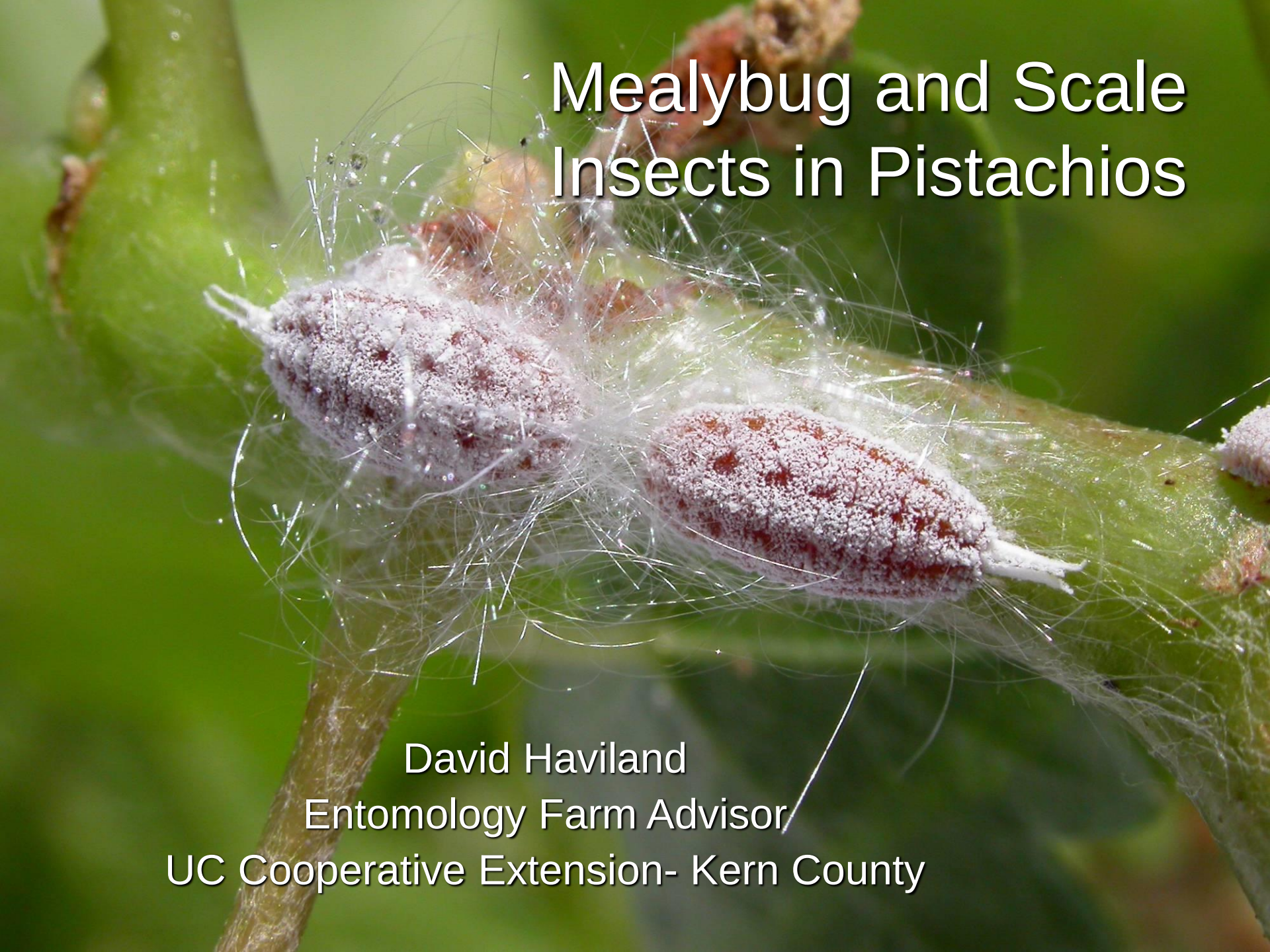


Mealybug and Scale Insects in Pistachios

David Haviland
Entomology Farm Advisor
UC Cooperative Extension- Kern County

Scale Insects

Black scale


European Fruit Lecanium

Frosted scale

Three species
1-5 generations per year
Suck plant juices
Can reduce yields,
produce honeydew that decreases photosynthesis

Management

- Primarily managed by biocontrol
- Examine scale for exit holes
- Monitor in January
- 10 scale per inch of new wood considered a heavy infestation
- Oil, pyriproxifen, buprofezin, carbaryl are all effective in mid-February

Gill's Mealybug- history

- Introduced into Tulare County in the mid to late 1990s, thought to be *Ferrisia virgata*
- Spread slowly initially
- 2002- Identified as a new species of mealybug, *Ferrisia gilli,* native to the southeast US
- 2004- pistachios now infested in >2,000 acres in at least 5 counties, also found in almonds and winegrapes
- 2005- ~3,000 acres infested, distribution widespread
- 2007- >6,000 acres infested


Adult females with glassy rods

Identification

- Most easily recognized by white excretions
  - Glassy white rods
  - Tail, no lateral filaments


Adult females with glassy rods

Note- immature females appear naked


Male pupal case

Life cycle

- Live birth of crawlers
- Nymphs molt several times
- Males develop into winged forms
- Females remain wingless
- All stages aggregate

- Gill's Mealybug
  - Two tails
  - Glassy rods
  - No egg sac
  - No red liquid

- Grape mealybug
  - Four tails
  - No glassy rods
  - Egg sac
  - Red liquid

- Gill's Mealybug
  - Two tails
  - Glassy rods
  - No egg sac
  - No red liquid

- Grape mealybug
  - Four tails
  - No glassy rods
  - Egg sac
  - Red liquid

- Gill's Mealybug
  - Two tails
  - Glassy rods
  - No egg sac
  - No red liquid

- Grape mealybug
  - Four tails
  - No glassy rods
  - Egg sac
  - Red liquid

- Gill's Mealybug
  - Two tails
  - Glassy rods
  - No egg sac
  - No red liquid

- Grape mealybug
  - Four tails
  - No glassy rods
  - Egg sac
  - Red liquid from ostioles

