



# Citrus Leafminer and Asian Citrus Psyllid Management in North Florida

University of Florida

North Florida Research and Education Center



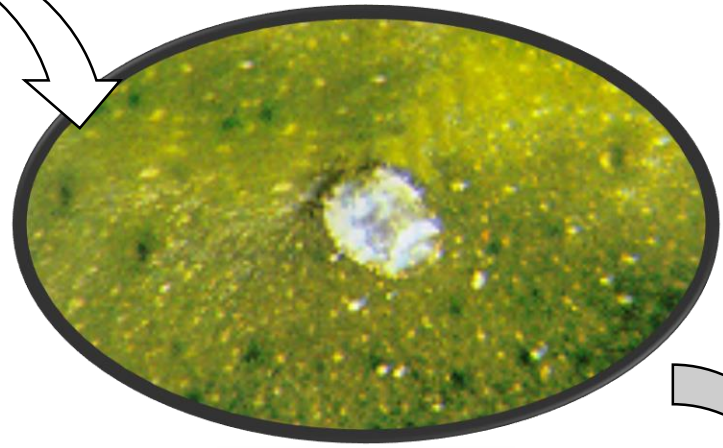
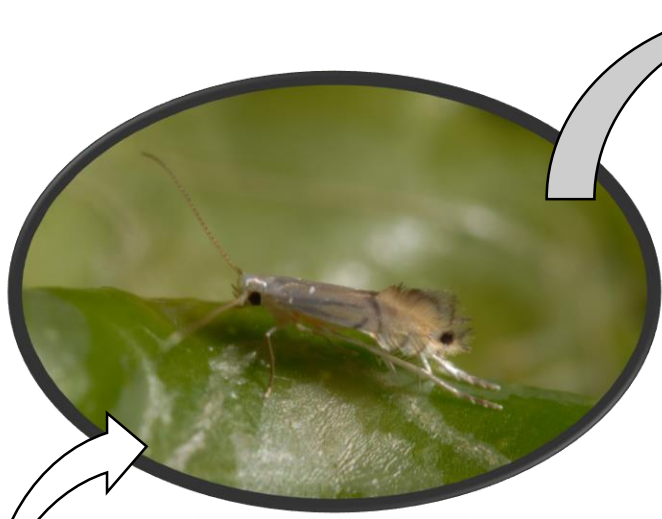
# The Citrus Leafminer





- **Adults are active diurnally and in the evenings**
- **Leaf mines are usually on the ventral leaf surface**





**2 to 10 days**



**5 to 20  
days**

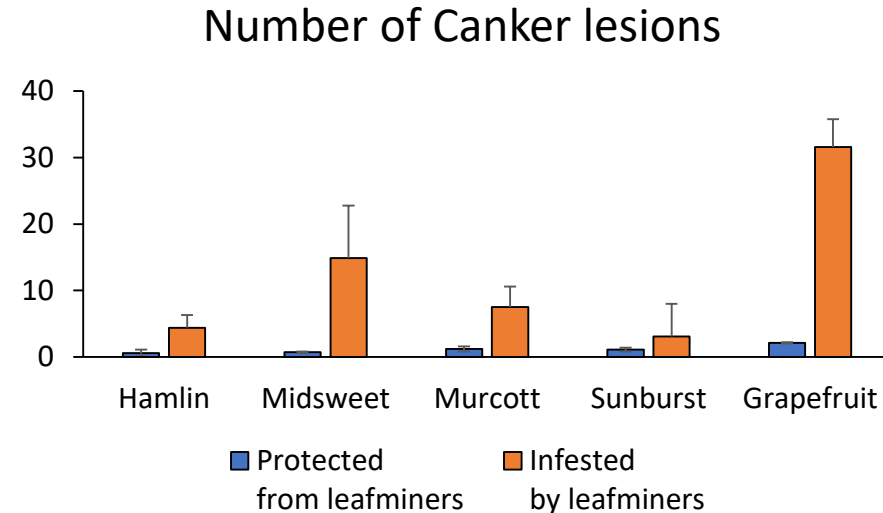


**6 to 22 days** In Florida, a new generation is  
produced about every 3 weeks.

# Damage caused by Citrus Leafminer



- **Damage heaviest during flush**
- **Direct damage greatest to young trees**
- **Reduce photosynthesis and tree growth**
- **Mines provide entry for pathogens**



Hall, D. G., Gottwald, T. R., & Bock, C. H. (2010). Exacerbation of citrus canker by citrus leafminer *Phyllocnistis citrella* in Florida. *Florida Entomologist*, 93(4), 558-566.

# Damage caused by Citrus Leafminer



**Citrus canker without leafminer lesion**



**Citrus canker with leafminer lesion**

# Biological control of Citrus Leafminer



*Ageniaspis citricola*

Imported in FL in 1994

Parasitism up to 100% in some areas

## **IPM compatibles:**

Micromite (diflubenzuron); Agri-Mek (Abamectin)

