2017 THE ALMOND CONFERENCE

INSECT PEST MANAGEMENT UPDATE

Room 308-309 | December 7 2017

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Almond Board of California

growing ADVANTAGE
The Almond Conference

AGENDA

- **Bob Curtis**, Almond Board of California, moderator
- **David Haviland**, UCCE, Kern County
- **Jhalendra Rijal** , UCCE, IPM Advisor
- **Emily Symmes**, UCCE, IPM Advisor

INSECT MANAGEMENT SESSION

Emily Symmes
David Haviland
Jhalendra Rijal

University of California Cooperative Extension
and UC Statewide IPM Program

Navel Orangeworm

- Sanitation
- Insecticides
- Mating disruption

Spider Mites

- Use of thresholds
- Biological control

Brown Marmorated Stink Bug

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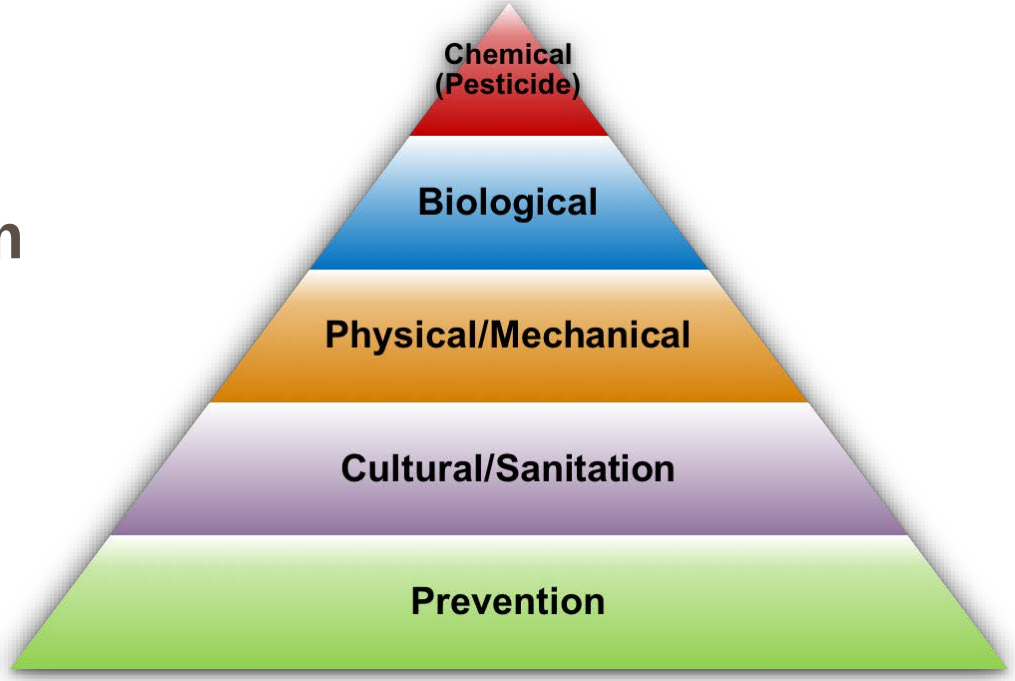
NOW in 2017 – Sanitation Issues

NOW in 2017 – Sanitation Issues

Fundamentals of NOW Management

- Sanitation
- Minimize damage from other sources
- Timely harvest
- Insecticides



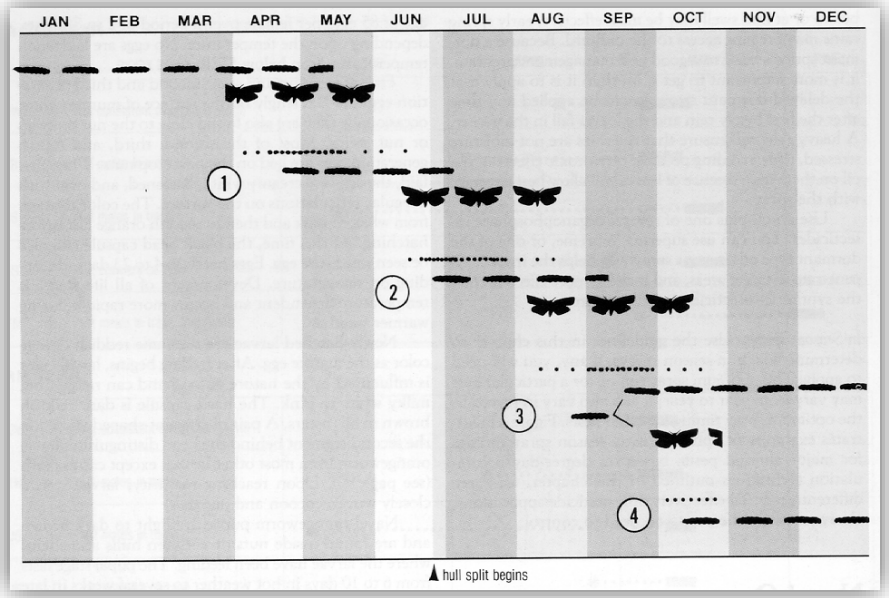
Fundamentals of NOW Management

Build your foundation…

SANITATION!!!

<u>No amount of sprays can make up for a shaky foundation</u>

Sanitation – Two-Fold Benefit



1. Direct reduction of overwintering populations

2. Minimize oviposition and development sites of early generations

Sanitation Research & Guidelines

TABLE 2. Relationship between average numbers of tree and ground mummies per tree and 'Nonpareil' kernel damage by navel orangeworm, 2003–2006

Tree mummies	Damage	Sections
avg. no./tree	*%*	*no.*
0	1.63	605
0.01–0.49	1.22	1,092
0.5–0.69	1.57	91
0.7–0.79	2.32	39
0.8–1.75	3.53	61
≥ 1.76	7.85	44
Ground mummies		
avg. no./tree	*%*	*no.*
0–4.9	1.39	1,272
4.91–7.9	1.57	300
7.91–8.9	1.72	67
8.91–9.0	2.78	44
≥ 9.1	2.72	238

Higbee & Siegel, Cal Ag 2009

Sanitation Thresholds*	
Southern & Central SJV	**Northern SJV & SV**
Average 0.2 mummies/tree AND 8/tree on ground	Average 2 mummies/tree

UC IPM Pest Management Guidelines 2017

NOW Predictor

Percent Previous NOW Damage	1.5%	*Mean = 1.5%; (Range 0 - 19.0%)*
PTB Damage	0.3%	*Mean = 0.3%; (Range 0 - 9.2%)*
Ground Mummies per Tree	4.9	*Mean = 4.9; (Range 0 - 43.7)*
Tree Mummies per Tree	1.0	*Mean = 1.0; (Range 0 - 69.7)*
Standardized Harvest Percentile	0.0	

*Choose a value from below***

0 - 2.5% =	**-2.6**
2.6% - 25% =	**-0.6**
50% =	**0**
51 - 75% =	**0.7**
76 - 97.5% =	**1.8**
98 - 100% =	**2.6**

Distance from Center to Nearest Pistachios	8,656	*Mean = 8,656; (Range 550 - 12,000)****
Predicted Damage	1.86%	*Based on sample data; the average damage in Kern County was 1.77% based on 1,279 40-acre plots in 2004 - 2006.*

almonds.com/pests/now-predictor

NOW Predictor

Percent Previous NOW Damage	3.0%	*Mean = 1.5%; (Range 0 - 19.0%)*
PTB Damage	0.0%	*Mean = 0.3%; (Range 0 - 9.2%)*
Ground Mummies per Tree	15	*Mean = 4.9; (Range 0 - 43.7)*
Tree Mummies per Tree	3.0	*Mean = 1.0; (Range 0 - 69.7)*
Standardized Harvest Percentile	0.7	

*Choose a value from below***

0 - 2.5% =	**-2.6**
2.6% - 25% =	**-0.6**
50% =	**0**
51 - 75% =	**0.7**
76 - 97.5% =	**1.8**
98 - 100% =	**2.6**

Distance from Center to Nearest Pistachios	5,000	*Mean = 8,656; (Range 550 - 12,000)****
Predicted Damage	3.39%	*Based on sample data; the average damage in Kern County was 1.77% based on 1,279 40-acre plots in 2004 - 2006.*

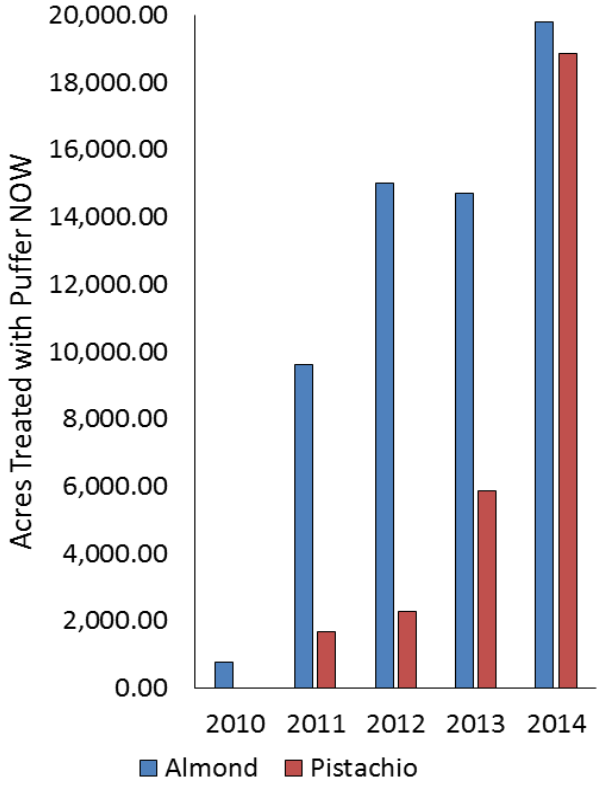
almonds.com/pests/now-predictor

CURRENT MANAGEMENT OPTIONS

- Winter sanitation
  - 0.5-2 Mummies per tree
- Early/Timely harvest
- Insecticides
  - 1-2 insecticide sprays
  - Intrepid, Altacor, pyrethroids
  - Resistance to pyrethroids
  - No new products coming down the pipe
- Mating Disruption

MATING DISRUPTION

- Use synthetically-produced pheromone to disrupt mating
- Pheromone is placed in aerosol cans inside cabinets
- Dispensers emit female pheromone when mating occurs
- Males struggle to find females
- Mating is delayed or reduced
- Egg deposition reduced



NOW Mating Disruption History

1980's

Trap suppression documented by Landolt, Curtis et al.

1990's

Shorey showed trap shut-down with puffers in 40 ac perimeters

2002-2007

Higbee and Burks demonstrated impact on damage reduction in 20 and 40 ac almond plots
Puffers in grids most effective

2005

Commercial product available

2008-2012

USDA NOW Areawide Project showed value of NOW mating disruption on commercial scale with, or in place of, traditional insecticides

PRODUCT COMPARISONS

Puffer NOW
(Suterra)

Semios NOW
(Semios)

Isomate NOW
(Pacific Biocontrol)

Cidetrak NOW?
(Trécé)
(Not Registered)

	Puffer NOW (Suterra)	Semios NOW (Semios)	Isomate NOW (Pacific Biocontrol)	Cidetrak NOW? (Trécé)
Registered	2006	2016	2017	Not Registered
Type	Aerosolized canister	Aerosolized canister	Aerosolized canister	Passive dispenser
Density per acre	2	1	1	20
Release rate	Static	Variable	Static	Static
Installation	Grower-supplied	Provided	Grower-supplied	Grower-supplied
Organic	No	No	No	Yes
Add-ons	No	Yes*	No	No
Price	Approx. $110-$120/acre, Semios has additional costs for add-ons			

*1 weather station, pheromone-based camera traps, temp/humidity sensors in all cabinets, alternaria model, NOW degree-day models, chill monitoring, irrigation monitoring, login-based computer interface

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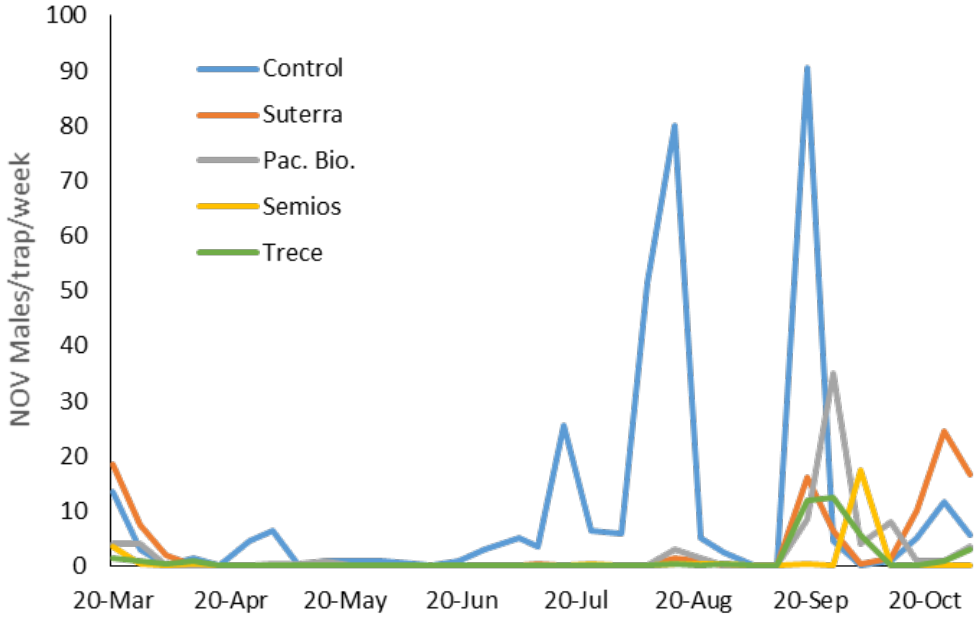
DESIGN

- 4 Treatments plus Check
- 40-acre plots (4,000 trees)
- Replicated in 3 orchards
- Entire orchards treated with 1-2 insecticides at hull split
- Weekly NOW trap counts
- 4 harvest samples at the core of each plot for each variety

