2023

THE ALMOND CONFERENCE

Connecting the Dots

GROWERS // HANDLERS // CUSTOMERS // CONSUMERS

Plant Bug Issues This Year and Beyond and Available Management Tools

Moderator: Lauren Fann (ABC)

Speakers: Mel Machado (Blue Diamond Growers), Kent Daane (UC Berkeley), Mateo Marquez (Integral Ag)

Power in Partnership

BLUE DIAMOND GROWERS

Plant Bug Damage in California Almonds

Plant Bugs

- Leaf-Footed Plant Bug

- Stink Bugs

Boxelder Bugs

Brown Spot - Monterey

Brown Spot

USDA Definition of Brown Spot

Kernels are now scored as Brown Spot (inedible) where

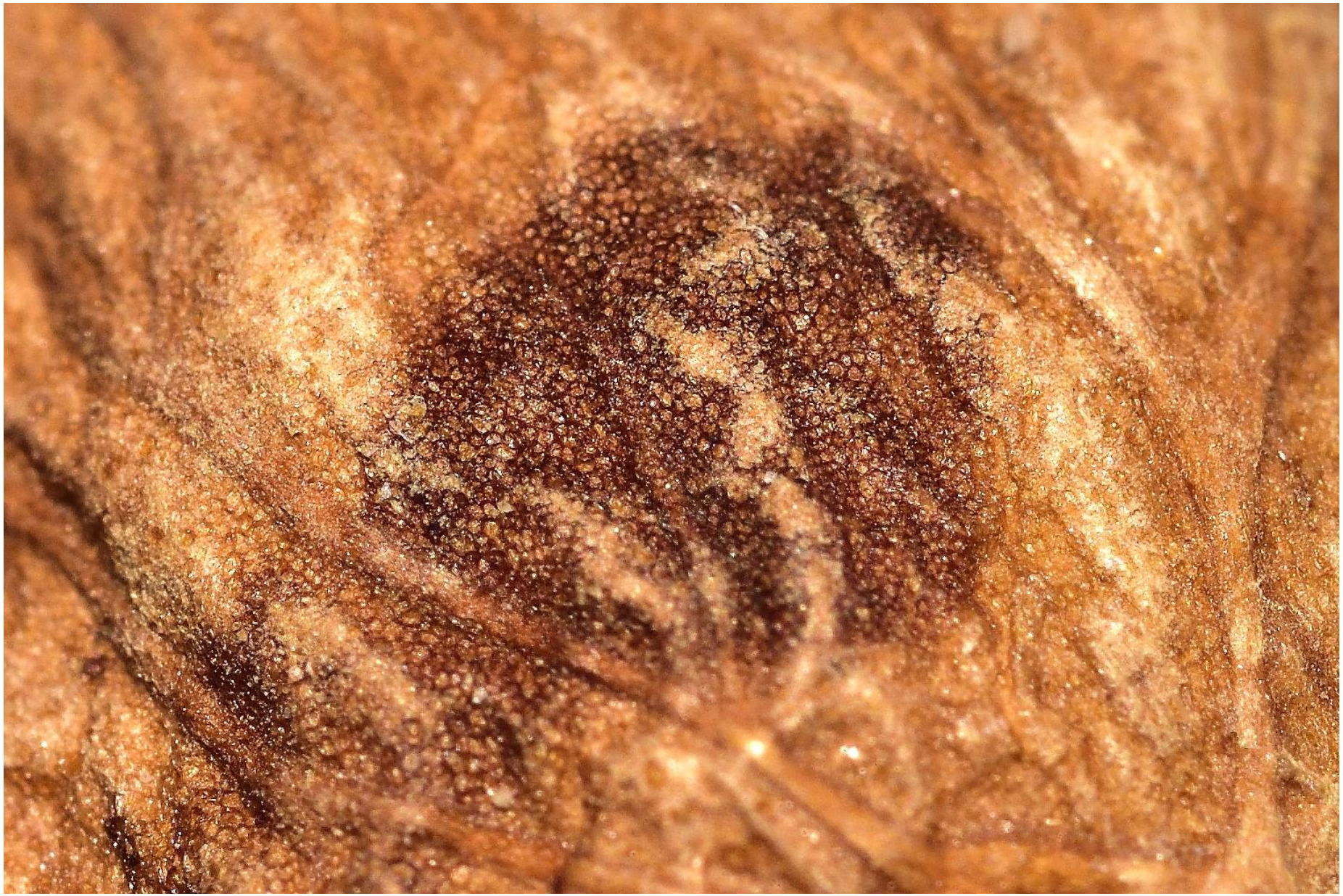
1. Brown discoloration is present, with or without sunken areas sunken
   or
2. Where sunken areas are present with or without brown discoloration.

Brown Spot

Brown Spot

Brown Spot or Pellicle Ink Stain?

Brown Spot or Pellicle Ink Stain?



Reject Comparison 2022 vs 2023

	2022 - 4.0% Total Rejects		2023 - 20.0% Total Rejects	
	Total	**Breakdown**	**Total**	**Breakdown**
NOW	0.60%	15.0%	15.00%	75.0%
Ants	0.12%	3.0%	0.10%	0.5%
Gum	0.08%	2.0%	0.10%	0.5%
Brown Spot	**3.00%**	**75.0%**	**3.00%**	**15.0%**
Mold	0.20%	5.0%	1.80%	9.0%
	4.00%	100.0%	20.00%	100.0%

Damage Data - Aldrich

Crop	RJS%	NOW	Ants	Gum	Brn Spot	Mold
2014	1.68%	**55.65%**	12.73%	12.68%	**8.20%**	5.99%
2015	1.56%	**52.54%**	16.61%	12.74%	**9.12%**	3.34%
2016	1.92%	**37.16%**	12.81%	23.65%	**18.39%**	3.42%
2017	4.14%	**55.09%**	12.73%	16.24%	**8.68%**	4.31%
2018	3.32%	**58.75%**	9.24%	12.51%	**11.12%**	5.35%
2019	2.04%	**53.93%**	11.60%	16.20%	**11.64%**	4.37%
2020	1.31%	**25.54%**	8.17%	18.18%	**35.96%**	8.75%
2021	1.80%	**42.92%**	6.51%	13.02%	**26.64%**	8.25%
2022	2.18%	**46.82%**	8.36%	15.16%	**21.18%**	6.76%
2023	3.84%	**69.08%**	3.65%	14.58%	**7.96%**	2.59%

Damage Data - Price

Crop	RJS%	NOW	Ants	Gum	Brn Spot	Mold
2014	0.69%	**35.22%**	31.50%	4.80%	**10.87%**	10.38%
2015	0.62%	**44.11%**	13.42%	12.27%	**15.91%**	10.54%
2016	0.54%	**31.24%**	24.62%	11.82%	**19.31%**	9.33%
2017	2.59%	**60.82%**	17.31%	7.44%	**4.82%**	6.59%
2018	0.60%	**46.34%**	14.91%	8.50%	**15.79%**	8.70%
2019	1.17%	**54.23%**	15.48%	8.15%	**11.71%**	6.84%
2020	0.71%	**38.72%**	17.98%	4.85%	**19.23%**	15.64%
2021	1.02%	**46.47%**	10.99%	6.26%	**20.05%**	13.57%
2022	1.40%	**37.46%**	11.38%	9.47%	**25.43%**	13.39%
2023	2.12%	**62.79%**	8.78%	7.48%	**11.72%**	6.45%

Damage Data - Fritz

Crop	RJS%	NOW	Ants	Gum	Brn Spot	Mold
2014	1.78%	**51.12%**	15.62%	17.43%	**2.80%**	6.91%
2015	1.00%	**50.45%**	7.85%	18.17%	**9.90%**	9.33%
2016	1.11%	**41.07%**	10.77%	23.71%	**9.96%**	6.57%
2017	2.25%	**57.68%**	7.50%	17.59%	**6.22%**	7.80%
2018	1.81%	**41.31%**	10.71%	30.44%	**8.13%**	5.42%
2019	1.70%	**59.53%**	6.57%	19.90%	**6.43%**	6.62%
2020	0.76%	**40.91%**	6.87%	19.88%	**18.67%**	10.06%
2021	1.86%	**43.92%**	5.85%	20.40%	**17.18%**	7.89%
2022	2.00%	**46.92%**	6.89%	18.05%	**13.77%**	11.26%
2023	5.47%	**78.31%**	2.50%	9.84%	**3.09%**	2.63%

Damage Data - Sonora

Crop	RJS%	NOW	Ants	Gum	Brn Spot	Mold
2014	2.83%	**53.28%**	17.56%	17.61%	**2.67%**	3.54%
2015	3.46%	**44.51%**	13.67%	28.91%	**4.16%**	3.45%
2016	1.97%	**38.52%**	19.06%	25.67%	**5.24%**	3.97%
2017	6.26%	**45.96%**	11.69%	34.31%	**2.30%**	1.99%
2018	2.76%	**45.98%**	13.39%	27.50%	**3.84%**	4.51%
2019	1.70%	**49.33%**	16.22%	16.66%	**6.29%**	5.18%
2020	2.06%	**41.79%**	14.90%	19.48%	**13.88%**	6.62%
2021	4.30%	**49.15%**	10.35%	25.09%	**8.06%**	4.79%
2022	3.02%	**47.91%**	10.71%	25.65%	**8.59%**	2.94%
2023	4.75%	**69.95%**	7.69%	11.75%	**3.74%**	4.21%

Damage Data - Monterey

Crop	RJS%	NOW	Ants	Gum	Brn Spot	Mold
2014	1.80%	**60.00%**	14.03%	6.97%	**8.59%**	7.28%
2015	1.15%	**59.12%**	9.56%	13.32%	**8.08%**	6.43%
2016	2.05%	**52.48%**	13.97%	13.59%	**5.26%**	7.61%
2017	4.96%	**69.78%**	6.82%	10.73%	**5.23%**	3.84%
2018	1.46%	**52.48%**	11.53%	17.00%	**8.19%**	6.90%
2019	1.73%	**68.00%**	8.22%	8.18%	**6.83%**	5.62%
2020	1.17%	**45.46%**	9.54%	11.62%	**17.05%**	11.92%
2021	2.42%	**49.16%**	8.37%	8.50%	**20.92%**	9.51%
2022	1.93%	**51.29%**	8.64%	10.90%	**15.29%**	10.87%
2023	3.72%	**79.55%**	3.40%	5.13%	**5.40%**	3.92%

Damage Data - Butte/Padre

Crop	RJS%	NOW	Ants	Gum	Brn Spot	Mold
2014	0.46%	**29.48%**	14.91%	16.66%	**9.64%**	21.80%
2015	0.45%	**39.43%**	12.75%	14.78%	**10.42%**	17.44%
2016	0.76%	**30.59%**	15.44%	17.66%	**11.01%**	18.46%
2017	1.20%	**47.12%**	10.02%	13.29%	**10.16%**	16.10%
2018	0.91%	**46.95%**	11.15%	11.68%	**11.85%**	13.38%
2019	1.32%	**48.33%**	11.45%	9.17%	**10.08%**	15.80%
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2021	1.01%	**28.36%**	7.49%	10.06%	**30.76%**	20.45%
2022	0.91%	**30.69%**	8.24%	15.47%	**25.27%**	17.40%
2023	1.75%	**61.27%**	5.21%	8.63%	**12.35%**	9.26%

Damage Data - Independence

Crop	RJS%	NOW	Ants	Gum	Brn Spot	Mold
2014	1.13%	**20.62%**	37.34%	6.19%	**28.68%**	3.76%
2015	1.94%	**17.61%**	35.11%	7.24%	**35.70%**	2.23%
2016	1.96%	**14.64%**	36.36%	10.01%	**24.30%**	5.65%
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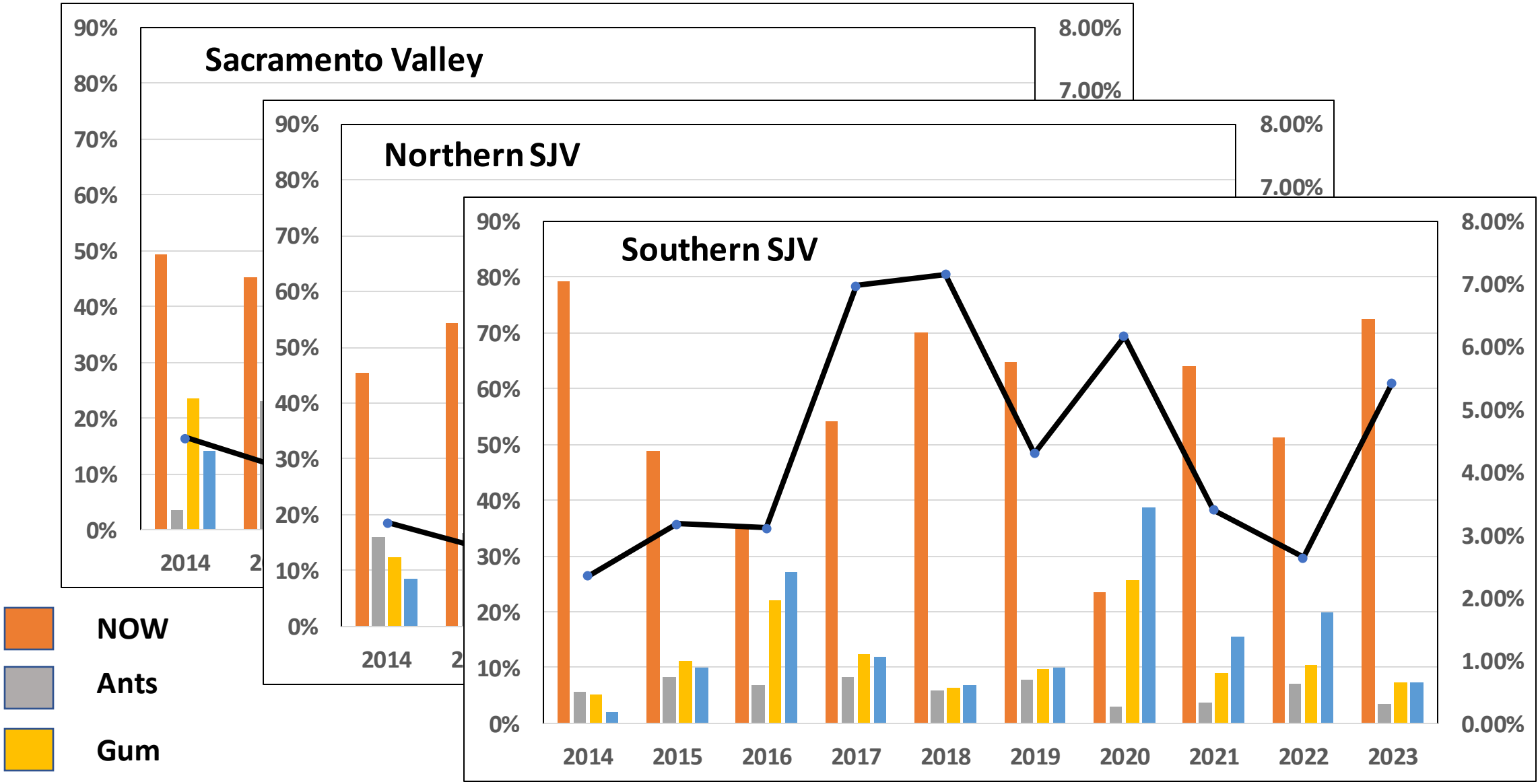
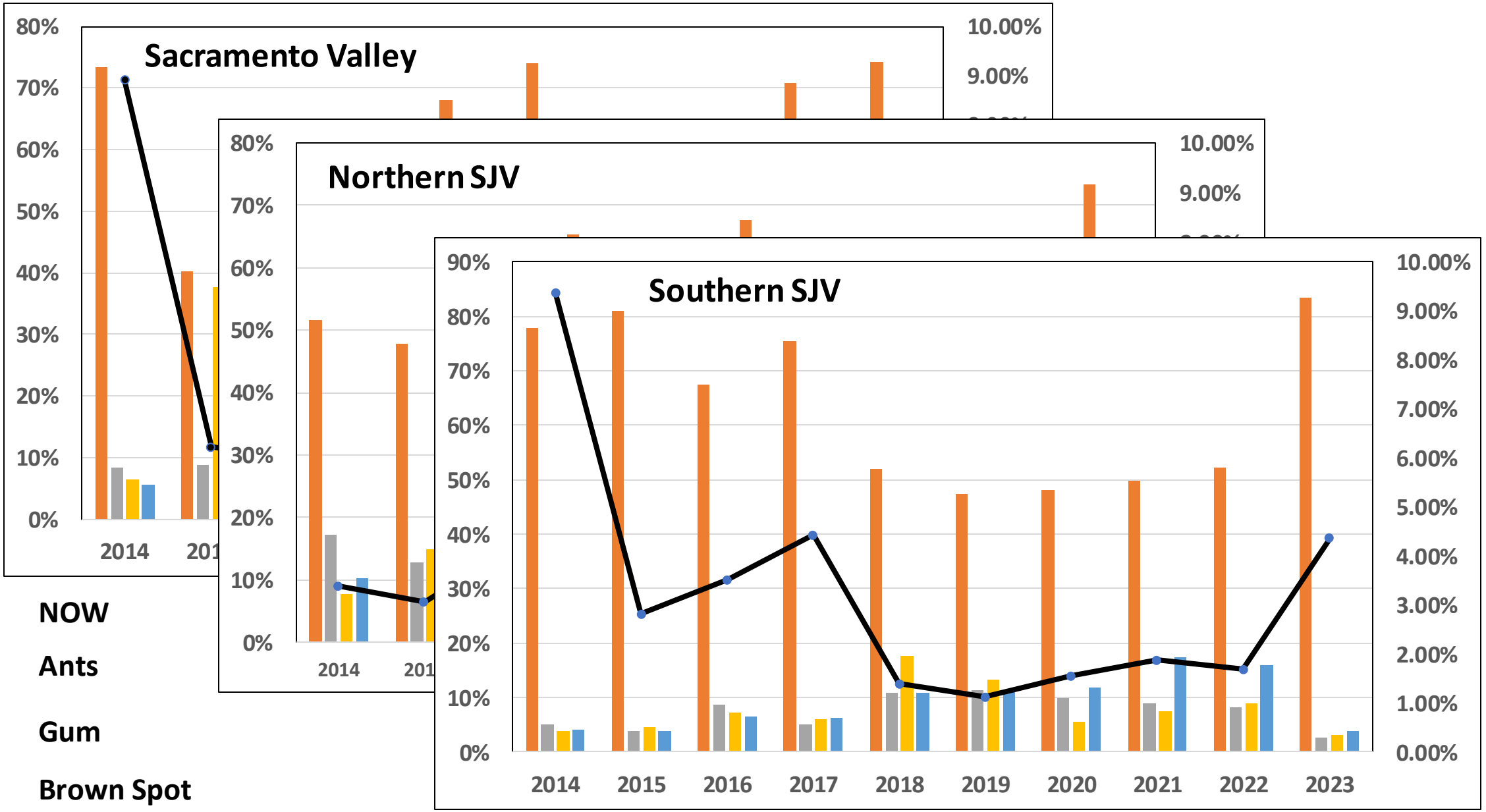
2023	2.51%	**41.78%**	20.33%	10.99%	**19.91%**	4.61%

