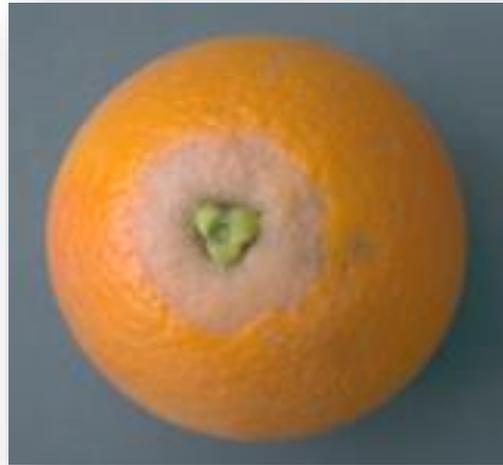


Citrus Thrips Biology and Management



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Kearney Ag Center and Lindcove REC

Technical Staff: Joshua Reger & Stephanie Doria

Citrus Thrips Life Cycle



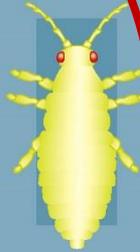
reproducing female



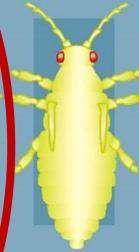
eggs embedded in citrus leaf tissue



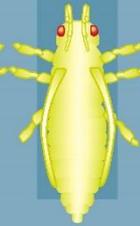
1st instar



2nd instar



3rd instar

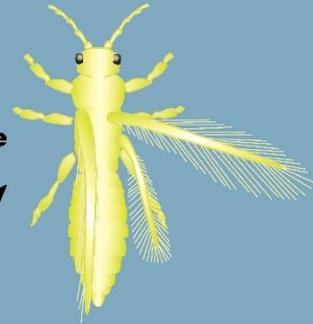


4th instar

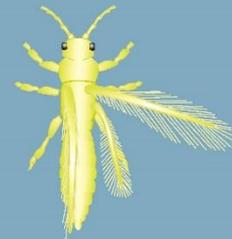
Propupa

Pupa

adult female



adult male



25 eggs/year
in flush, fruit
or green twigs

1/3 in the tree
2/3 in the soil

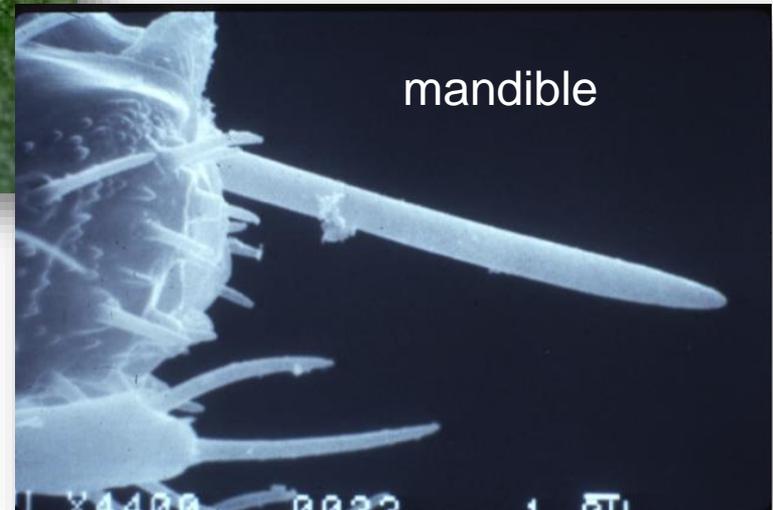
Citrus thrips attack leaves and very young fruit

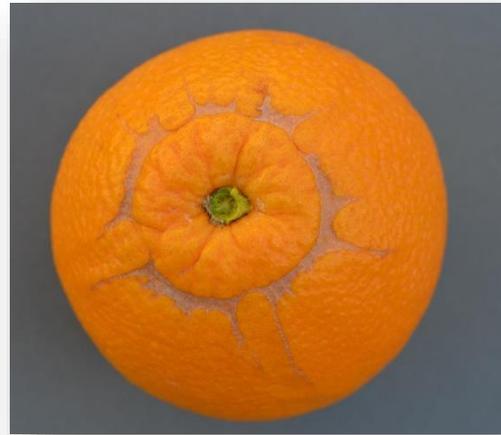


Citrus thrips are thigmotactic (like to crawl into tight spaces such as under the sepals of young fruit)



They use their mandible to pierce cells,
then they drink up the fluid with their straw-
like stylets
– round and round they go.

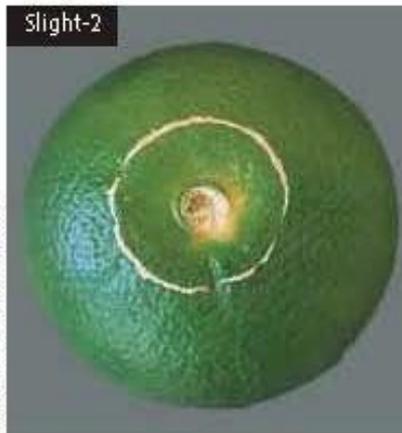




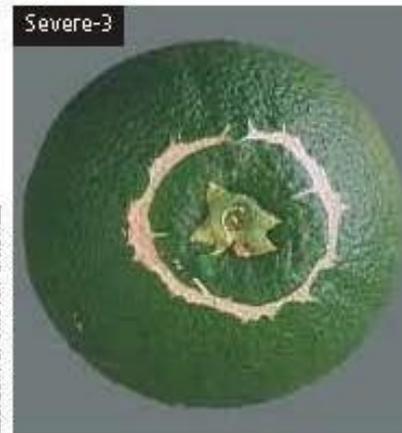
Focus on protecting young fruit from 1st and 2nd in star thrips to minimize severe scarring



ELIZABETH E. GRAFTON-CARDWELL



ELIZABETH E. GRAFTON-CARDWELL



ELIZABETH E. GRAFTON-CARDWELL



ELIZABETH E. GRAFTON-CARDWELL

Degree days

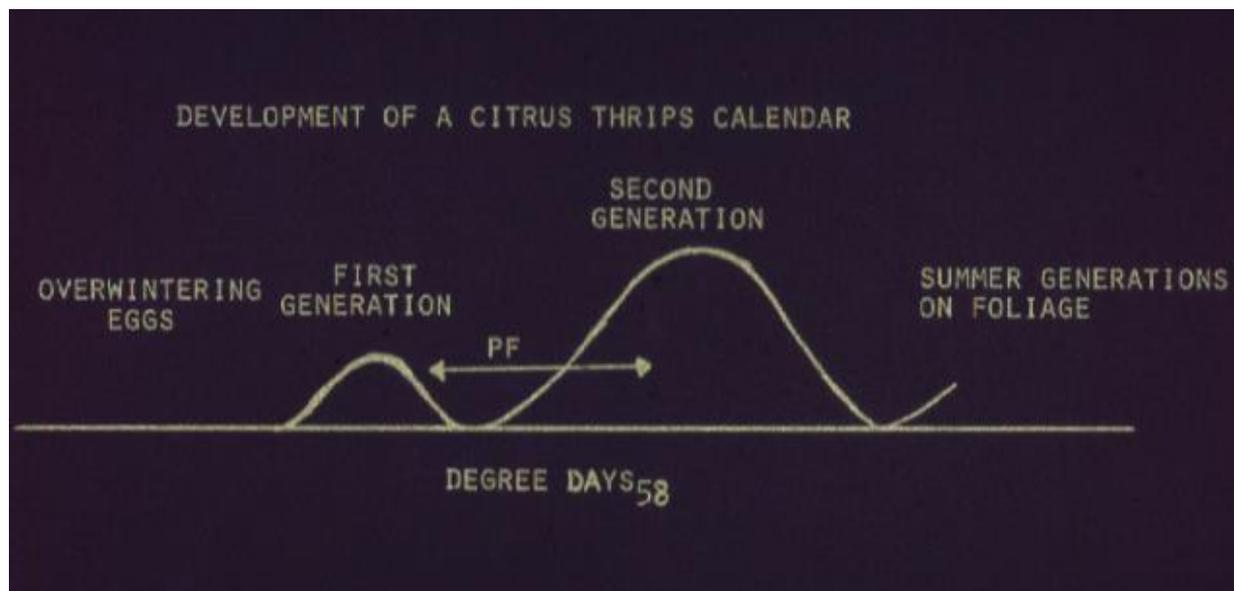
$(\text{Min temp} + \text{Max temp})/2 - \text{lower developmental threshold}$

