Navel Orangeworm Biology and Management

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Outline for Today

Origins and Distribution

- Arrival in California
- **Current pest status**

Basic Biological Parameters

- Life stages
- Mating and reproduction
- Seasonal phenology

Modern Management

- Crop sanitation
- **Biological control** Mating disruption
- Monitoring, degree-days
- Insecticide sprays
 Early/timely harvest

Key Additional Resources

Local Farm/IPM Advisor

https://ucanr.edu/About/Locations/

UC Statewide IPM Program Website
https://www2.ipm.ucanr.edu/agriculture/pistachio/Navel-Orangeworm/

Pistachio Production Manual (2016)

- UC ANR Publication #3545 https://anrcatalog.ucanr.edu/Details.aspx?itemNo=3545





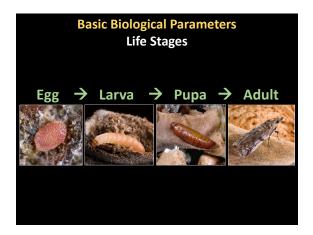
Navel Orangeworm Origins, Arrival in CA, Current Pest Status

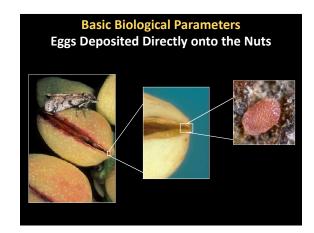
Navel	Orangewor	m
Origins	+ Arrival in	CA
Species Name Order: Lepidoptera Family: Pyralidae Species: Amyelois transit	rella	
Arrival in California		E IRIG W V
1800s – Reported in Mexico, Caribl		South America
1900s – Reported on citrus in AZ ("	,	BOOM DISECT PESTS OF SALT RIVER VALUES. 289
1940s – Reported on walnuts and a 1970s – Reported on pistachio in C		has been found in New Mexico that sweet-corn planted later than usual escapes the myages of the worm, the moths having already laid their eggs in the earlier plants. On the same prin- eighs, in the Swits, corn is planted alread of the cotton and after a while destroyed, with the result that the cotton is less injured,
	Navel Orangeworm on Walnuts industrials instruction distinct existing and instruction are instructions and instruction are instructions are instructionally and instructionally and instructionally and instructionally are instructionally and instructionally and instructionally and instructionally are instructionally and instructionally are instructionally and instructionally are instructionally and instructionally and instructionally are instructionally and	On Octobe 22. Househour Presents rue omages on the amount of the present rue omages on the senges had been controlled and the senges had instead other premanently, and deepey off at the land touch. From the spech taing in och care a small amount of defen, preclaiming the presence of a worm, and dataspade. One of the controlled her benefit to the special present of the sengent of the sengent of the special present of the special pres



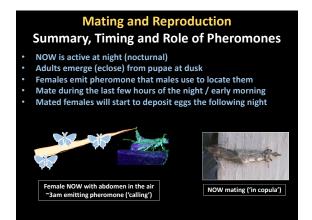
Navel Orangeworm Current Pest Status Extremely Low Tolerance for Damage (<2%) Aflatoxin Known human carcinogen, regulated in domestic/foreign markets Aspergillus flavus fungi produce aflatoxin NOW adults move Aspergillus around Larval feeding create opportunities for fungal growth on nuts Spread of Asperlllus flavus by Navel Orangeworm (Amyelois transitells) on Almond After the Parkinson of Results (Alph Tot Muman Research Cont. Nate Cont. Nate

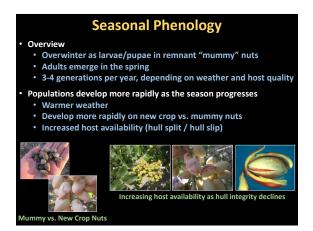
Navel Orangeworm Biology, Behavior and Ecology

