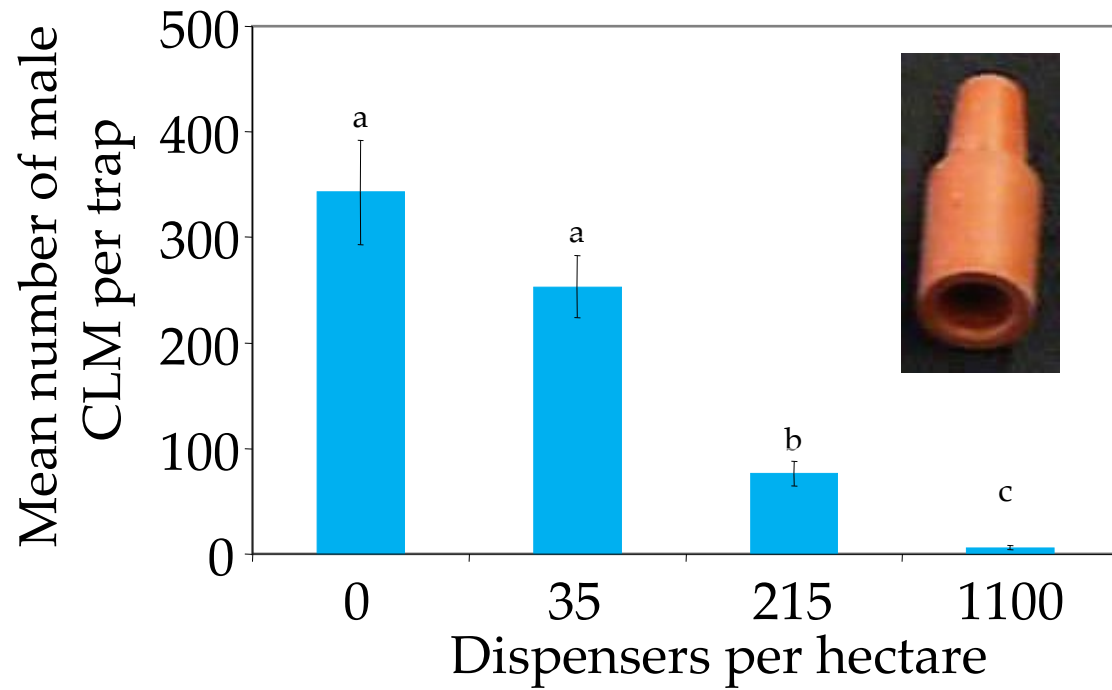
## Female sex pheromone:

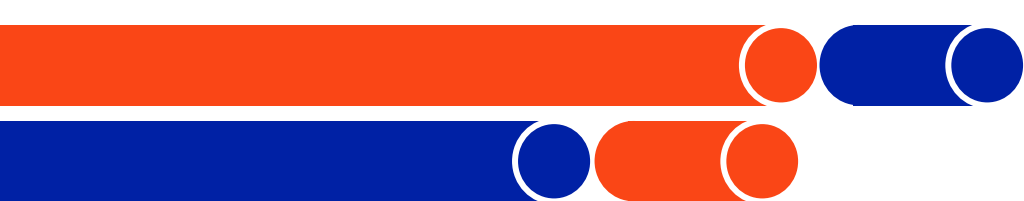
30 (Z,Z,E)-7,11,13-hexadecatrienal

10 (Z,Z)-7,11-hexadecadienal

1 (Z)-7-hexadecenal

Two deployments of 1.5 g AI/ha each achieved 221 d of nearly 100% disruption.





# SPLAT CLM became first mating disruption product labeled for use in citrus

## Challenges

- Cost of active ingredient
- Requirement for specialized application
- Huanglongbing in citrus: Net capital loss ~\$1 billion per year since its introduction to Florida in 2005

## SPLAT CLM™

For Mating Disruption of the Citrus Leafminer,  
*Phyllocnistis citrella*

*SPLAT (Specialized Pheromone and Lure Application Technology) is an amorphous polymer matrix for the sustained passive release of insect pheromones. SPLAT CLM provides control of the citrus leafminer by disrupting mating behavior.*

