

*Annual Central Coast Strawberry Meeting  
Watsonville, February 5, 2013*

# Drosophila and Mites in Strawberries, 2013?

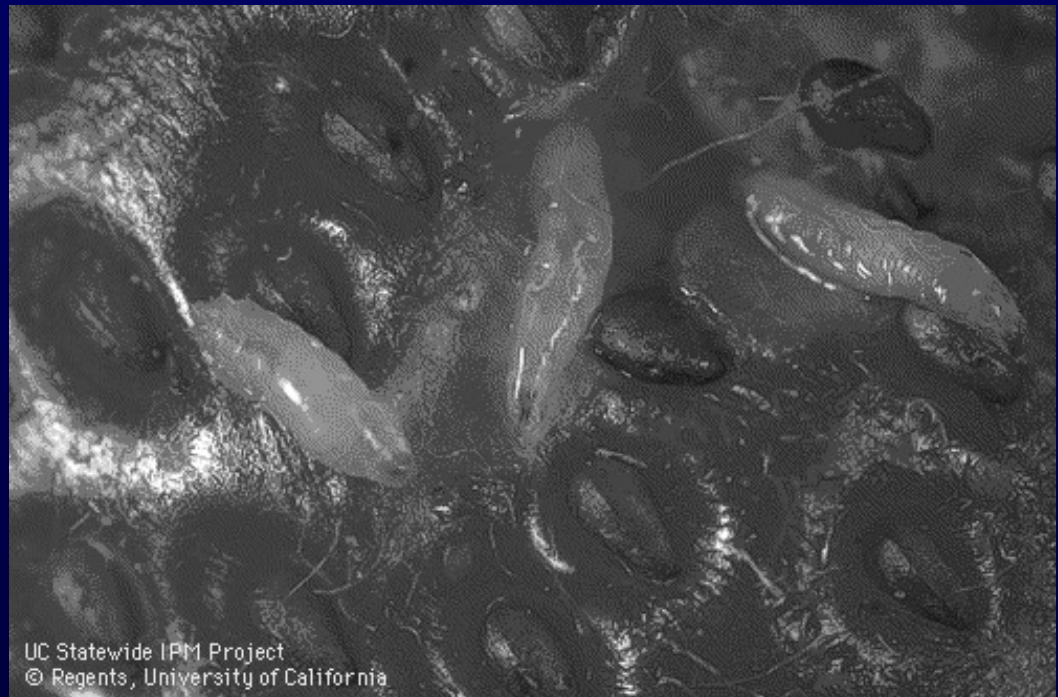
Frank Zalom

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# *Drosophila* spp. - aka 'Vinegar flies'

Usually considered a processing concern.

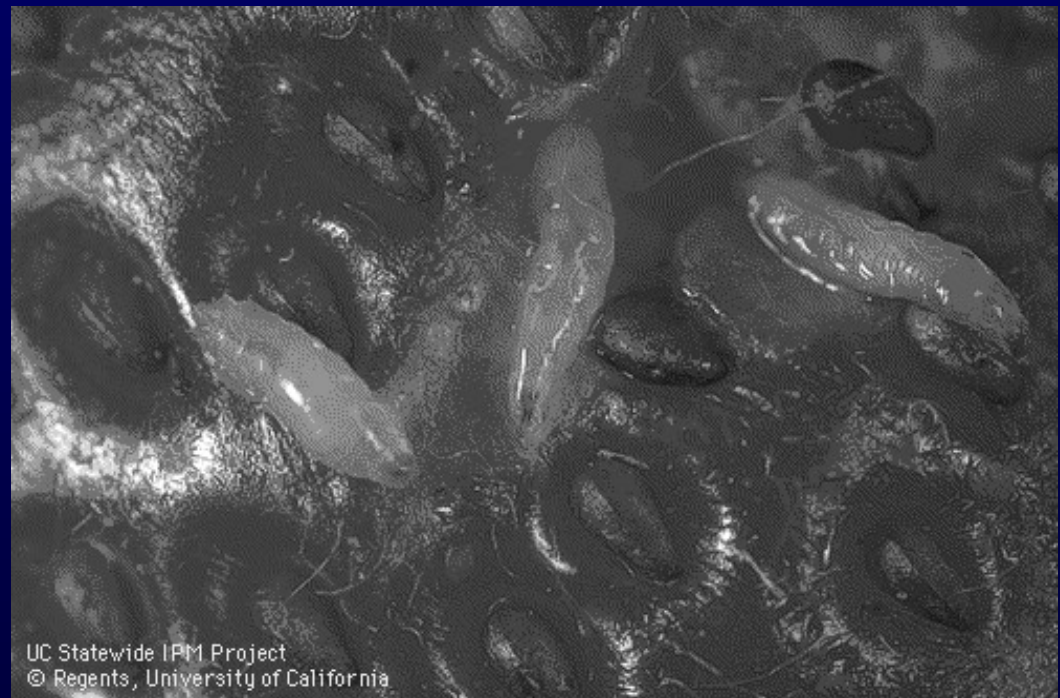
One of the few insects considered a contaminant in processed products by the Food and Drug Administration, depending on the crop and type of product.



# *Drosophila* spp. - aka 'Vinegar flies'

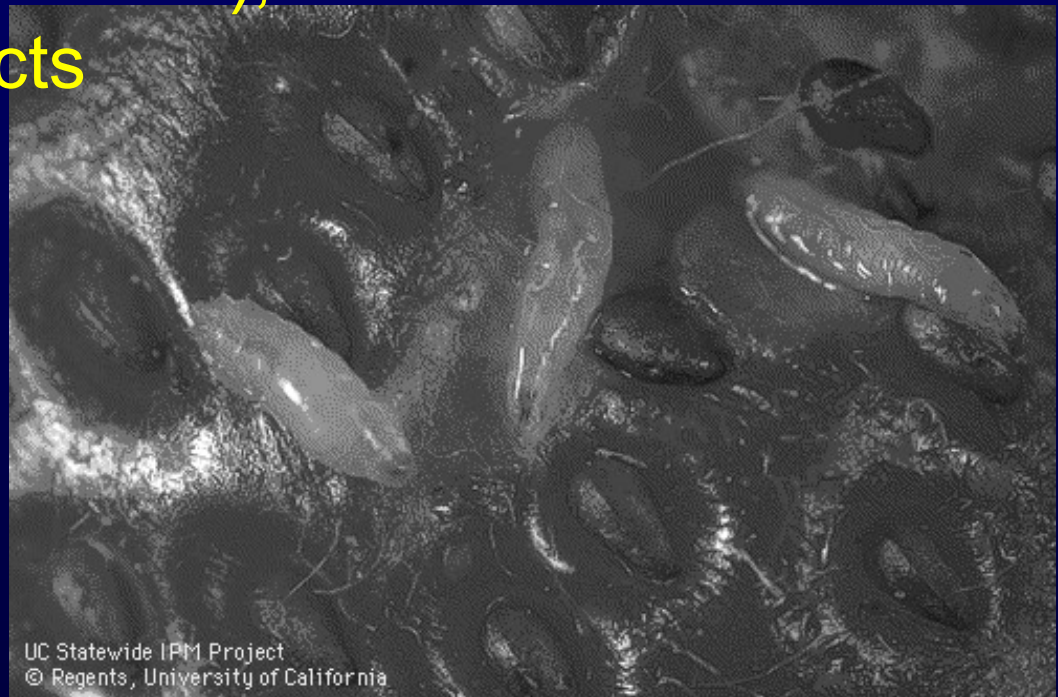
Has been an export phytosanitary concern.

