Navel Orangeworm- What Happened in 2017 & How to Prevent it in 2018



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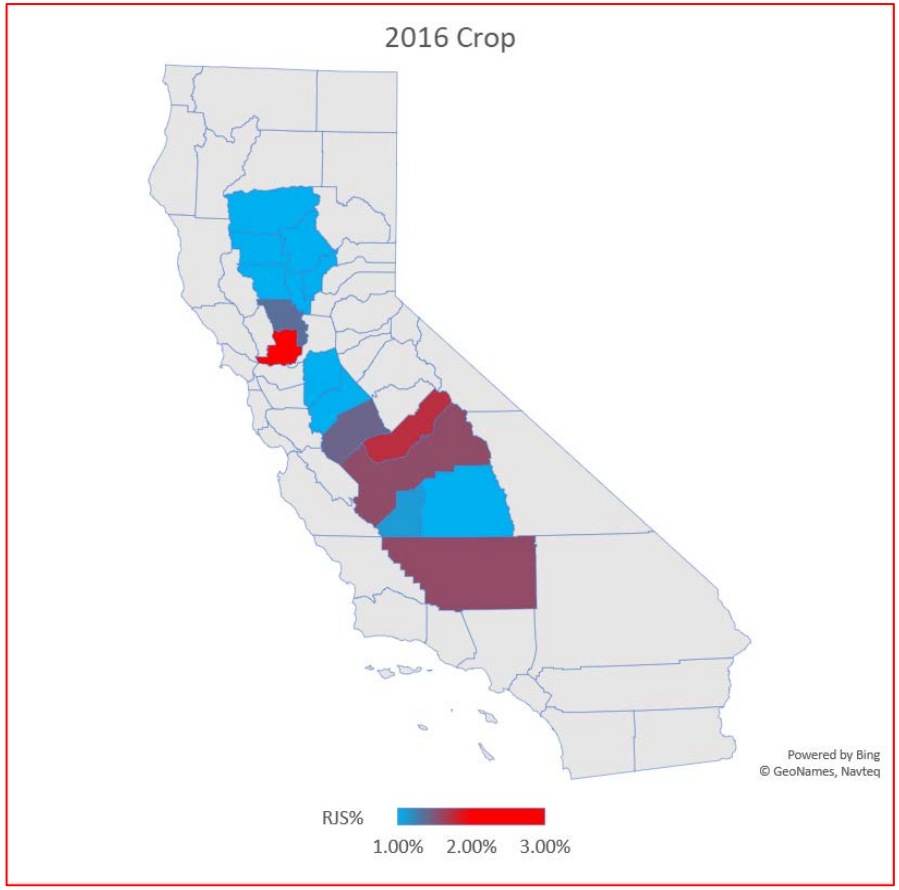
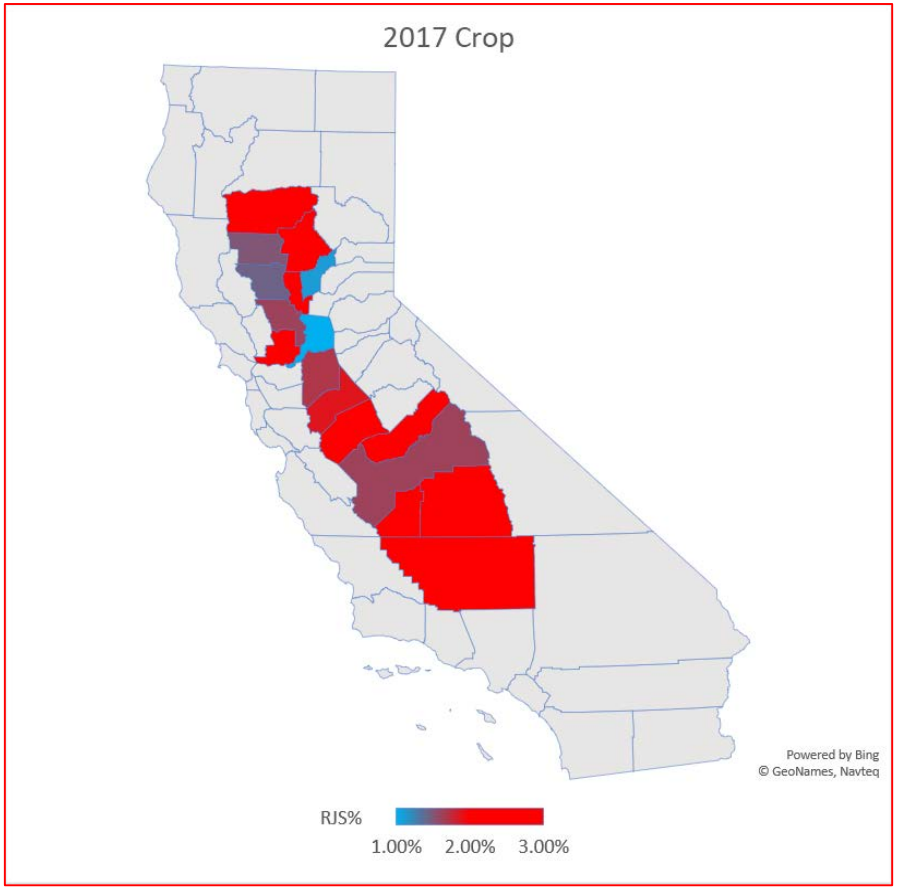
7 Feb., 2018
NSJV Almond Day, Modesto, CA

Overview of 2017 Season-NOW Damage

Nonpareil Reject Levels 2016 vs 2017





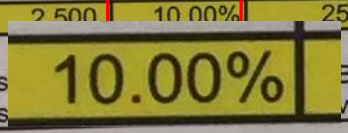
Slide Courtesy: Blue Diamond

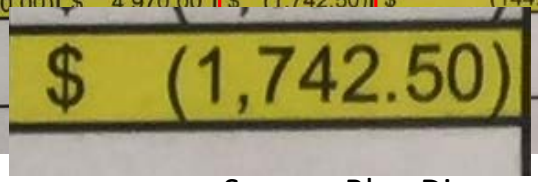
Nonpareil Reject Levels

Comparative Values at Varying Reject Levels

	Yield		2,500							
	Price		$ 2.50							
							Total Premium			
TMS	RJS%	RJS Wt	Field Loss	TGM	Base	Rate	Amount	Total Value	Loss	Incremental Loss
2,500	0.00%	0.0	0.0	2500.0	$ 6,250.00	$ 0.1850	$ 462.50	$ 6,712.50		
2,500	1.00%	25.0	25.0	2450.0	$ 6,125.00	$ 0.1750	$ 428.75	$ 6,553.75	$ (158.75)	
2,500	2.00%	50.0	50.0	2400.0	$ 6,000.00	$ 0.1150	$ 276.00	$ 6,276.00	$ (436.50)	$ (277.75)
2,500	3.00%	75.0	75.0	2350.0	$ 5,875.00	$ 0.0500	$ 117.50	$ 5,992.50	$ (720.00)	$ (283.50)
2,500	4.00%	100.0	100.0	2300.0	$ 5,750.00	$ 0.0450	$ 103.50	$ 5,853.50	$ (859.00)	$ (139.00)
2,500	5.00%	125.0	125.0	2250.0	$ 5,625.00	$ 0.0350	$ 78.75	$ 5,703.75	$ (1,008.75)	$ (149.75)
2,500	6.00%	150.0	150.0	2200.0	$ 5,500.00	$ 0.0250	$ 55.00	$ 5,555.00	$ (1,157.50)	$ (148.75)
2,500	7.00%	175.0	175.0	2150.0	$ 5,375.00	$ 0.0150	$ 32.25	$ 5,407.25	$ (1,305.25)	$ (147.75)
2,500	8.00%	200.0	200.0	2100.0	$ 5,250.00	$ 0.0050	$ 10.50	$ 5,260.50	$ (1,452.00)	$ (146.75)
2,500	9.00%	225.0	225.0	2050.0	$ 5,125.00	$ (0.0050)	$ (10.25)	$ 5,114.75	$ (1,597.75)	$ (145.75)
2,500	10.00%	250.0	250.0	2000.0	$ 5,000.00	$ (0.0150)	$ (30.00)	$ 4,970.00	$ (1,742.50)	$ (144.75)

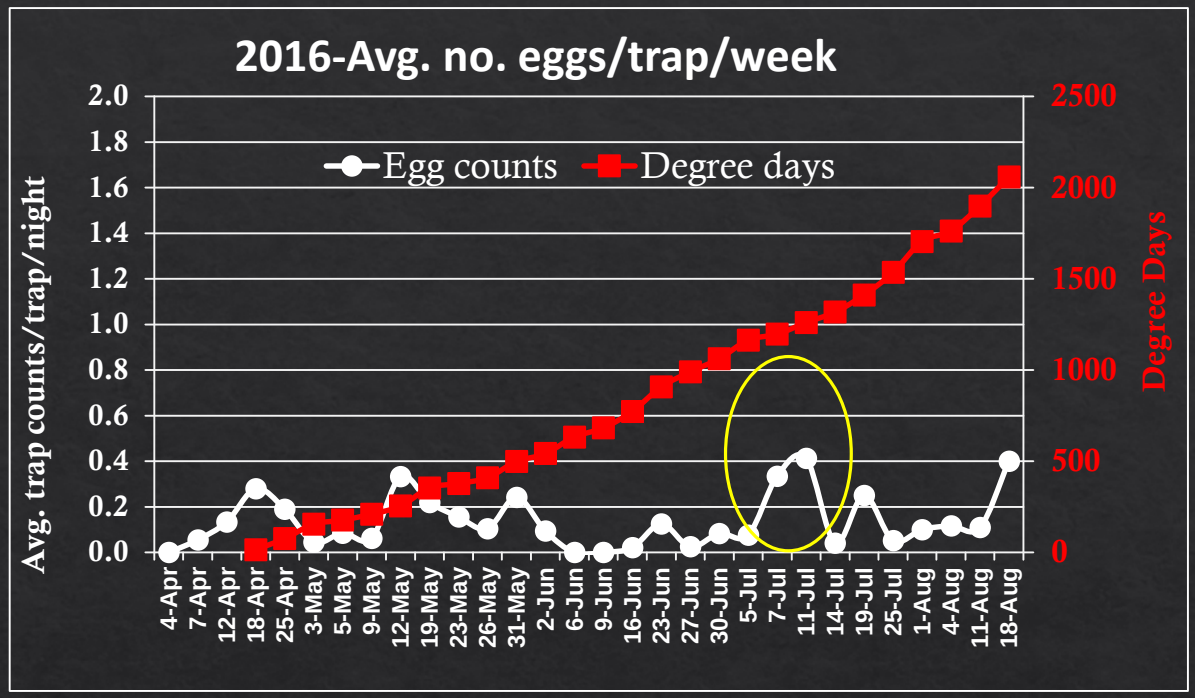
Assumes Broken and Foreign Material = $.055
Assumes very.