### ACTIVE INGREDIENT:

Citrus Leafminer Lepidoptera Pheromone

(Z,Z,E)-7,11,13-Hexadecatrienal:.....0.15%

OTHER INGREDIENTS:.....99.85%

TOTAL:.....100.00%

Net Contents: \_\_\_\_\_ Lbs \_\_\_\_\_ Kg

Batch Number: \_\_\_\_\_

EPA Reg. No. 80286-

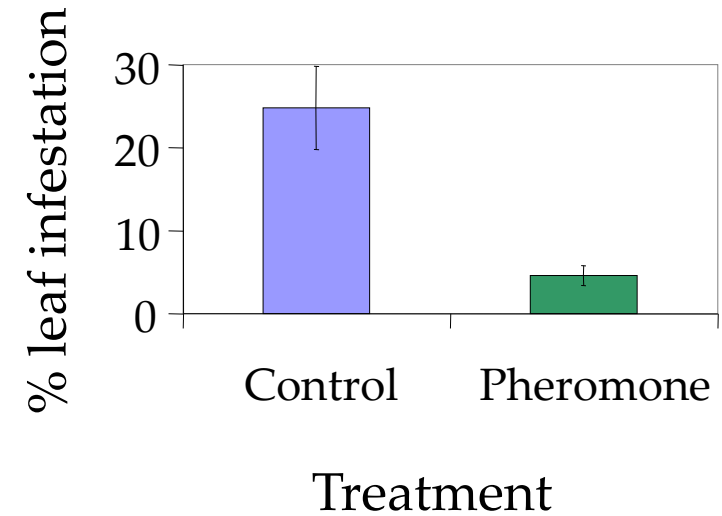
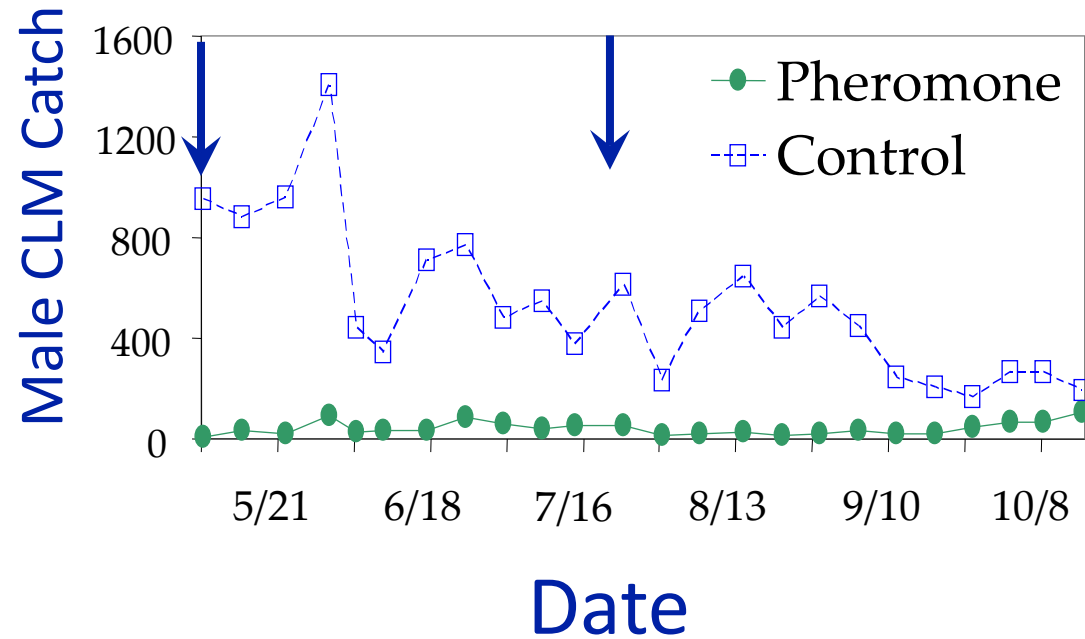
EPA Est. No. 80286-CA-004

**KEEP OUT OF REACH OF CHILDREN  
CAUTION**

# Season-long effectiveness



↓ = application date



Source: Stelinski, L.L., S.L. Lapointe, and W.L. Meyer. 2010. Season-long mating disruption of citrus leafminer, *Phyllocnistis citrella* Stainton, with an emulsified wax formulation of pheromone. *Journal of Applied Entomology*. 134: 512-520.



# Applicator for SPLAT



Source: Lapointe, S.L., and L.L. Stelinski. 2011. An applicator for high viscosity semiochemical products and intentional gaps for mating disruption of *Phyllocnistis citrella*. *Entomologia Experimentalis et Applicata*. 141: 145-153