Quality assurance protocol developed for shipping frozen strawberries to Japan in 1997.



# *Drosophila* spp. - aka 'Vinegar flies'

Vinegar flies are rarely ever a problem in fresh production fields where they are incidentally managed by incidental controls such as relatively frequent harvests, sanitation (keeping the field free of old, over ripe or rottin fruit), and insecticides applied for other insects



# *Drosophila* spp. - aka 'Vinegar flies'

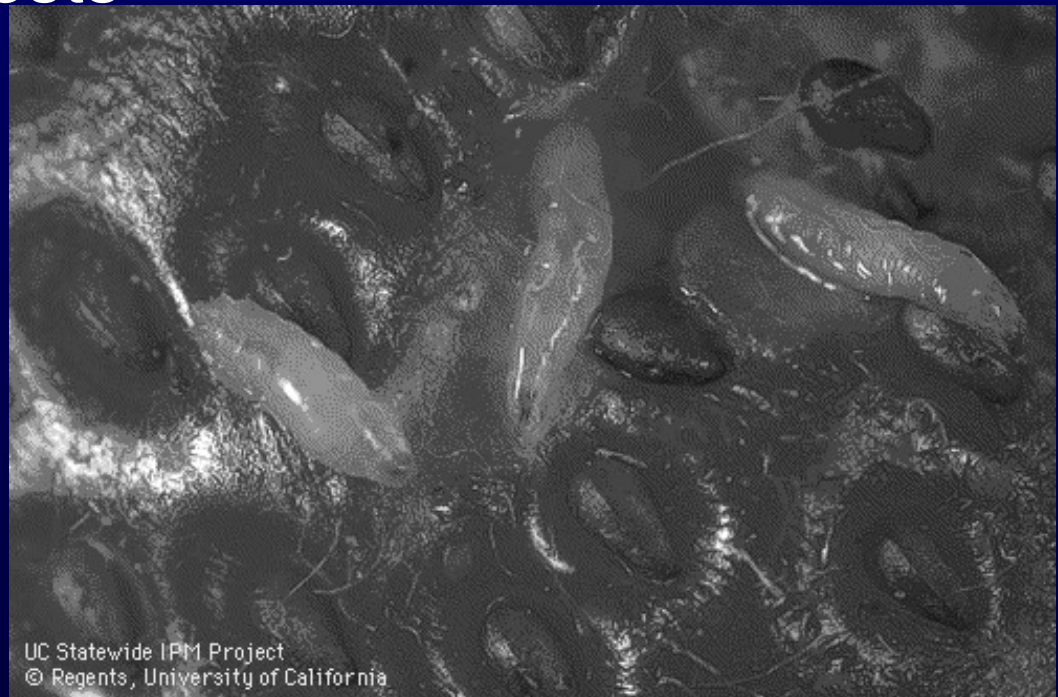
Guidelines for managing vinegar flies, developed as quality control standards following the 1997 incident with shipments to Japan included:

Monitoring for presence of adult flies

More frequent harvests

Sanitation

Insecticides





# *Drosophila* spp. - aka 'Vinegar flies'

Camarillo, 2012





# *Drosophila* spp. - aka 'Vinegar flies'

## Sources



Overripe fruit



Unharvested fruit



# *Drosophila* spp. - aka 'Vinegar flies'

## Sources

Some of the problem was due to insufficient labor that increased harvest intervals and precluded removal of old fruit.

Some of the problem was lack of monitoring for vinegar flies and application of treatments only after the problem had become severe.

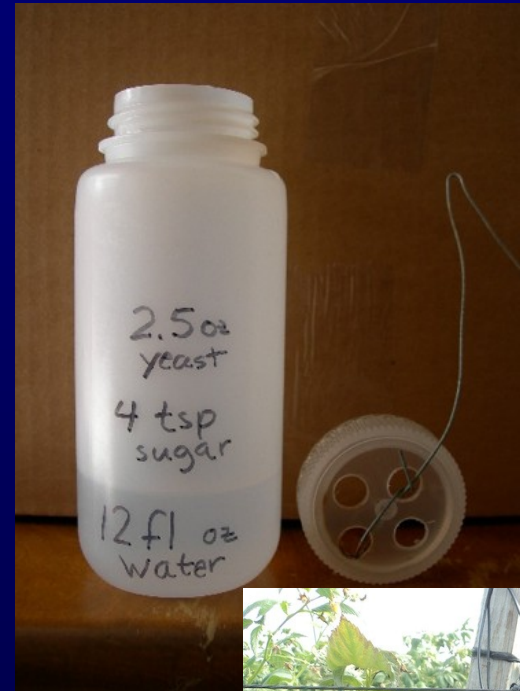




# *Drosophila* spp. - aka 'Vinegar flies'

Traps will capture many species and other flies, too

Traps contain either:  
baker's yeast + sugar + water  
or apple cider vinegar



# *Drosophila* spp. - aka 'Vinegar flies'

Insecticides won't control the maggots once fruit are infested, they can only knock down adult flies and protect uninfested fruit.

