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

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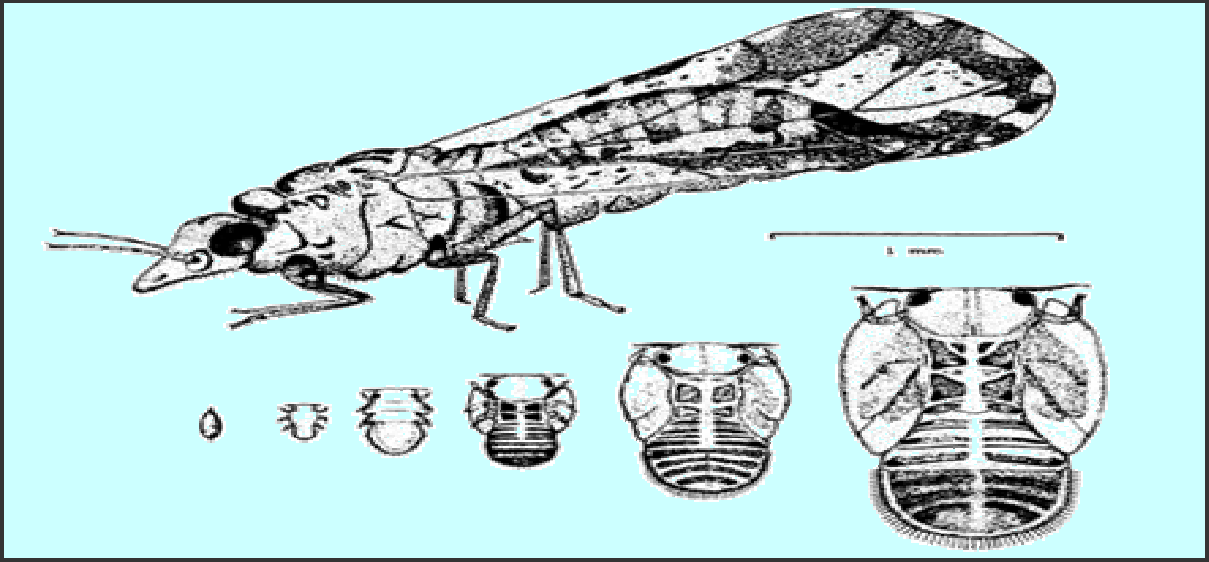
# Presentation Outline

- 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



# Florida Citrus: 1998-2010

Asian citrus psyllid discovered, 1998

Huanglongbing (citrus greening) discovered, 2005

Psyllid management to reduce incidence of HLB

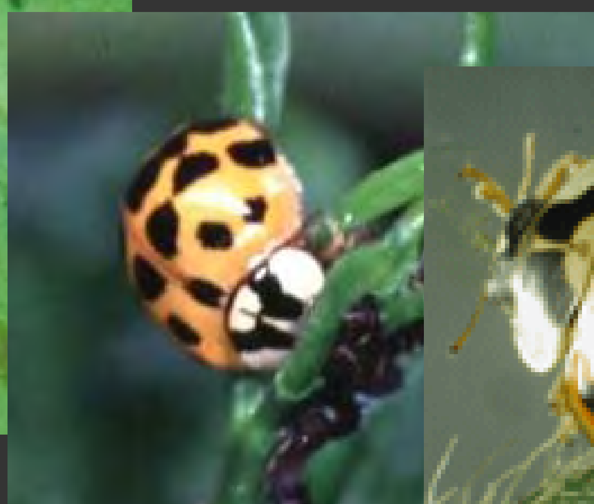
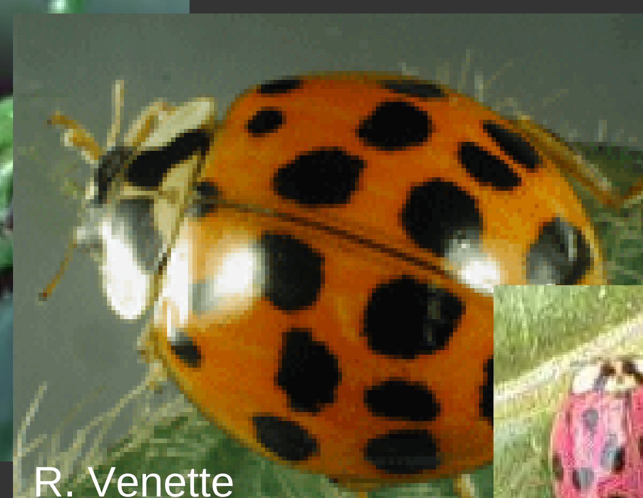
- Insecticides testing
- Enhancement of biological control
  Predators, Parasitoids