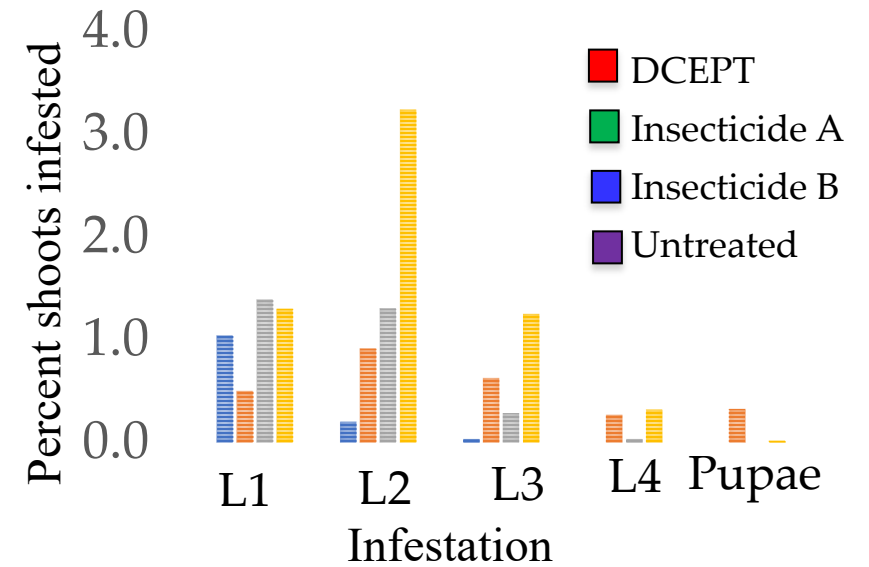
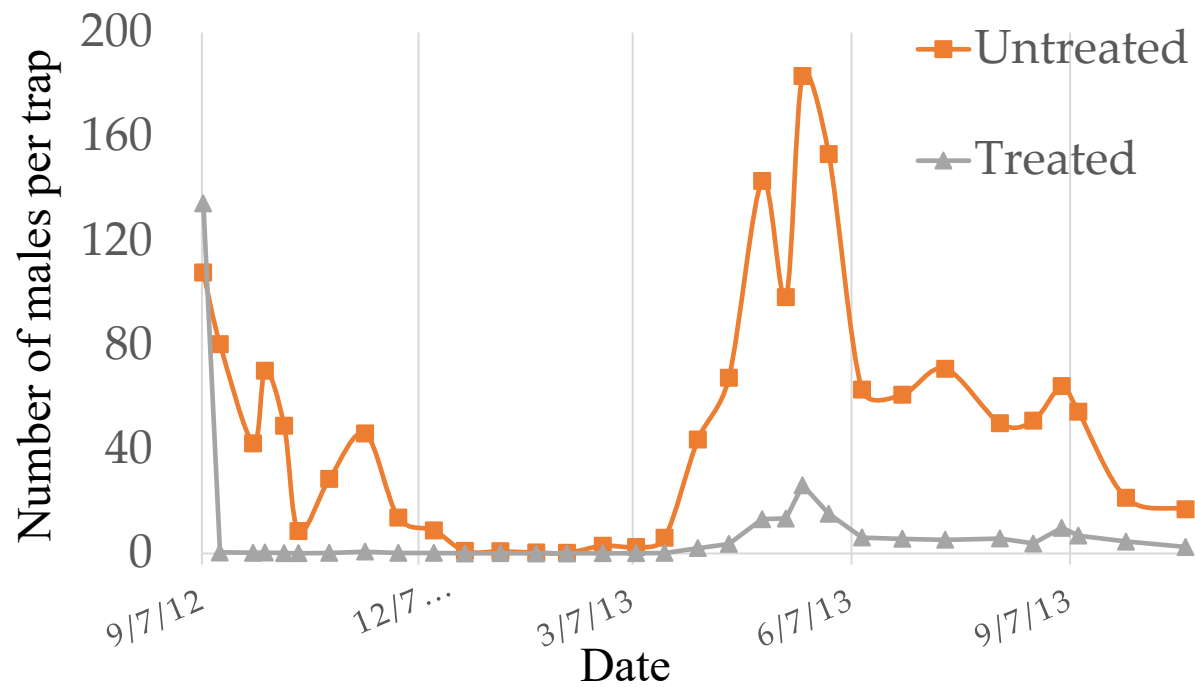


## Commercial Product Delivery

- Funding for two years, 2014 and 2015
- Partial subsidy for purchase of DCEPT-CLM™ by three cooperators:
- The Packers of Indian River
- Golden River Fruit Co.
- TRB Groves
- Coordinated and monitored by USDA-ARS and UF CREC
- 2014: 350,000 devices deployed to approx. 3,000 acres
- Approximately 128 units/acre
- Application cost: \$6 - 8/acre



Source: Lapointe, S.L., C.P. Keathley, L.L. Stelinski, W.H. Urrutia, and A. Mafra-Neto. 2015. Disruption of the leafminer *Phyllocnistis citrella* (Lepidoptera: Gracillariidae) in citrus: effect of blend and placement height, longevity of disruption and emission profile of a new dispenser. *Florida Entomologist*. 98: 743-748.



