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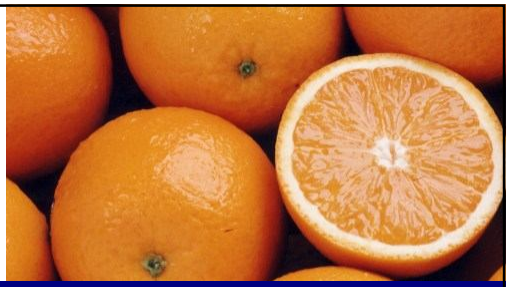

Citrus IPM
Managing Pests in a Real World System

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Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



Citrus Red Mite, *Panonychus citri*


Citrus Thrips, *Scirtothrips citri*


Forktailed Bush Katydid, *Scuddaria furcata*


Citrus Cutworm, *Egira curialis*

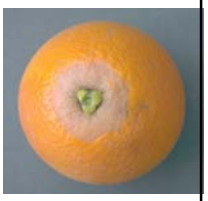

California red scale, *Aonidiella aurantii*

Citricola scale, *Coccus pseudomagnoliarum*

Cottony cushion scale, *Icerya purchasi*

Citrus Thrips, *Scirtothrips citri*



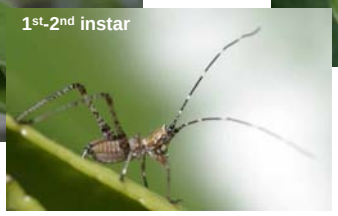



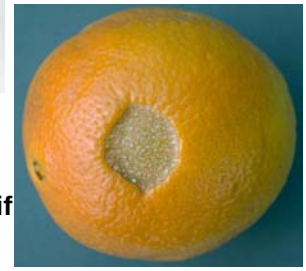

Monitoring Method
At petal fall, collect 100 fruit 2x per week
(4-30 mm in size) and examine the stem end for nymphs.

Treatment threshold for navels:
5% of fruit infested without natural enemies
10% fruit infested if >0.5 predatory mites/leaf

Cultural Control: wet, cool spring weather reduces pupae
Biological Control: predatory mites assist

Forktailed Bush Katydid, *Scudderia furcata*





Monitoring Methods:
Timed search for katydid nymphs and damaged fruit

Treatment Threshold:
Most growers treat as soon as they see katydids if fruit is small and susceptible to damage

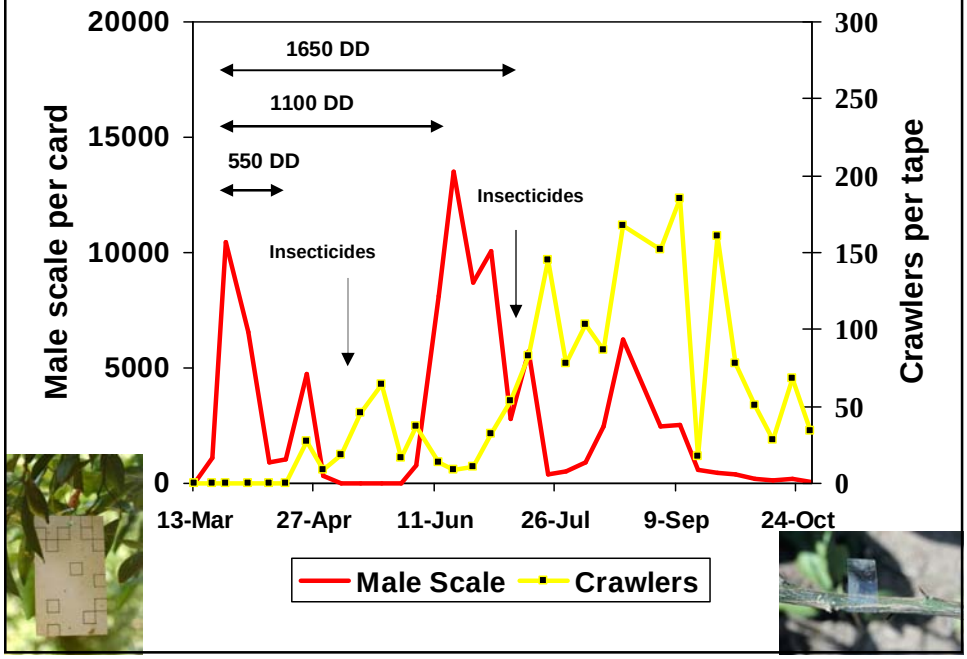
Biological Control:
Parasites of egg stage are not very effective