Thrips Development – Lower developmental threshold 58°F

Citrus Development – Lower developmental threshold 49°F

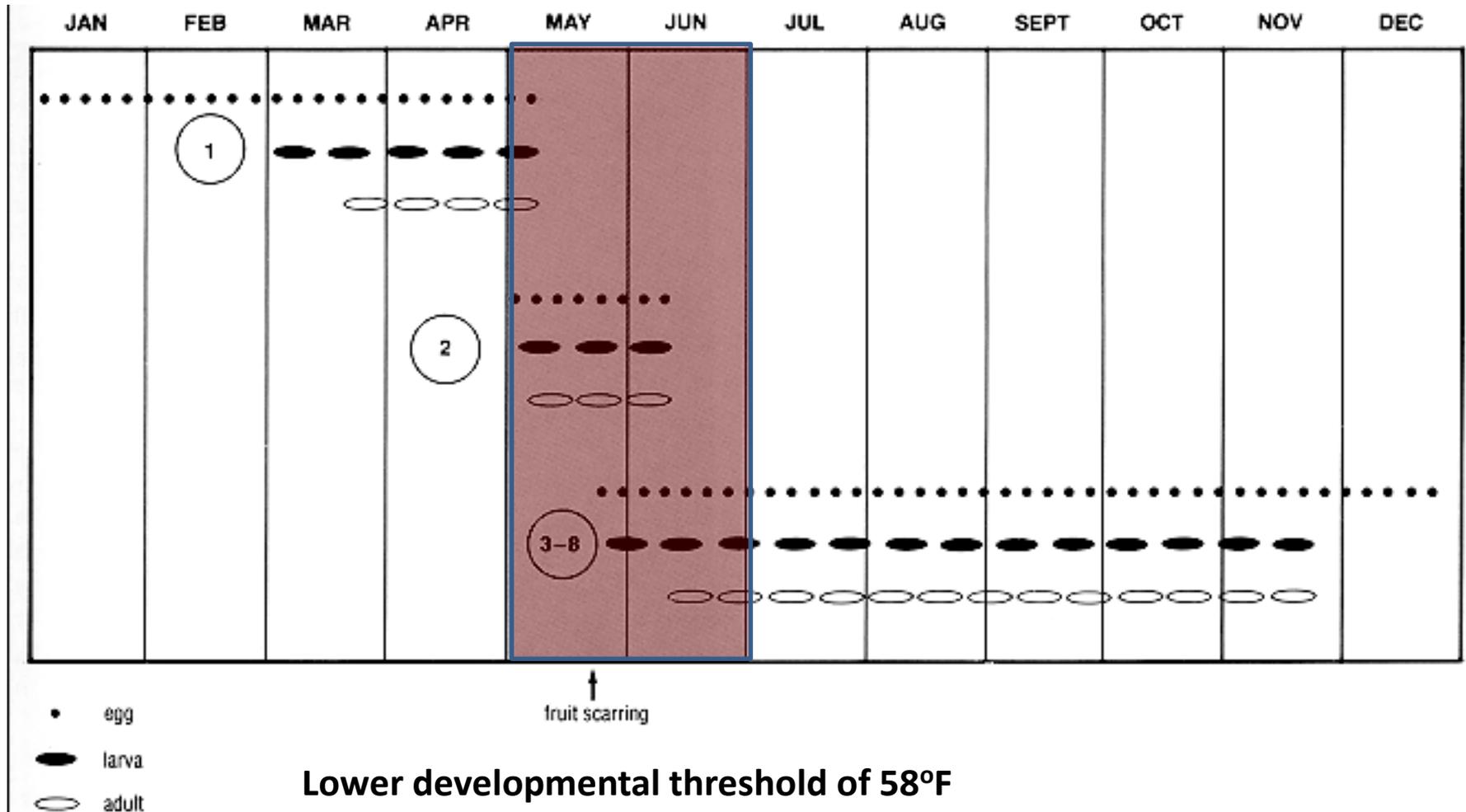
Bloom is 534 DD

Petal fall is 767 DD



7-8 generations of citrus thrips per year

The most important generations are the 2nd and 3rd that damage the fruit from petal fall until the fruit is 38 cm (1½ inches) in diameter



Thrips **pupate** (2/3) mostly in the soil:



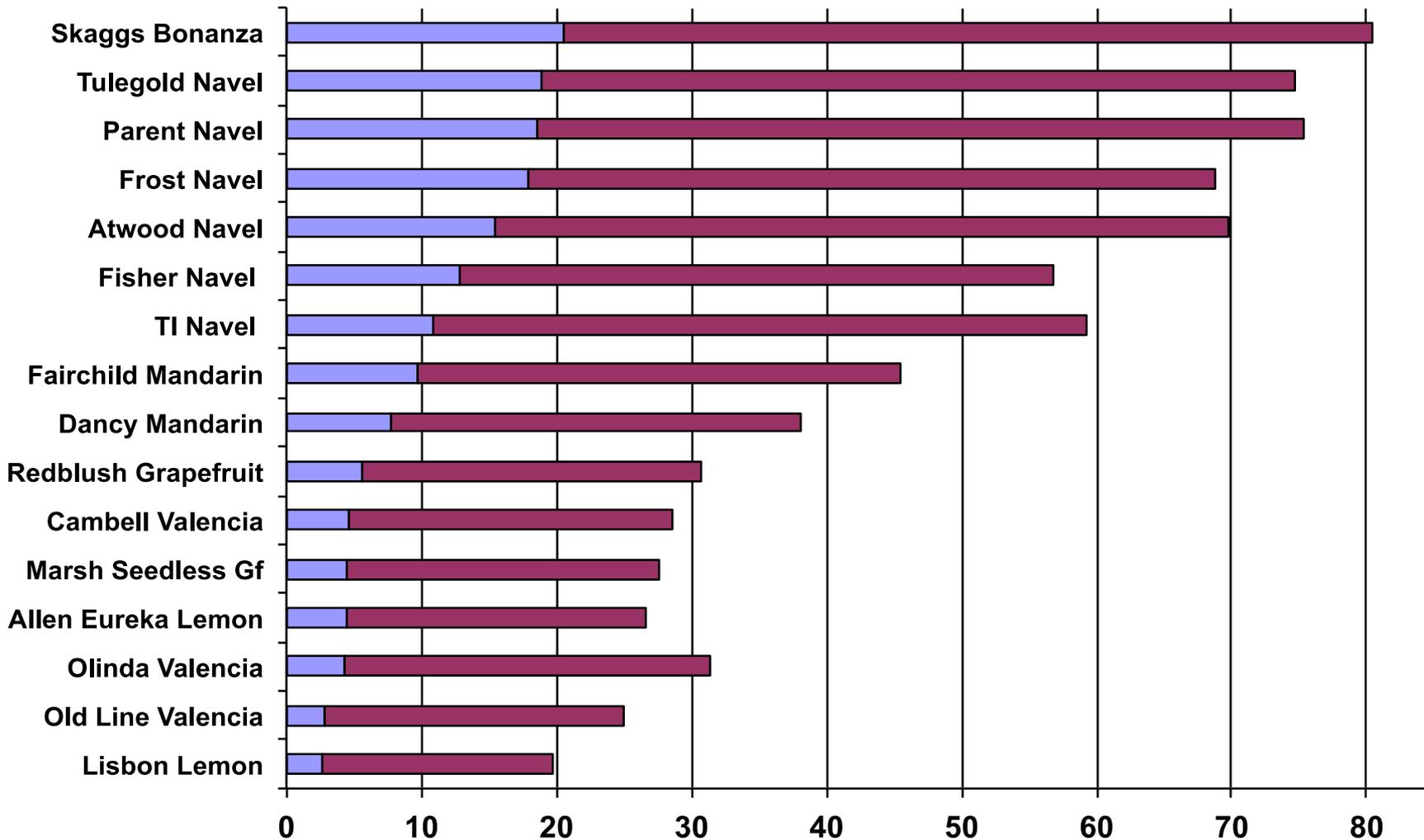
Dry hot years (2012-2018) helps pupae survive in the soil and accelerates the development of the thrips. – young trees are at risk

Wet cool years slow the development of the thrips and the moisture in the soil seems to promote microorganisms that attack the thrips.