# 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

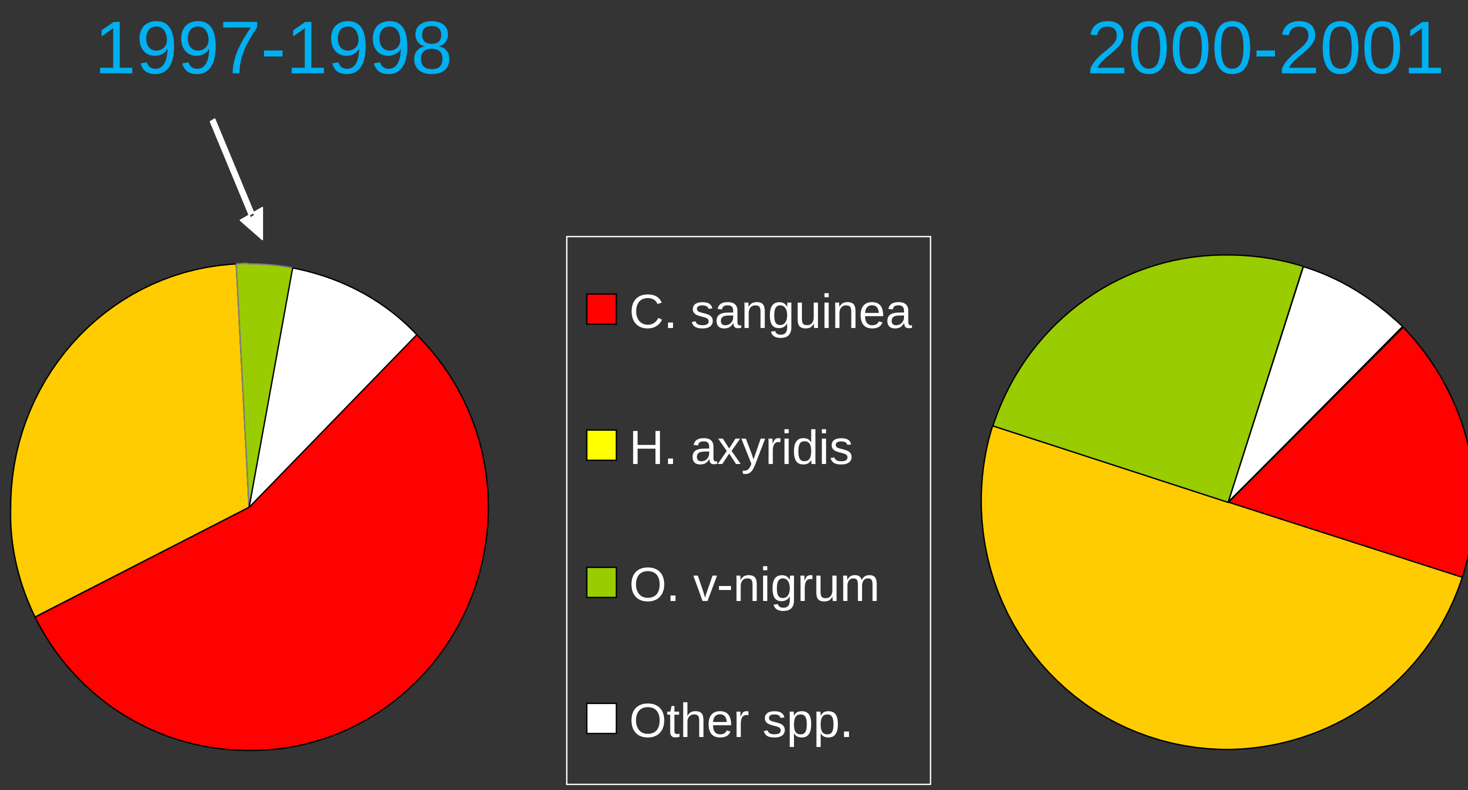

# Metallic blue ladybeetle
# *Curinus coeruleus*


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

# 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



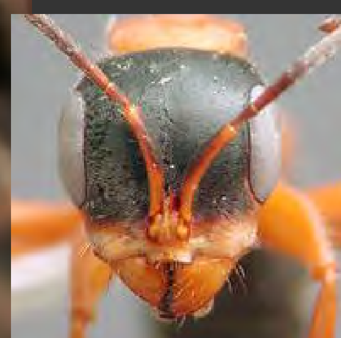

J. P. Michaud (2001)

# Lacewings - Chrysopidae




# Predators






*Pseudomyrmex ants*

Xiao et al. (2007)

# Methods to measure the impact of natural mortality factors on psyllid populations

## Cohort establishment

- 17 experiments: 23 Jan 2006 – 11 May 2007
- 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

1-2

4

3

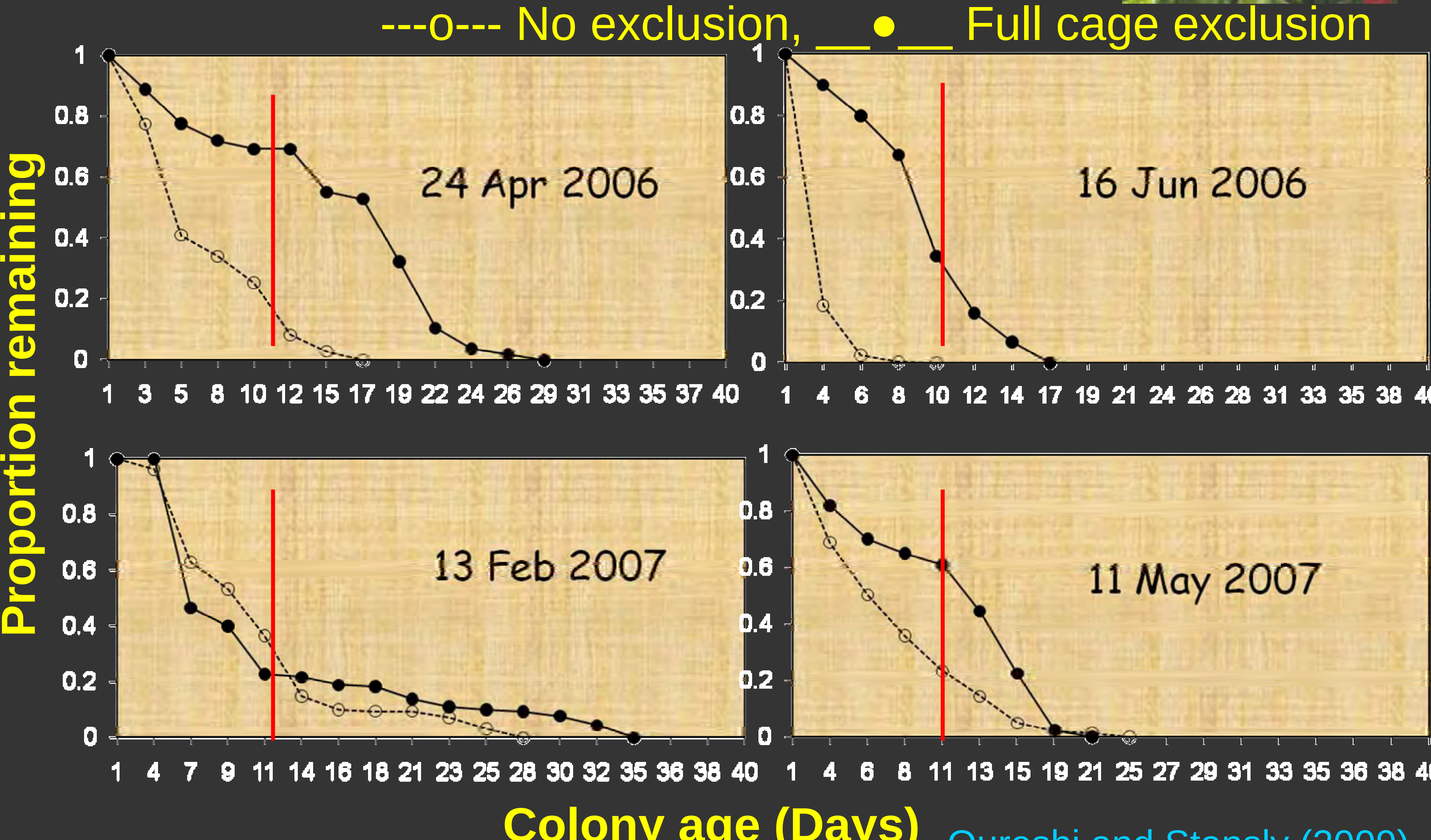
Qureshi and Stansly (2009)

