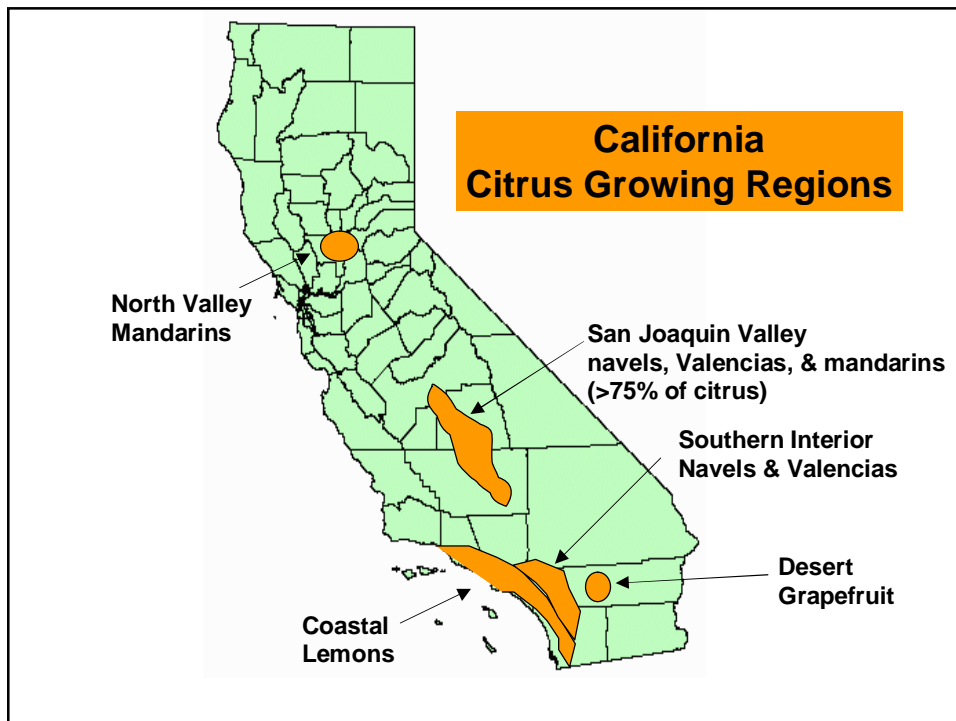




Citrus IPM Managing Pests in a Real World System

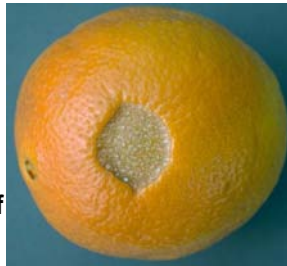
Beth Grafton-Cardwell
Dept. of Entomology, UC Riverside
Stationed at the Kearney Ag Center
Director, Lindcove Research & Extension Center



