

# Pest Control of Citrus in Nurseries and Resistance Management

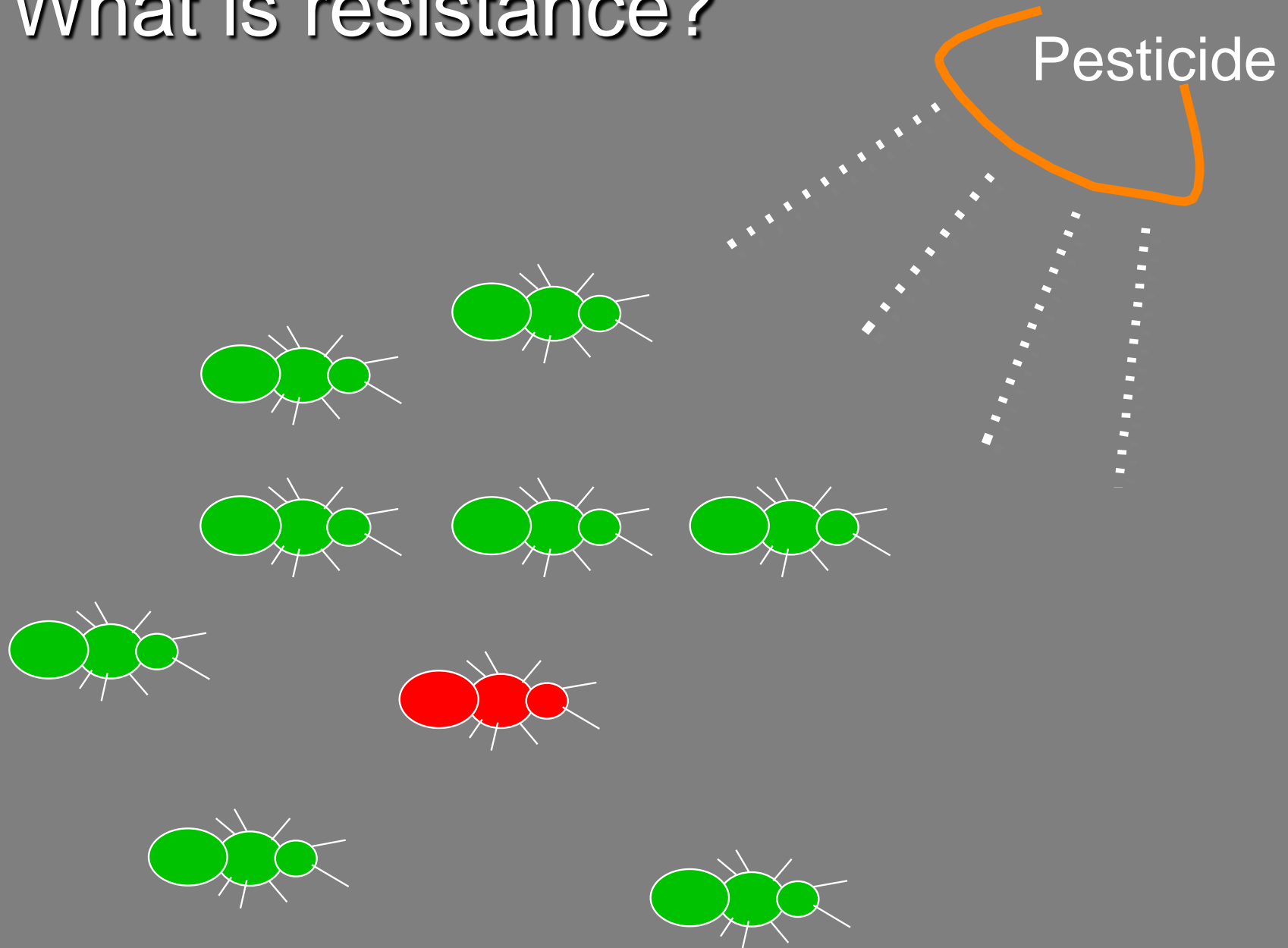


Beth Grafton-Cardwell

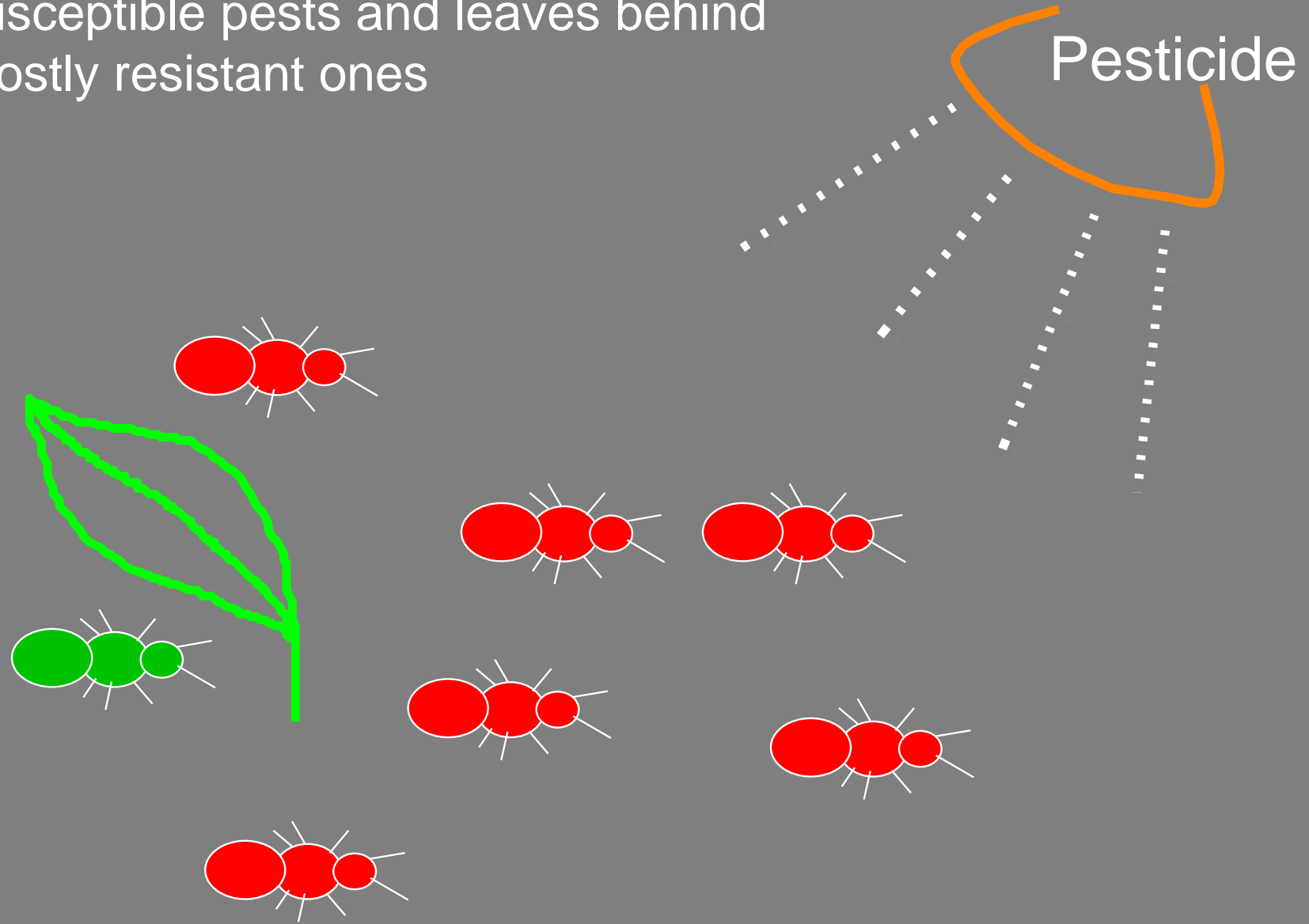
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# What is resistance?