# 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

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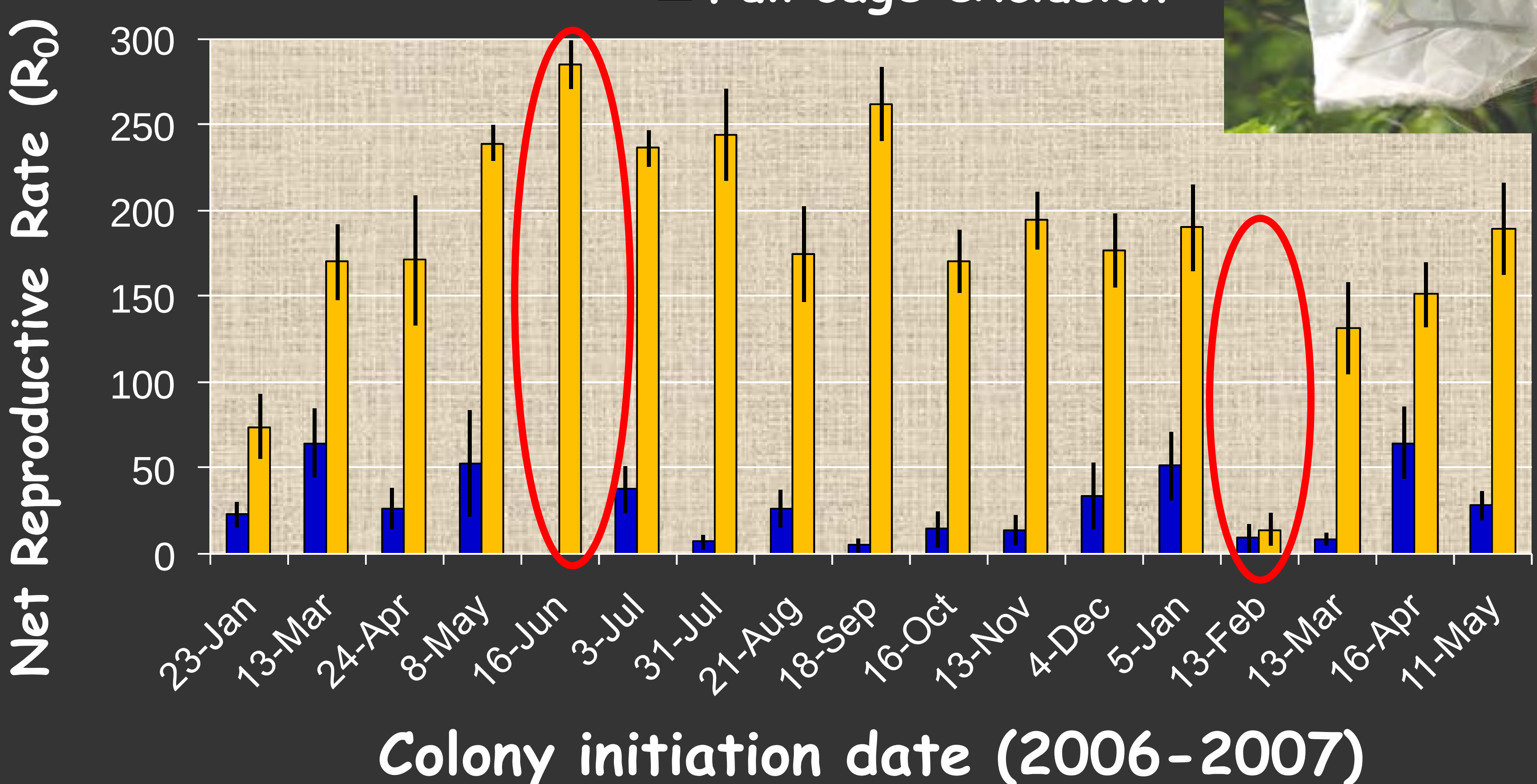
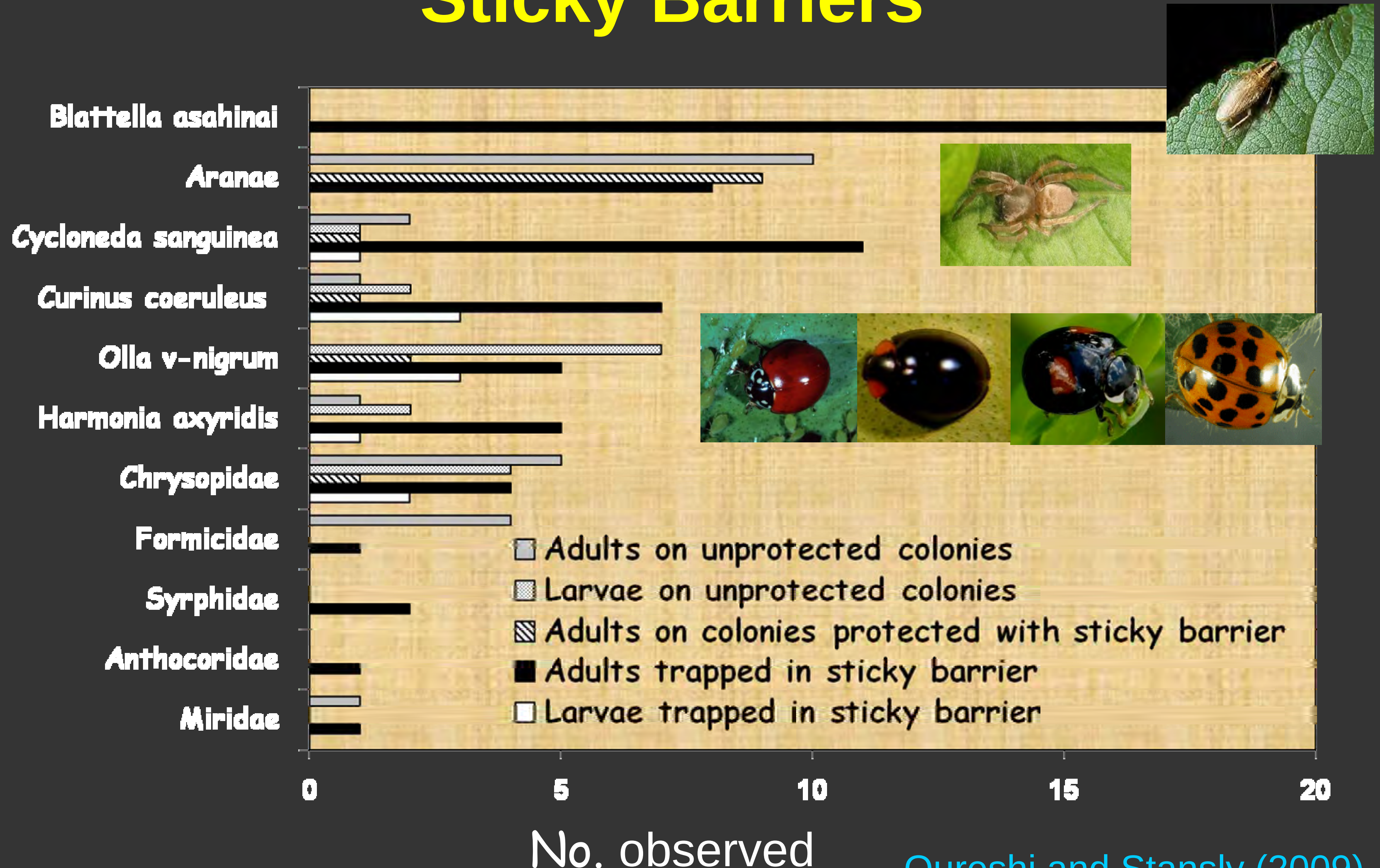
# Suppression of Psyllid Populations by Predacious Insects