Reject Breakdown – Aldrich (Of Deliveries Requesting)



Reject Breakdown – Monterey (Of Deliveries Requested)



Power in Partnership

BLUE DIAMOND GROWERS

Plant Bug Damage in California Almonds

The Almond Conference – Connecting the Dots

Plant Bug Issues This Year and Beyond and Available Management Tools

Kent Daane, Glenn Yokota & Judith Stahl UC Berkeley

Houston Wilson, Sean Halloran, Sarah Meierotto & Jocelyn Millar UC Riverside

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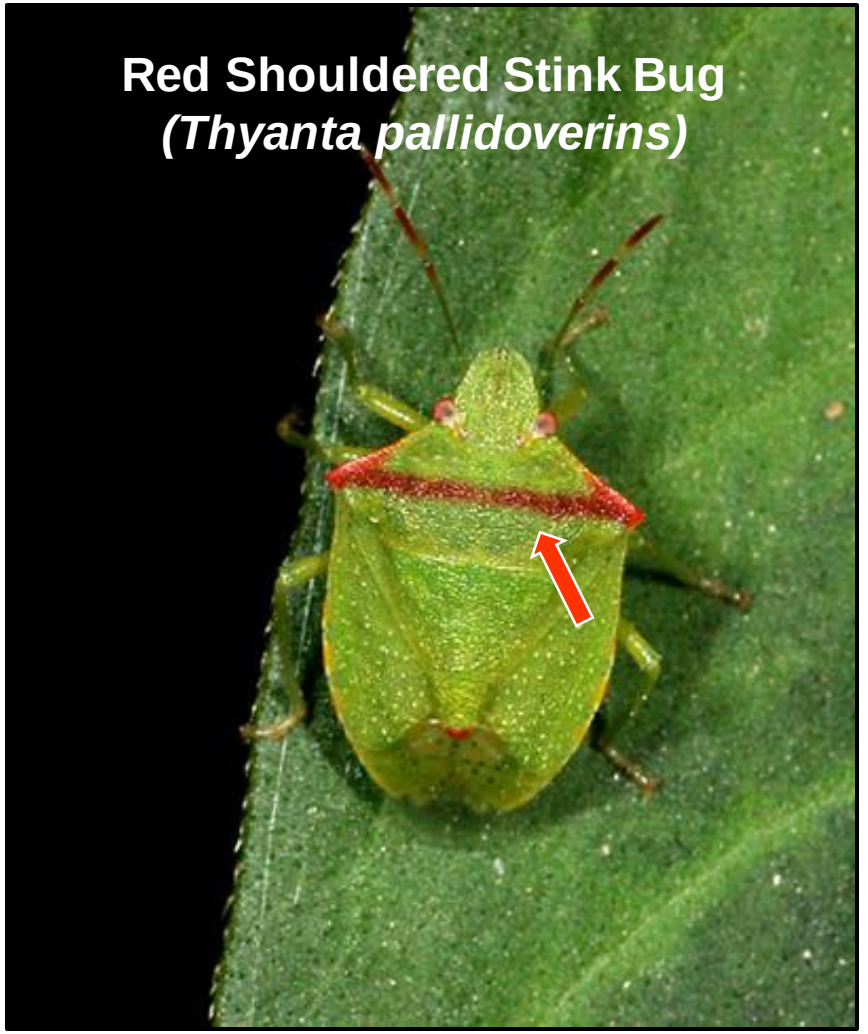
Outline

- Bug Species & Damage
  - Stink Bugs
  - Leaffooted Bugs
- Damage
  - LFB Economic Injury
  - LFB Seasonal Biology
- Controls
  - Current Monitoring
  - LFB Pheromone

Green Stink Bug
(Chinavia (=Acrosternum) hilaris)

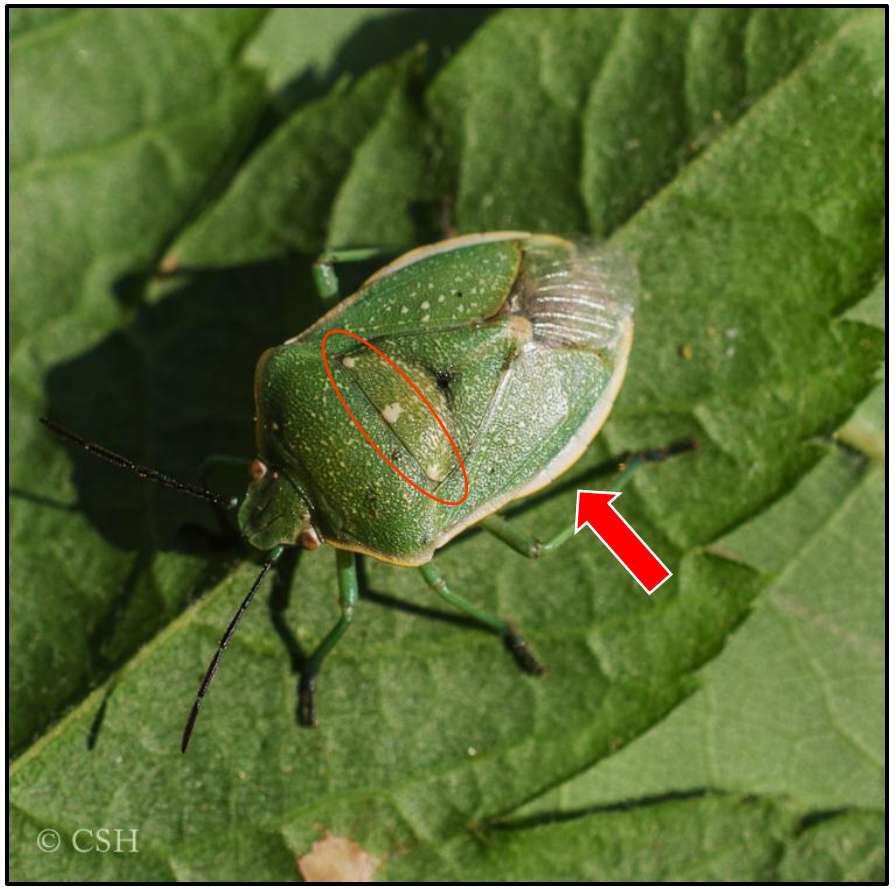
Stink bugs (Pentatomidae)

Green Stink Bug
(Chinavia (Acrosternum) hilare)



Stink bugs (Pentatomidae)

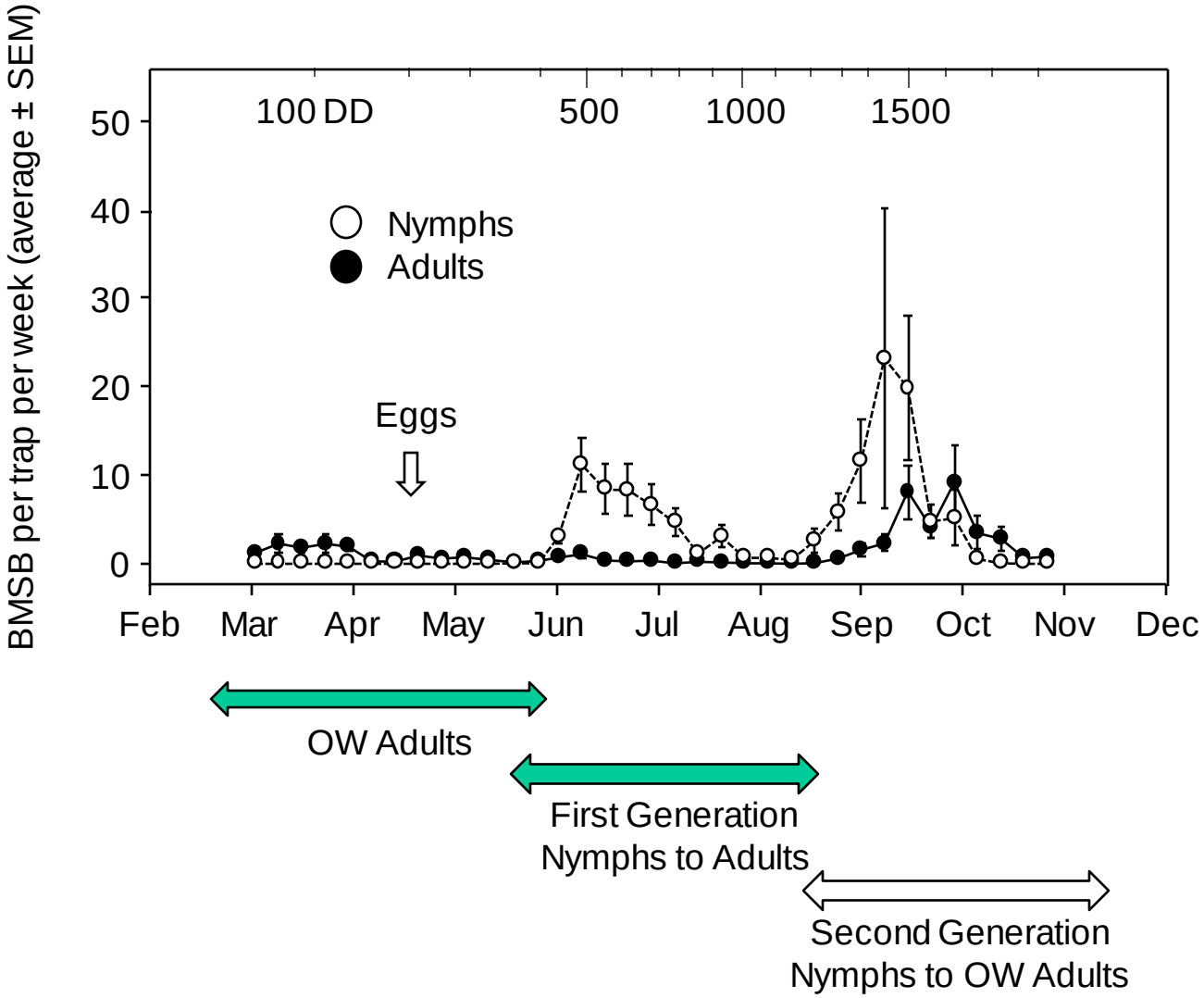
Say's Stink Bug
(Chlorochroa sayi)



Uhler's Stink Bug
(Chlorochroa uhleri)

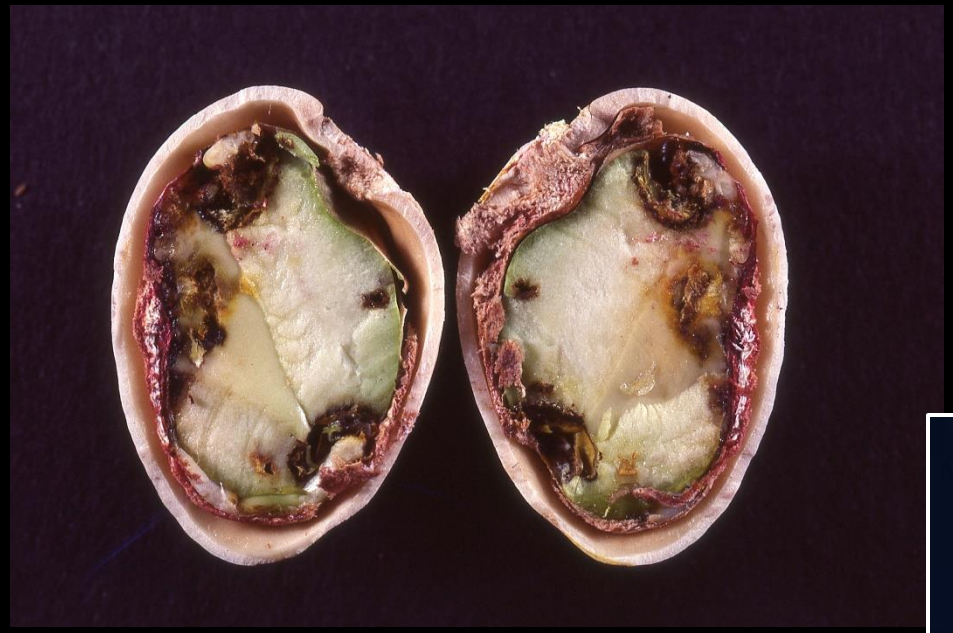
Stink bug life cycle
Green Stink Bug
(Chinavia hilaris)