PHEROMONE TRAP CAPTURES

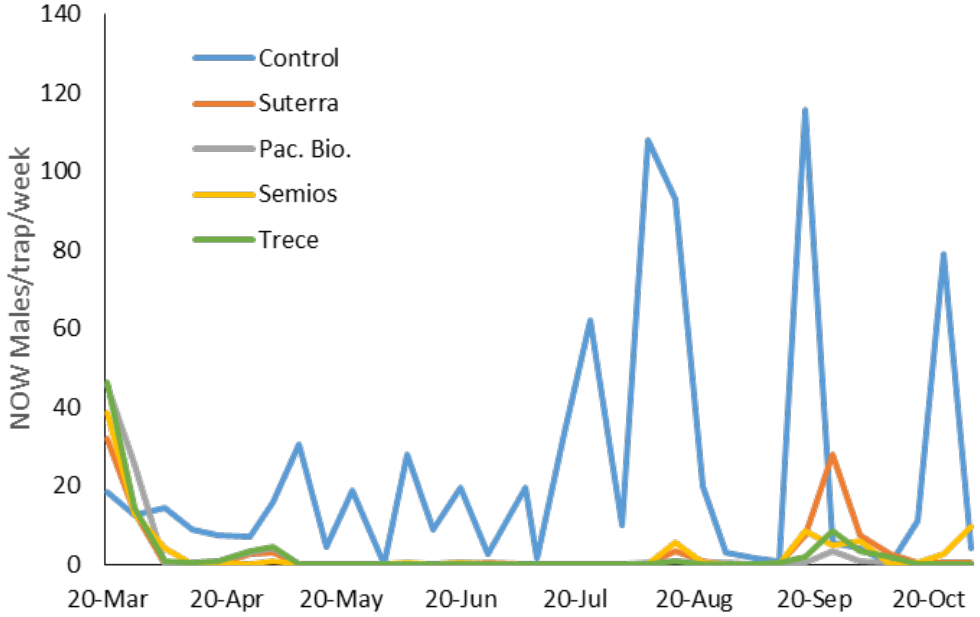
WASCO



	Cum. Apr-Sept	% Re-duction
C	300	
Su	28	91
PB	54	82
Se	20	93
Tr	31	89
	Avg.	89%

PHEROMONE TRAP CAPTURES

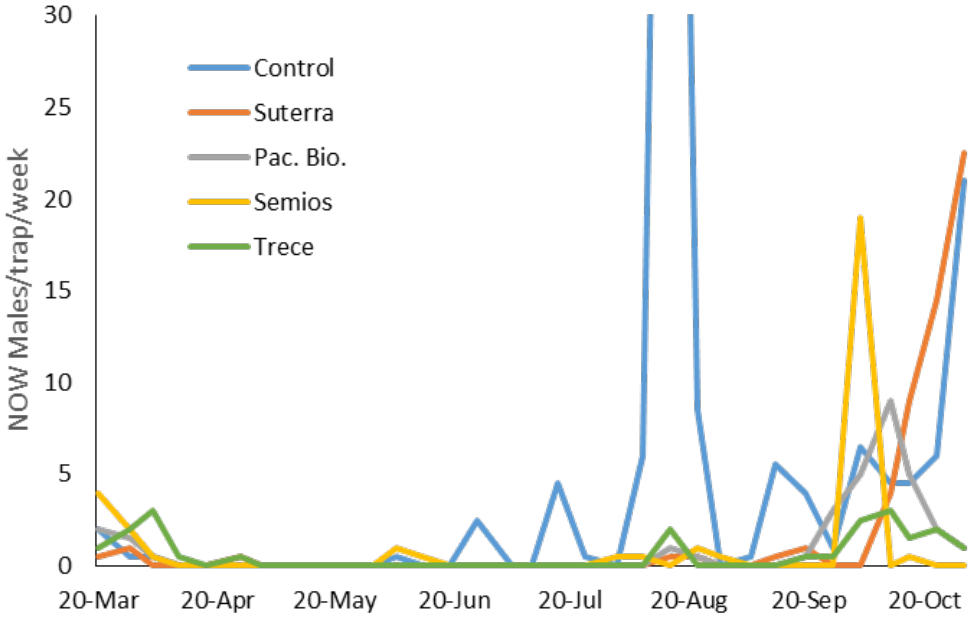
MARICOPA



	Cum. Apr-Sept	% Re-duction
C	645	
Su	54	92
PB	17	97
Se	32	95
Tr	26	96
	Avg.	95%

PHEROMONE TRAP CAPTURES

BUTTONWILLOW



	Cum. Apr-Sept	% Re-duction
C	133	
Su	3	97
PB	11	92
Se	24	82
Tr	10	93
	Avg.	91%

HARVEST

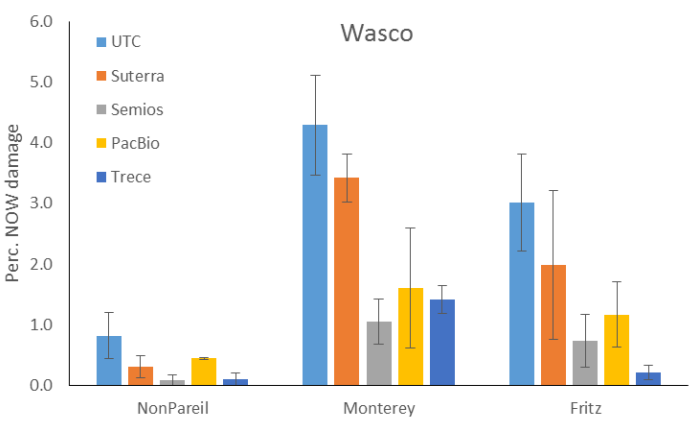
Damage Reductions

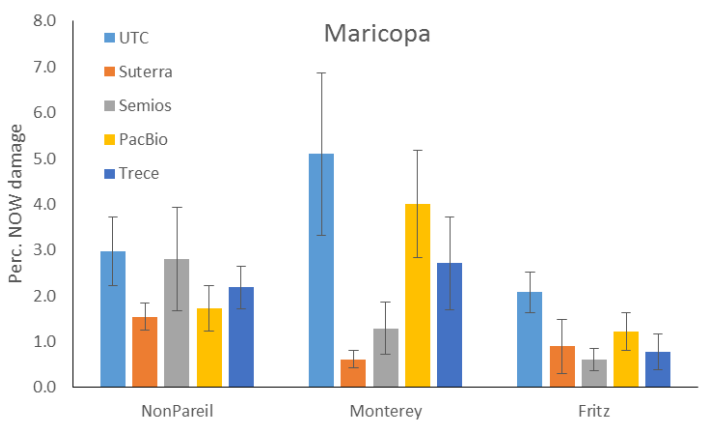
Wasco 62%

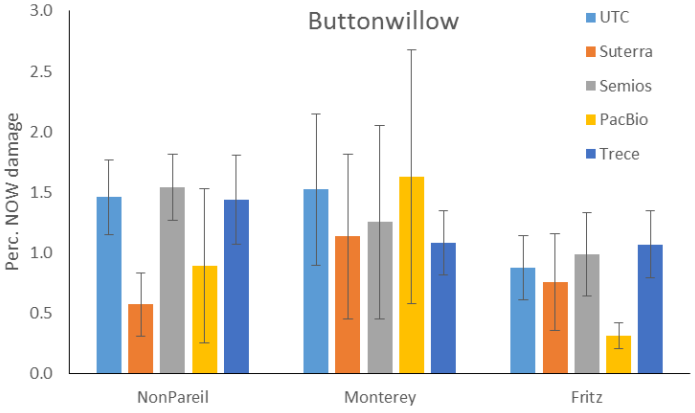
Maricopa 45%

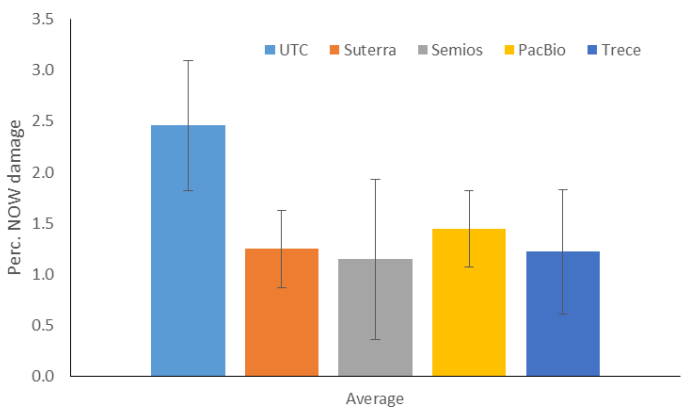
Buttonwillow 20%

Average 46%



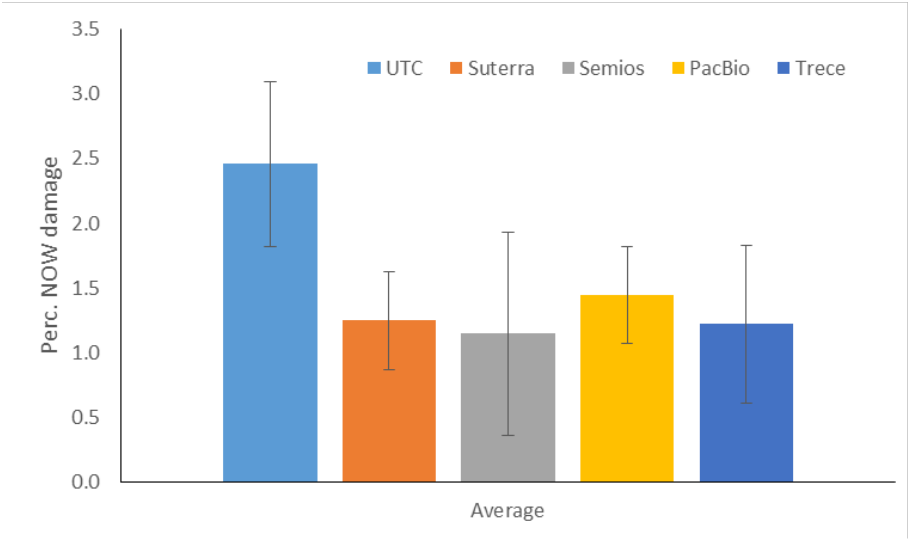






Economics

- Assumptions
  - 3000 lb/ac for each variety
  - 50% NP, 25% Mont. 25% Fritz
  - $2.50/lb for NP, $2.25 for pollinizers
  - $0.0 to $0.16 premium sliding scale for low Nonpareil damage based on Blue Diamond Crop Quality Schedule
  - $0.0 to $0.09 premium for pollinators
  - Premiums for in-shell nuts are not included
  - Assume half of damaged kernels blown out at harvest or removed through the shelling process



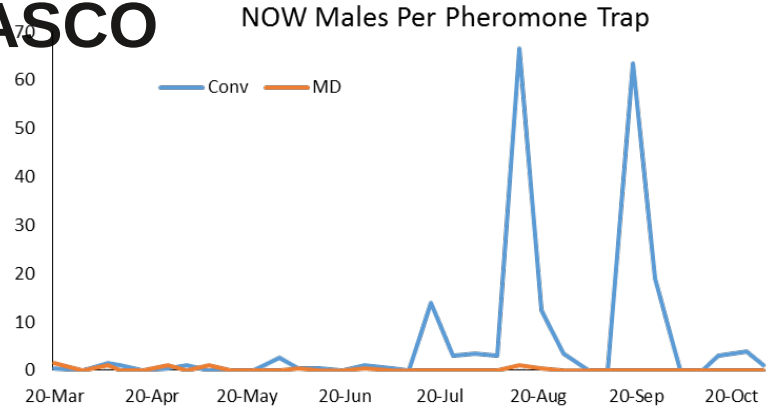
	Per/acre returns	$ difference/ac
No MD	$7,275	
Suterra	$7,400	+$125
Semios	$7,385	+$110
Pac. Bio.	$7,385	+$110
Trécé	$7,381	+$106

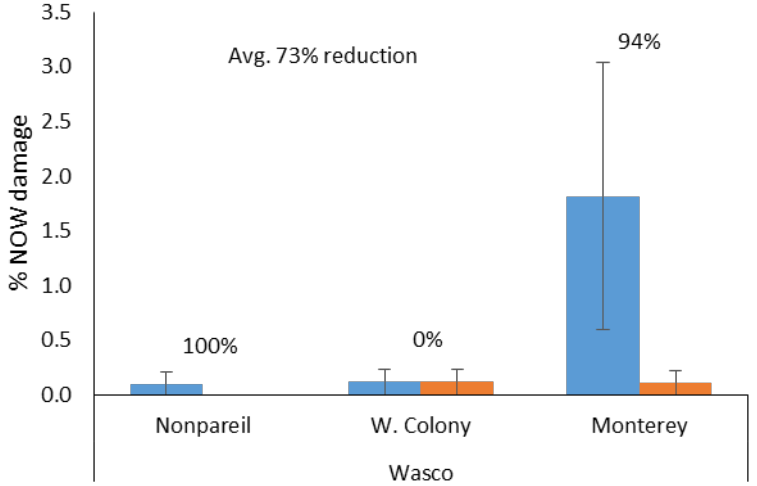
PEST MANAGEMENT ALLIANCE GRANT

- Demonstration project
- Funded by DPR
- Partnership between DPR, UC, Almond Board, Growers, PCAs
- Side by side comparisons
- Objective is to improve IPM
- NOW goal- demonstrate MD
  - In addition to a spray program
  - Or in exchange for a spray program
- Spider mites- demonstrate threshold-based decision-making
  - Impacts on biocontrol
  - Documentation of role of sixspotted thrips in biocontrol
  - Demonstrate ability to reduce miticide use

DEMONSTRATION PLOTS- WASCO

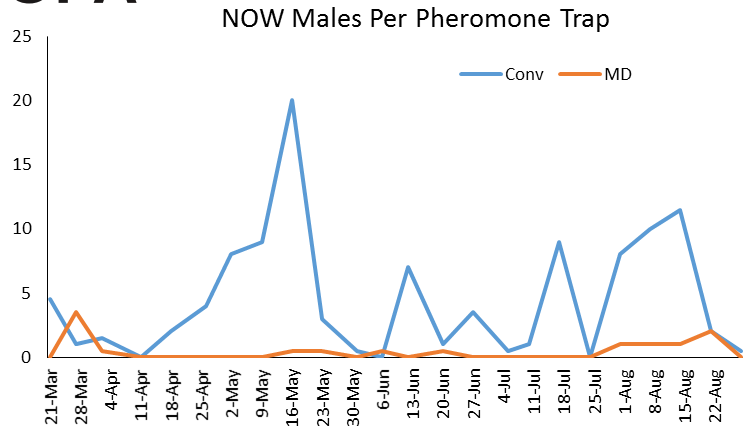
- Conventional Program
  - Hull split spray $60
  - Post-hull split spray $60
- PMA Program
  - Mating disruption $120
- Results
  - Low NOW pressure
  - 97.2% reduction in moth captures
  - 73% reduction in damage
  - $33.50 increase in crop value
  - Spray and MD costs offset
  - $33.50 increase in profit

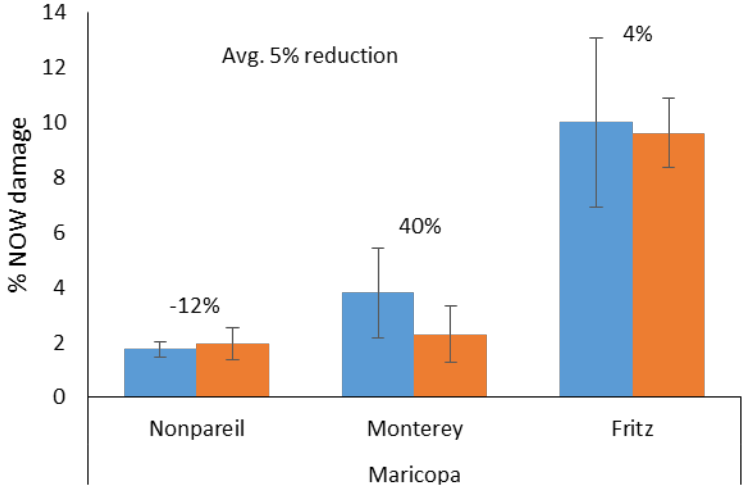




DEMONSTRATION PLOTS- MARICOPA

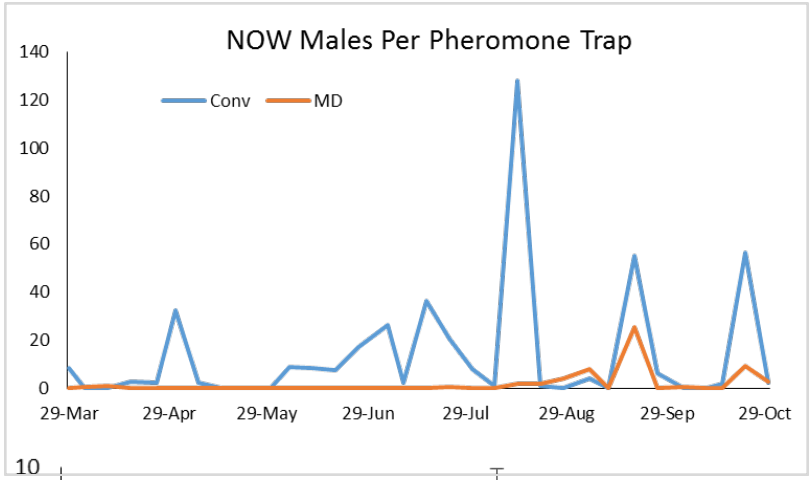
- Conventional Program
  - Hull split spray $60
- PMA Program
  - Hull split spray $60
  - Mating disruption $120
- Results
  - Moderate NOW pressure
  - 92.7% reduction in moth captures
  - 5% reduction in damage
  - $39.22 increase in crop value
  - $120 cost for MD
  - $80.78 net loss