## Organophosphates

Malathion

## Pyrethroids\*

Danitol, (Brigade, Bifenture)

## Spinosyns

Entrust, Success, Radiant

*\* Using pyrethroids can exacerbate Lygus resistance*

# Spotted Wing Drosophila

*Drosophila suzukii*

New species in North America  
Attacks sound fruit  
Problem for fresh market



*Drosophila melanogaster*  
and other species

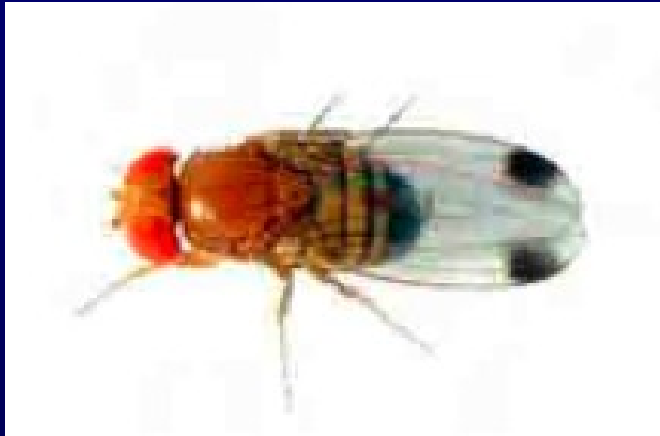
Always present  
Attacks older fruit  
Problem for processing





# Spotted Wing Drosophila

## Identification



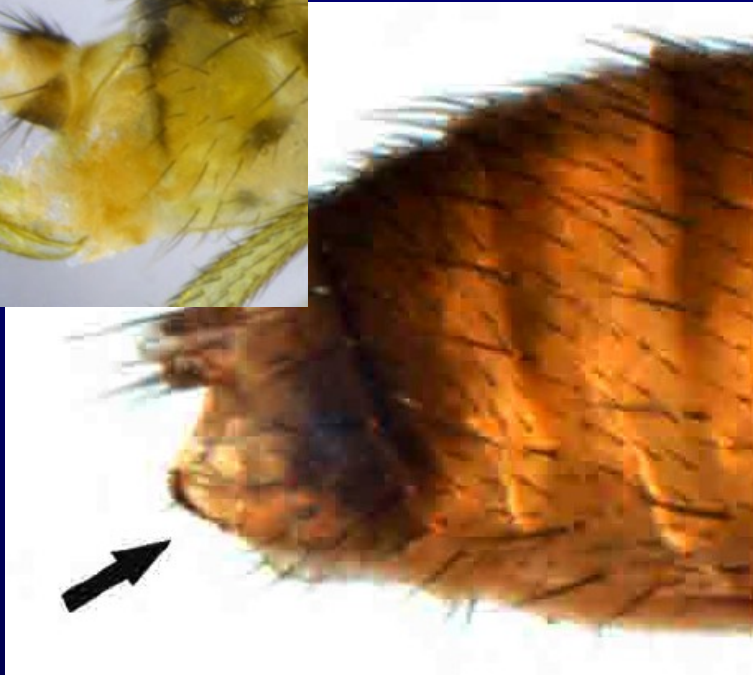
Male



Female

Adults are 2-3 mm in size. Females and their larvae (maggots) are easily confused with other *Drosophila*

# Spotted Wing *Drosophila*



Other *Drosophila*



*Drosophila suzukii*

Female *D. suzukii* have a specialized sharp ovipositor that is different from other common *Drosophila*.

# Spotted Wing Drosophila

Management is same as for all *Drosophila*

- Sanitation, remove mature and overripe fruit
- Sanitation, eliminate alternate habitat (culled fruit and abandoned host fields) that sustains the infestation
- Monitoring and trapping to quickly detect infestations - get ahead of the damage
- Use insecticidal sprays or baits to suppress fly populations
  - organophosphates, pyrethroids, spinosyns



# Spotted Wing Drosophila - research

Seasonal trapping of *D. suzukii* in  
Watsonville raspberries with Mark Bolda and  
Monise Sheehan

Adult trap lure comparison (yeast vs. vinegar)

Vacuum sampling

Larval sampling

# Spotted Wing Drosophila - research

New project with Mark Bolda, monitor *D. suzukii* and other *Drosophila* in strawberries:

- Monitor densities and fruit damage at different distances from infested host fields
- Effect of harvest interval on fruit infestation

# Spotted Wing Drosophila - research

## Collaborations on *D. suzukii* biology

Dr. Zain Syed

*D. suzukii* scent/taste  
organs

Electroantennograms

Host odor profiles





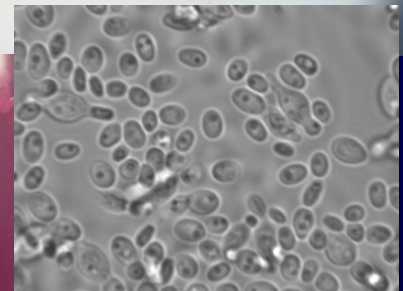
# *D. suzukii* yeast associations

Yeasts are an important food source for *D. melanogaster*, and they have recently been found to cultivate or 'farm' specific yeasts

Are species-specific yeasts more attractive?; implications for better trapping and baits

Isolated yeast from juice of infested fruit, adult midguts, and larval frass from both cherries and raspberries

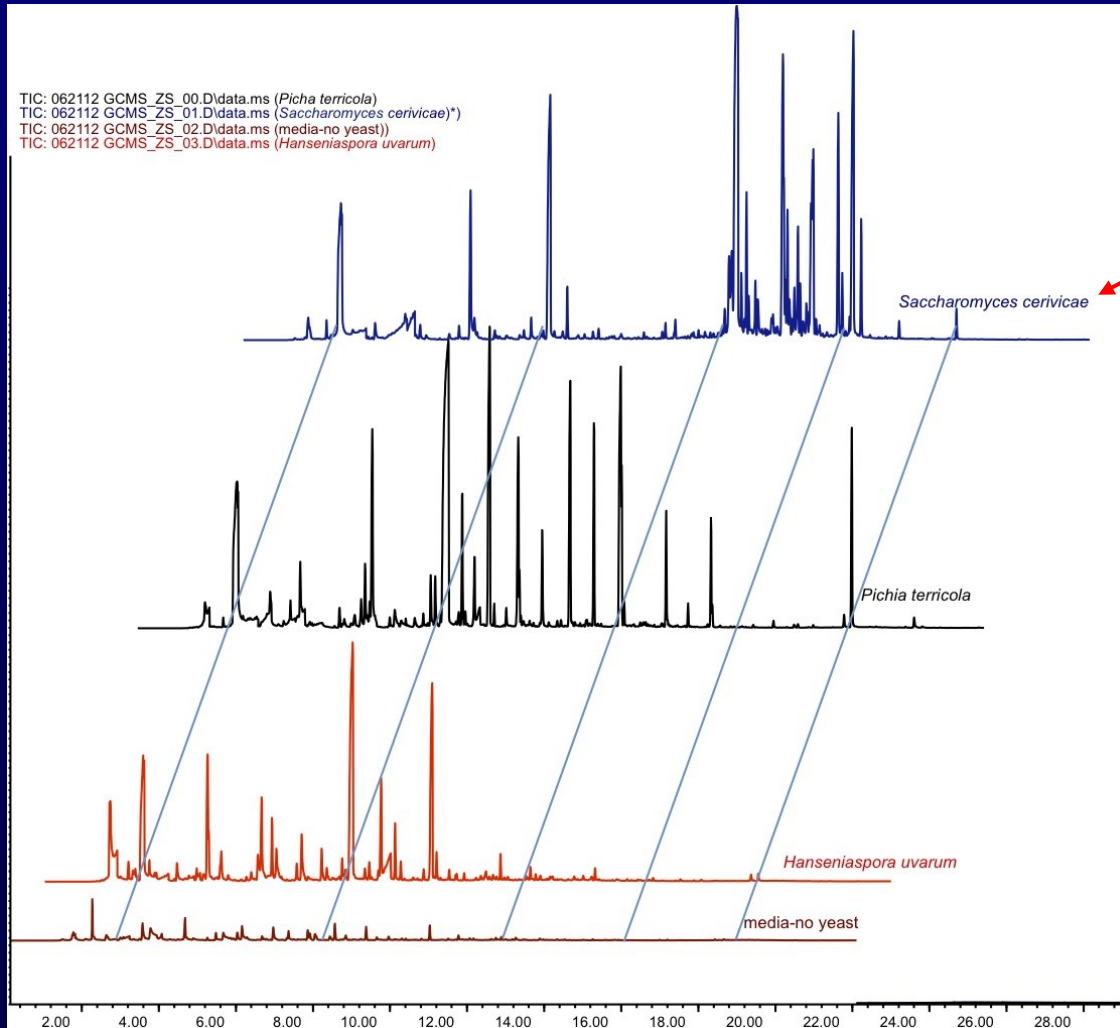
A few of the yeast species were found in most samples