Qureshi and Stansly (2009)

# Predators Observed on Colonies and Sticky Barriers

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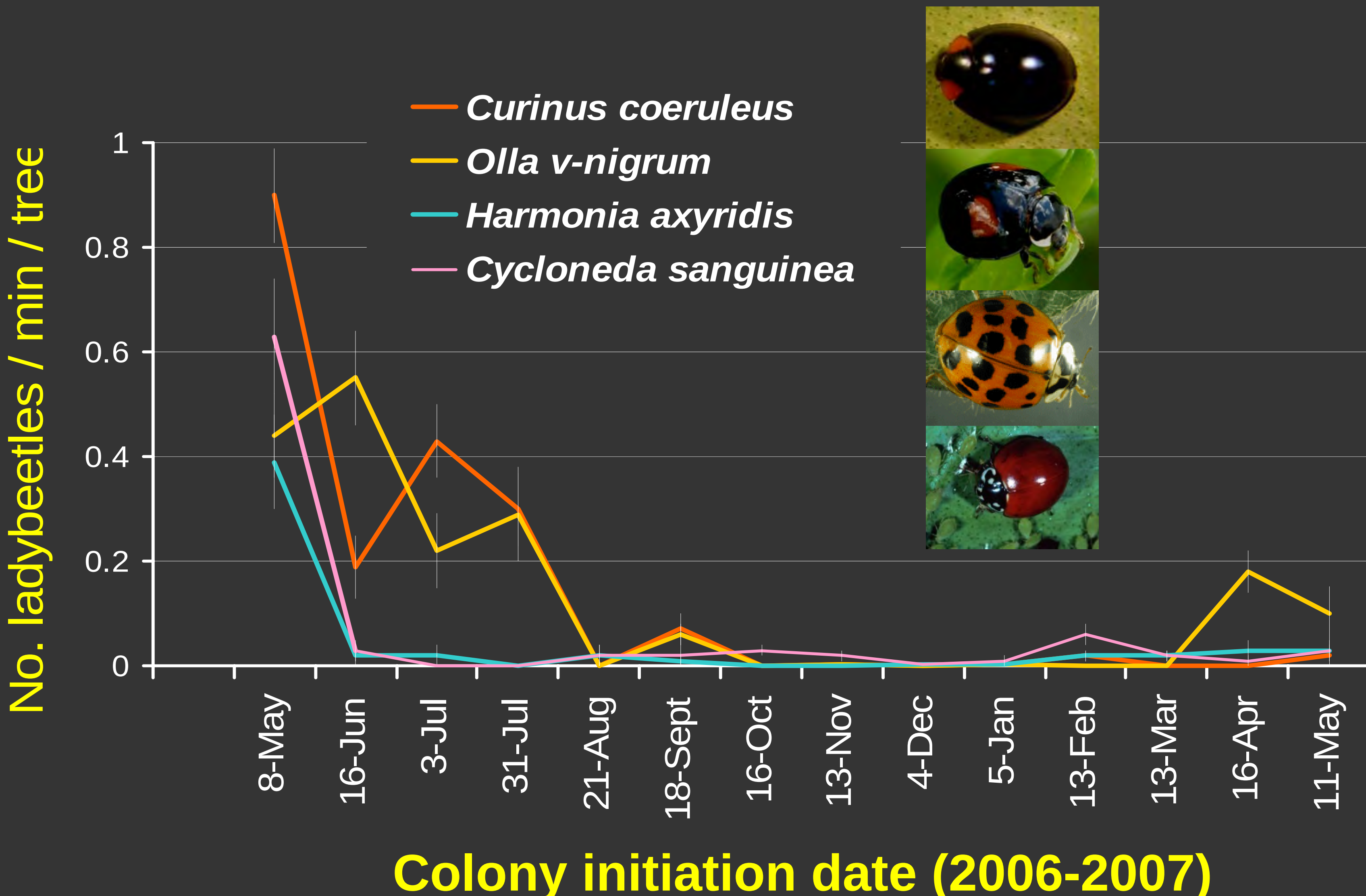
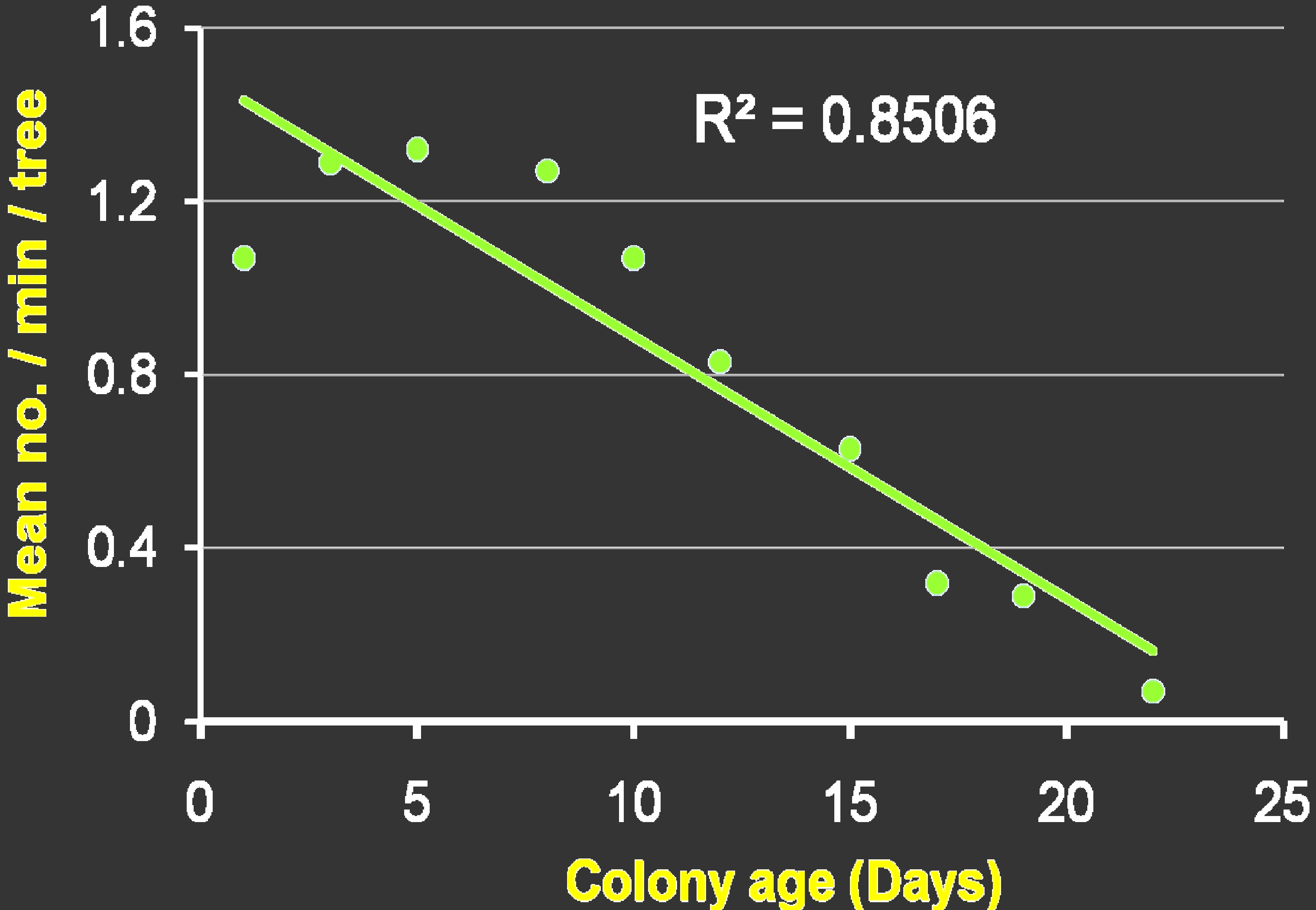
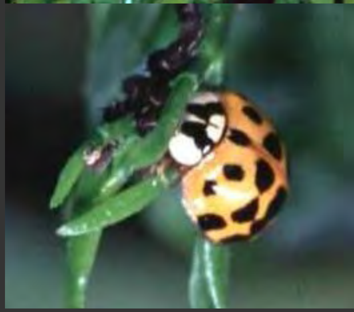
# Ladybeetles Abundance from Visual Observation of Foliage on Experimental Trees