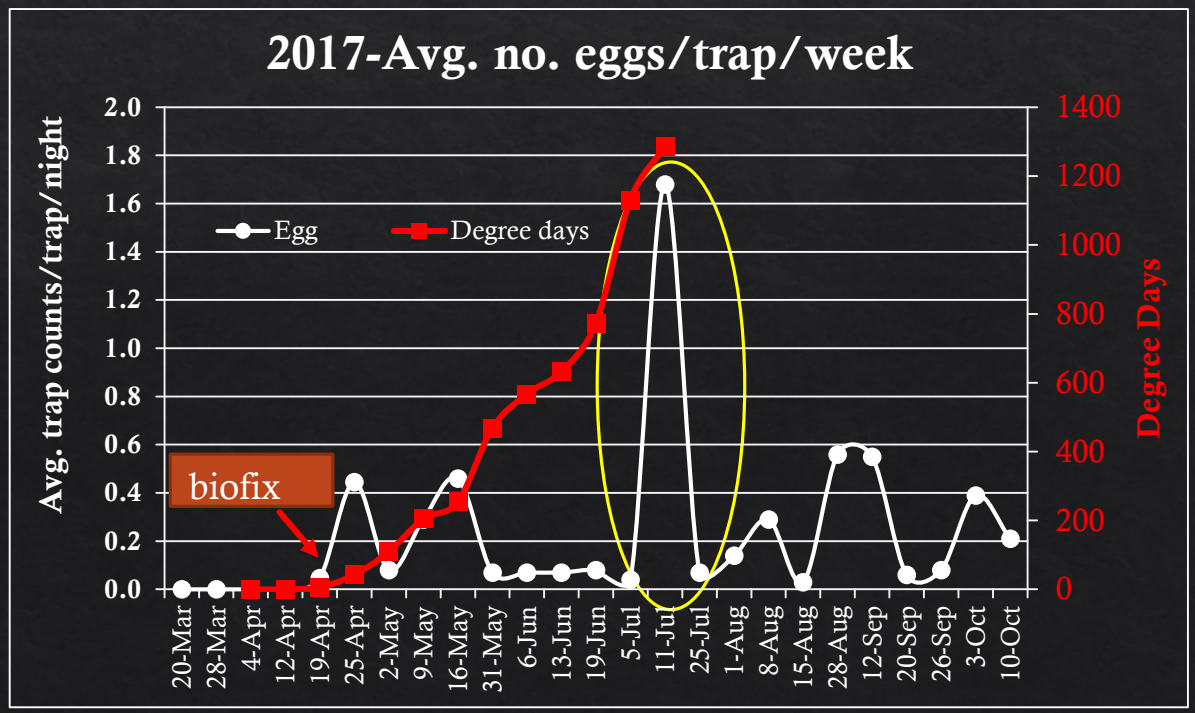




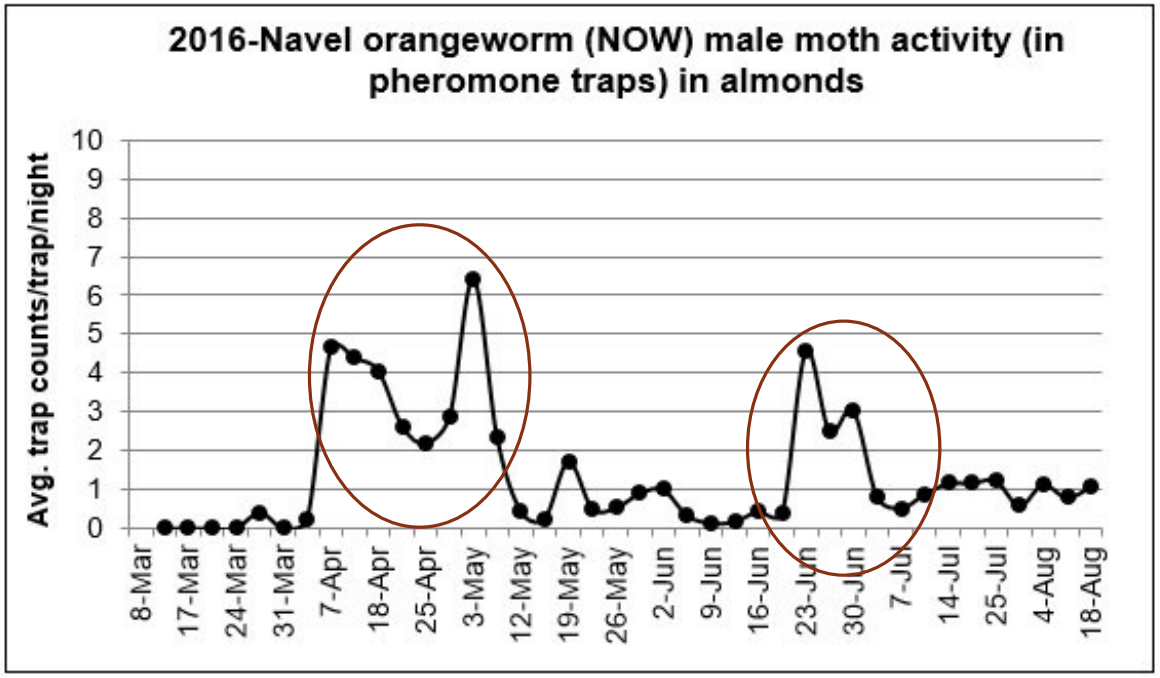
Source: Blue Diamond

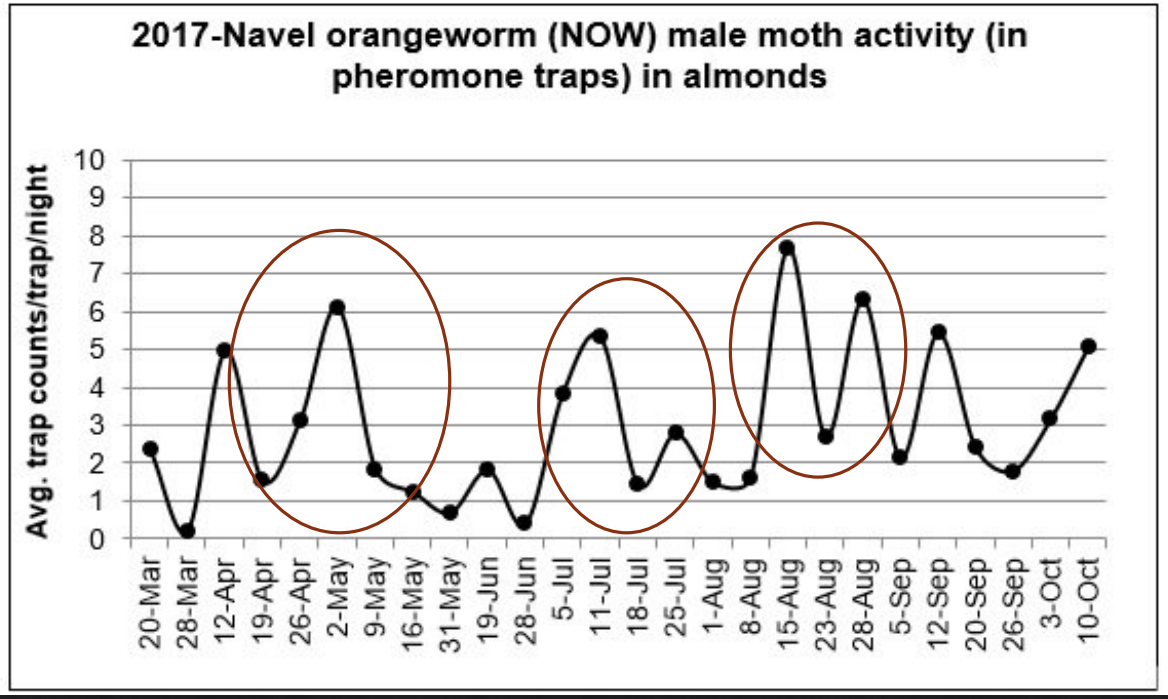
NOW egg laying activity: 2016 *vs.* 2017





NOW male moth activity: 2016 *vs.* 2017





2017-Potential Reasons for High NOW Year

- Poor winter sanitation
- Contiguous habitat for NOW

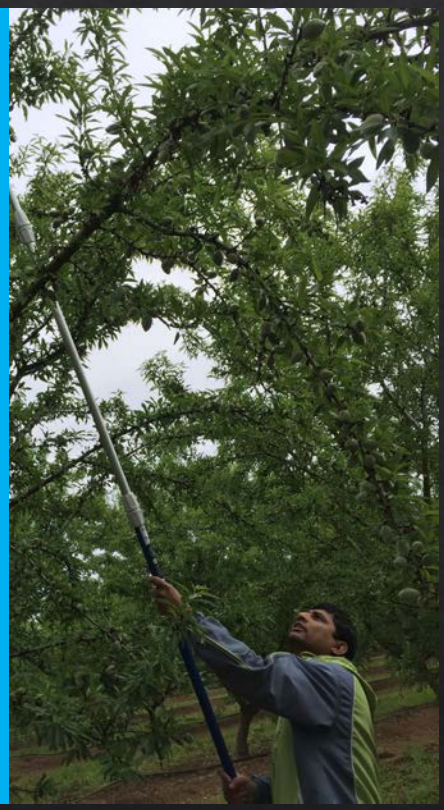
  (>2 million acres)
- Warm summer night temperatures

  (39 days of 100+ temperature in Modesto)
- Earlier third flight than normal years

Source: Almond Almanac 2016, Almond Board of CA

How to Prevent it 2018

1. Effective monitoring
2. Orchard sanitation
3. Early harvest
4. Mating disruption
5. Insecticide/ combination



How to Prevent it 2018

Effective Monitoring

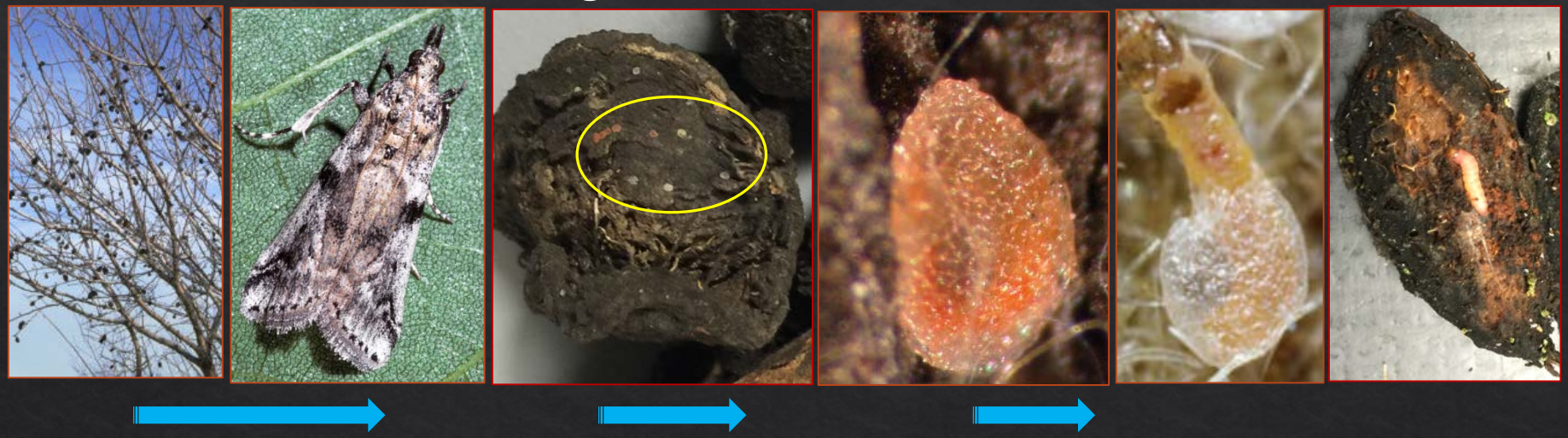
- Egg traps/female-traps
- Pheromone traps
- Harvest samples
- Mummy nut samples
- Orchard history

How to Prevent it 2018- Management Options

1. Orchard sanitation
2. Early harvest
3. Mating disruption
4. Insecticide/ combination

NOW Life Cycle

1st generation on mummies



2nd-4th generations on fresh nuts

1. Orchard Sanitation

Foundation for NOW management

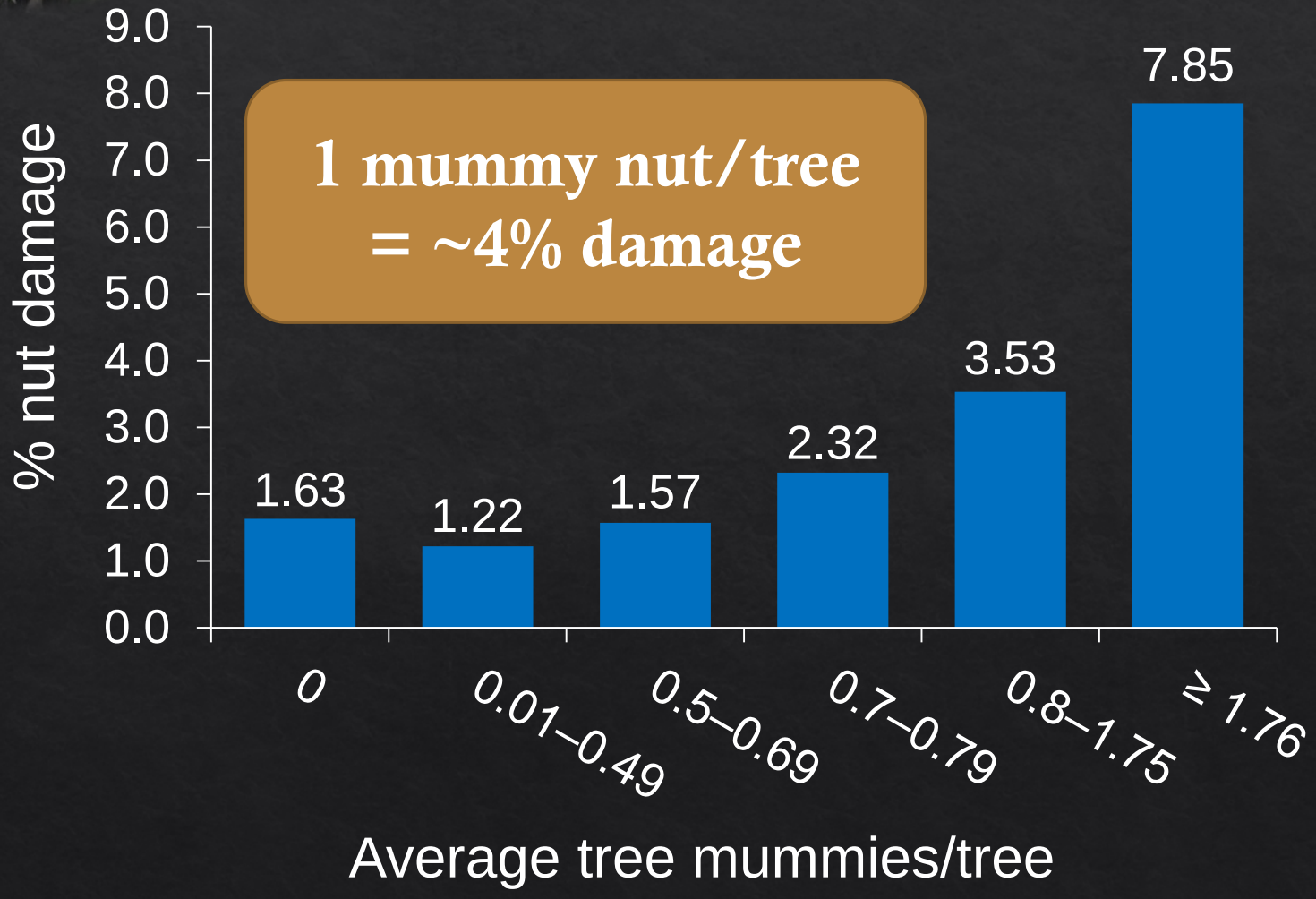
Mummy nuts :