Pistachio large bugs typically have 2 generations



Stink bug and LFB damage can look the same

Stink bug and LFB damage can look the same



LFB adults are larger so more damage later in the season

Leaffooted Bugs (LFB)
Key Species in California

Leptoglossus zonatus

- Two distinct yellow marks on pronotum
- Most common species currently

Leptoglossus clypealis

- Distinct clypeus points outward from head
- Used to be abundant, now less common

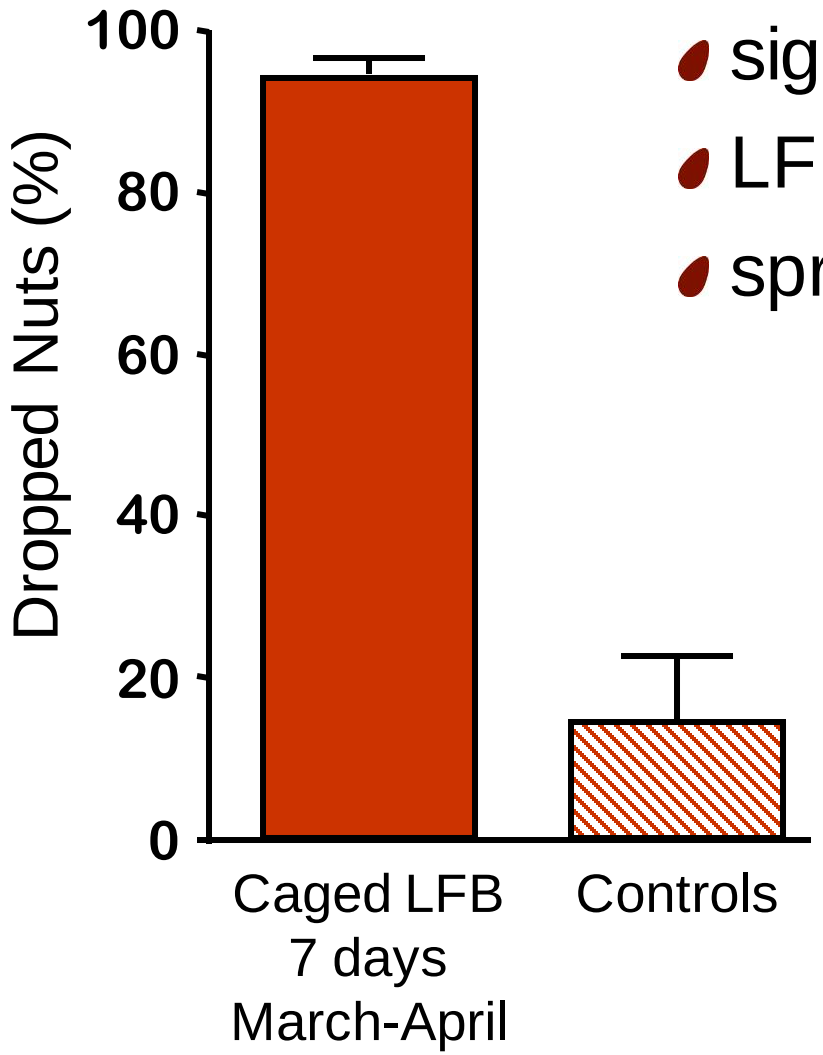
Leptoglossus occidentalis

- No marks, no clypeus
- Rare, mostly a forest/conifer pest

LFB Damage to Almonds – cage studies

- 7-day feeding periods
- different seasonal periods
- different almond cultivars
- rated “types” of damage

RESULTS – March-April



- significant nut drop
- LFB population levels
- spring monitoring is critical

RESULTS – April (fruit set)

Damage (% of total)

Cultivar	Drop	Shell	Nut
N.-Pareil	2.1	8.0	5.0
Fritz	10.7	12.3	6.9
Carmel	20.2	17.5	1.2
Butte	10.5	6.5	3.3
Mission	5.6	0	0

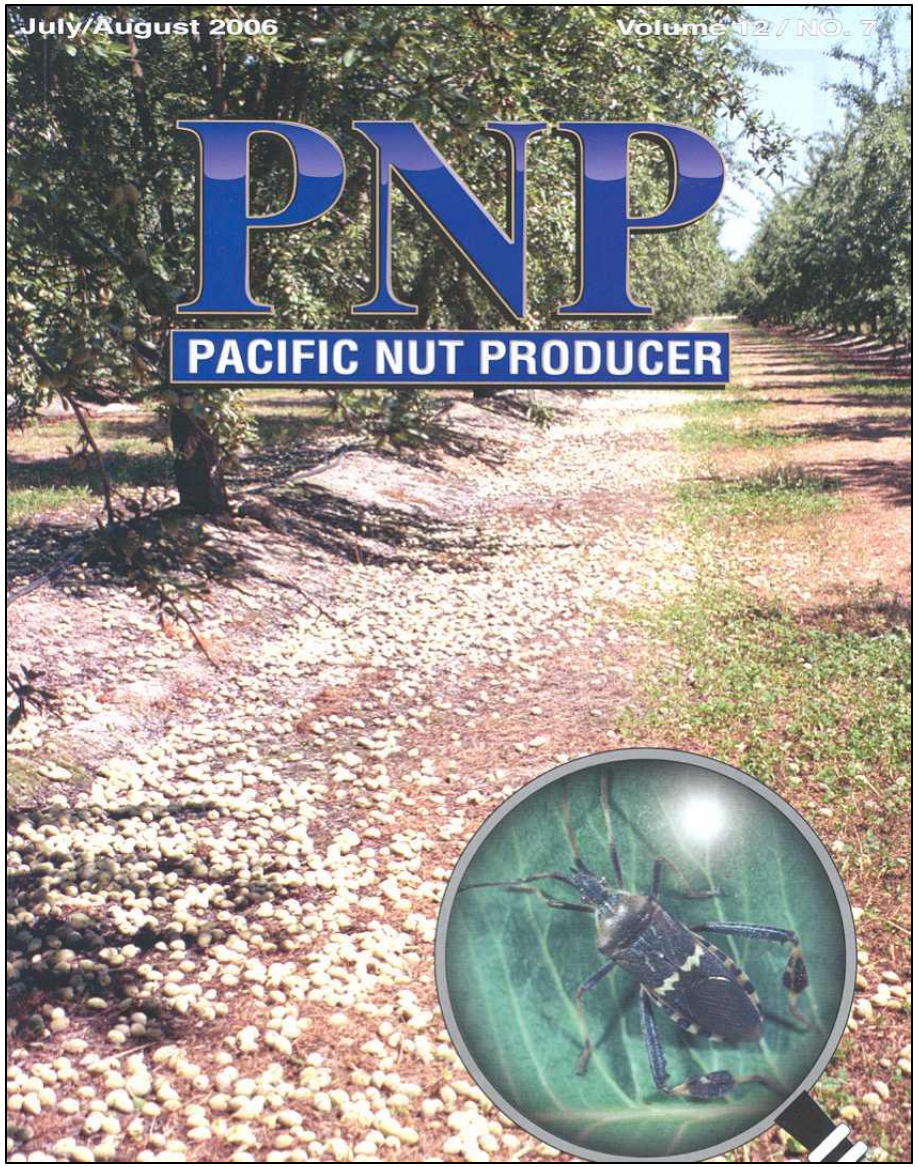
- total damage from 5.6 to 38.9%
- softer-shelled cultivars more susceptible
- most crop loss is from dropped nuts
- shell damage not always kernel damage

RESULTS – April (fruit set)

Damage (% of total)

Cultivar	Drop	Shell	Nut
N.-Pareil	2.1	8.0	5.0
Fritz	10.7	12.3	6.9
Carmel	20.2	17.5	1.2
Butte	10.5	6.5	3.3
Mission	5.6	0	0

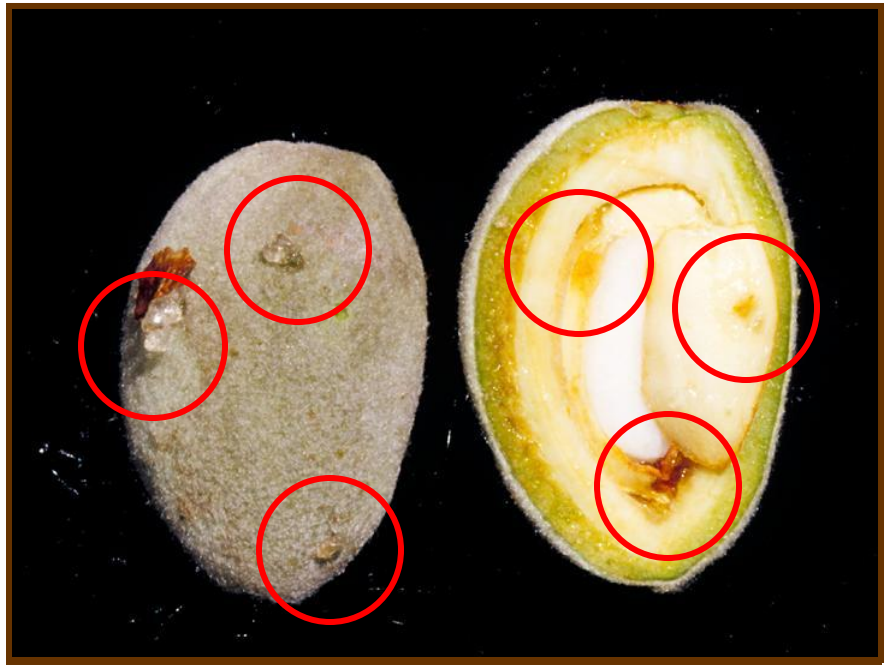
2006 saw significant spring damage from LFB dropped nuts.



RESULTS – June/July (harden shell)

Damage (% of total)

Cultivar	Drop	Shell	Nut
N.-Pareil	2.2	8.4	0
Fritz	0	12.8	3.8
Carmel	0	3.6	0
Butte	0.5	6.5	0
Mission	0	2.5	1.0



- total damage from 3.6 to 16.6%
- softer-shelled cultivars more susceptible
- most damage is “cosmetic” to the shell
- little or no kernel damage at harvest time

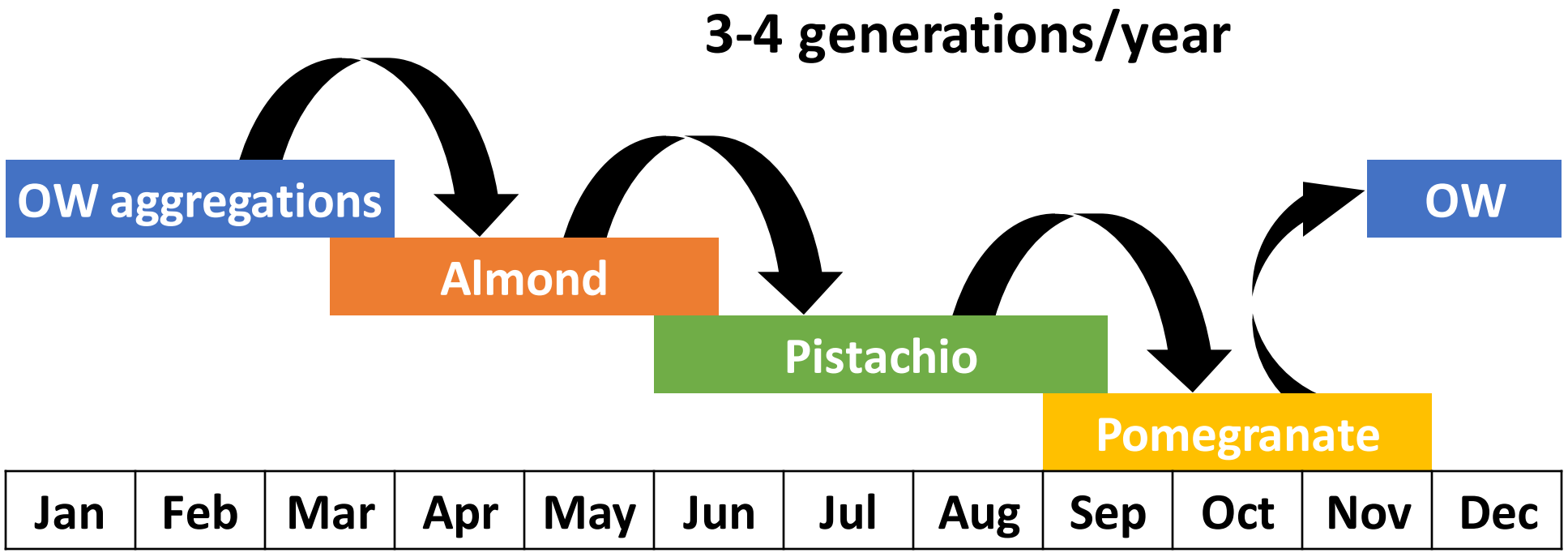
Outline

- Bug Species & Damage
  - Stink Bugs
  - Leaffooted Bugs
- Damage
  - LFB Economic Injury
  - LFB Seasonal Biology
- Controls
  - Current Monitoring
  - LFB Pheromone