Qureshi and Stansly (2009)

# Cumulative abundance of four predatory ladybeetles during cohort development May – October, 2006



# 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.

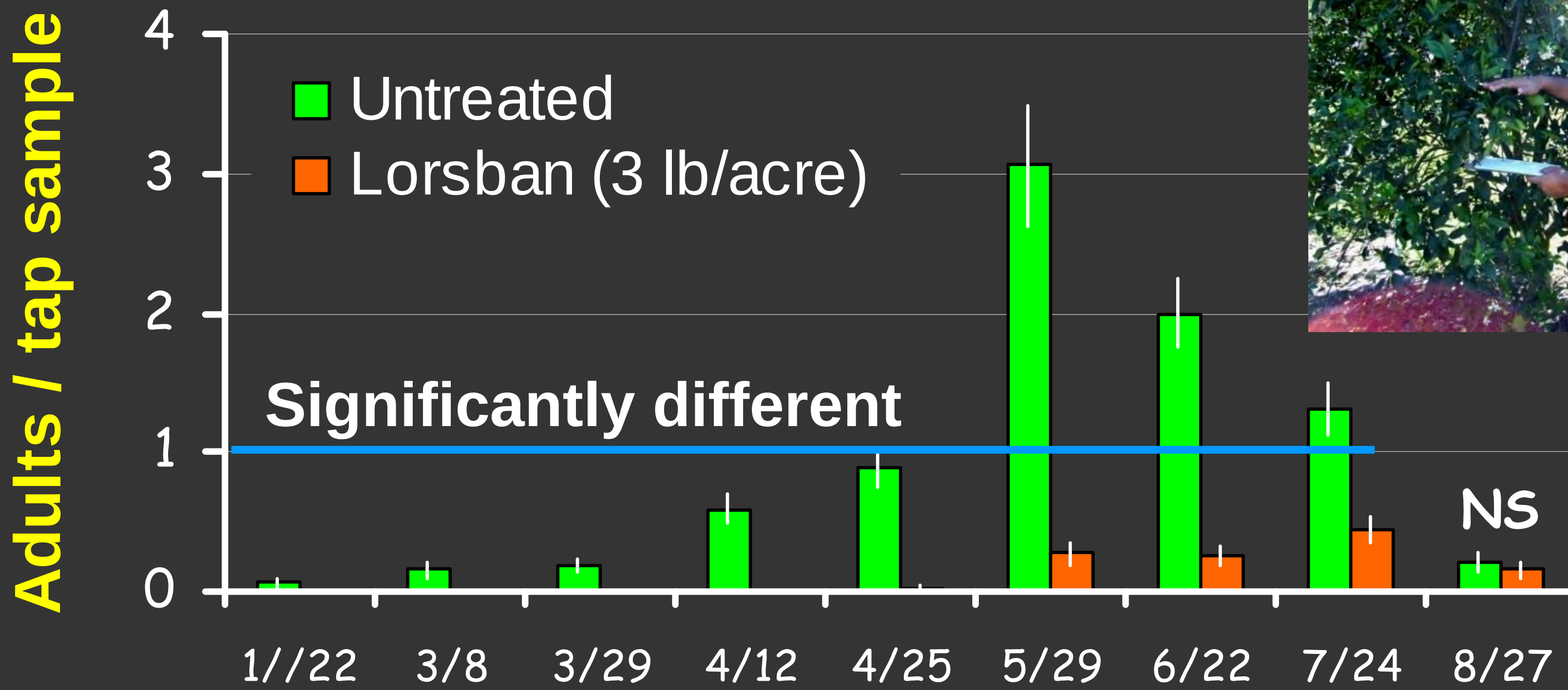
# Enhancement of Biological Control through Compatibility with Insecticides