## **NOT compatible with:**

Neonicotinoids

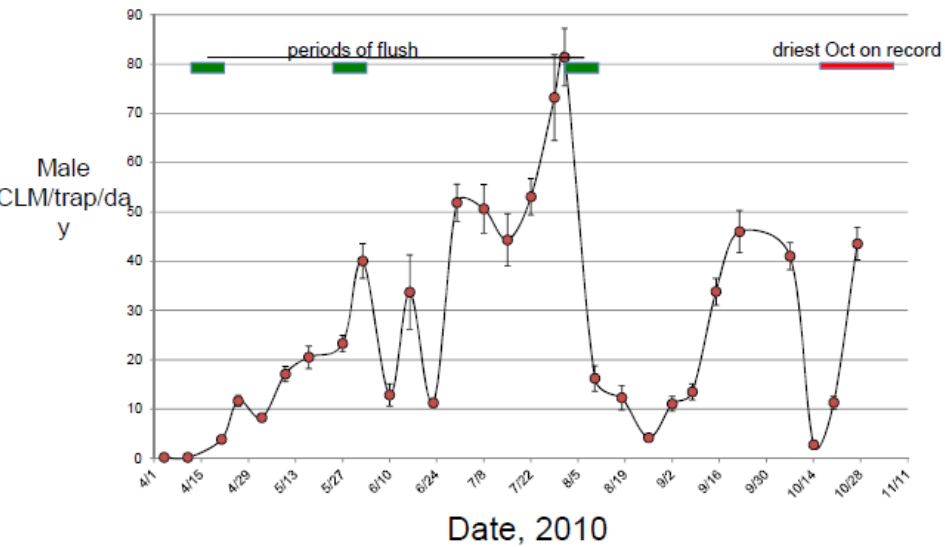




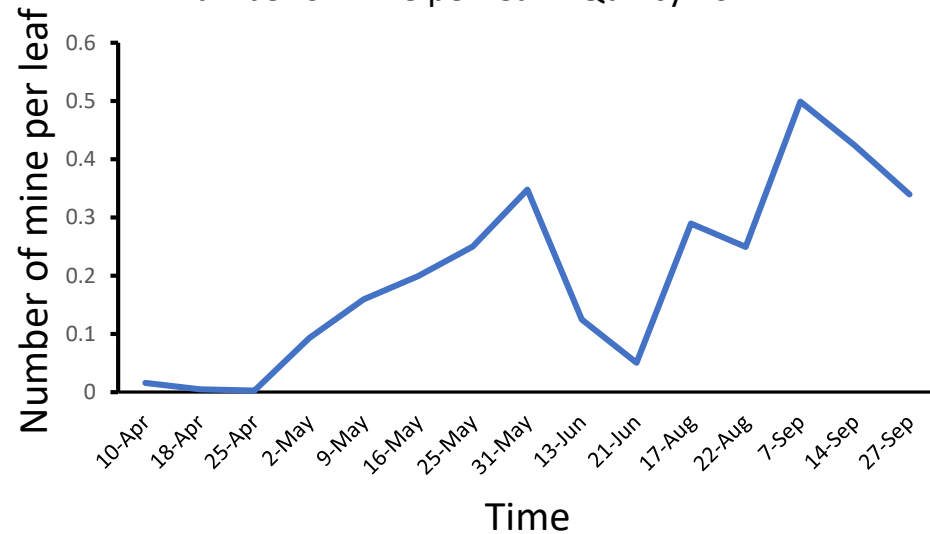
# Phenology



No. male CLM/trap/day,  
2010, St. Lucie County, FL



Number of mine per leaf – Quincy 2017

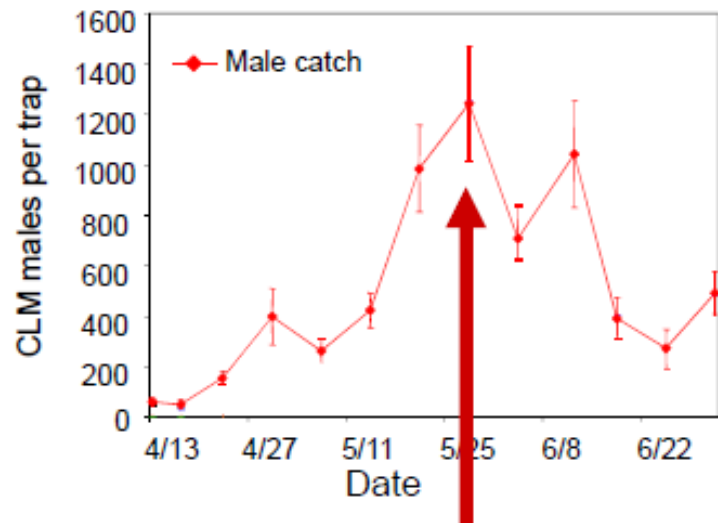




# Phenology



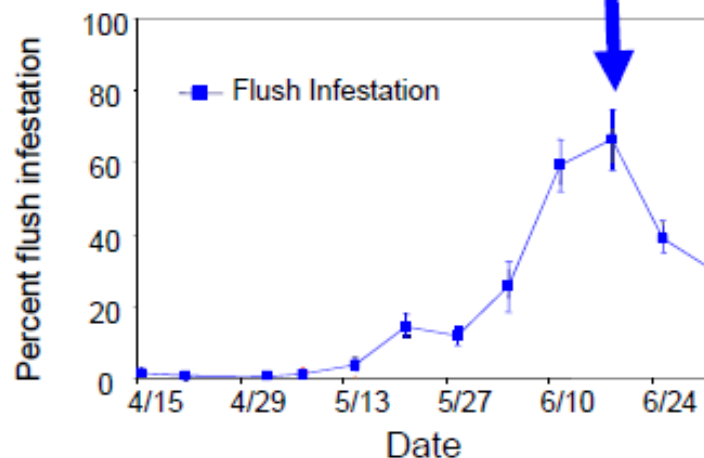
## Moth catch in pheromone-baited traps



Peak  
catch in  
monitoring  
traps

But,  
the peak infestation  
was observed almost  
one month later

## CLM infestation



- Populations of leafminer build rapidly on the spring flush, and then vary with the flushing cycles
- Moth adults arrive one month before actual nymph infestation
- Leafminer populations decline to their lowest levels during the winter



# Citrus Leafminer control

Non-bearing trees

→ Citrus trees of at least 3 years of age



- Effectively controlled in young trees by **systemic insecticides** (neonicotinoids or diamides).
- Soil applications of neonicotinoids should be made about 2 weeks prior to leaf expansion.
- Applications of neonicotinoids should be timed to avoid rain events within 24 hours.
- The appearance of leafminers in young flush of these trees is an indication that residual effects have worn off.
- Foliar applications of products effective against CLM may follow when flush is about halfway extended to kill the maximum number of larvae.

# Citrus Leafminer control

Bearing trees

→ Over 3 years old



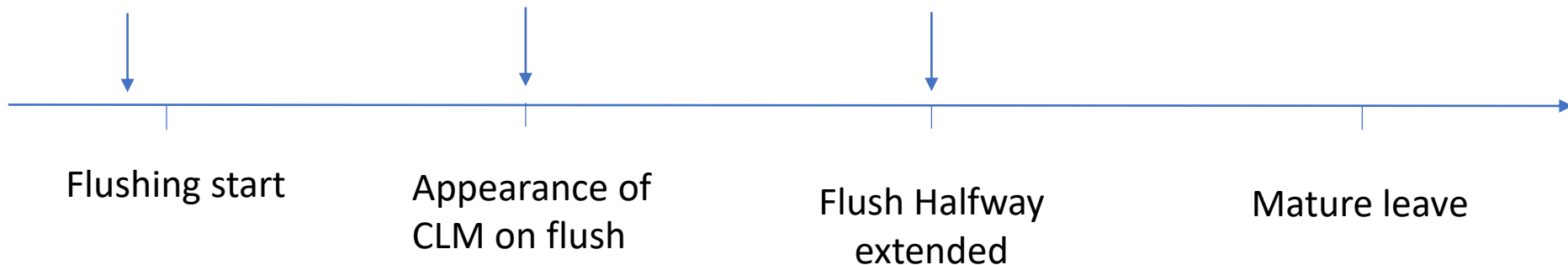
- In the absence of canker, moderate leafminer damage is acceptable on bearing trees, unless they recover from heavy defoliation.
- Since leafminers affect only developing leaves, coverage of peripheral leaves in the canopy with foliar pesticides is enough.
- Foliar sprays are directed against the larvae and should be timed to coincide with the appearance of the first visible leaf mines.
- Foliar applications do not control CLM adults.
- Pheromone traps are also available commercially to help monitor CLM population trends.

## Non-bearing trees

Soil application of  
Neonicotinoid or  
diamide

Foliar insecticide

Foliar insecticide



**\*\*Do not use neonicotinoids or diamide in spray if you already used them in soil application**

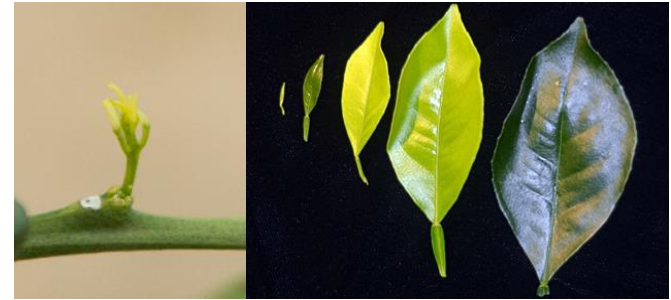
## Bearing trees

Foliar insecticide





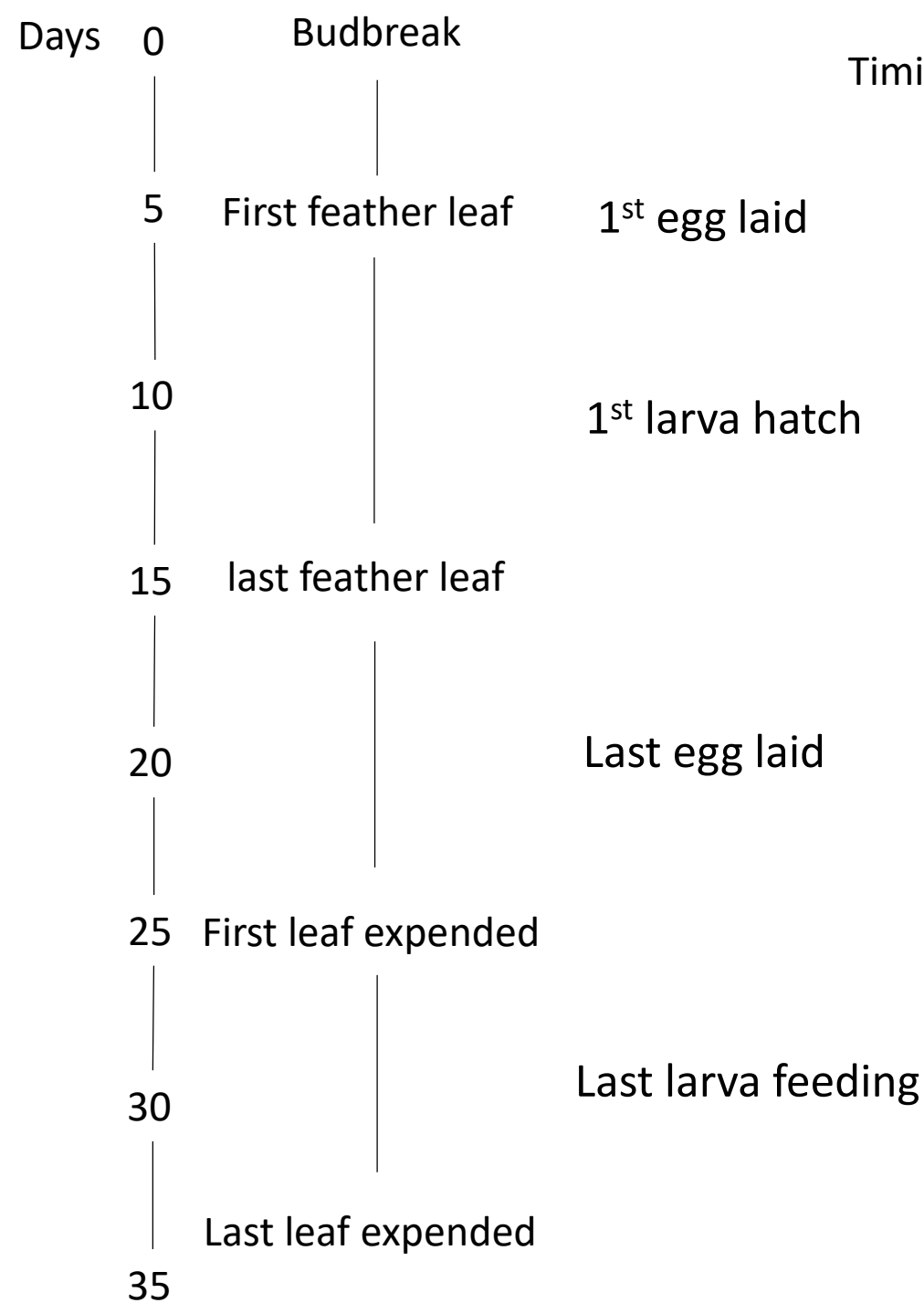
# Timing of foliar application for leafminer control



