# Insecticidal control of Asian citrus psyllid: effects on secondary pests and natural enemies

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The citrus agrosystem is characterized by a rich complex of insects and mites, of which only a small portion — some 50 species in Florida — are known to feed on the crop itself. Few of these ever reach economically damaging levels, thanks to biological control provided by various beneficial organisms, which are their natural enemies. An objective of integrated pest management (IPM) is to minimize negative impacts on these natural enemies to avoid disruption of the often delicate balance between pests and their natural enemies.

Pests can be divided into three categories according to the frequency and severity of the damage they cause:

1) *Secondary pests* are almost always under satisfactory biological control, but do have the potential to become economically damaging. Examples in Florida include cottony cushion scale, green scale, various whiteflies, citrus blackfly and mealybugs.

2) *Occasional pests* are under more tenuous biological control and therefore more likely to cause problems when conditions favor their development or disfavor their natural enemies. Examples include the spidermites which may reach damaging levels during dry periods, rust mites which can be flared by insecticides or copper fungicides for the same reason, and citrus leafminer whose biological control depends on a number of parasitic wasps and predators such as ants, lacewings and spiders.

3) *Key pests:* This group includes those species for which biological control is usually not sufficient to avoid economic injury. Key pests are often vectors of plant disease. Pest management strategies are often based on insecticides, and thus may conflict with biologically based IPM strategies for secondary and occasional pests. Therefore, special attention is often needed to limit collateral damage to beneficial organisms.

## ASIAN CITRUS PSYLLID AND HLB

The Asian citrus psyllid (ACP), *Diaphorina citri*, is the vector of citrus greening disease or huanglongbing (HLB), caused by the bacteria *C. Liberibacter asiaticus*. ACP instantly became a key pest of citrus in Brazil in the year of its first detection there, followed by Florida in 2005, Mexico in 2009 and Texas in 2012. The pest is present in California, where discovery of HLB is probably a matter of time. A recent study in Florida blamed HLB for a $3.63 billion reduction in revenues and loss of more than 6,000 jobs since 2006 (http://edis.ifas.ufl.edu/fe903). Fortunately, recent juice prices have mitigated economic losses and permitted ACP management programs that have slowed disease spread and helped affected trees deal with infection, perhaps by reducing reinoculation of the causative bacteria.

**Table 1.** Calendar of sprays for ACP control used in the threshold experiment

| Date | Insecticide | Rate | Mineral Oil | Treatments sprayed |
|---|---|---|---|---|
| August 2010 | Spinetoram (Delegate WG) | 4.5 oz/ac | 5% | Calendar, 0.2 thrsld |
| November 2010 | Dimethoate (Dimethoate 4E) | 24 oz/ac | | Calendar |
| January 2011 | Fenpropathrin (Danitol 2.4 EC) | 8 oz/ac | | Calendar, 0.2 thrsld 0.7 thrsld |
| February 2011 | **** | **** | | **** |
| March 2011 | Diflubenzuron (Micromite 80WGS) | 6.25 oz/ac | 5% | Calendar |
| April 2011 | Carbaryl (Sevin XLR Plus) | 0.75 gal/ac | | Calendar |
| May 2011 | Spinetoram (Delegate WG) | 4.5 oz/ac | 5% | Calendar |
| June 2011 | Imidacloprid (Admire Pro) | 4.5 oz/ac | 3.5% | Calendar |
| July 2011 | Abamectine (Agri-Mek SC) | 3.5 oz/ac | 2% | Calendar |
| August 2011 | Malathion (Gowan Malathion 8F) | 2.5 pt/ac | | Calendar |
| September 2011 | Fenpropathrin (Danitol 2.4 EC) | 18 oz/ac | | Calendar |
| October 2011 | Spirotetramat (Movento MPC) | 16 oz/ac | 2% | Calendar |
| November 2011 | Carbaryl (Sevin XLR Plus) | 0.75 gal/ac | | Calendar |
| December 2011 | Phosmet (Imidan 70-W) | 1 lb/ac | | Calendar, 0.2 thrsld |
| January 2012 | Zeta-cypermethrin (Mustang) | 4.3 oz/ac | | Calendar, 0.2 thrsld 0.7 thrsld |

## ACP CONTROL STRATEGIES

Biological control alone has not proven sufficient to suppress ACP populations in Florida, despite activity of many predators such as ladybeetles, lacewing larvae and spiders, as well as establishment of the parasitic wasp, *Tamarixia radiata*. For the moment at least, insecticidal control is necessary for psyllid suppression in Florida and elsewhere. Choices made executing such a program — what, when and how to apply — will govern success and impact on natural enemies.

Soil-applied systemic insecticides have proven best to control ACP on young trees and avoid direct contact with beneficials.