Fruit scarring data from the Winter 2016 Citrograph article

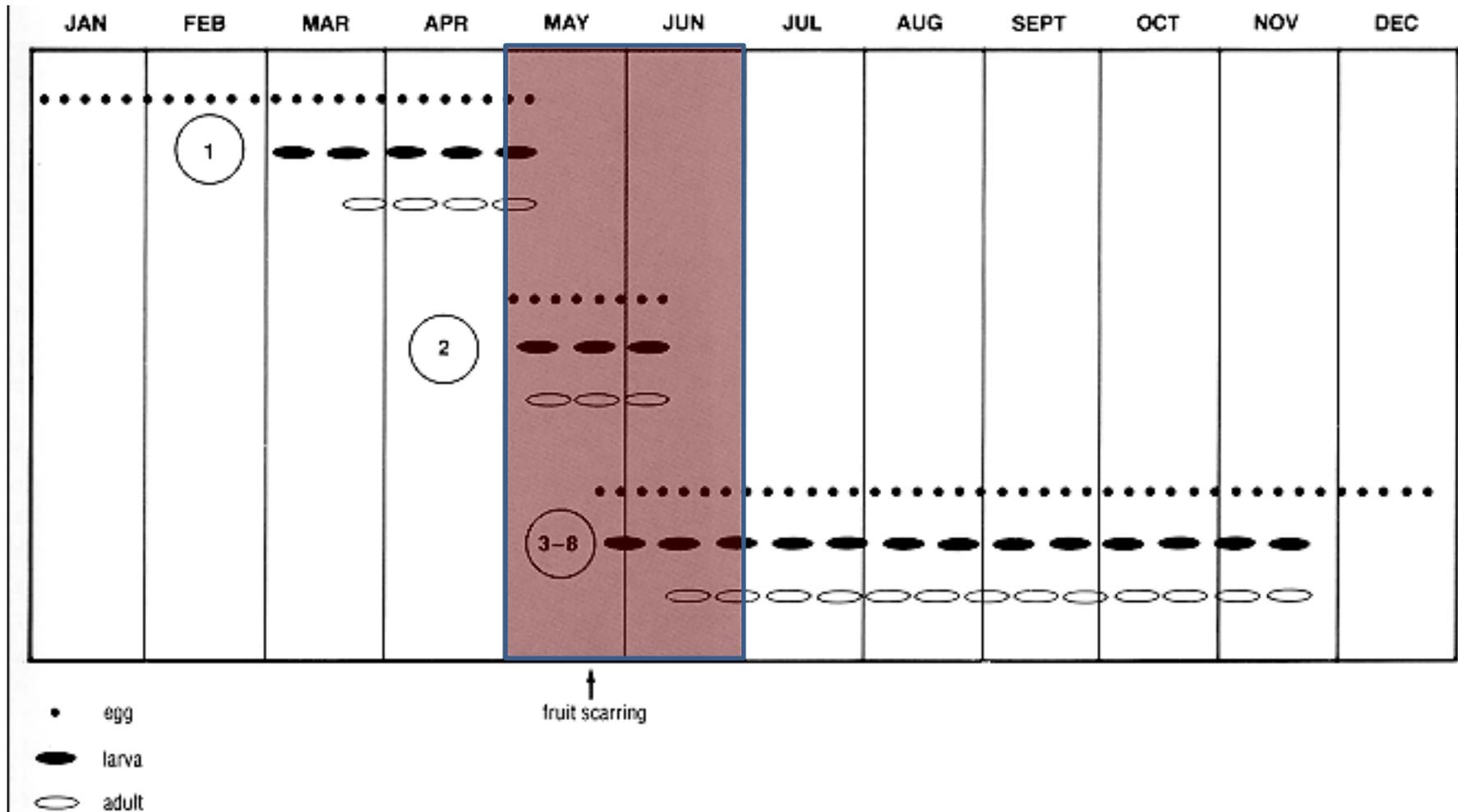
Fig. 2. Average Severe (Blue) and Total Citrus Thrips Fruit Scarring

Over 5 Years on 16 Varieties of Citrus



If you treat young nonbearing trees frequently, you could select the thrips for resistance before there is even fruit on the tree!

7-8 Generations of citrus thrips per year



Does treating young trees improve their growth and yield?



Valencias – No difference in trunk diameter or yield in years 4 and 5
19 treatments over a 3 year period (1990-1992):

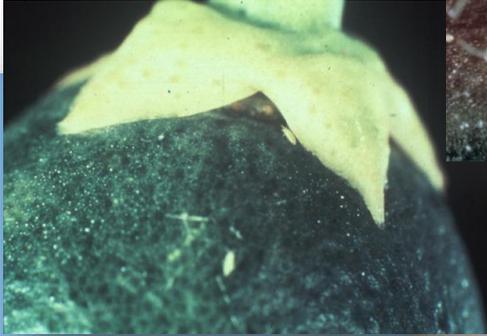
Veratran (2), dimethoate (5), Malathion (1), Carzol (3), Mavrik (3),
Lannate (1), Lorsban (3), Naled (1)

Navels - No difference in trunk diameter or yield

17 Carzol treatments over a 3 year period (1985-1986):

Mandarins?
Drought?

Monitoring Citrus Thrips

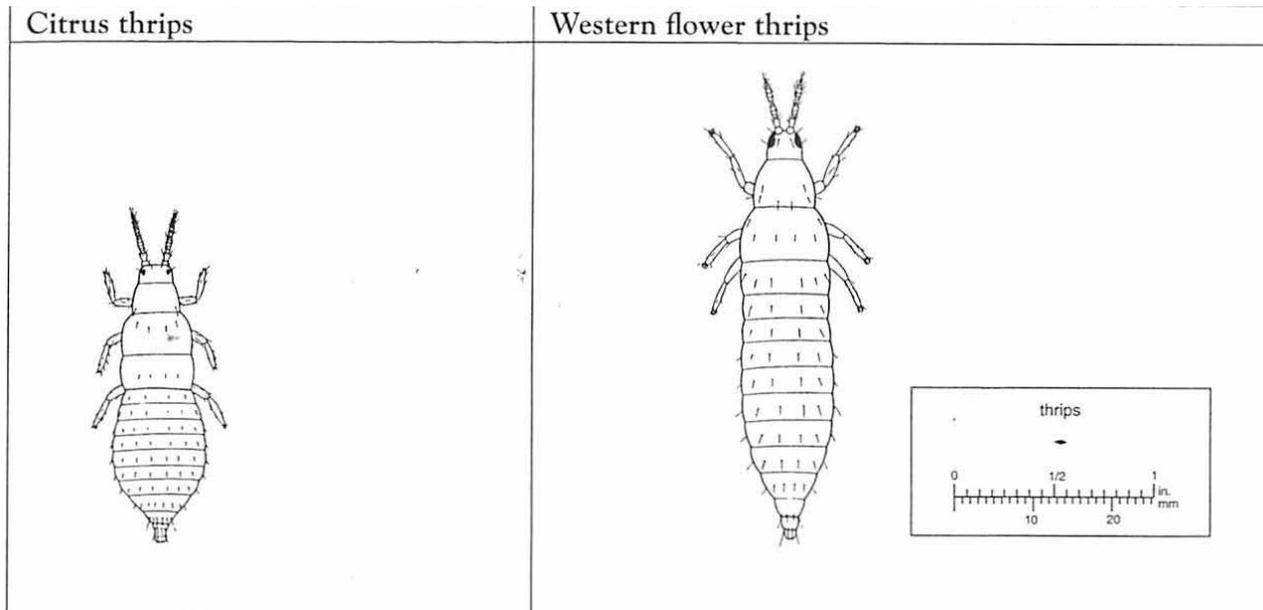


- Start at petal fall and sample 100 fruit 2x per week in each block
- Sample healthy green outside fruit
- Sample between 10 am and 2 pm
- Sample the stem end for 1st and 2nd instars
- Sample from petal fall until the fruit reaches 1 ½ inches
- Calculate the percentage of fruit infested

	High predatory mites >.5/leaf	Low predatory mites <.5/leaf
Navels	10%	5%
Valencias	20%	10%
Mandarins	?	?

How do I tell citrus thrips from flower thrips?

Citrus thrips	Flower thrips
Found on young leaves and fruit	Found among flowers and nectar
Very active, especially during sunny weather	Sluggish and move in an S-shaped pattern – especially the 2 nd instars
Short, plump abdomen, with waist	Longer, cigar-shaped abdomen
No hairs on the tip of the abdomen	Hairs on the tip of the abdomen



1st instar citrus thrips



2nd instar citrus thrips



Adult citrus thrips



1st instar flower thrips



2nd instar flower thrips



Adult flower thrips



Biological Control: (Difficult)

- **Predatory Mite:** *Euseius tularensis*, assists but does not reduce heavy populations below the economic threshold
- **Parasitic wasps:** *Goetheana incerta* (S. Africa), *Ceranisus* species found on sumac in CA but not citrus
- **Thrips predator:** *Franklinothrips orizabensis* for avocado thrips – not effective enough
- **Fungal pathogens:** *Beauveria bassiana* attacking pupae – unsuccessful in the field
- **Decollate snails:** some indication that they lower the pupal stage of thrips