Forktailed Bush Katydid, *Scudderia furcata*



1st-2nd instar



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

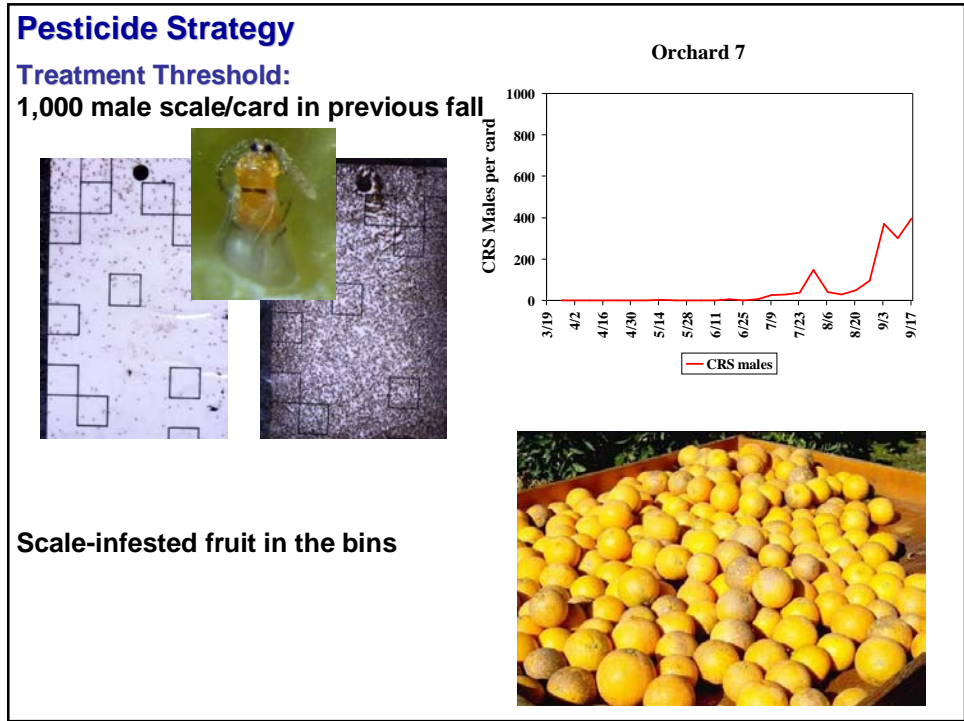
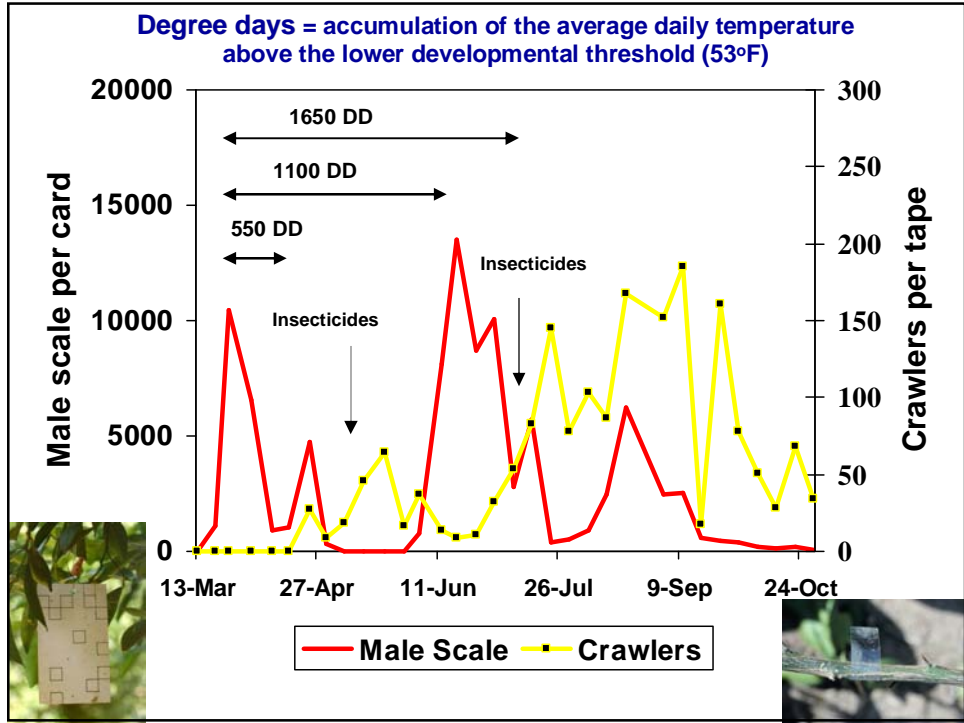
California Red Scale, *Aonidiella aurantii*

Tree Damage – dieback of branches



Fruit Damage – downgrading of fruit





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

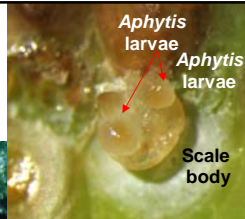
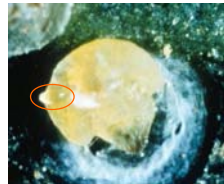
Cost: \$.85/1,000 wasps = \$85/acre



300 psi (21kg/cm²)



California red scale biological control



Life Stages of California Red Scale and Its Parasitoids

Robert F. Cook and Elizabeth C. Lindbeck-Gardner

California Red Scale—General Parasitoids

FIGURE 1

Dried up scale body



Citricola Scale, *Coccus pseudomagnoliarum*

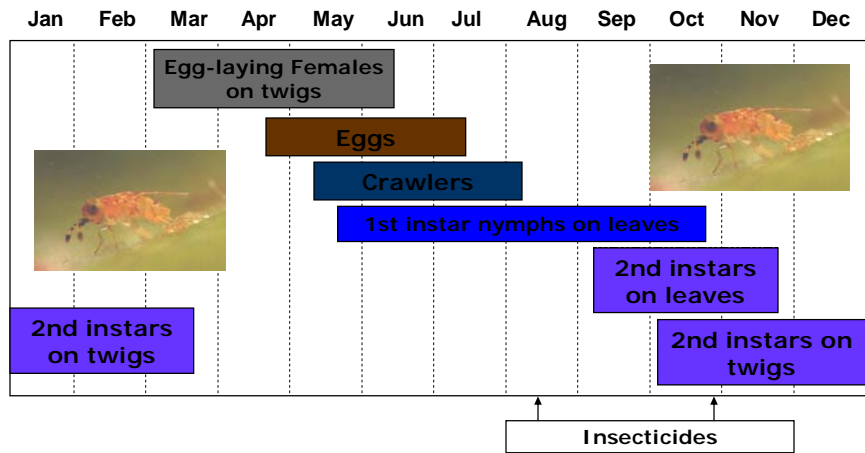
Damage: sooty mold, yield losses

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	<i>Aphytis</i> 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 <i>Bacillus thuringiensis</i>	<i>Bacillus thuringiensis</i>
Cottony cushion scale	Vedalia beetle	Vedalia beetle