**Insecticide A:**

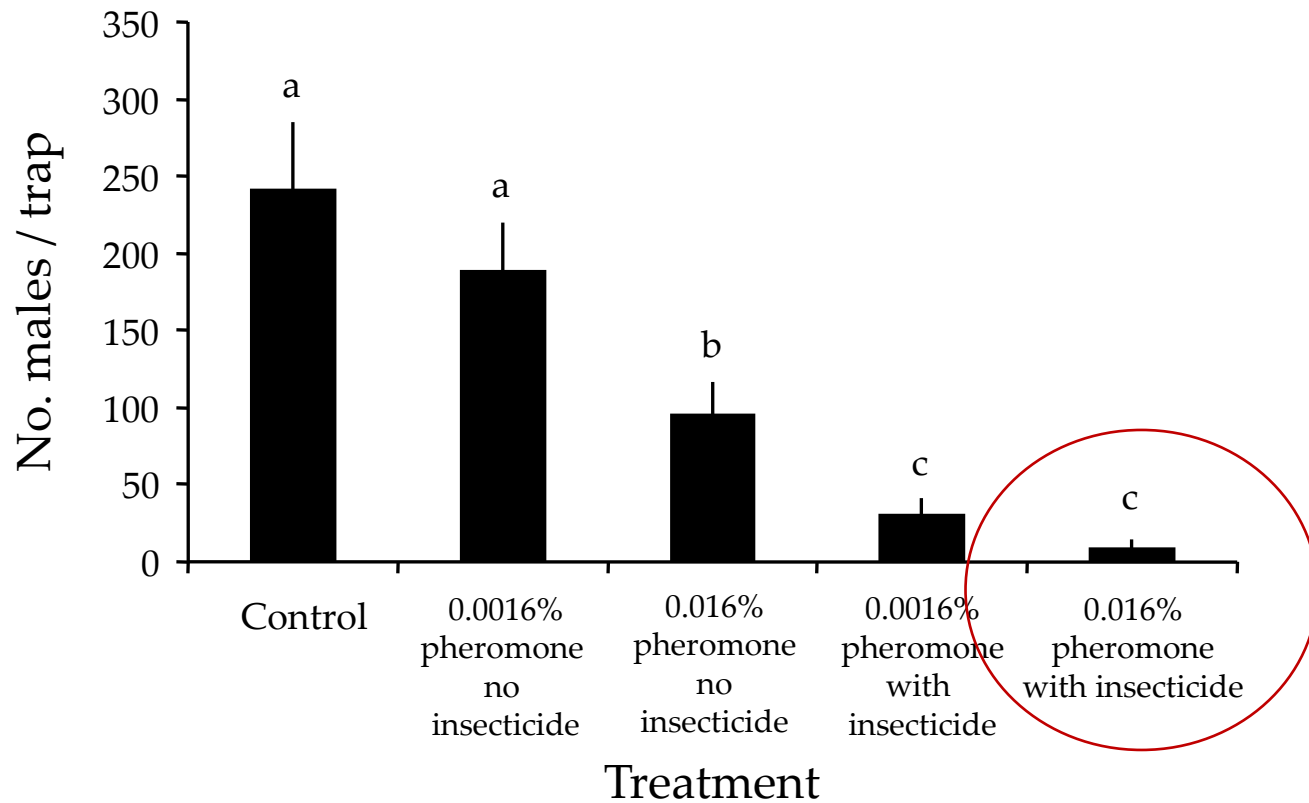
4/16: Micromite 3.125 oz.  
 4/16: Abacus 5 oz.  
 4/30: Epimek 5 oz.  
 5/12: Epimek 5 oz.  
 5/22: Epimek 5 oz.  
 5/22: Admire Pro 3.5 oz.  
 5/30: Mustang 4.3 oz.  
 6/9: Epimek 5 oz.  
 6/9: Admire Pro 3.5 oz.  
 6/23: Epimek 5 oz.  
 6/23: Knack 8 oz.

**Insecticide B:**

4/19: Danitol 16 oz  
 5/7: Intrepid 8 oz.  
 5/27: Micromite 6.25 oz  
 6/15 Intrepid 8 oz.  
 6/18: Delegate 4 oz

# LastCall available from Alpha Scents:

Has to be applied every 3-4 weeks to get this type of efficacy



# Type of pheromone formulations

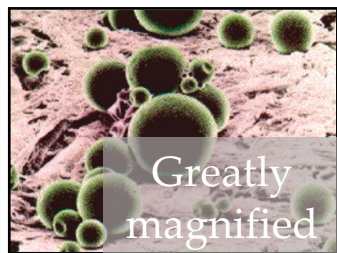
## 1) Female equivalent dispensers (Waxes, Flakes, Fibers)

Rate: 200-500 / acre

600-1000 X' s a calling female / unit



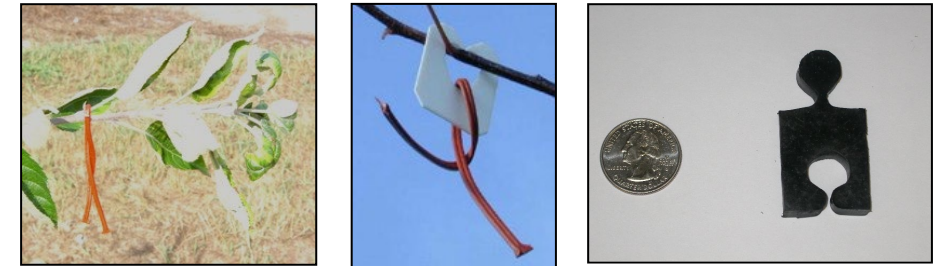
## 3) Sprayable microencapsulated formulations