Seasonal Ecology

Movement Between Orchards

Adults Become Active in March/April

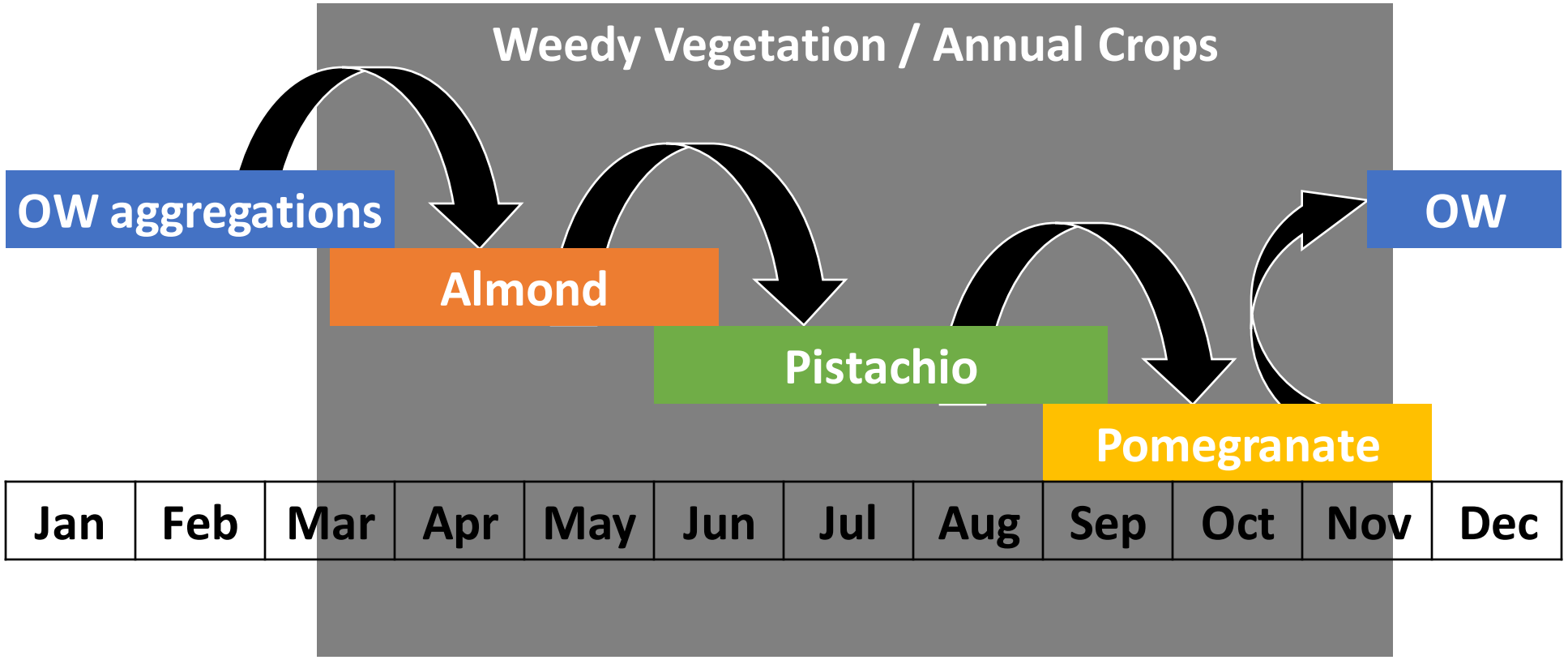


Slide courtesy of Houston Wilson

Seasonal Ecology

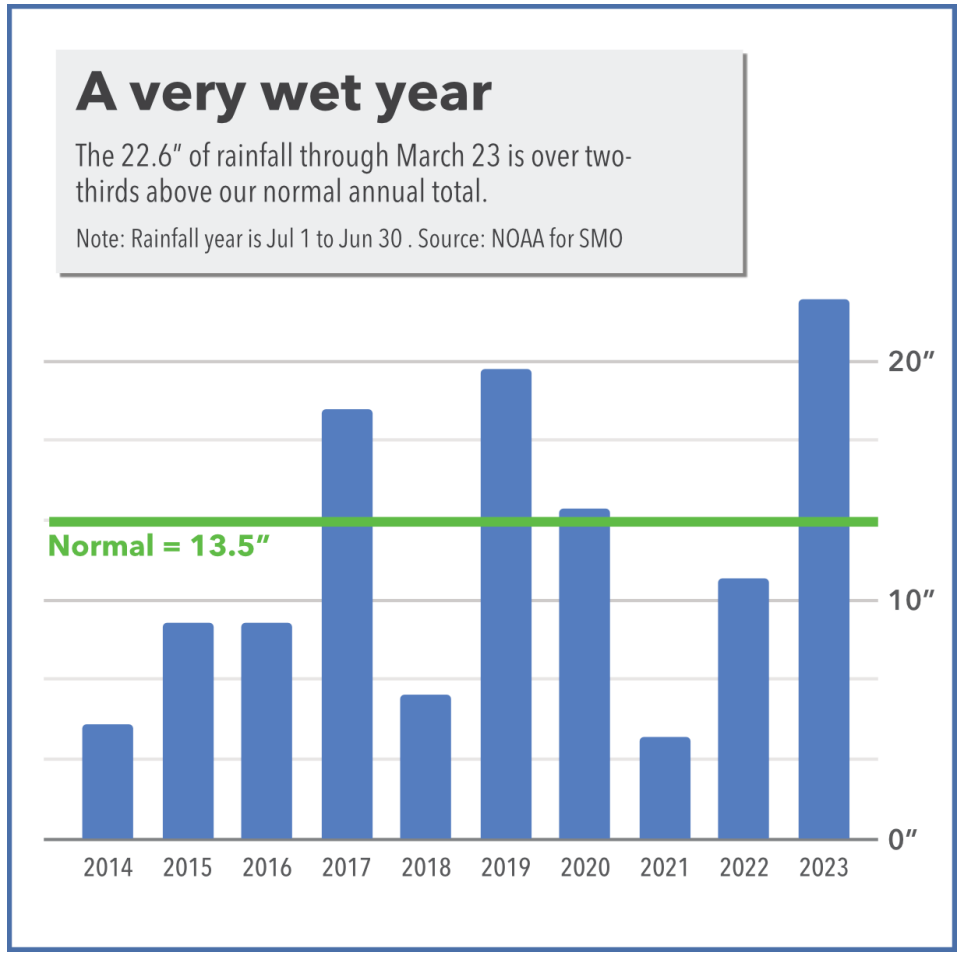
Movement Between Orchards

Potential Role of Alternate Hosts



Slide courtesy of Houston Wilson

Why was 2023 a bad year?
(1) Alternate host plants



Seasonal Movement Between Orchards

Gut Content Analysis Shows Alternate Hosts

Gut Contents	Orchard Type		
	Pistachio	Almond	Pomegranate
Pomegranate	0.2	1.0	68.2
Pistachio	34.8	16.4	0.8
Cucurbita spp.	32.6	1.1	2.7
Almond	2.2	27.6	0.0
Helianthus spp.	3.8	10.7	1.2
Peppers	0.0	12.6	0.0
Pinus spp.	0.0	7.2	0.0
Sowthistle	7.0	0.1	0.0
Corn	1.0	2.1	0.7
Alfalfa	0.2	2.8	0.0
Kiwi	0.3	0.4	0.4
Juniper	0.7	0.2	0.1
Strawberry	0.1	0.0	0.1
Cucumber	<0.1	<0.1	<0.1
Potato	<0.1	<0.1	<0.1
Tomato	<0.1	<0.1	<0.1
Other	0.1	<0.1	<0.1

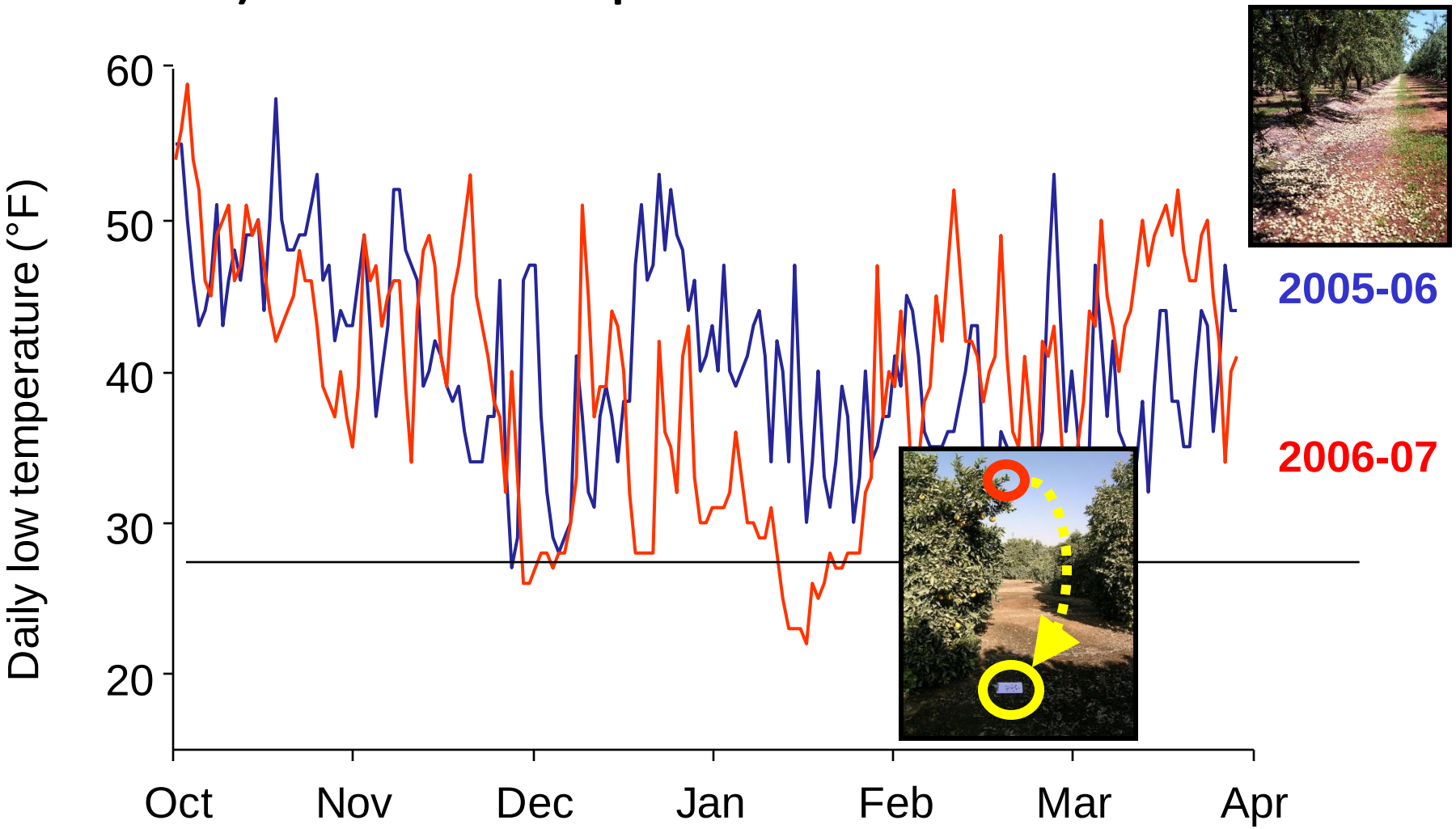
Data: D. Evans (CSU Fresno)

Slide courtesy of Houston Wilson

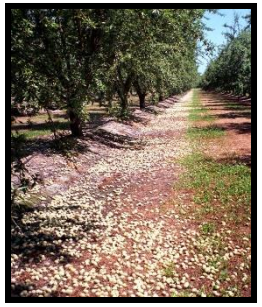
Why was 2023 a bad year?
2) Overwintering populations

Woodpiles, Barns, Olives, Residential areas, Eucalyptus, Citrus, Palm, Cypress, Juniper, Riparian areas, etc.