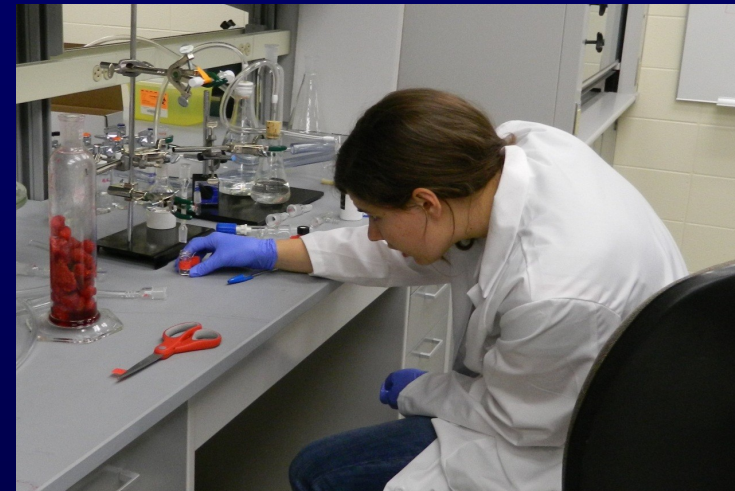
A maggot 'walk'  
on a yeast plate



# Preliminary Results



baker's yeast

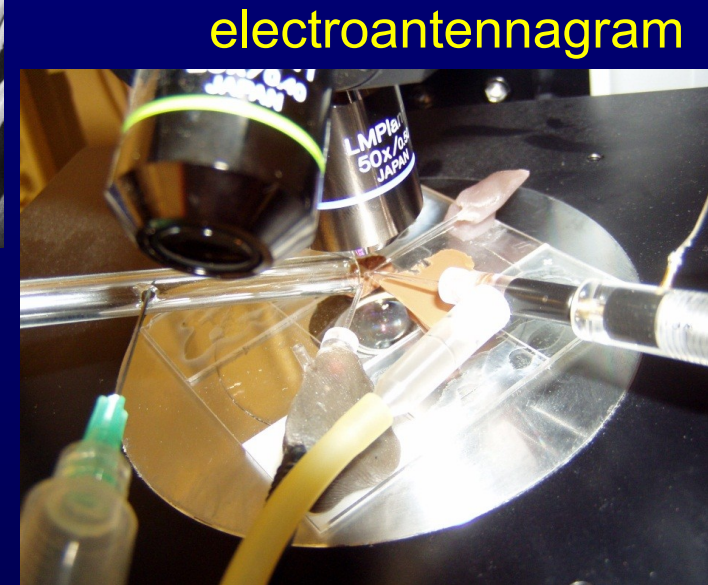
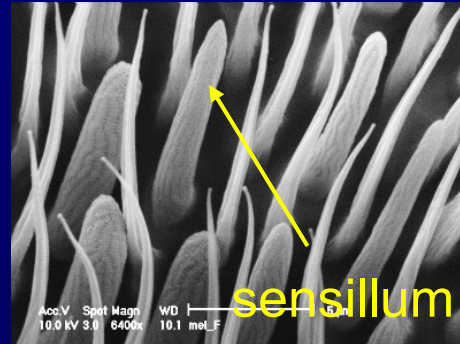
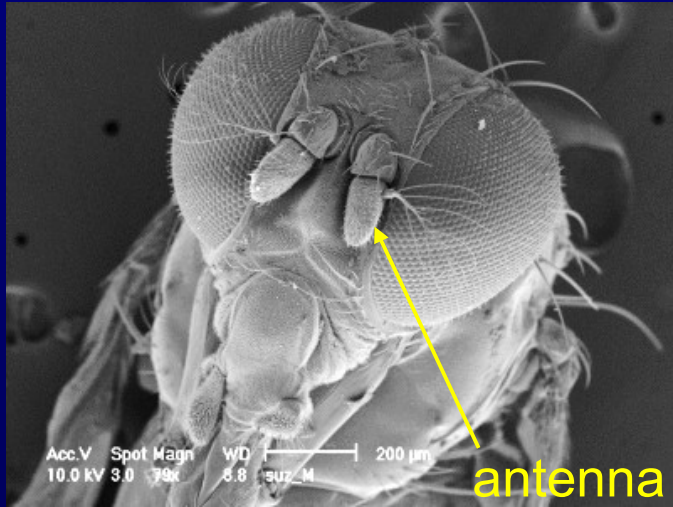