# Dormant Season Foliar Applications:

Effect of Chlorpyrifos (Lorsban 4 E, 3 lbs/acre) Treatment on Psyllid, 2007

**Silver Strand North, Immokalee, FL**

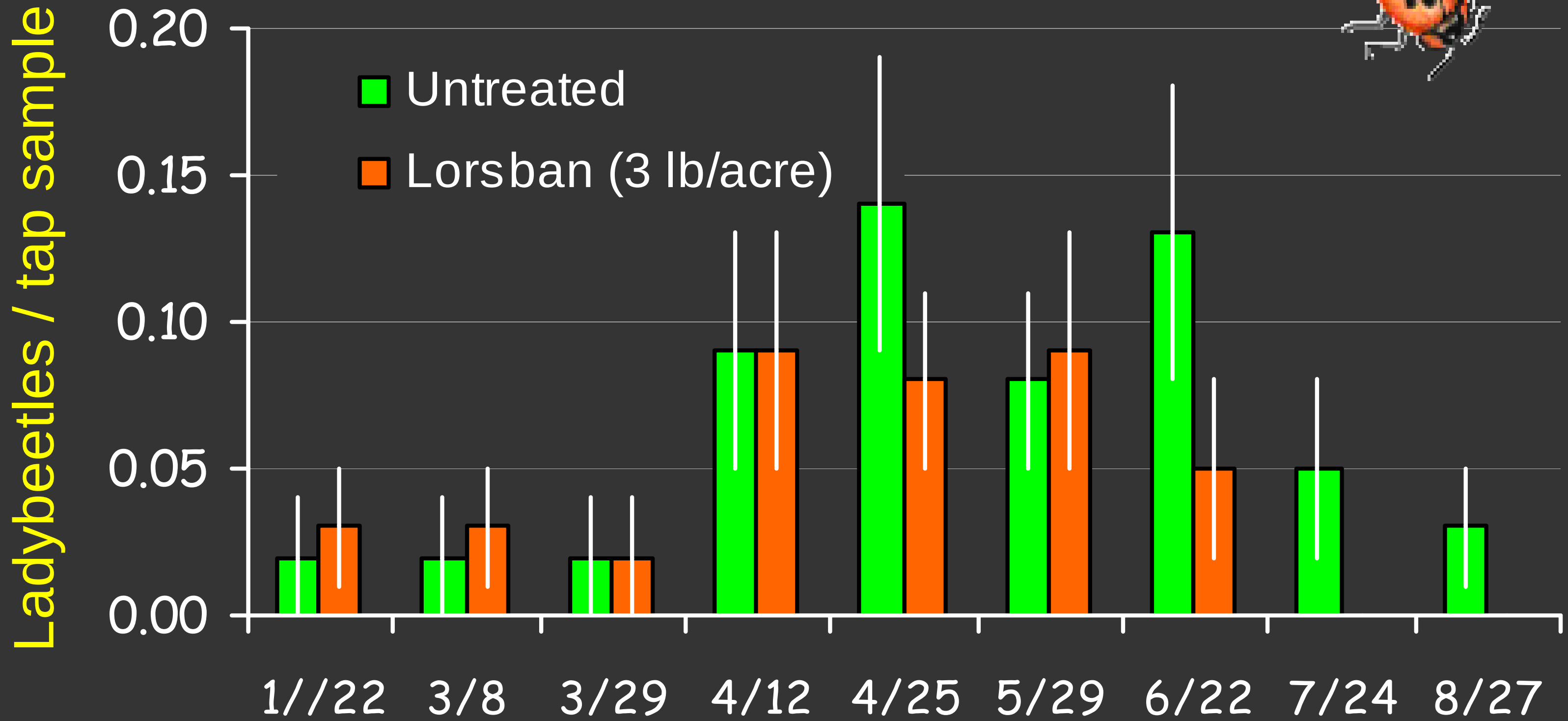



**Application Jan, 15**

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**