13 days from general  
budbreak is earliest  
time for application

18-day window

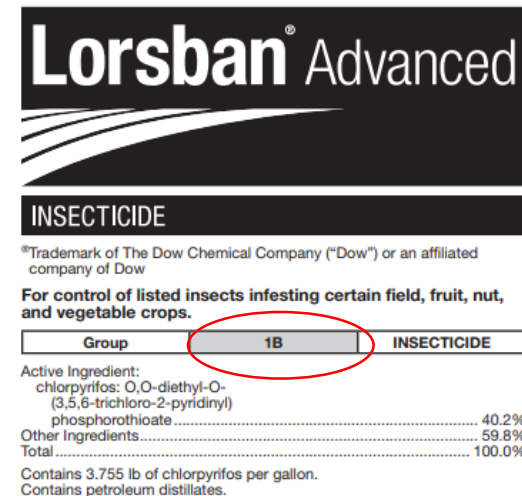
Last potential date  
for leafminer  
application is 31  
days after budbreak



# Understanding Mode of Action and resistance management



- Each insecticide is classified for its mode of Action (MOA) by the Insecticide Resistance Action Committee (IRAC).
- Repeated use of insecticides with the same MOA increases the risk of insecticide resistance
- Active ingredients with different names still can have the same MOA.
- Ex: Clothianidin, Imidacloprid and Thiamethoxam are all in class 4A (neonicotinoids)



What causes insecticide resistance?

- Over-dependency on a single MOA
- Number of applications per crop cycle and per year
- Use rate per application, spray interval

# Citrus Leafminer Toolbox



## Soil applied neonicotinoid (soil drench) – Mode of Action class 4A

- Clothianidin (Belay 50 WDG)
- Imidacloprid (Admire Pro)
- Thiamethoxam (Platinum)

## Soil applied diamides - Mode of Action class 28

- Cyantraniliprole (Verimark)
- Soil drenches are best applied using an applicator metered to deliver 8–10 oz of formulated drench solution per tree.
- Drench applications should be applied directly at the soil-rootstock interface.

Rates and specific indications can be found in <https://edis.ifas.ufl.edu/cg098>

# Citrus Leafminer Toolbox

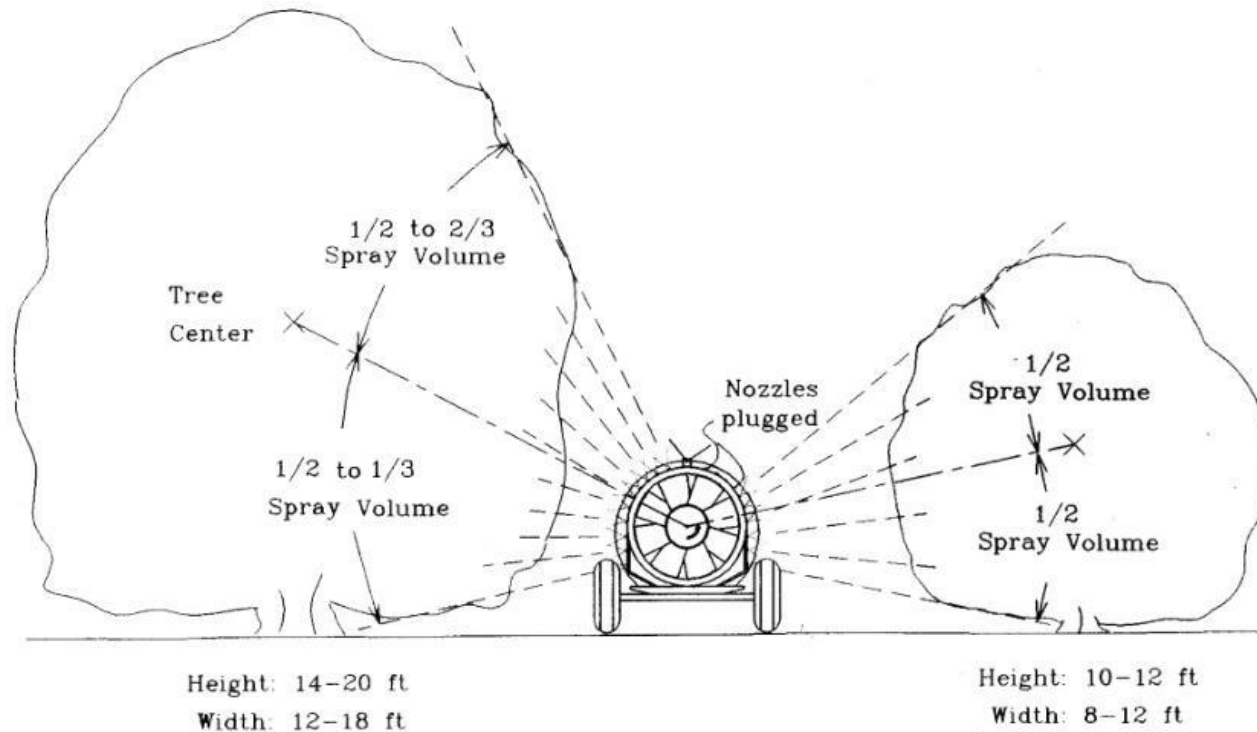


## Foliar applications

- Spinetoram (Delegate) and Spinosad (Entrust) – **MOA class 5**
- Abamectin (Agri-Mek) - **MOA class 6**
- Difubenzuron (Micromite) - **MOA class 15**
- Methoxyfenozide (Intrepid) - **MOA class 18**
- Cyantraniliprole (Exirel) – **MOA class 28** - if not used in soil application
- Volian Flexi (Thiamethoxam (**MOA 4A**) + Chlorantraniliprole (**MOA 28**), only for bearing trees.
- Agri Flex (Thiamethoxam (**MOA 4A**) + Abamectin (**MOA 6**))