4) Winter cold temperatures – think citrus freeze

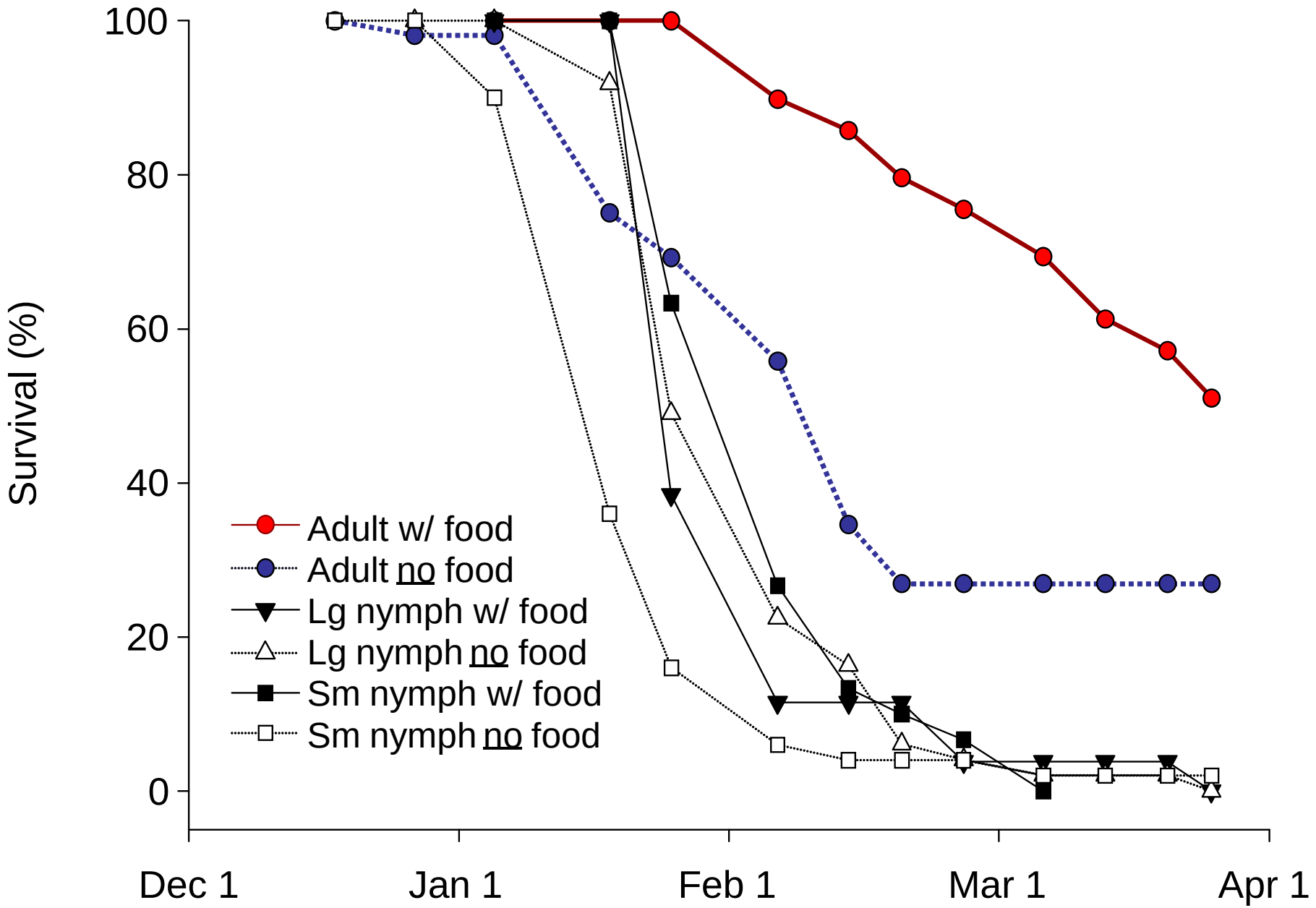


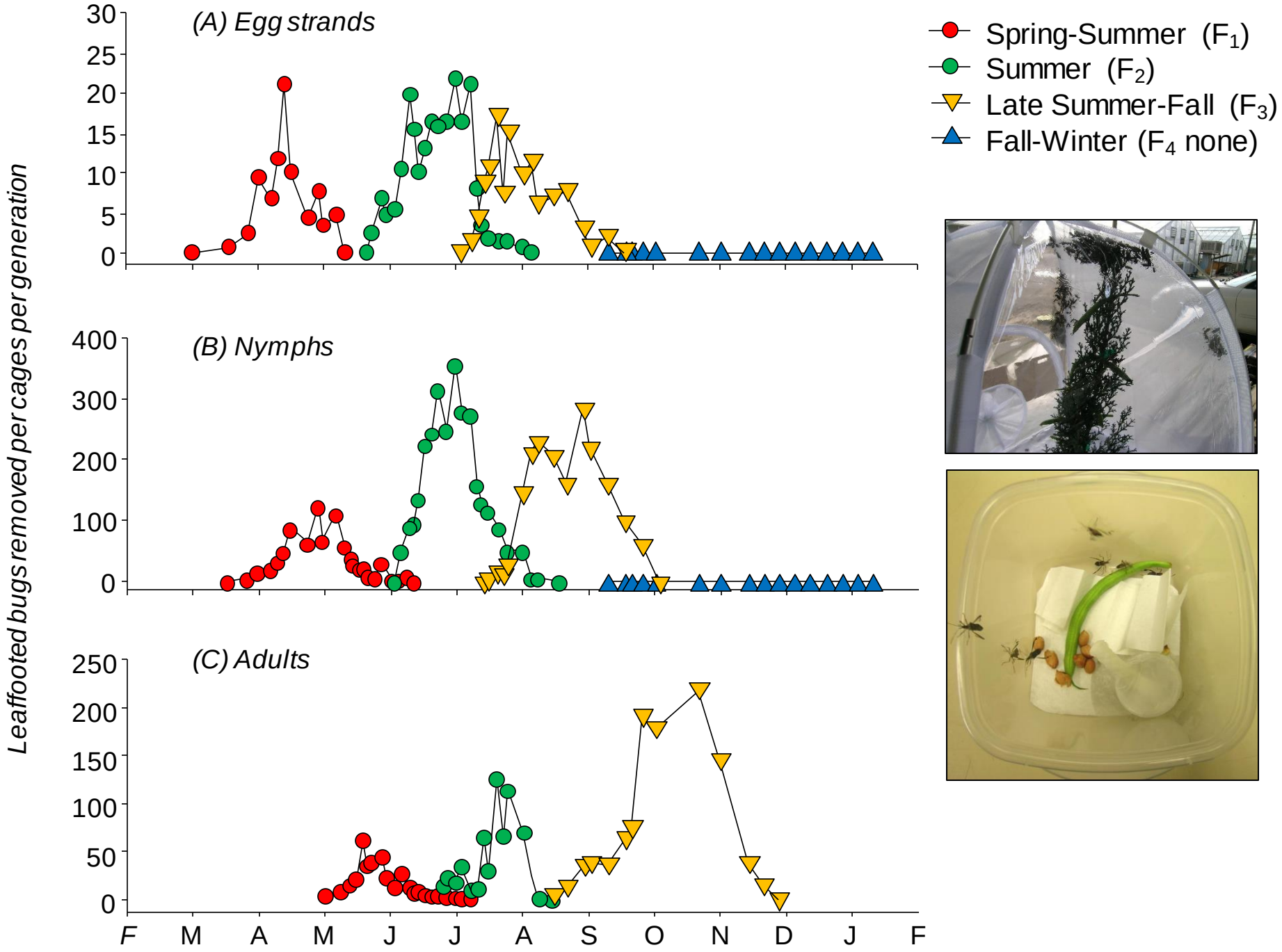
There were great losses in 2006, but low densities in 2007



Why was 2023 a bad year?
3) Are there ‘super foods’

More LFB survive and develop on pomegranates in fall that on other hosts that appear to be more for shelter only.

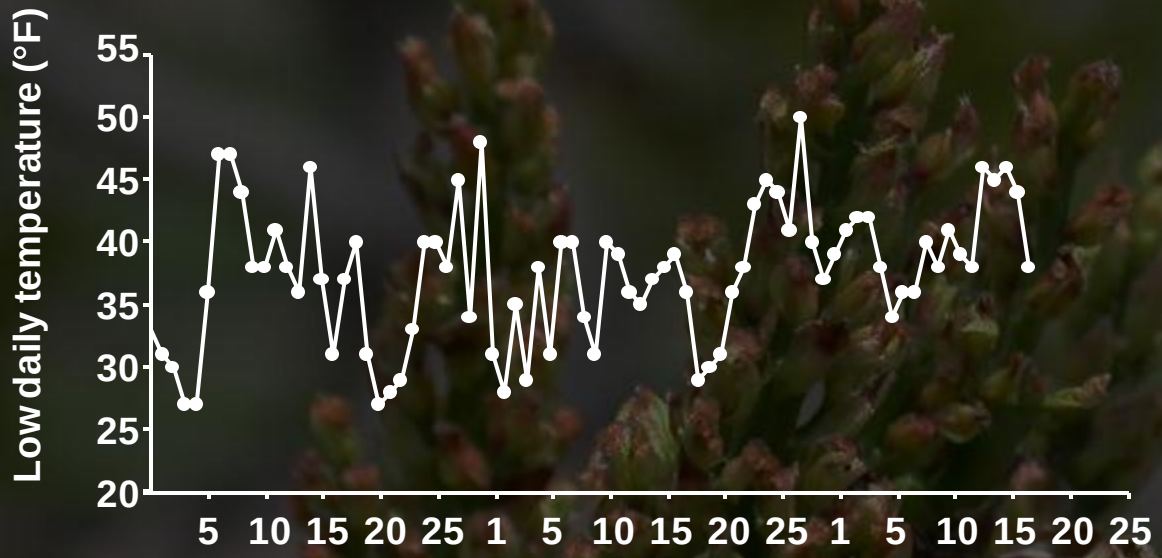

100
80
60
40
20
0
Survival (%)
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
Adult w/ food
Adult no food
Lg nymph w/ food
Lg nymph no food
Sm nymph w/ food
Sm nymph no food

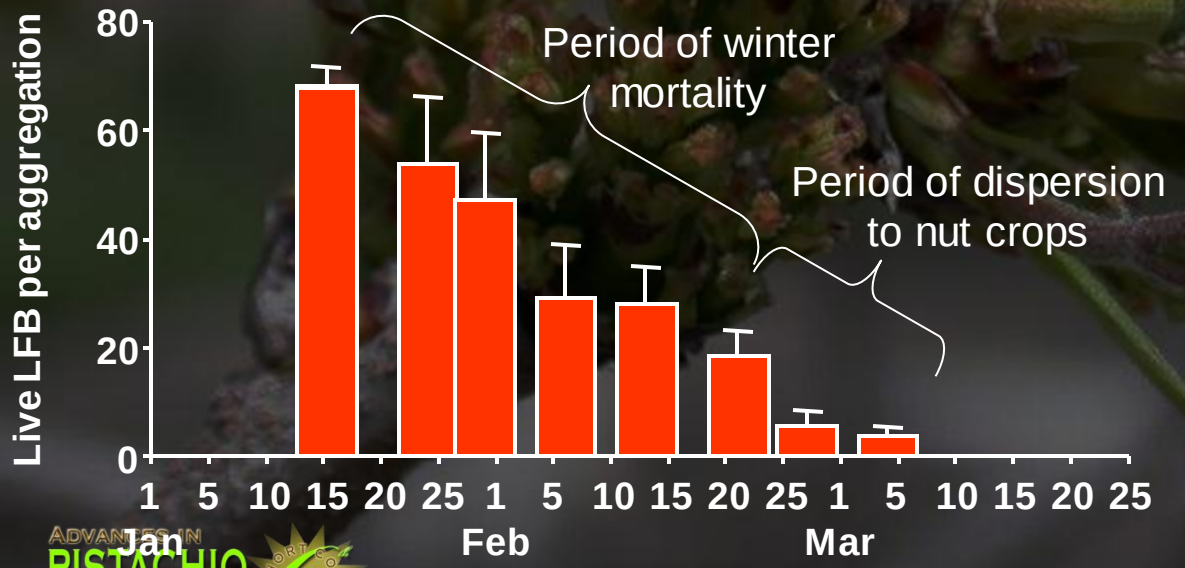

(A) Egg strands
(B) Nymphs
(C) Adults
Leaffooted bugs removed per cages per generation
Spring-Summer (F1)
Summer (F2)
Late Summer-Fall (F3)
Fall-Winter (F4 none)
30
25
20
15
10
5
0
400
300
200
100
0
250
200
150
100
50
0
F M A M J J A S O N D J F

Outline

- Bug Species & Damage
  - Stink Bugs
  - Leaffooted Bugs
- Damage
  - LFB Economic Injury
  - LFB Seasonal Biology
- Controls
  - Current Monitoring
  - LFB Pheromone

Winter Monitoring for Leaffooted Bugs





ADVANCES IN PISTACHIO PRODUCTION 6 SHORT COURSE
VISALIA CONVENTION CENTER NOVEMBER 13 - 15, 2012

Monitoring

Beat Sampling, Visual Searching

Start Monitoring Weekly in April

Visual Damage

- Small black nuts in clusters or on the ground in late April / early May

Canopy/Cluster Beat Sampling

- Early in the morning, bugs less active
- Hold tray below, strike clusters
- Look for nymphs and adults

Thresholds

- Not well-developed
- “1 bug per 15-20 beats” – treatment

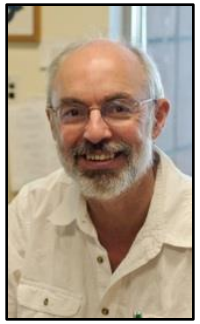
Sampling the pistachio canopy with a beat tray

New Traps and Pheromone Lures for LFB Passive Sampling System

Active, time intensive sampling of tree canopy

Passive trapping with pheromone lures

Kent Daane
(UC Berkeley)



Jocelyn Millar
(UC Riverside)

Houston Wilson
(UC Riverside)

New Traps and Pheromone Lures for LFB
LFB Produce Various Chemical Compounds

Types of Chemicals

- Alarm
- Aggregation
- Sex Pheromones
- Aphrodisiac

Key Aspects

- Males use pheromone and aphrodisiac to attract/mate with females
- Can we leverage this into a trap/lure system?