California Red Scale, *Aonidiella aurantii*

Tree Damage – dieback of branches

Fruit Damage – downgrading of fruit

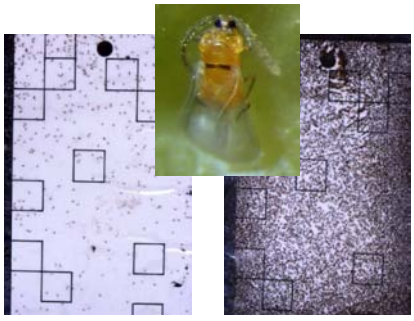
Degree days = accumulation of the average daily temperature above the lower developmental threshold (53°F)



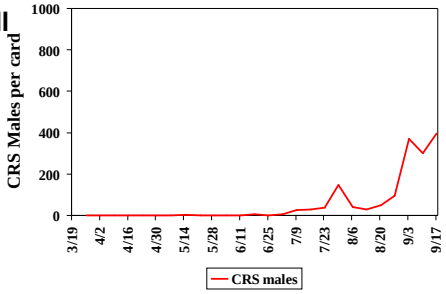
Pesticide Strategy

Treatment Threshold:

1,000 male scale/card in previous fall



Orchard 7



Scale-infested fruit in the bins

Biological Control Strategy

Cultural Control:

Reduce dust, prune trees, use a high pressure washer to remove scale

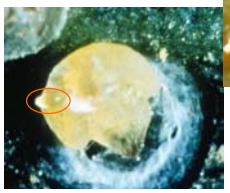
Biological Control:

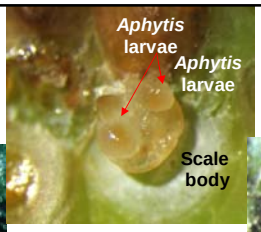
***Aphytis melinus*: Release 5,000/acre every two weeks from March 1 to October 31 = 100,000/acre**

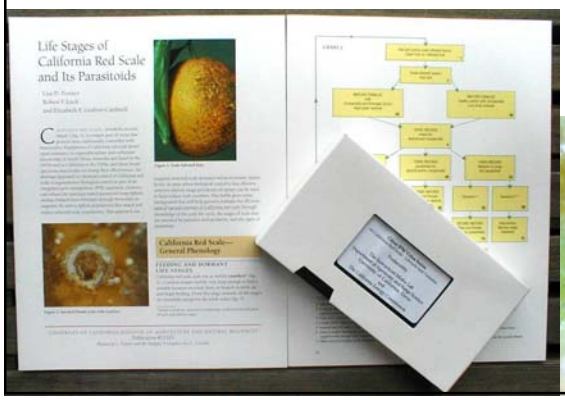
Cost: $.85/1,000 wasps = $85/acre

300 psi (21kg/cm²)

California red scale biological control







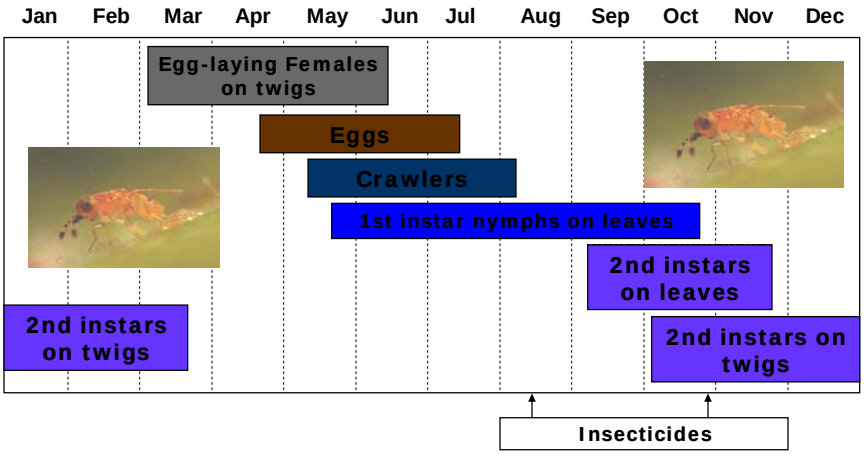
Citricola Scale, *Coccus pseudomagnoliarum*