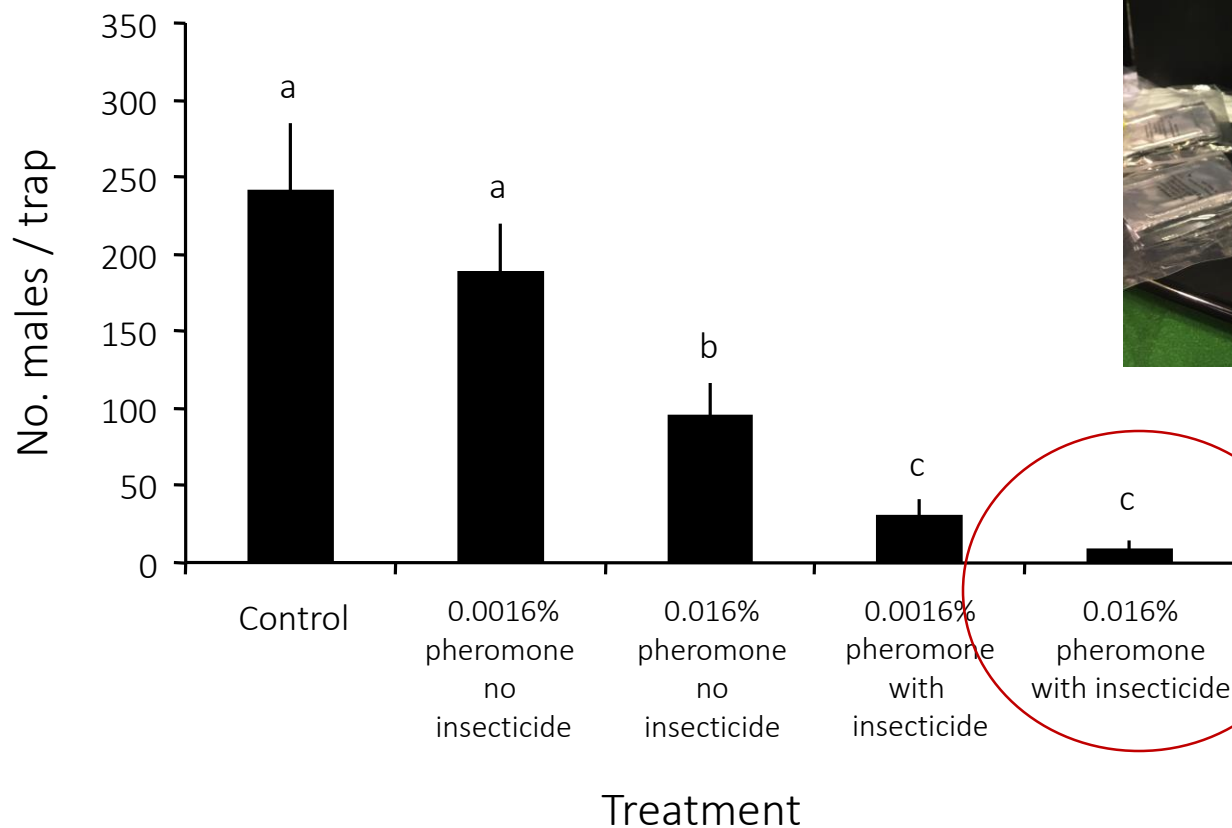
# Citrus Leafminer Toolbox



- Foliar applications are made with air-carrier ground sprayers.
- Choose a 1/2-1/2 (uniform) nozzle arrangement.
- Information on pesticide application technology can be found: <https://edis.ifas.ufl.edu/cg024>

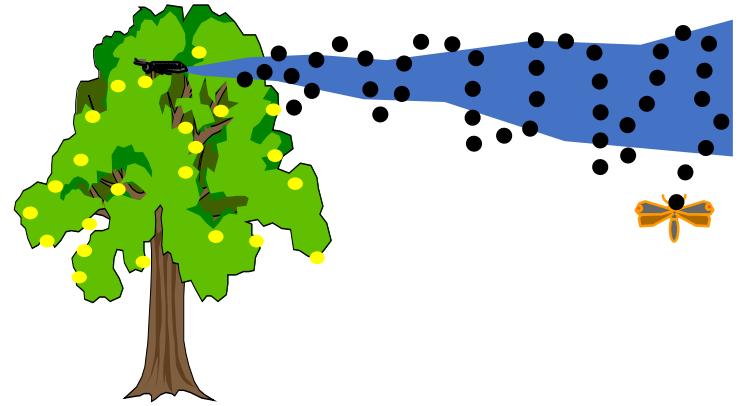
# Attract-and-kill for leafminer control

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

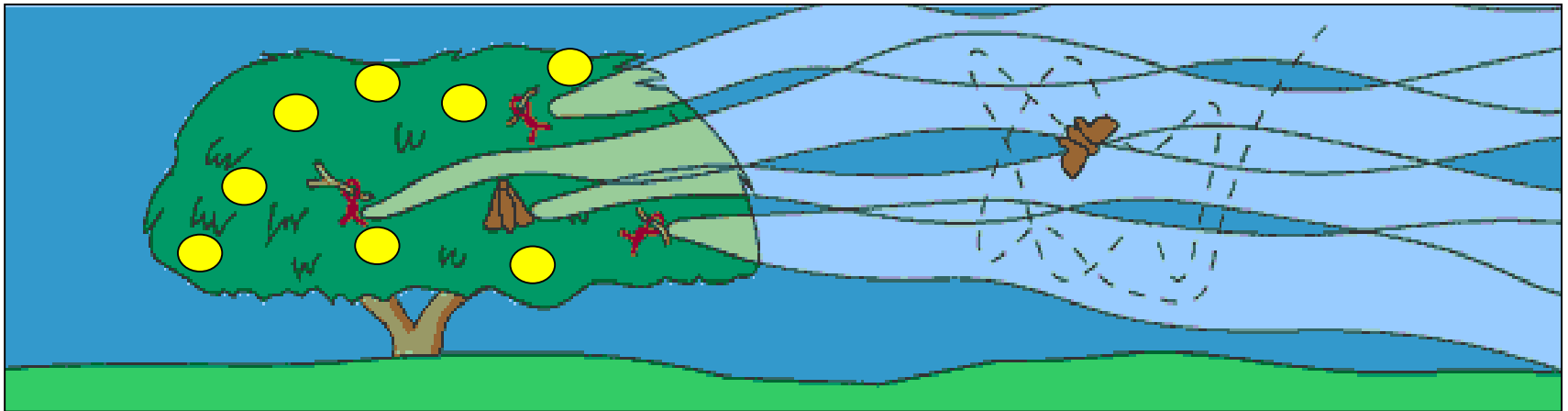


# What is Mating Disruption?

- Male moths follow pheromone plume to locate female



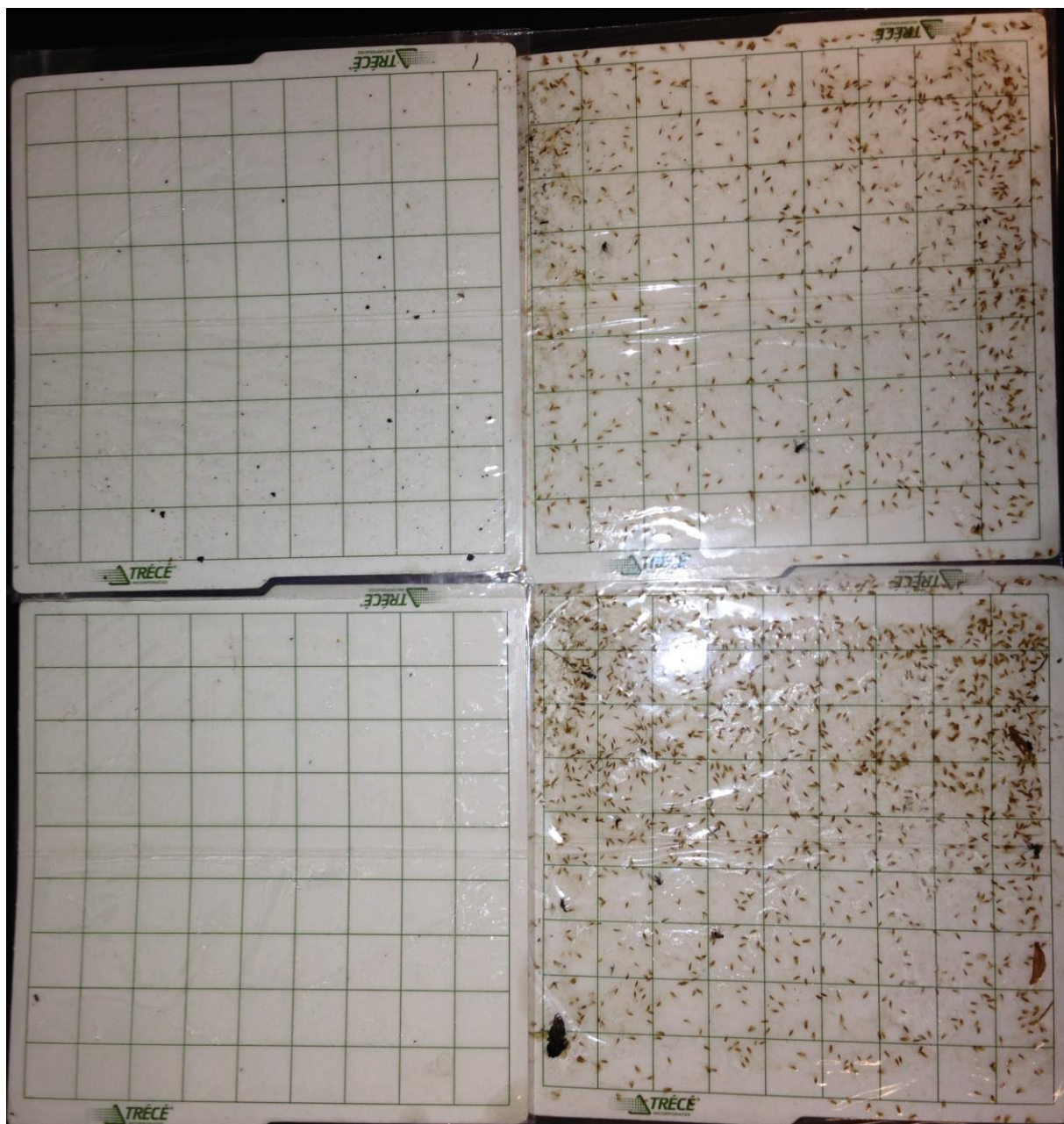
- Application of synthetic pheromone sources confuses males and prevents mating, reducing larval numbers and crop damage



