

Integrated Pest Management of Codling Moth

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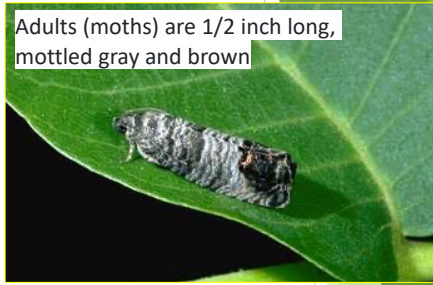


Codling Moth IPM Webinar
May 6, 2024

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Codling Moth (*Cydia pomonella*)

- Codling moth is the most destructive pest of apple and pear globally. Also, key pest in walnuts.
- Other major hosts include crabapple, quince, hawthorn, peach, apricot, etc.
- Larvae feeding on the fruit and causes damage



Damage to:



Apple



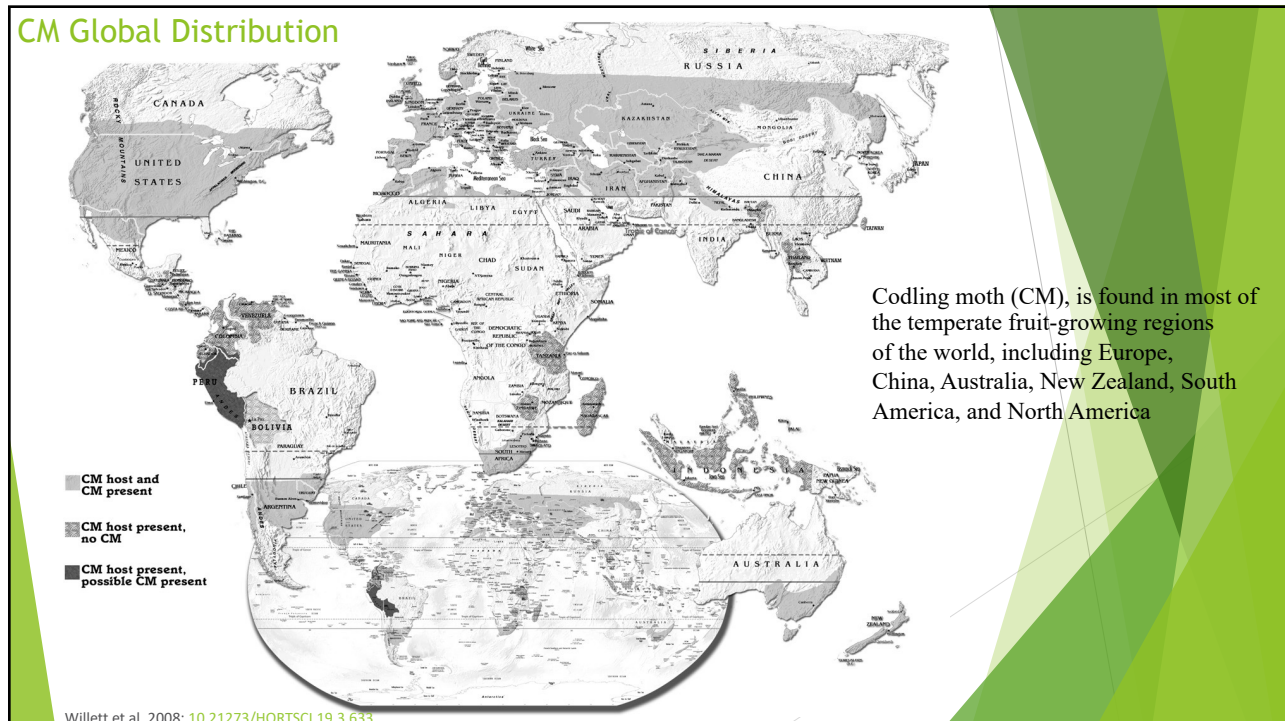
Pear



Walnut

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CM Global Distribution



Codling moth (CM), is found in most of the temperate fruit-growing regions of the world, including Europe, China, Australia, New Zealand, South America, and North America