## 2) Hand-applied dispensers (Ropes)

Rate: 200-500 / acre

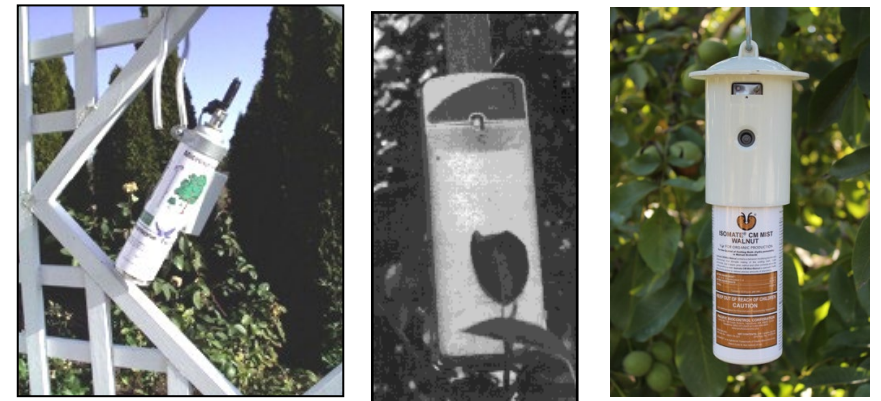
600-1000 X' s a calling female / unit



## 4) Aerosol emitters (Puffers)

Rate: 1-2 / acre