Winter

Pistachios- March

Pistachios-spring Late March-April


Pistachios- Late April


June 1


Late June to Early July


Mid-July to early August


Early August

Pistachios- August and September

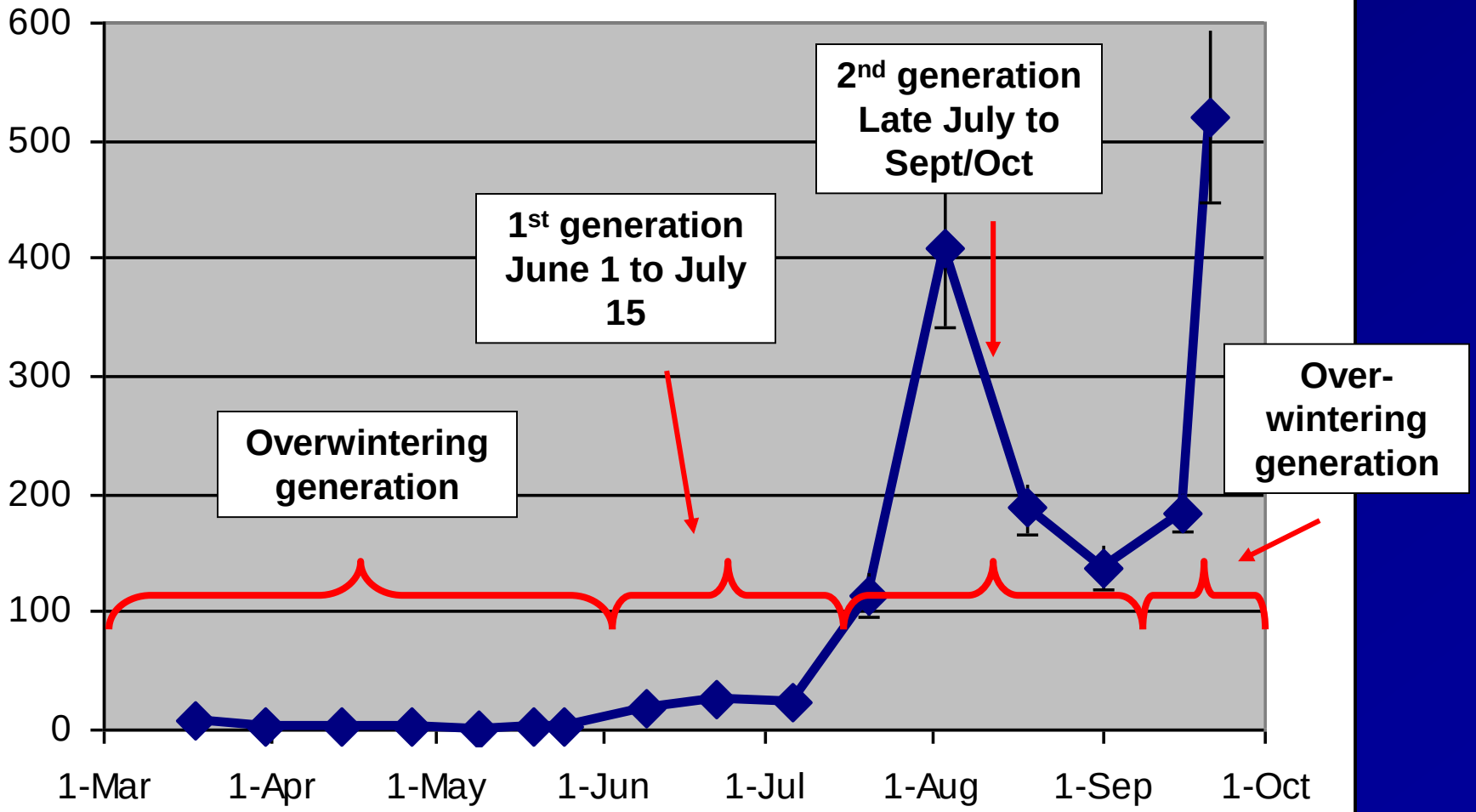
Mealybugs, honeydew, and sooty mold in the cluster

Damage

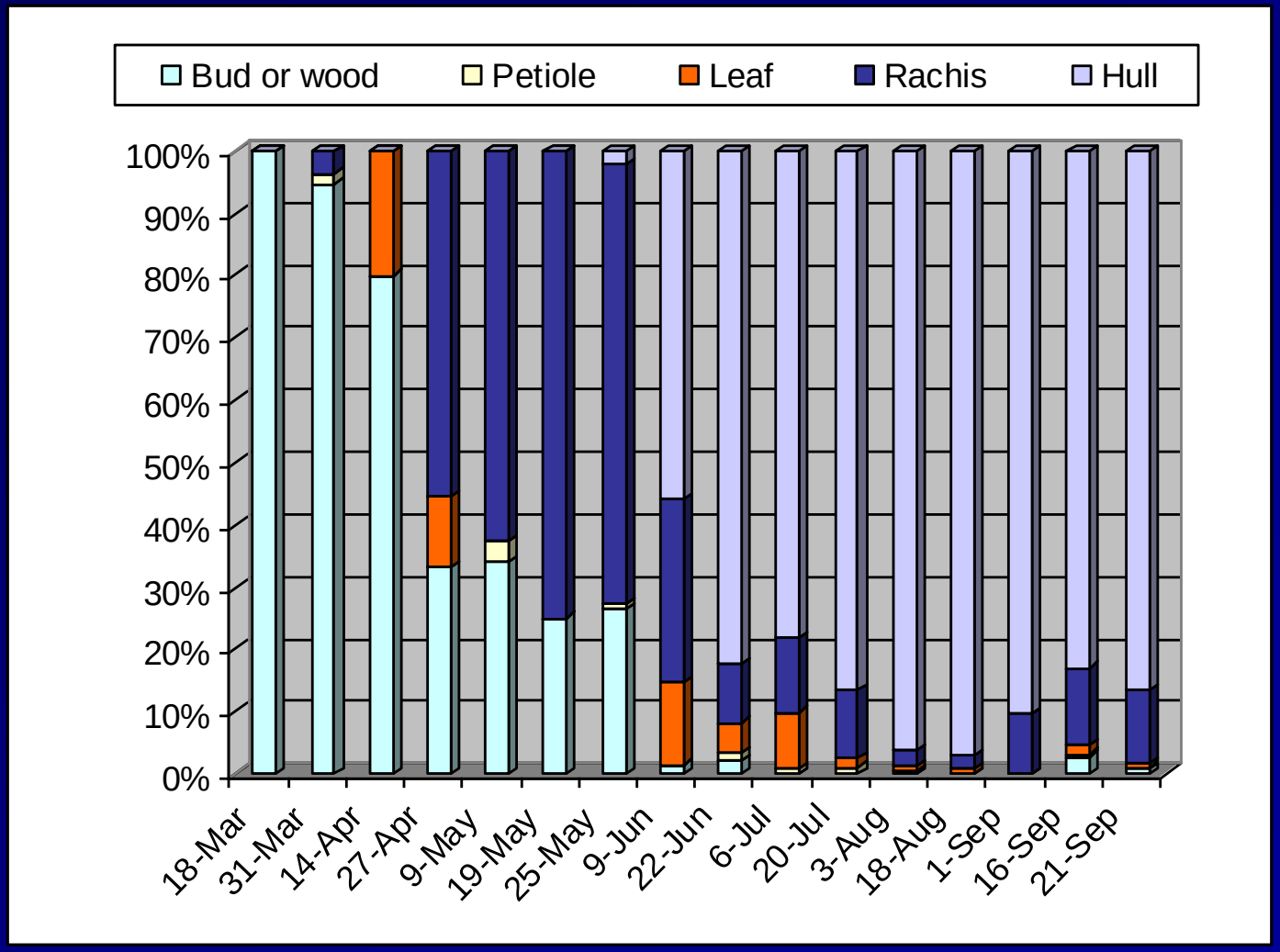
Mealybugs intercept carbohydrates that were intended for kernel development. Smaller kernels = less weight and less splitting