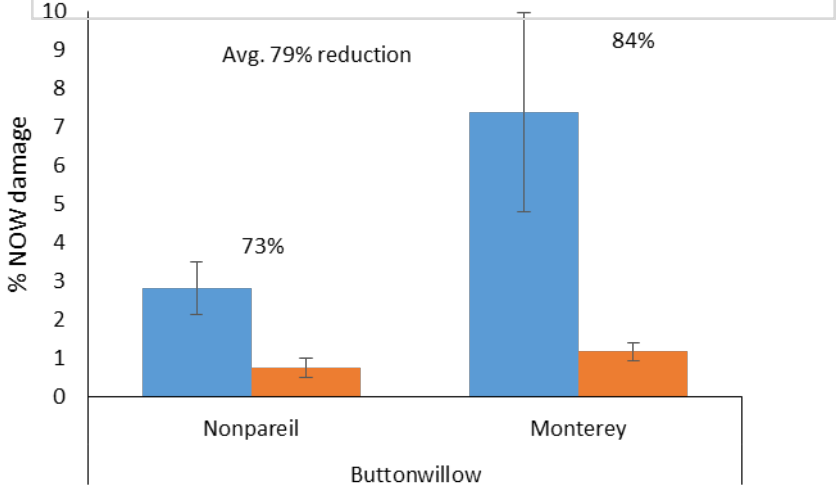




DEMONSTRATION PLOTS- BUTTONWILLOW

- Conventional Program
  - Hull split spray $60
- PMA Program
  - Hull split spray $60
  - Mating disruption $120
- Results
  - Moderate NOW pressure
  - 94.2% reduction in moth captures
  - 79% reduction in damage
  - $363.81 increase in crop value
  - $120 cost for MD
  - $243.81 net benefit





Economic and other values for MD

- Increases in crop value *(Avg. $143) offset costs for MD (Appx. $120)
- Reduction of aflatoxins
- Value of being ‘sustainable’ when marketing
- Reduced risk of NOW resistance to limited insecticide tools (Intrepid, Altacor, pyrethroids)
- Benefit 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

MAXIMIZING BIOLOGICAL CONTROL FOR SPIDER MITES IN ALMONDS

IPM IN ALMONDS

	15 years ago	current
Navel orangeworm	Azinphos-methyl	Methoxyfenozide, Chlorantraniliprole
San Jose scale	Methamidiphos, other OPs	*Aphytis*, *Encarsia*, IGRs
Fire ants	Chlorpyrifos	Ant baits
Leaffooted bug	Chlorpyrifos, bifenthrin	Abamectin
Peach twig borer	Pyrethroids, OPs, Oil	Biocontrol, various
Spider mites	Propargite	Many options

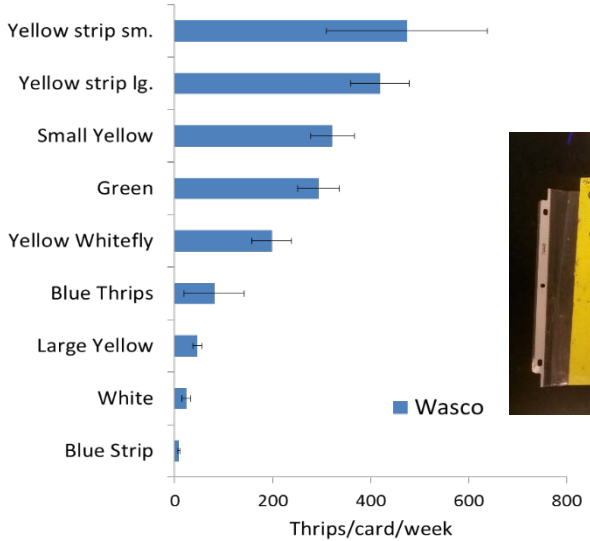
SPIDER MITE BIOCONTROL- SIXSPOTTED THRIPS

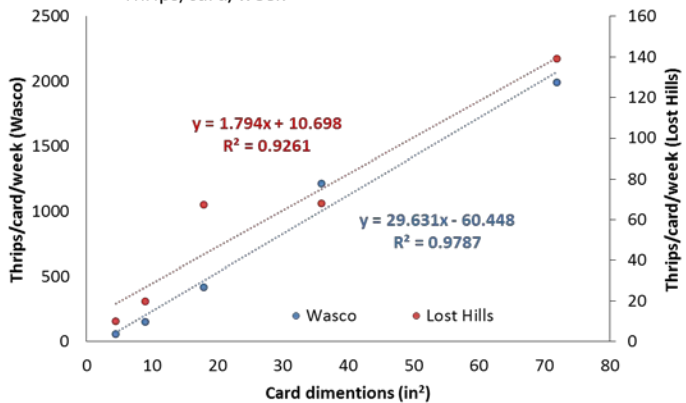
- Entire life cycle passed on the host
- Facultatively arrhenotokous
  - Mating, but if not mated males only
- Food- almost exclusively spider mites
  - 49.7 (86F) to 20.7 (68F) mite eggs per day
  - Also eat other stages of mites
  - Cannibalistic if food is scarce
- Population doubling time
  - 8.7 (68°F) to 2.7 (86°F) days
- Thigmotaxis evident on all stages
  - They love to get inside of webbing

Gilstrap and Oatman, 1976; Coville and Allen, 1977

MONITORING FOR SIXSPOTTED THRIPS

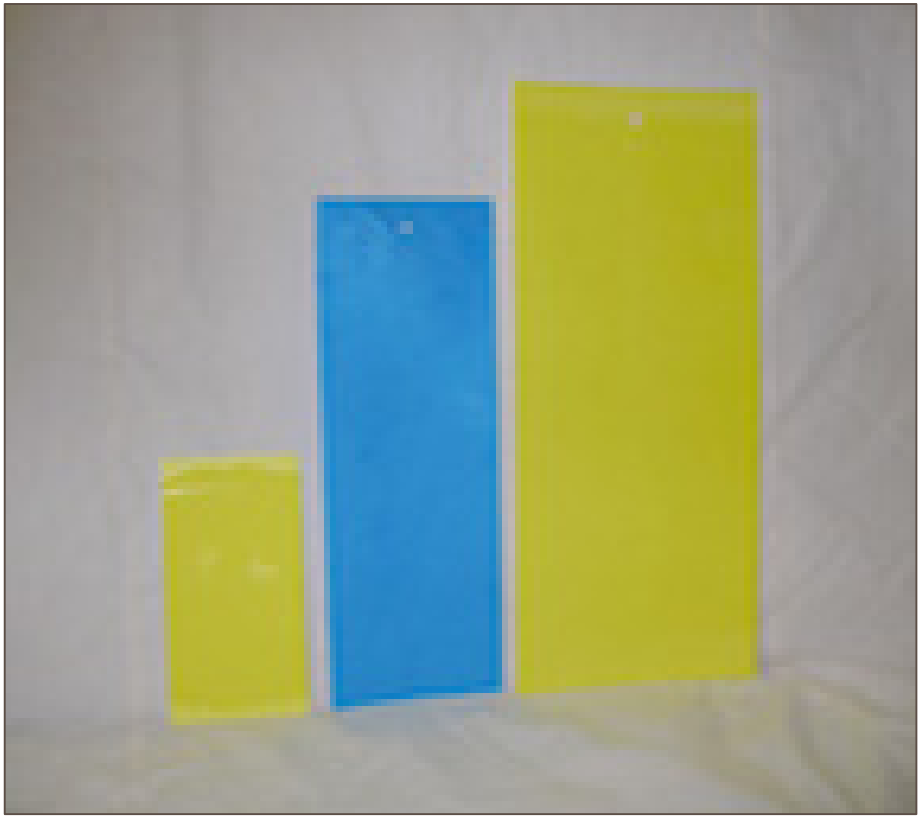
- Evaluated 7 card types at two locations
- Cut them all to the same size
- Averaged 3 to 475 thrips/week
- Yellow strip, small yellow and green cards caught the most
- Green is hard to use
- Yellow strip is the cheapest





MONITORING- CARD SIZE RESULTS

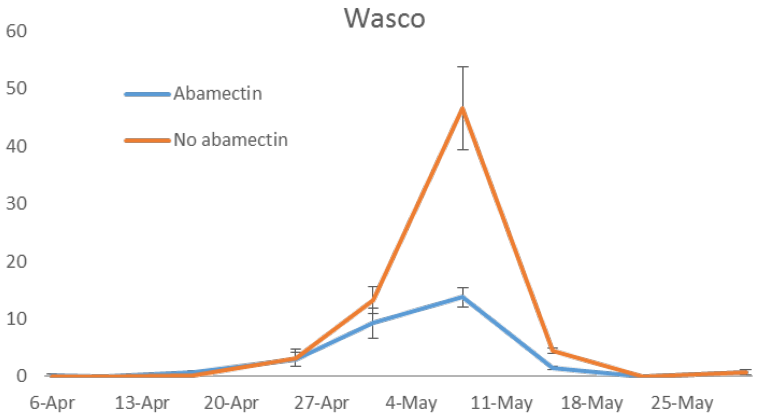
- For trials we now use yellow strip traps
- 3” x 5”
- Case of 1000 for $260
- Great Lakes IPM
- Hang from tree using binder clop and large uncoiled paper clip

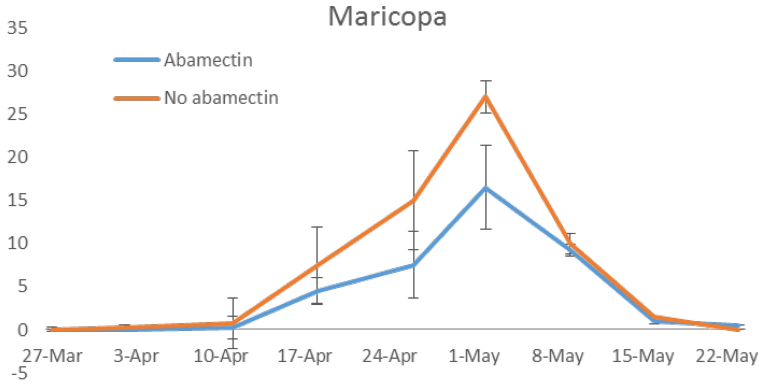


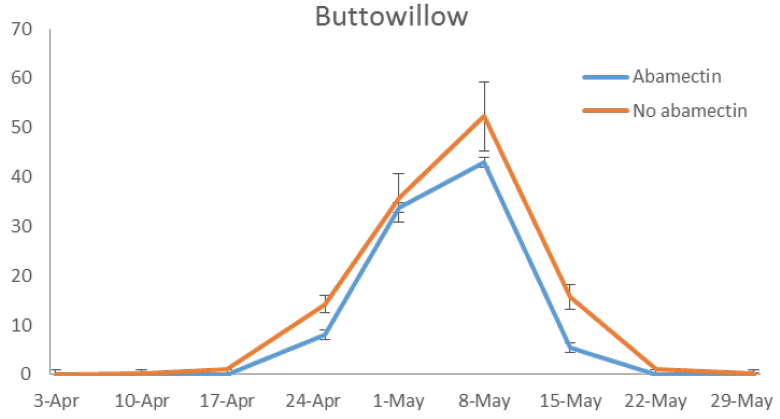
SIXSPOTTED THRIPS ACTIVE MID-APRIL TO MID-MAY

- Traditional ‘preventative’ spray timing
- Miticides should never be used in May without monitoring for spider mites and thrips
- Don’t starve sixspotted thrips
- If thrips are present, avoid use of pyrethroids and abamectin

Sixspotted thrips/card/week

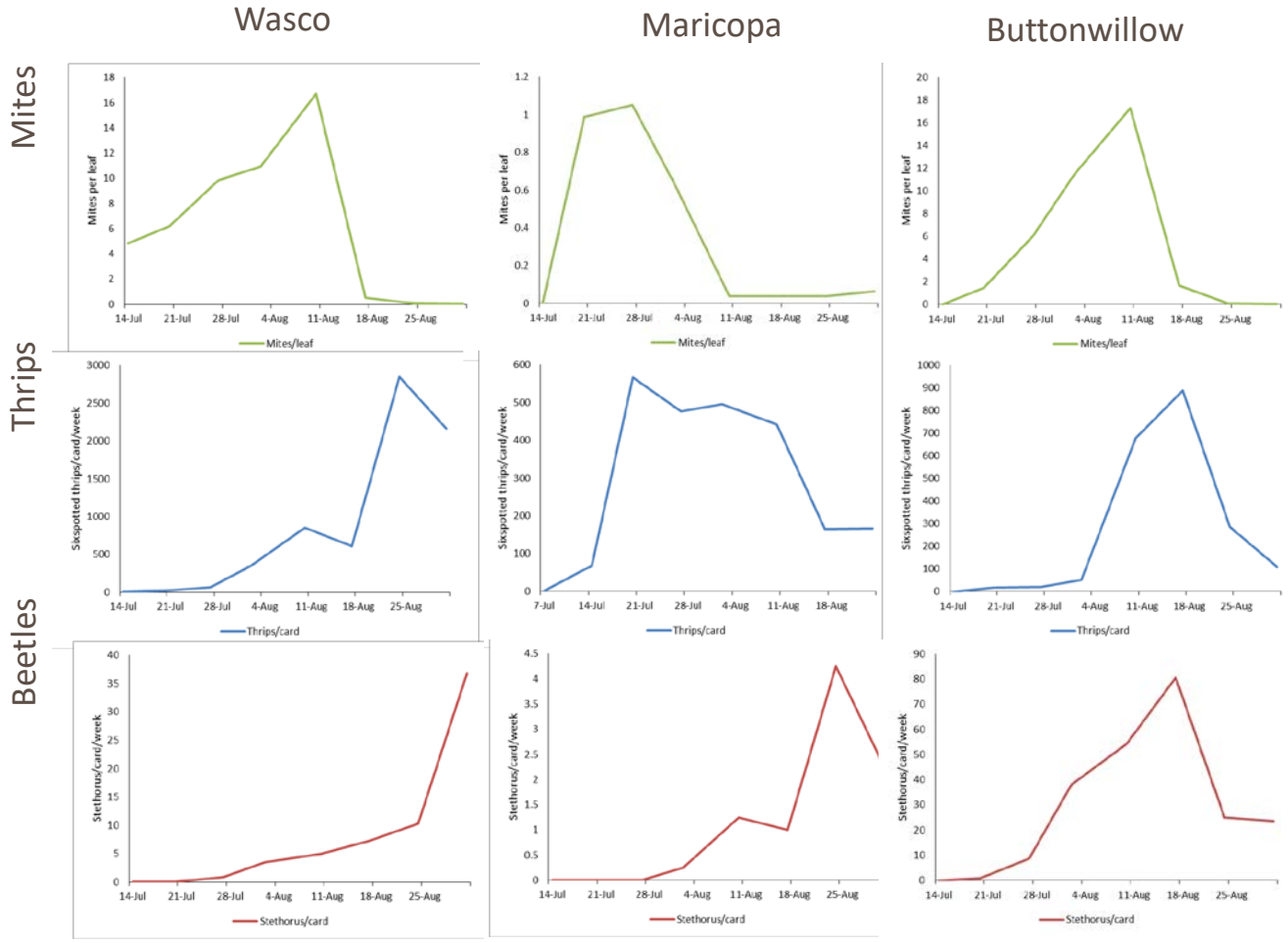






MITE BIOCONTROL

- Sixspotted thrips present in all three locations
- Approximate 2-week delay between exponential mite increases and exponential thrips response
- Sixspotted thrips populations doubled every 2.4, 2.7, and 3.6 days (Avg. 2.9)
- Predatory beetles present at all sites
- Using thresholds and thrips we reduced mite sprays by 1-2 per season



Population Doubling Time

Year	Location	Doubling time in days	
		Pacific Spider Mite	Sixspotted thrips
2016	Shafter	15.9	4.2
2016	McFarland	6.0	4.2
2017	Shafter	3.8	2.3
2017	Maricopa	9.3	2.7
2007	Buttonwillow	3.0	3.6
Average		7.6	3.4