Nicole Sheidle,  
Grad student  
University of Notre Dame

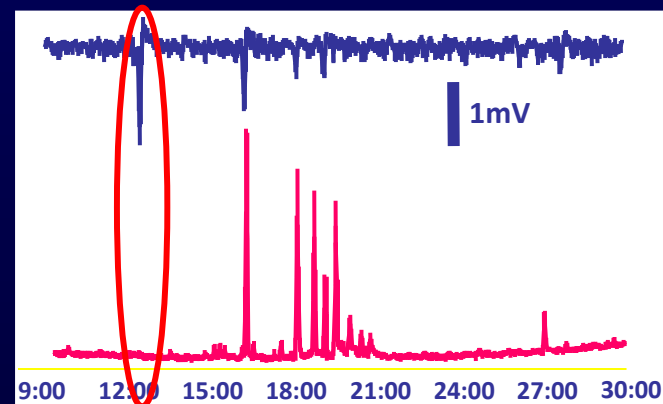
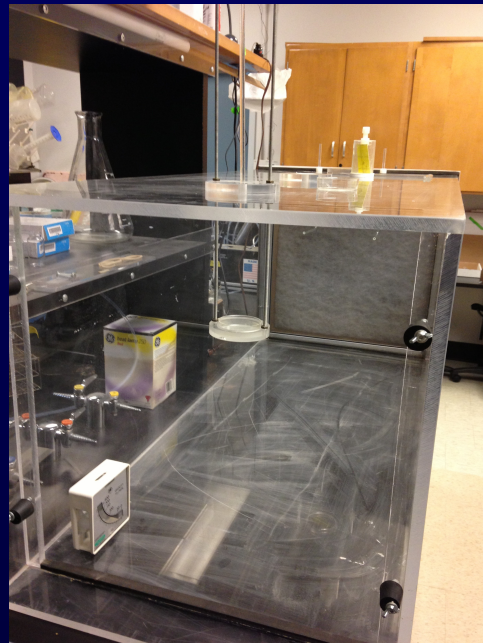
Yeast-associated volatile profiles



# *D. sukuzii* scent detection



flight chamber





# Spotted Wing Drosophila - research

## Collaborations on *D. suzukii* biology

Dr. Joanna Chiu

Circadian rhythms

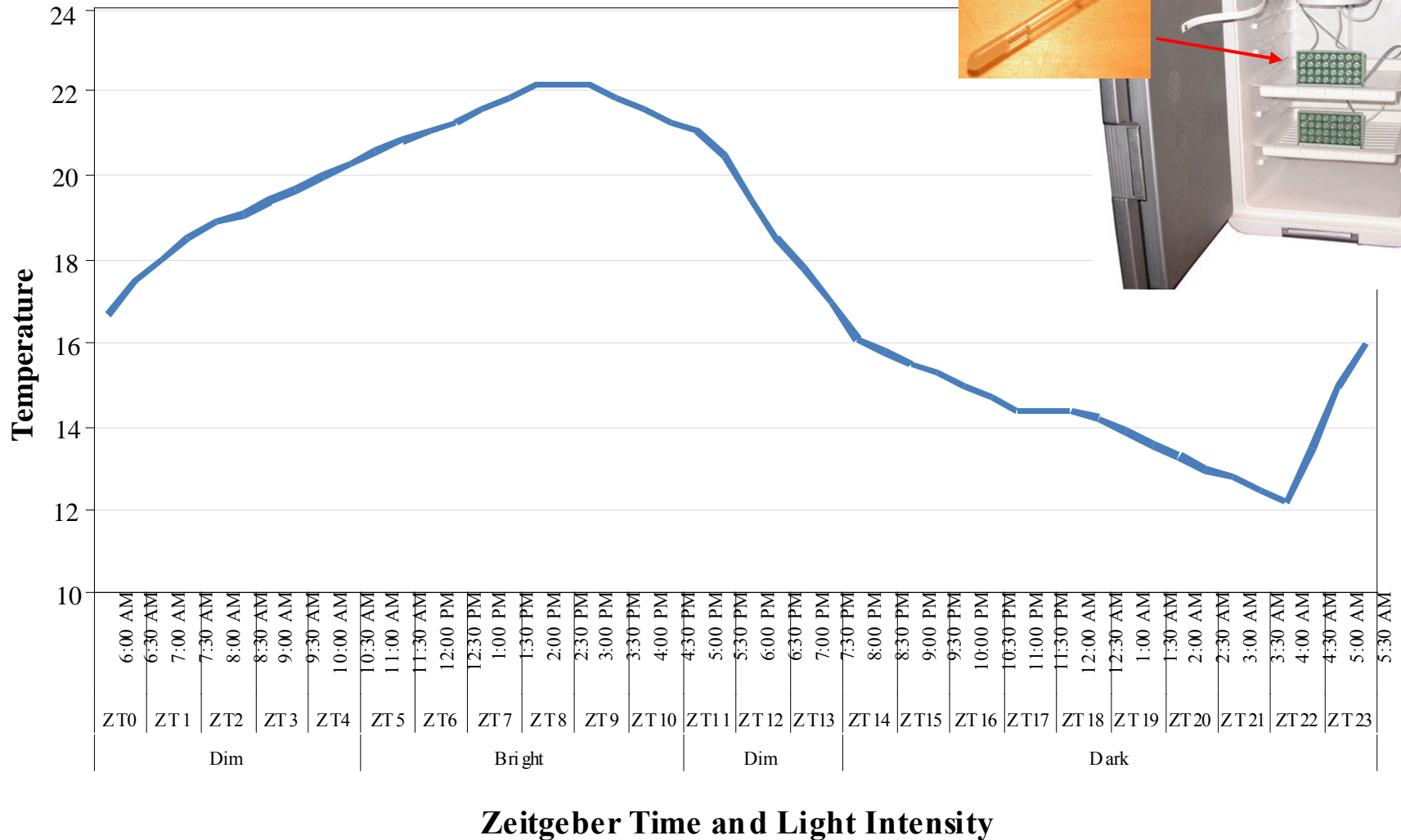
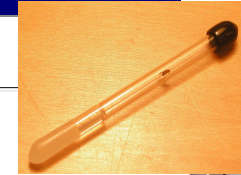
Activity monitoring system

Insecticide activity



Circadian rhythm - ('biological clock'); A daily cycle of biological activity based on a 24-hour period and influenced by regular variations in the environment, such as the alternation of night and day.