Sprays of broad-spectrum insecticides (pyrethroids and organophosphates) targeting adult ACP during the dormant winter season when many natural enemies are not present or exposed have been successful in reducing the psyllid population entering the spring flush, especially when applied area-wide. This practice provides a measure to control ACP during the subsequent growing season when

***Figure 1a (left).*** *Elasmus tischeriae (Hymenoptera: Elasmidae), parasitic wasp of citrus leafminer*

***Figure 1c (right).*** *Hentzia sp. (Araneae: Salticidae). Spider, cited as predator of citrus leafminer and other pests*

***Figure 1b (left).*** *Azya orbigera (Coleoptera: coccinellidae). Predator of soft scales such as citrus green scale*
***Figure 1d (above).*** *Pseudomyrmex gracilis (Hymenoptera: formicidae). Generalist predator that inhabits the tree canopy and helps control citrus leafminer*

monitoring pest populations is important for timing applications and more selective insecticides can be used to limit collateral damage to beneficials.

Additionally, studies are being conducted to evaluate the feasibility of bolstering the impact of *T. radiata* through mass-release.

## EFFECTS ON NATURAL ENEMIES

A three-year study initiated in 2010 to evaluate different levels of ACP control in two commercial citrus groves includes an untreated check at one extreme and monthly sprays at the other. The calendar spray regimen was chosen based on common practice, rotation of modes of action for resistance management, and balance between selective and broad spectrum products (Table 1, previous page).

Two intermediate treatments use arbitrarily chosen thresholds of 0.7 and 0.2 ACP adults per stem tap to trigger sprays. Citrus natural enemies are being monitored by tap sampling, vacuum sampling and direct observation using a hand lens. Results so far demonstrate a diverse complex of natural enemies that includes many groups with diverse feeding habits and prey preferences: parasitic wasps (Figure 1a), lady beetles (Figure 1b), spiders (Figure 1c), arboreal ants (Figure 1d; figures 1a-1d are on page 14), lacewing larvae (Figure 1e), predatory flies (Figure 1f) predatory mites (Figure 1g) and others.

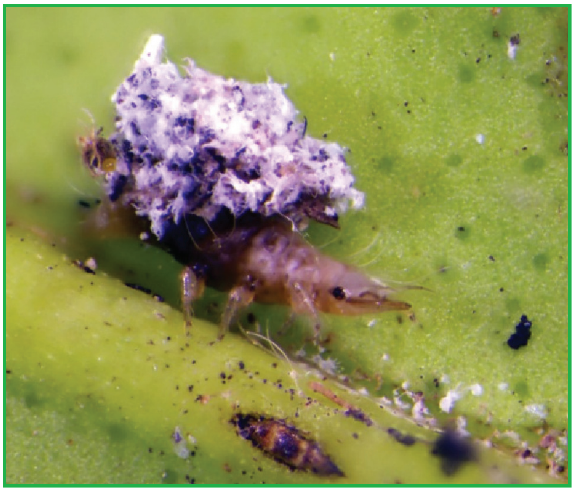


***Figure 1e (above left).*** *Lacewing larva, also known as a "trash bug," feeds on psyllids, aphids, whiteflies and other insects.*

***Figure 1f (above right).*** *Predaceous fly larva (Diptera: Cecidomyiidae). Predator of aphids, spider mites and scales*

***Figure 1g (right).*** *Predatory mite (Acari: Phytoseidae). Natural enemy of rust mites, spidermites, whiteflies and scales*

Preliminary results show decreasing numbers of certain beneficial arthropods associated with the calendar sprays strategy (Figure 2a above and Figure 2b on page 16). Arboreal ants, thought to be critical for citrus leafminer control, are most affected so far, with densities three times to seven times lower under the calendar spray regime compared to the remaining treatments. Lady beetles, spiders and predaceous phytoseiid mites have been reduced between 1.5 and five times by the calendar sprays. Other more mobile beneficial groups such as parasitic wasps, lacewings or predatory flies seem to be less affected by frequent insecticide sprays, possibly because they are better equipped to recolonize treated areas.