CONCLUSIONS

- Sixspotted thrips is a formidable predator
- Don’t treat for mites without monitoring mites and sixspotted thrips
- Can be monitored with sticky cards
- Shows up naturally, highly mobile
- Excellent population doubling times
- Excellent predator characteristics
  - Thigmotactic, high preference for spider mites, cannibalistic when food is scarce
- Don’t starve them, use thresholds
- Don’t kill them with insecticides

**THIS RESEARCH WAS FUNDED BY THE ALMOND BOARD OF CALIFORNIA
CA DEPT. OF PESTICIDE REGULATION
WITH IN-KIND CONTRIBUTIONS FROM SUTERRA, SEMIOS, PACIFIC BIOCONTROL, AND TRÉCÉ**

Thank you
Grower and PCA Cooperators
Field assistance- Stephanie Rill, Dan Rivers, Chelsea Gordon, Joseph Aguilar, Laurren Heppner, Mackenzie Zeimet, Eryn McKinney, Daniel Green and Emily Buerer

NAVEL ORANGEWORM AND MITES: NORTHERN SAN JOAQUIN VALLEY PERSPECTIVE

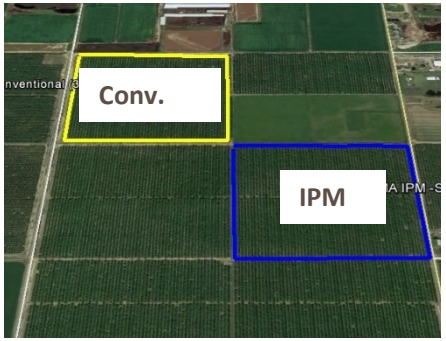
Jhalendra Rijal

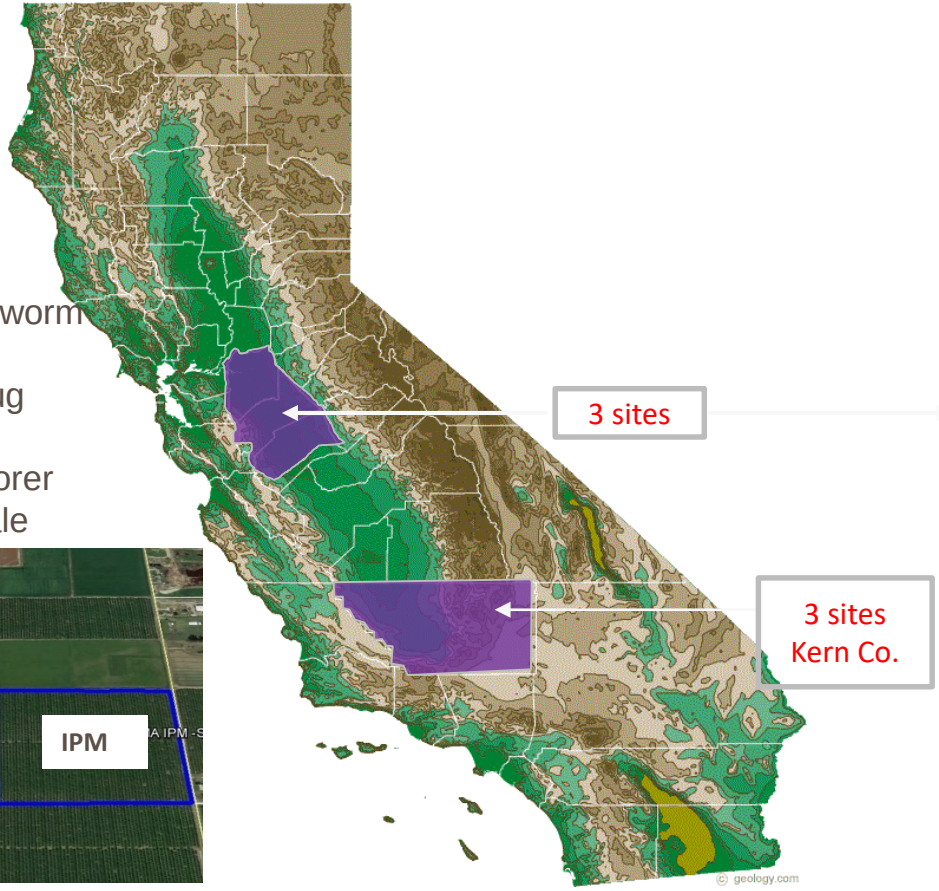
IPM Farm Advisor, Northern SJV

UC Cooperative Extension-Stanislaus, Modesto, CA

PMA project sites

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



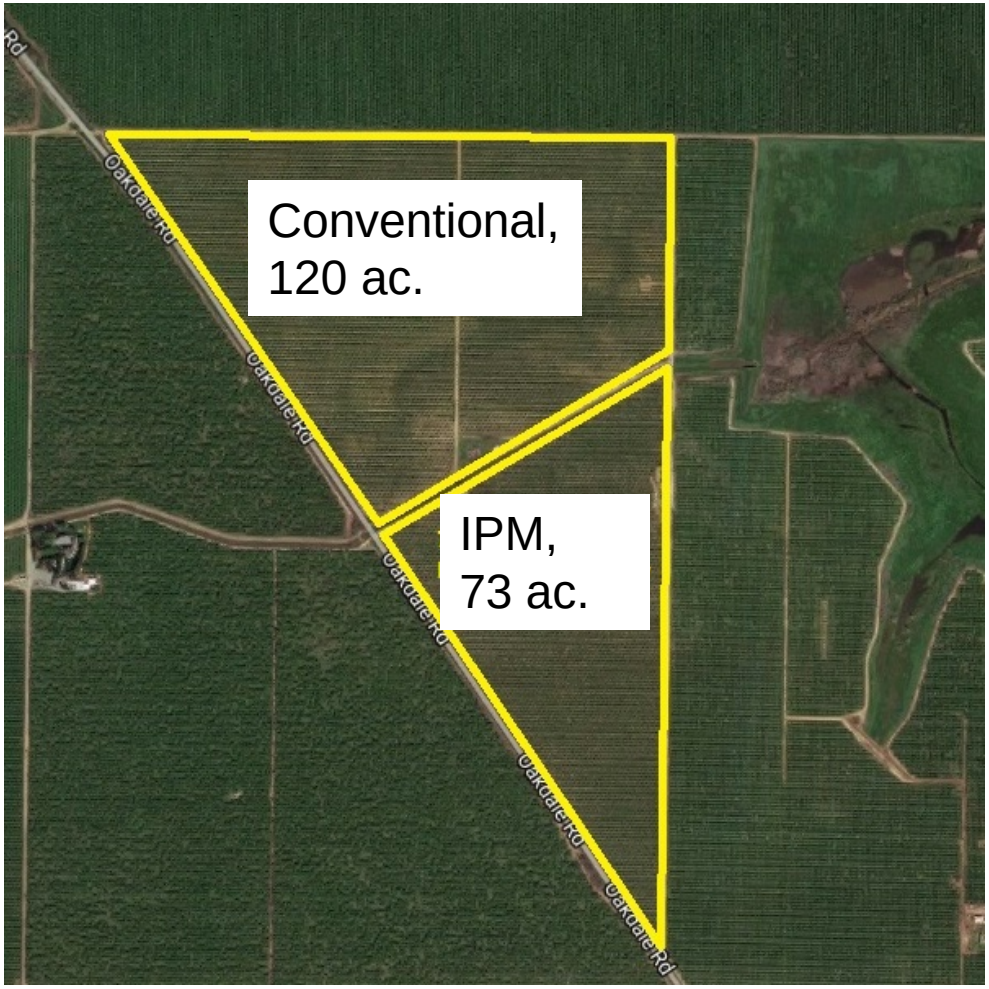


(Northen San Joaquin Valley)

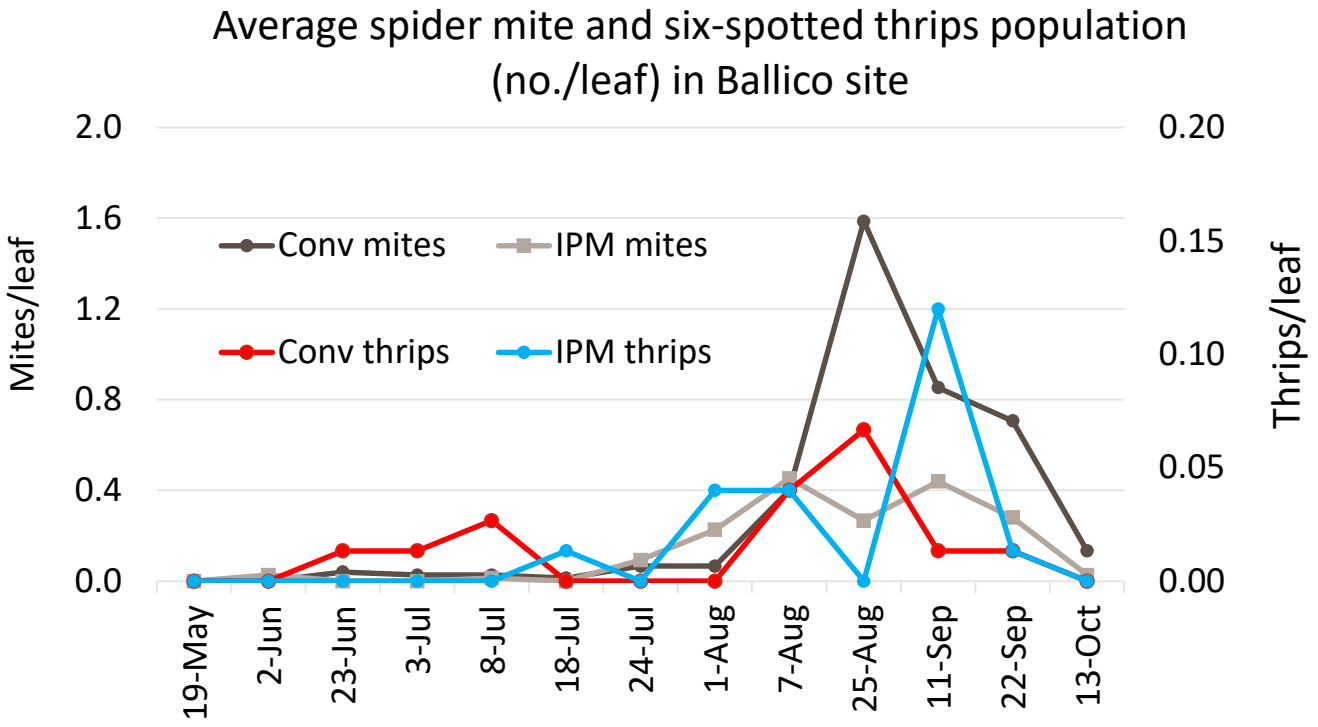
Ballico site, Merced Co.

Variety: NP/Monterey/Fritz
Age: 5th leaf

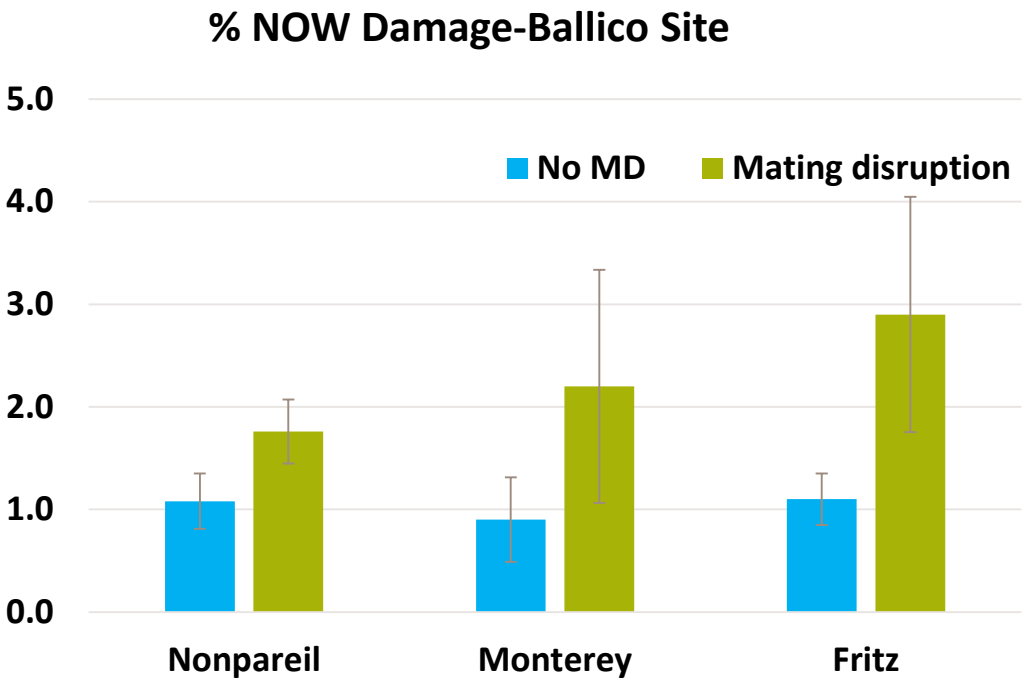
Practice	Conv.	IPM
Winter sanitation	Yes	Yes
NOW mating disruption	No	Yes
May worm spray	Yes (pyrethroid)	No
May mite spray (Abamectin)	Yes	Yes
Hull-split worm (Intrepid)	Yes	Yes
Hull-split mite (Fujimite)	Yes	Yes