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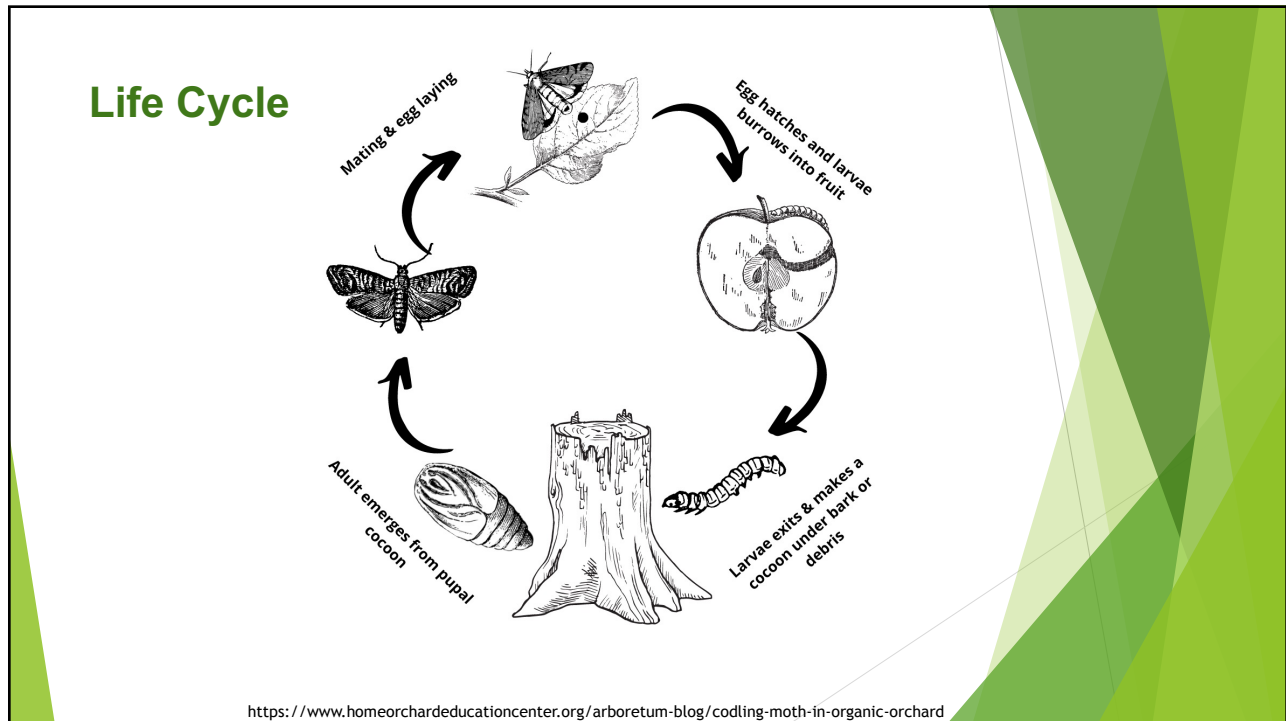
Codling Moth Biology

- Overwinters as a larva on tree barks
- Overwintering generation adults (first flight) emerge in March-May
- Females can lay 30 (overwinter) to 60 (seasonal) eggs singly on leaves (apple, pear) or fruits (apple, pear, walnut)
- 3-4 generations per year
- Larvae of all generations can be economically important for their host crops – apples and pears



3-4 generations/year

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Integrated Pest Management -IPM

“IPM is a decision-based process involving coordinated use of multiple tactics for optimizing the control of all classes of pests (insects, pathogens, weeds, vertebrates) in an ecologically and economically sound manner.” - Ronald J. Prokopy

What does IPM mean for IPM practitioners?