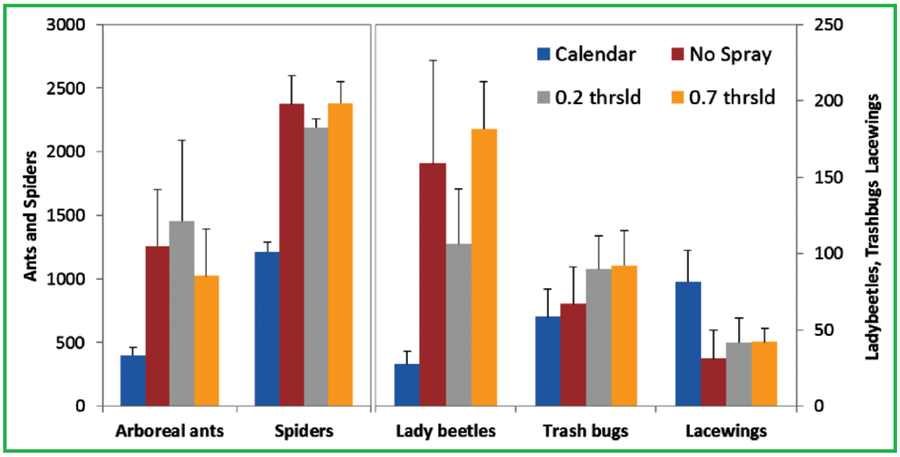



***Figure 2a (right).*** *Abundance of natural enemies under different ACP management strategies obtained by tap sampling in a commercial citrus grove. Abundance is expressed as cumulative numbers.*

## EFFECTS ON SECONDARY AND OCCASIONAL PESTS

We have observed predation on citrus leafminer reduced from 90 percent to 70 percent by calendar sprays (Figure 3). Furthermore, parasitism by the formally dominant introduced wasp *Ageniaspis citricola* has been reduced to 3 percent of the total, compared to other less specialized species such as *Elasmus tischeriae, Pnigalio minio* or *Horismenus sardus* (Figure 4).

Parasitism of citrus blackfly nymphs by parasitoids in the genus *Encarsia* and *Amitus* was 50 percent less in the calendar treatment compared to control. As a result, citrus blackfly eggs and nymphs were 23 percent more abundant in the calendar treatment than in the untreated check.

Citrus red mite populations have

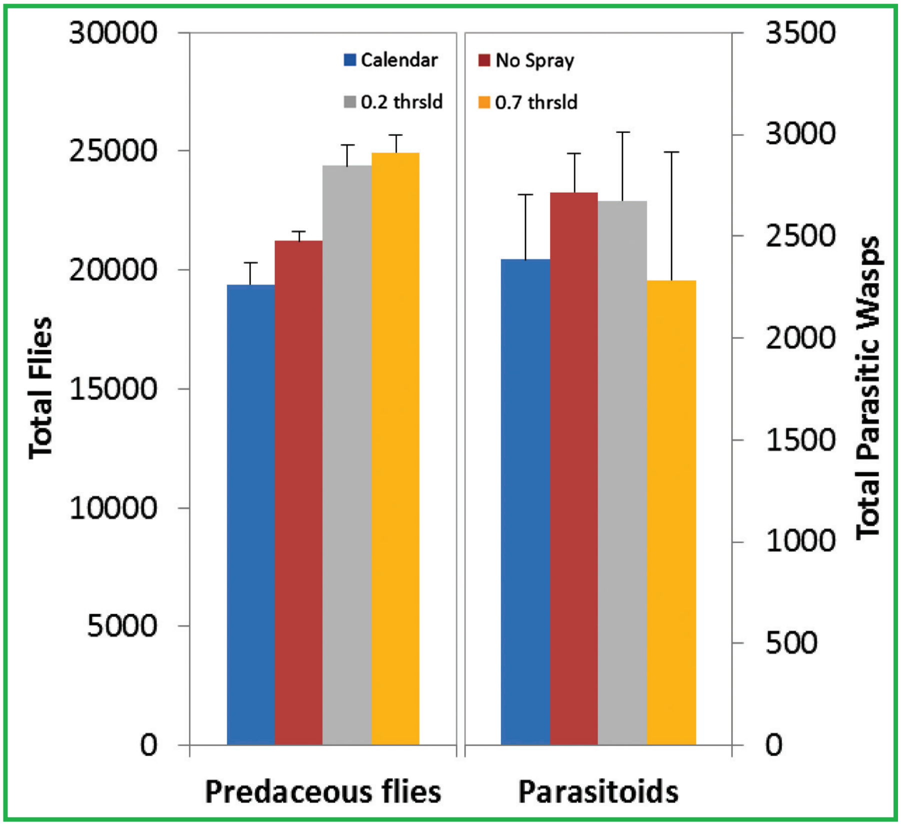
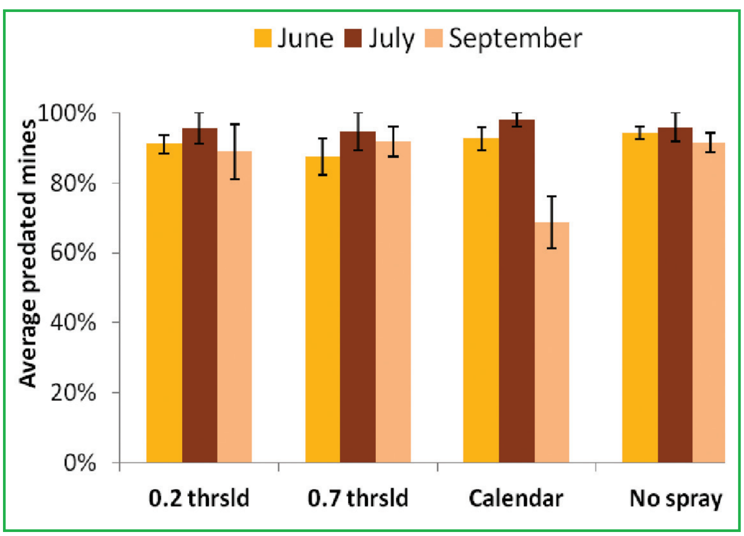