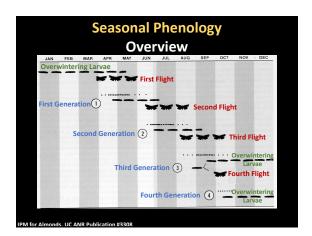


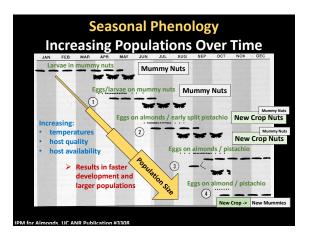


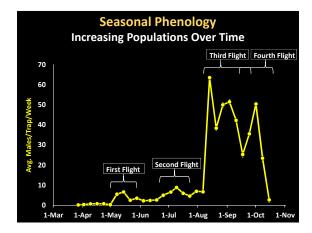
	gical Parameters Stages
Eggs Deposited directly onto nuts Larvae Crescent-shaped marked Pass through 5-6 stages (insta	rs)
Frass and webbing as they fee Pupae Spins a silk coccoon Adults	Crescent Mark
Has a pronounced "snout"	Frass, webbing, silk cocon











Navel Orangeworm Integrated Pest Management

Modern NOW Management in Pistachio Integrated Pest Management

Key Tools

- 1. Sanitation Destroy mummy nuts
- 2. Biological Control Natural enemies predate/parasitize
- 3. Mating Disruption Reduce mating/reproduction
- 4. Monitoring Egg traps, flight traps, biofix, degree days 5. Spray Timing Maximize impacts
- 6. Early/Timely Harvest Logistics

The Key to Success is Using Multiple Points of Attack!

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Winter Sanitation / Crop Sanitation

Key Points

- NOW overwinter as larvae in remnant "mummy" nuts
- These larvae are the base population for the coming year
- Mummies are ALSO reproductive substrate for moths in the spring!





Winter Sanitation / Crop Sanitation

Procedures

- Harvest in a timely manner!
- The longer nuts are exposed, the higher infestation rate of mummies
 After harvest get all mummies onto the orchard floor
 Shake or pole trees to remove mummies from canopy, tree crotches etc.
- Blow/sweep burms to aggregate mummies in the row middles
- Mow/disc the mummies to destroy them





Winter Sanitation / Crop Sanitation Fewer Mummies = Lower Damage The property of the Country of

Winter Sanitation / Crop Sanitation

Take Note

- Sanitize ASAP before orchard access becomes difficult
- Weather (cold, moisture) can cause some NOW mortality
- For instance, mummies...
 - on the ground fair worse than those in the tree canopy
 - in ground covers fair worse than those on bare soil
 - on moist bare soil fair worse than those on dry bare soil

REGARDLESS → Don't leave it up to Weather + Microbes!

Go into your orchard, aggregate and destroy the mummies!!

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Biological ControlNatural Enemies of NOW

Parasitoids

- Goniozus legneri attack larvae
- Copidosoma plethorica attack eggs
- Not very effective at low NOW densities



Goniozus leaner

Vertebrates

- Some birds/mice eat mummy nuts or knock them to the ground
- · Impacts are unclear

Predators

- Lacewings
- · Phytocoris spp.



Phytocoris sr

Biological Control

Phytocoris relativus + Phytocoris californicus

These small bugs attack...

- NOW eggs
- Soft scales
- Young pistachios





NOW Fggs

Young Pistachio

So are they good or bad?

- · Can be a benefit...
- Tradeoffs with small/large bug control
- Monitoring is critical
- Newer pyrethroids (Brigade, Warrior) are more detrimental



Phytocoris sp.

Modern NOW Management in Pistachio Integrated Pest Management

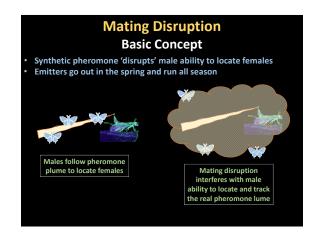
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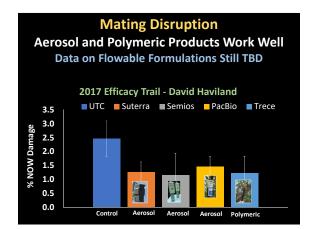
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Mating Disruption Active and Passive Emissions Active Emitters • Aerosol "Puffers" • Pressurize aerosol cannister • 1-2 cannisters/acre, spray frequently over the night Microencapsulated "Flowable" • Liquid that you apply like a pesticide • Applied multiple times, 30-day activity period Passive Emitters • Polymeric Strips • Plastic material impregnated with pheromone • 15-20 emitters/acre, passively emit all the time