Ballico site, Spider mites



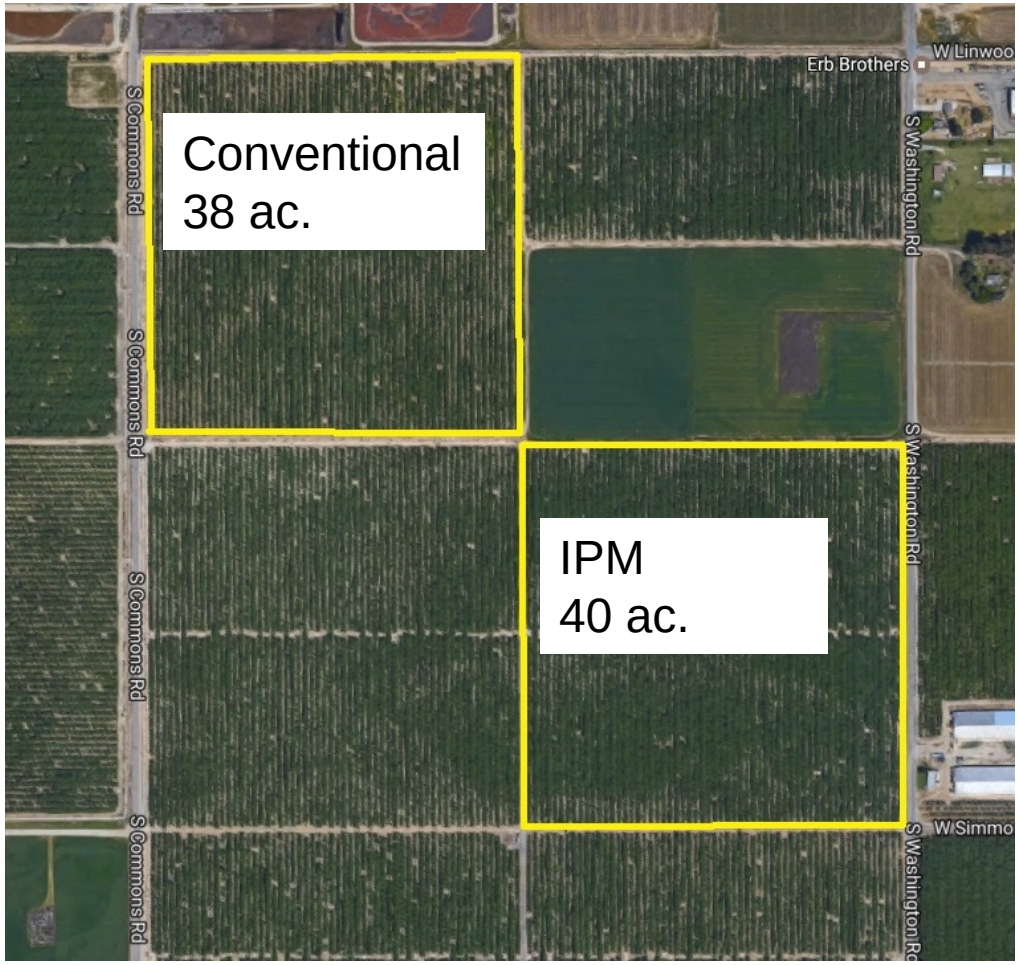
Ballico site, Navel Orangeworm



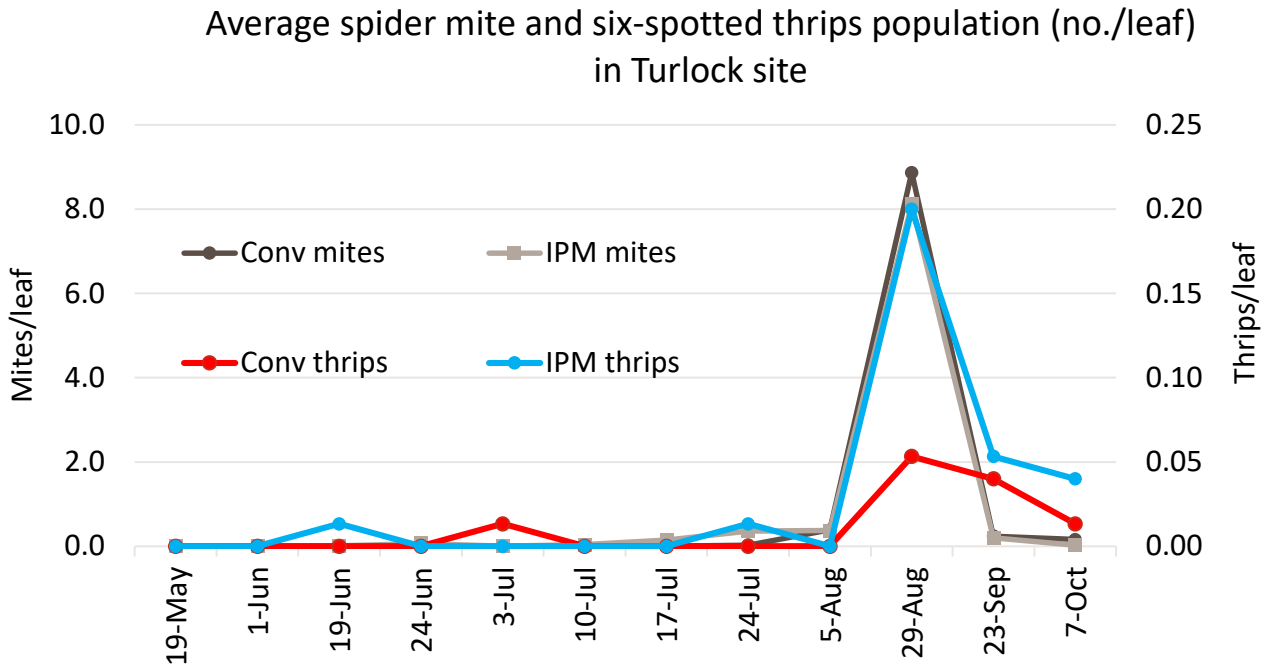
Turlock site, Stanislaus Co.

Variety: NP/Carmel/Monterey
Age: 10-12th leaf

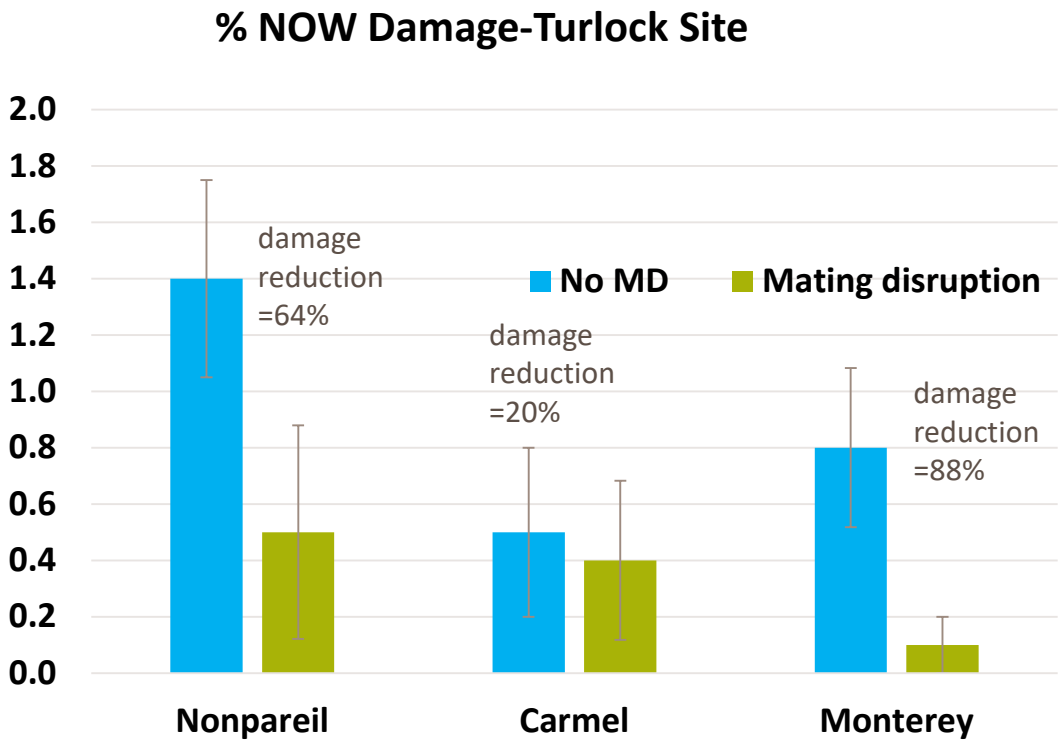
Practice	Conv.	IPM
Winter sanitation	Yes	Yes
NOW mating disruption	No	Yes
May worm spray	No	No
May mite spray (Abamectin)	No	No
June LFB spray	Yes	Yes
Hull-split worm (Intrepid)	Yes	Yes
Hull-split mite	Yes	Yes



Turlock site, Spider mites



Turlock site, Navel Orangworm

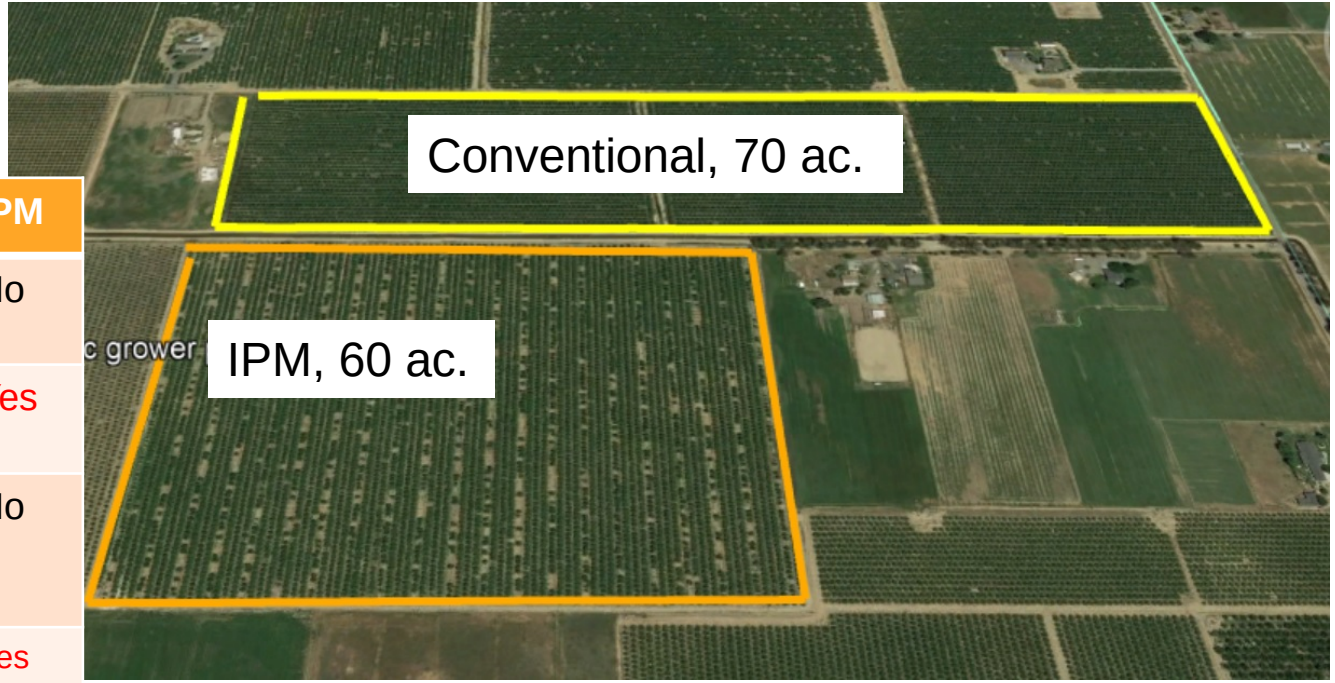


Overall damage reduction =57.3%

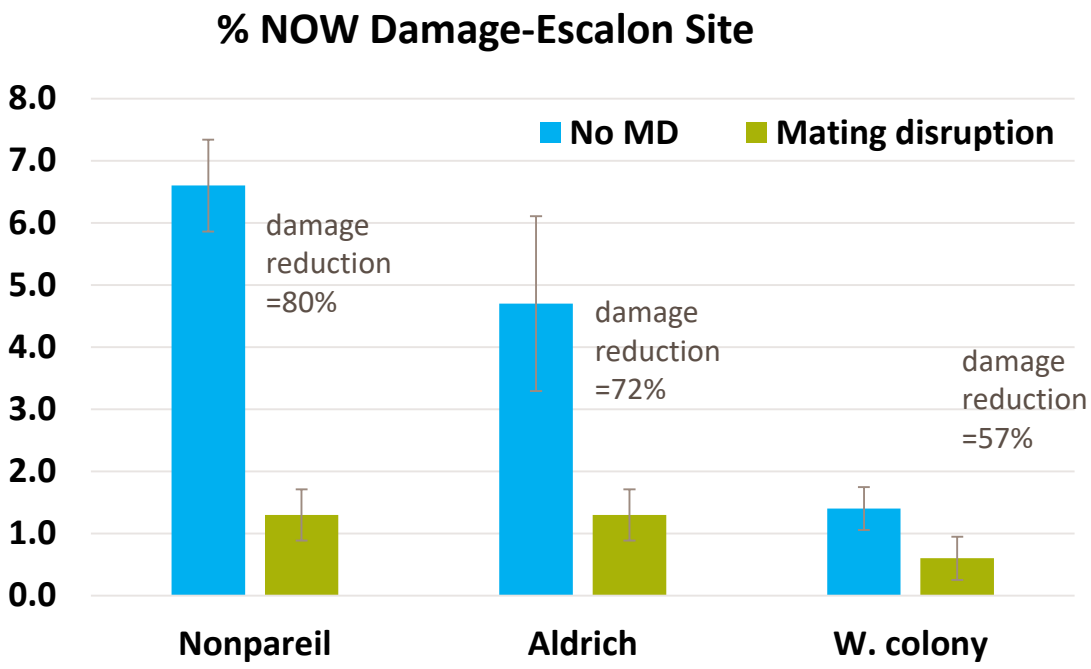
Escalon site, San Joaquin Co.

Variety: NP/Aldrich/Woodcolony
Age: 4th leaf

Practice	Conv	IPM
Winter sanitation	No	No
NOW mating disruption	No	Yes
May worm/mite spray	No	No
Hull-split worm spray	Yes (Intrepid+pyrethroid	Yes (Intrepid)
Hull-split mite (Abamectin)	Yes	Yes



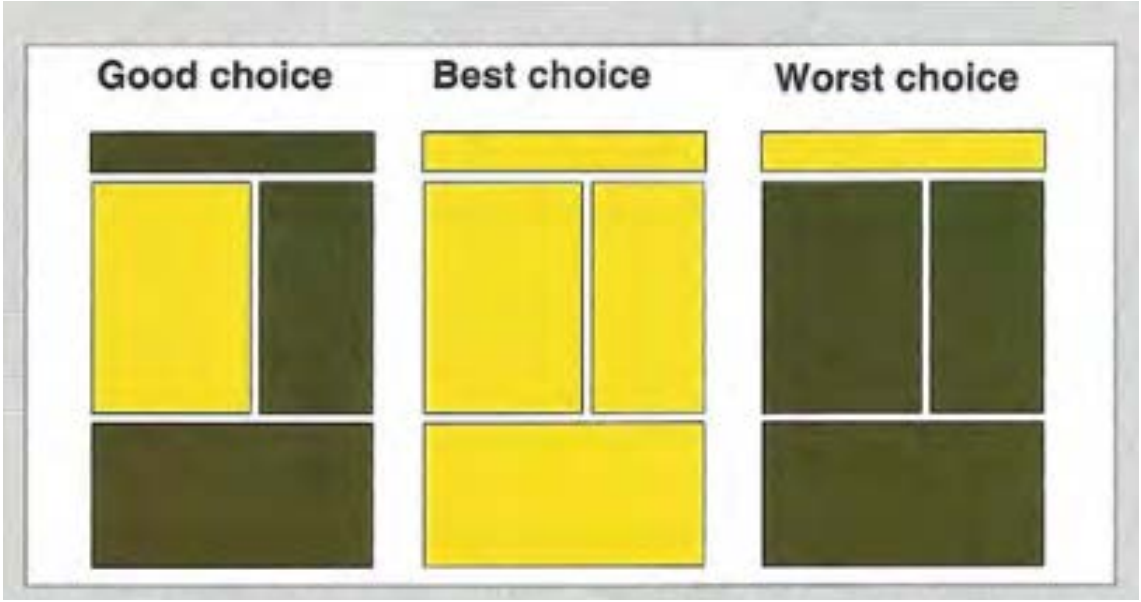
Escalon site, Navel Orangeworm



Overall damage reduction = 70%

CONSIDERATIONS WHILE USING MATING DISRUPTION

- **Area/block size under mating disruption**



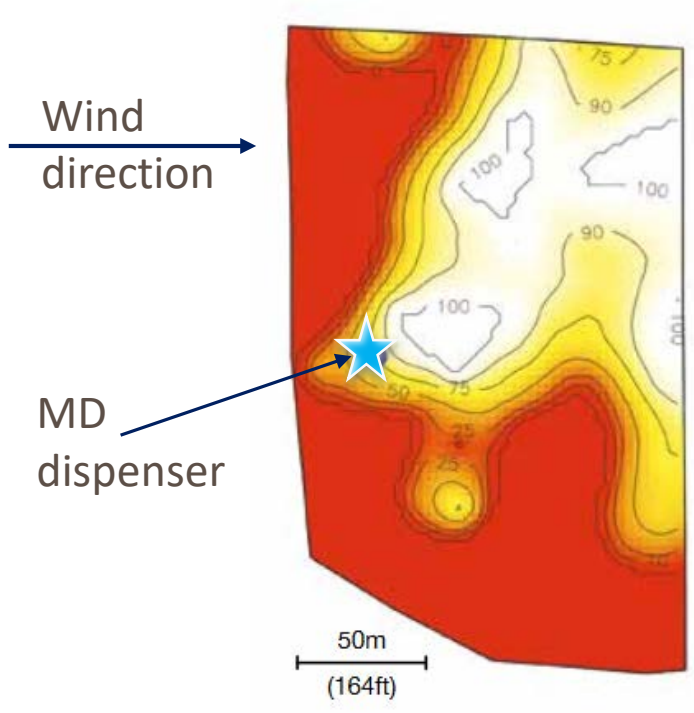
http://www.ipm.msu.edu/uploads/files/IPMA/CMInfoSeries.pdf