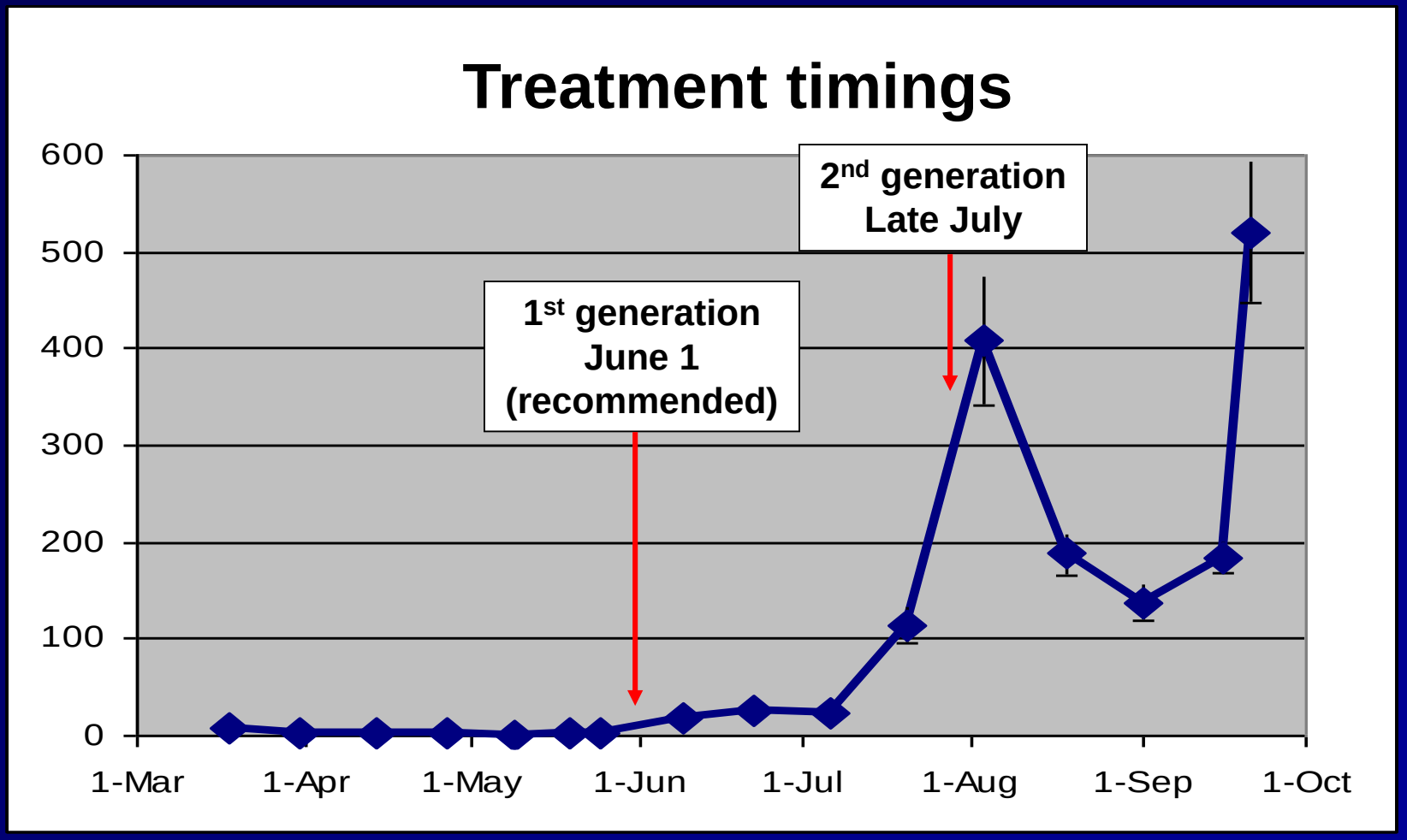
- Decrease in split inshell (% dry)
- Increase in closed shell
- Increased shell staining
  - Only on late harvests
- Possible increase in adhering hulls with later harvests
- Increase in sticktights (observed)
- No association with aflatoxins

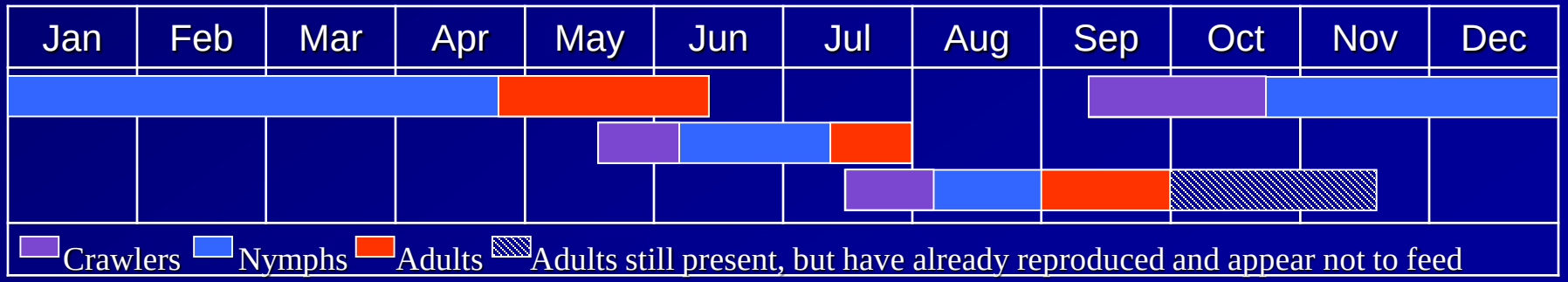
Total mealybugs per cluster



Monitoring - Mealybug Distribution




Treatment timings
600
500
400
300
200
100
0
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
2nd generation
Late July
1st generation
June 1
(recommended)


Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Crawlers
Nymphs
Adults
Adults still present, but have already reproduced and appear not to feed

Economic Injury Levels

- Journal of Economic Entomology
  - July 2015
- Utilizes data from field research in 2005-2007
- Establishes economic injury levels

Journal of Economic Entomology Advance Access published July 29, 2015

HORTICULTURAL ENTOMOLOGY

Crop Loss Relationships and Economic Injury Levels for *Ferrisia gilli* (Hemiptera: Pseudococcidae) Infesting Pistachio in California

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J. Econ. Entomol. 1–8 (2015); DOI: 10.1093/jee/tov223

ABSTRACT *Ferrisia gilli* Gullan (Hemiptera: Pseudococcidae) is a new pest in California pistachios, *Pistacea vera* L. We conducted a 3-yr field study to determine the type and amount of damage caused by *F. gilli*. Using pesticides, we established gradients of *F. gilli* densities in a commercial pistachio orchard near Tipton, CA, from 2005 to 2007. Each year, mealybug densities on pistachio clusters were recorded from May through September and cumulative mealybug-days were determined. At harvest time, nut yield per tree (5% dried weight) was determined, and subsamples of nuts were evaluated for market quality. Linear regression analysis of cumulative mealybug-days against fruit yield and nut quality measurements showed no relationships in 2005 and 2006, when mealybug densities were moderate. However, in 2007, when mealybug densities were very high, there was a negative correlation with yield (for every 1,000 mealybug-days, there was a decrease in total dry weight per tree of 0.105 kg) and percentage of split unstained nuts (for every 1,000 mealybug-days, there was a decrease in the percentage of split unstained of 0.560%), and a positive correlation between the percentage of closed kernel and closed blank nuts (for every 1,000 mealybug-days, there is an increase in the percentage of closed kernel and closed blank of 0.176 and 0.283%, respectively). The data were used to determine economic injury levels, showing that for each mealybug per cluster in May there was a 4.73% reduction in crop value associated with quality and a 0.866 kg reduction in yield per tree (4.75%).