Registrations of Insecticides for Citrus since 1991

Pyrethroids (affects the sodium channel of nerves)

cyfluthrin¹⁹⁹¹
fenpropathrin²⁰⁰¹

Neonicotinoids (attacks nicotine acetylcholine receptors in insects)

imidacloprid
acetamiprid

Insect Growth Regulators (prevents molting and egg hatch)

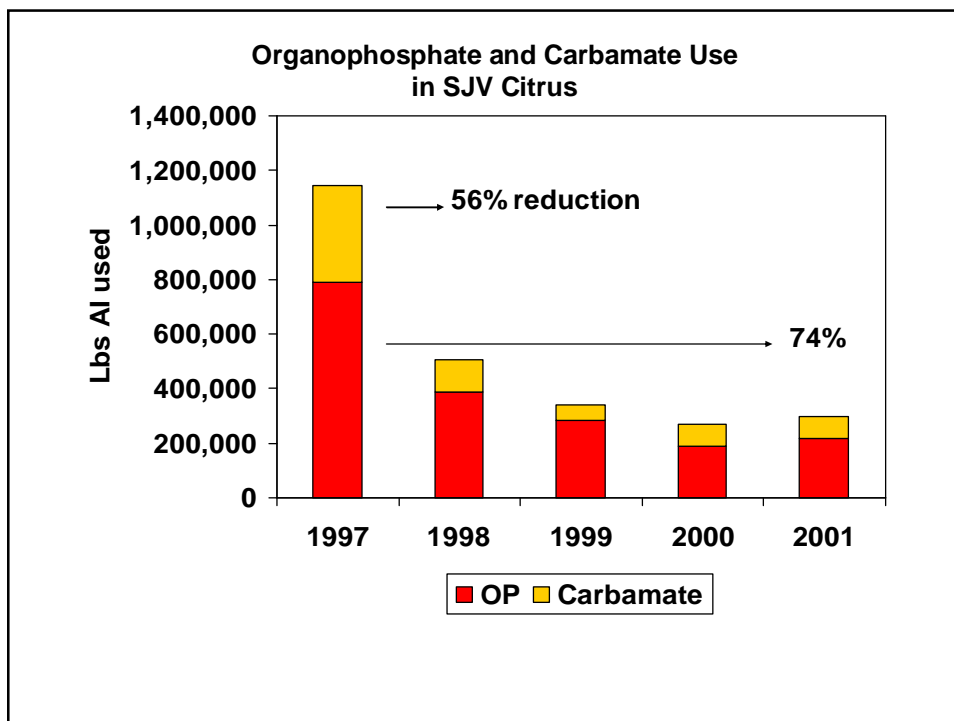
pyriproxyfen¹⁹⁹⁸ for California red scale
buprofezin²⁰⁰²
diflubenzuron²⁰⁰³

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

abamectin¹⁹⁹⁴
spinosad¹⁹⁹⁸ for citrus thrips
spinetoram²⁰⁰⁸

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

spirodiclofen²⁰⁰⁷
spirotetramat²⁰⁰⁸



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	∅ 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