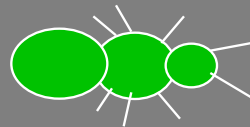
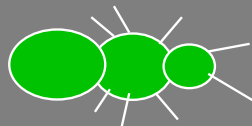
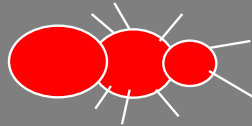
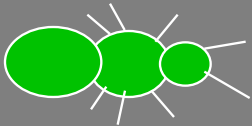
Treating repeatedly kills off the  
susceptible pests and leaves behind  
mostly resistant ones



Often, the susceptible pests are more fit than the resistant ones and so if left alone they will increase in the population

- Produce more eggs
- Grow quicker

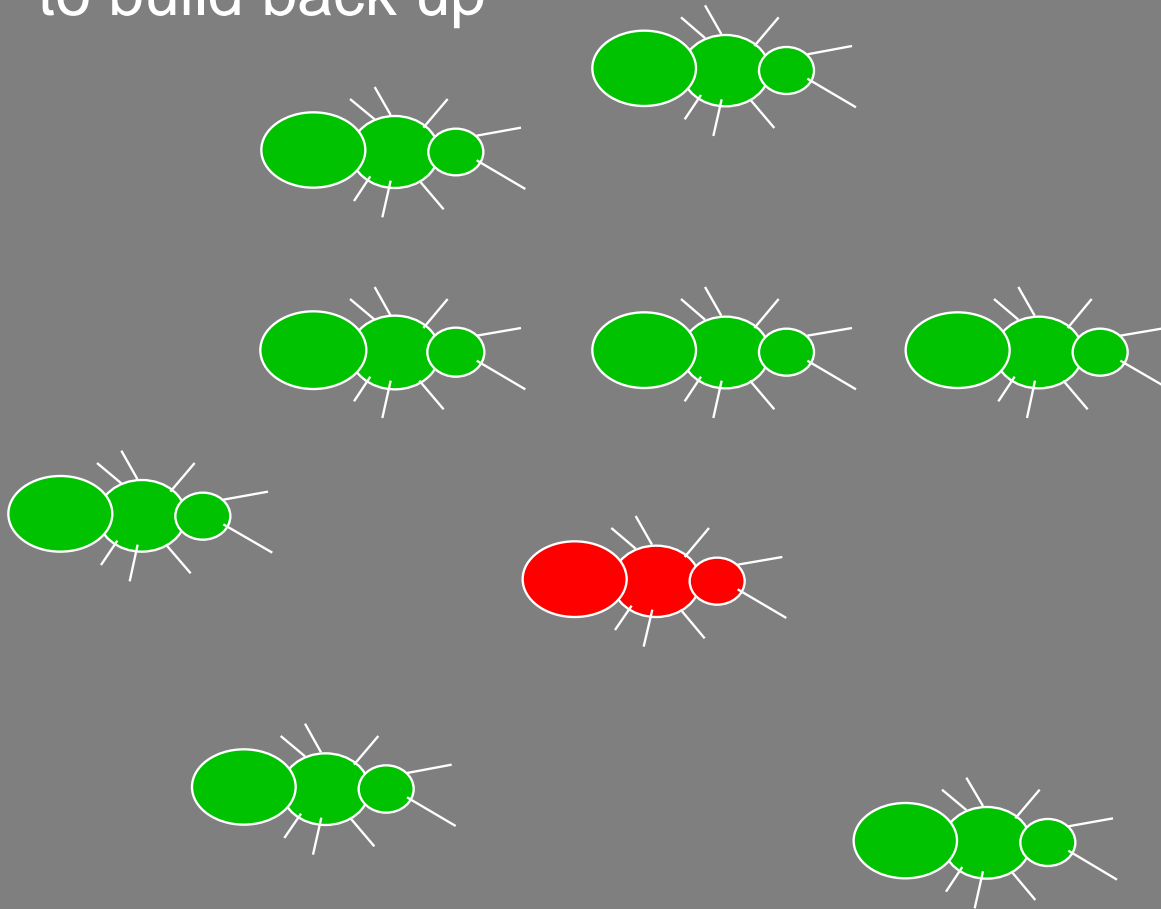
Pesticide



Two most important things you can do:

1. Change the chemical so that the resistant ones can't survive
2. Treat as infrequently as possible so that you give the susceptible ones time to build back up

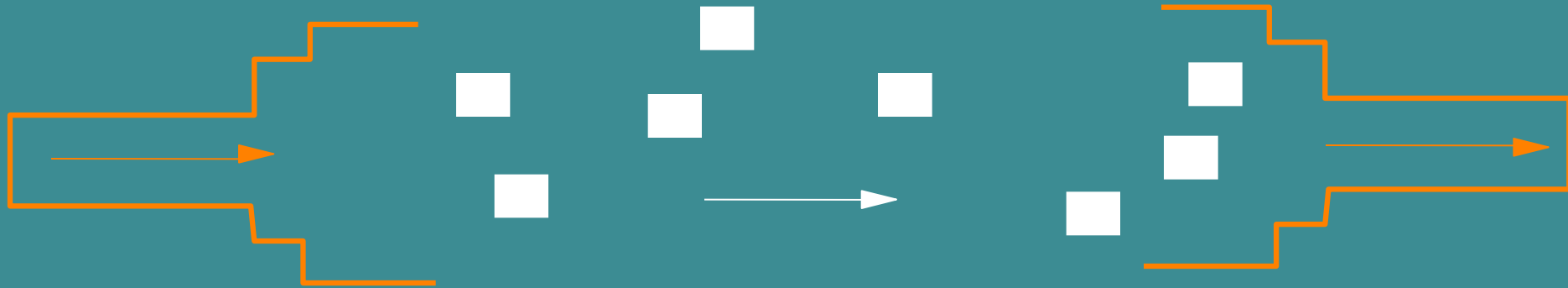
Pesticide



# How do insects develop resistance?

- Change their behavior
- Change their cuticle so that the pesticide can't penetrate
- Increase the number of enzymes they have in their system to detoxify the pesticide and maintain normal function
- Change the shape of their enzymes so that the pesticide can't block them