- Harbor the overwintering larvae
- serve as the only resource for egg laying by first generation moths

NOW eggs on tree mummies

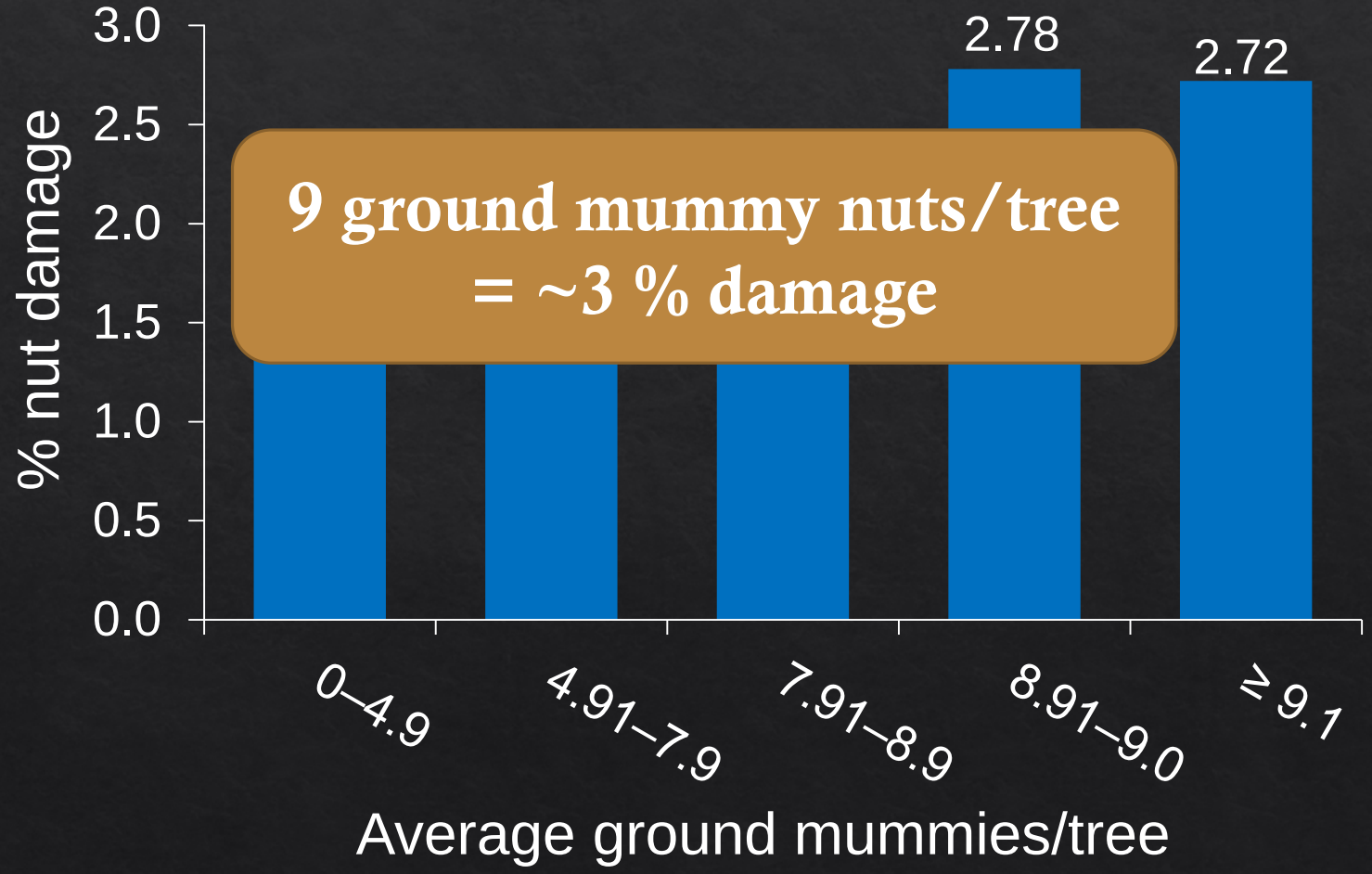
Multiple larvae in a mummy nut

Mummy nuts vs. % damage by NOW



Source: Higbee and Siegal 2009

Mummy nuts vs. % damage by NOW



Source: Higbee and Siegal 2009

1. Orchard Sanitation

1. Orchard Sanitation

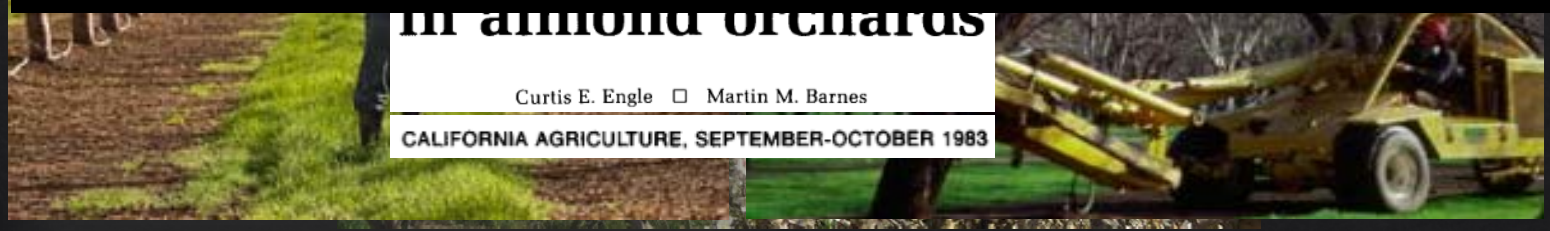
Sanitation:

- Removal of mummy nuts from trees **by Feb. 1**
- **Destroy nuts by March 15**
- **<2 mummies/tree**

(Sacramento and upper San Joaquin Valleys)

- **0.2 (tree mummies/tree) and 8 (ground mummies/tree)**

(lower San Joaquin Valley)



2. Early Harvest

- **Harvest early before the 3rd generation eggs hatch.**
- **Harvest when 100% of nuts at 6-8 ft height are at hullsplit**

NOW male captures in traps

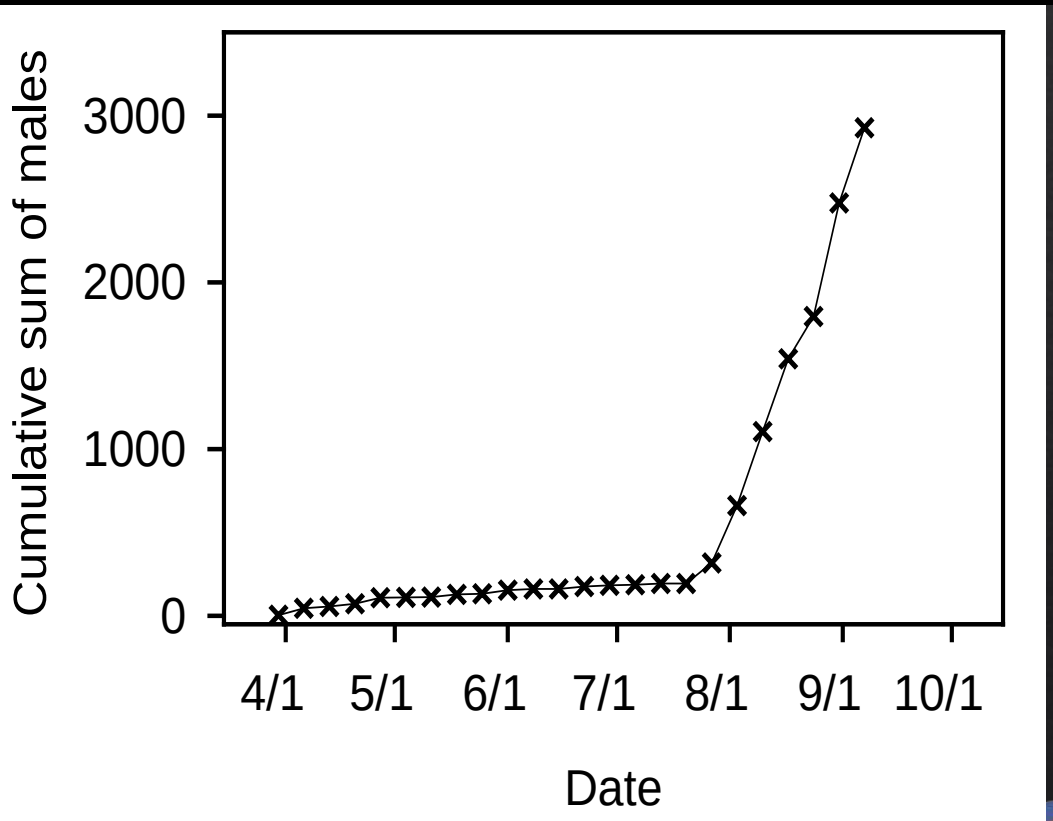
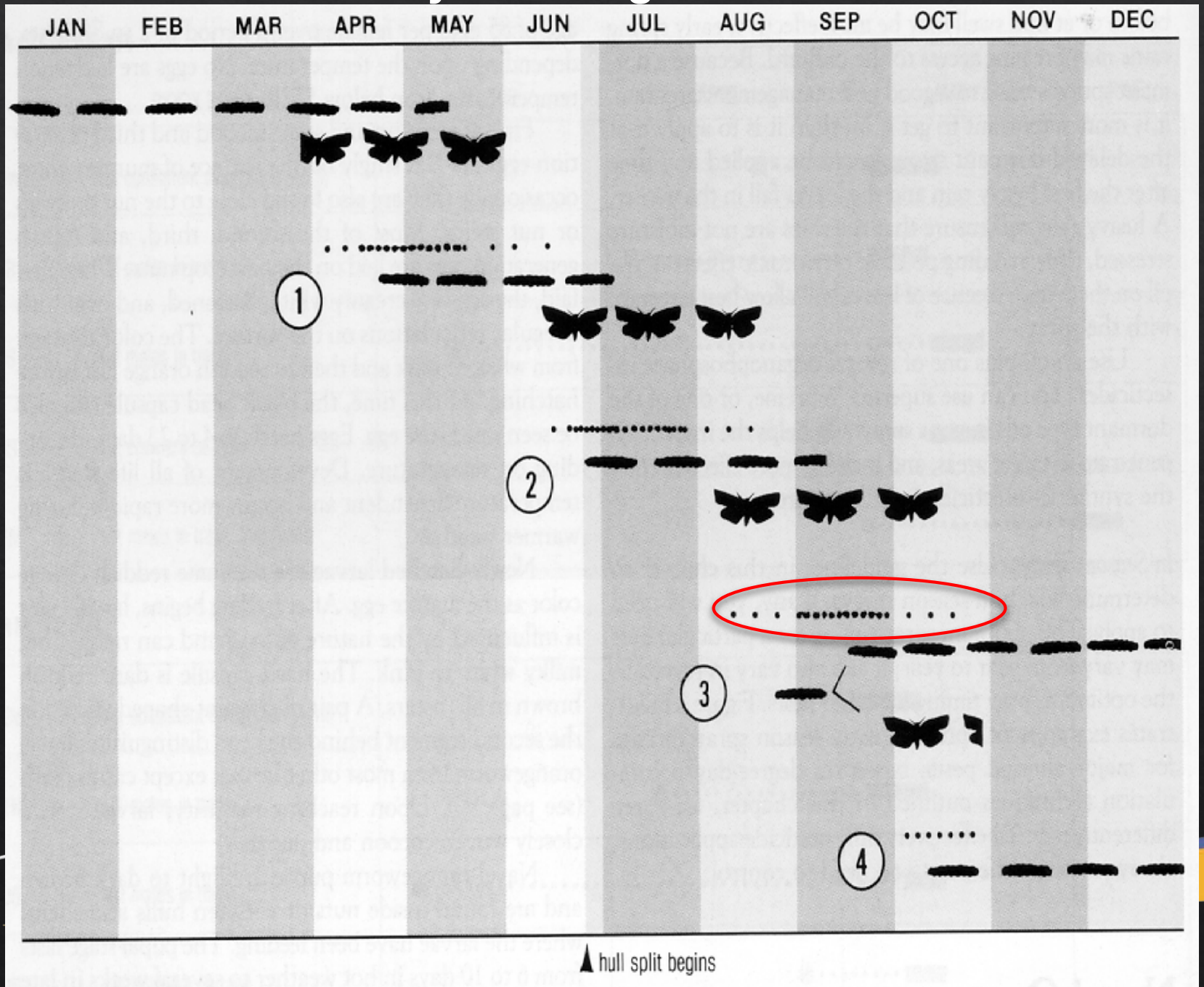
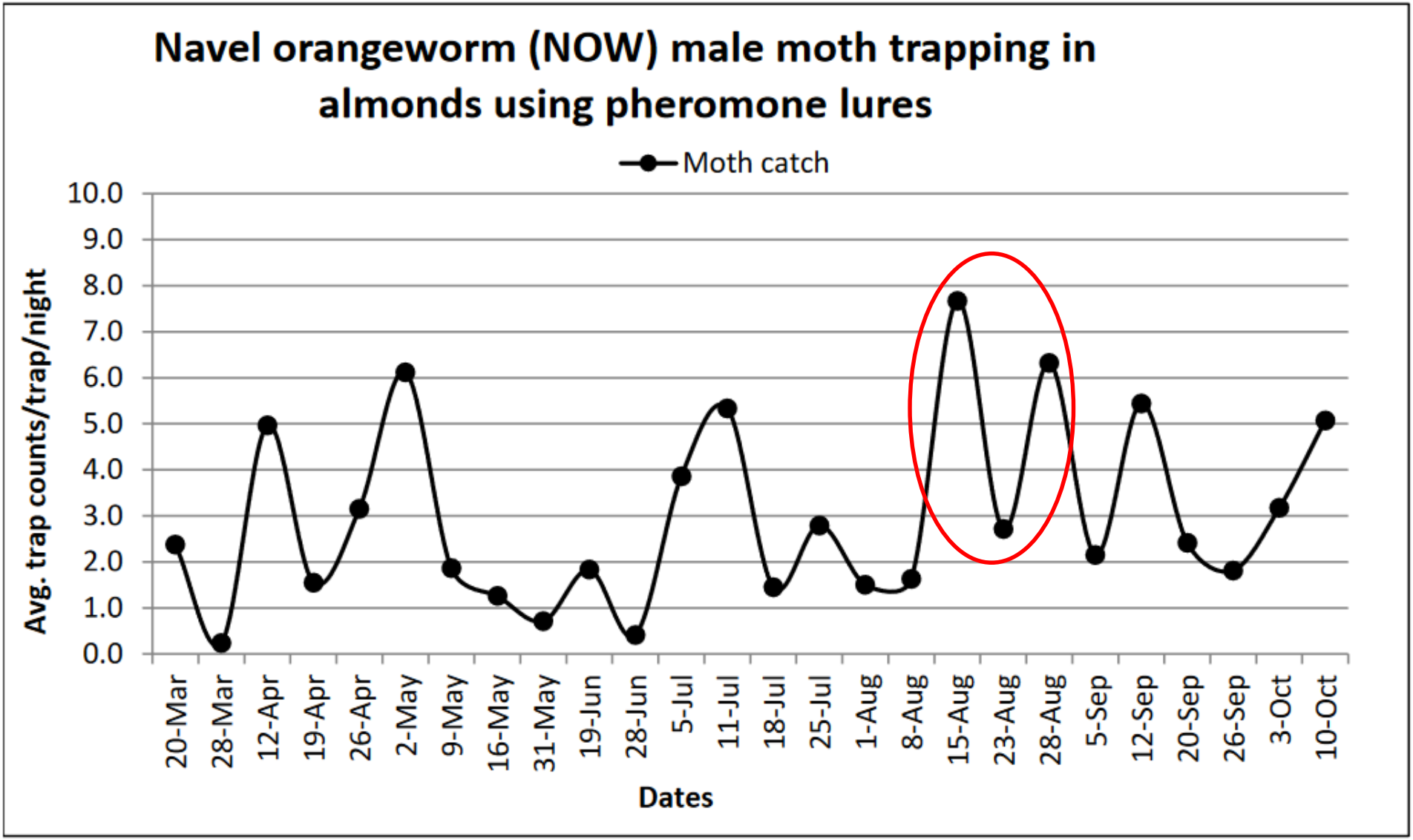