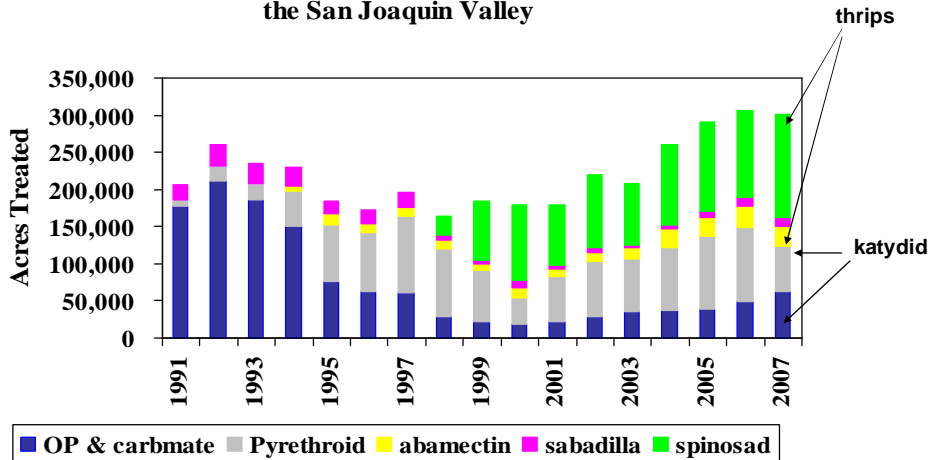
Katydid

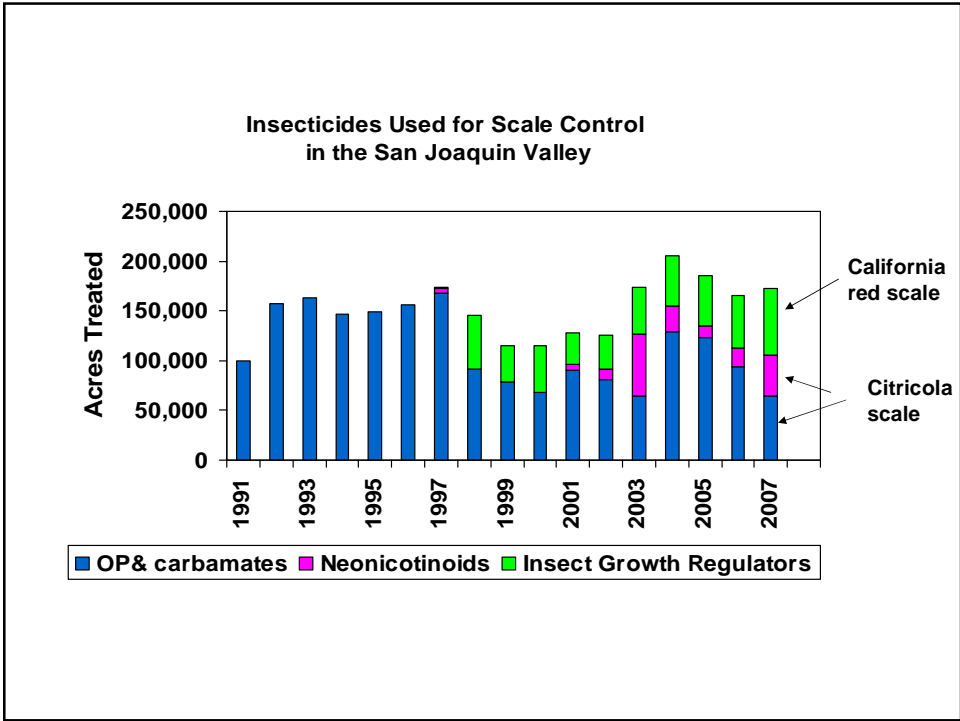


Citricola scale






Insecticides Used for Citrus Thrips & Katydid Control in the San Joaquin Valley





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

	<i>Aphytis melinus</i>	<i>Rodolia cardinalis</i>	<i>Euseius tularensis</i>
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	<i>Aphytis</i> releases Oil	Insect growth regulator Spirotetramat <i>Aphytis</i> 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

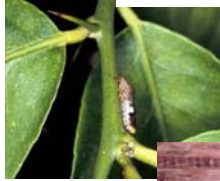
Worker safety: insecticide, equipment etc.

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

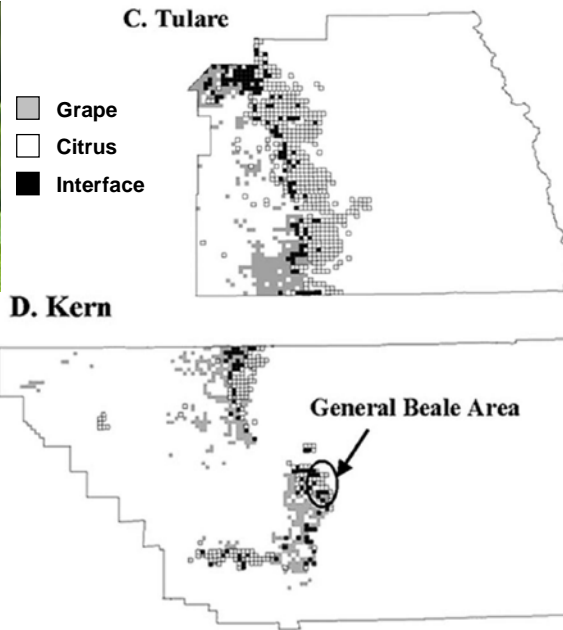
Glassy-winged sharpshooter, *Homalodisca coagulata*

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



Reasons Why Growers Minimize Pesticide Use

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