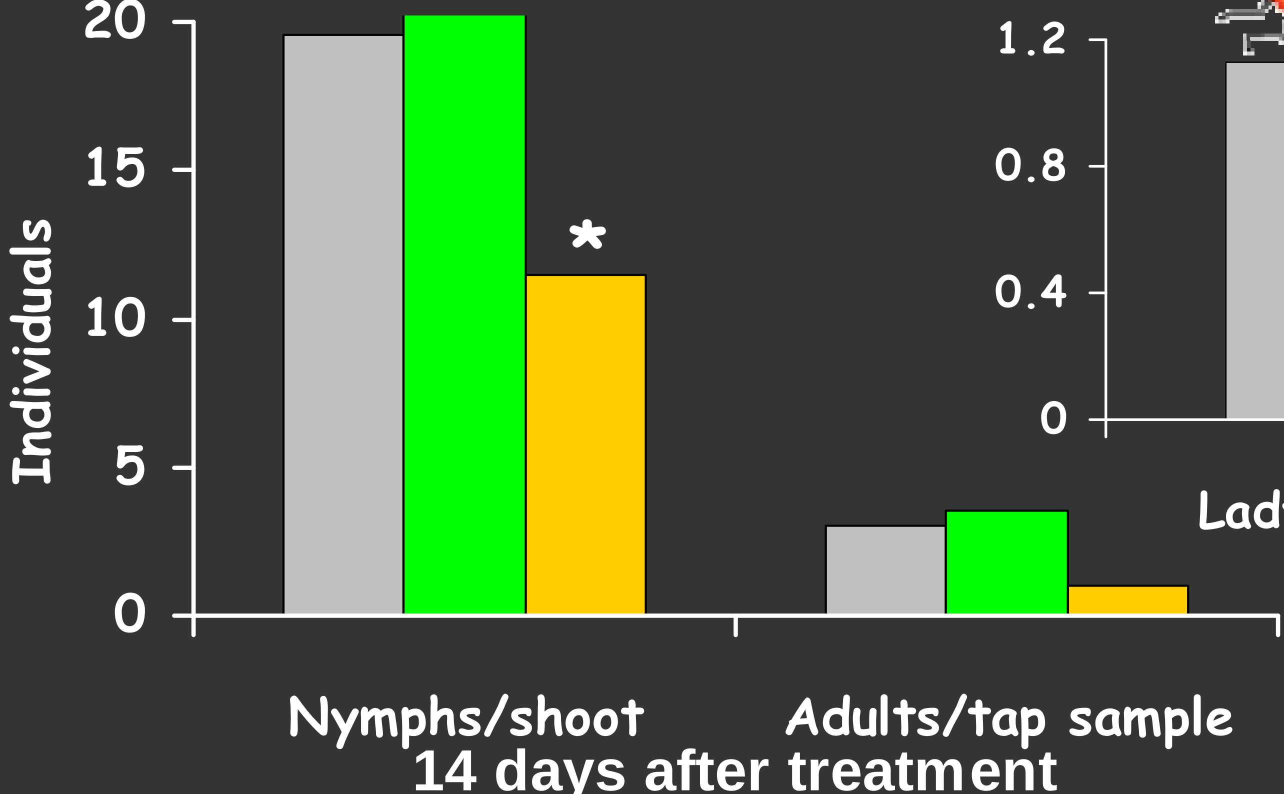


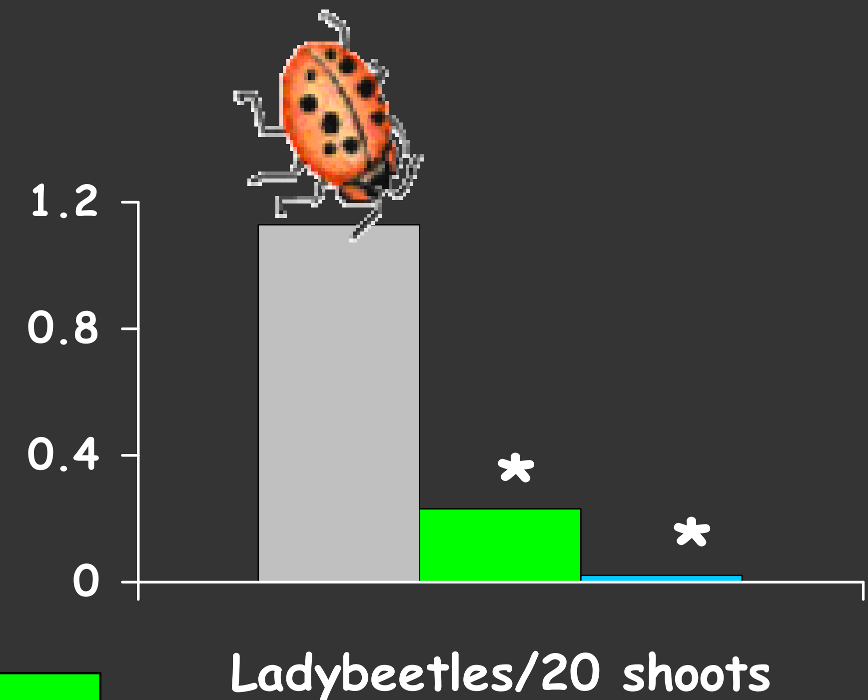

**Application Jan, 15**

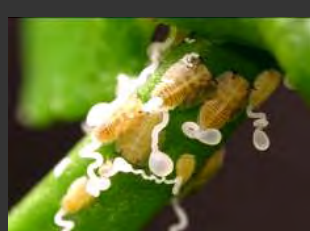
Qureshi and Stansly (2007, 2010)

# 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)

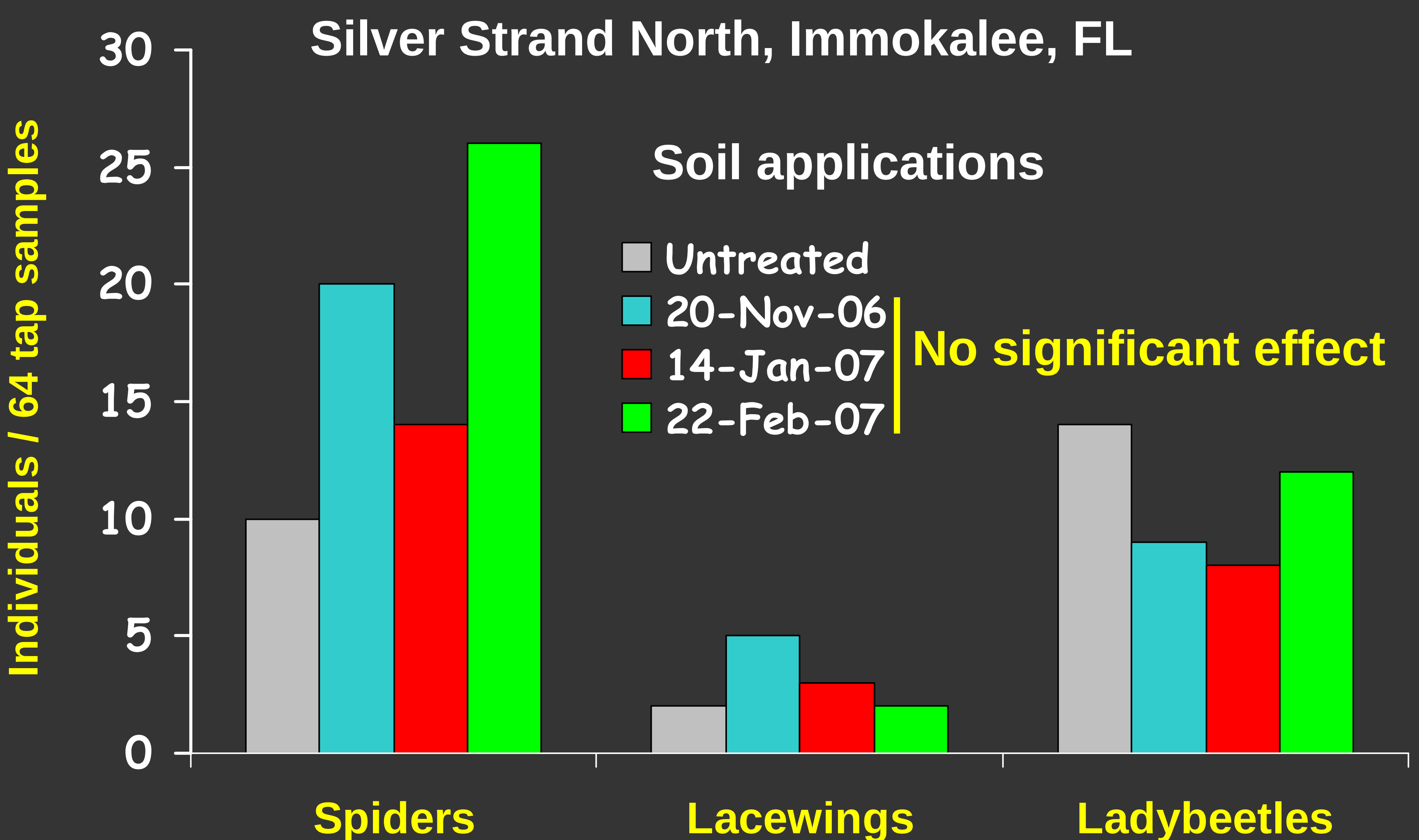


Qureshi and Stansly (2007)