Fig. from Chuck Burks

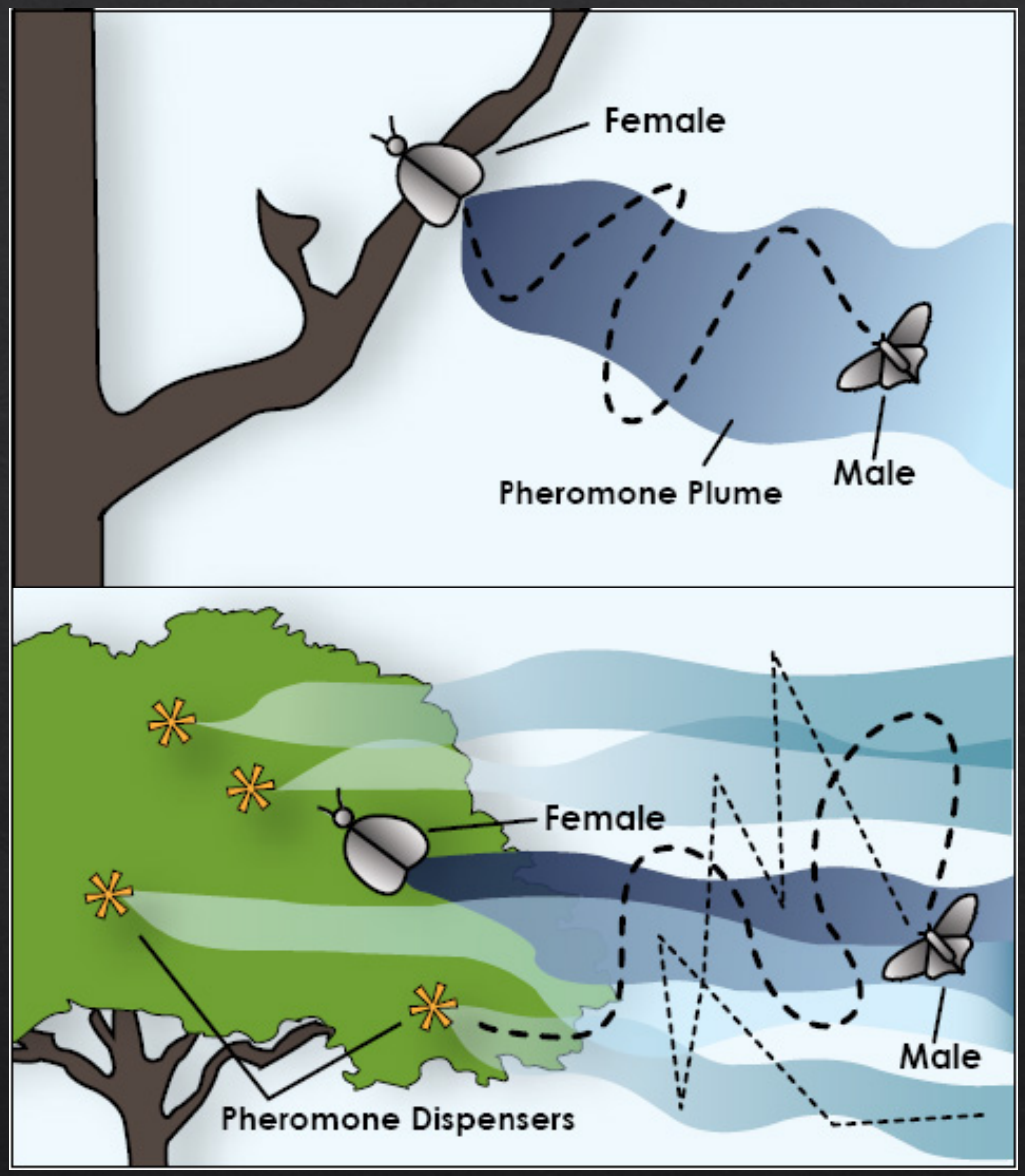
NOW life cycle and generations in CA



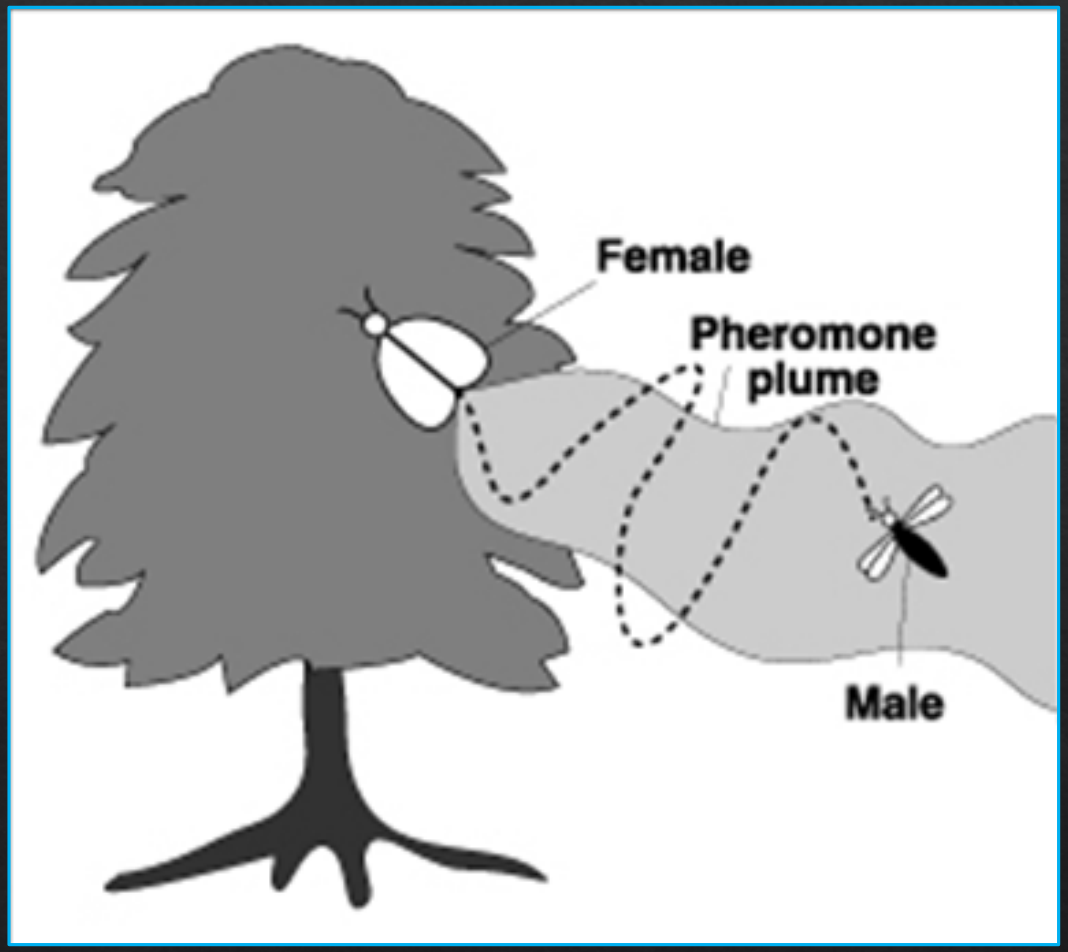
Navel Orangeworm (NOW) Male-2017



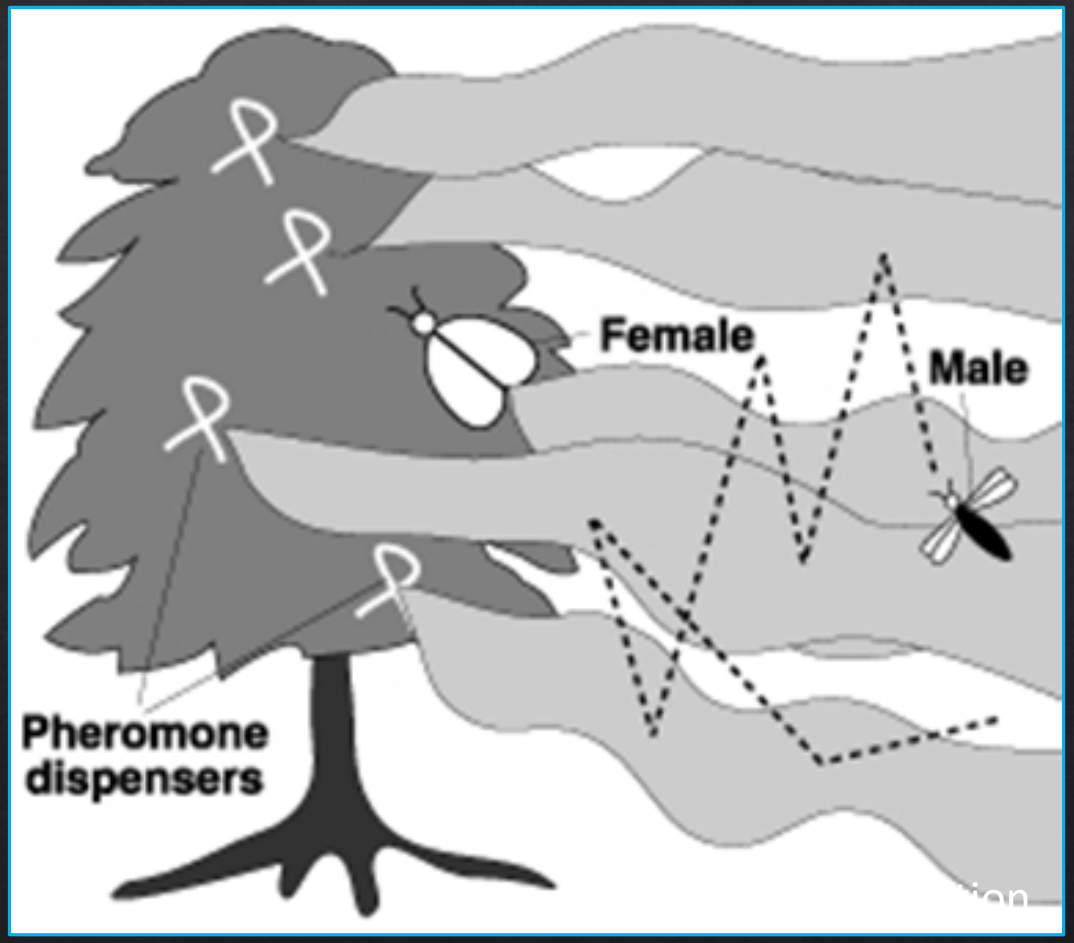
3. Mating disruption



No Mating Disruption

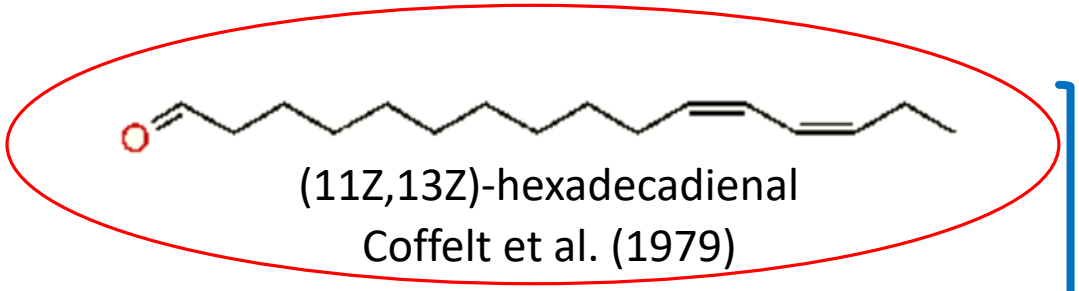


Mating Disruption



NOW Pheromone and Practical Use

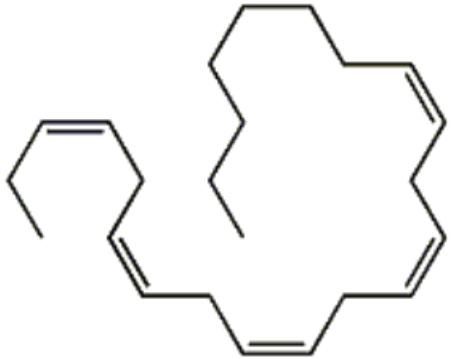
Used in Mating Disruption



(11Z,13Z)-hexadecadienal
Coffelt et al. (1979)

Necessary for attraction

NOW males are not attracted to the aldehyde-only formulation (Kuenen et al. 2001)



Modified from: Chuck Burks

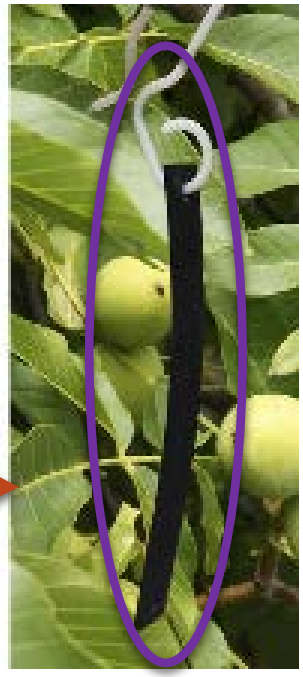
NOW-Mating disruption products

Puffer NOW (Suterra)
@2 units/A; 7.48 g a.i./A

Semios NOW Plus (Semios)
@1-2 units/A; variable a.i.??

ISOMATE NOW Mist
(Pacific Biocontrol)
@1 unit/A; 7.1 g a.i./A

Cidetrak NOW Meso
(Trécé)
(Not Registered)
@10-30 dispensers/A??



- Moths are sexually active at night
- Except NOW Meso, all products dispense pheromone every 15 min. interval for 8-12 hours
- Variable release rates for Semios