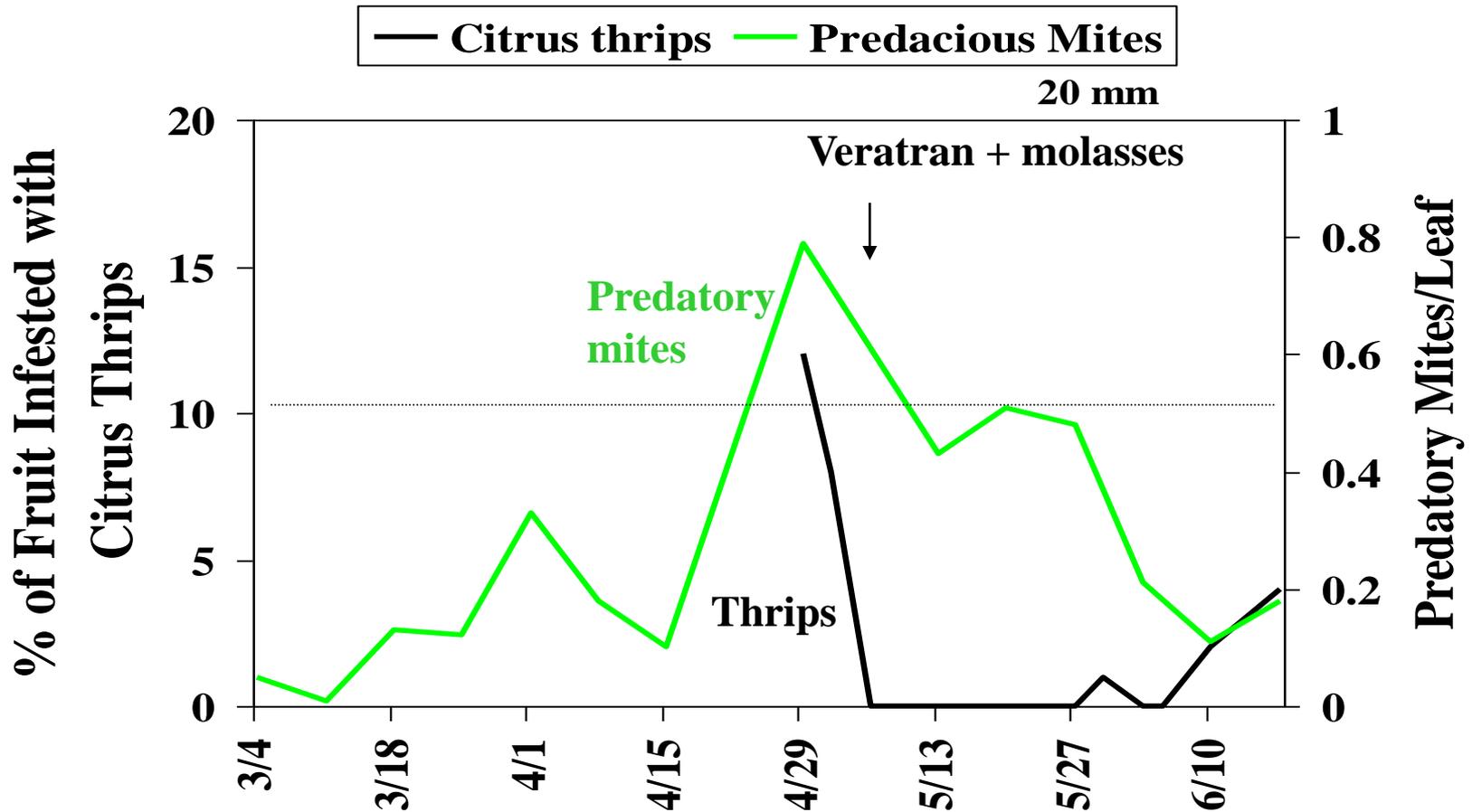
Predatory mite feeding on a thrips



Soft Insecticides are easy on natural enemies

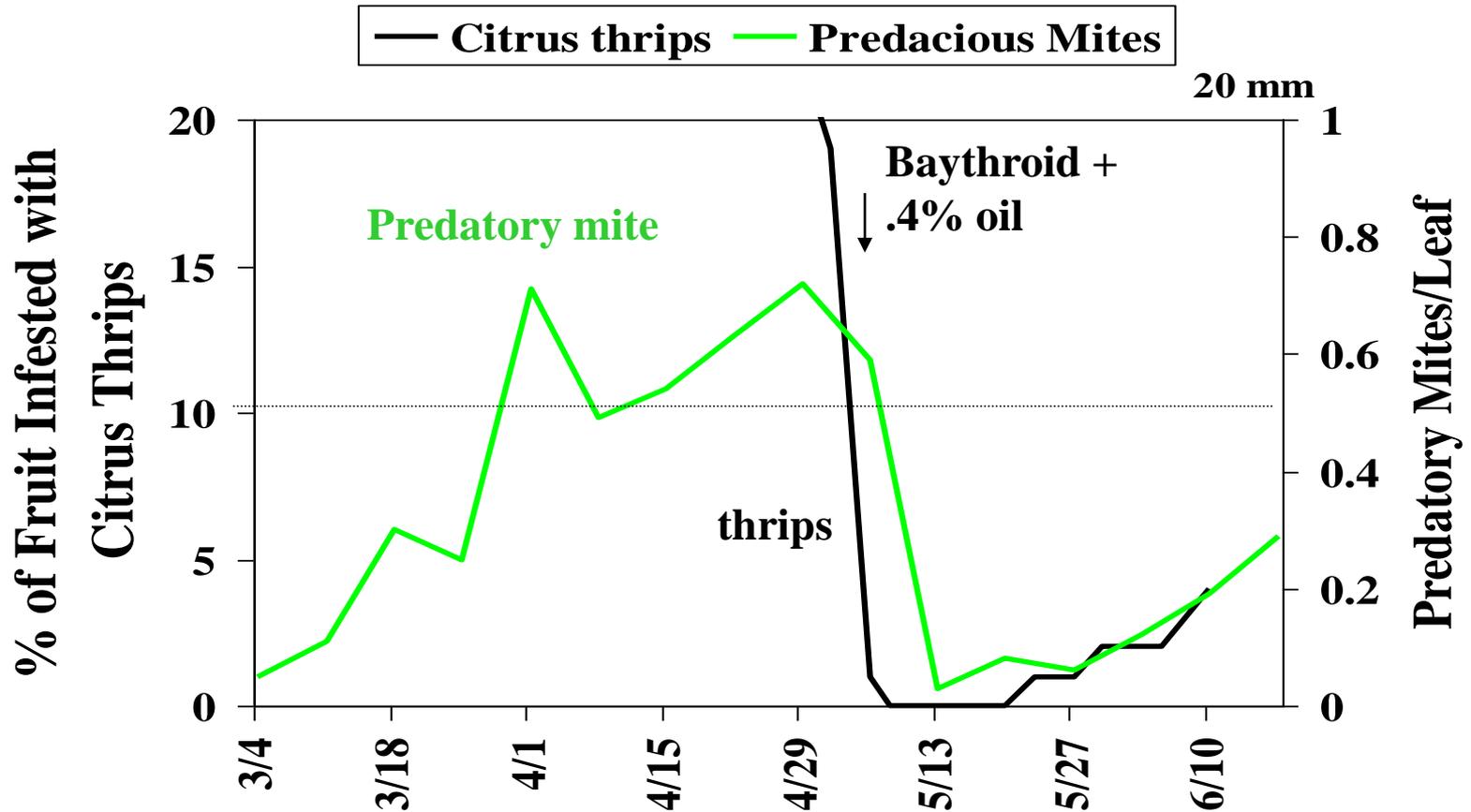
--data from the 1990s

Orchard 4



Broad spectrum Insecticides can knock down predatory mites

Orchard 9



Selectivity of citrus thrips treatments



	MOA	Parasites	Predatory mites	Predatory beetles
OPS and Carb	1a,b	Rate dependent	Resistant	resistant
Pyrethroids	3	Very toxic	Very toxic	Very toxic
Sivanto (flupyradifurone)	4d	Toxic (8 wk)	Soft	Egg prod
Success (spinosad)	5	Soft	Soft	soft
Delegate (spinetoram)	5	Toxic (7 wk)	Toxic (4 wk)	Egg production
Agri-Mek (abamectin)	6	Soft	Toxic (4 wk)	Soft
Exirel (cyantraniliprole)	28	Soft	Soft	Soft
Minecto Pro (cyan + aba)	28+6	Soft	Toxic (4 wks)	Soft

The impact of broad spectrum insecticides is reduced by the fact that the treatments are outside coverage