Mating Disruption

Key Considerations

- Mated female NOW can still migrate into your blocks
 - · Best used in large contiguous areas
 - Square blocks >40 acres, ideally >100 acres
- It will shut down your pheromone traps
 - Phenyl-proprionate (PPO) lures will remain attractive
 - · Egg traps will remain attractive
- **Background NOW population is important**
 - · Works best with lower populations of NOW
 - Get them down, and then keep them down

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Monitoring

Key Points

- With 2% damage tolerance, economic thresholds don't exist
- Monitoring is to track insect phenology to determine spray timing
- No singular method is perfect, use multiple trap types
- Populations are highly variable, so more traps is better than fewer









Monitoring

Overwintering Larvae

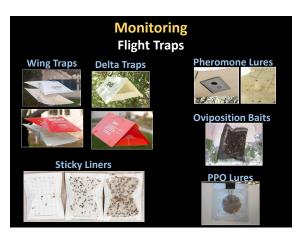
- Examine nuts around 20 trees/block
- Count total mummies and crack out to inspect for NOW larvae
- Provides info on relative mummy abundance and infestation rate
- Do you have a lot of mummies and/or NOW larvae in your blocks?



Monitoring Egg Traps

1	2





Monitoring Flight Traps Trap Types Pheromone trap Attracts males – pheromone lure Peterson trap Attracts females – oviposition bait Remains attractive under mating disruption Also marketed for mass-trapping females PPO trap Attracts males + females – PPO lure Remains attractive under mating disruption

Monitoring Flight Traps Timing and Use • Set out traps in March / early April • 1 trap/10 acres (2 per block min.) Hang where unobstructed by foliage Check 1x/week Replace liners every 1-2 weeks Replace baits every 4-6 weeks



Biofix



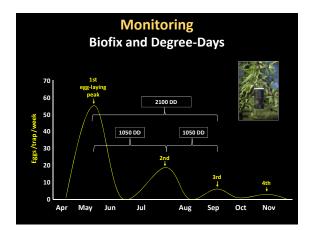
	Monitoring Early Splits
•	Early splits provide opportunity for NOW to get an early start
•	Monitor in mid/late July
•	Consider treatment is >2 early split per 100 nuts

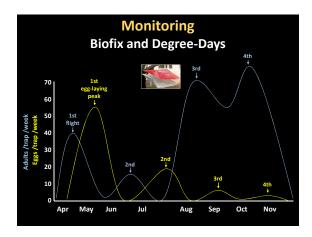


Monitoring Biofix and Degree-Days Start-date for development of the insect, determined by trap catch Lower and Upper Developmental Thresholds • Range of temperature within which an insect will develop Degree-Days (DD) • Unit of measure to track rate of development Calculated based on lower/upper thresholds 1 Degree-Day = 24 hours at 1 degree above the Lower Threshold

Time

Monitoring Biofix and Degree-Days NOW Developmental Thresholds Lower Threshold = 55°F Upper Threshold = 94°F NOW Degree-Day Requirements 1050 DDF between egg-deposition periods 2100 DDF to go from 1st to 3rd egg-deposition period NOW Biofix Determined by egg trap data ID the 1st peak egg-deposition period



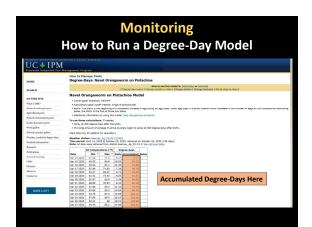


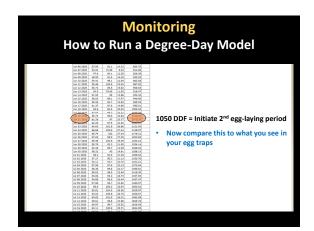
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Links	FIVE PTS A (CIMIS #2, Five Points/WSFS USDA)	1992 to present				
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Chemical Control / Insecticides Timing = Insect x Crop Phenology

- Degradation of hull integrity = crop vulnerability Spray timing should be based on...
- - Insect phenology monitoring data
 Crop phenology hull integrity
 Current pest pressure



Chemical Control / Insecticides Current Products

Intrepid (methoxyfenozide)

- Ecdysone Receptor Agonists
- IRAC Group 18
- Toxin is ingested, larvae don't

Altacor (chlorantraniliprole)

- · Also referred to as rynaxypyr
- Anthranilic Diamide
- IRAC Group 28
- Ovi-larvicides
- Affects calcium channel in muscles, jaws won't work