Application of Dispensers in the Field

- **Timing:** Begin before the moth emergence in the spring and continue pass the susceptible stage of the crop

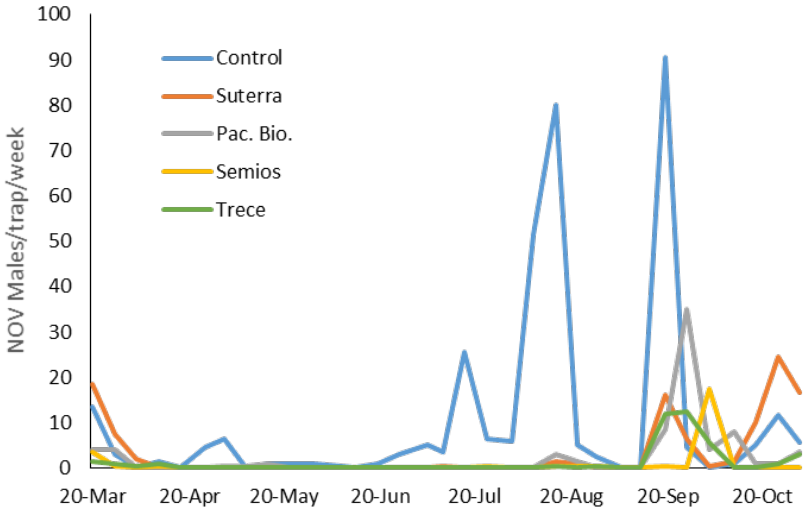
- Distribute the units @1-2 units/acre in a grid pattern, plus few more in upwind edge to compensate wind influence
- Select the limb closer to the center of the tree at upper 1/3 of the tree height
- Place in a way to avoid direct insecticide spray on the unit
- Avoid nozzle of the canister facing the foliage/limbs (3-ft clearance if possible)
- Grower applied vs. company applied

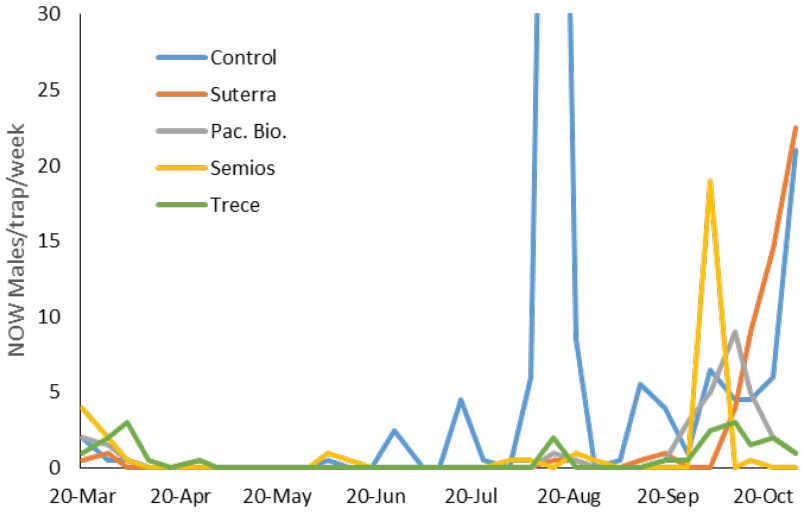
Navel orangeworm trials- Haviland and Rijal, 2017

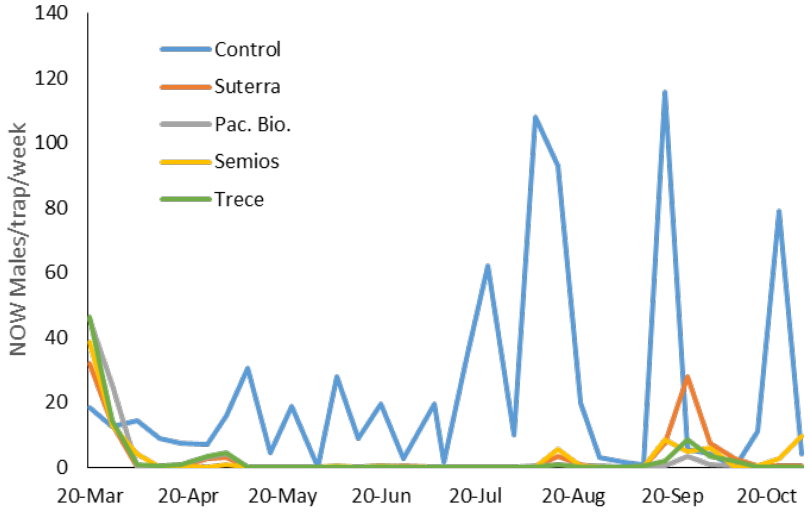
- Almond Board Project (Haviland)
  - –Evaluate 4 mating disruption products
  - –40-acre plots, 3 replicate orchards
- DPR Pest Management Alliance Grant (Haviland & Rijal, et al)
  - –Side-by-side demonstrations, 40-100 acre plots
  - –3 demonstrations lower SJV
  - –3 demonstrations upper SJV
- ABC project (Symmes)
  - –Adds 2 demos in Sac Valley 2018
- Total= 9 locations, >1,200 acres of mating disruption