# DCEPT dispenser for CLM mating disruption

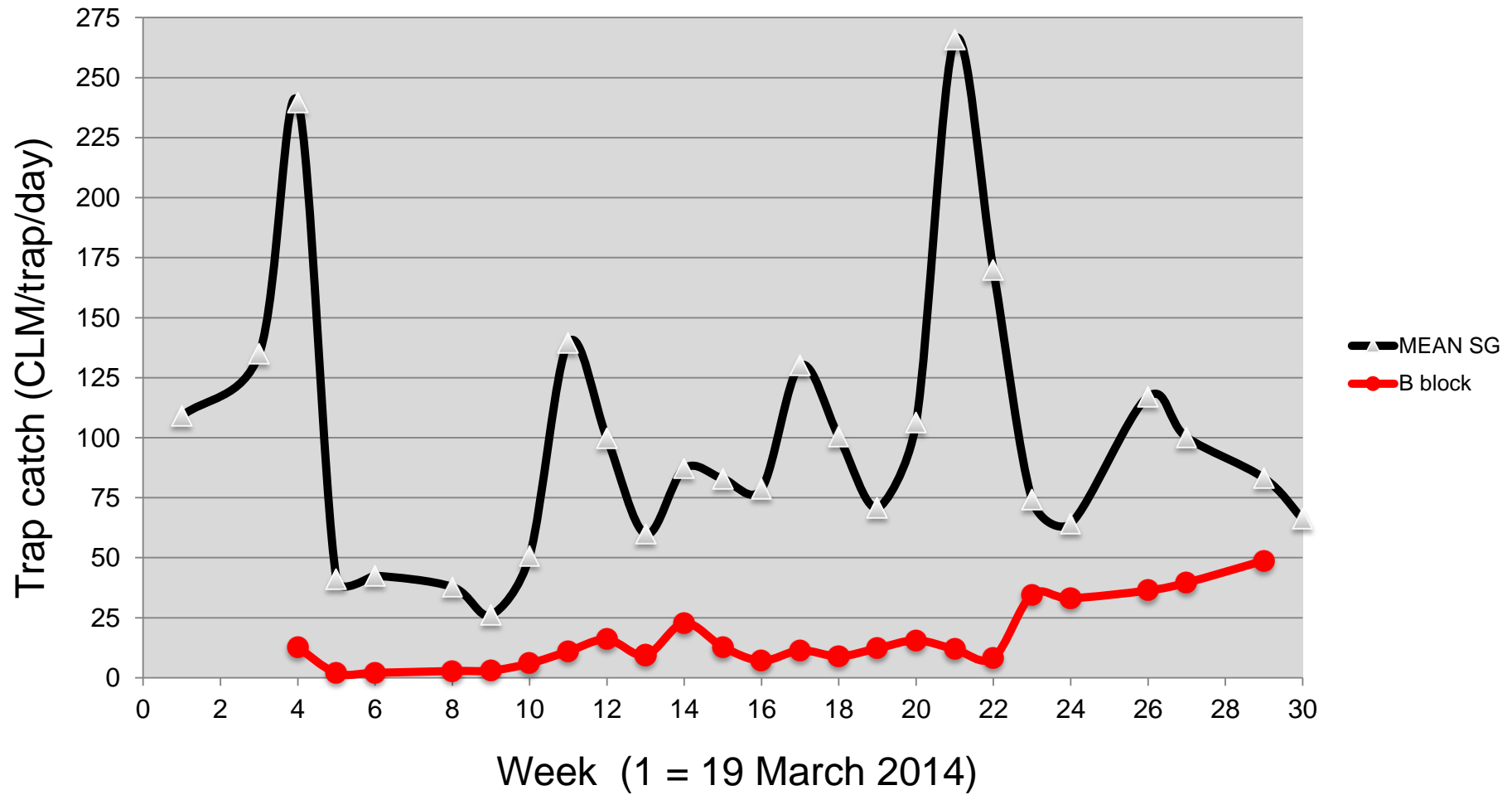






# Emerald Grove

## The Packers of Indian River



# Pheromone mating disruption

- All data over 8 years of development in Florida suggest that MD is feasible
- Reduction in mining demonstrated in small plots
- Large scale applications in 2014 suggest control equal to multiple insecticide applications
- Longevity in 2014 was approximately 12 weeks
- Pheromone loading rate for 2015 increased by >2X
- MD of CLM will be a valuable tool for growers in an IPM context

Funding provided by grants from the Citrus R&D Foundation, and the Specialty Crop Block Grant, USDA Farm Bill.

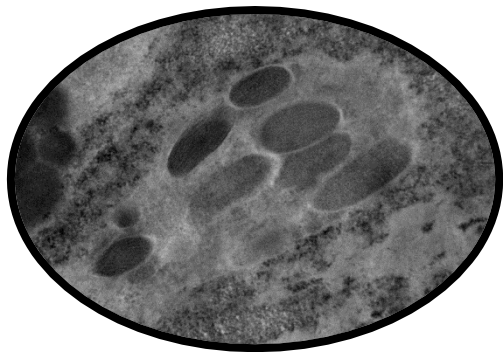




# The Asian citrus psyllid



- *Diaphorina citri*, the Asian citrus psyllid. First found in Florida in June 1998
- Vector of *Candidatus Liberibacter asiaticus* (CLas) pathogen responsible for Huanglongbing (HLB)