Nerve Synapse

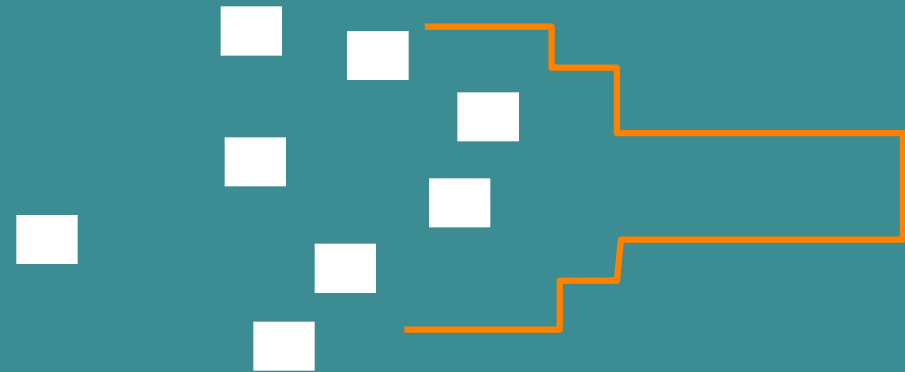


Acetylcholine

Enzyme  
Acetylcholine  
esterase



Nerve Synapse



Acetylcholine



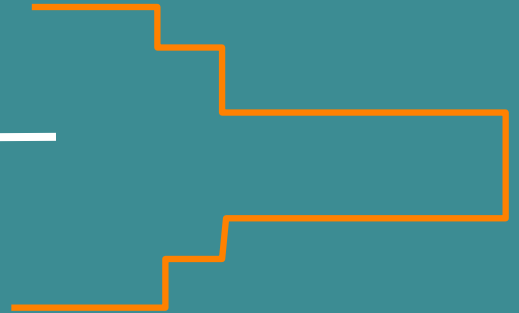
Enzyme  
Acetylcholine  
esterase



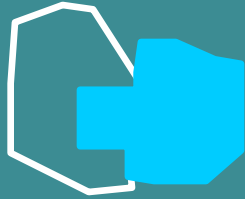
Nerve Synapse



Acetylcholine

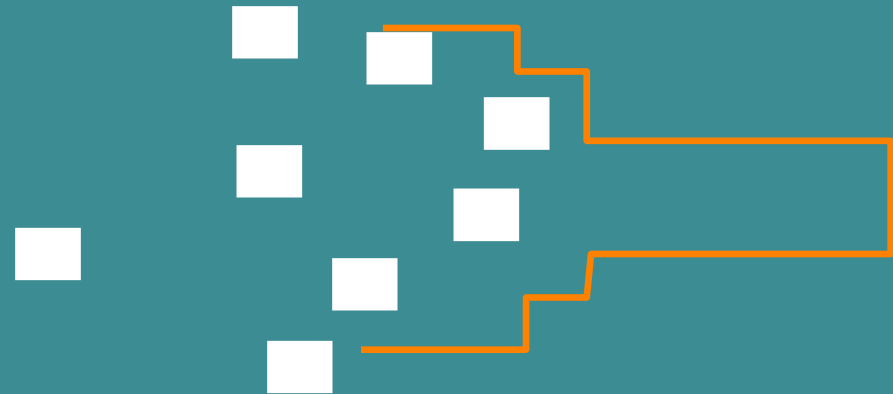


Acetylcholine  
esterase



Organophosphate or  
Carbamate Insecticide

Nerve Synapse

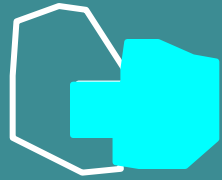


Acetylcholine

# One method of resistance: the insect makes more AchE

Acetylcholine  
esterase

Pesticide



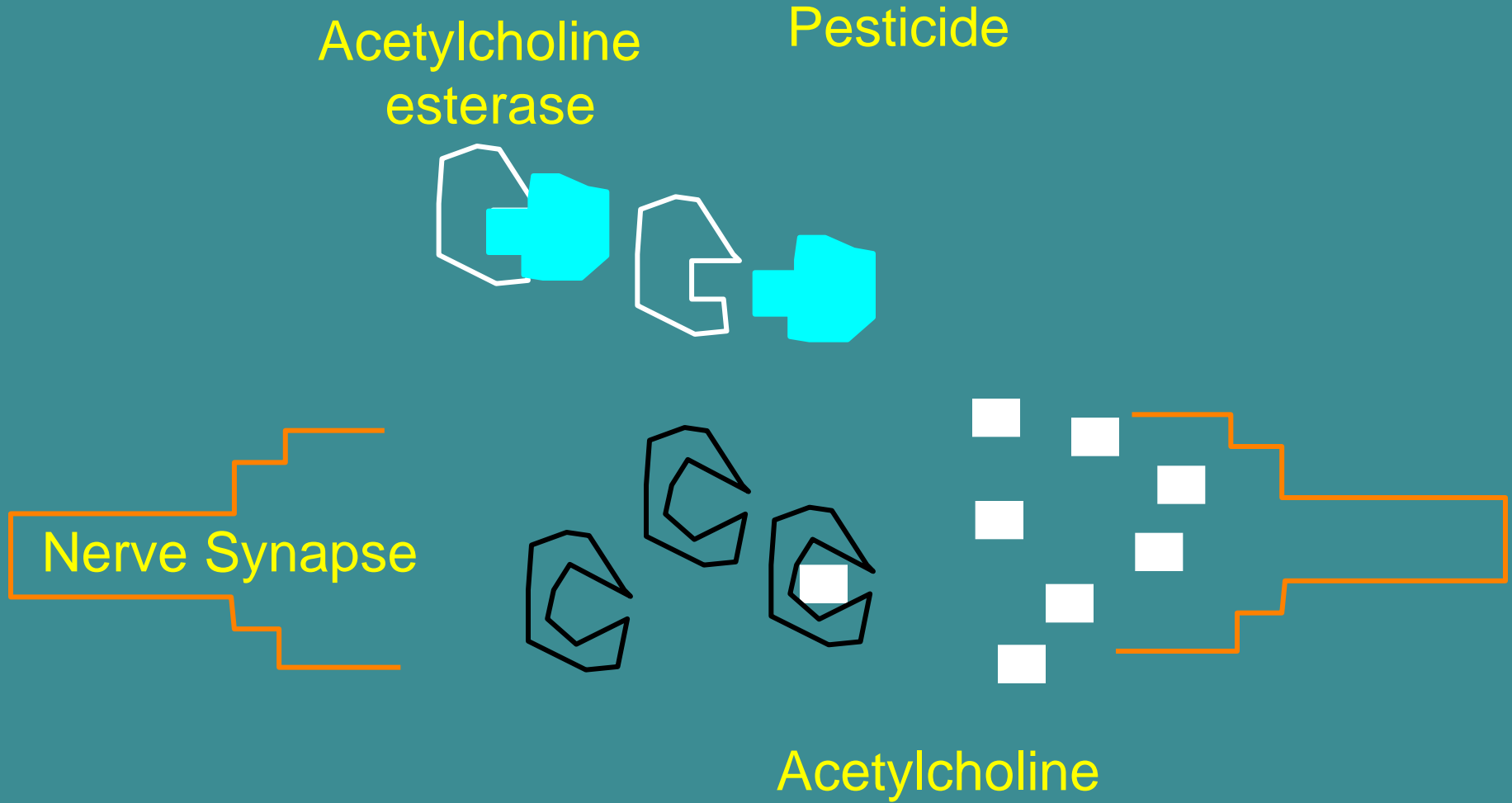
Nerve Synapse



Acetylcholine



Second method of resistance: the insect makes a different AchE (decreased target site sensitivity)



# Citrus Nursery Pest Issues

## Common pests

Mites (two-spotted, citrus red mite)  
Citrus thrips  
Citrus Leafminer

## Occasional Pests

Caterpillars (leafrollers, cutworms)  
Katydid  
Aphids  
Whiteflies  
California red scale  
Brown soft scale  
Earwigs  
Snails/slugs  
Ants





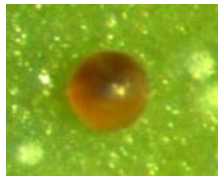
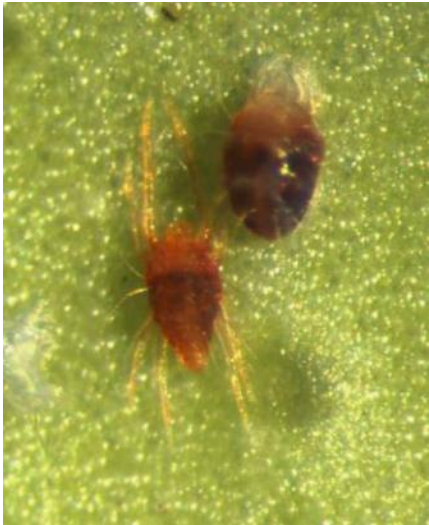
# Citrus Red Mite- stippling leaves



Adult Female



Male guarding  
a quiescent female



Egg



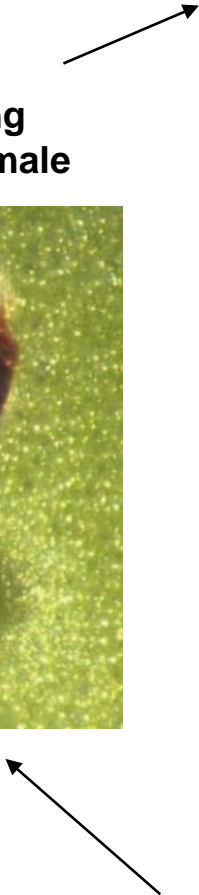
Larva (6 legs)