First Round of Polling Questions

Pesticides Recommended for Control of Citrus Thrips

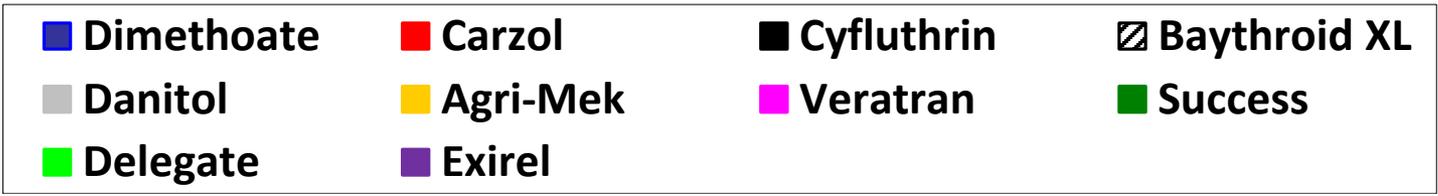
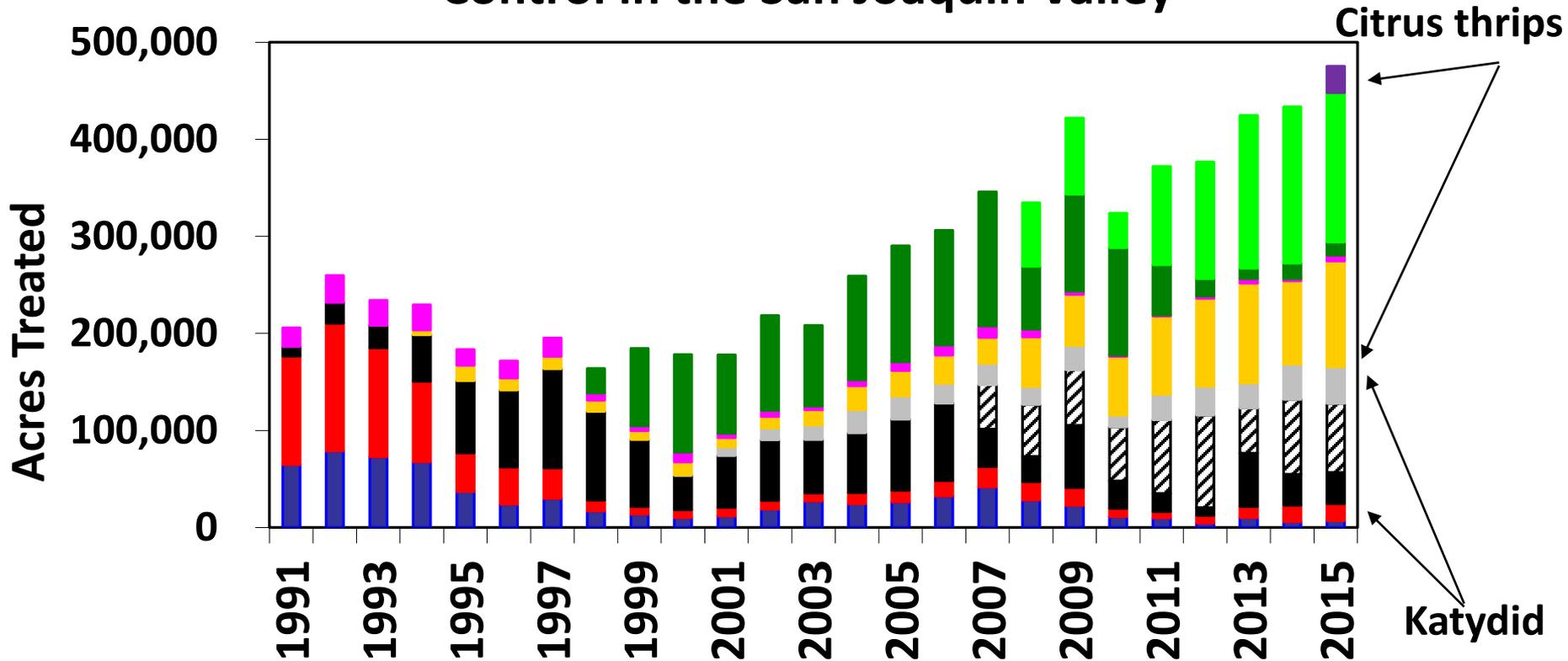
(UC Citrus Pest Management Guidelines -- <http://www.ipm.ucdavis.edu/>)

<u>Trade Name</u>	<u>Common Name</u>	<u>Pesticide Class</u>
Selective Materials:		
Success (Entrust) + oil	spinosad	5
Delegate + oil	spinetoram	5
Agri-Mek + oil	abamectin	6
Exirel + oil	cyantraniliprole	28
Minecto Pro	cyan. + abamectin	28+6
Veratran D + sugar	sabadilla	botanical

Broad-spectrum materials (resistance in the SJV):

Baythroid XL	beta cyfluthrin	3
Danitol 2.4 EC	fenpropathrin	3
Carzol SP	formetanate	1A
Cygon/Dimethoate	dimethoate	1B

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



Citrus Thrips trial 2015

Treatment	Application dates	Rate/acre	% Total Scarring	% Severe Scarring
Untreated control			27.0a	6.1a
Movento + Omni 6E oil	17 Apr, 6 May	10 fl oz + 0.75%	27.0a	5.5a
Sivanto + Omni 6E oil	17 Apr, 4 May	14.0 fl oz + 0.50%	16.0b	3.7abc
Actara + Omni 6E oil	17 Apr, 5 May	5.5 oz + 0.50%	14.3ab	2.4cd
Veratran D	17 Apr, 6 May	15 lbs	14.7b	1.6cdef
Entrust + Omni 6E oil	17 Apr, 6 May	10 oz + 0.50%	6.3cde	1.3cdef
Agri-Flex + Omni 6E oil	17 Apr, 5 May	8.5 oz + 0.50%	7.4cd	1.1cdef
Agri-Mek + Omni 6E oil	17 Apr, 5 May	3.5 oz + 0.50%	6.7cde	0.6ef
Exirel + Omni 6E oil	17 Apr, 5 May	20.5 fl oz + 0.50%	3.2e	0.4f
Delegate + Omni 6E oil	17 Apr, 4 May	6.0 oz + 0.50%	7.4cde	0.3f
Exirel + Omni 6E oil	17 Apr, 5 May	16 fl oz + 0.50%	4.4de	0.1f

Agri-Flex (Agri-Mek + Actara)

Citrus Thrips trial 2016 – 2 treatments: April 19-20 and May 3-4

Treatment	Rate Form/acre	% Severe Scarring
Sevin XLR Plus + Omni 6E oil	3 qt + 0.5%	18.7a
Bexar + Dyne-Amic	27 fl oz + 0.25%	14.4b
Untreated control		13.2bc
Sevin XLR Plus + Omni 6E oil	5 qt + 0.5%	11.2cd
Micromite 2L + Omni 6E oil	10 fl oz + 0.5%	6.0e
PQZ + Dyne-Amic	6.4 fl oz	4.7bcd
Delegate WG + Omni 6E oil	6 oz + 0.5%	1.3f
Minecto Pro + Omni 6E oil	12 fl oz + 0.5%	1.0f
Exirel + Omni 6E oil	16 fl oz + 0.5%	0.7f

Minecto Pro (Agri-Mek + Exirel)

PQZ - NNI0101: pyrifluquinazon

Bexar: tolfenpyrad

Citrus Thrips trial 2017 – 2 treatments: April 25-26 and May 9-10

Formulation	Rate form/ acre	% Total Scarring	% Severe Scarring
Fujimite x 2	48 oz	33.0a	9.5a
Control		18.3b	4.1b
Bexar x 2	27 oz	5.9c	1.0c
Delegate x 2	6 oz	2.6d	0.8cd
Agri-Mek x 2	4.25 oz	2.3d	0.4cd
PQZ x 2	6.4 oz	2.4de	0.1cd
Exirel x 2	16 oz	1.7def	0.1d
Minecto Pro x 2	12oz	0.9f	0.0d
Minecto Pro x 2	8oz	0.4f	0.0d