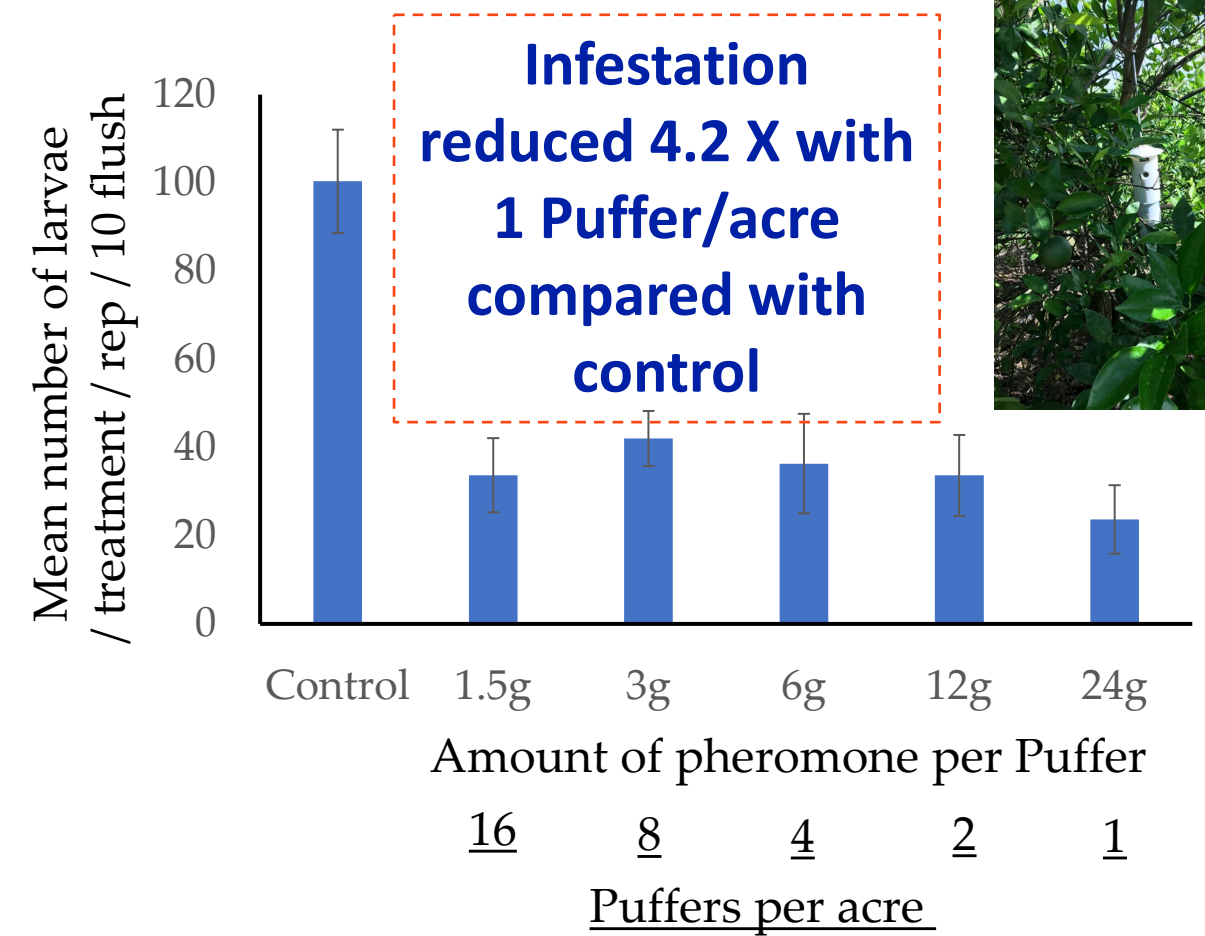
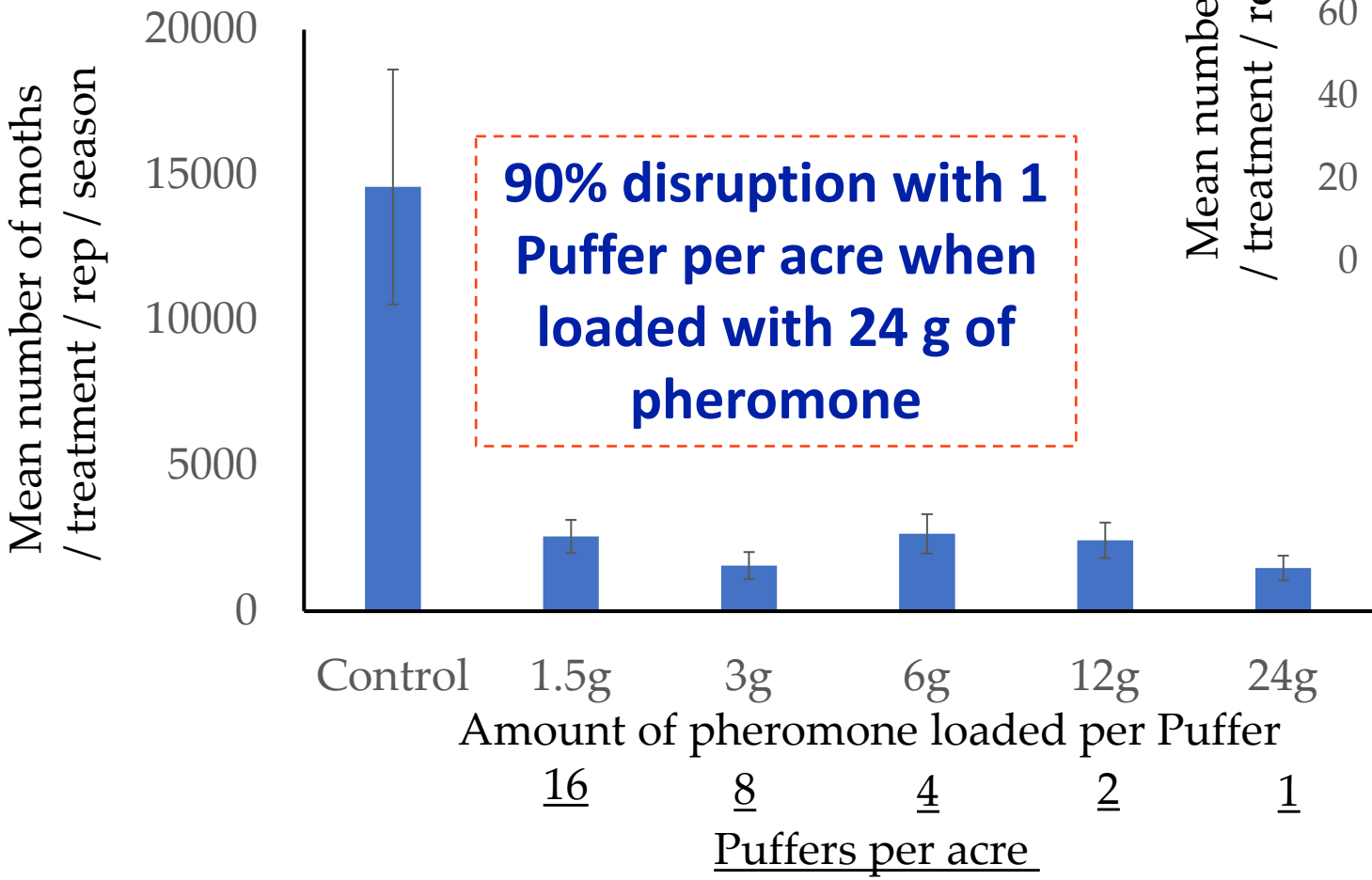
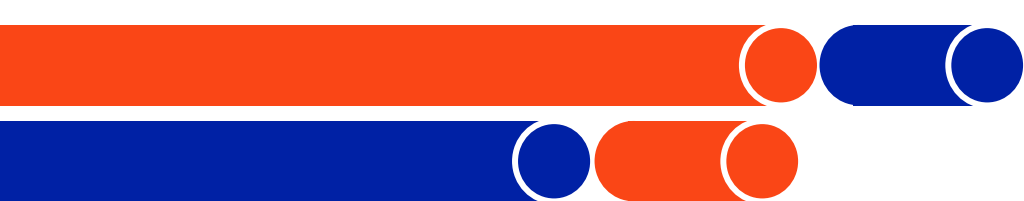
> 300,000 X' s a calling female / unit