Deutonymph



Protonymph (8 legs)



# Two-spotted spider mite -stippling leaves + webbing



- Keep plants irrigated and unstressed
- Space out the plants
- Overhead irrigation helps to reduce
- Apply miticides when populations are low



# Citrus Miticides

Chemical	Formulation	Chem grp	REI	Bearing	Non-bearing	Nurseries	Enclosed structures
Milbemectin	Ultiflora	6	12 h	No	Yes	Yes	No
Hexythiazox	Savey 50 DF	10A	12 h	No	Yes	Yes	NS
	Onager			Yes	Yes	Yes	NS
	HexygonDF			No	Yes*	Yes	Yes
Etoxazole	Zeal Miticide TetraSan 5 WDG	10B	12 h	No	Yes	NS	NS
				No	Yes *	NS	NS
Fenbutatin oxide	Vendex 50 WP <sup>1</sup>	12B	48 h	Yes	Yes	NS	NS
Propargite	Omite 30WS <sup>1</sup>	12C	16 d	No	Yes	NS	NS
	Omite 6E <sup>1</sup>						
Acequinocyl	Kanemite 15 SC	20B	12 h	Yes	NS	NS	NS
Pyridaben	Nexter	21A	12 h	Yes	Yes	Yes	Yes
Fenpyroximate	FujiMite 5 EC	21A	12 h	Yes	Yes	No	No
Spirodiclofen	Envidor 2 SC	23	12 h	Yes	NS	NS	No
Spiromesifen	Judo	23	12 h	No	Yes*	Yes	Yes
Bifenazate	Acramite 50 WS	un	12 h	No	Yes	Yes	NS

\*nonbearing fruit trees – citrus not specified

<sup>1</sup> Cat I: certified applicator required

NS: not specified

Available chemical groups:

6 for non-bearing

5 for nursery

3 for enclosed structures



# Citrus thrips – stunting and curling of leaves



- Lay their eggs in the leaf tissue and produce many generations per year
- Develop resistance very rapidly: DDT, Organophosphates, carbamates, pyrethroids
- No new chemicals for control

# How do I control citrus thrips?

**1. Rotate chemicals: Resistance and label restrictions for nurseries make this difficult**

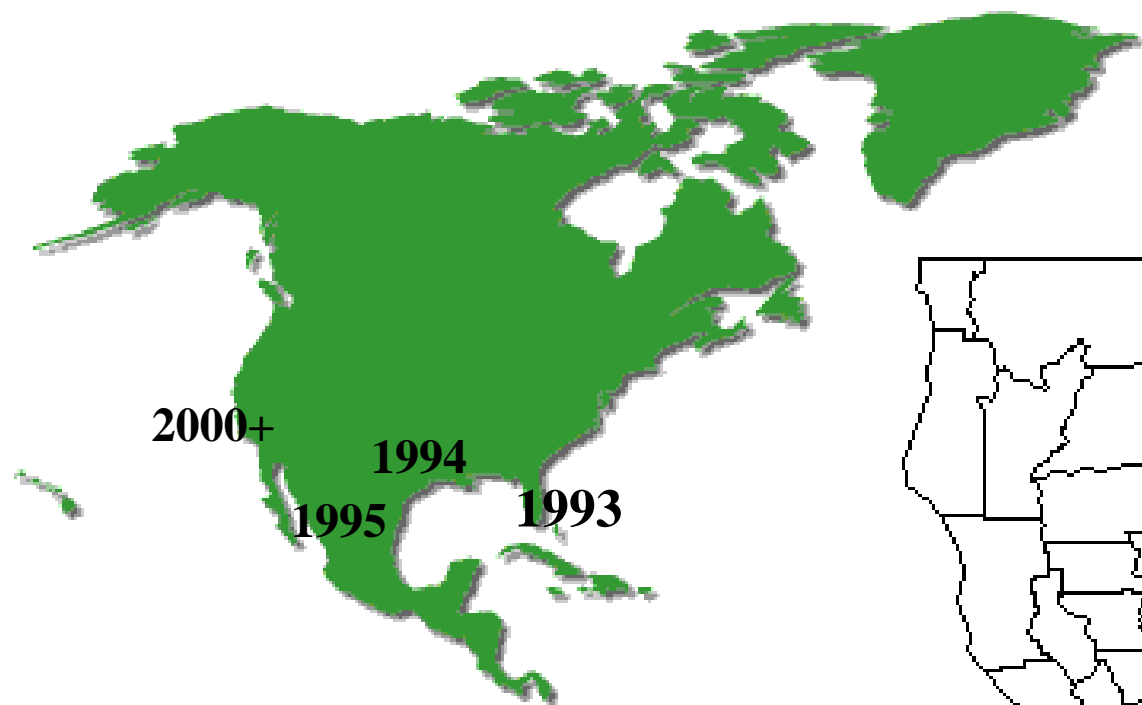
**1. Spray as infrequently as possible**

- Keep plants well-irrigated and unstressed
- Be careful not to over-fertilize as this may stimulate thrips populations
- Overhead irrigation helps to reduce thrips by increasing humidity
- Spray only when thrips are actually present, but at fairly low densities

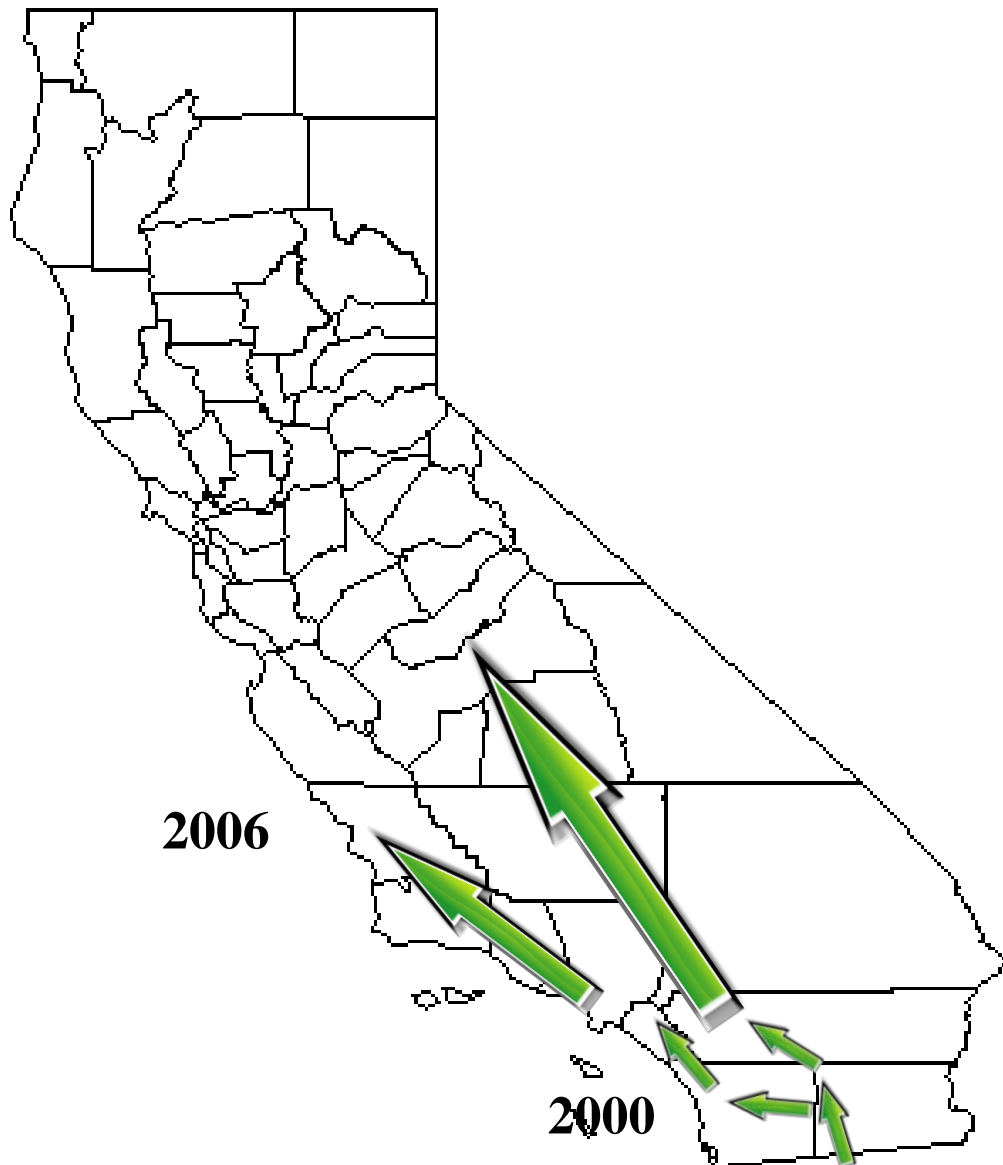
# Citrus Leafminer, *stunting and curling of leaves*