Damage: sooty mold, yield losses

Biological control: poor

Treatment threshold: 0.5 nymph/leaf

Citricola Scale Lifecycle – San Joaquin Valley



San Joaquin Valley Citrus Pest Management Prior to 1995 (3-4 treatments/orchard)

Target Pest	Conventional Program	Biologically-based IPM program
Citrus thrips	Organophosphates Carbamates	Botanical sabadilla
California red scale	Organophosphates Carbamates	*Aphytis* parasite releases Oil
Katydid	Not needed	Low rate of OP Cryolite
Citricola scale	Not needed	Low rate of OP
Citrus Red Mite	Miticides: dicofol, propargite	Oil
Citrus cutworm	Organophosphate *Bacillus thuringiensis*	*Bacillus thuringiensis*
Cottony cushion scale	Vedalia beetle	Vedalia beetle

Registrations of Insecticides for Citrus since 1991

Pyrethroids (affects the sodium channel of nerves)

- cyfluthrin[1991]
- fenpropathrin[2001]

Neonicotinoids (attacks nicotine acetylcholine receptors in insects)

- imidacloprid
- acetamiprid

Insect Growth Regulators (prevents molting and egg hatch)

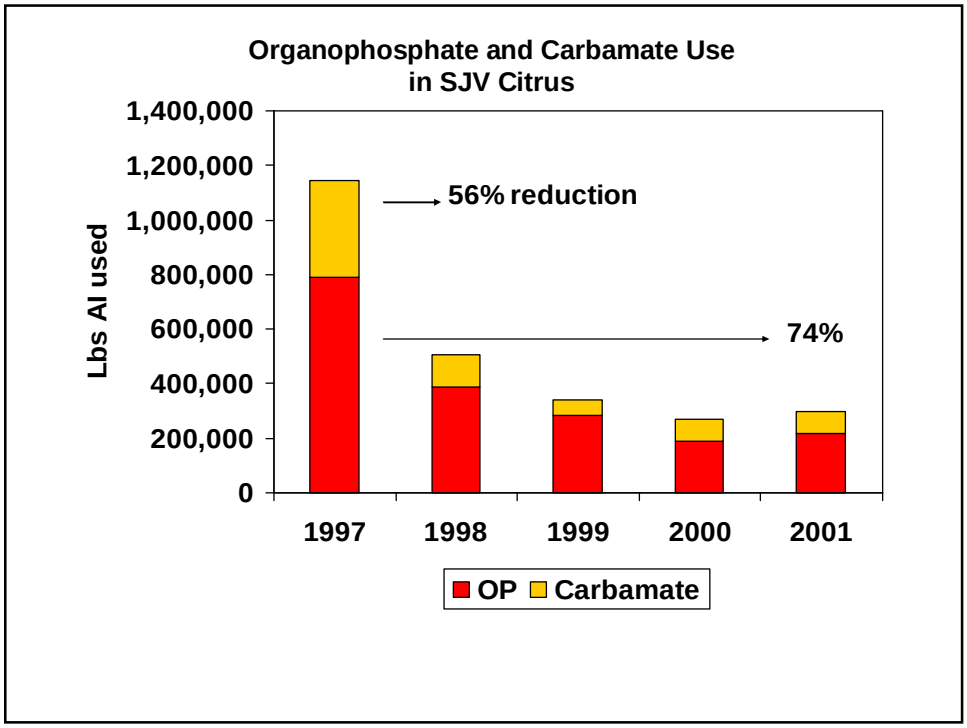
- pyriproxyfen[1998] for California red scale
- buprofezin[2002]
- diflubenzuron[2003]

Spinosyns and avermectins (attacks nervous system of insects and mites)

- abamectin[1994]
- spinosad[1998] for citrus thrips
- spinetoram[2008]

Tetronic Acid (inhibits synthesis of fatty acids in insects and mites)

- spirodiclofen[2007]
- spirotetramat[2008]