- Identifying the pest (s) and understanding pest biology;
- Regular monitoring of pests, and their natural enemies;
- Use of thresholds when deciding to apply control methods;
- Integrated use of preventative and suppressive control methods

What are the ultimate goals?

- ▶ Reduce pesticide use
- ▶ Protect the environment and human health
- ▶ Provide economic savings

Modified from Lester Ehler

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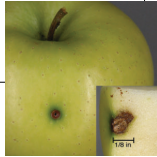
Identifying Pest/Damage

Damage Biology:

- Eggs are pinhead-sized, flat & oval, and translucent at first, later turning white.
- Laid singly on fruit or on upper surface of leaves near fruit.
- Newly hatched larva (1/10th inch) may enter through the fruit's sides, stem end, or calyx (flower) end.

Damage symptoms:

- Deep tunnels from the larvae to the center of the fruit
- Brown frass (excrement) extrudes from entry and exit holes
- Stings - healed shallow or aborted entries (unsuccessful entry)



<https://tfrec.cahrs.wsu.edu/postharvest-export/qpests/cm-id/>

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Pest monitoring

A. Predictions Models

B. Monitoring tools

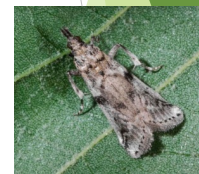
Predictions Models: Biofix and Degree Days

Biofix: The date at which biological event of a particular insect begins. Useful in degree-days calculation

Example 1: 75% or more traps have increased navel orangeworm egg no. in two consecutive weeks

Example 2: Codling moth, biofix is the first date that moths are consistently found in traps and sunset temperatures have reached 62°F

Example 3: Exact date (Jan. 1 or March 1 etc.)

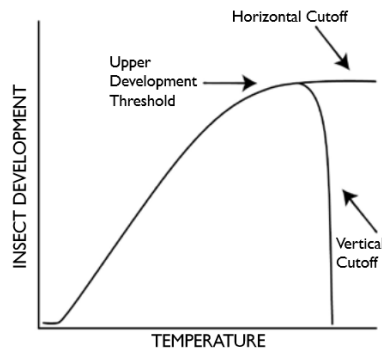


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Degree days

A degree day: A degree day (DD) is a measurement of heat units over time, calculated from daily maximum and minimum temperatures.

- ▶ Degree days are based on the rate of an insect's development at temperatures between upper and lower limits for development



Why is the DD important?

-Guides the pest control decisions

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CM Monitoring

Under no-mating disruption:

- ▶ **1 mg (1X) lure**, put traps (southeast side of the tree, 6-7 feet high), higher placement-more capture
- ▶ 1X lures has pheromone (codlemone), only attracts males

Under mating disruption or influenced by MD

- ▶ Use both: 1x, and CM-DA combo lures
- ▶ CM-DA combo has both codlemone and kairomone (pear volatile), and attracts both male and female

Use traps to determine the biofix and track the flights and degree-days to make spray timing decisions



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Degree Days Calculation

UC IPM
Statewide Integrated Pest Management Program

Run Models and Calculate Degree-Days

Our degree-day calculator has two branches. You can run preset models as recommended in our pest management guidelines. Or, you can specify thresholds and method of calculation to calculate any degree-days. Weather data for the calculations may come from the UC IPM database for California, a file you supply, or data you enter online. | Acknowledgments |

| Using this calculator | Reference degree-day tables | About degree-days |

Run models
Calculate degree-days

Run models—using degree-days, as recommended by UC Cooperative Extension

Select an organism and preset thresholds

Fuller rose beetle (Lower=51 F)
Lygus bug (Lower=54 F)
Navel orangeworm (Lower=55 F, Upper=94)
Obliquebanded LR on Pistachio (Lower=43 F, Upper=90)
Obliquebanded LR on Prune (Lower=43 F, Upper=85)
Omnivorous leafroller (Lower=48 F, Upper=87)
Orange tortrix (Lower=43 F, Upper=78)
Oriental fruit moth (Lower=45 F, Upper=90)