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



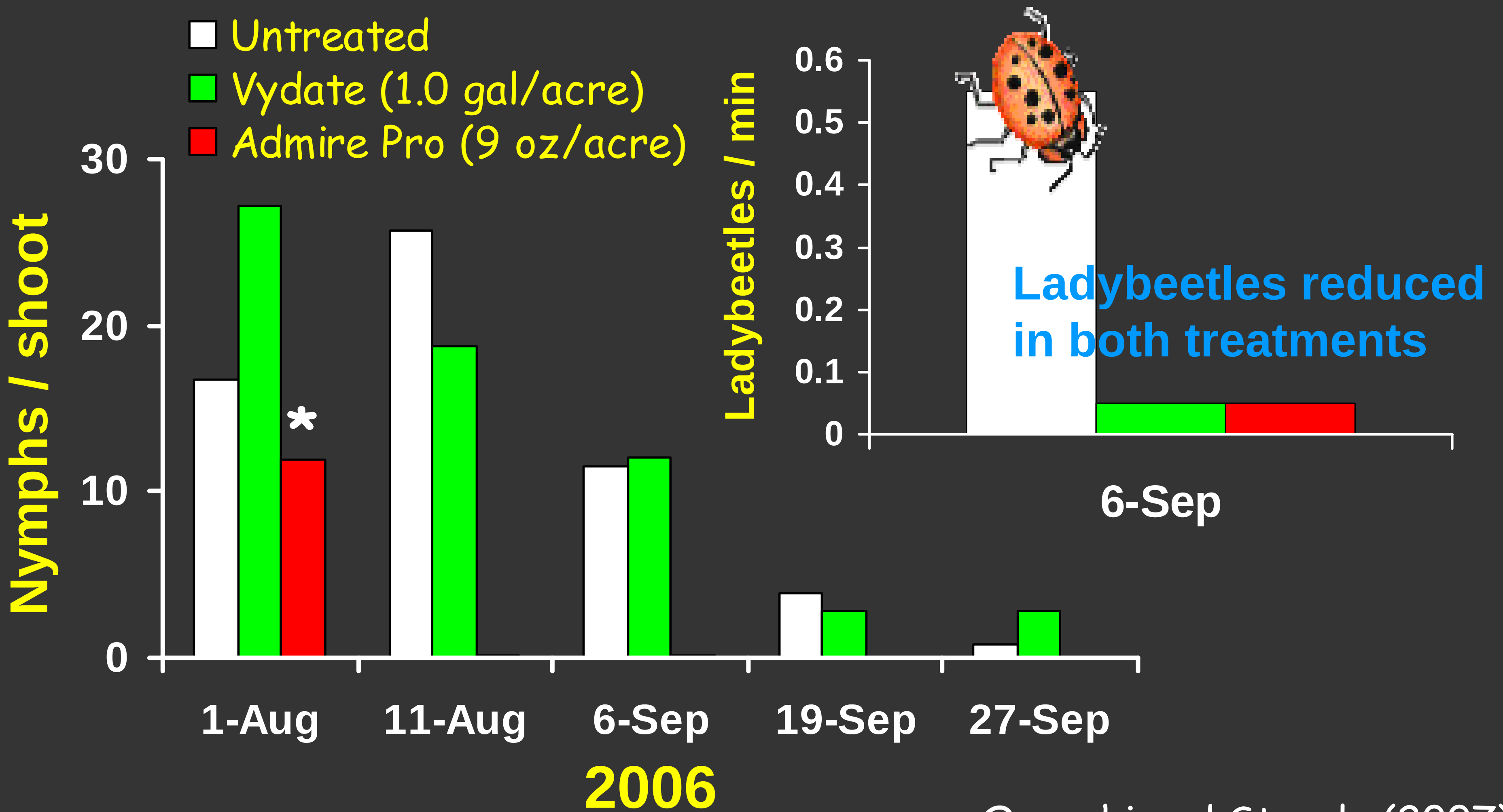

Qureshi and Stansly (2008)

# 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

# Insecticidal Control and Compatibility with Biological Control

## Conclusions and Implications

- Aldicarb applied 2-3 months before spring flush to mature trees and imidacloprid to young trees controls psyllids with minimal impact on generalist predators

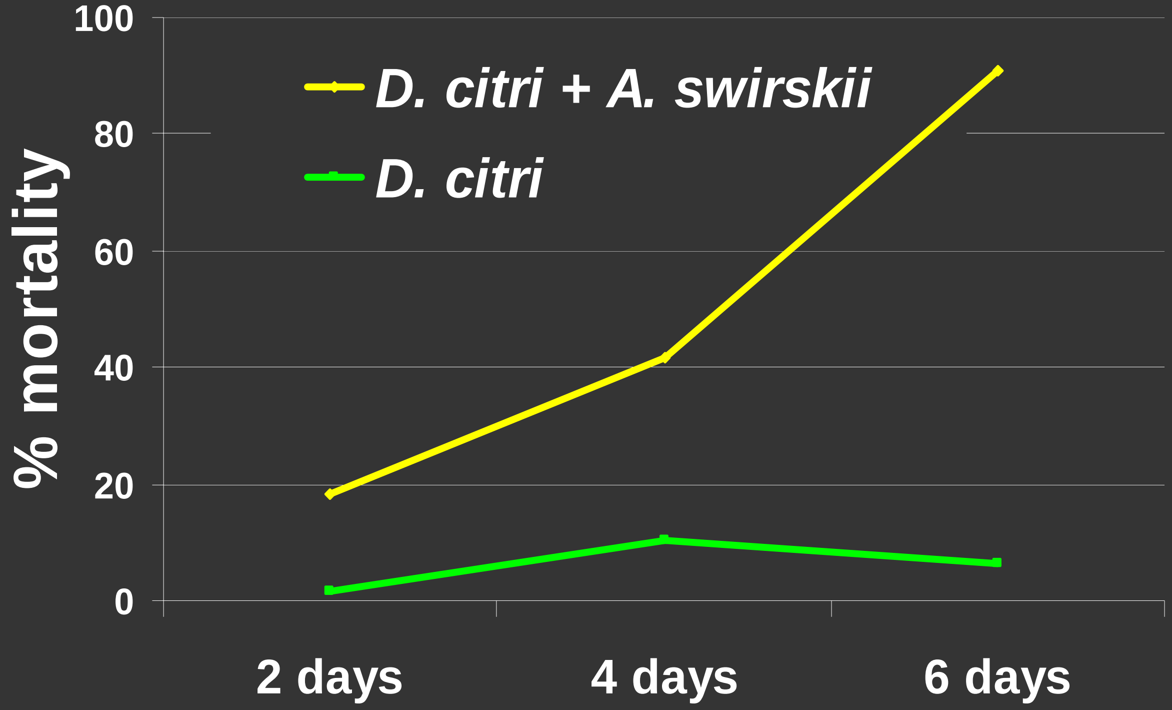
- Maximum protection in spring flush will reduce psyllid pressure and necessity of insecticide applications later in the year

- 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



# 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)

# Predators and their impact on *Diaphorina citri* populations in Florida

## Conclusions and Implications

- Overall, natural enemies play a vital role in regulating the dynamics of *D. 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.

# Acknowledgements


- Funding: Florida Citrus Production Research Advisory Council
- Insecticide industry particularly Bayer Cropscience and Dow Agroscience for large scale studies
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