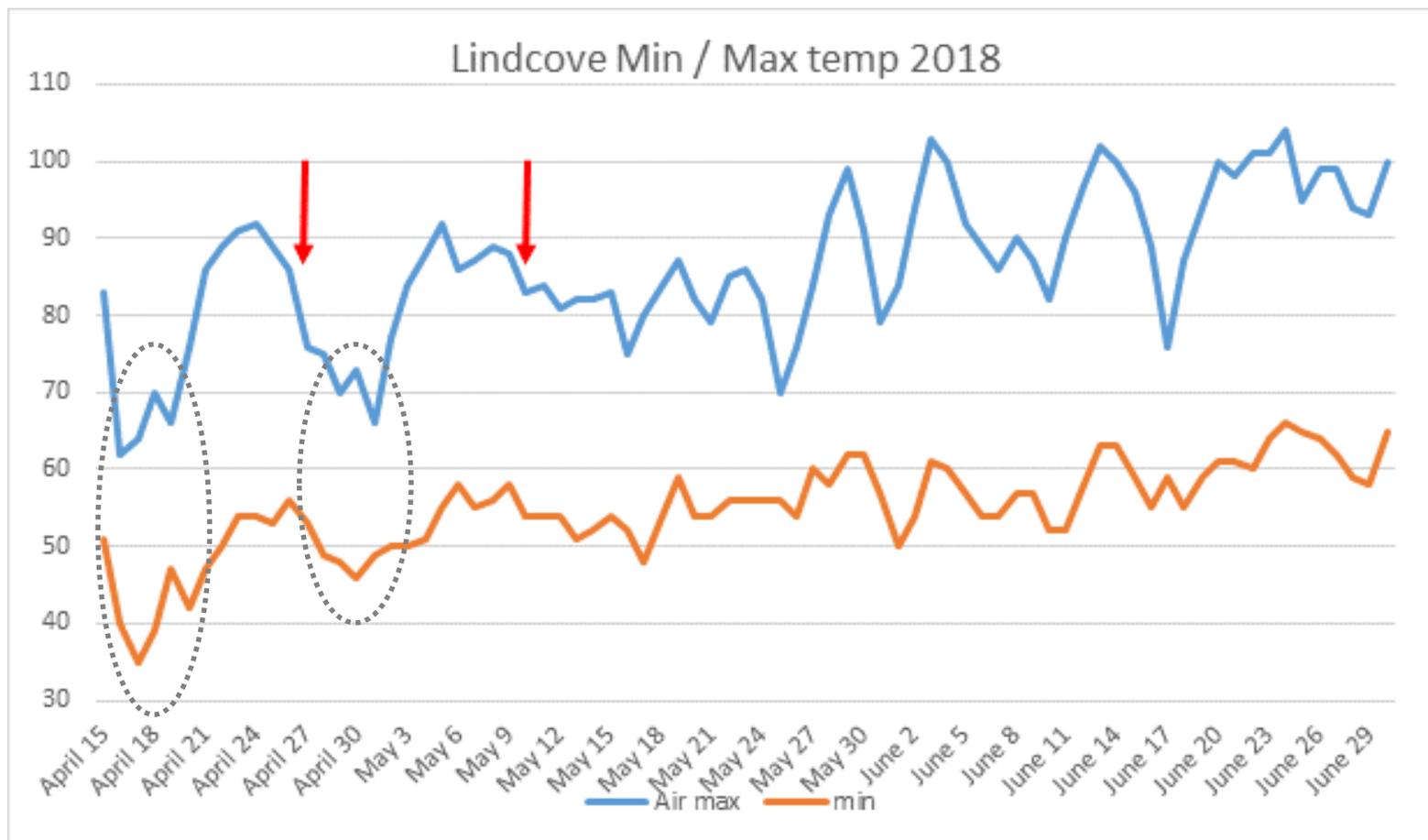
Formulation	Rate form/ acre	% Total Scarring	% Severe Scarring
Control		17.8	2.7a
Delegate x2	6 oz	5.2	0.7ab
Movento x2	10oz	5.3	0.3ab
Sivanto Prime x2	14 oz	8.3	0.0ab

Citrus Thrips trial 2018 – 2 treatments: April 26 and May 10

0.5% Omni 6E oil added to all treatments

Treatment	Rate Form/acre	% Severe Scarring
Untreated control		34.6g
Sivanto HL x2	7 oz	28.2fg
Sivanto Prime x2	14 oz	27.2fg
Delegate x2	6 oz	6.1d
Delegate	6 oz	4.3cd
Agri-Mek	4.25 fl oz	
Delegate	6 oz	4.2cd
Exirel	20.5 fl oz	
PQZ x2	6.4 fl oz	4.1cd
Minecto Pro	12 fl oz	3.0bc
Delegate	6 oz	
Delegate	6 oz	1.1ab
Minecto Pro	12 fl oz	
Minecto Pro x2	12 fl oz	0.7a

Thrips lower developmental threshold: 59°F

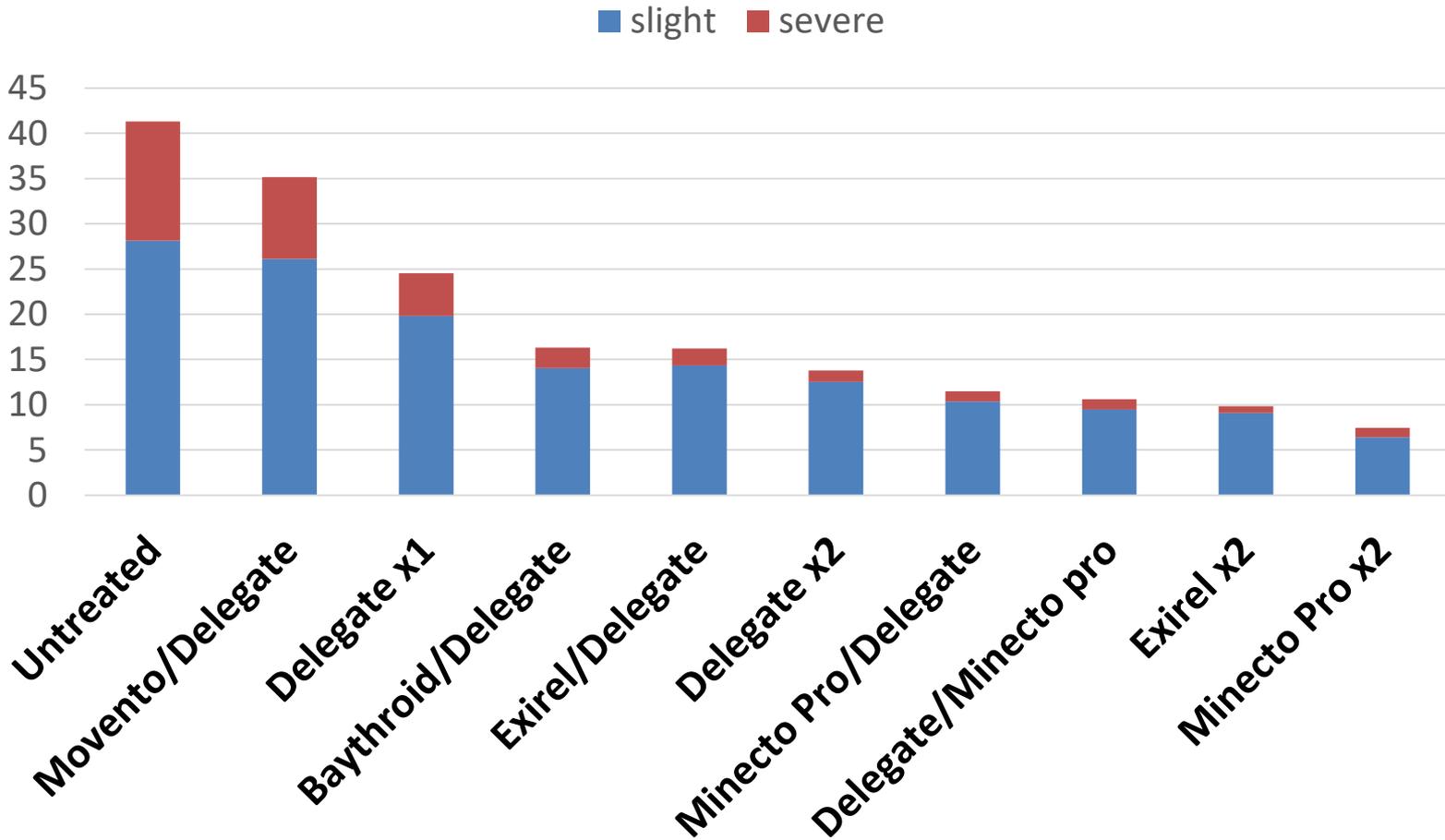


Thrips Degree days when temp is low $(48+68/2) - 59 = 0$ DD

Tree DD = 10 DD

Degree days at higher temps: $(54+90/2)-59 = 13$ DD

2016 Improving efficacy and managing resistance by rotating insecticides– 2 treatments at petal fall and 2 weeks later



Thrips densities vs. scarring at harvest (*Citrusformatics* database 2003-12)