***Figure 2b.*** *Abundance of natural enemies under different ACP management strategies obtained by suction sampling in a commercial citrus grove. Abundance is expressed as cumulative numbers.*



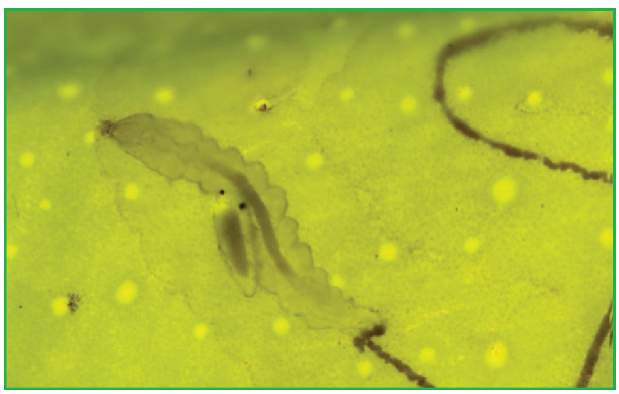
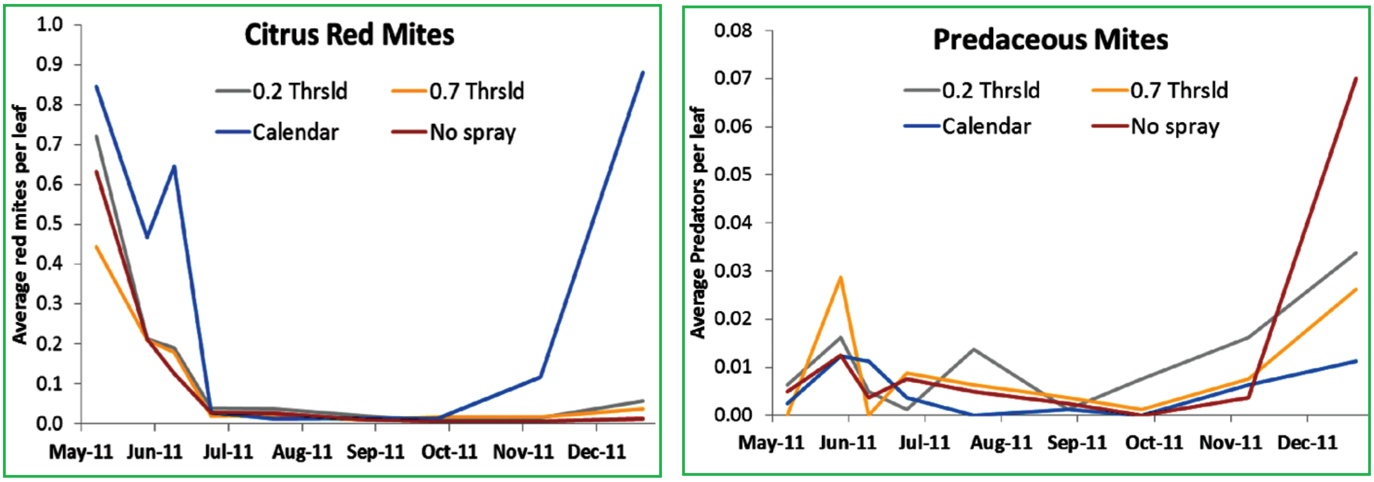



***Figure 3 (left).*** *Average mortality (%) of citrus leafminer larvae due to predation under different ACP management strategies, June, July and September 2011*

***Figure 4 (above).*** *Parasitic wasp larva feeding on a citrus leafminer*




***Figures 5a (left) and 5b (right).*** *Seasonal abundance of citrus red mites and predaceous (phytoseiid) mites associated with different ACP management strategies*

also increased markedly in calendar sprays plots (Figure 5a), presumably in response to depressed populations of predaceous mites (Figure 5b). Citrus rust mite and green scales have increased in the sprayed areas.

These are just a few examples illustrating how spray programs may impact the natural enemy complex and consequently the incidence and activity of beneficial organisms. Loss of biological control will translate into additional short- or medium-term control costs or yield losses from occasional and secondary pests. Eliminating excessive insecticide use and/or choosing selective insecticides where appropriate will provide unseen benefits.

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