Slide courtesy of Houston Wilson

New Traps and Pheromone Lures for LFB Trap Comparison Study: 2017-2019

UniTrap

Hanging Panel

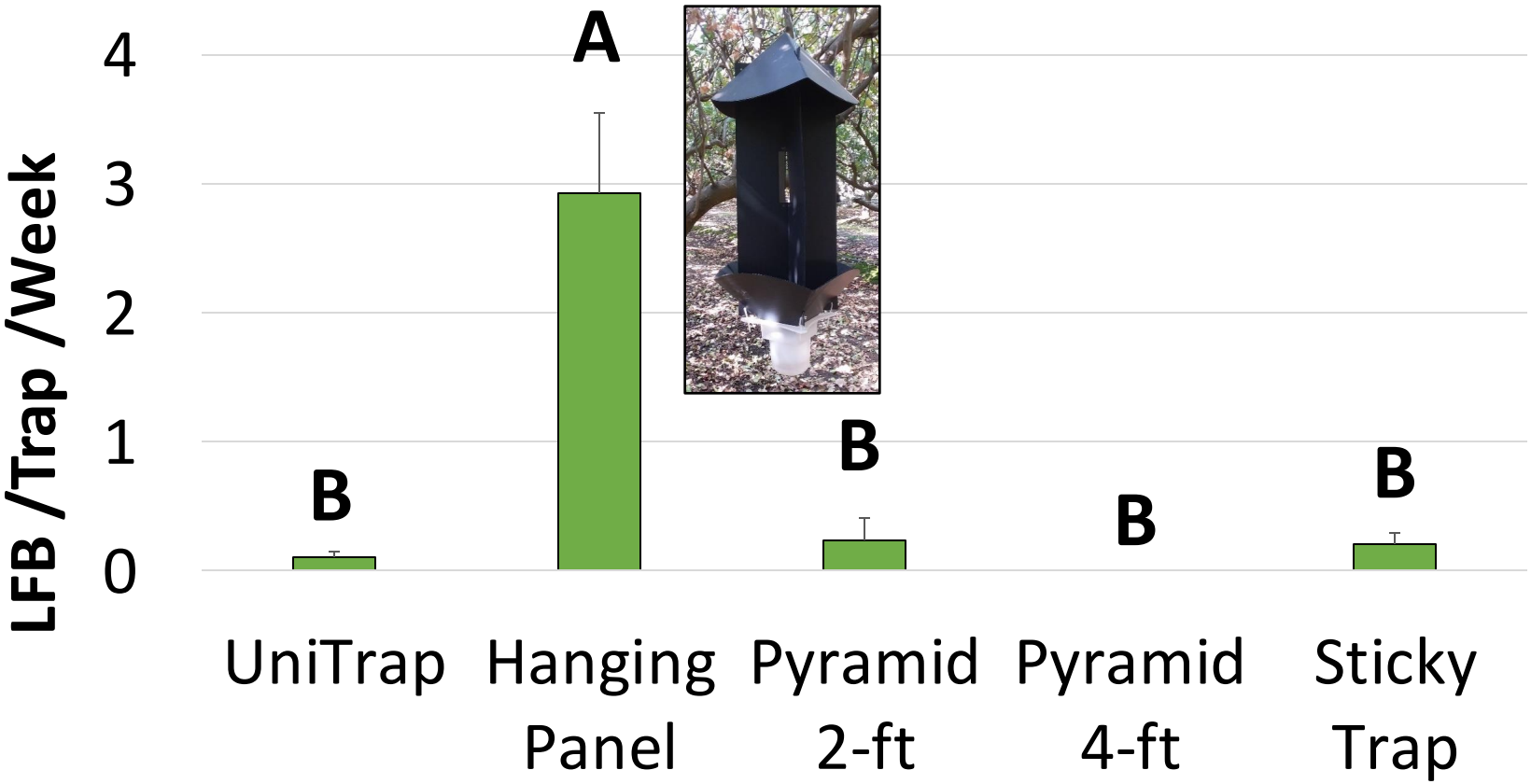
Pyramid 2-ft

Pyramid 4-ft

Clear Sticky

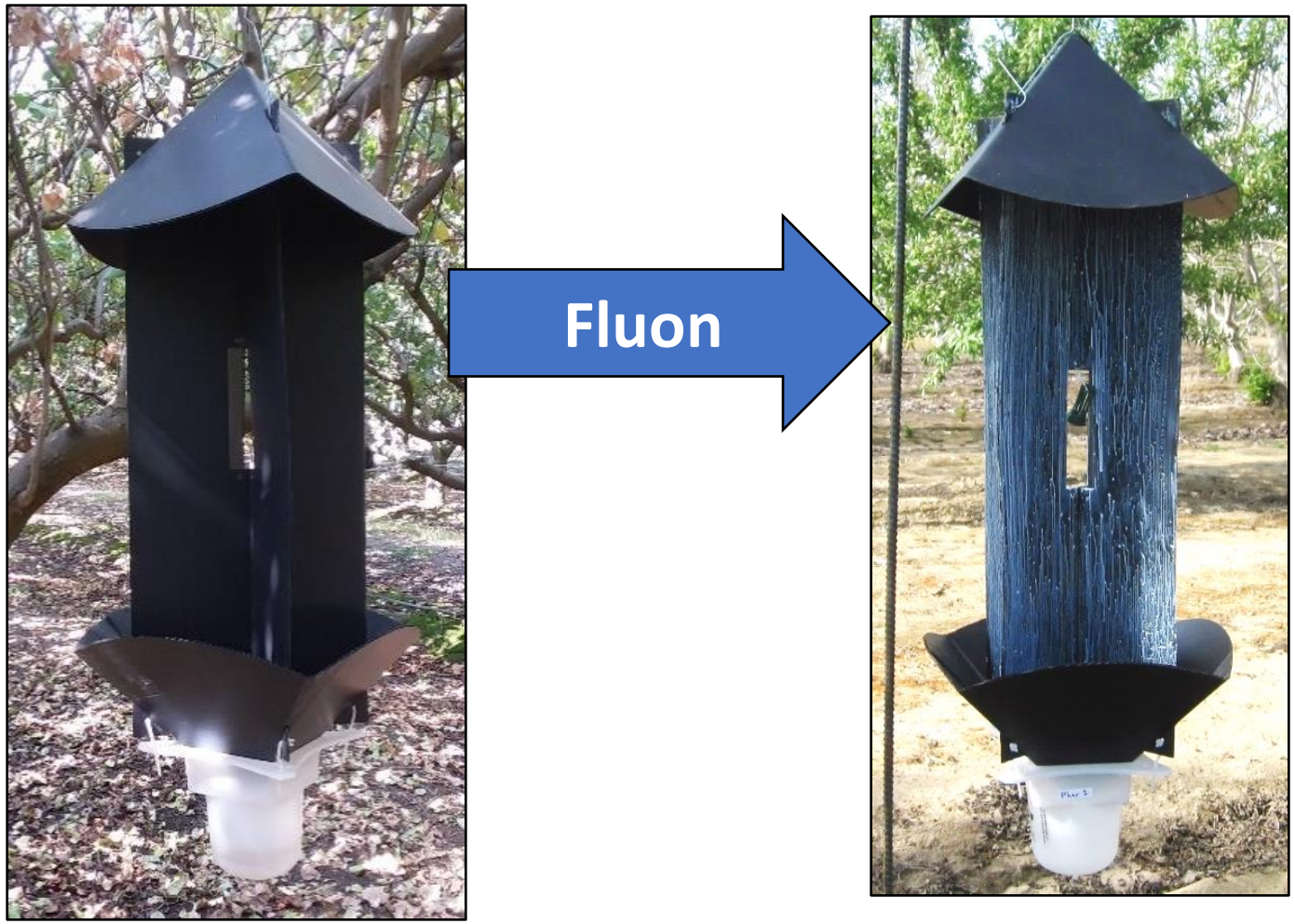
Slide courtesy of Houston Wilson

New Traps and Pheromone Lures for LFB
Trap Comparison Study: 2017-2019

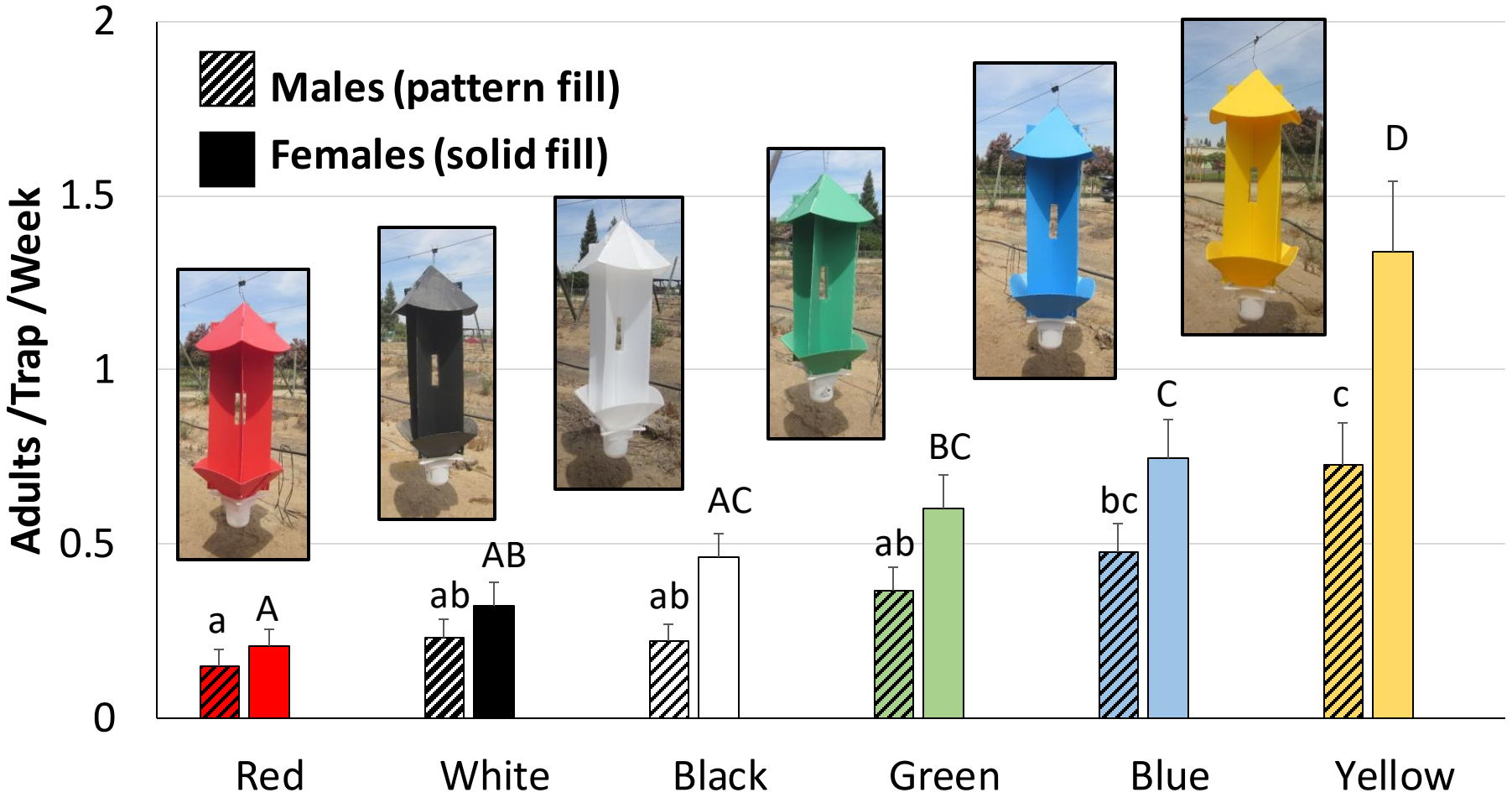


Slide courtesy of Houston Wilson

New Traps and Pheromone Lures for LFB Trap Comparison Study: 2017-2019



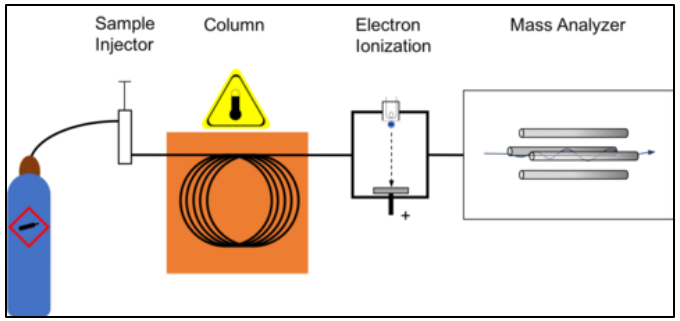
New Traps and Pheromone Lures for LFB
Trap Comparison Study: 2017-2019

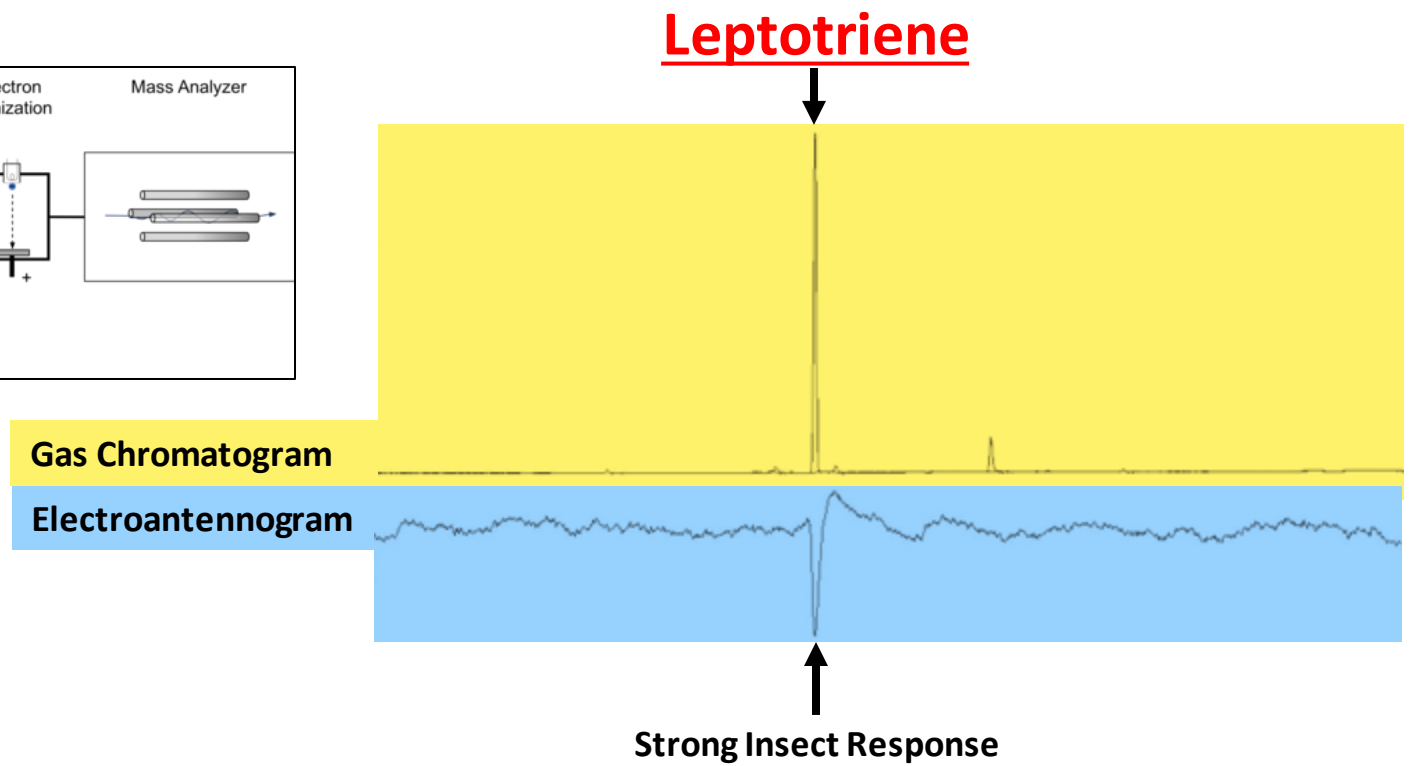


New Traps and Pheromone Lures for LFB
Pheromone Characterization and Synthesis

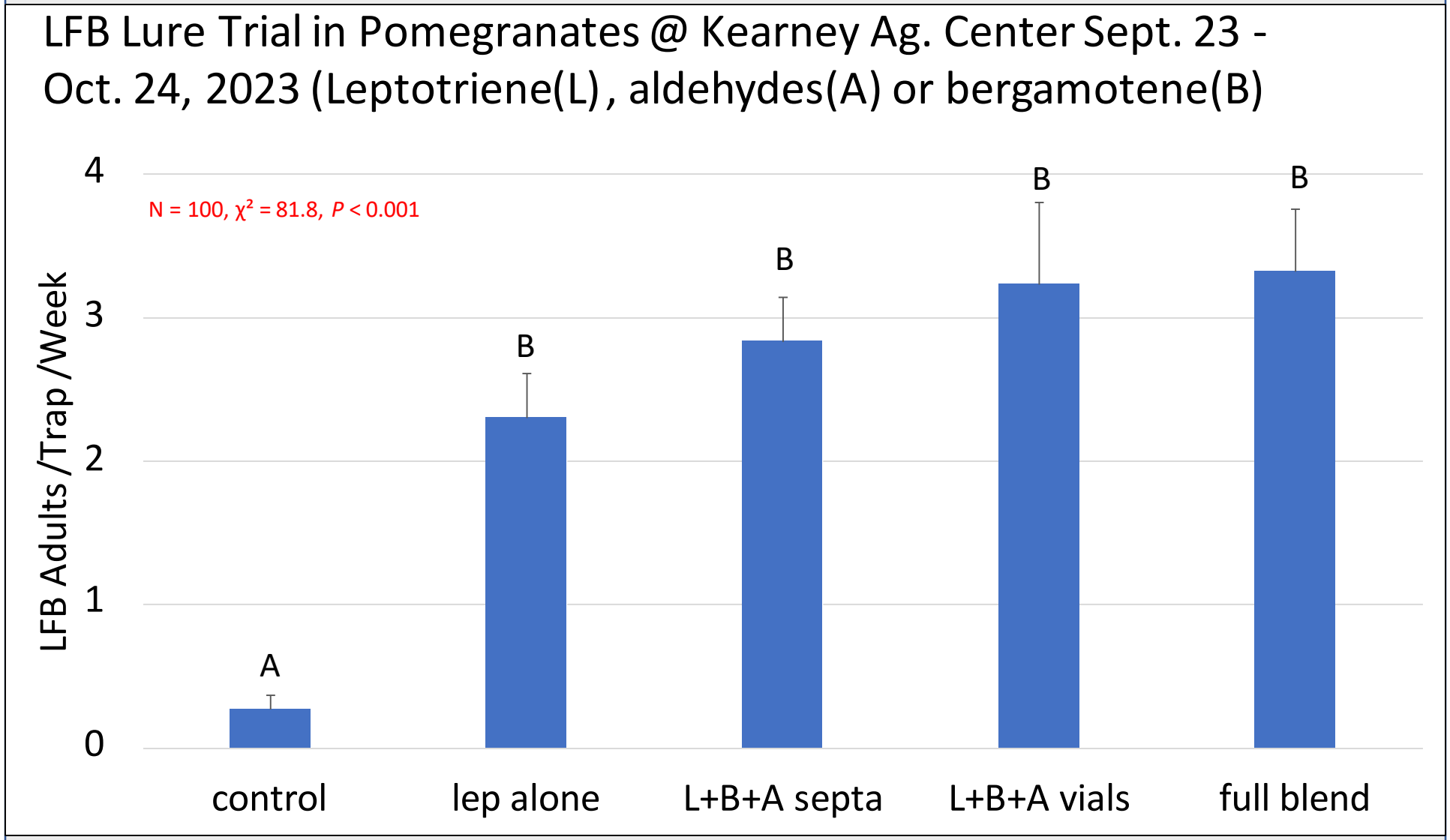
General Approach

- Isolate reproductively mature males
- Capture and analyze pheromones
- Measure response of females to individual compounds





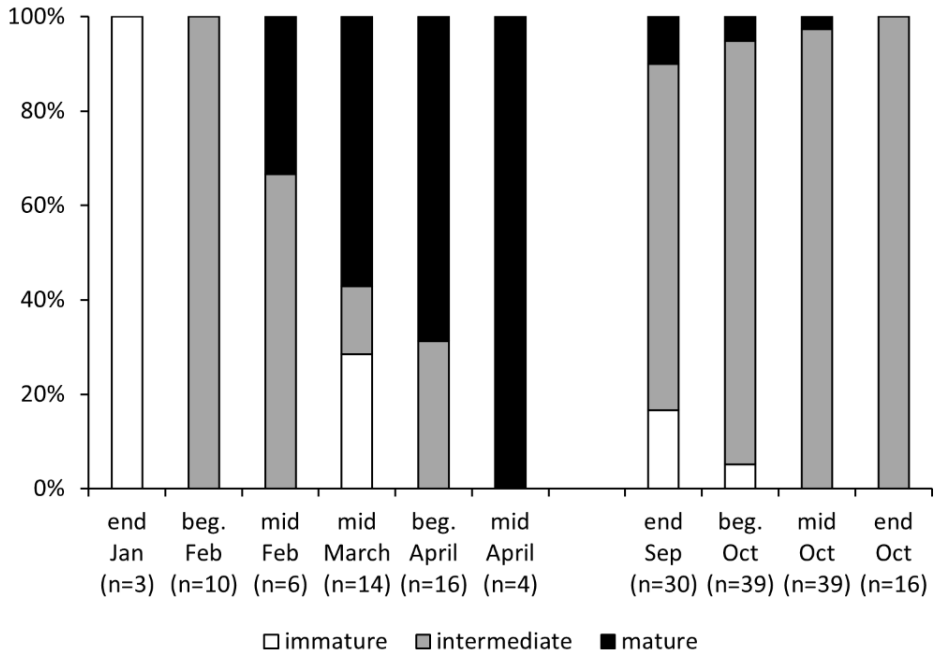
- All lures were more attractive than the hexane control
- No separation between any of the different lures



LFB Overwintering Biology

Dissections and behavioral experiments suggest mating occurs before dispersal from overwintering sites.