Reference degree-day tables for accumulating degree-days by hand.
Other models of plants, pests, and beneficials—using degree-days (unknown validation)

Continue Clear Selections

Calculate degree-days—specify thresholds

Specify thresholds and method of calculation

Thresholds
 Fahrenheit Celsius

Enter lower Enter upper (optional)

Method of calculation Single sine Upper cutoff method
Horizontal or none

Continue Clear Selections

Degree-days: Navel Orangeworm in Almonds

Use this program to run a model of navel orangeworm in almonds, recommended by UC Cooperative Extension. In calculating degree-days, the program uses temperatures from the UC IPM weather database, a file you supply, or data you enter online.

How to use this model in: almonds, or pistachios
| Calculate any degree-days | Using this calculator | Reference degree-day tables | About degree-days |

Navel Orangeworm in Almonds

- Lower/upper threshold: 55/94°F
- Calculation/upper cutoff method: single sine/horizontal
- Biofix: The first biofix is the beginning of a consistent increase in egg laying on egg traps. When at least 75% of the egg traps in a given location show increases in the number of eggs on two consecutive monitoring dates, the biofix is the first of those two dates.
- Additional information on using this model: Pest Management Guideline

Specify source of temperature data

Select the source of temperatures to be used to calculate degree-days. You may also use your own maximum and minimum temperatures and look up approximate daily degree-day values in a reference degree-day table for navel orangeworm, then total them yourself.

Weather station from UC IPM database

Select from stations in which California county?
Sierra
Siakou
Solano
Sonoma
Stanislaus Include active stations only

Set time period for running model

Biofix (start date): March 15 2021
Biofix (start date): The first biofix is the beginning of a consistent increase in egg laying on egg traps. When at least 75% of the egg traps in a given location show increases in the number of eggs on two consecutive monitoring dates, the biofix is the first of those two dates.

End date: October 12 2021

Continue

Your data file

Choose File no file selected Text file (comma or tab delimited) format

Continue

Enter data online Continue



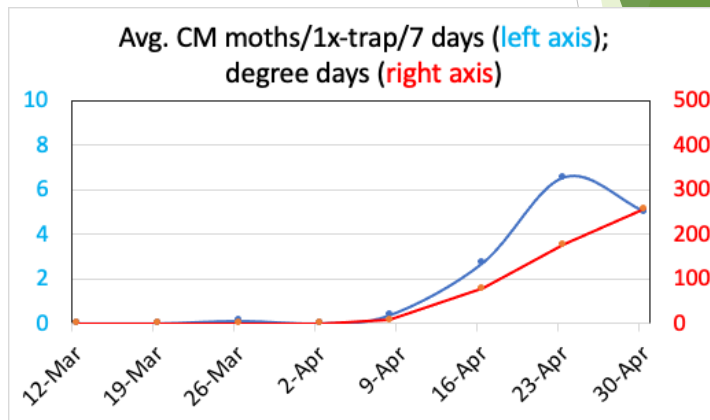
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UCIPM Degree Days Calculation

Weather station: Denair_ILA (CIMIS #206, Denair II)
Time period: April 8, 2024 to July 5, 2024, retrieved on May 6, 2024 (89 days).
Note: Only 29% of requested data were available from station Denair_ILA. See retrieval table.