KEY WORDS *Ferrisia gilli*, mealybug, pistachio, economic injury level, crop damage

The mealybug *Ferrisia gilli* Gullan (Hemiptera: Pseudococcidae) is an important new pest of pistachios, *Pistacea vera* L., in California. It was discovered in 1997 in commercial pistachio orchards in Tulare County, CA, and was later described as a new species by Gullan et al. based on differences in behavior, morphology, and genetics from existing species (Gullan et al. 2003, 2010). Since that time *F. gilli* has been reported from all major pistachio-producing regions of California (Haviland et al. 2012). *F. gilli* can cause visible damage by residing in and fouling the pistachio cluster; moreover, the excreted honeydew is rich in carbohydrates that promote sooty molds, which can further foul the cluster. Haviland et al. (2012) reported that two of three annual generations occur from June through September when the *F. gilli* population is predominantly found in the pistachio cluster feeding on the hulls or rachis of fruit and that, in untreated pistachio trees, it can reach densities greater than 100 mealybugs per cluster in August and September. It is unknown, however, if large populations of *F. gilli* reduce tree vigor and the resulting crop yield or if mealybug feeding on the cluster damages shell or nut quality underneath the exterior hull. Nevertheless, concerns by growers and researchers over high numbers of *F. gilli* feeding in the clusters have made this an economically important pest of pistachios that needs to be managed (Gullan et al. 2003, Haviland et al. 2006).

Management programs for *F. gilli* in California are based on the application of an insecticide, usually containing the active ingredient buprofezin, during early June when mealybugs are primarily in the cluster and in the first (crawler) or second instar developmental stage, which are easier to kill with insect growth regulators (Bentley et al 2012, Haviland et al. 2006). Application timing is improved by monitoring for mealybugs in May and early June, which is accomplished by identifying trees with *F. gilli* infestations and then evaluating these trees weekly to determine peak crawler emergence in order to properly select and time insecticide treatment. However, applications are based solely on the presence of mealybugs and the farm manager's risk tolerance, and economic injury levels (EILs) have not been established for *F. gilli* in pistachio.

We conducted a 3-yr field study in a commercial pistachio orchard to develop economic injury levels to improve treatment decisions for monitoring programs used in May and June. Insecticides were used to establish pistachio trees with gradients of mealybug densities

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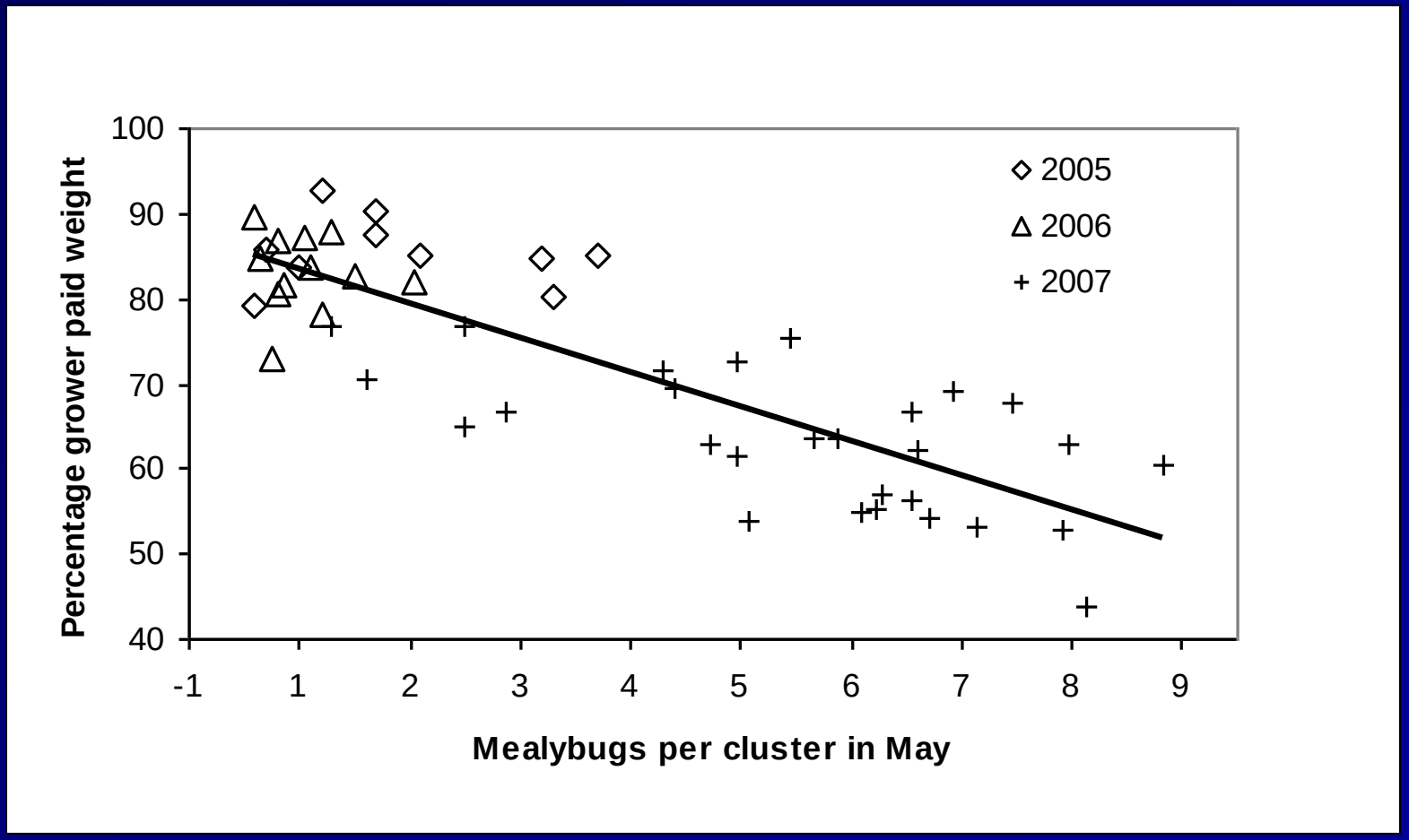
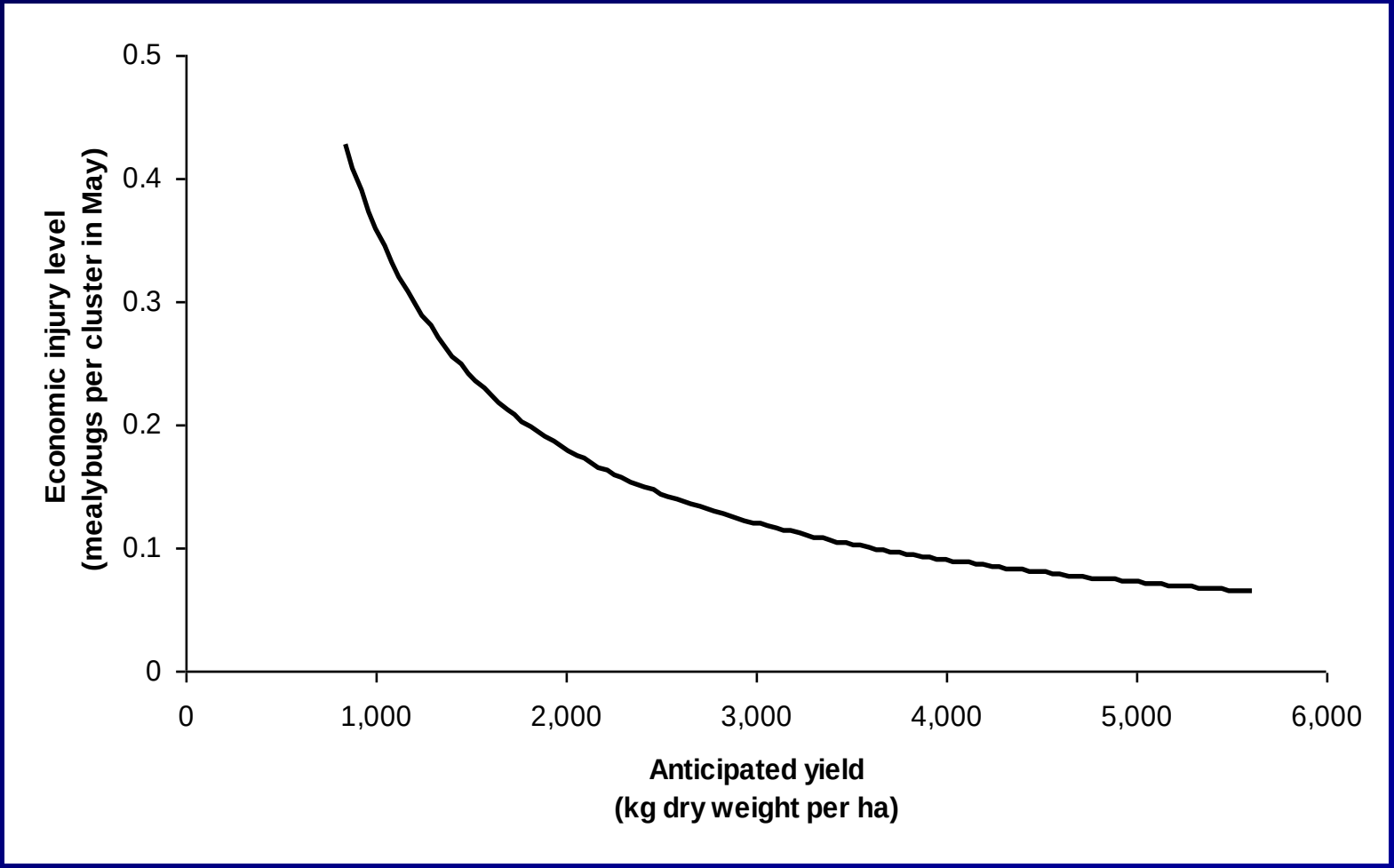
Pistachios- Late April