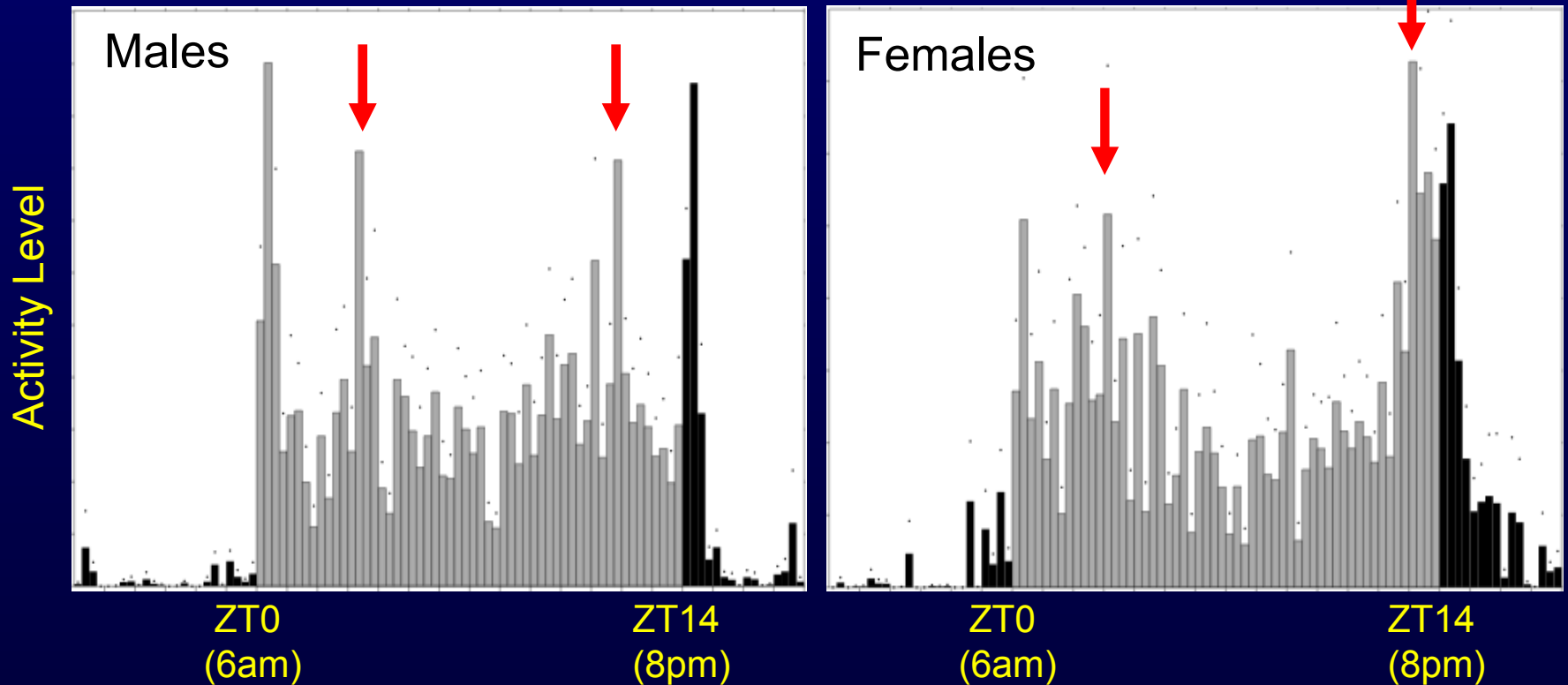
Studies are performed in a growth chamber programed to be similar to a Watsonville summer day



# Circadian rhythms and pesticide efficacy

If flies more active, they are more likely to be more easily vacuumed or captured in traps

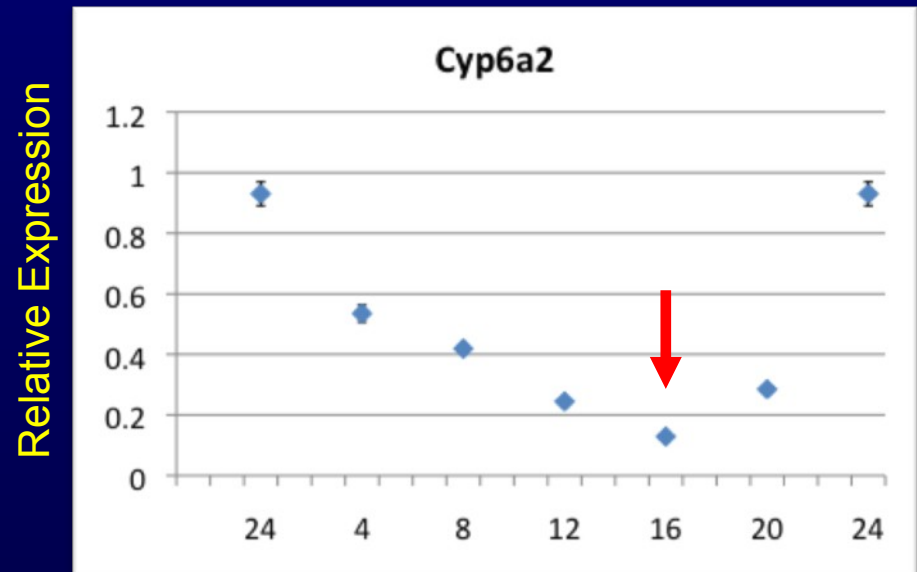
If flies are more active and more likely to be hit by spray or to contact residues



# Circadian rhythms and pesticide efficacy

In *Drosophila melanogaster*, the amount of detoxification enzyme present changes with time of day

Using molecular techniques to measure the relative expression of the detoxification enzyme for organophosphates in *D. suzukii*...