Temperature significantly impacted LFB egg hatch – impacting timing of the first summer generation.



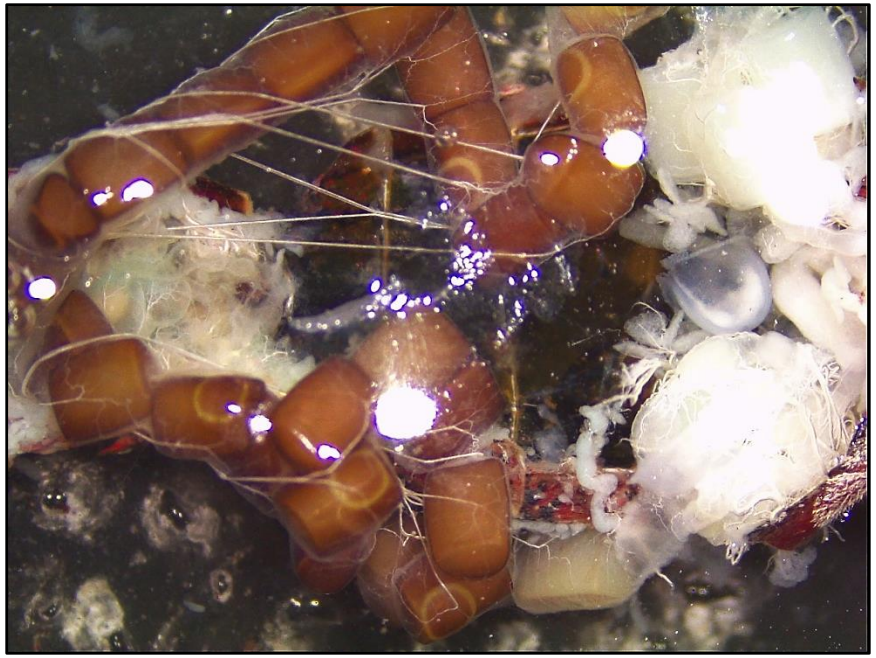



Photo credit Tim Haye

Thank You and Concluding Remarks

Large Bugs

- Stink bugs and LFB cause similar damage
- Larger bugs and stages cause more damage
- Overwintering LFB are important
- LFB can be mated leaving OW site

Monitoring - achievements

- Found a suitable LFB trap
- Identified the key pheromone compounds
- Synthesized each of the 9 chemicals
- Determine the optimal blend
- Field trials show positive results

Next Steps for Monitoring

- Improve synthesis of the compounds
- Trap counts x orchard populations/damage

Plant Bug Issues –This Year and Beyond

And available Management tools

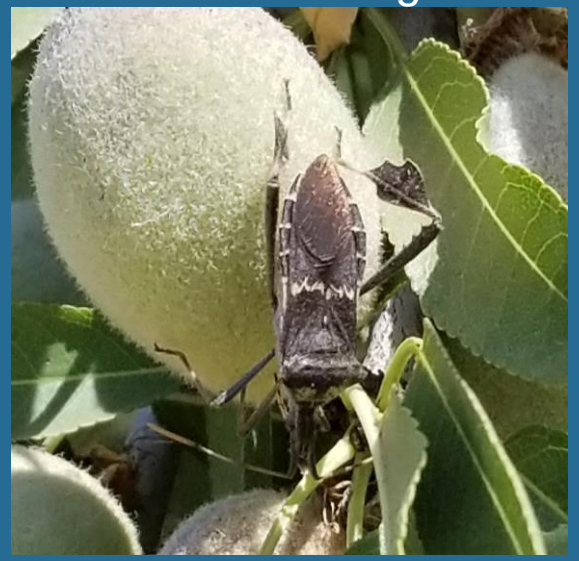
Plant Bug Issues This Year And Beyond

AND AVAILABLE MANAGEMENT TOOLS

- Plant Bugs in Almond
- Damage
- Monitoring
- Management
- The Future

Plant Bugs In Almond

Leaf Footed Bug



Credit: Justin Nay

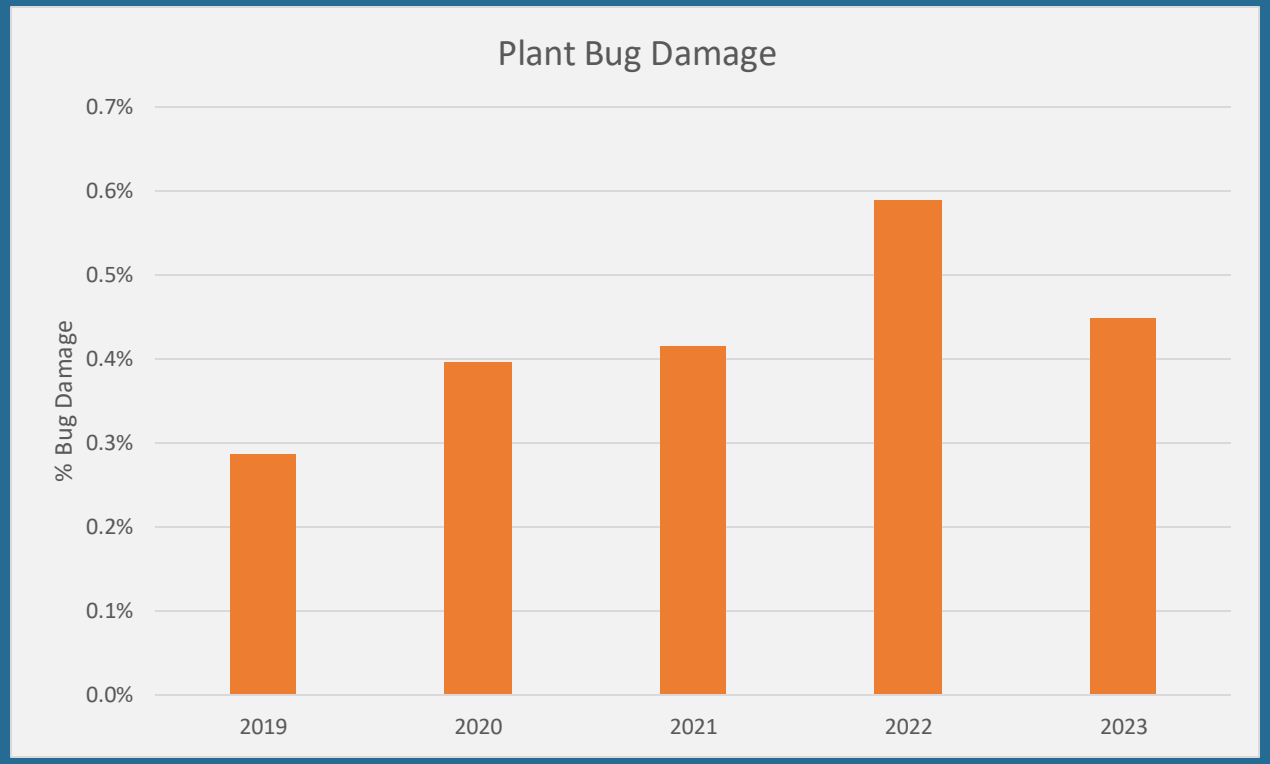
Stink Bugs

https://ipm.ucanr.edu/PMG/A/I-HM-AHIL-AD.004.html

Box Elder Bug

https://ipm.ucanr.edu/PMG/L/I-HM-LTRI-AD.003.html

Plant Bugs In Almond

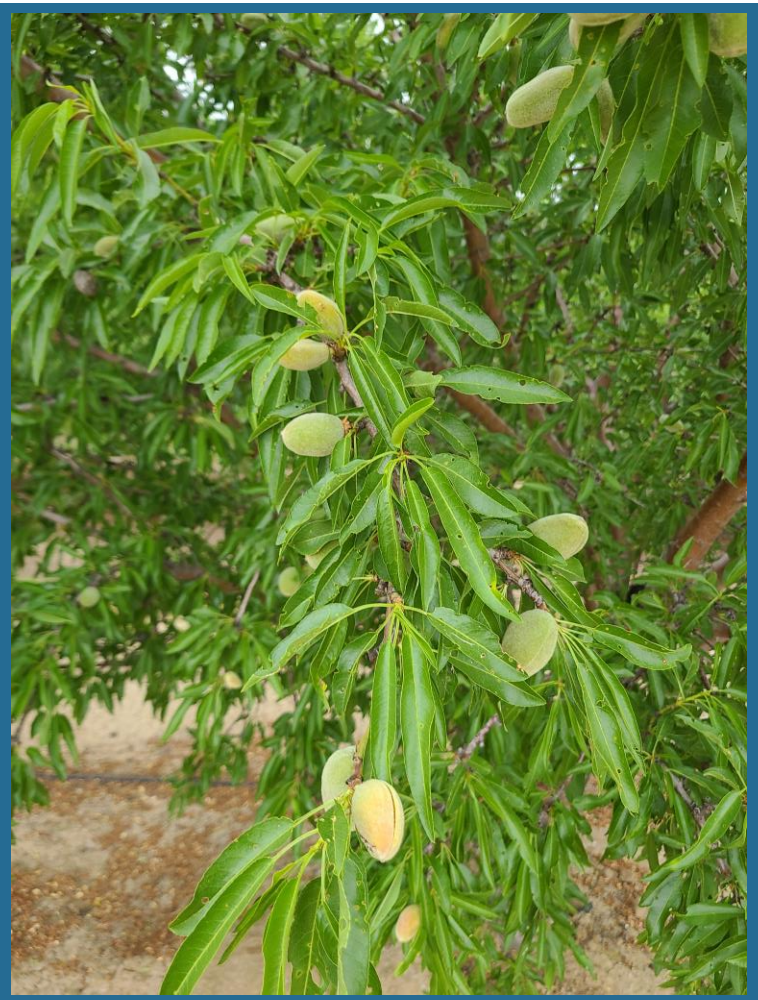


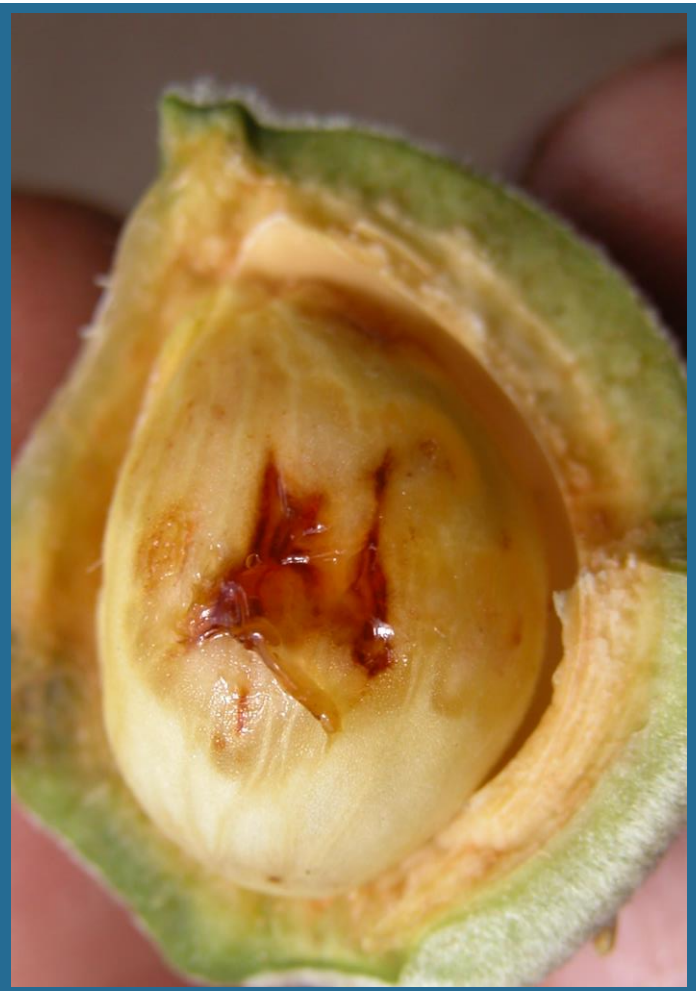
Damage

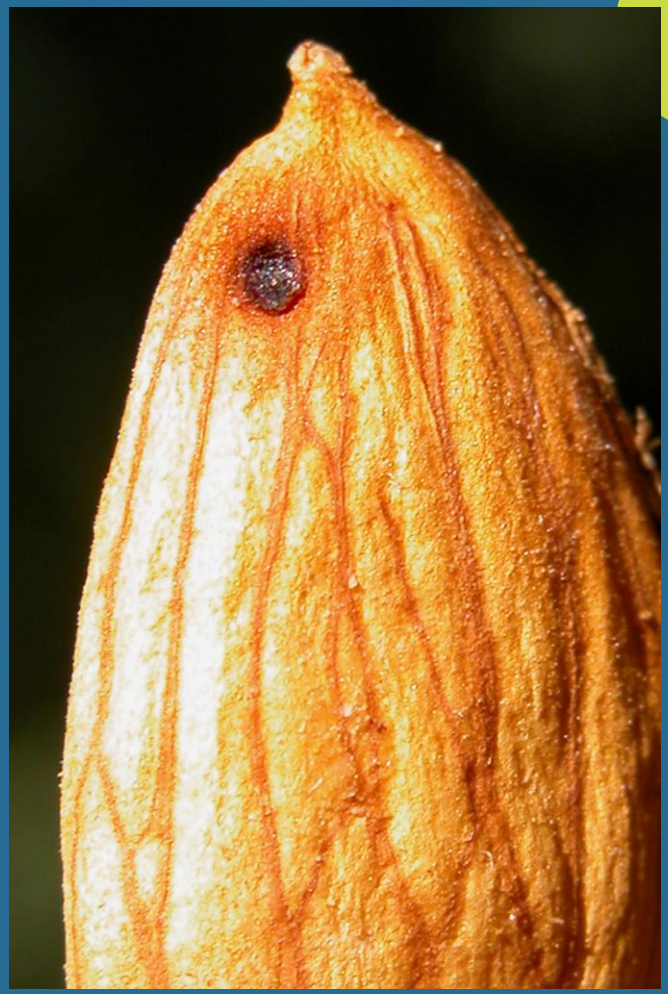
- Piercing/sucking mouthpart
- Physical damage
- Chemical damage