*Candidatus Liberibacter asiaticus*



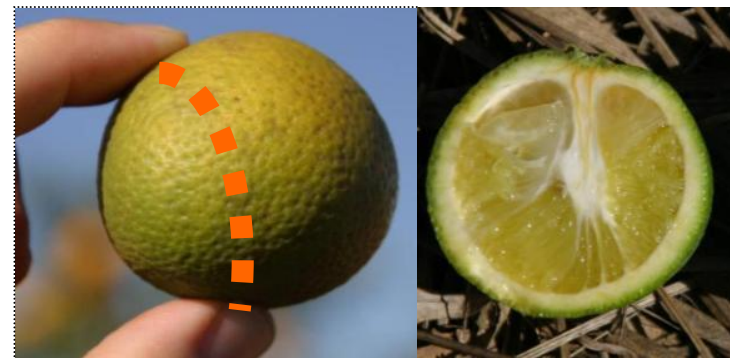
Uninfected



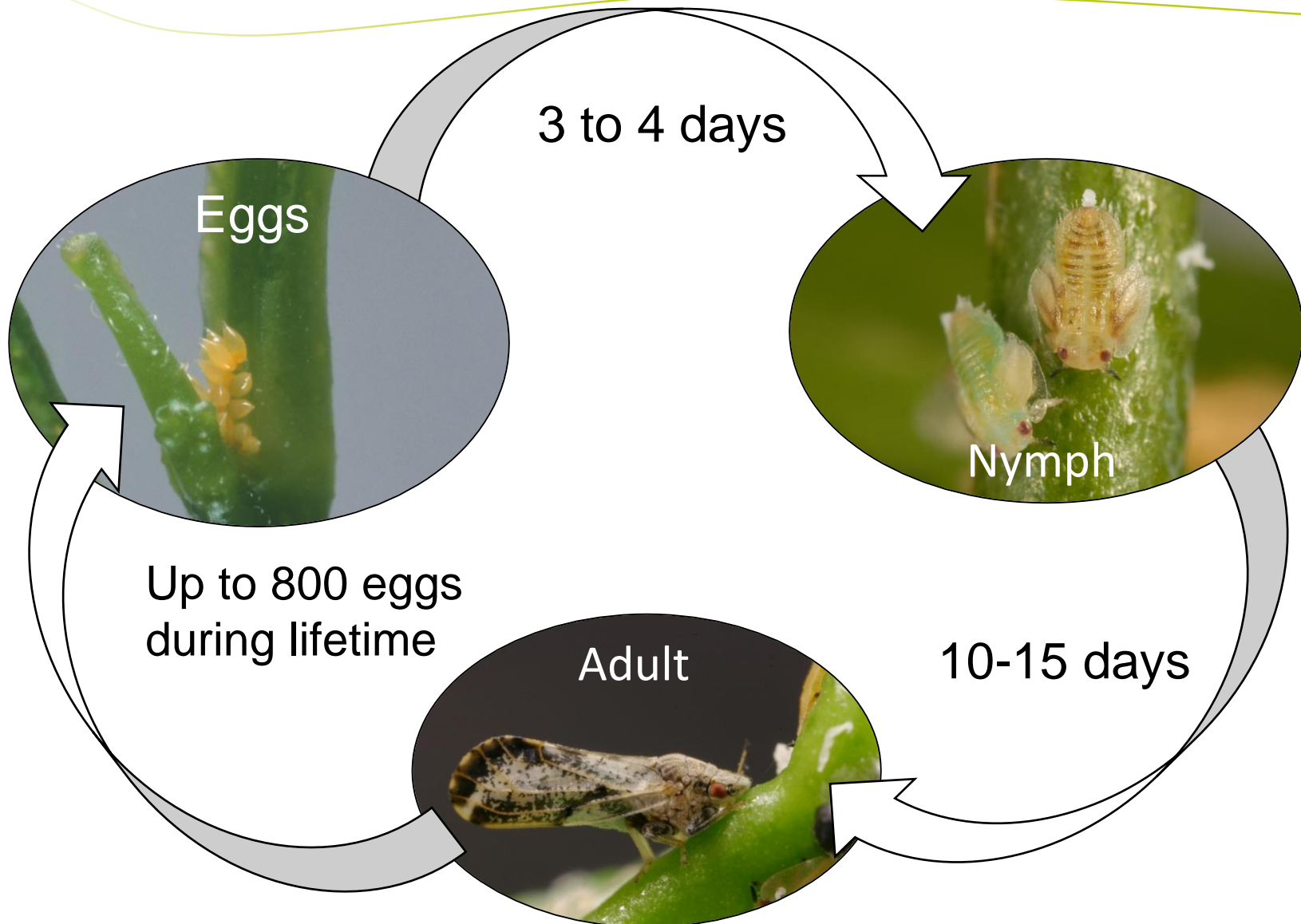
# Economic impact of HLB in Florida



- Death of citrus trees only a few years after infection
- Undesirable organoleptic properties
- All known commercial citrus species are susceptible to HLB infection
- Citrus yield decreased from 133.6 millions of boxes in 2012-2013 to 78 millions of boxes in 2019-2020
- HLB infection rate in Florida is approximately 80%



# The Asian citrus psyllid: Life Cycle



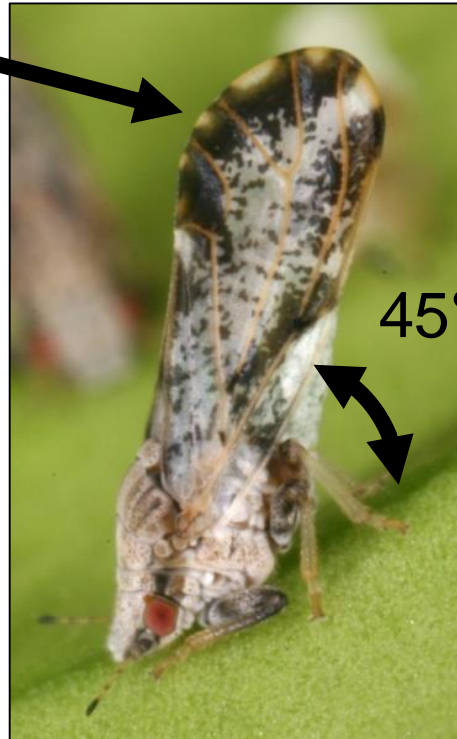


# The Asian citrus psyllid



- Adults jump when approached
- They sit in a vertical position with abdomen up in the air

Black  
coloration at  
the end of the  
wings



45°

1/10 to 1/6  
inches

- Nymphs are always found on new emerging leaves
- Can be confused with scale insects, but scale insects do not move and do not produce white honeydew.

Flat yellow  
body

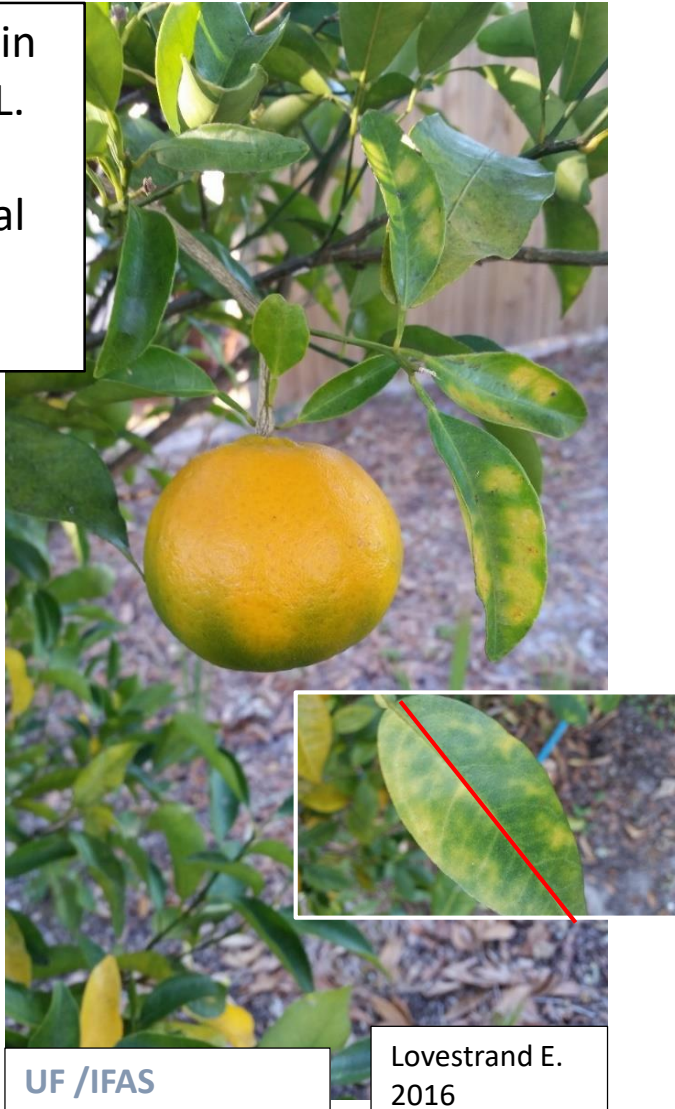


White honeydew

Leaf distortion

# HLB symptoms

Citrus plant in Carabelle, FL. Note the asymmetrical chlorosis on the leaves.