Toxicity Ratings of Insecticide Groups used in Citrus Pest Management

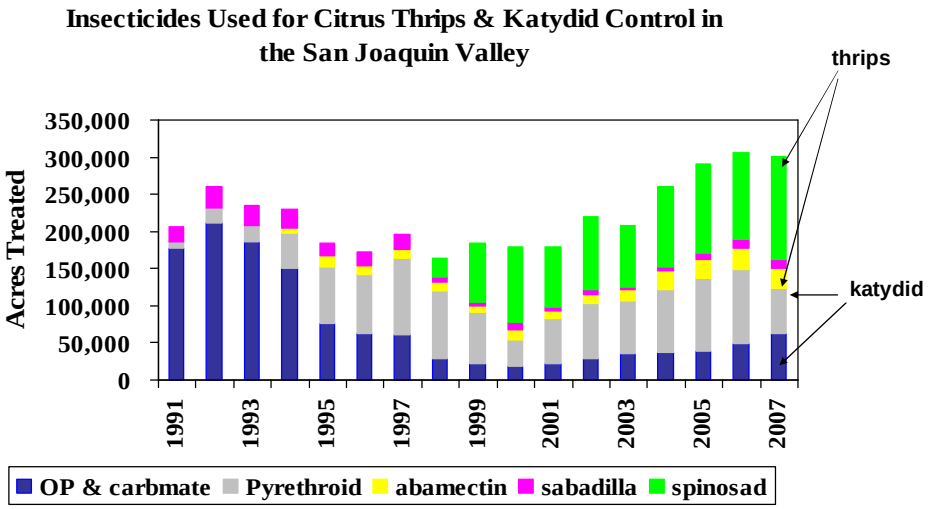
	Oral Toxicity Rat LD 50 mg/kg	Toxicity Rating	Symptoms
Organophosphate	500	Warning	headache, dizziness, twitching, nausea sweating, blurred vision, salivation, convulsions
Pyrethroids (Danger)	650	Warning	Salivation, weakness, ataxia, tremors and convulsions
Neonicotinoids	850	Caution	eye and skin irritation
Insect growth regulator	4200	Caution	minor eye and skin irritation
Tetronic acid	Ø 2000	Caution	minor eye and skin irritation
Fermentation Products	>5000		minor eye and skin irritation

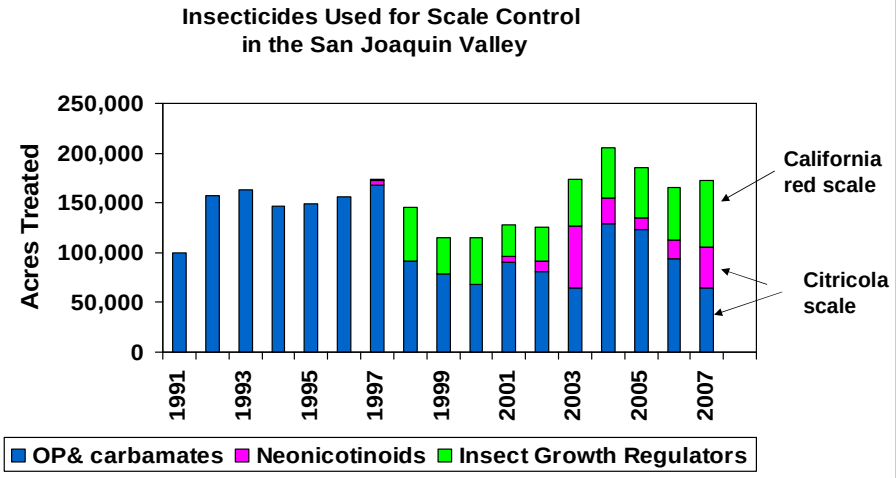
*Goals: efficacy and selectivity favoring humans and natural enemies

Secondary pests with poor biological control became primary pests when organophosphate and carbamate use was halted

Katydids

Citricola scale





Consequence of shift in pesticide use: Change in toxicity to natural enemies

	Aphytis melinus	*Rodolia cardinalis*	*Euseius tularensis*
OPs & carbamates	Toxic unless low rates – some resistance	Highly resistant	Resistant
Pyrethroids	Highly toxic	Highly toxic	Highly toxic
Neonicotinoids	Foliar toxic for 3 mo Systemic less toxic	Systemic toxic for 6 mo Foliar 3 mo	Systemic slight Foliar 2 mo
Spinosad	Nontoxic	Nontoxic	Relatively nontoxic
Insect growth regulators	Nontoxic	Highly toxic for 7 mo	Nontoxic