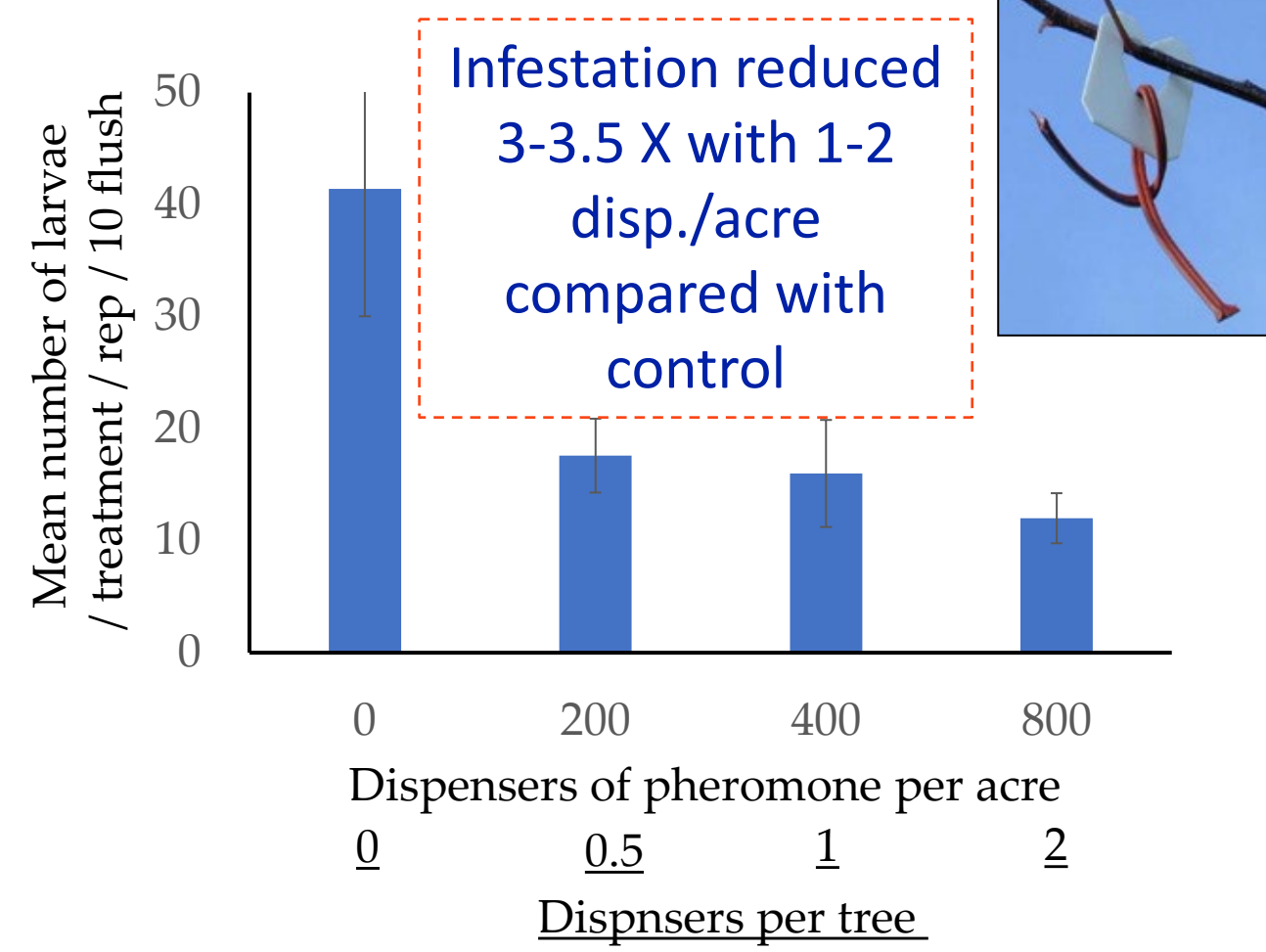
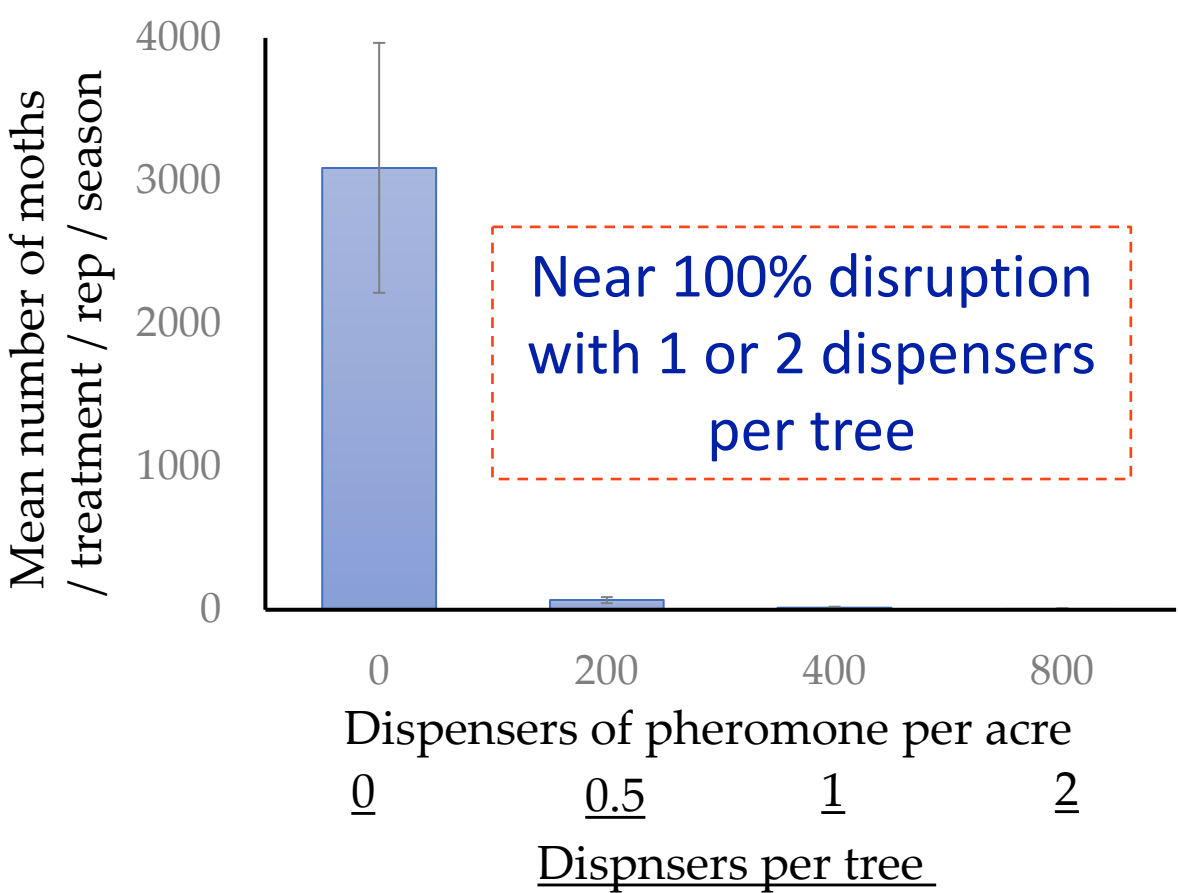
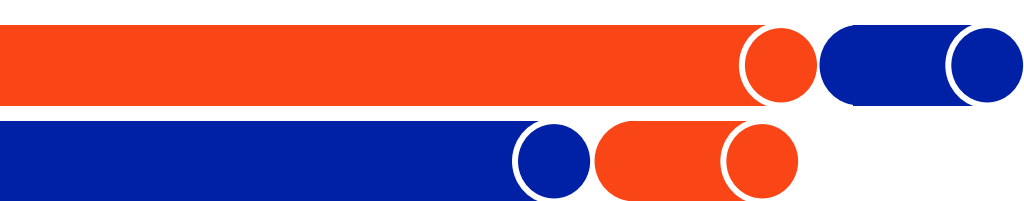


# PBC / UF ISOMATE Mist CTLM

- **Delivery Program:**
- 240 days
- Cycle (hrs) - 19:00 - 24:00 (5 hrs)
- Interval: 15 minutes
- 3 g AI/can
- **Dosages:** 0, 0.2, 0.4, 0.6, 0.8, 1 units/ac
- **Corresponding 1 unit / N acres:** 0, 1/ 5ac, 1/ 2.5ac, 1/ 1.7ac, 1/ 1.25ac, 1/ 1ac
- Weekly trapping CTLM at 5 traps / acre











## Summary and conclusions

- Window for spraying against CLM is between 13-31 days after budbreak.
- Apply soil systemics before leaf flush (10-14 d) because it takes time for the concentration of insecticide to build up.
- Pheromone mating disruption interferes with leafminer mating which decreases infestation.
- Several formulations have been available over the years.
- Much less expensive (competitive with insecticides) formulation is being registered.