Relationship between grower paid weight an mealybug density



Research

Relationship between anticipated yield and EILs



Economic Injury Level

EIL =

$$\frac{\text{(cost of control) x (unit of pest density)}}{\text{(yield)(price)(crop loss to quality)(crop loss to yield)}}$$

EIL in May in mealybugs per cluster =

$$\frac{\text{Control cost per acre x 1 mealybugs/cluster}}{\text{Anticipated yield in lbs/acre x crop price in \$/lb x .0475 x .0475}}$$

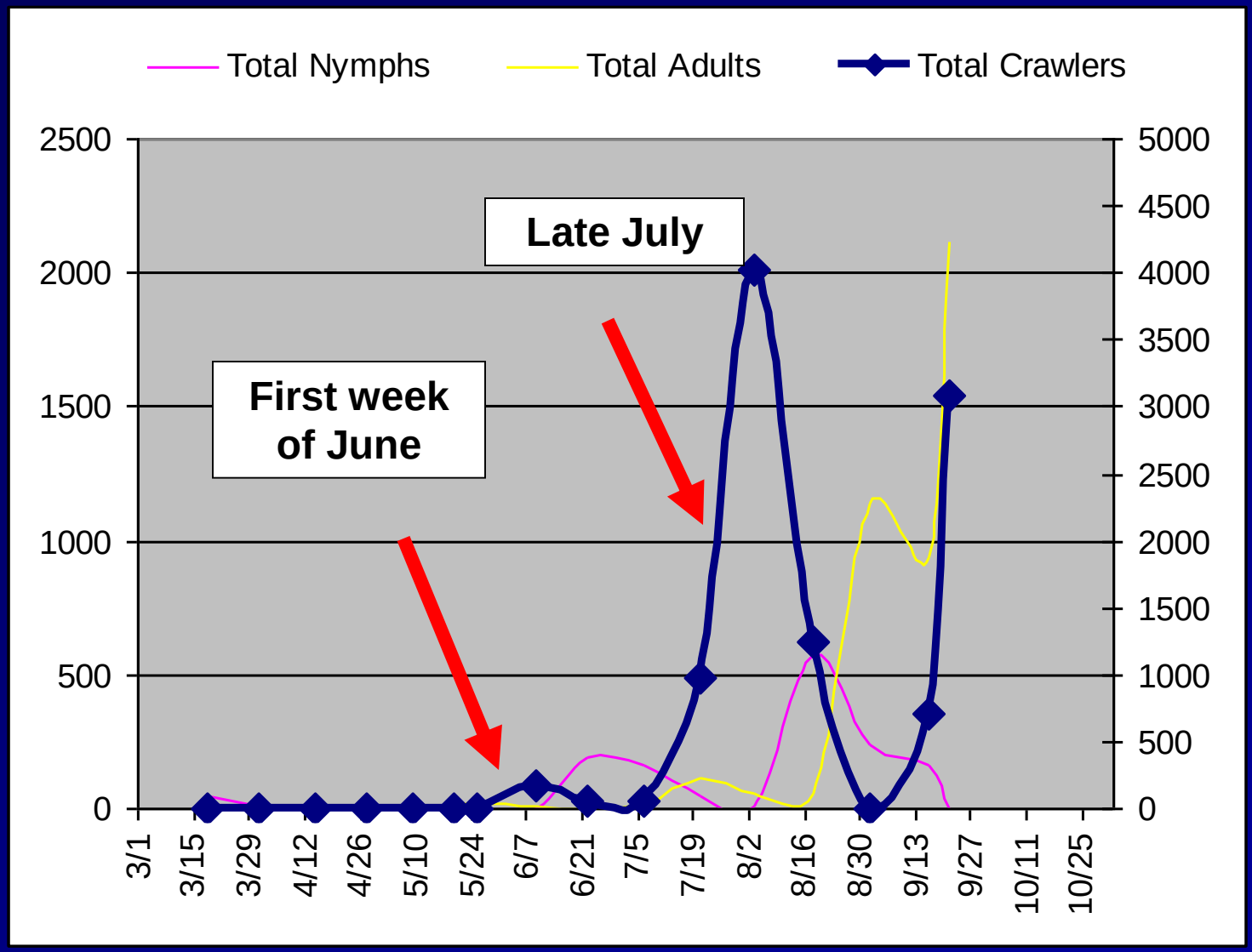
=

$$\frac{\text{\$60/ac x 1}}{\text{3,000 lb/ac x \$2/lb x .0948}} = .10 \text{ mealybugs per cluster in May}$$