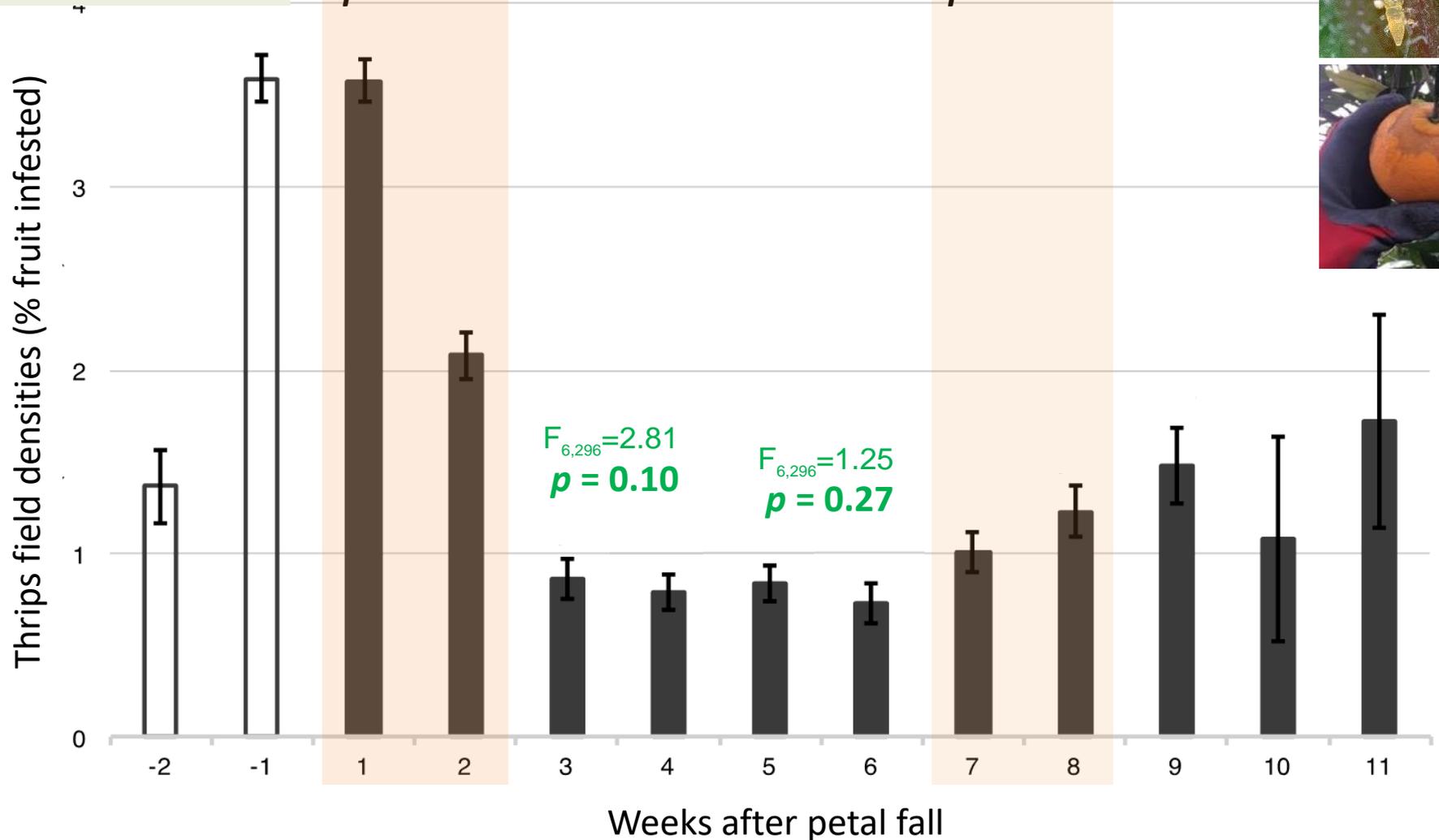
UC Davis Entomology

Dr. Jay Rosenheim

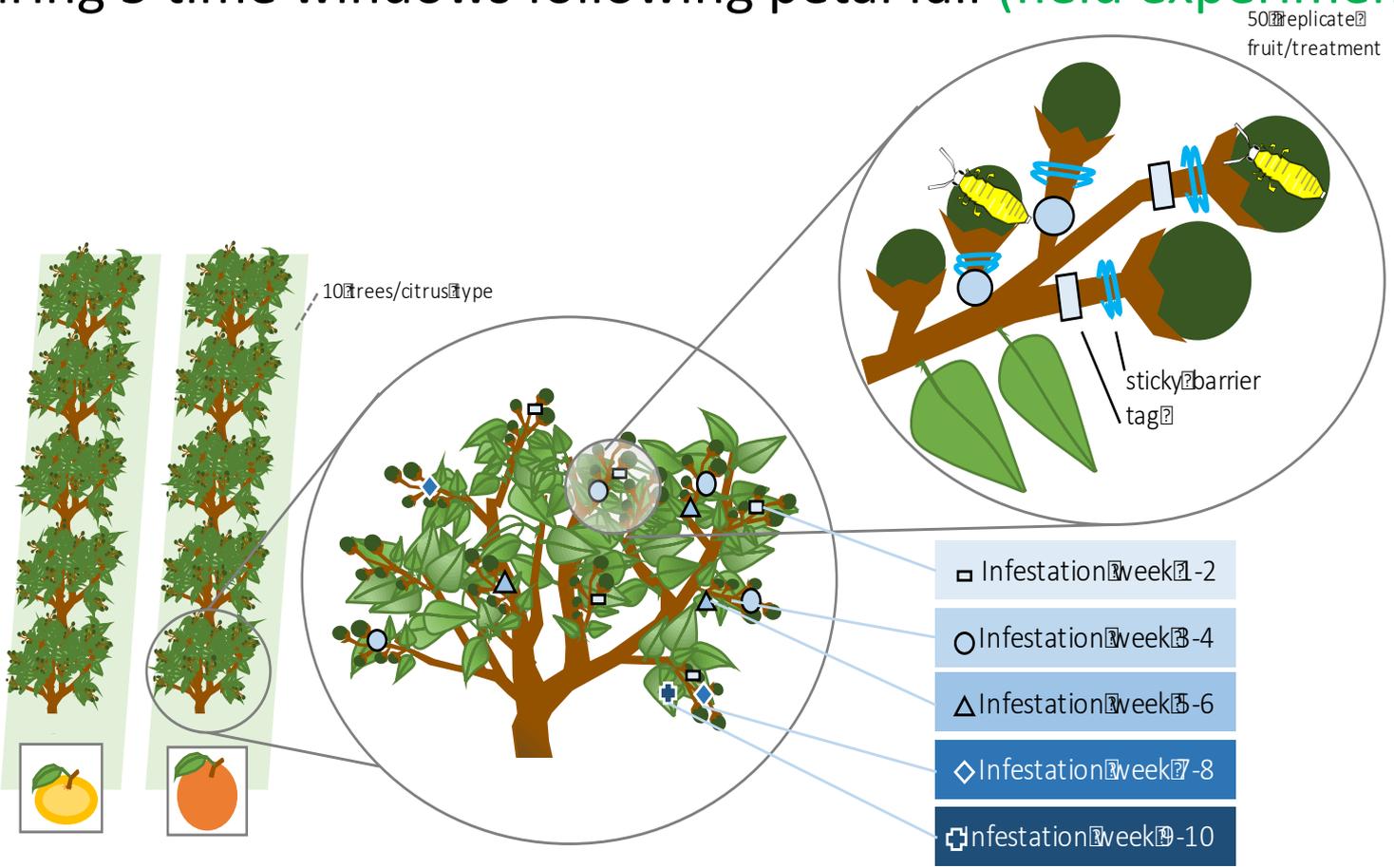
Dr. Bodil Cass

Hanna Kahl

Tobias Mueller



Experiment 1: Quantify the impact of **citrus thrips** on fruit scarring during 5 time windows following petal fall (**field experiment 2019**).



Experiment 2: Survey thrips densities on different citrus species in the 10 weeks after petal fall (**field experiment 2018-2020**).

- Navel oranges (*C. sinensis*)
- Mandarin oranges (*C. reticulate*)
- Clementines (*C. clementina*)
- Satsumas (*C. unshiu*)
- Tangelo (*C. tangelo*)

Insecticides that work the best when thrips pressure is heavy:

Delegate

Exirel or Minecto Pro

Insecticides that control thrips when thrips pressure is light-moderate:

Veratran

Success

Agri-Mek

Sivanto

PQZ

Insecticides with resistance issues

Carzol

Dimethoate

Baythroid

Danitol

Citrus Thrips Resistance

Thrips develop resistance easily

1950s: DDT

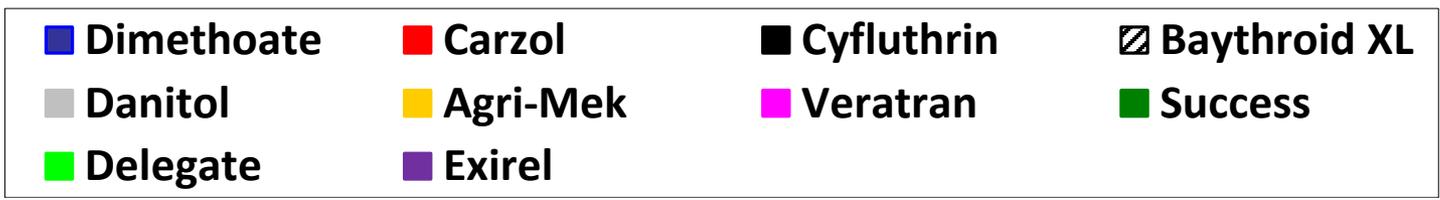
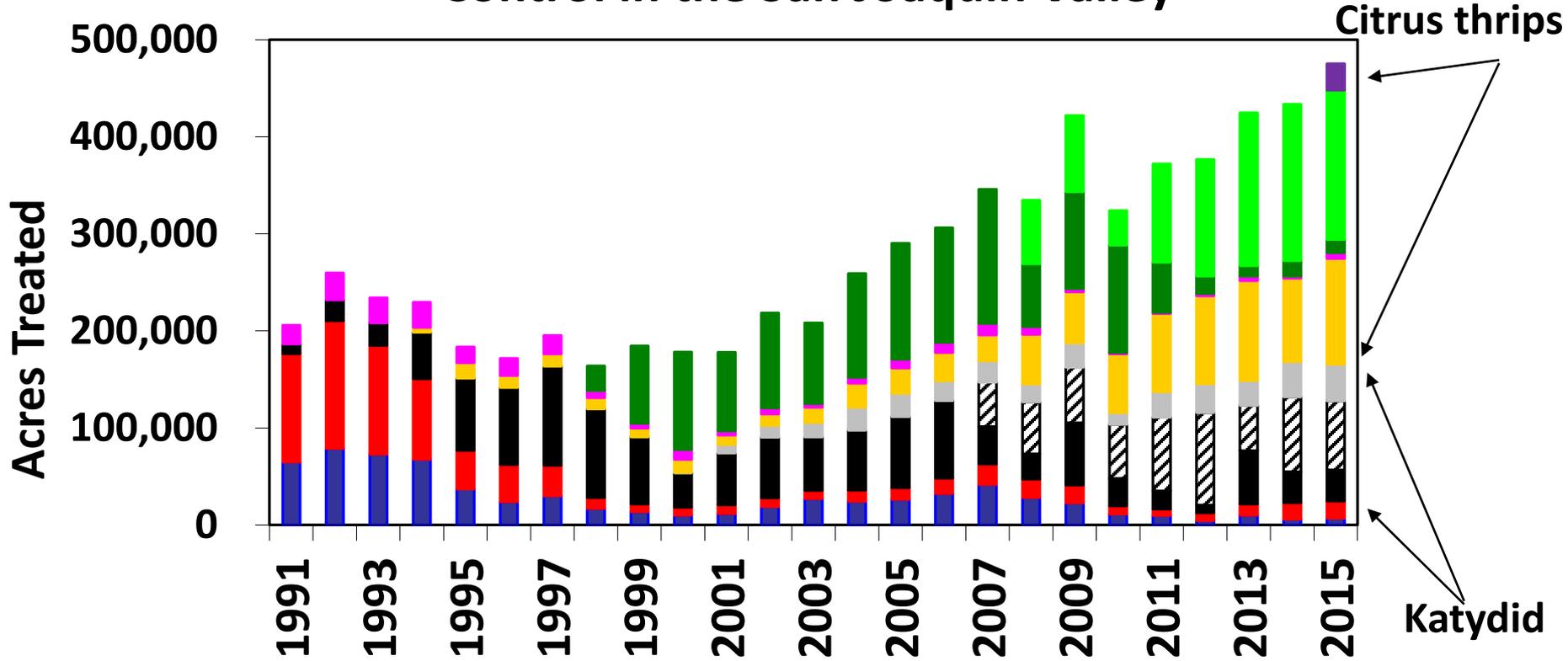
1960s: Organophosphates (Dimethoate)

1970s: Carbamates (Carzol)

1990s: pyrethroids (Baythroid)

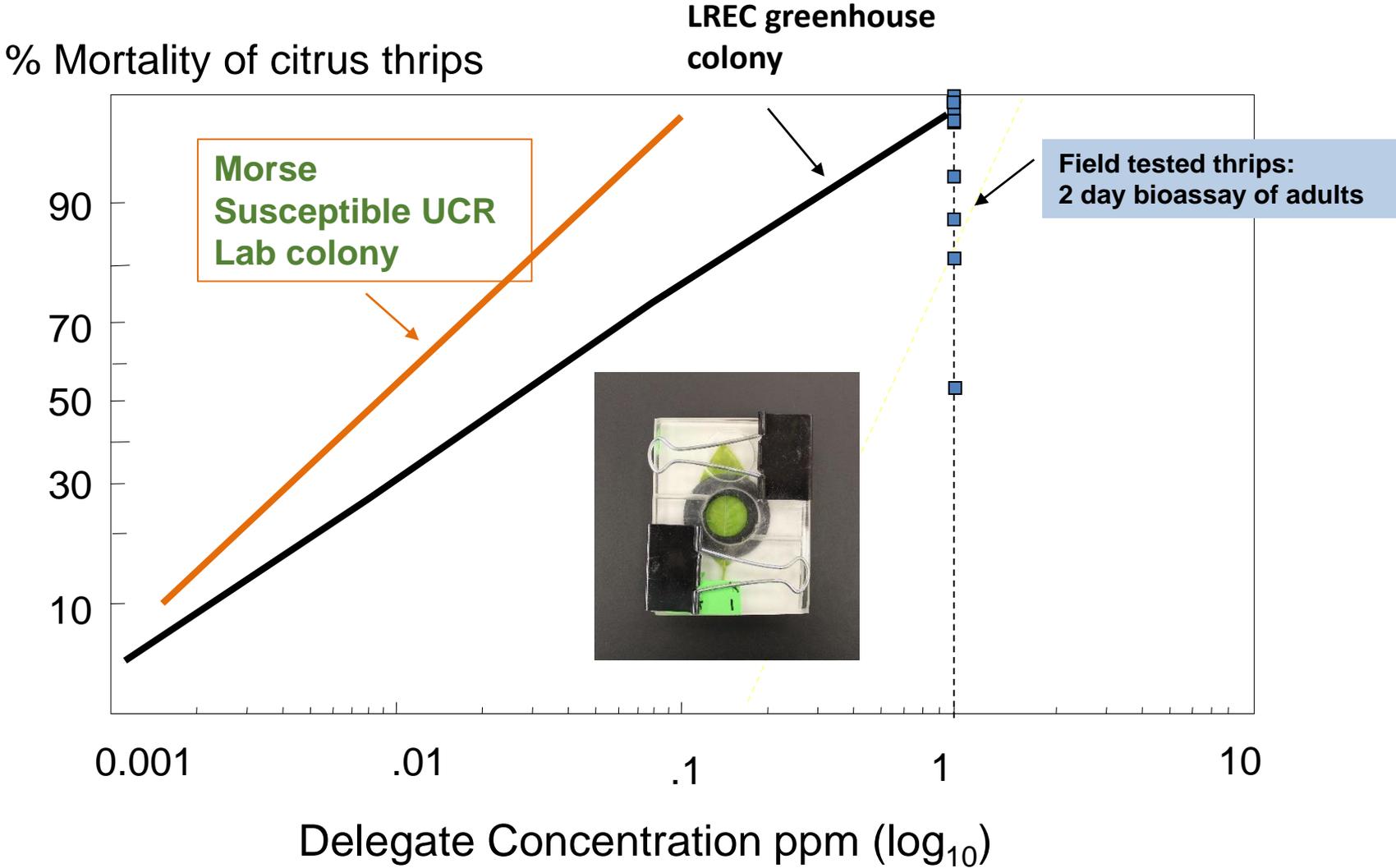
2010s: Delegate and Success resistance in blueberries

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



Mortality at 1 ppm	100%	85-99%	<85%
# sites tested in 2017	3	3	6

Delegate field rate = 45-56 ppm
6 oz in 200-250 gpa



Pesticides Recommended for Control of Citrus Thrips

(UC Citrus Pest Management Guidelines -- <http://www.ipm.ucdavis.edu/>)

Trade Name	Common Name	Pesticide Class	yr reg.
Selective Materials:			
Success (Entrust) + oil	spinosad	5	1998
Delegate + oil	spinetoram	5	2008
Agri-Mek + oil	abamectin	6	1994
Exirel + oil	cyantraniliprole	28	2015
Minecto Pro	cyan. + abamectin	28+6	2018
Veratran D + sugar	sabadilla	botanical	1980s
Broad-spectrum materials (resistance in the SJV):			
Baythroid XL	beta cyfluthrin	3	1980s
Danitol 2.4 EC	fenpropathrin	3	2001
Sivanto Prime	pyrifluquinazone	4d	2015
Carzol SP	formetanate	1A	1970s
Cygon/Dimethoate	dimethoate	1B	1960s

Thrips spray recommendations

- Use outside coverage and 200 gpa (cut back the blower wind velocity)
- Timing is important – treat as the 1st instars are emerging
- Additives
 - Add oil to Delegate, Success, Entrust, Exirel, Minecto Pro
 - Add sugar or molasses to Veratran (do not add nutritionals, check pH)
- Apply insecticides only as needed
- Rotate insecticide chemistries to avoid resistance

Second Round of Polling Questions