https://ucanr.edu/blogs/Topics//blogfiles/48000_original.png

Damage







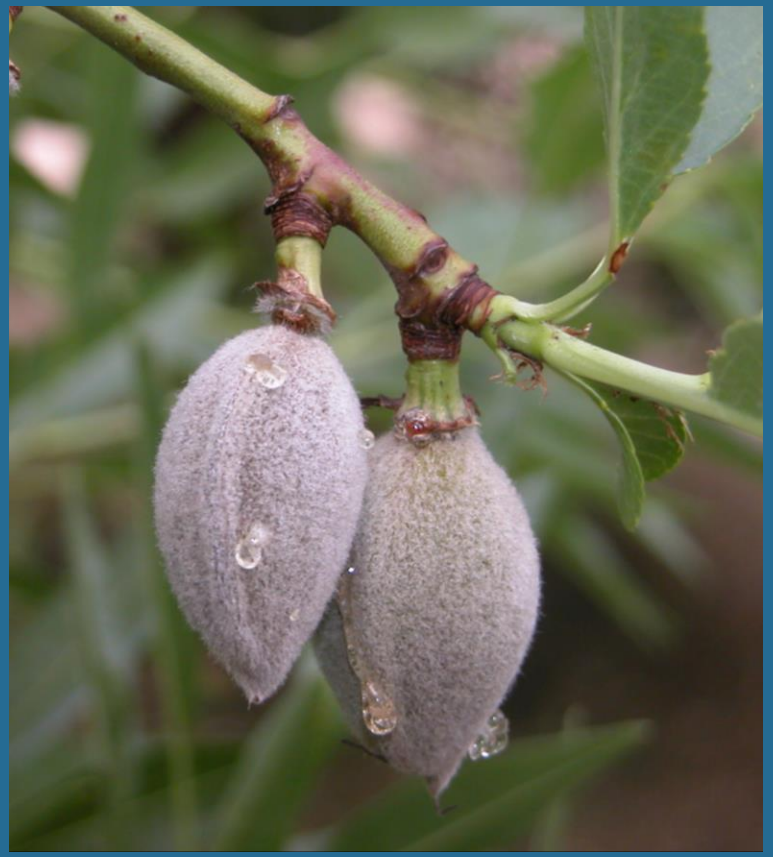
Damage

Monitoring

- Field scouting is the Gold Standard
- Time consuming, tedious
- Goal is to locate individuals
- Signs/Symptoms are helpful, but do not tell the whole story
- ★ Regular, frequent checks are key

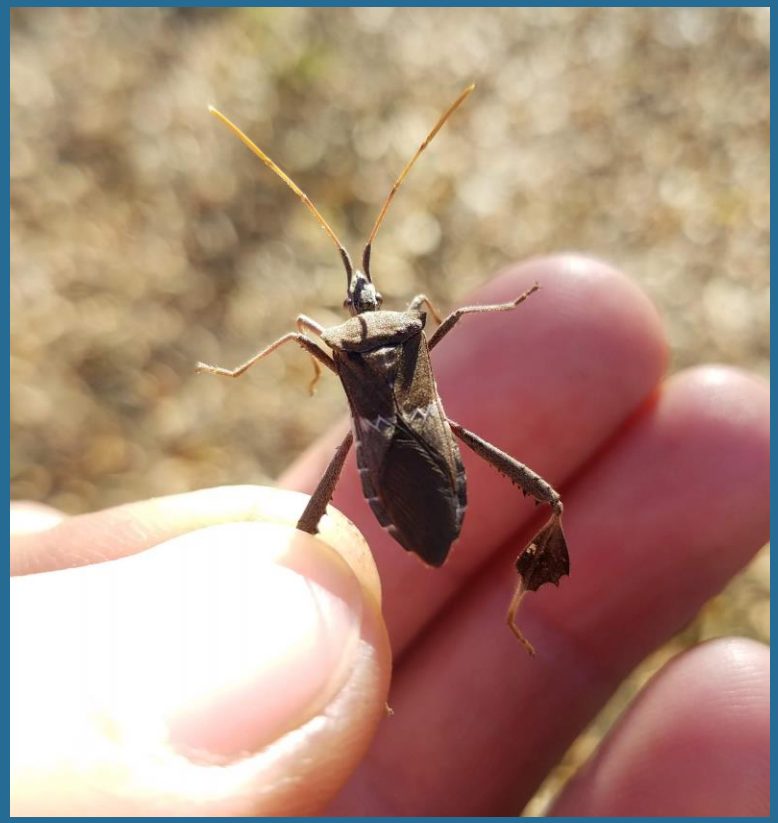
Monitoring

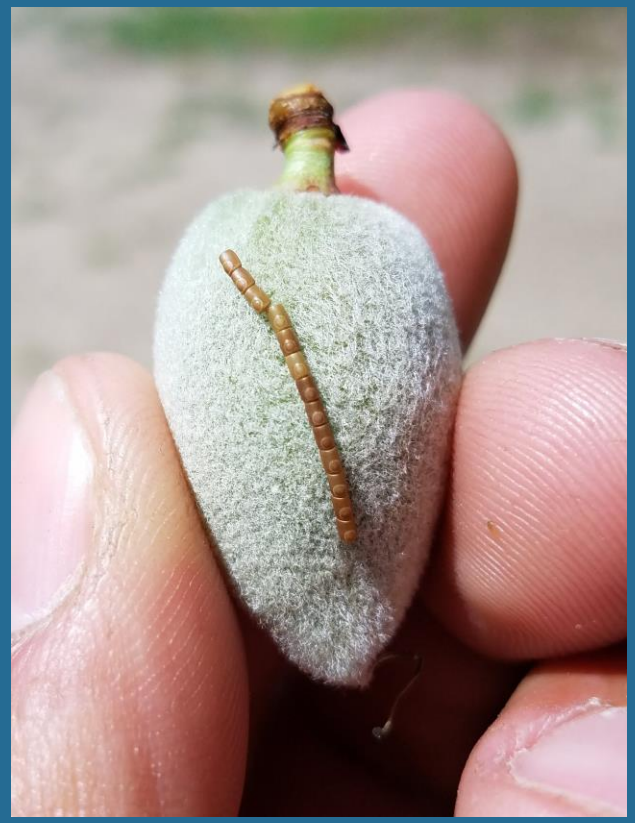
SIGNS AND SYMPTOMS



Monitoring

IDENTIFICATION: LEAF FOOTED BUG

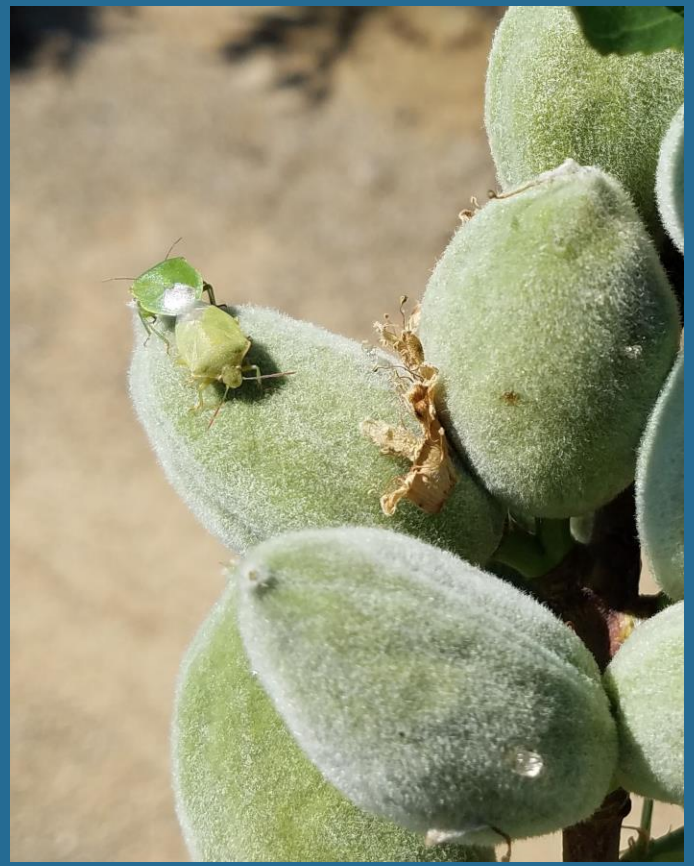




Credit: Justin Nay

Monitoring

IDENTIFICATION: STINK BUG

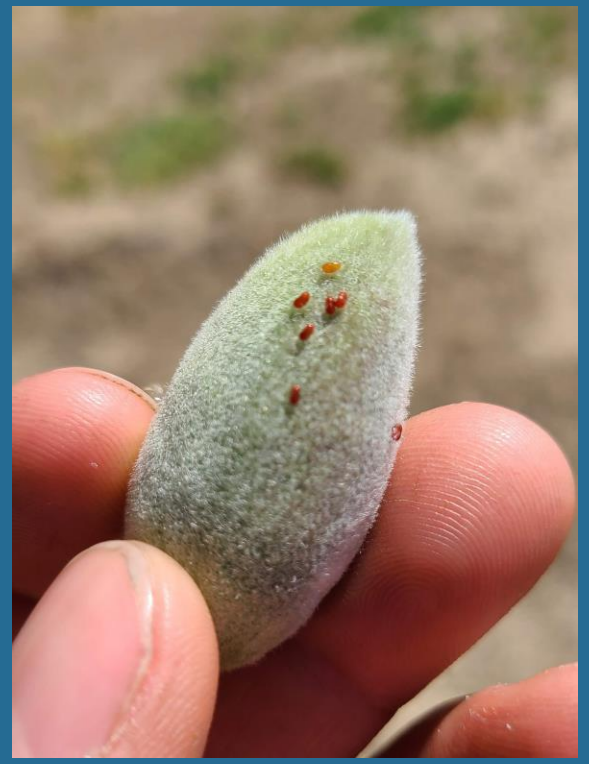


Credit: Justin Nay

Monitoring

IDENTIFICATION: BOXELDER BUG

Credit: Justin Nay



Monitoring

IDENTIFICATION: BENEFICIALS

Rough Stink Bug

https://ipm.ucanr.edu/PMG/B/I-HM-BSUL-AD.001.html

Assassin Bug

Credit: Joseph King

https://ipm.ucanr.edu/natural-enemies/assassin-bugs/

Monitoring

IDENTIFICATION: NUTRIENT DEFICIENCY

Monitoring

IDENTIFICATION: DISEASE

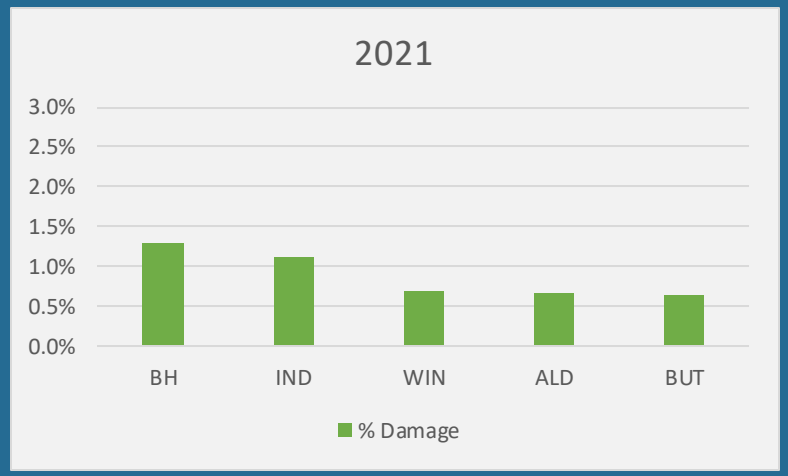
Monitoring

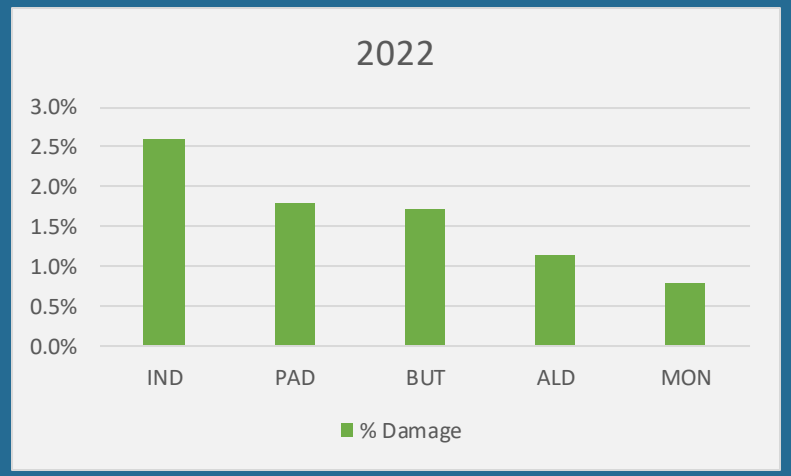
TIPS

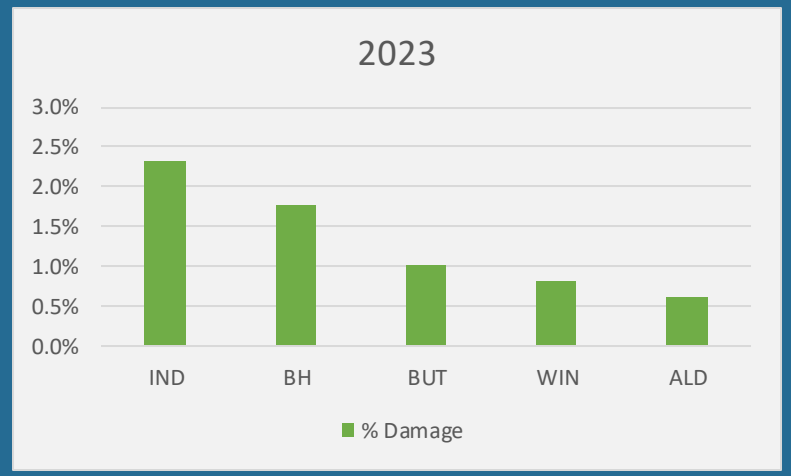
- Know the field history
- Nearby overwintering sites
- Look on sunny sides of trees
- Concentrate on edges
- Use a long stick or pole to knock branches
- Use all senses (Sound, Smell)
- Some varieties seem to be preferred

Monitoring

VARIETAL SUSCEPTIBILITY







Independence, Aldrich, and Butte are frequently targeted

Management

- Pyrethroids (Asana, Bifenture, Lambda Cy)
- Belay (clothianidin) – softer, but as effective?
- How severe is infestation?
- Piggyback with another treatment? Wait until next treatment window?
- What time of year is it?
  - Prior to shell hardening vs after
- Varietal spray?

The Future

- Plant bug pressure increasing
- Losing pyrethroids?

- Pheromone monitoring lure in development
  - “Leptotriene”
  - Potential for monitoring and “attract and kill” program

Summary

- Take the time to scout fields
- Regular checks are key
- New Lure may make life easier
- Potential for increasing pressure with fewer tools

https://www.redbubble.com/i/poster/It-wasn-t-me-Stink-Bug-by-houseofwray/94543869.LVTDI


california almonds
Almond Board of California
Thank you