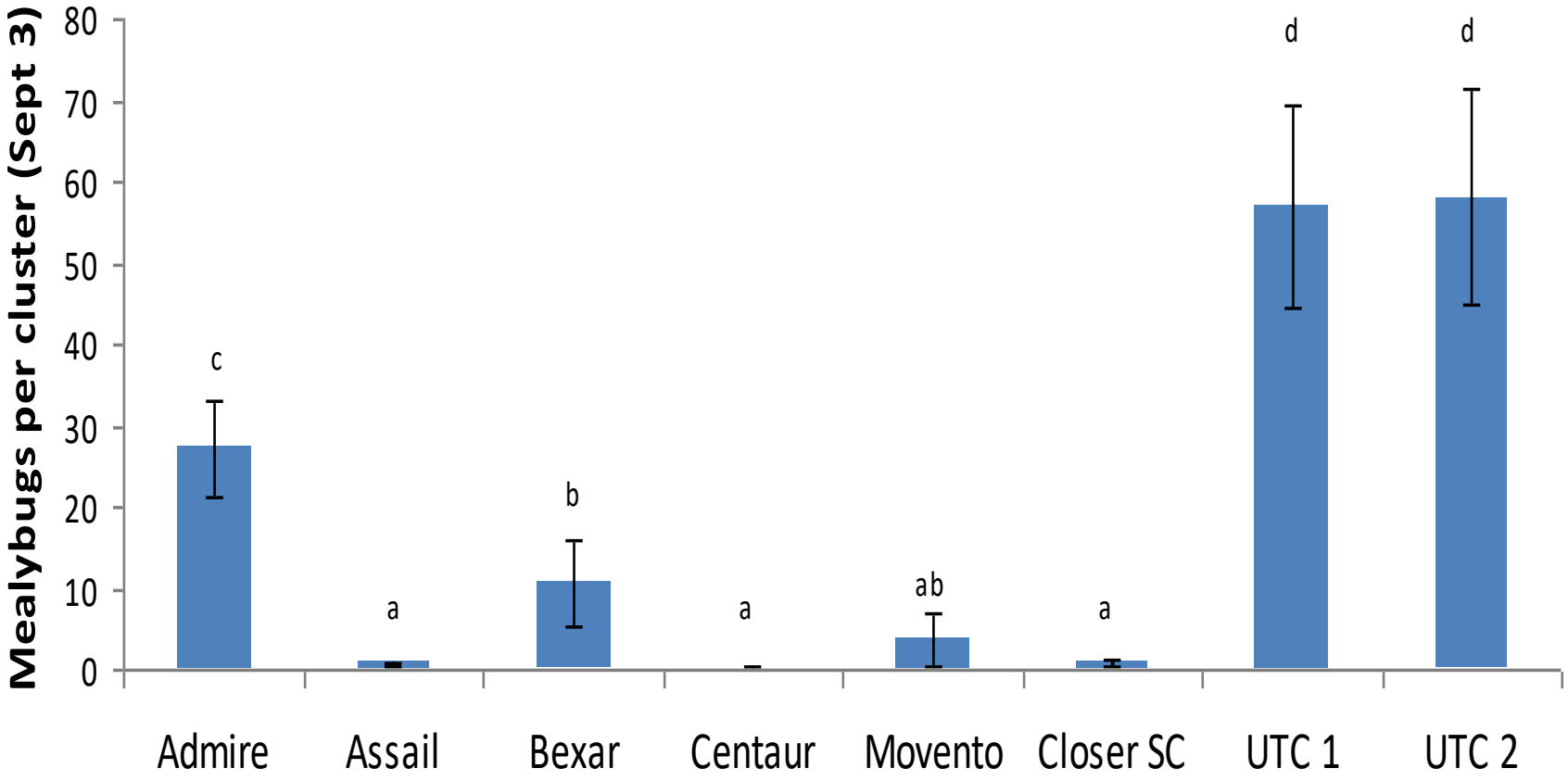
EIL math

	Long-term average	Low cost High yield High price	Med cost Avg yield High price	High cost Low yield Low price
Cost per acre for control	$60	40	60	80
÷ anticipated yield in lbs/acre	3,000lb/ac	4,000	3,000	1,500
÷ anticipated price in $	$2/lb	4	4	2
÷ 0.094	0.01	0.01	.01	.01
= EIL in mealybugs per cluster in May	0.10 (1 in 10)	.02 (1 in 50)	0.10 (1 in 20)	0.27 (1 in 4)

