# WALNUT HUSK FLY:
## BIOLOGY, MONITORING, MANAGEMENT AND IMPACTS

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# BIOLOGY

- *Rhagoletis completa* – a tephritid fruit fly native to Texas and surrounding states.
- One generation per year with emergence from late May through early September
- Peak emergence usually July/August
- After mating, females deposit about 15 eggs below the surface of the husk
- Larvae feed for three to five weeks causing the husk to become soft and black
- Larvae exit and drop to the ground where they overwinter as pupae


within a week
Egg laying
4-7 days
Eggs hatch
Maggots feed
3 - 5 weeks
Maggots drop
Pupae
over wintering
Adult
8 or more days
Mating
Spray during this period

Male


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Female


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## Sting or Ovipositor Scar


## Eggs

# WHF Larva


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# WHF Infested Walnuts

# VARIETAL SUSCEPTIBILITY

- All varieties are susceptible to damage to varying degrees
- Highly susceptible: Payne, Serr, Hartley, Tulare
- Moderately susceptible: Howard
- Less susceptible: Chandler

# MONITORING

- WHF is monitored by utilizing traps.
- The most common type trap is the yellow sticky board which is also called an “apple maggot” or AM trap. Buy “no-bait” traps.
- The traps usually have some type of external bait in addition. The most common bait is ammonium carbonate.
- Place traps in orchard prior to expected emergence of first flies – early June in coastal climates, late June or early July in the Central Valley.

# TRAPS AND BAITS

- There are many manufacturers of the yellow AM traps: Trece, Suterra, AlphaScents, etc.
- They vary somewhat in trap size, type of stickem and bait dispenser.
- The three most important aspects of trapping are to:

1. maintain a sticky surface.
2. maintain an effective bait.
3. place traps both low and high in the tree on the north side within canopy cover, not in the sun

# TIMING

- Timing is critical for WHF control.
- Timing of the first spray may be accomplished by spraying at the first rise in trap counts or by squeezing the female flies to determine presence of eggs. The technique for squeezing female flies is shown in a UC ANR DVD
- Additional sprays are applied at two to three week intervals or when fly catches increase
- Sprays usually are not needed after hull split or less than one month from harvest

# Female WHF with Eggs Squeezed Out

# CONTROL

- Two spray techniques have been utilized
- Full coverage sprays with no bait – usually as part of a codling moth spray program. Some codling moth insecticides are not effective for WHF control.
- Bait sprays – specific for WHF. Often applied with reduced spray volumes and/or reduced coverage since the bait attracts the flies to the spray. Often more effective than full coverage sprays without bait.
- No effective biological or cultural controls

# SPRAY VOLUME

- Traditionally, sprays were applied with air blast sprayers at 400 gal of water per acre
- Most sprays are now applied as concentrate or semi-concentrate sprays
- The latest trend is very concentrated bait sprays with spray volumes in the range of 5 to 15 gal per acre. This has the potential to dramatically reduce the cost of applying sprays and the time required to apply sprays
- We have only limited research testing at these low volumes. Bob Van Steenwyk and I plan to do more testing this year in field trials.

# BAITS

- Nu-Lure Insect Bait
- Monterey Insect Bait

- Attractants or feeding stimulants?

# ORGANO-PHOSPHATES

- Malathion
- Chlorpyrifos (Lorsban)
- Phosmet (Imidan)

# NEONICOTINOIDS

- Imidacloprid (Provado)
- Acetamiprid (Assail)

# PYRETHROIDS

- Esfenvalerate (Asana XL)
- Lambda-cyhalothrin (Warrior with Zeon)
- Cyfluthrin (Baythroid)
- Bifenthrin (Brigade)
- Other synthetic pyrethroids
- Pyrethrins are ineffective

# SPINOSYNS

- SPINOSAD
  - Success
  - Entrust (organic)
  - GF-120 (organic)
- SPINETORAM
  - Delegate

# GF-120

- Contains its own bait
- Organically acceptable, easy to apply
- Applied at very low volumes: 20 ounces per acre in 30-100 ounces of water
- Use large droplet size
- Applied as soon as WHF is caught, and as often need afterwards to keep WHF populations low
- Has worked well in Central Coast organic orchards but has provided variable control in the Central Valley possibly due to higher temperatures and lower humidity