- Broad spectrum
 Also kill beneficial parasitoids and
- Issues with off-site movement into
- waterways Potential for regulation
- NOW becoming resistant to bifenthrin

Delegate (spinetoram)

- Fungal fermentation productContact and ingestion toxin
- Primarily a larvicide, can kill adults
 Intrepid Edge = Intrepid + Delegate

Chemical Control / Insecticides Possible Timings and Priorities No ideal application date (long flight), efficacy undocumented, disruption of 1st flight (late Apr-May) Prevent oviposition into Phytocoris Typical timing in almonds, used in high-pressure pistachios Prevent oviposition into early July) Prevent late 2nd flight eggs from getting on early splits Treatment based on flight data, prevalence of early splits, split date Early splits (late July) All orchards need a treatment Usually ~4 weeks to harvest rd flight Prevent eggs on new crop at 'hull split/slip' 1st Based on flights/pressure and harvest date Post 3rd flight (late Aug-early Sept) Maintain insecticide residues on hulls Based on flights, pressure, data from first shake, anticipated harvest date 4th flight (mid-Sept) Protect nuts for second shake or late first shake Slide/Table: D. Haviland

Chemical Control / Insecticides Make Your Sprays Count For ANY spray... • Spray calibration, drive speed (go slow) and weather conditions are critical Consult With... • Local Farm/IPM Advisor • https://ucanr.edu/About/Locations/ • UC Statewide IPM Program Website • https://www2.ipm.ucanr.edu/agriculture/pistachio/Navel-Orangeworm/ Spray Training Opportunities Available • http://ipm.ucanr.edu/training/

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Early/Timely Harvest

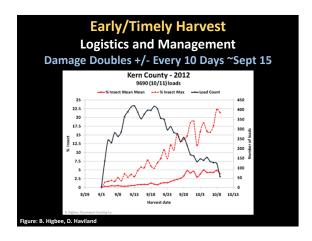
Logistics and Management

- NOW populations build exponentially over time
- Longer crop hangs on the tree = higher probability of infest
- Higher infest a problem this year + mummies the following year Late $1^{\rm st}$ shake begets a late $2^{\rm nd}$ shake





Early/Timely Harvest Logistics and Management Damage Doubles +/- Every 10 Days ~Sept 15 Kern Co. Tulare Co. Kings Co. 9% 8% Percentage damage to split instance damage y = 5E-08e^{0.0036} 1% $R^2 = 0.9029$ 0%







Bringing It All Together Ideal NOW Management Program

October – February

Crop sanitation – get mummies on the ground, blow/sweep, mow/till them

March-April

- Set out your flight traps and egg traps monitor 1-2x/week
 Setup mating disruption

April-May

Monitor traps and determine biofix

June

Monitor traps, run degree-day models, see 2nd flight, adjust biofix if needed

July

Monitor traps, degree-day models, monitor for early splits, prepare for 3rd flight

August

Monitor traps, see 3rd flight, spray for 3rd flight moths

September-October

Harvest ASAP, start thinking about sanitation

Bringing It All Together

Ideal NOW Management Program

Closing Thoughts...

- Crop sanitation is fundamental do it!
 - In a bad year, no amount of spraying can replace this
- Logistics, planning and management are fundamental
 - Develop a monitoring plan and then follow it!
 - · Coordinate equipment/crews with weather/phenology

Bringing It All Together

Ideal NOW Management Program

Closing Thoughts...

Number of Treatments

- Mummy assessments, trap catch compared to last year
- Damage last year
- Neighbors and surrounding crops
- Crop size and value, 1 vs 2 shakes, reliability of harvest date

- Treatment Timing
 Egg-trap biofix to predict 3rd flight
 - Pheromone trap data
 - · Early splits, hull integrity
 - How long until harvest?
 - How long to cover your acreage?

Product Choice

- Costs
- Green vs broad spectrum
- Resistance to pyrethroids
- Total number of treatments needed

Bringing It All Together Ideal NOW Management Program

Closing Thoughts... Remember you have resources

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 https://ucanr.edu/About/Locations/
- UC Statewide IPM Program Website
 https://www2.ipm.ucanr.edu/agriculture/pistachio/Navel-Orangeworm/
- Pistachio Production Manual (2016)
 UC ANR Publication #3545
 https://anrcatalog.ucanr.edu/Details.aspx?itemNo=3545

Thank you!! Good luck out there!
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