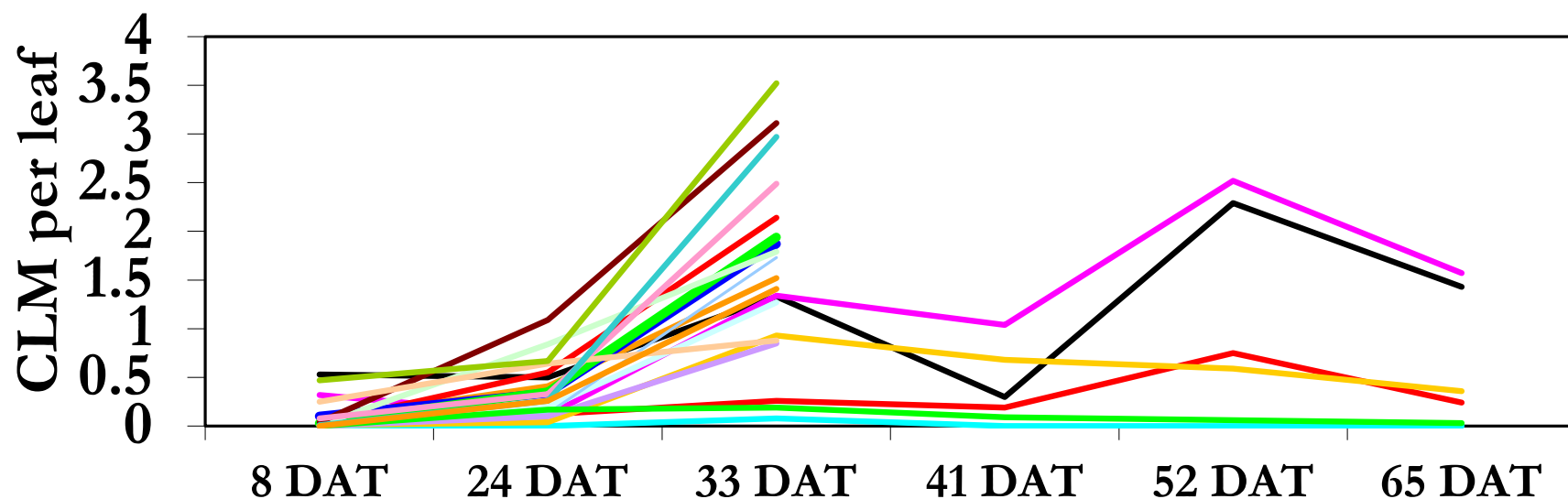
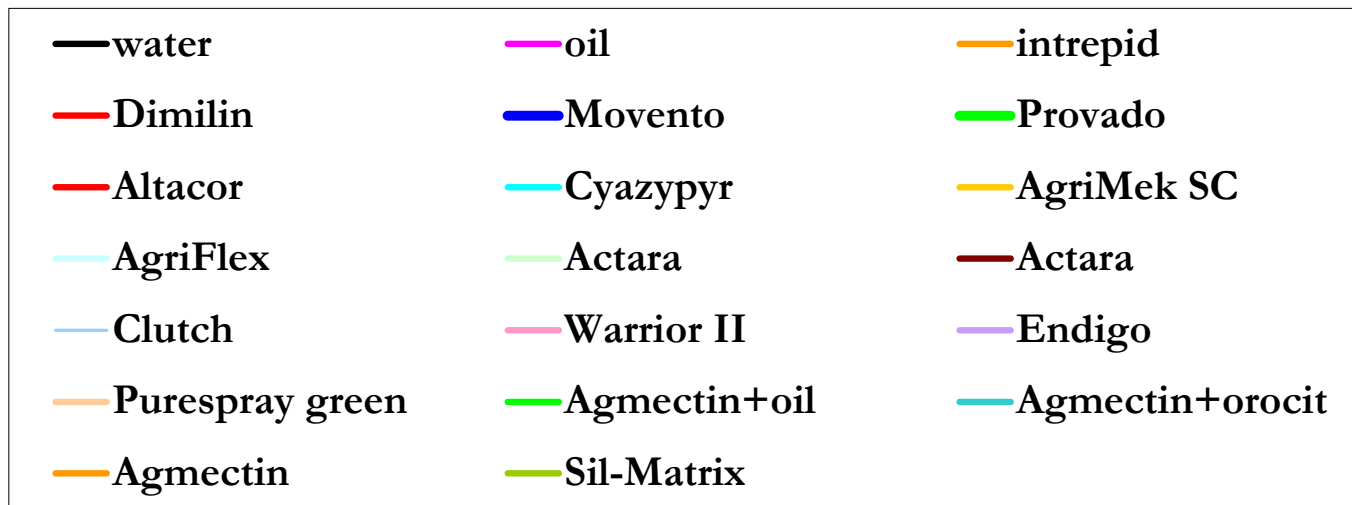