Pheromone trap captures- Southern SJV

Haviland Almond Board Project, 2017







Reductions in trap captures

89%

95%

91%

NOW damage at harvest- Southern SJV

Haviland Almond Board Project, 2017

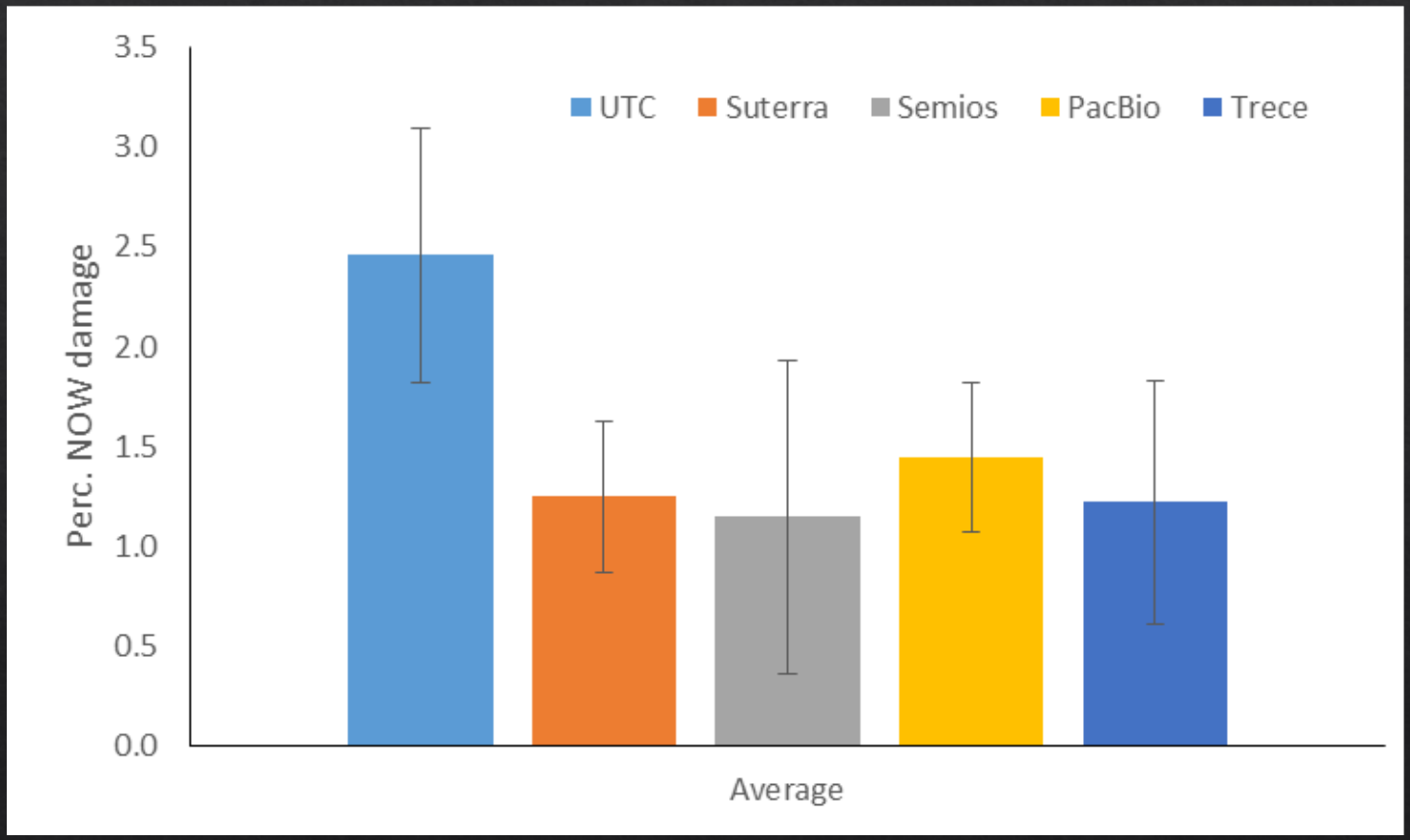
Damage Reductions

Wasco
62%

Maricopa
45%

Buttonwillow
20%

Average
46%

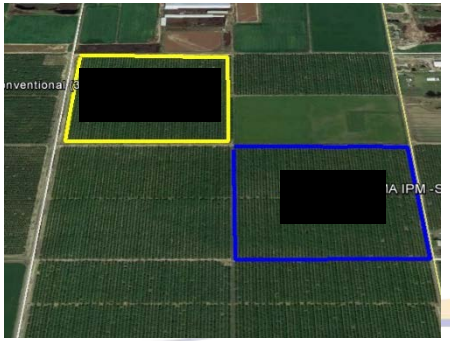


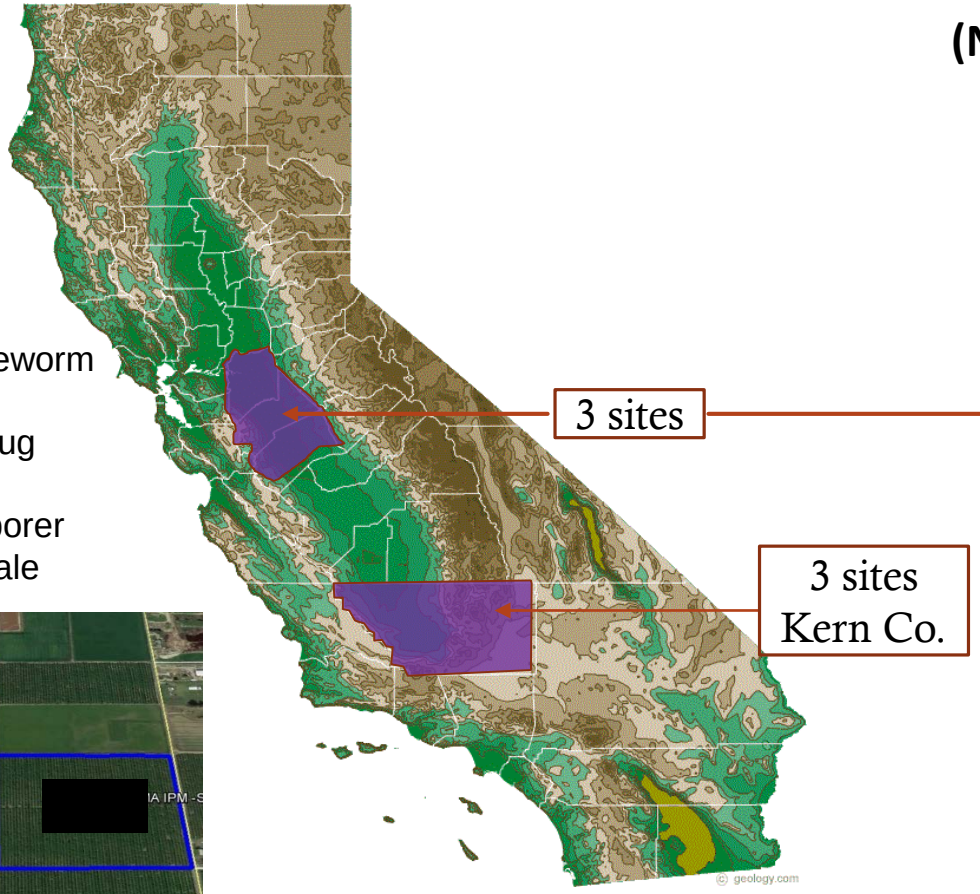
Crop Values- Haviland Almond Board Project

	Per/acre returns	$ difference/ac
No MD	$7,275	
Suterra	$7,400	+$125
Semios	$7,385	+$110
Pac. Bio.	$7,385	+$110
Trécé	$7,381	+$106

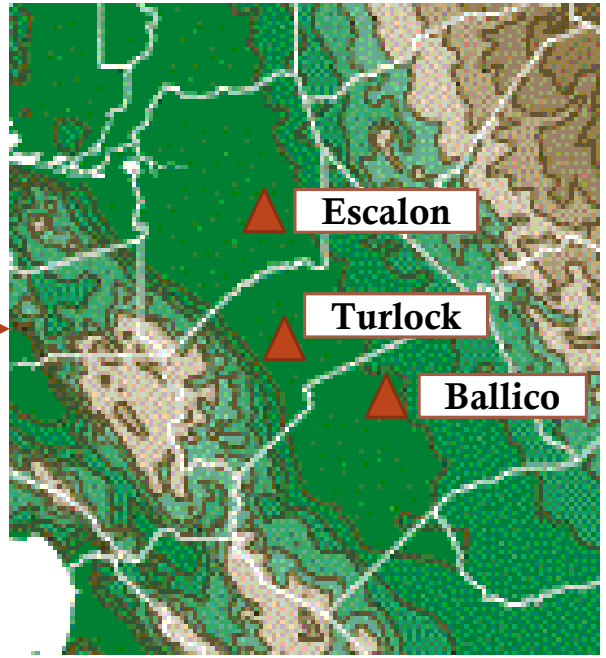
Haviland and Rijal
- Pest Management Alliance DPR Project, 2017

1. Navel orangeworm
2. Spider mites
3. Leaffooted bug
4. Ant
5. Peach twig borer
6. San Jose scale



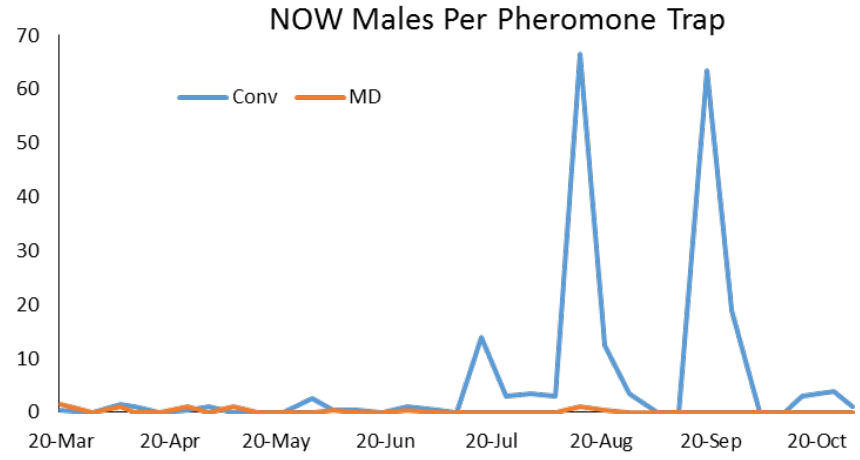


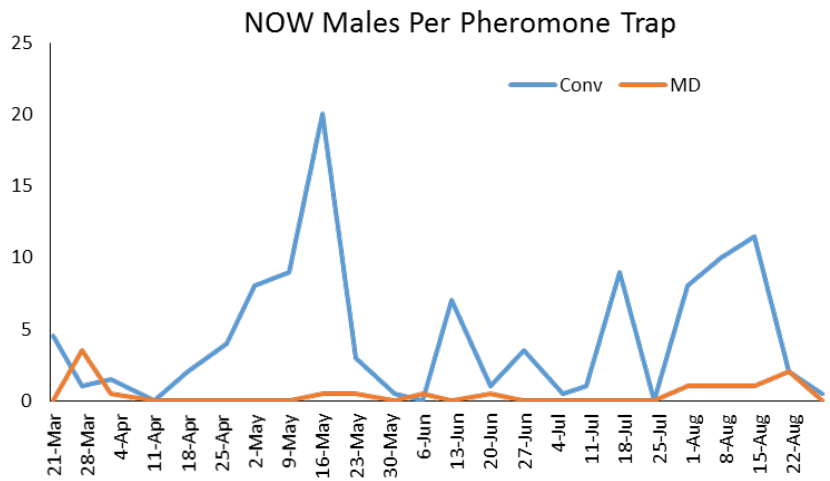
(Northen San Joaquin Valley)