# WALNUT HUSK FLY IMPACTS ON QUALITY

- Walnut husk flies infest the hulls of walnuts beginning as early as June and continuing into September
- Only the hull is infested, not the kernel
- Visible impacts are the hull adhering to the shell and shell staining
- Previous reports have anecdotal references to mold, shrivel and kernel darkening
- Only one previous research report in the 1980's looked at the economic impact of walnut husk fly damage

# RESEARCH ON THE IMPACTS OF WALNUT HUSK FLY ON WALNUT QUALITY

- From 2005 through 2008, I collected samples from several orchards with a range of varieties. These samples were paired samples – 100 nuts infested with WHF and 100 nuts uninfested from the same trees.
- These were hulled, dried and loose adhering hull was scraped off. They were then rated for a wide range of quality characteristics.

# CHARACTERISTICS MEASURED

- Although many other characteristics were measured this talk will concentrate on the following:
- External: Mean nut weight, % adhering hull, % large sound nuts
- Internal:% edible yield, % mold, % shrivel, % extra-light kernel color, reflected light index (light bounced off of composite samples)
- Overall: Relative value (Edible Yield X Reflected Light Index X .0364)
- Thanks to Diamond Walnut for processing quality samples

# MEAN NUT WEIGHT (g)

| | | Infested | Uninfested |
|---|---|---|---|
| 2005 | Serr | 11.24 | 12.05 |
| 2005 | Tulare | 12.35 | 13.03 |
| 2005 | Vina | 9.55 | 11.01 |
| 2006 | Chandler | 10.3 | 10.9 |
| 2007 | Hartley | 10.42 | 11.11 |
| 2007 | Tulare | 10.32 | 13.00 |
| 2007 | Chandler | 7.46 | 9.62 |
| 2008 | Payne | 11.14 | 11.36 |
| 2008 | Hartley | 11.39 | 11.38 |

# % ADHERING HULL

| | | Infested | Uninfested |
|---|---|---|---|
| 2005 | Serr | 91.0 | 0.0 |
| 2005 | Tulare | 93.8 | 0.0 |
| 2005 | Vina | 78.1 | 0.0 |
| 2006 | Chandler | 90.0 | 0.0 |
| 2007 | Hartley | 90.6 | 0.0 |
| 2007 | Tulare | 100.0 | 0.0 |
| 2007 | Chandler | 5.2 | 2.9 |
| 2008 | Payne | 91.1 | 0.0 |
| 2008 | Hartley | 56.8 | 0.0 |

# % LARGE SOUND NUTS

| | | Infested | Uninfested |
|---|---|---|---|
| 2005 | Serr | 2.4 | 87.2 |
| 2005 | Tulare | 4.8 | 98.7 |
| 2005 | Vina | 0.0 | 84.2 |
| 2006 | Chandler | 0.0 | 97.0 |
| 2007 | Hartley | 0.0 | 87.3 |
| 2007 | Tulare | 0.0 | 100.0 |
| 2007 | Chandler | 0.0 | 64.8 |
| 2008 | Payne4.4 | 95.8 | |
| 2008 | Hartley | 1.0 | 93.7 |

# % MOLD

| | | Infested | Uninfested |
|---|---|---|---|
| 2005 | Serr | 3.4 | 0.0 |
| 2005 | Tulare | 2.5 | 0.0 |
| 2005 | Vina | 12.4 | 0.0 |
| 2006 | Chandler | 14.0 | 0.0 |
| 2007 | Hartley | 26.0 | 0.0 |
| 2007 | Tulare | 4.1 | 0.0 |
| 2007 | Chandler | 32.8 | 0.0 |
| 2008 | Payne 20.0 | 0.0 | |
| 2008 | Hartley | 10.2 | 0.0 |

# % SHRIVEL

| | | Infested | Uninfested |
|---|---|---|---|
| 2005 | Serr | 6.7 | 0.0 |
| 2005 | Tulare | 1.2 | 0.0 |
| 2005 | Vina | 21.9 | 0.0 |
| 2006 | Chandler | 0.0 | 5.0 |
| 2007 | Hartley | 0.0 | 0.0 |
| 2007 | Tulare | 2.1 | 0.0 |
| 2007 | Chandler | 3.7 | 1.0 |
| 2008 | Payne | 0.0 | 0.0 |
| 2008 | Hartley | 1.1 | 0.0 |