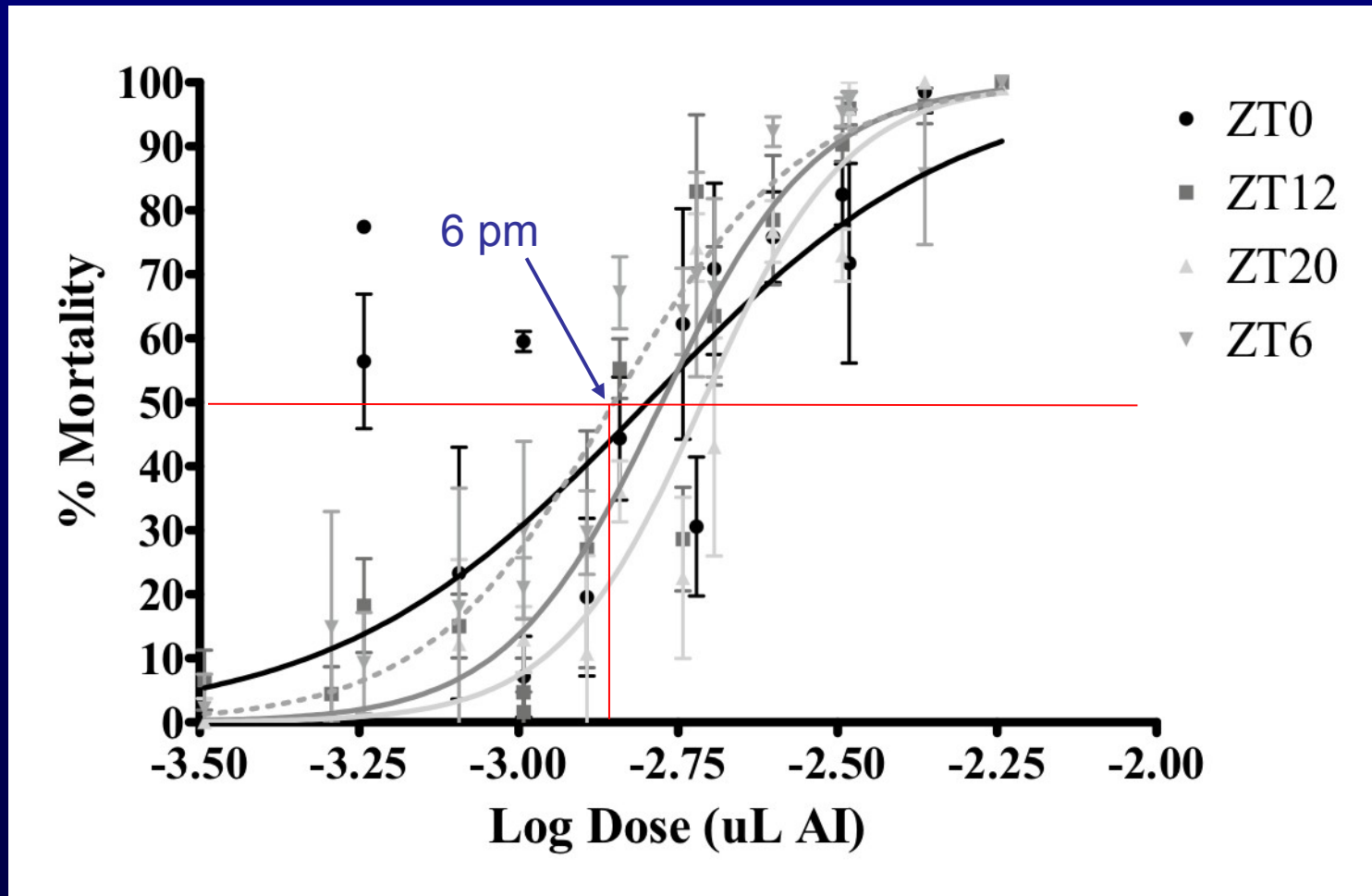


Quantitative PCR measuring expression of *cyp6a2* encoding cytochrome P450 in *Drosophila suzukii* over a circadian day (n=3).