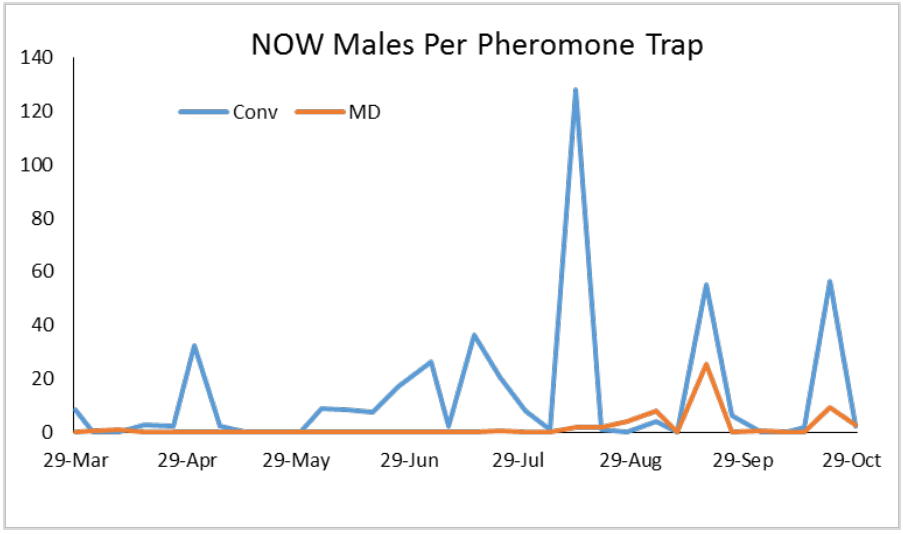


Pheromone trap captures- Southern SJV

Haviland and Rijal- Pest Management Alliance DPR Project, 2017







Reductions in trap captures

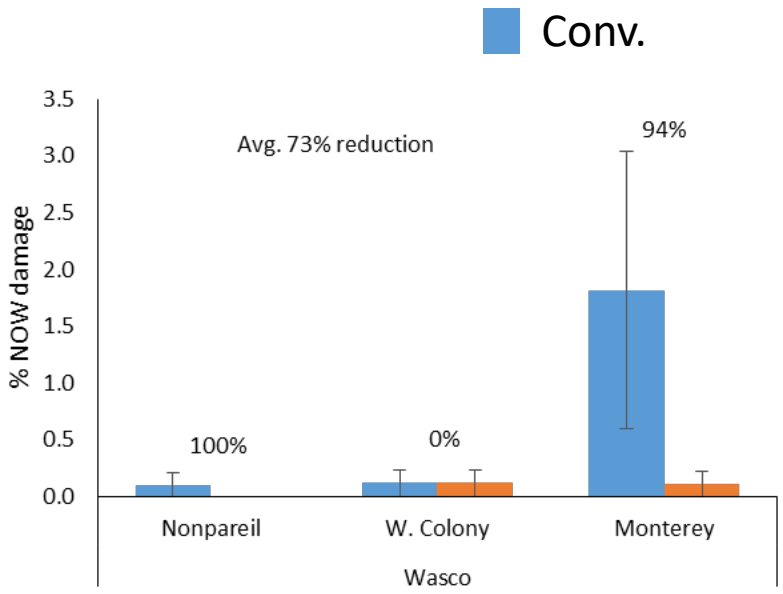
97.2%

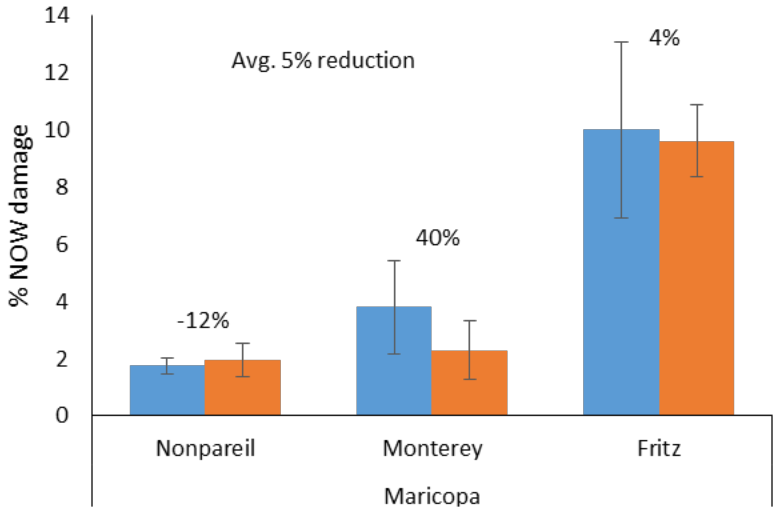
92.7%

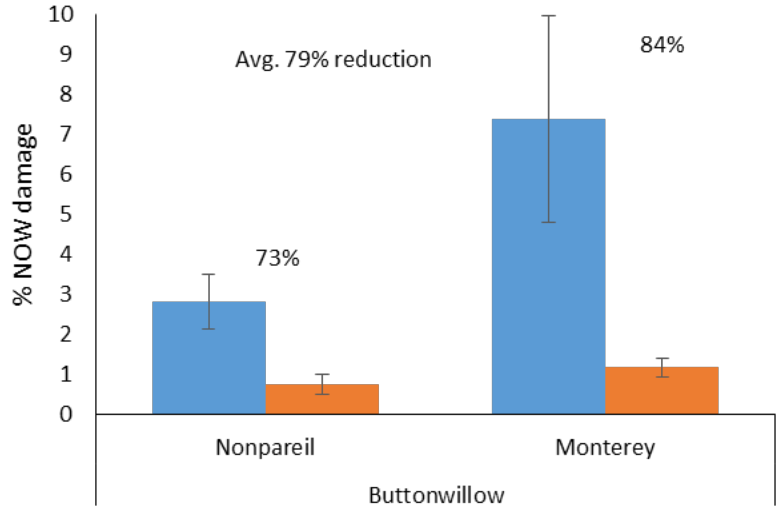
94.7%

NOW Damage at harvest- Southern SJV

Haviland and Rijal- Pest Management Alliance DPR Project, 2017



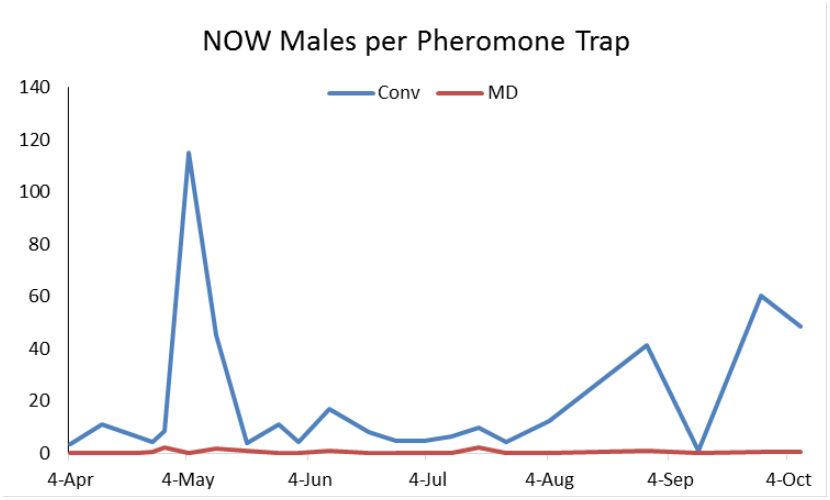


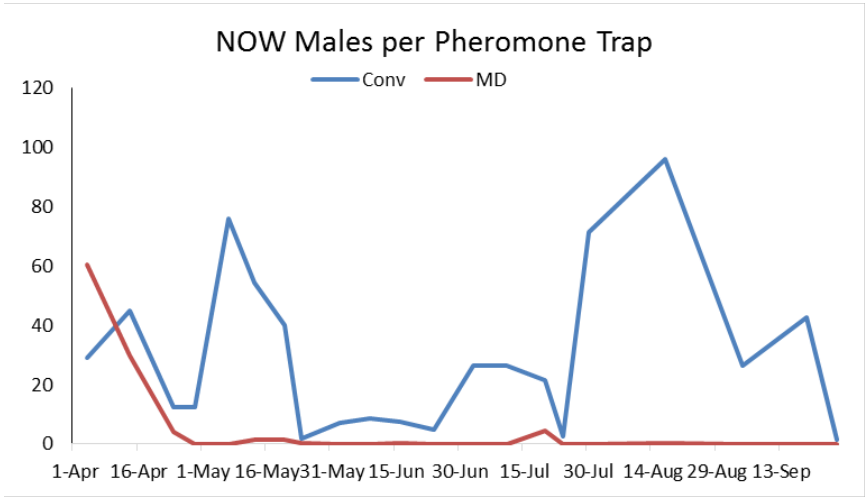


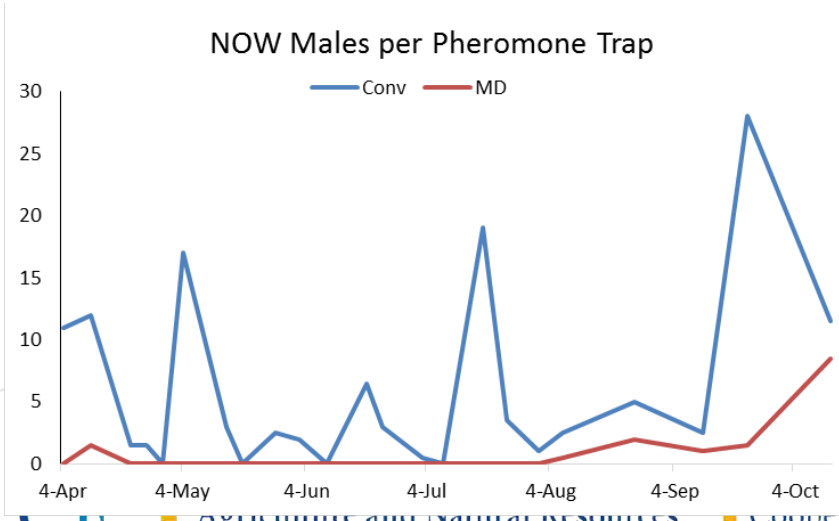
Reductions in damage	Change in crop value
73%	+$153
5%	+$39
79%	+$363

Pheromone trap captures- Northern SJV

Haviland and Rijal- Pest Management Alliance DPR Project, 2017







Reductions in trap captures

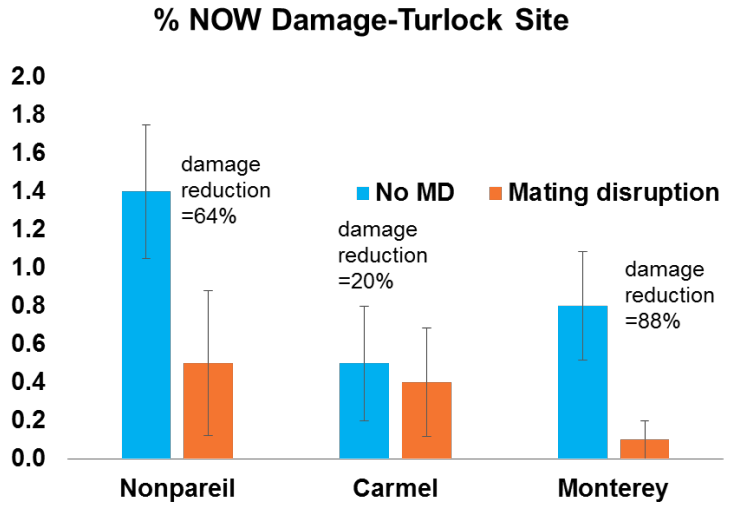
97.1%

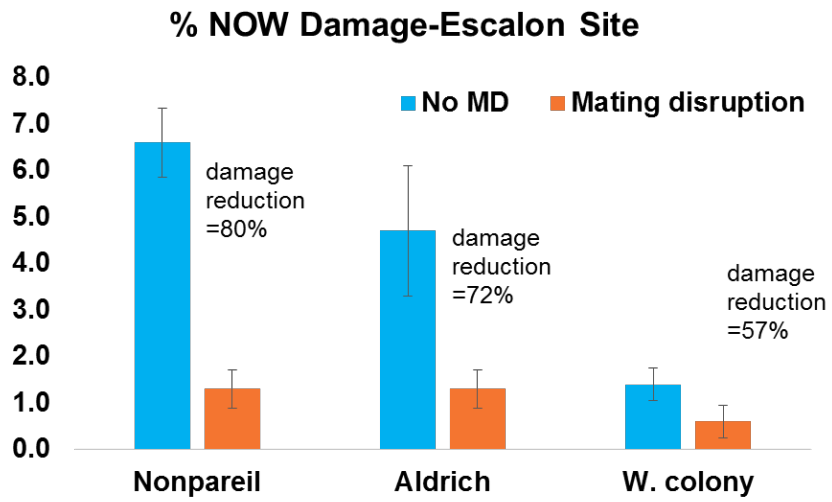
94.7%

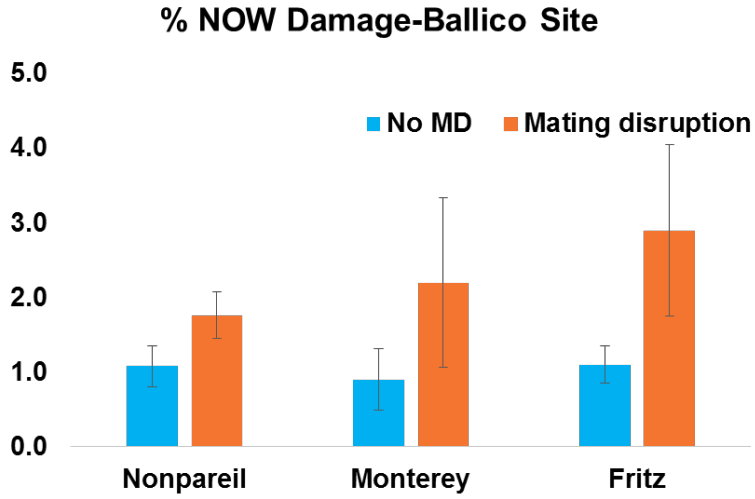
83.2%

NOW Damage at harvest- Northern SJV

Haviland and Rijal- Pest Management Alliance DPR Project, 2017







Reductions in damage	Change in crop value
50%	+$40
77%	+$334
-100%	-$76

NOW Damage Summary- Haviland and Rijal- DPR PMA Project, 2017

Wasco

NOW damage Down 74%

Lost Hills

Down 79%

Turlock

Down 50%

Escalon

Down 77%

Maricopa

Down 5%

Ballico

Up 100%

Square sites MD cost/benefit
~$120 for MD = ↑$222 in crop value

Triangle sites
~$120 for MD = ↓$17

Other Economic Considerations for Mating Disruption

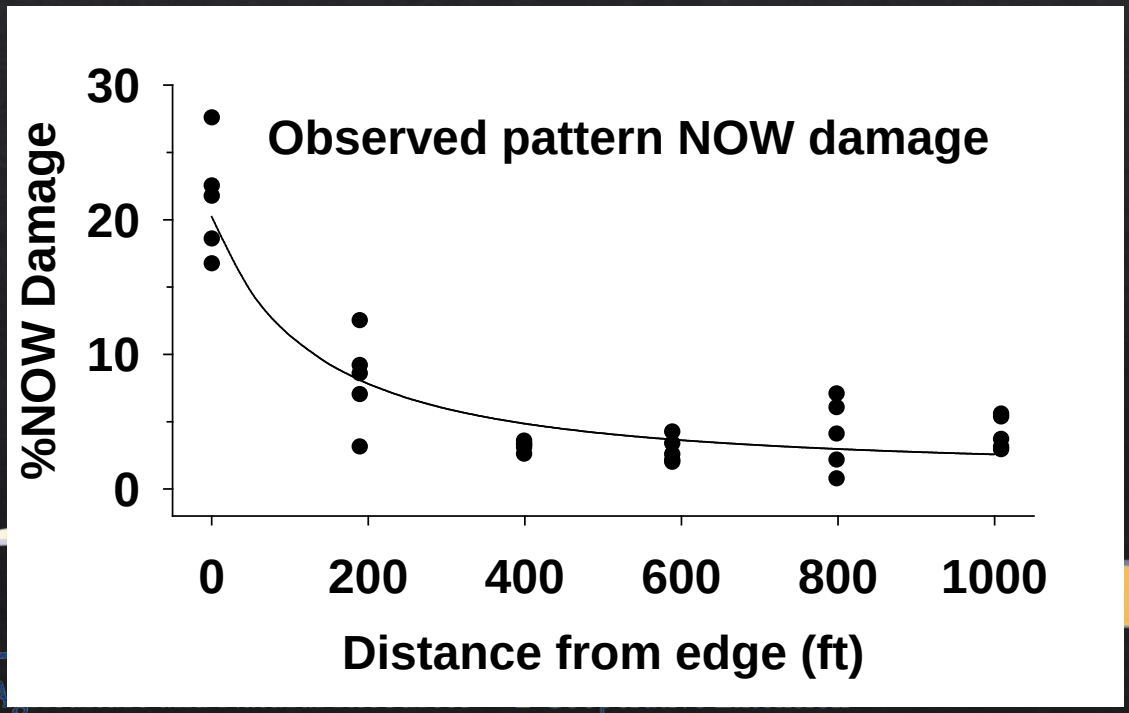
- Increases in crop value more than offset costs for MD
- Reduction of aflatoxins
- Value of being 'sustainable' when marketing
- Reduced risk of NOW resistance to limited insecticide tools (Intrepid, Altacor, pyrethroids)
- Scale matters- benefits likely increased in larger plots
- Year over year benefit (post-harvest mating disruption)
- Setup and takedown occur when labor is available
- No treatment timings, PHIs, REIs or residues
- Cost-benefit ratios would be higher in higher-pressure orchard situations

- Information contained in these slides was developed by David Haviland and Jhalendra Rijal
- If using this information in a presentation, please notify David Haviland of the event and number of attendees so it can be listed in reports required by DPR and other funding agencies
- Funding was provided by the Almond Board of California and a California Department of Pesticide Regulation Pest Management Alliance Grant