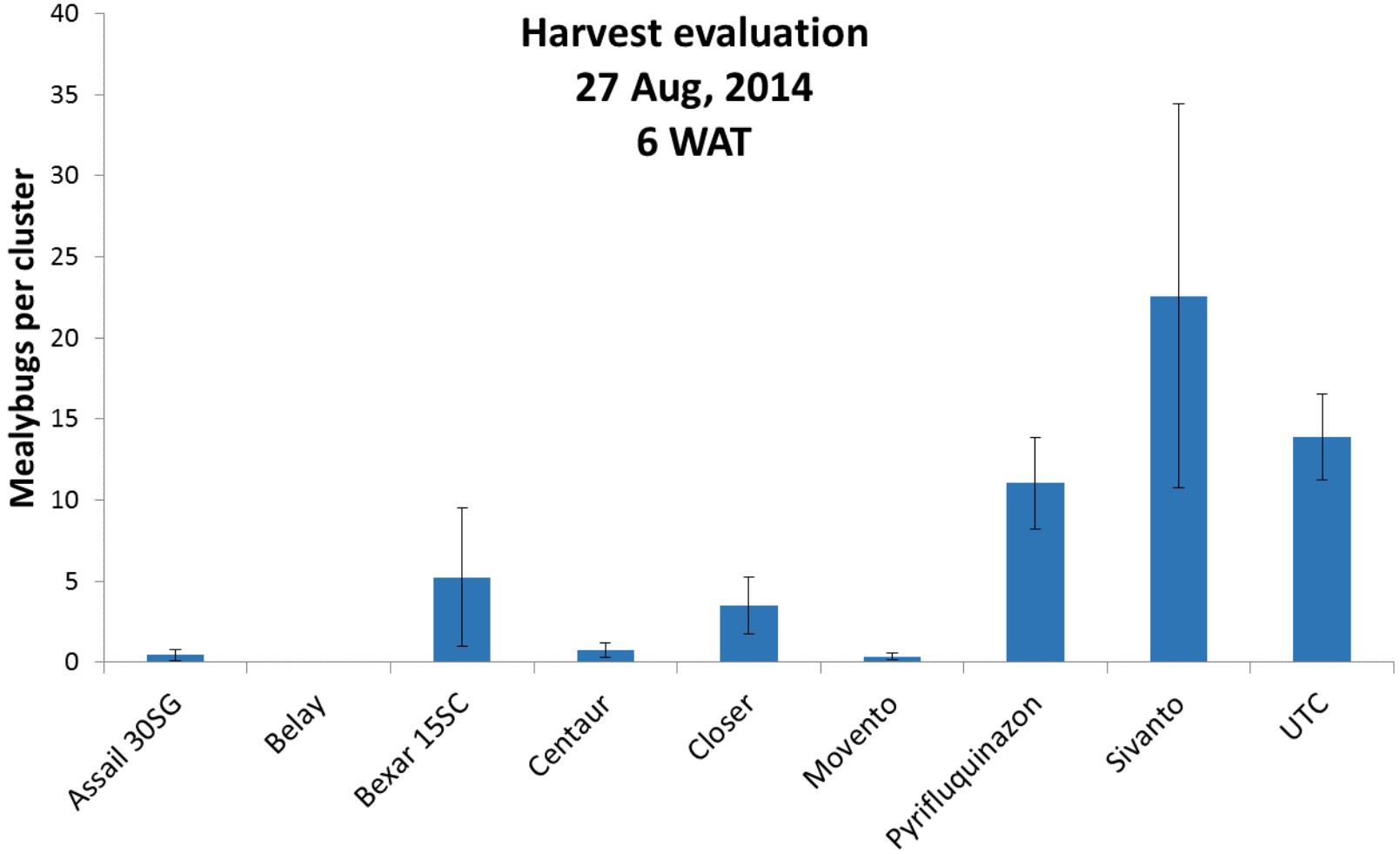
Insecticide Timing



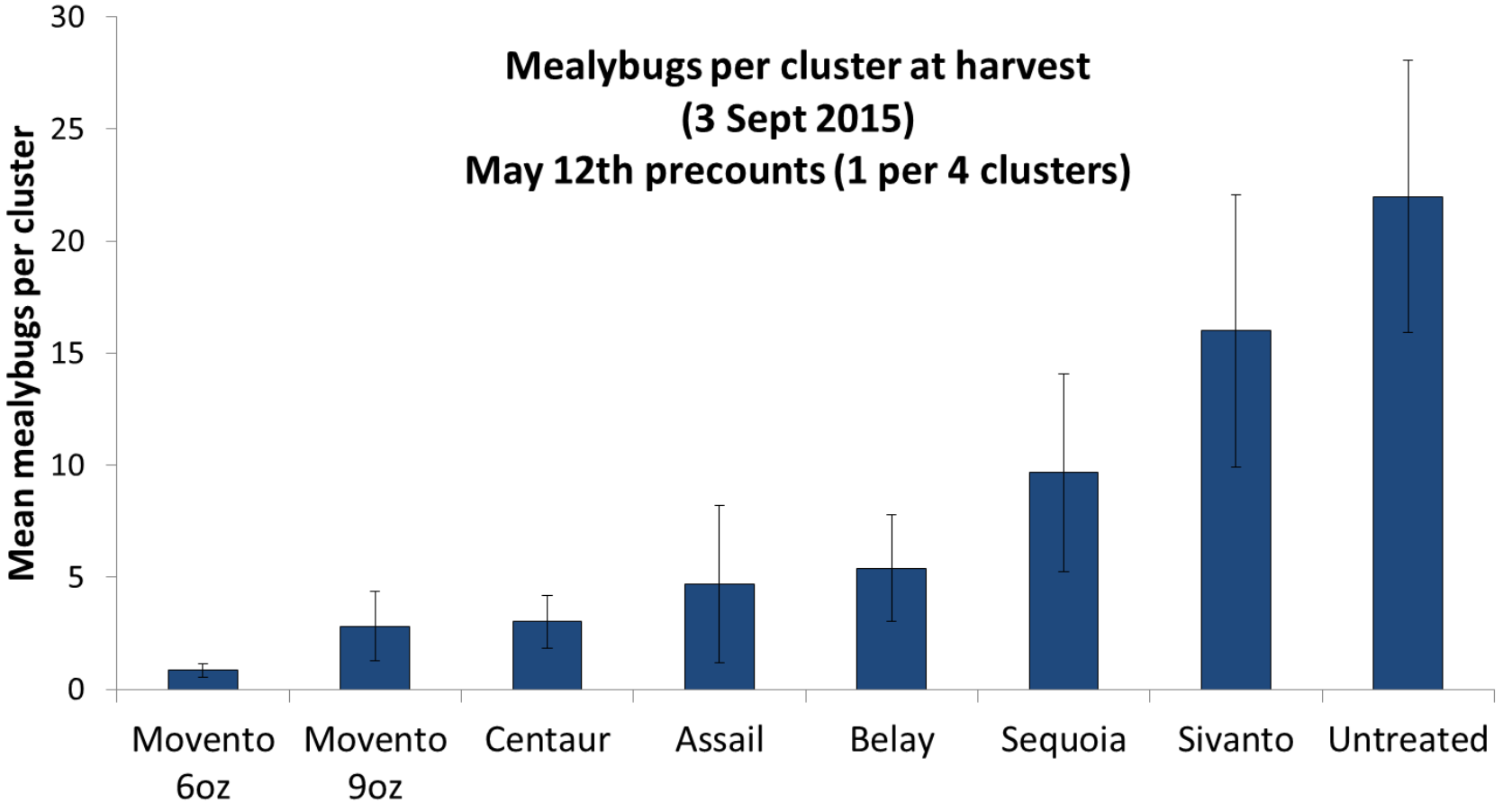
2013 Insecticide Trial



2014 Insecticide Trial



2015 Insecticide Trial

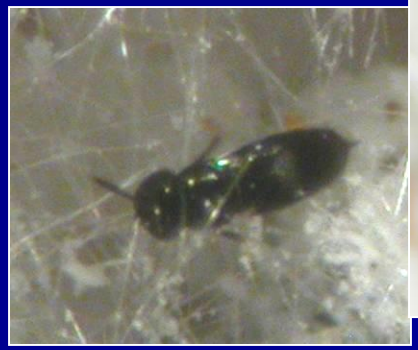


Management with insecticides

- Centaur (buprofezin)
  - Time to first generation crawlers
- Movento (spirotetramat)
  - Time to first generation, maybe ~2-3 weeks earlier
  - Surfactant is required
  - 6 oz as good as 9 oz rate in 2015 study
- Assail (acetamiprid)
  - Time to first generation
  - Best option for second generation control (mid-July)
- Admire (imidacloprid)
  - Not as effective, but inexpensive and no application costs
- Non-registered insecticides also effective
  - Bexar and Closer