CONSIDERATIONS WHILE USING MATING DISRUPTION

- **Topography of the land**

CONSIDERATIONS WHILE USING MATING DISRUPTION

- **Wind direction/edge effect**

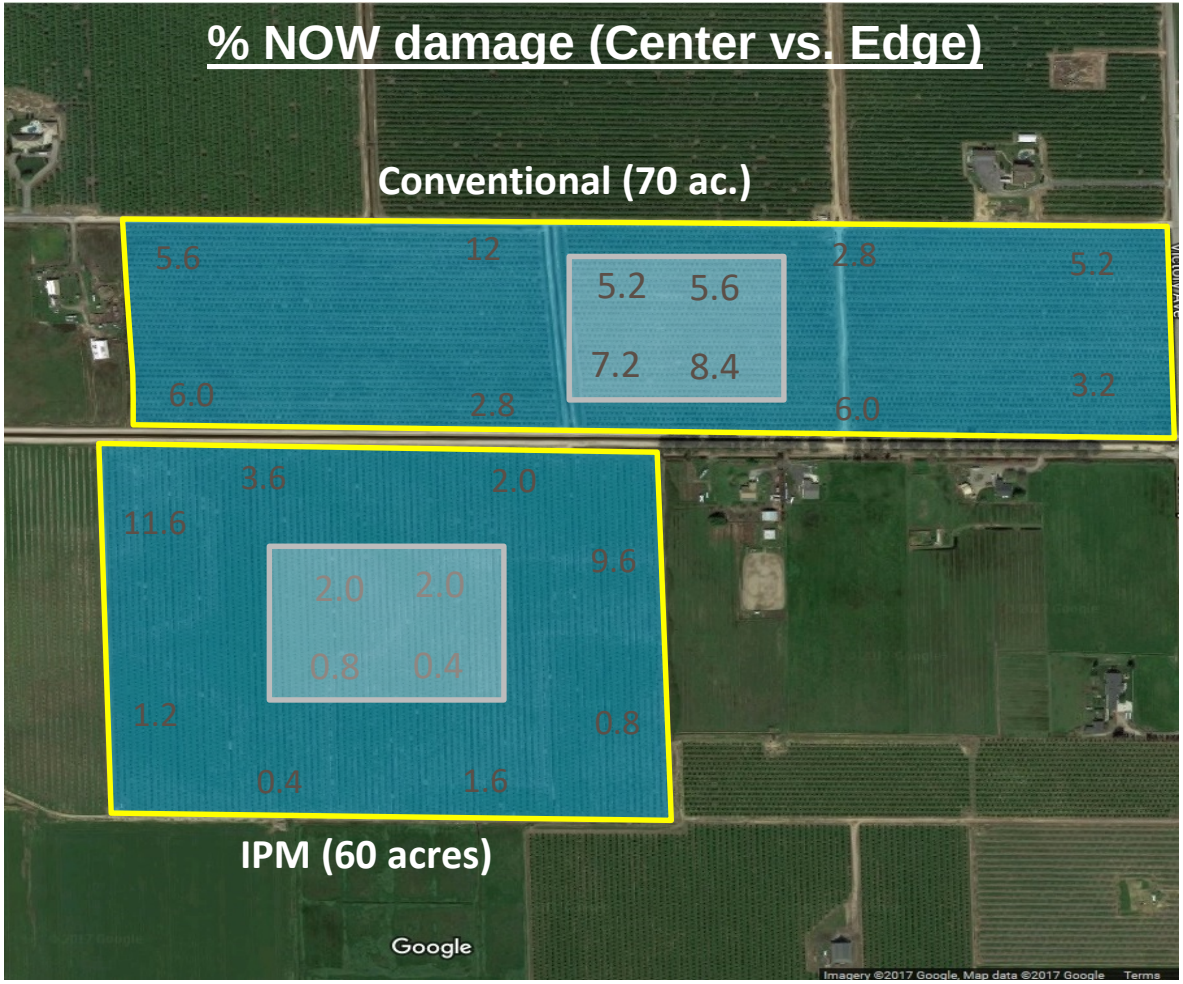


Source: Suterra.com

Escalon site

Conventional site:
Avg % damage (edge)= 5.5
Avg % damage (center)= 6.6

IPM site:
Avg % damage (edge)= 3.8
Avg % damage (center)= 1.3



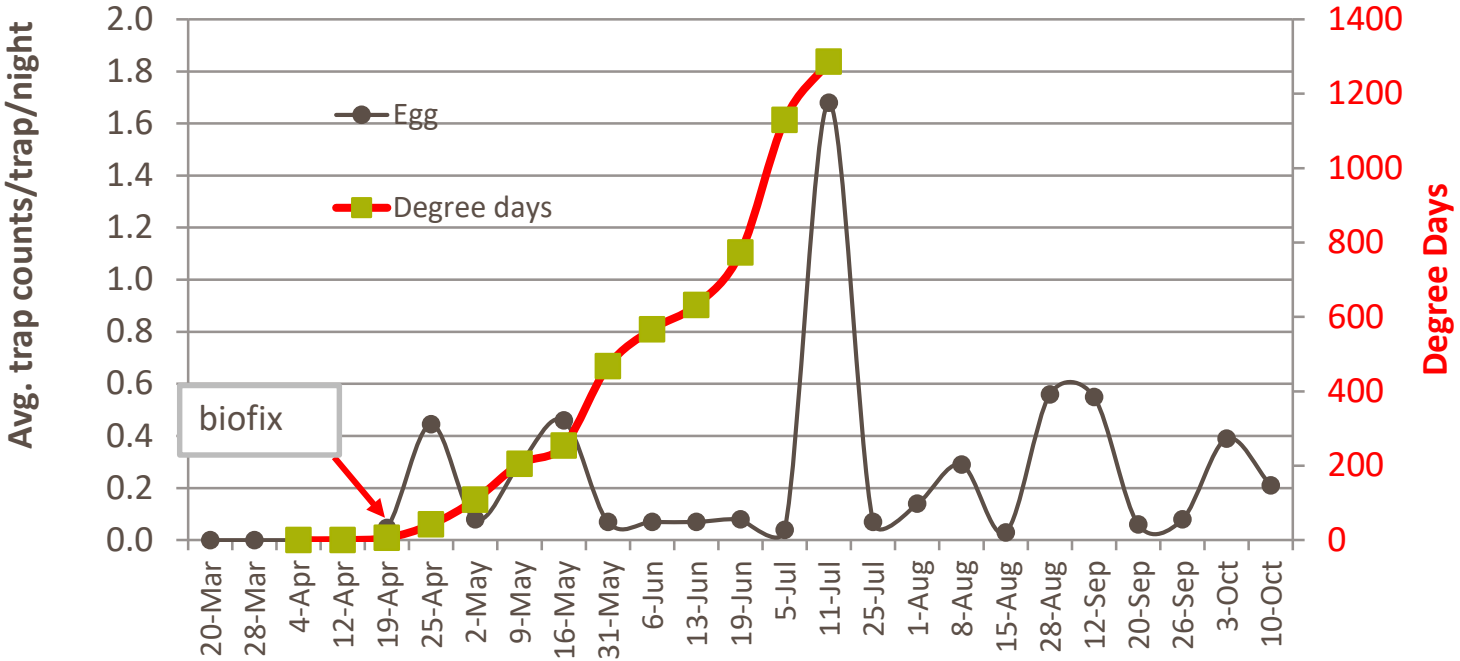
Turlock site

Conventional site:
Avg % damage (edge)= 1.35
Avg % damage (center)= 1.40

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

Navel orangeworm (NOW) egg trap and degree days (Modesto area) (avg. of total 12 traps in 3 orchards)

Egg biofix: 19 April 100 DD: 2 May
1200 DD: 8 July



Conclusion: IPM Approach for mite and NOW management

1. Mites:
    - Monitor mites and predator population
    - Threshold-based treatment
    - Avoid broad-spectrum insecticides and prophylactic miticide application

2. Navel orangeworm
    - Monitoring/DD (egg traps, adult traps)
    - Winter sanitation
    - Use of mating disruption (an excellent candidate for IPM)
    - Insecticide (based on DD and crop phenology)
    - Synergy between insecticide and mating disruption
        - Reducing high pest pressure
        - Targeted application in the orchard such as edge,
        - bottom of the hills etc.

NEW PEST UPDATE: BROWN MARMORATED STINK BUG (BMSB)

Jhalendra Rijal

IPM Farm Advisor, Northern SJV

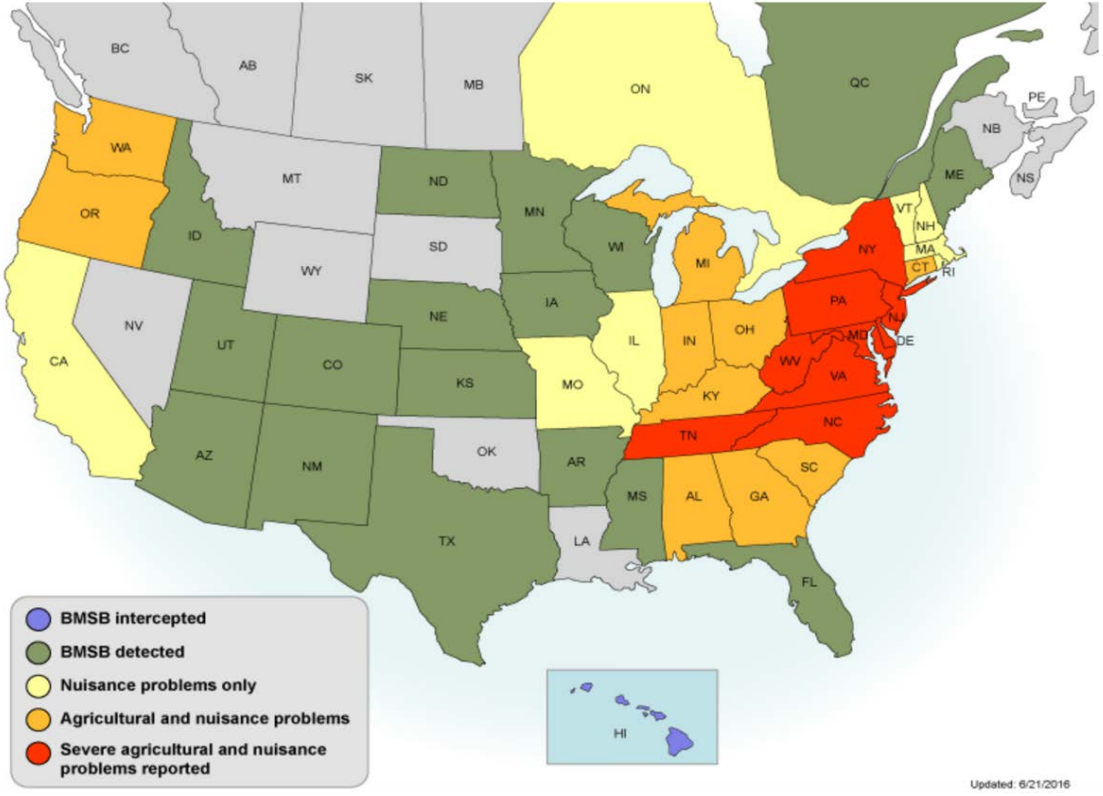
UC Cooperative Extension-Stanislaus, Modesto, CA

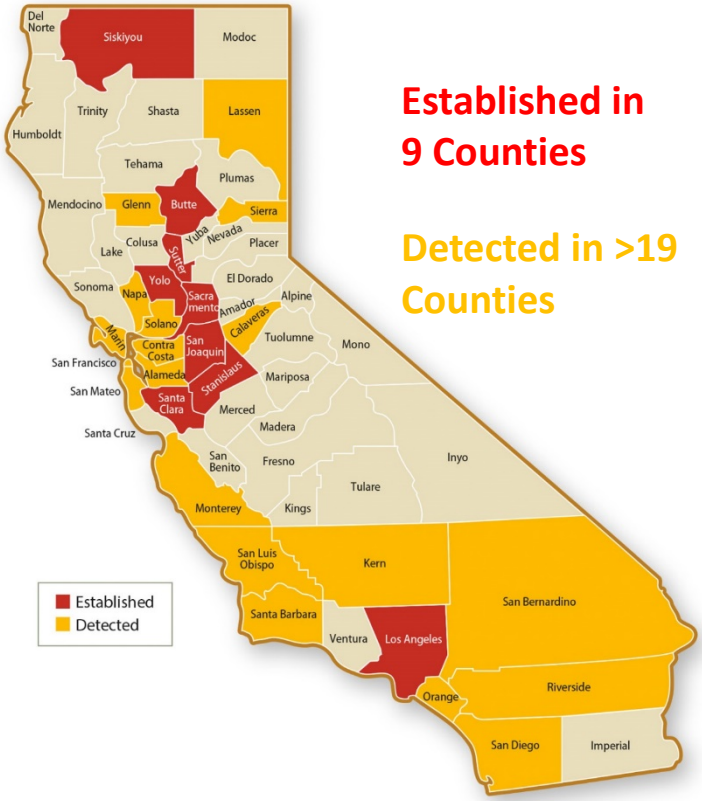
BROWN MARMORATED STINK BUG

- Invasive stink bug, *Halyomorpha halys* (Stal)
- First detection in PA around late-1990s
- In 2010, significant economic loss in Mid-Atlatitc States ($ 37 million only in apple)

Photo: Doug Pfeiffer, Virginia Tech

BMSB DISTRIBUTION IN THE US: 43 STATES





Established in 9 Counties

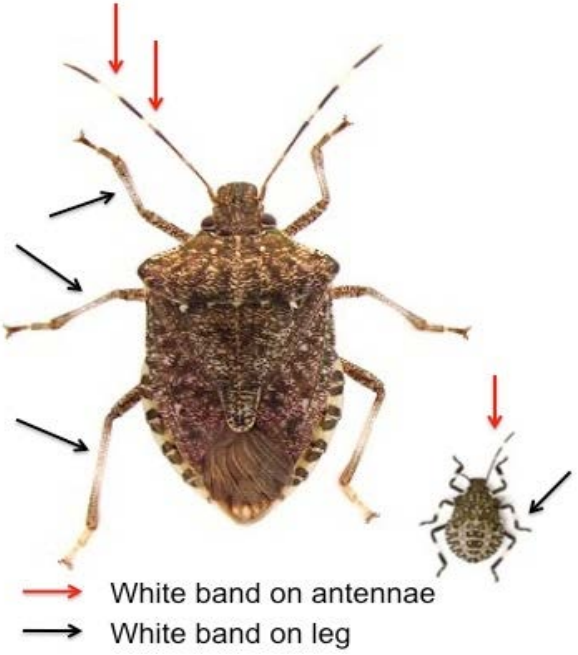
Detected in >19 Counties

HOW DIFFERENT BMSB FROM OTHER STINK BUGS

Rough Stink Bug,
Brochymena quadripustulata

Consperse Stink Bug
Euschistus conpersus

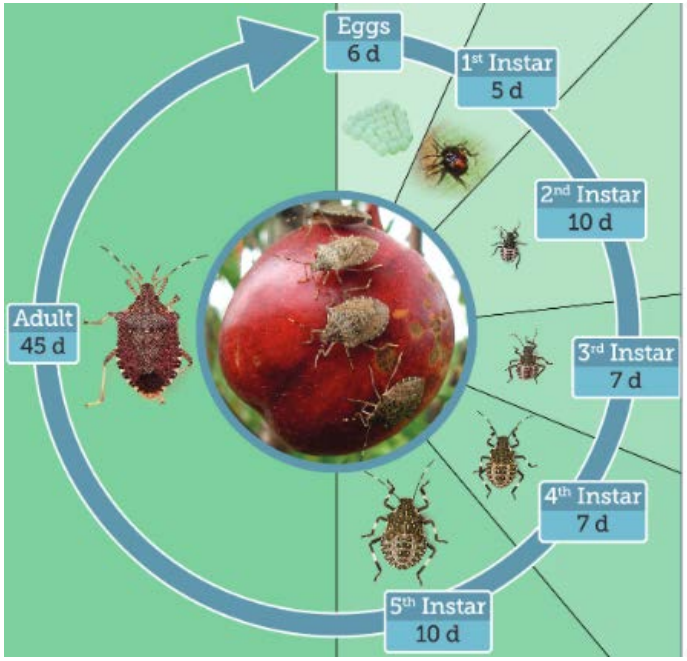
Brown Marmorated Stink Bug
Halyomorpha halys