San Joaquin Valley Citrus Pest Management (2-3 treatments/year)

Target Pest	Conventional Program 1990s	Biologically-based IPM program 1990s	Current Program
Citrus thrips	Organophosphates Carbamates	Botanical sabadilla	Spinosyns
California red scale	Organophosphates Carbamates	*Aphytis* releases Oil	Insect growth regulator Spirotetramat *Aphytis* releases Oil
Katydid	Not needed	Low rate of organophosphate Cryolite	OP: low rate Pyrethroid: low rate Insect growth regulator
Citricola scale	Not needed	Low rate of organophosphate	OP every two years Neonicotinoid
Citrus Red Mite	Miticides	Oil	Oil Miticides
Cottony cushion scale	Vedalia beetle	Vedalia beetle	OP if vedalia disrupted

Reasons Why Growers Minimize Pesticide Use

Cost: pesticide + application costs range from $80-150/acre

Pest upsets: when a pesticide disturbs the natural enemies needed for another pest

Worker safety: insecticide, equipment etc.

Orchard health: compaction, fruit and tree damage

Environmental risk: potential offsite movement

Exotic Pests are arriving at an increasing rate

Glassy-winged sharpshooter
Homalodisca coagulata

Citrus Peelminer, *Marmara gulosa*

Citrus Leafminer,
Phyllocnistis citrella

Diaprepes Root Weevil,
Diaprepes abbreviatus

Asian Citrus Psyllid,
Diaphorina citri

Exotic pests influence pesticide practices

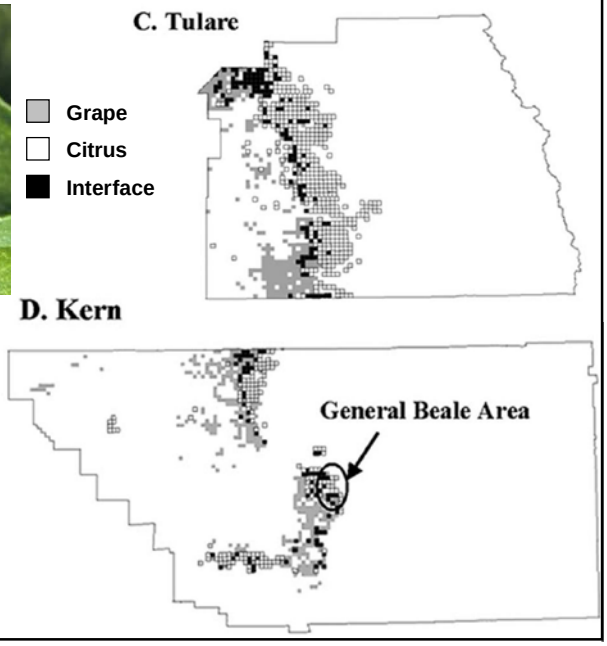
- **Eradication programs require pesticides because natural enemies are either lacking or don't control plant disease fast enough**
- **Neonicotinoids and/or pyrethroids are used because they have broad registration and broad efficacy against many pests**

Glassy-winged sharpshooter, *Homalodisca coagulata*

Arrived in California in the 1990s

Vector of *Xylella fastidiosa* the bacterium that causes Pierce's Disease of grapevines and the citrus disease variegated chlorosis (not found in CA)

Neonicotinoids
Acetamiprid (foliar)
Imidacloprid (systemic)

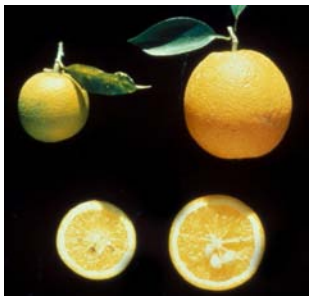


Asian Citrus Psyllid *Diaphorina citri*

Arrived in Florida in 1998 and California in 2008

Huanglongbing (citrus greening) disease

Detected in Florida in 2005



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