UF /IFAS

Lovestrand E.  
2016

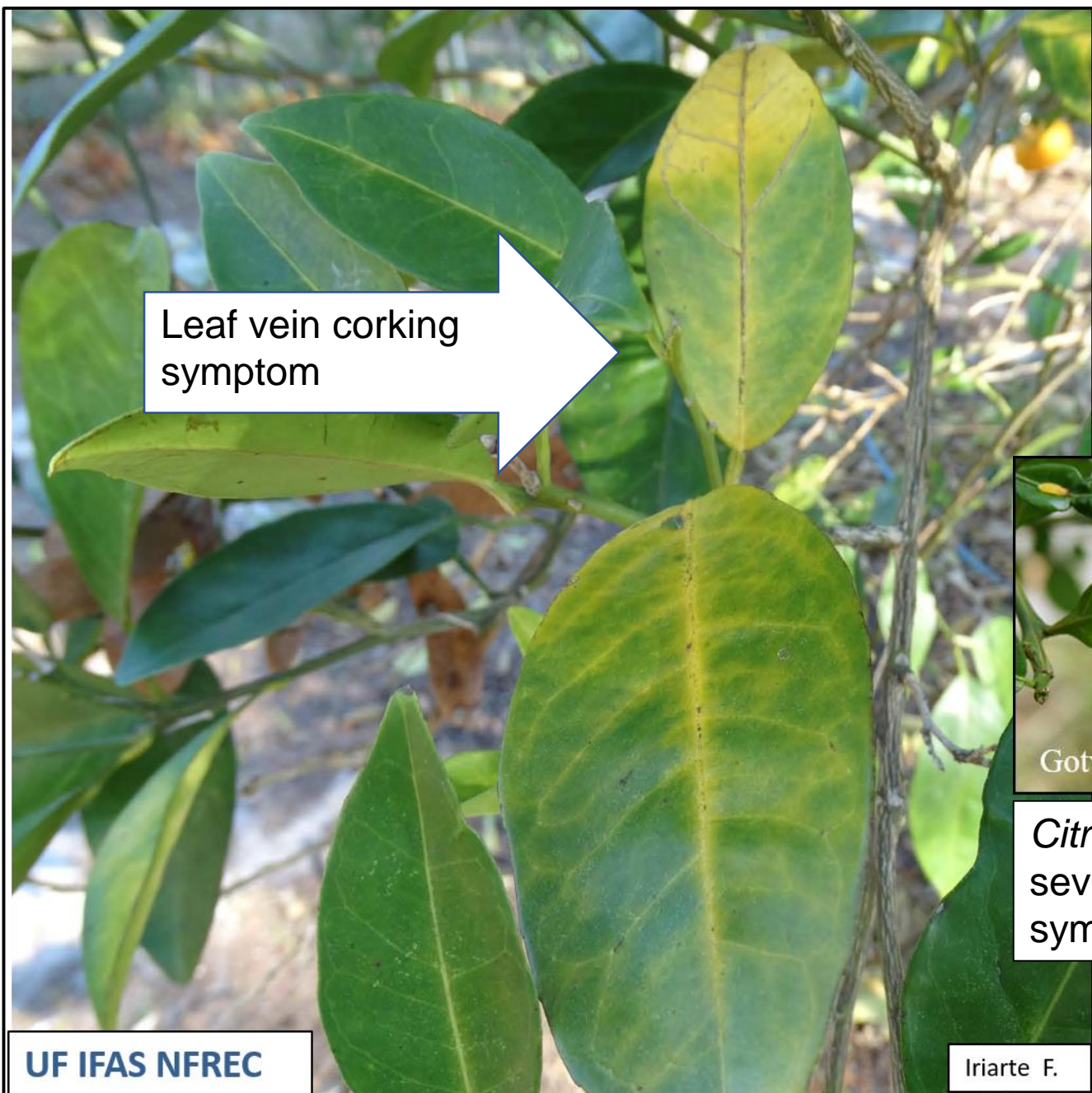
Citrus tree in Carabelle, FL. Note the leaf mottle and shape and color of the fruit.



UF/IFAS

Lovestrand E.  
2016





Leaf vein corking  
symptom

Leaves can become  
thicker, with veins  
enlarged and corky  
in appearance



Gotwald T. R.

*Citrus hystrix* tree showing  
severe vein corking  
symptom

Fruit is usually small, poorly colored, lopsided and may have lack of coloration at the stylar end



Infected fruits have stylar end "lack of coloration"



Fruit taste may be bitter, medicinal and sour.

Infected trees may not show symptoms for several years (1-5 years or more).



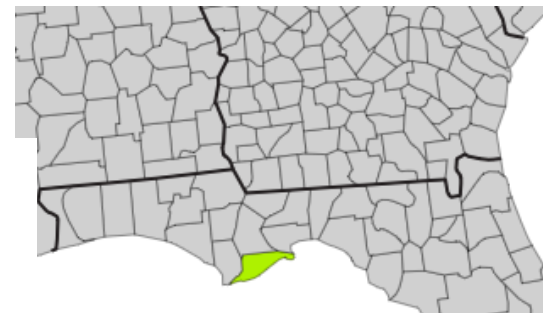
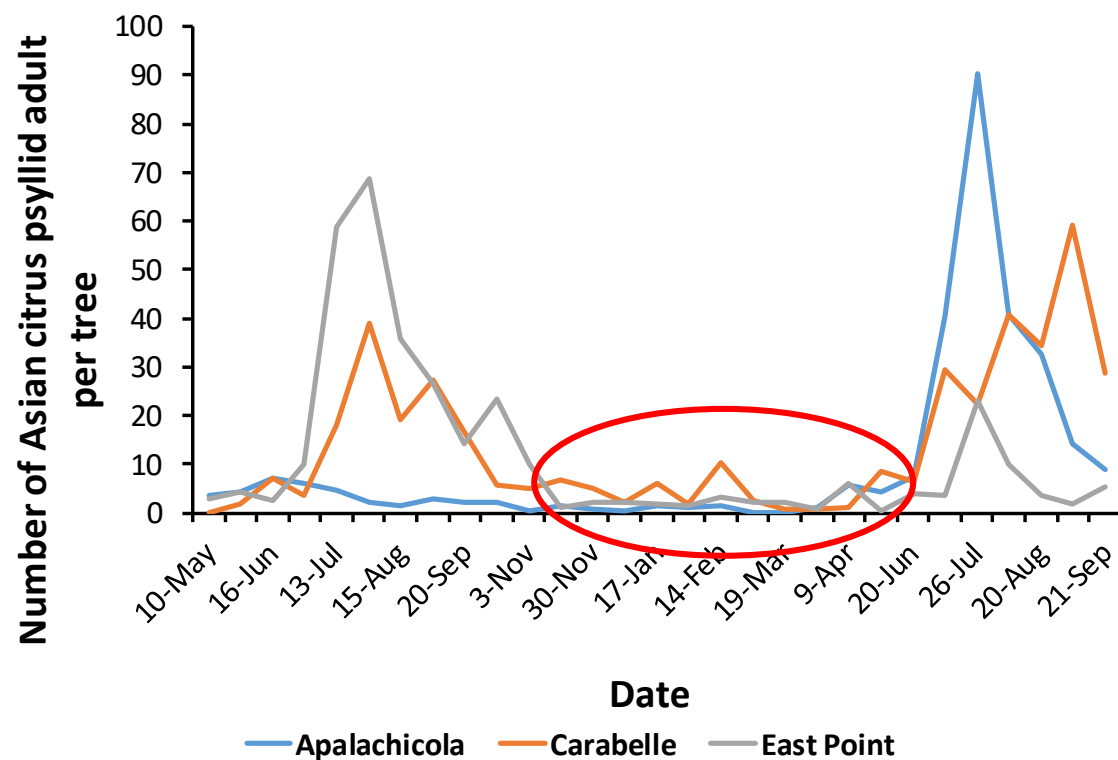
Asymmetrical "lopsided" sweet orange fruit from São Paulo, Brazil