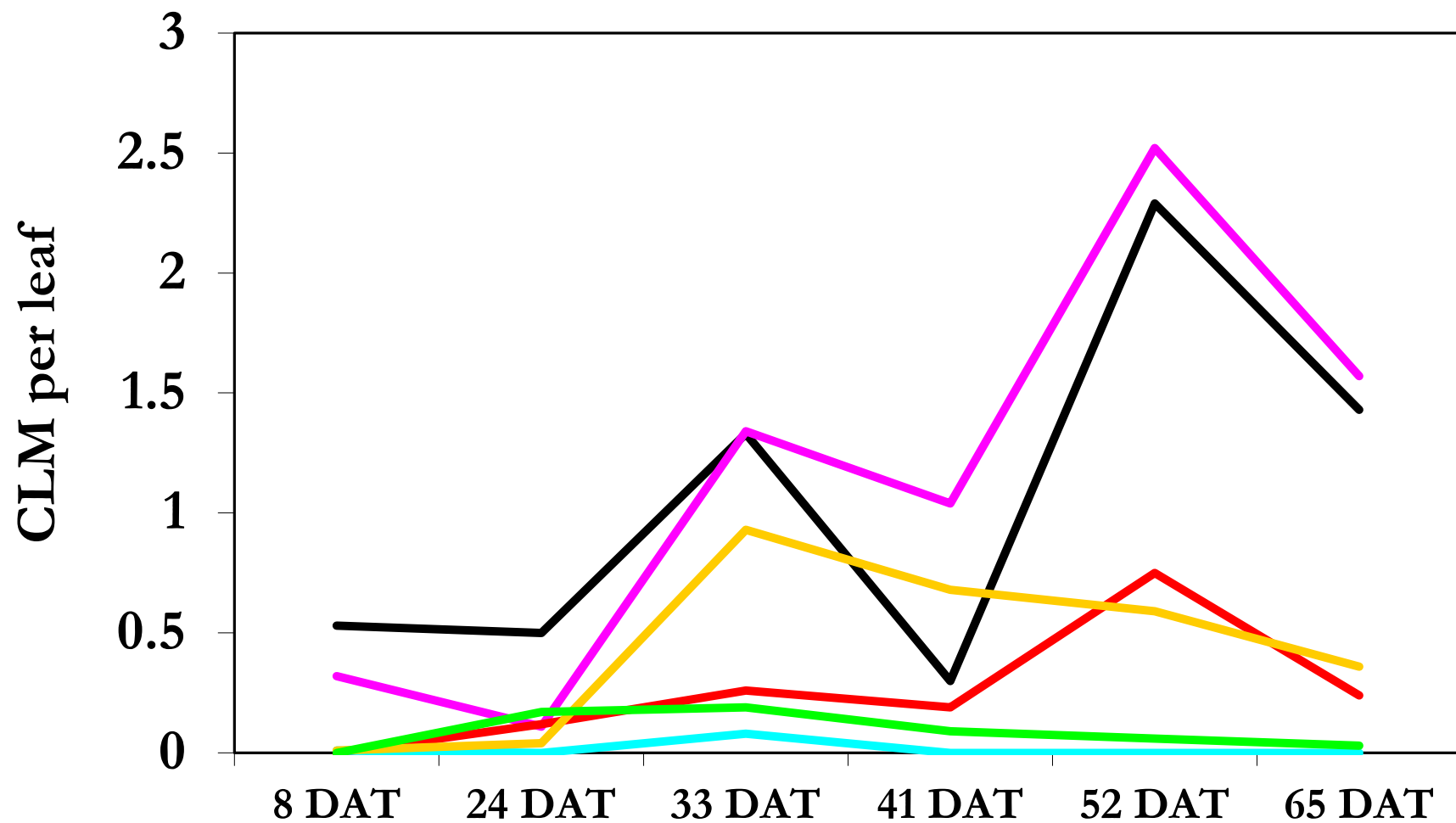


**We are one of the last citrus growing regions on earth to be invaded by citrus leafminer**



# LREC Field

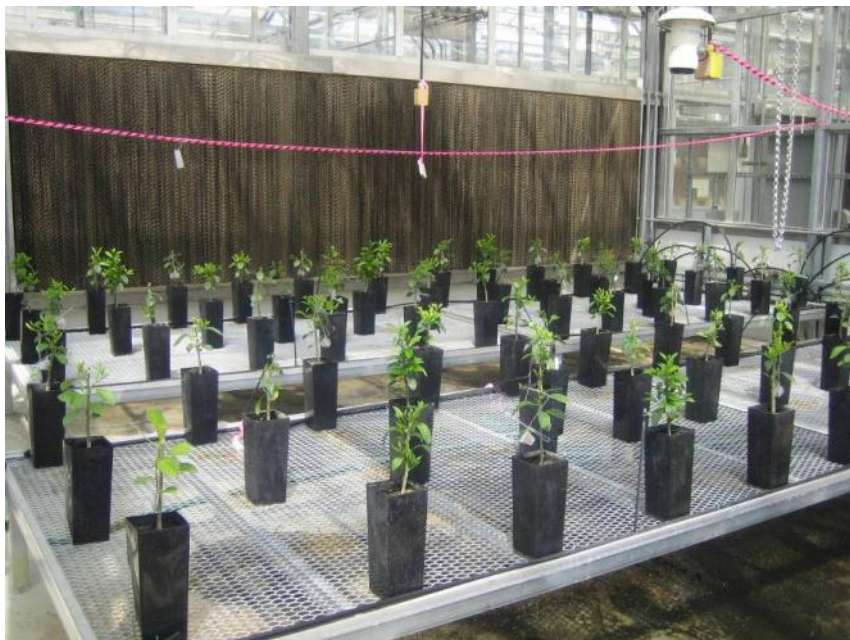






**Unsightly plants**  
**Pest free plant material**

**4 Pheromone lures** in a room such as this reduced egg laying by 50-70% and adding an oil treatment reduced their numbers even further.

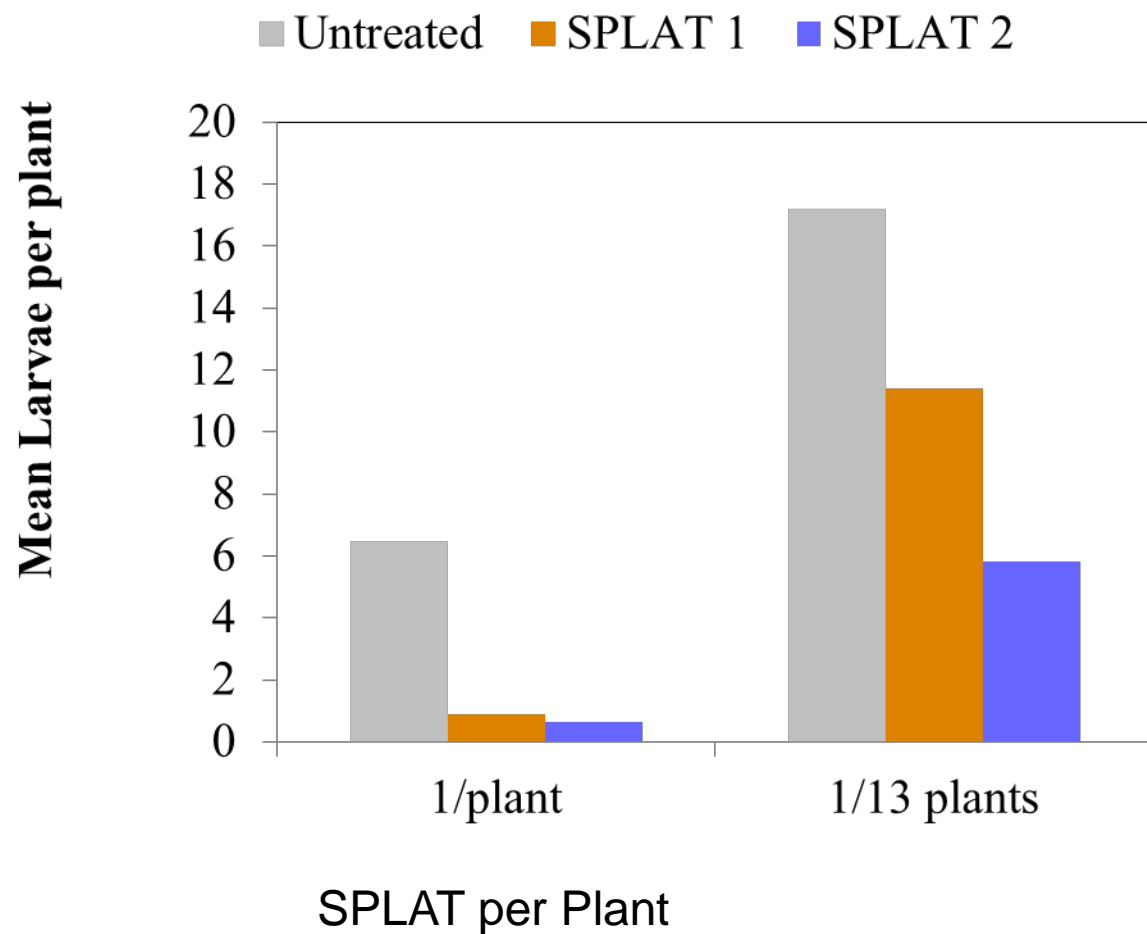


## ISCA Lures

	Leafminer per pot	
	Pheromone	No pheromone
Oil	0.17	0.28
No oil	0.55	1.08



## SPLAT CLM Pheromone confusion



# How do I control citrus leafminer?

**1. Rotate chemicals: Resistance and label restrictions for nurseries make this difficult**

**1. Spray as infrequently as possible**

- Be careful not to over-prune as new flush provides a home for leafminer
- Reduce treatments in the winter in cool situations when activity is low
- Use low rate oil treatments every 10-14 days instead of an insecticide
- Experiment with pheromone lures

