Arthropod predators attacking Asian citrus psyllid and their impact on psyllid populations in Florida

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Presentation Outline

• Brief biology of Asian citrus psyllid (ACP)
• Florida citrus: ACP and huanglongbing (HLB)
• Arthropod predators attacking ACP in Florida
• Methods to measure impact of natural mortality factors on psyllid populations
• Impact of natural mortality factors on psyllid populations
• Enhancement of biological control
• Conclusions and implications
Asian Citrus Psyllid (ACP)  
*Diaphorina citri* (Hemiptera: Psyllidae)

- Optimal temperature for development 25-28 °C
- Unfold and tender leaves needed for oviposition
- Egg to adult (2 Weeks)
- 5 nymphal stages
- 10-12 generations / year

M. Rogers
Florida Citrus: 1998-2010

Asian citrus psyllid discovered, 1998

Huanglongbing (citrus greening) discovered, 2005

Psyllid management to reduce incidence of HLB

- Insecticides testing
- Enhancement of biological control
  - Predators, Parasitoids
Southern 2-spotted ladybeetle
*Olla v-nigrum*

- Primarily a mite feeder
- Also feeds on aphids and psyllids
- Its abundance increased in response to psyllid invasion
Multicolored asian ladybeetle
*Harmonia axyridis*

- An introduced species
- A good predator of aphids and psyllids
- Also feeds on mites, scales, mealybugs, leafminers, and eggs and larvae of several other insects
Blood-red ladybeetle
*Cycloneda sanguinea*

- Important predator of aphids and psyllids
- Also feeds on mites, scales, and mealybugs
Metallic blue ladybeetle
*Curinus coeruleus*

- Imported from Mexico in 1950s
- Primarily a scale feeder
- Also feeds on aphids, and psyllids

J. P. Michaud
Little red ladybeetle

*Exochomus childreni*

- A native species most abundant in central Florida
- Primarily a scale feeder
- Also feeds on aphids and psyllids
Relative Abundance of Ladybeetle Species in Florida Citrus

1997-1998

2000-2001

- C. sanguinea
- H. axyridis
- O. v-nigrum
- Other spp.

J. P. Michaud (2001)
Lacewings - Chrysopidae

Chrysoperla spp.

Psyllid Eggs & Nymphs

Ceraeochrysa spp.

P. Stansly
Predators

Asian cockroach
*Blattella asahinai*

Pseudomyrmex ants

Sac spider

Acrobat ants
*Crematogaster*

Xiao et al. (2007)
Methods to measure the impact of natural mortality factors on psyllid populations

Cohort establishment

- Trees 5-10 yr old ‘Valencia’ orange
- Trimmed to induce shoots and psyllid oviposition
- Young shoots with eggs caged for 3 days
- Eggs and 1st instar nymphs counted
- Treatments assigned at random
- Ten colonies per treatment
- One or more exclusion techniques

Qureshi and Stansly (2009)
Exclusion Techniques

1. Full cage exclusion
2. Partial cage exclusion
3. Sticky barrier exclusion
4. No exclusion

Qureshi and Stansly (2009)
Observations and Mortality Analysis

- Colonies examined with a 10x land lens every other day
- Eggs, nymphs, and any emerging adults or their exuviae counted
- Mortality estimated by the disappearance of nymphs or by their emergence as adults
- Net reproductive rate calculated for each colony as the product of nymphal survival and temperature dependent fecundity (Liu and Tsai, 2000)
- Predators or parasitoids observed on the colonies or sticky barrier were counted and removed from the latter
- Predators counted for one minute per tree at each observation

Qureshi and Stansly (2009)
Colony Survival

---o--- No exclusion, ___ Full cage exclusion

Qureshi and Stansly (2009)
Suppression of Psyllid Populations by Predacious Insects

Net Reproductive Rate ($R_0$)

Colony initiation date (2006-2007)

Qureshi and Stansly (2009)
Predators Observed on Colonies and Sticky Barriers

Qureshi and Stansly (2009)
Ladybeetles Abundance from Visual Observation of Foliage on Experimental Trees

Colony initiation date (2006-2007)

Qureshi and Stansly (2009)
Cumulative abundance of four predatory ladybeetles during cohort development
May – October, 2006

R² = 0.8506
Impact of Natural Enemies on Psyllid Populations: Summary

- Survival was significantly reduced in the unprotected colonies compared to fully protected colonies resulting in 5 to 27 fold reduction in net reproductive rate of *D. citri* in the unprotected colonies attributed mainly to predation.