http://www.stopbmsb.org/stink-bug-basics/look-alike-insects/

LIFE STAGES OF BMSB

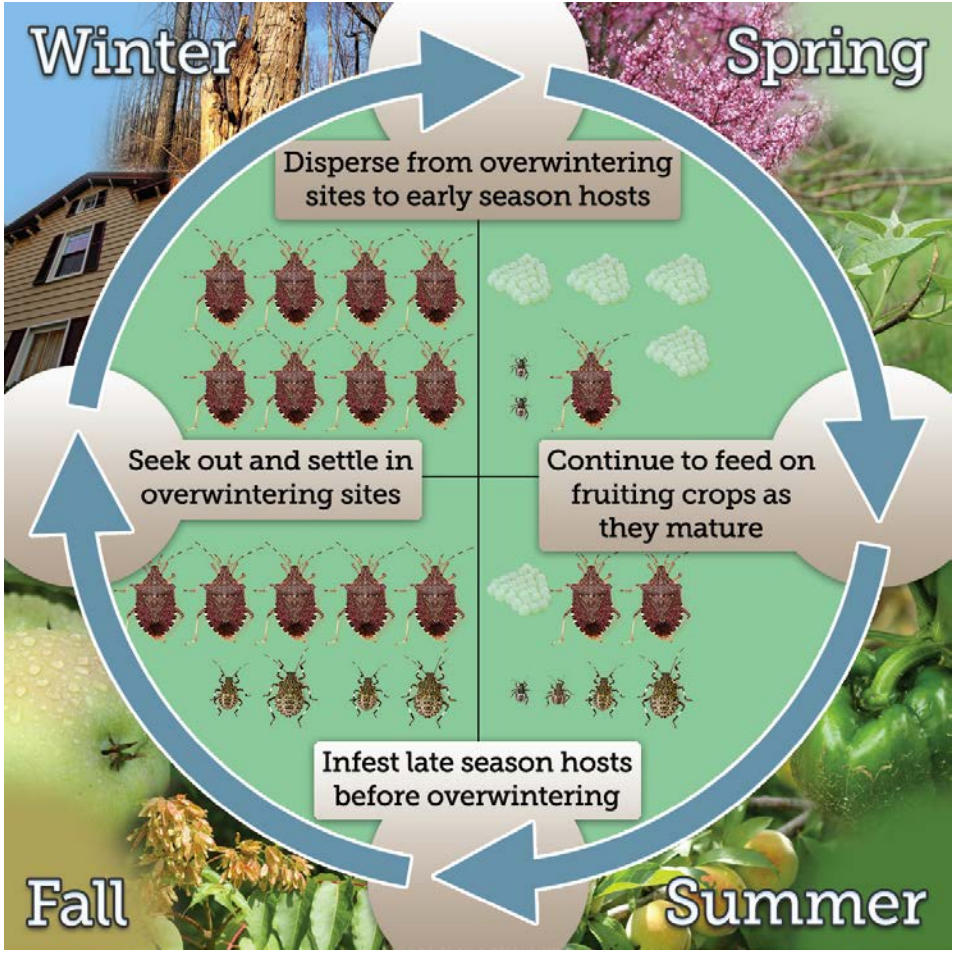
Eggs/1st instar nymphs



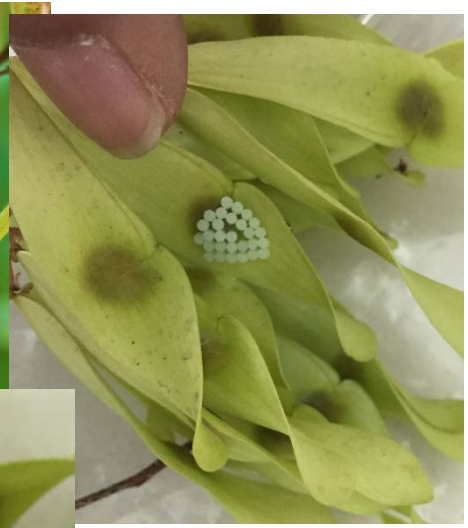
SEASONAL PHENOLOGY

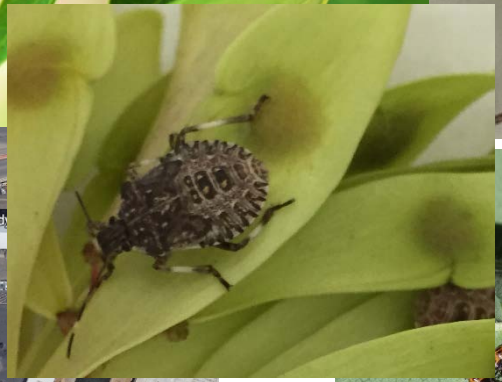
Winter/late Fall

http://extension.usu.edu/files/publications/factsheet/bmsb-5-11.pdf

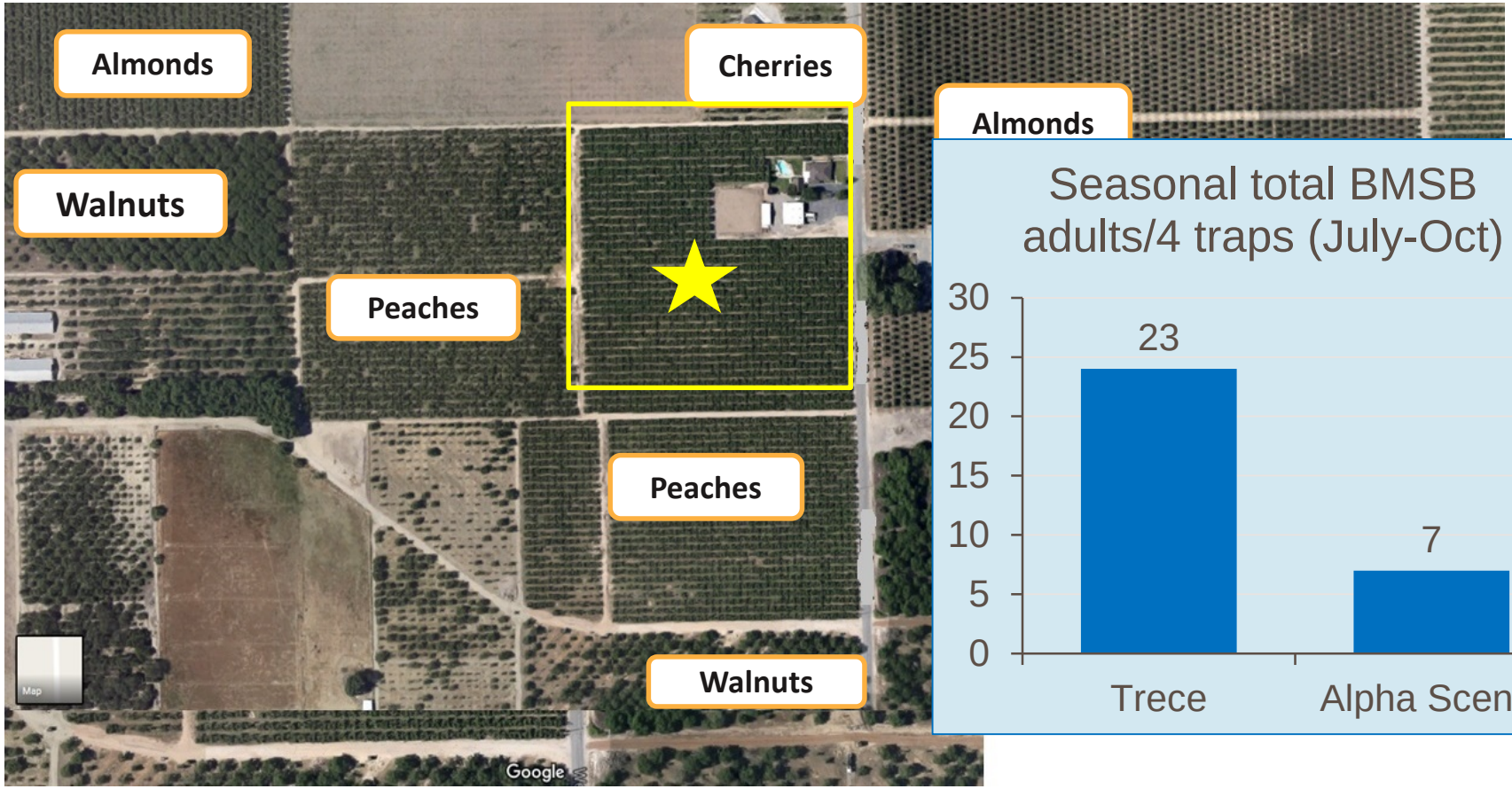


2015-BMSB IN MODESTO (NEAR HIGHWAY-99)



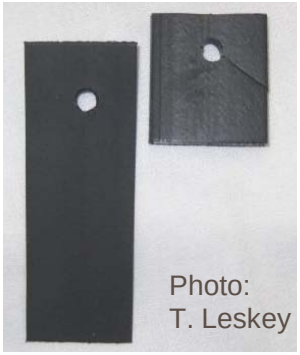


2016-BMSB FINDING IN A PEACH ORCHARD



2017 BMSB MONITORING

Pyramid Trap

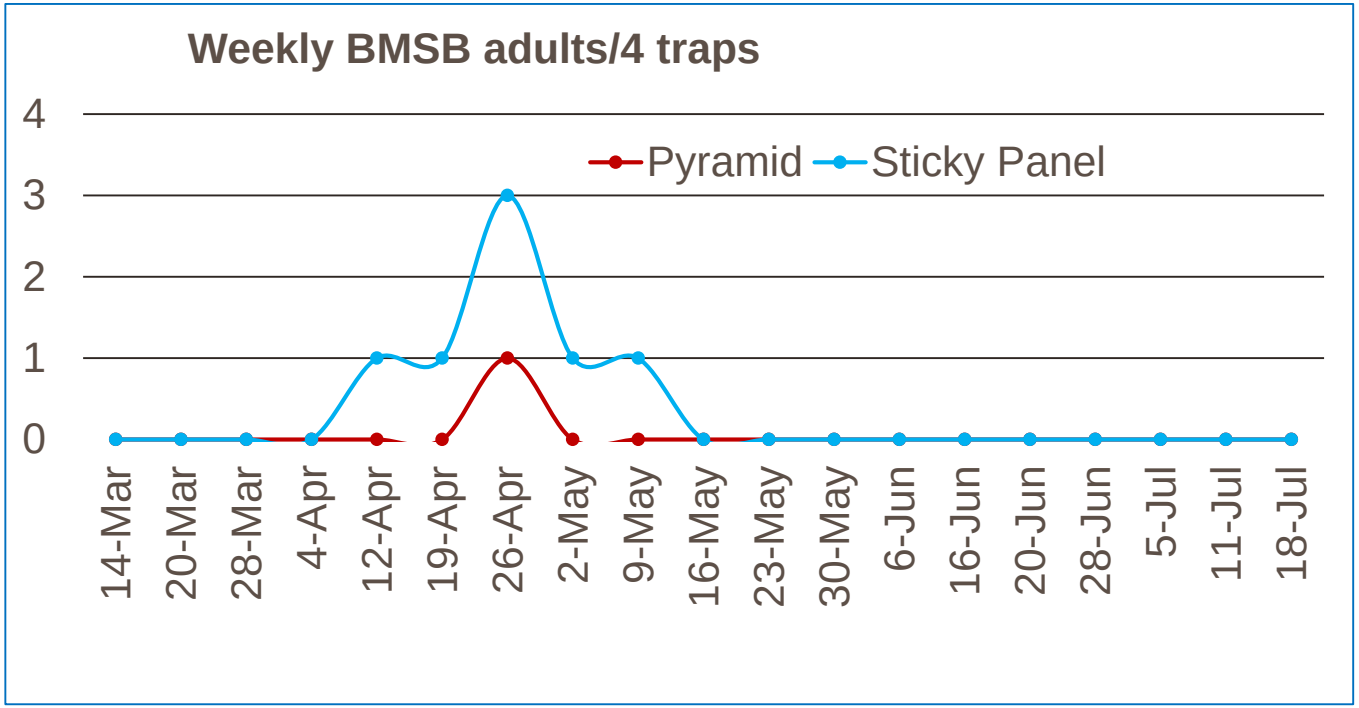


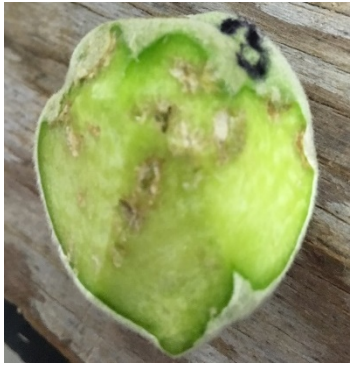
Trécé dual lure
(murgantiol & MDT)