# Population dynamic of the Asian citrus psyllid in Franklin county



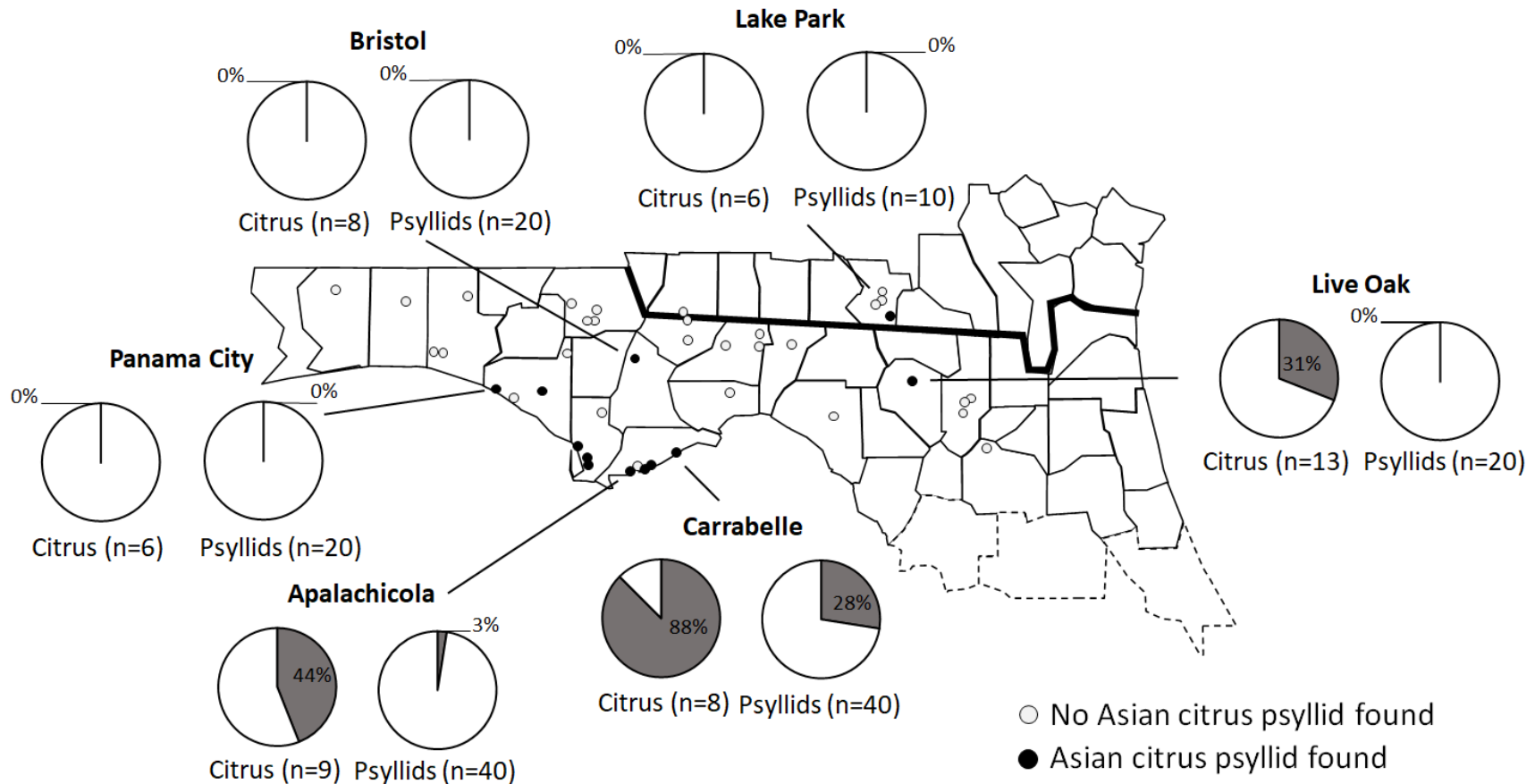
Asian citrus psyllid adults



Adult population peaks between June and November

Asian citrus psyllids survive winter

# Asian citrus psyllid and Citrus Greening situation in North Florida in 2018



We found Asian citrus psyllids and citrus greening in a single grove in 2019. Infected trees have been removed and psyllids eradicated from the area.

# Strategy for Asian citrus psyllid management in North Florida



1. Scout your grove for Asian citrus psyllid on a regular basis especially between June to November
  - Sticky traps
  - Flush inspection
2. If you find Asian citrus psyllid in your grove, do not wait
  - Treat immediately with a foliar application
  - Contact your local IFAS extension agent to let us know
  - Scout you grove 1 and 2 weeks later to see if the application has been efficient
3. Scout your trees for Citrus Greening
  - Visual inspection. Send any suspicious samples to our plant clinic at the NFREC
  - Scout with canine detection
4. Immediately remove any tree positive for greening
5. Speak to your neighbor and colleagues about need to control ACP when they find it, and to monitor their groves for Greening.

# Psyllid sampling methods



**Flush examination:** observing and counting psyllid adults found in tree canopy within approximately 40s

**Sticky traps**

[www.alphascents.com](http://www.alphascents.com)

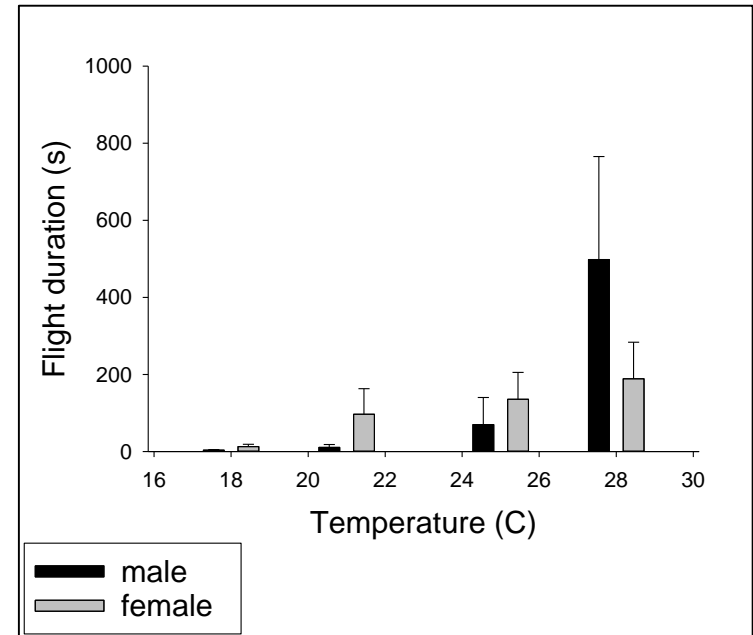
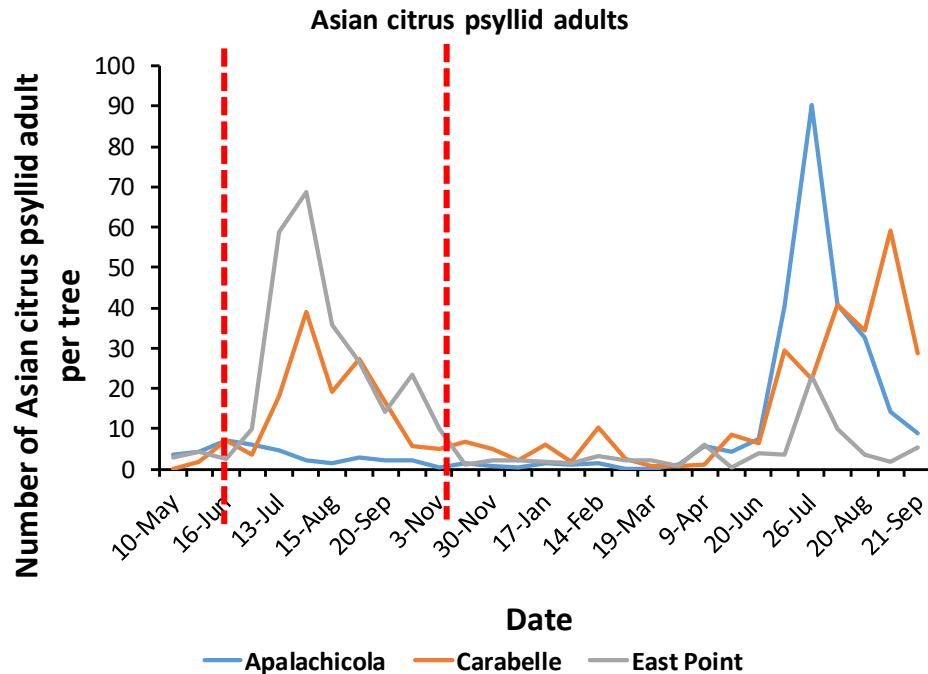
[www.iscatech.com](http://www.iscatech.com)



**Tapping:** Tap a randomly selected branch three times with a stick (PVC pipe). Psyllid adults are counted as they fall on a clipboard below.



# When to sample?



June to October is the period with the highest risk of psyllid infestation in North Florida and Georgia

# Canine detection



False negative      False positive



1 trial: 100 trees



**F1K9**

<https://f1-k9.com>

Gottwald et al. 2020.  
*Proceedings of the National  
Academy of Science.*

99.6% 98.8% 99.6% 99.1% 99.1% 99.5% 99.1% 99.0% 99.1% 98.7% → accuracy

Two dogs are used for confirmation. If the two dogs agree, the risk of error is about 1 for 10.000 trees.

# Canine detection



# Insecticide applications



**Insecticide soil applications** for leafminers are also effective on Asian citrus psyllid. If you already treat your trees for leafminers, your tree will be also treated for psyllid. No need to add another soil application.

## **Foliar application (only if you found psyllids in your grove):**

Lorsban 4 E, Baythroid XL, Neonicotinoids (if not used in soil application), Sivanto 200 SL, Delegate WG, Portal, Movento, Exirel (if you didn't use already Verimark in soil application), Voilam Felxi, Agri-Flex...

## **During bloom consider the following spray program:**

Sivanto 200 SL, Micromite , Portal, Movento

Horticultural mineral oil is an effective insecticide that can be tank mixed with most insecticides



# Acknowledgments

Danielle Sprague  
Charlene Cupp Kinch  
Kathi Malfa