- Spiders and insect predators in the families Coccinellidae, Blattellidae, Chrysopidae, Formicidae, Syrphidae, Anthocoridae, and Miridae were observed on the colonies or caught in sticky barriers.

- Spiders, the ladybeetles *Curinus coeruleus*, *Olla v-nigrum*, *Harmonia axyridis*, and *Cycloneda sanguinea*, and the lacewings, *Ceraeochrysa* sp. and *Chrysoperla* sp., were most often encountered.

- Therefore, efforts are warranted to enhance biological control of psyllid through conservation and mass releases.
Enhancement of Biological Control through Compatibility with Insecticides

Foliar

Drench

Soil Incorporation
Dormant Season Foliar Applications: Effect of Chlorpyrifos (Lorsban 4 E, 3 lbs/acre) Treatment on Psyllid, 2007

Silver Strand North, Immokalee, FL

Application Jan, 15

Qureshi and Stansly (2007, 2010)
Dormant Season Foliar Applications: Ladybeetles Equally Abundant in Chlorpyrifos (Lorsban 4 E, 3 lbs/acre) Treated and Untreated Trees, 2007

Silver Strand North, Immokalee, FL

Qureshi and Stansly (2007, 2010)
Foliar Applications Directed at Immatures on Young Flush: Effects on Psyllid and Ladybeetles, June 2006

Untreated
Acetamiprid (Assail 30 SG, 7 oz/ac)
Imidacloprid (Provado 1.6 F, 10 oz/ac)

Nymphs/shoot 14 days after treatment

Adults/tap sample

Qureshi and Stansly (2007)
Predators Equally Abundant in Aldicarb (Temik 15G, 33 lbs/Acre) Treated and Untreated Trees, 2007

Silver Strand North, Immokalee, FL

Soil applications

- Untreated
- 20-Nov-06
- 14-Jan-07
- 22-Feb-07

No significant effect

Qureshi and Stansly (2008)
Drench Applications on Young Trees: Effects on Psyllids and Ladybeetles, 2006

1st application (July 21, 2006, no rain)
2nd application (August 21, 2006), Vydate only

SWFREC, Immokalee, FL

Qureshi and Stansly (2007)
Insecticidal Control and Compatibility with Biological Control

**Conclusions and Implications**

- Control of overwintering psyllid adults with effective foliar applications during tree dormancy protects spring flush and provides long lasting psyllid suppression.

- Generalist predators are not abundant during late fall and winter and are therefore at low risk from such applications, but return in spring to help maintain psyllid control.

- Foliar applications of insecticides directed at immatures on young flush during the growing season reduced psyllid populations for a short time, but significantly impacted ladybeetle populations.
Aldicarb applied 2-3 months before spring flush to mature trees and imidacloprid to young trees controls psyllids with minimal impact on generalist predators.

Maximum protection in spring flush will reduce psyllid pressure and necessity of insecticide applications later in the year.

Reduced insecticide use on mature trees during the growing season will provide refuge for natural enemies and enhance the effectiveness of ladybeetles, lacewings, spiders, parasitoids and bees.
Tests with new candidates and their mass releases

**Predatory mite: *Amblyseius swirskii***

Used in greenhouses to control whiteflies, thrips and broadmites

![Graph showing mortality percentages for *D. citri* and *A. swirskii* over 2 days, 4 days, and 6 days.](image)
Release of 0.5 million *Amblyseius swirskii*, Coyote Organic Grove, Lake Wales FL, March 2009
Release of Millions of Ladybeetles (*Hippodamia convergens*) in Southwest Florida Commercial Groves (Started: 18 Mar 2009, Immokalee FL)
Conclusions and Implications

- Overall, natural enemies play a vital role in regulating the dynamics of *Diaphorina citri* populations and reducing the spread of pest and disease.

- Therefore, integrated control programs based on conservation of natural enemies of *D. citri* through judicious use of insecticides and mass releases are being developed and delivered to growers for sustainable management of pest and disease.
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