Biological Control

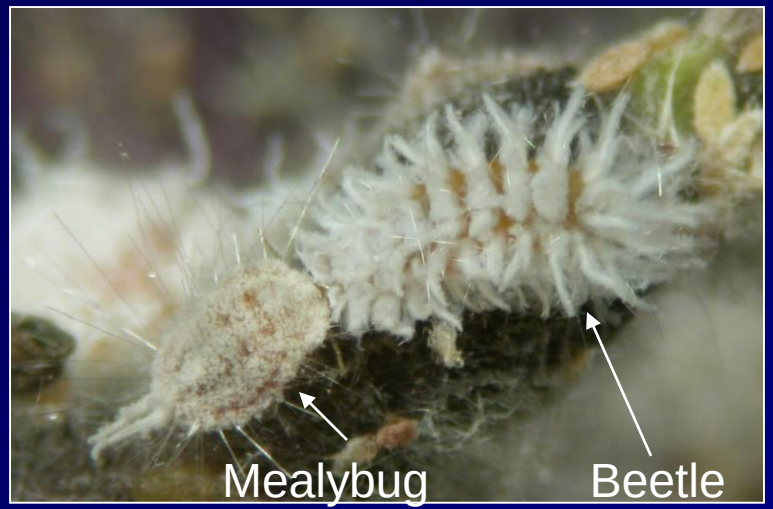
Biological control- parasitoids

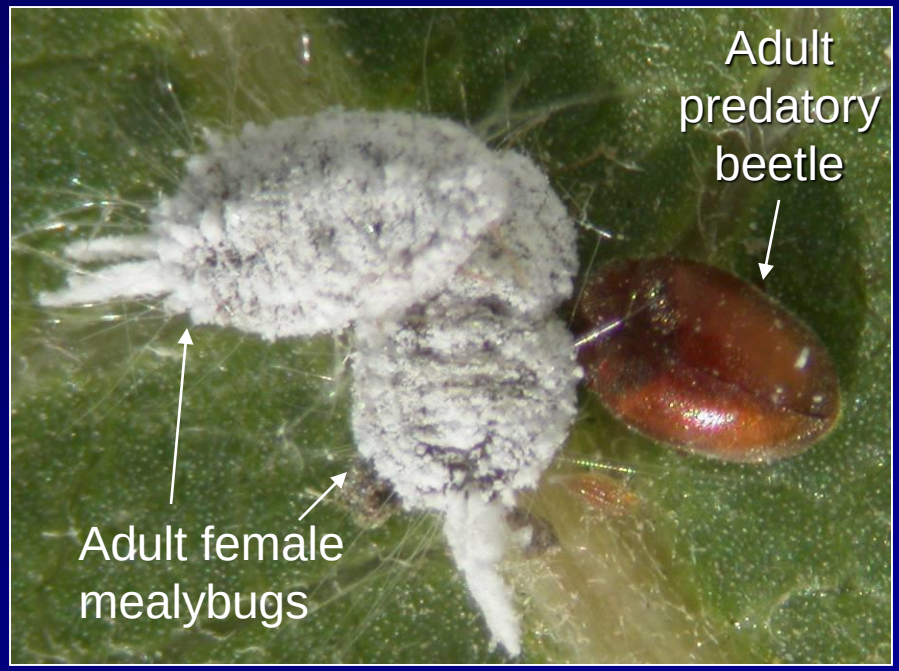


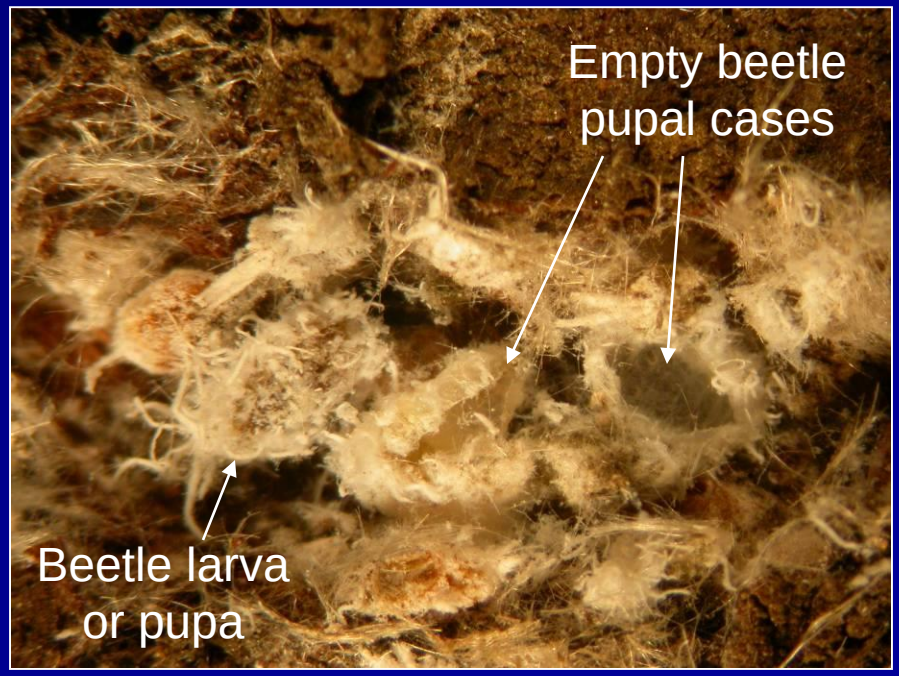
We have reared at least two species of parasites from mealybugs in Almonds.

None found yet in pistachios… likely due to permethrin for true bugs.

Biological control- predatory beetles







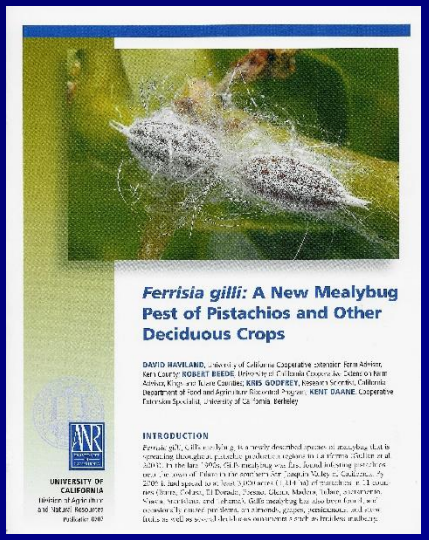
Pyrethroid/Permethrin use

- For NOW and bugs
- No magic application date
- Sprayed
  - With fungicides
  - With foliar nutrients
  - On their own
  - At hull split
  - Between shakes
  - 4-6 applications per season is common

Stopping the spread at harvest

- Wash equipment when leaving infested blocks
  - High pressure (or even low pressure) water
  - Shakers, catch frames, etc.
- Wash bulk containers when leaving infested blocks or after their use
  - Use bulk transport
  - 4 x 4 bins (best if kept in field)
- Avoid leaf trash from blowing out of bins during transport
- Communication
  - Growers should identify fields to harvesters
  - Hullers should be aware of infested bins
  - Hullers should have sanitation/isolation plans in place

Summary


Ferrisia gilli: A New Mealybug Pest of Pistachios and Other Deciduous Crops

DAVID HAVILAND, University of California Cooperative Extension Farm Advisor, Kern County; ROBERT BEEDE, University of California Cooperative Extension Farm Advisor, Kings and Tulare Counties; KRIS GODFREY, Nursery Scientist, California Department of Food and Agriculture Biocontrol Program; KENT DAANE, Cooperative Extension Specialist, University of California Berkeley

INTRODUCTION

- Monitor in May
- Treat if you have 1 mealybug per 6-12 clusters
- Centaur, top of the label, good coverage, first two weeks in June when crawlers emerge
- Movento and Assail also options
- Prevent spread by washing harvest equipment before moving off or on site
- Monitor at harvest-winter to find newly infested fields
- Long-term solution… biological control

***Ferrisia gilli*: A New Mealybug Pest of Pistachios and Other Deciduous Crops**

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INTRODUCTION

Ferrisia gilli, Gill's mealybug, is a newly described species of mealybug that is spreading throughout pistachio production regions in California (Gullan et al. 2003). In the late 1990s, Gill's mealybug was first found infesting pistachios near the town of Tulare in the southern San Joaquin Valley of California. By 2009, it had spread to at least 3,000 acres (1,214 ha) of pistachios in 22 counties (Butte, Colusa, El Dorado, Fresno, Glenn, Madera, Tulare, Sacramento, Shasta, Stanislaus, and Tehama). Gill's mealybug has also been found, and occasionally caused problems, on almonds, grapes, persimmons, and stone fruits as well as several deciduous ornamentals such as fruitless mulberry.

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Thank you

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