## Treatments for pest quarantine

Asian citrus psyllid, *Diaphorina citri*

Imported fire ant, *Solenopsis invicta*

Glassy-winged sharpshooter, *Homalodisca vitripennis*

Diaprepes root weevil, *Diaprepes abbreviatus*







Eggs and nymphs on young flush



Adults on any leaves



# Asian Citrus Psyllid and Huanglongbing (HLB)

HLB causes yellowing of leaves, odd fruit shape, color and size and bitter juice





**Thin, unproductive trees with bitter juice and fruit that falls off easily  
Trees can die in as little as 5 years**

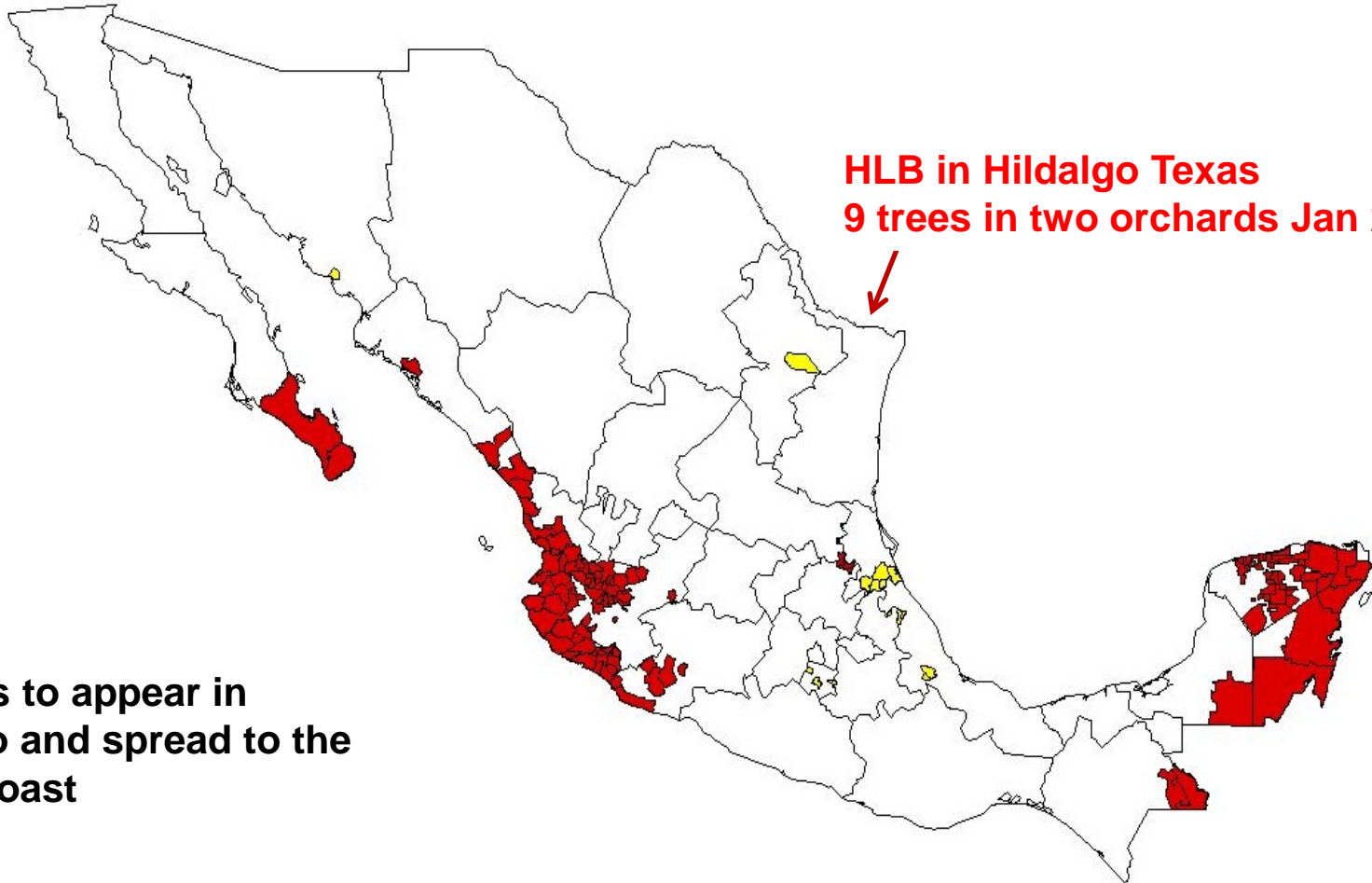


# HLB Update

↖ **HLB in Hacienda Heights California**  
**1 tree in a backyard Mar 2012**



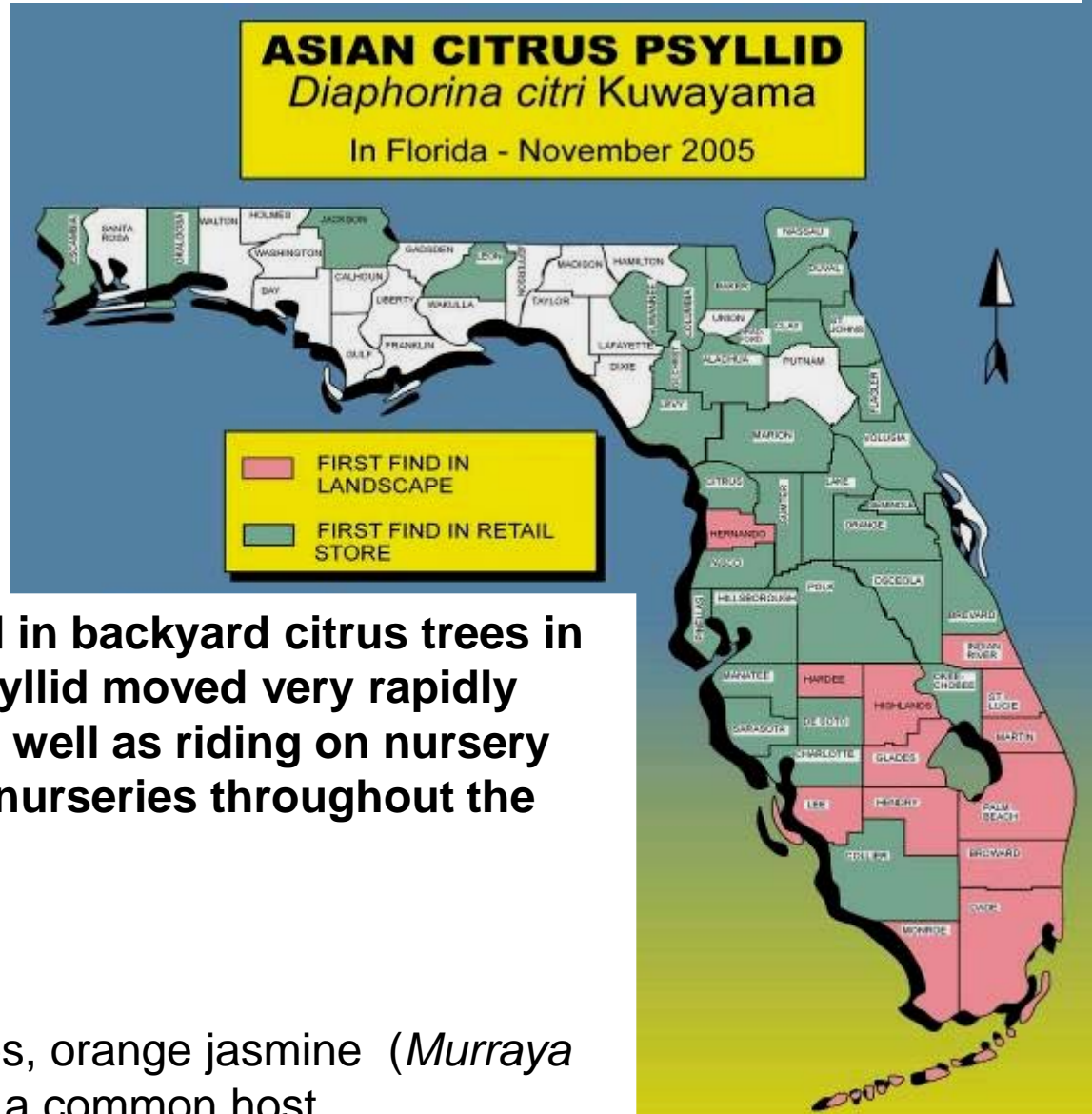
**HLB in Hidalgo Texas**  
**9 trees in two orchards Jan 2012**