*Preliminary results*

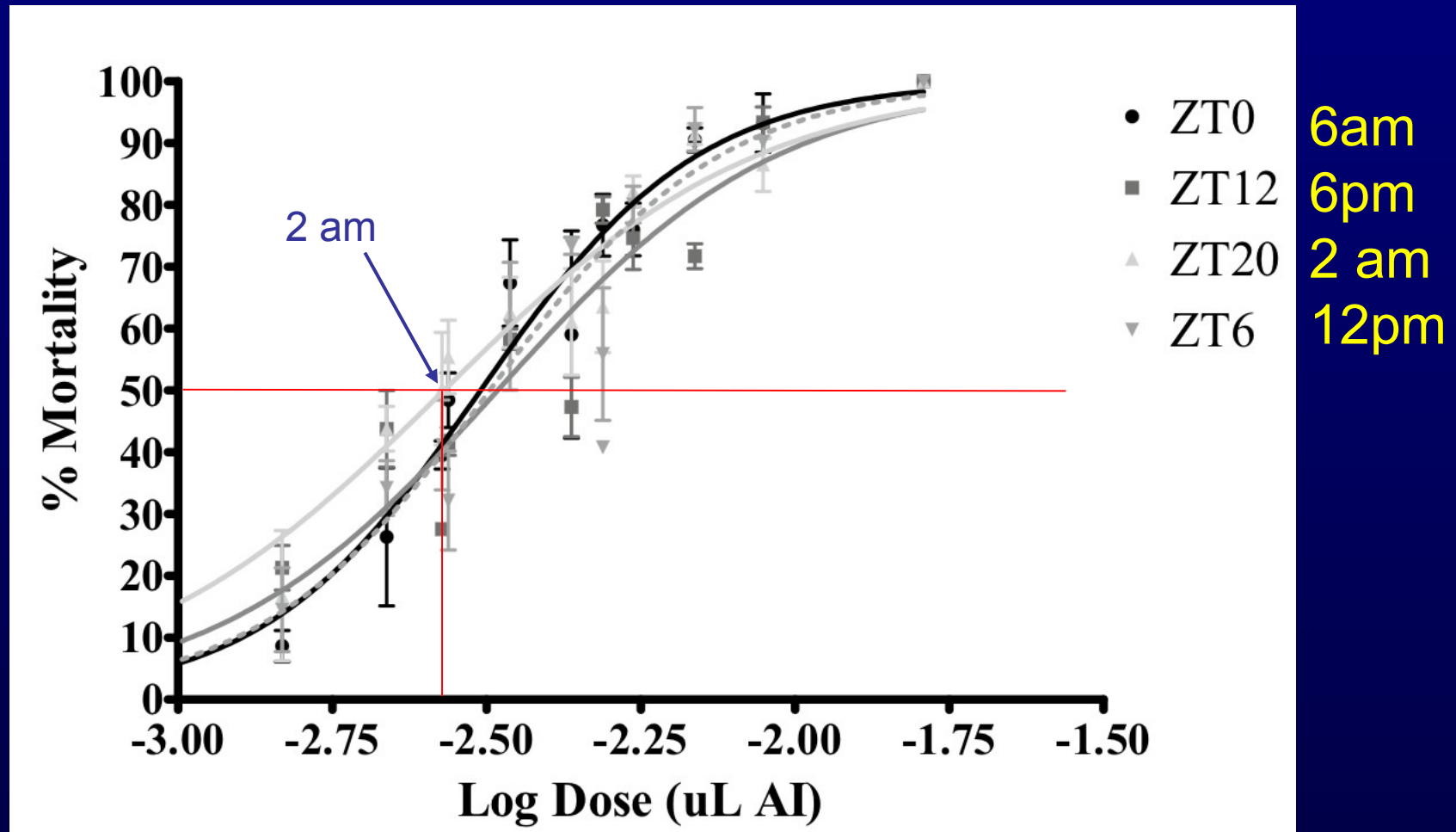


# Malathion circadian rhythm bioassays



• ZT0 6am  
■ ZT12 6pm  
▲ ZT20 2 am  
▼ ZT6 12pm

# Danitrol circadian rhythm bioassays



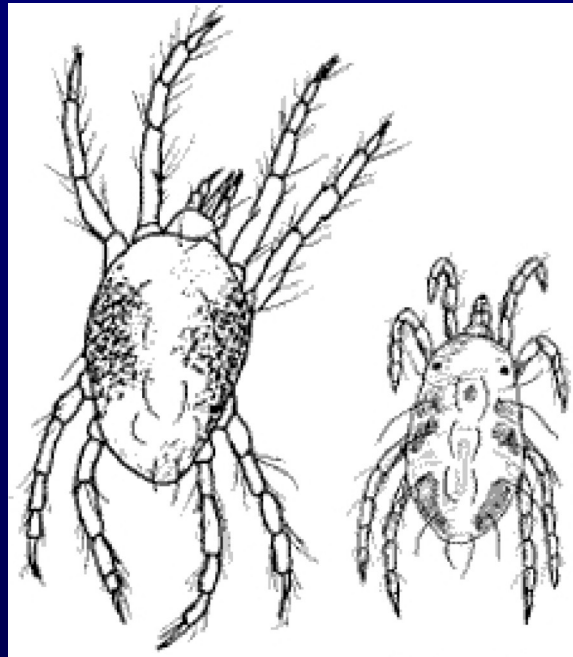
# Spider mites



*Tetranychus urticae*



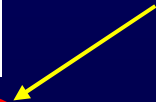
*Eotetranychus lewisi*



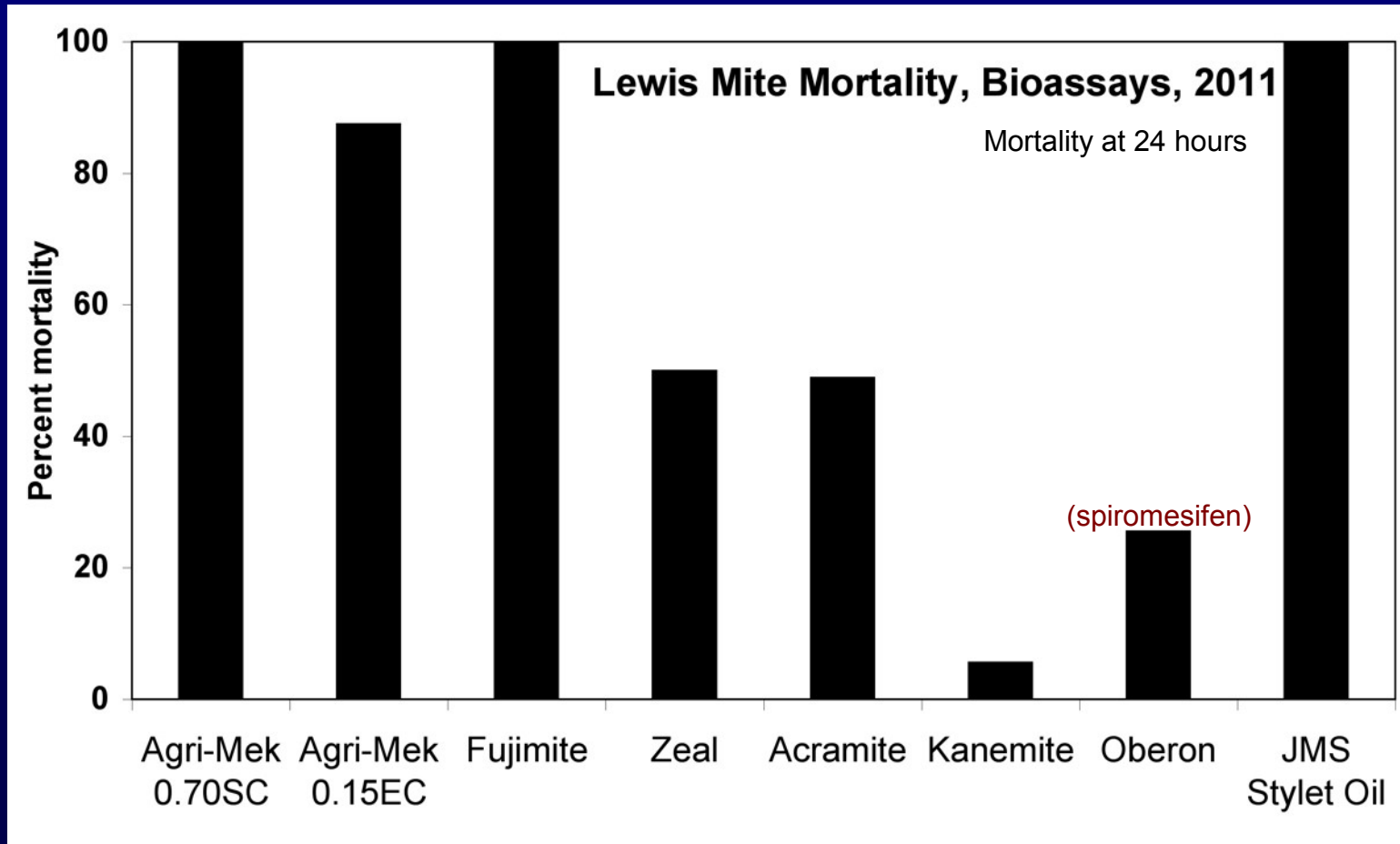
Twospotted spider mite

Lewis mite

Emerged as a problem in some Oxnard area fields in 2011



# Lewis Mite - Bioassays



Also determined percent egg hatch for mite growth regulators:  
No eggs hatched for either Savey or Zeal



# Spider mite resistance?

- Dip strawberry leaves in different concentrations
- Let leaves air dry
- Transfer 10 to 15 adult female mites to the leaves
- Evaluate for mortality after 72 hours

# Spider mite resistance?

Source of adult females are collections from strawberry fields. Population colonies are established on strawberry plants until sufficient adult females are available to conduct miticide bioassays

Initial locations:

- Zalom susceptible colony (>25 years without treatment)
- Irvine
- Santa Maria (West Stowell Rd.)
- Nipomo (Oso Flaco Lake Rd.)

# Spider mite resistance?

## Agrimek

<u>Sampling site</u>	Collection date	n	Slope ± SE	LC50 ppm	LC90 ppm
Zalom Lab Susceptible					
Santa Maria (Stowell Rd.)					
Nipomo (Oso Flaco Rd.)					
Irvine					
<u>Lewis Mite, Ventura Co.</u>					

Field rate -

16 oz./acre in 200 gal. = 11.25 ppm

# Spider mite resistance?

## Acramite

Sampling site	Collection date	n	Slope $\pm$ SE	LC50 ppm	LC90 ppm
Zalom Lab Susceptible					
Santa Maria (Stowell Rd.)					
Nipomo (Oso Flaco Rd.)					
Irvine					
Lewis Mite, Ventura Co.					

Field rate -

1 lb./acre in 200 gal. = 300 ppm



# Lewis mite vs. Twospotted spider mite development - different hosts

- Ten female *E. lewisi* and *T. urticae* transferred to whole castor bean and strawberry leaves placed into Petri dishes
- Leaves and dishes transferred to growth chambers and held at 3 temperatures
- Females removed after 72 hours
- Total eggs laid and total number of mites surviving to the adult stage were determined



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