Considerations while using mating disruption

- **Edge effects/immigrating moths**

- The pheromone does not kill the pest; thus, mated females can fly into the treated area and lay eggs, producing larvae that will cause damage



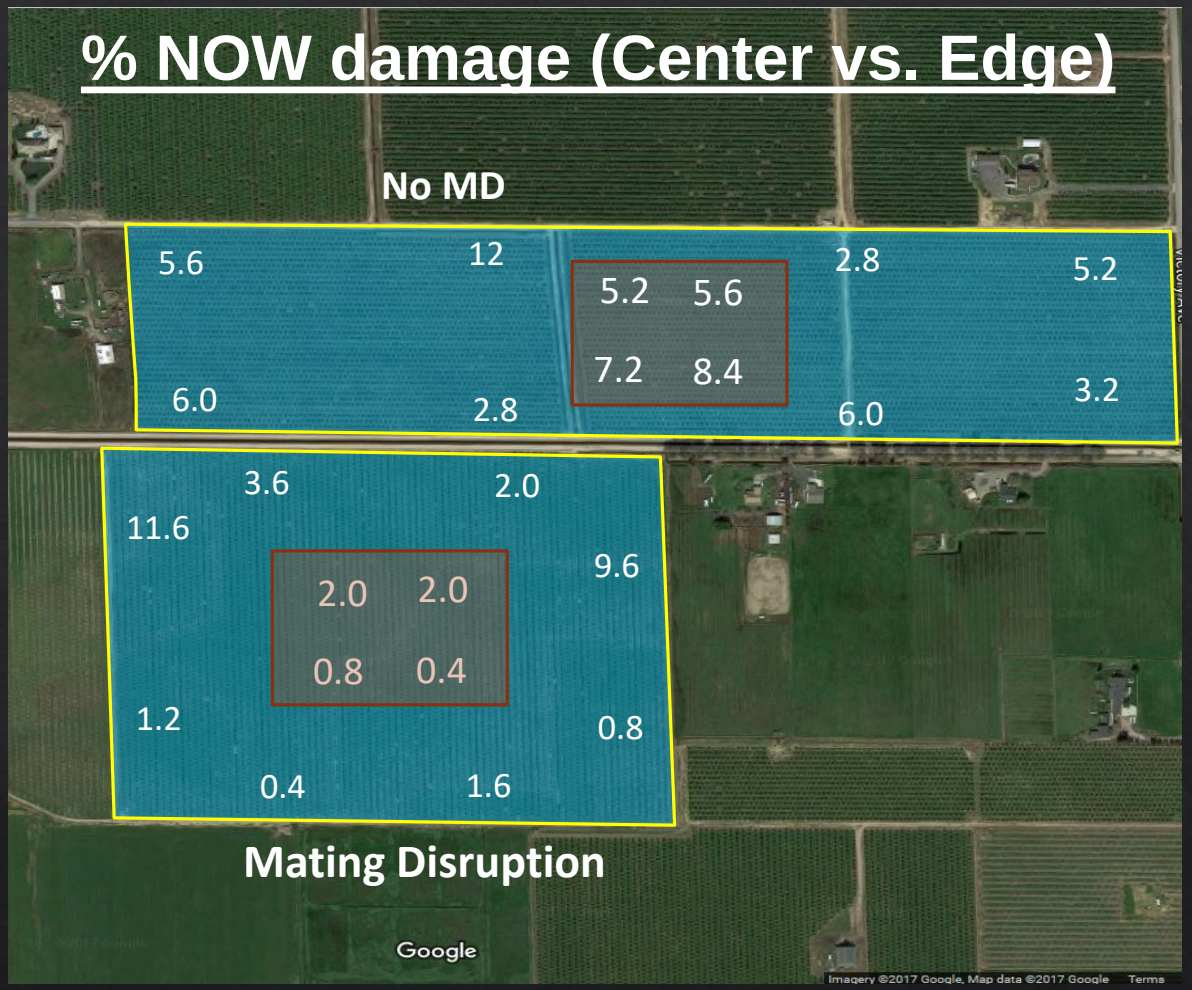
Went from 15% to <5% damage within 400 ft from edge

Slide: C. Burks

Site 1
Almonds

<u>Conventional site (No MD):</u>
Avg % damage (edge)= 5.5
Avg % damage (center)= 6.6

<u>IPM site (Mating disruption):</u>
Avg % damage (edge)= 3.8
Avg % damage (center)= 1.3



% NOW damage (Center vs. Edge)

Site 2
Almonds

Conventional site (No MD):
Avg % damage (edge)= 1.35
Avg % damage (center)= 1.40

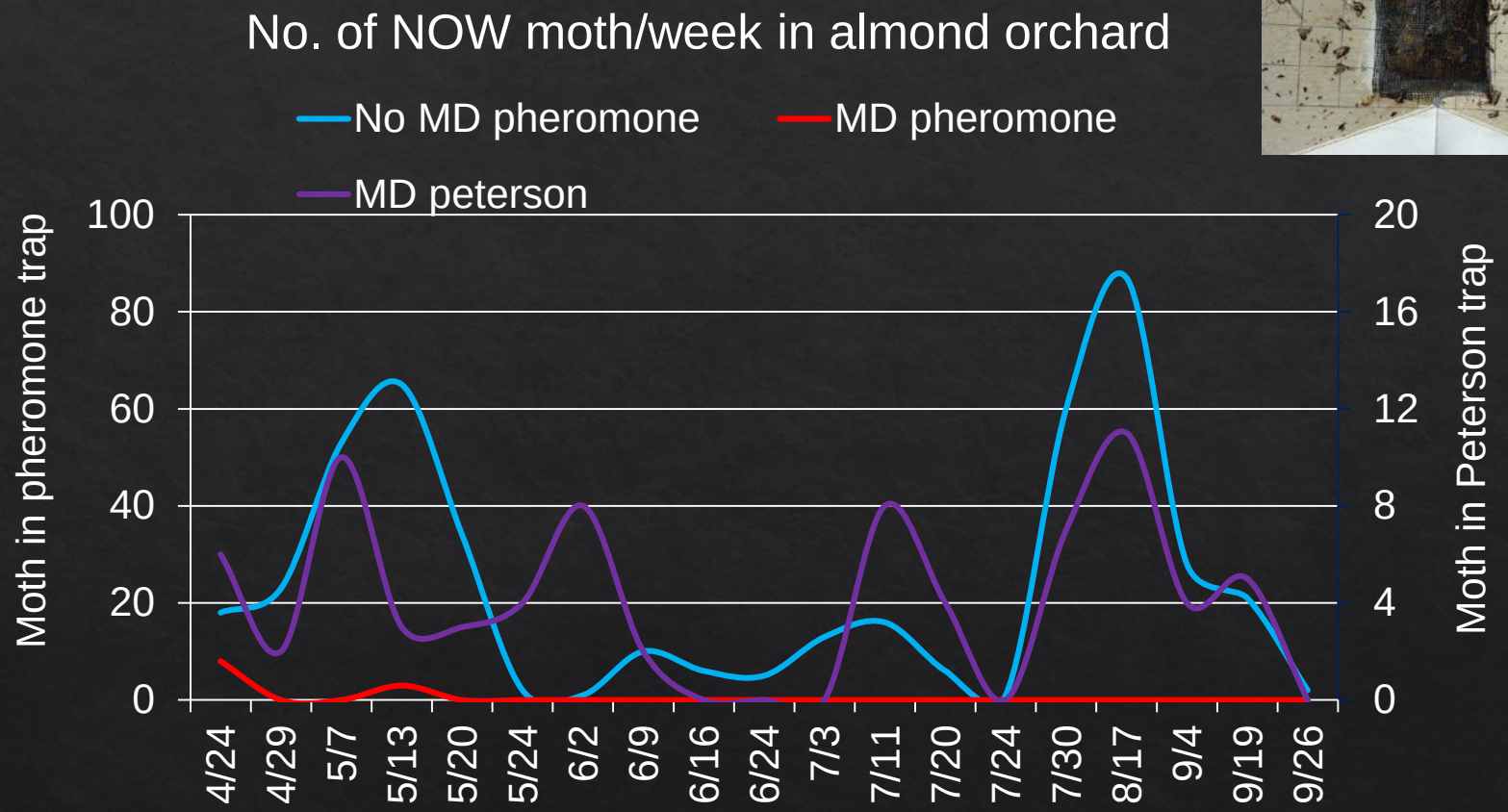
IPM site (Mating disruption)
Avg % damage (edge)= 1.1
Avg % damage (center)= 0.5

4. MD in conjunction with insecticide

NOW Monitoring under mating disruption

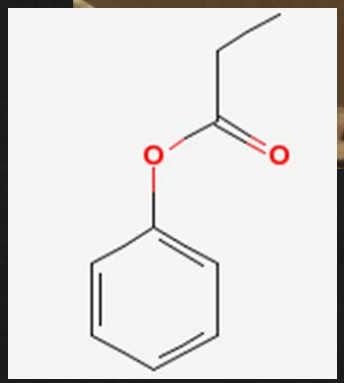
- Monitoring eggs on early-split nuts
- Female-based traps (egg trap, Peterson traps) are useful for monitoring

NOW Monitoring tools under mating disruption



NOW Monitoring tools under mating disruption

Phenyl Propionate (PPO)



100 mg/day

Kairomone blend (five compounds)

5 mg/day

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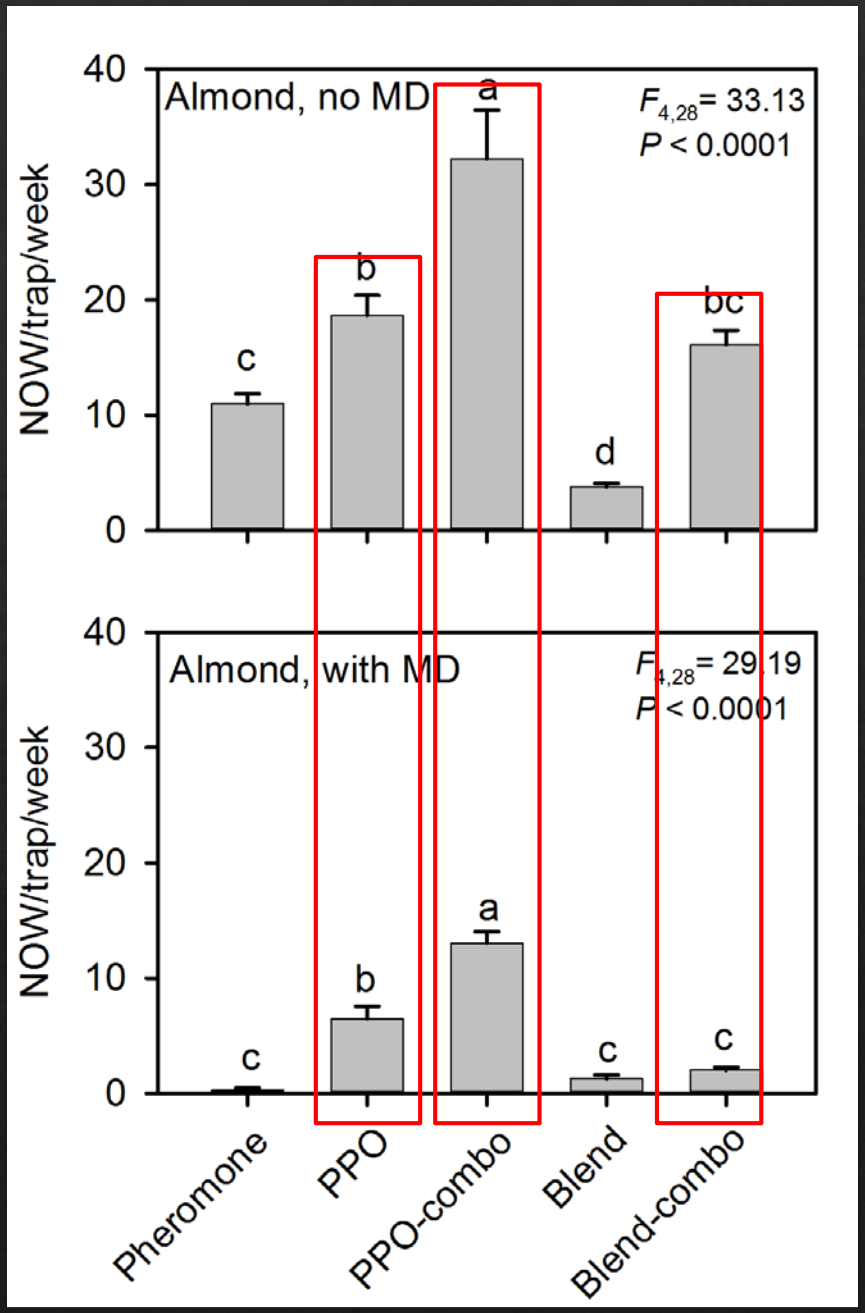
PPO vs. Kairomone blend



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Thank you for your attention

Thanks to:

- Cooperator Growers,
- Pest Control Advisers
- Farm Advisors

UC CE University of California Agriculture and Natural Resources Cooperative Extension