**2 years to appear in  
Mexico and spread to the  
west coast**



# How did the psyllid and HLB spread through Florida?



The psyllid was first detected in backyard citrus trees in south Florida in 1998. The psyllid moved very rapidly both by flying (pink areas) as well as riding on nursery plants moved between retail nurseries throughout the state.

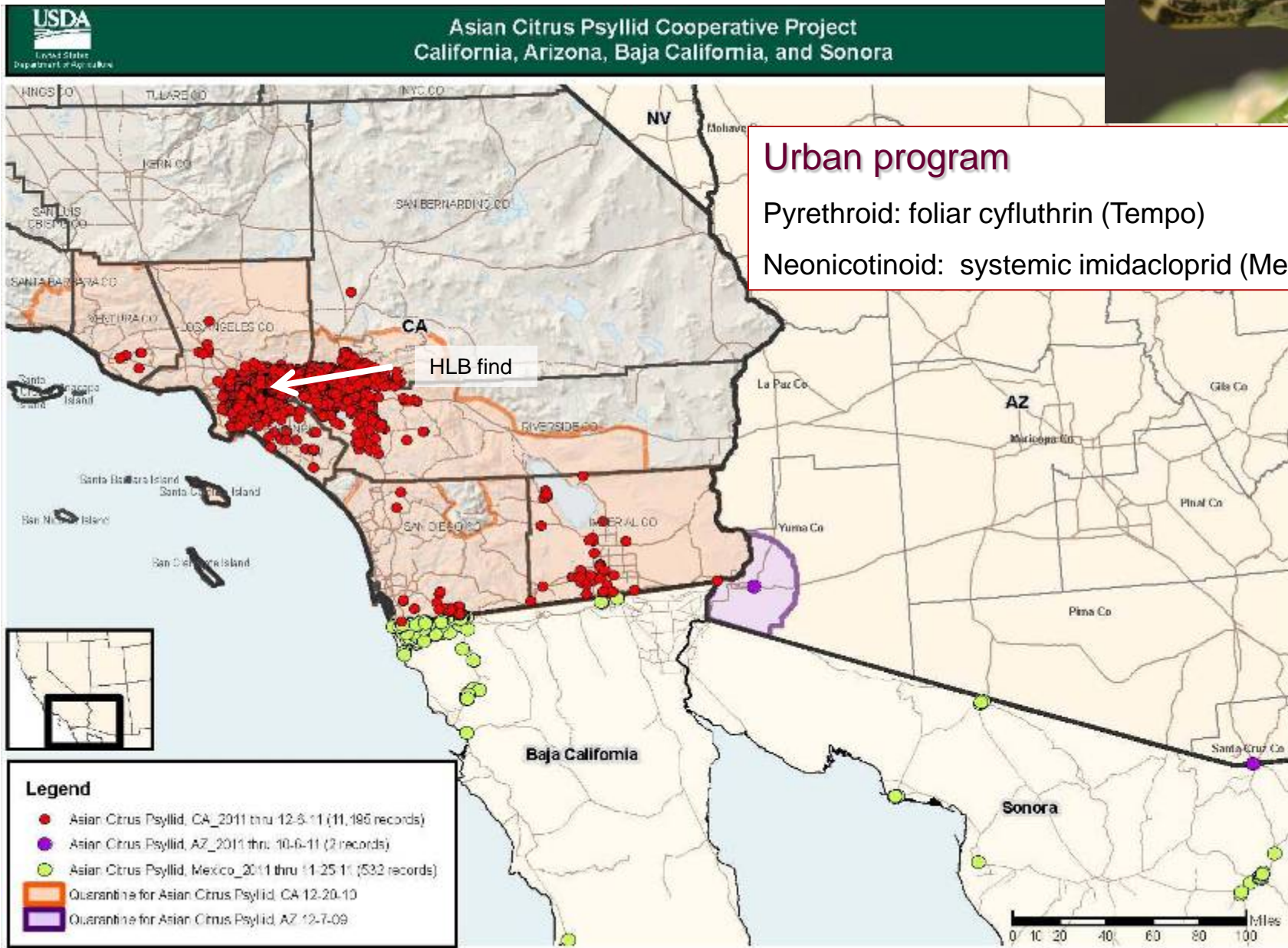
In retail nurseries, orange jasmine (*Murraya paniculata*) was a common host.



# Psyllid Control Program

ACP was first discovered in California in 2008

Treatments have kept it contained for 3 years



# Nursery Quarantine Treatments for ACP

One foliar and one systemic required to move within the ACP quarantine area

Class	Insecticide	Bearing	Non-bearing
<b>Systemic</b>			
Neonicotinioid	Imidacloprid	Admire Pro, Macho, Nuprid, Alias, Advise, Couraze, Widow	Merit, CoreTect Marathon II
Neonicotinoid	Thiamethoxam		Flagship
Neonicotinoid	Dinotefuran		Safari
<b>Foliar</b>			
Pyrethroid	Cyfluthrin	Baythroid	Tempo
Pyrethroid	Fenpropathrin	Danitol	Tame, Decathlon
Pyrethroid + neonicotinoid	Cyfluthrin + imidacloprid		Discus <sup>^</sup>
Organophosphate	Chlorpyrifos	Lorsban, Warhawk Quali-Pro Chlorpyrifos	
Carbamate	Carbaryl	Sevin	Sevin
Tetronic acid	Spirotetramat	Movento <sup>^</sup>	Kontos

<sup>^</sup>No GH

<http://www.cdфа.ca.gov/phpps/acp/quarantine.html>

**Issue 1:** Treating plant material for quarantine pests  
(Preparing for shipment)

**Issue 2:** How to manage existing pests in enclosed structures  
(transition from primarily outdoor plantings to indoors)

## **Regulatory response to Asian citrus psyllid and huanglongbing disease**

January 1, 2012: Registered mother trees under screen

January 1, 2013: Increase trees under screen

When HLB arrives: Production trees under screen



# Lindcove screenhouses and positive pressure greenhouse



# Pest Quarantine Treatments

Formulation	Glassy-winged Sharpshooter	Asian citrus psyllid	California red scale	Diaprepes Root weevil	Imported Fire ant
Pyrethroids-foliar	Eggs/nymphs, Adults	+++	++	Adults	
Pyrethroid – soil (Talstar)	-	-		Larvae	+++
Neonicotinoids systemic	Eggs/nymphs, Adults	++	-	Adults	
Neonicotinoids foliar	Adults	+++ (except Assail)	-	Adults	
Organophosphates	+	++	+++	Adults	
Carbamates	Egg/Nymphs	+	+	Adults	

## Issues:

- Quarantine pests are best controlled with long-lasting broad spectrum insecticides
- Most insecticides have maximum label rates per season or year. If you reach the limit during the year for endemic pests, then you can not use them to treat for quarantine pests.