# % EXTRA-LIGHT KERNEL COLOR

| | | Infested | Uninfested |
|---|---|---|---|
| 2005 | Serr | 0.0 | 22.0 |
| 2005 | Tulare | 0.0 | 35.0 |
| 2005 | Vina | 0.0 | 21.0 |
| 2006 | Chandler | 0.0 | 24.0 |
| 2007 | Hartley | 6.9 | 73.6 |
| 2007 | Tulare | 0.0 | 73.2 |
| 2007 | Chandler | 0.0 | 70.4 |
| 2008 | Payne 20.5 | 75.6 | |
| 2008 | Hartley | 5.1 | 64.2 |

# REFLECTED LIGHT INDEX

| | | Infested | Uninfested |
|---|---|---|---|
| 2005 | Serr | 45.9 | 51.3 |
| 2005 | Tulare | 44.4 | 53.9 |
| 2005 | Vina | 47.9 | 50.4 |
| 2006 | Chandler | 50.0 | 56.9 |
| 2007 | Hartley | 49.7 | 57.9 |
| 2007 | Tulare | 47.2 | 55.9 |
| 2007 | Chandler | 47.2 | 55.6 |
| 2008 | Payne49.5 | | 55.2 |
| 2008 | Hartley | 46.4 | 57.1 |

# IMPACTS ON SOME SELECTED NUT CHARACTERISTICS

| | -WHF | +WHF |
|---|---|---|
| % Mold | 0.0 | 13.9 |
| % Edible Yield | 48.7 | 39.1 |
| % Extra-light kernels | 51.0 | 3.6 |
| Reflected light index | 54.9 | 47.6 |
| Relative value | 0.97 | 0.68 |

# SUMMARY: IMPACTS DUE TO WHF – 2005 to 2008

- MEAN NUT WEIGHT: 9.2 % LOSS
- % ADHERING HULL: 80.9 % VS 0.4 %
- % LARGE SOUND NUTS: 0.0 % VS 97.6 %
- % EDIBLE YIELD: 21.1 % LOSS
- % MOLD: 11.9 % VS 0.1 %
- % SHRIVEL: 5.0 % VS 0.8 %
- % EXTRA-LIGHT KERNELS: 0.9 % VS 37.1 %
- REFLECTED LIGHT INDEX: 12 % LOSS
- RELATIVE VALUE: 31 % LOSS

# EARLY VERSUS LATE WHF DAMAGE – CHANDLER 2007

| | EARLY | LATE | UNINFESTED |
|---|---|---|---|
| MEAN NUT WEIGHT: | 7.46 | 9.09 | 9.62 |
| % ADHERING HULL: | 5.2 | 3.6 | 2.9 |
| % LARGE SOUND: | 0.0 | 0.0 | 64.8 |
| % EDIBLE YIELD: | 45.4 | 52.0 | 51.4 |
| % MOLD: | 32.8 | 26.4 | 0.0 |
| % SHRIVEL: | 3.7 | 0.9 | 1.0 |
| % EXTRA-LIGHT | 0.0 | 10.6 | 70.4 |
| REFLECT LT INDEX: | 47.2 | 50.7 | 55.6 |
| RELATIVE VALUE: | 0.78 | 0.96 | 1.04 |

# LATE DAMAGE WHF IMPACTS

- Late WHF damage does not appear to reduce % edible yield or increase % shrivel.
- Late WHF damage increases % adhering hull and % mold. It decreases mean nut weight, % large sound, % extra-light kernel color, reflected light index and relative value.

# EXAMPLES OF WHF DAMAGE TO WALNUT KERNELS

UNINFESTED

EARLY INFESTATION

LATE INFESTATION

# Sources of Information

- www.ipm.ucdavis.edu
- walnutresearch.ucdavis.edu
- “Integrated Pest Management for Walnuts” UC ANR Publication 3270
- “Walnut Husk Fly: Biology, Monitoring and Control Strategies” UC ANR DVD 6567D
- Thanks to Bob Van Steenwyk for collaborating with me for the last 30 years