- 4 Pyramid traps
- 4 Sticky panel traps

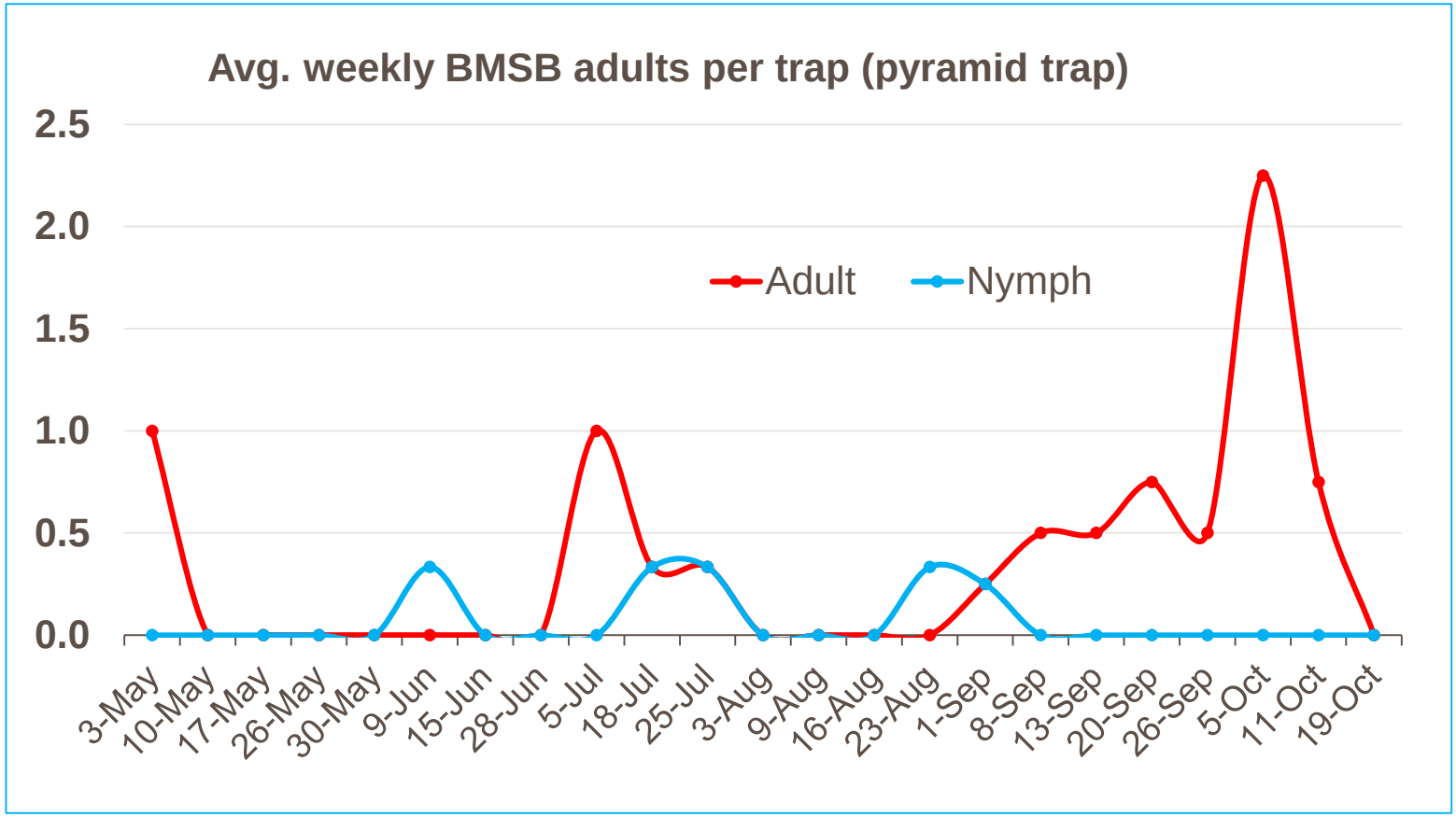
Sticky Panel Trap

2017-BMSB TRAPPING IN PEACH ORCHARD

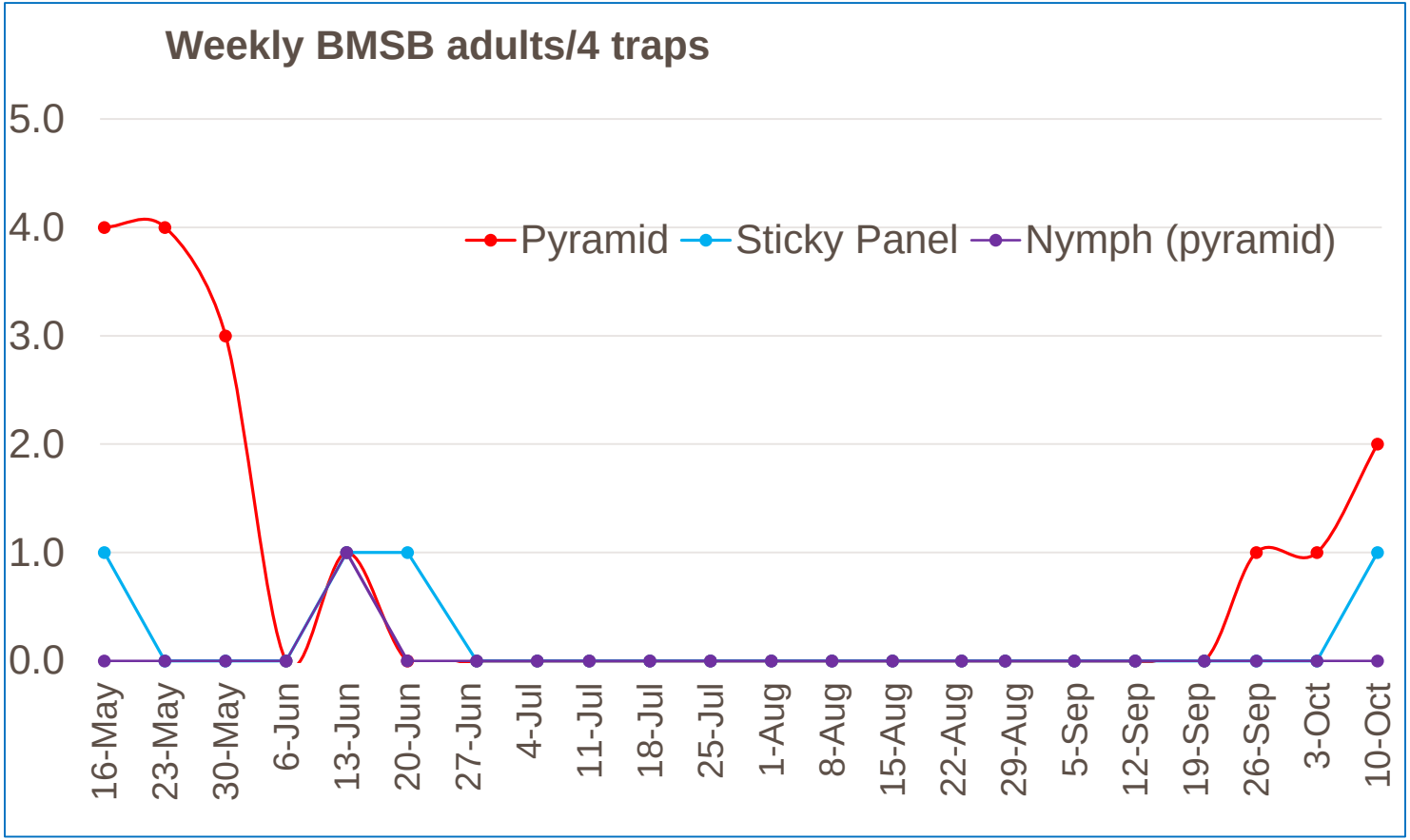




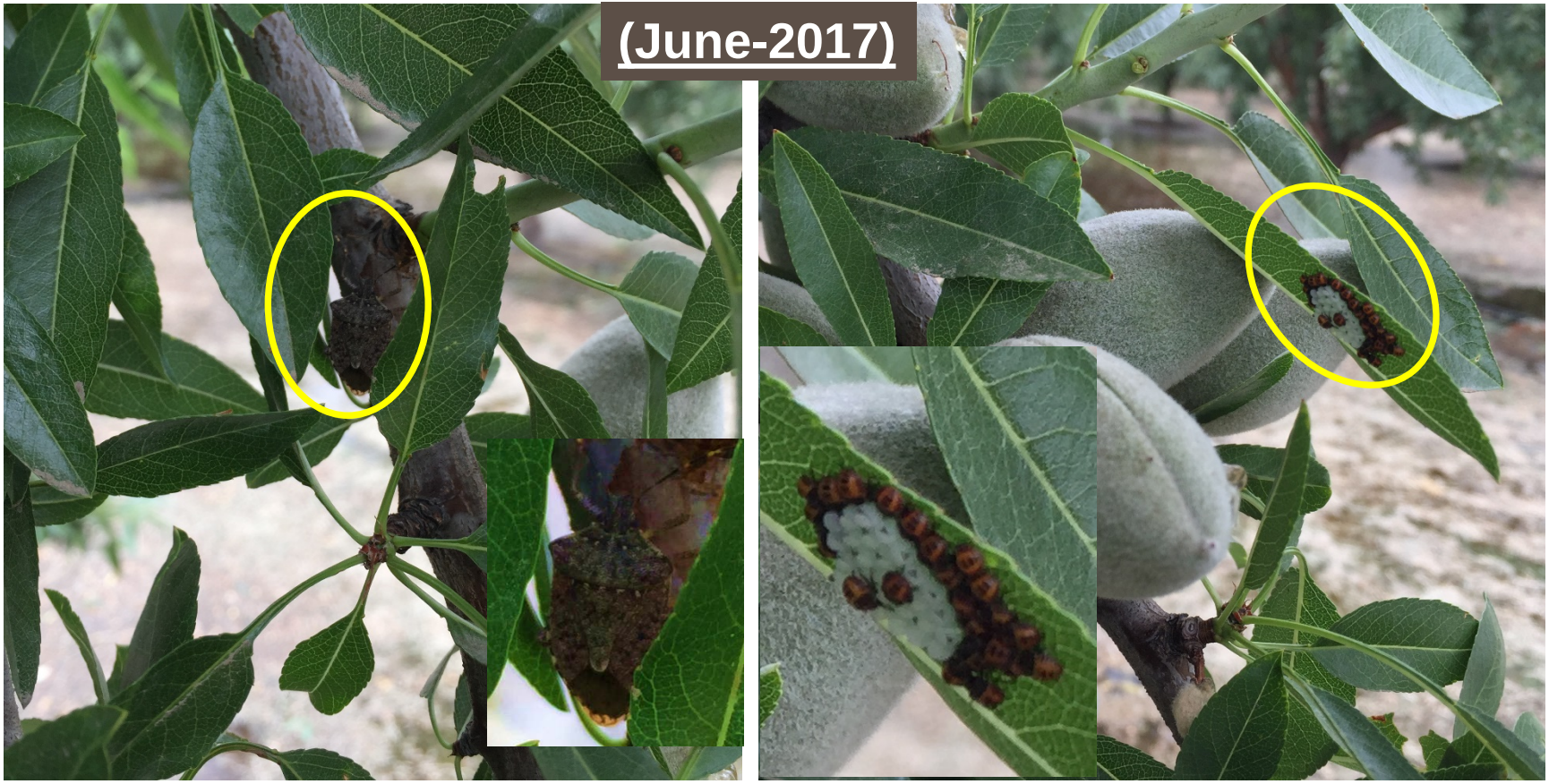
BMSB PHENOLOGY IN MODESTO AREA (2017-NSJV)



2017-BMSB TRAPPING IN ALMOND ORCHARD

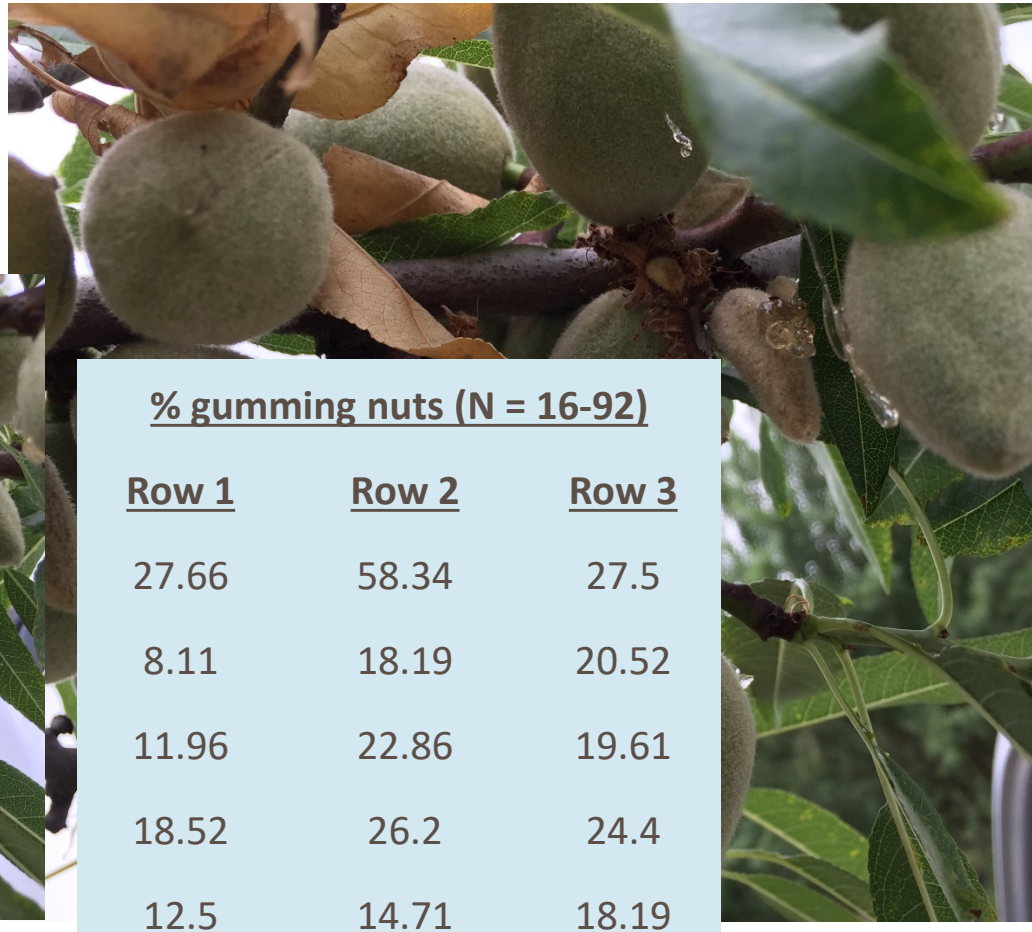


BMSB IN ALMONDS



BMSB IN ALMONDS

- Excessive gumming, 2 orchards, maybe contributed by other bugs as well



% gumming nuts (N = 16-92)

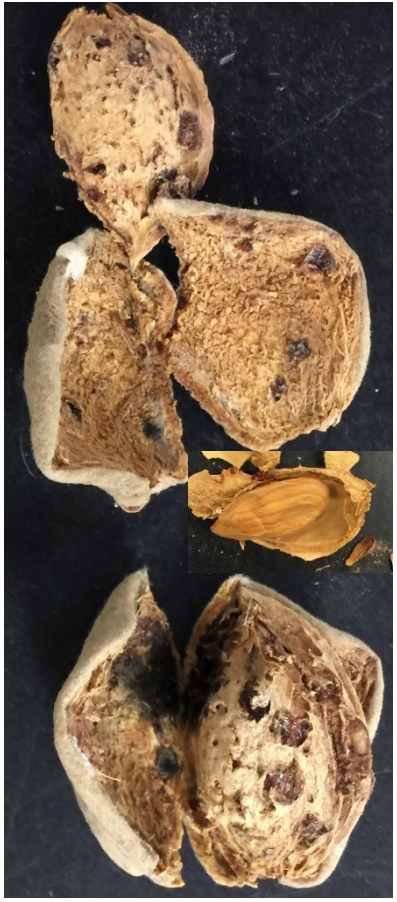
Row 1	Row 2	Row 3
27.66	58.34	27.5
8.11	18.19	20.52
11.96	22.86	19.61
18.52	26.2	24.4
12.5	14.71	18.19

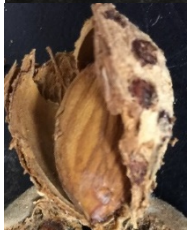
Gumming nuts: 8 – 58%

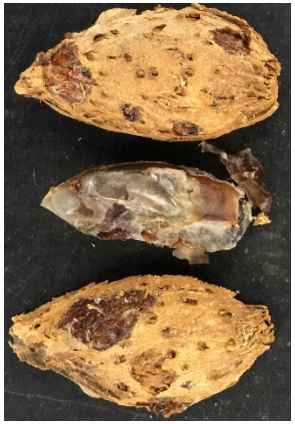
BMSB IN ALMONDS: JUNE FINDING

- Presence of necrotic spots (internally)

DAMAGE EVALUATION AT HARVEST

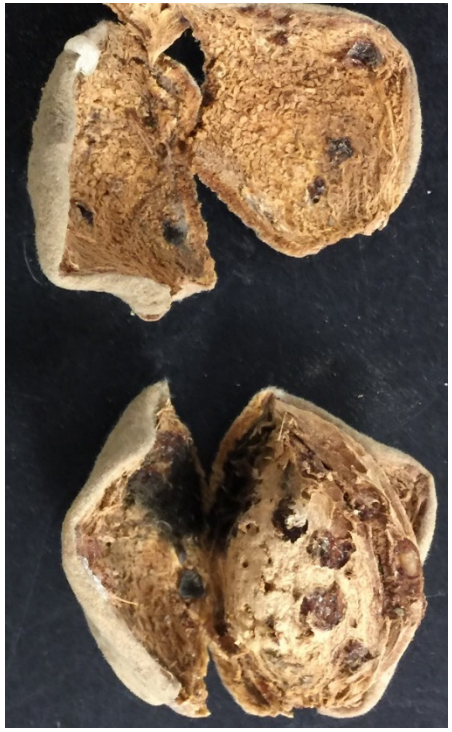






SIMILAR TYPE OF DAMAGE OBSERVED IN FEW OTHER ORCHARDS

We found



PCA found

CONCLUSION AND RECOMMENDATION FOR BMSB MONITORING

- BMSB spreading to agricultural areas
- BMSB can potentially cause damage to almonds
- Be vigilant about BMSB infestation in peach/almond orchards
- Conduct visual observation
- Inspect the fruits for damage (April-May)
- Use sticky panel traps with BMSB lure early in the season to detect BMSB presence in the orchard

ACKNOWLEDGEMENTS

Thank you to:

- Cooperator Growers,
- Pest Control Advisers
- Farm Advisors

Help from: Daniel Green, Daniel Rivers, Raquel Gomez, Emily Buerer,

USDA United States Department of Agriculture National Institute of Food and Agriculture NIFA

USDA-NIFA SCRI 2016-51181-25409