Date	Air temperatures (°F)		Degree-days		Notes
	Min	Max	Daily	Accumulated	
Apr 08 2024	37	69	6.68	6.68	
Apr 09 2024	40	75	9.84	16.52	
Apr 10 2024	45	78	12.34	28.86	
Apr 11 2024	48	83	15.70	44.57	
Apr 12 2024	51	76	13.50	58.07	
Apr 13 2024	42	58	2.55	60.61	
Apr 14 2024	43	60	3.50	64.11	
Apr 15 2024	42	66	6.03	70.14	
Apr 16 2024	44	73	9.68	79.83	
Apr 17 2024	48	77	12.72	92.55	
Apr 18 2024	47	80	13.89	106.44	
Apr 19 2024	51	78	14.50	120.94	
Apr 20 2024	48	79	13.72	134.66	
Apr 21 2024	47	81	14.38	149.04	
Apr 22 2024	47	85	16.36	165.40	
Apr 23 2024	50	72	11.00	176.40	
Apr 24 2024	49	69	9.10	185.50	
Apr 25 2024	50	76	13.00	198.50	
Apr 26 2024	48	70	9.26	207.75	
Apr 27 2024	43	73	9.47	217.23	
Apr 28 2024	46	76	11.63	228.85	
Apr 29 2024	47	76	11.91	240.77	
Apr 30 2024	46	77	12.12	252.89	
May 01 2024	50	78	14.00	266.89	
May 02 2024	45	82	14.29	281.18	
May 03 2024	52	82	17.00	298.18	
May 04 2024	43	57	2.23	300.40	
May 05 2024	39	64	4.76	305.16	
May 06 2024	52	79	15.50	320.66	
May 07 2024	52	80	16.00	336.66	
May 08 2024	54	81	17.50	354.16	
May 09 2024	53	80	16.50	370.66	
May 10 2024	52	81	16.50	387.16	

► 2024 Codling Moth (CM): Biofix 8 April; Modesto

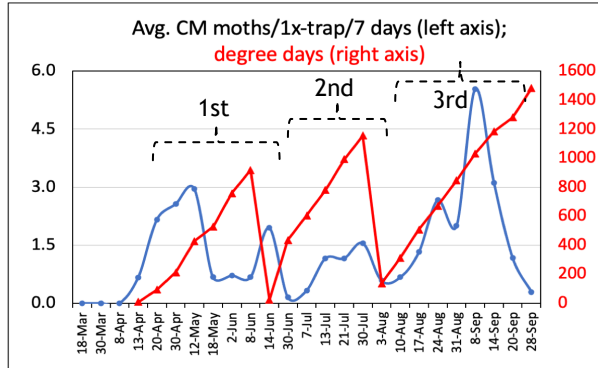


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Example: Seasonal trap counts and treatment decisions using degree days (Y 2016)

Codling moth (Stanislaus)

- 1st flight biofix: 13 April;
- 2nd flight biofix: 14 June; spray timing (300DD): June 26
- 3rd flight biofix: 30 July; spray timing (300 DD): August 9
- Accumulated degree-days at 10/4: 1481



Typical generation periods and spray timing

Generation Length (degree-days)			Spray Timing (degree-days)	
1st	2nd	3rd	Early generation	Later generations
1060	1100	1200	250-300	250

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Fruit Sampling

- ▶ Fruit damage can occur even when no moths are caught in traps, so check fruits for damage.
- ▶ Examine at least 200 fruits from throughout the orchard as well as in known hot spots and areas vulnerable to wind (edges, high spots), which can reduce pheromone concentration.
- ▶ If fruit damage exceeds 0.5%, supplemental sprays are warranted for the next generation. If the damage is light and in borders, treating 5-10 rows along the problem border may be adequate
- ▶ Assess your program: evaluate 300 fruit left on trees after harvest to assess overwintering population levels.

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Cultural & Mechanical


Sanitation

- ▶ Pay attention to nearby abandoned orchards (apple, pear, and walnut) and remove the hosts if possible
- ▶ Remove props, picking bins, and fruit and wood piles from the orchard.
- ▶ Hand thinning to remove all infested fruit during each generation, before worms leave fruit, and removal of infested and dropped fruit

- ▶ Fruit bagging 
- ▶ Tree netting 
- ▶ Cardboard banding: a trap for mature CM larvae as they crawl on the tree in search of a place to pupate



Minimum 2-inch wide; placed 12-18 inches above the base of the trunk



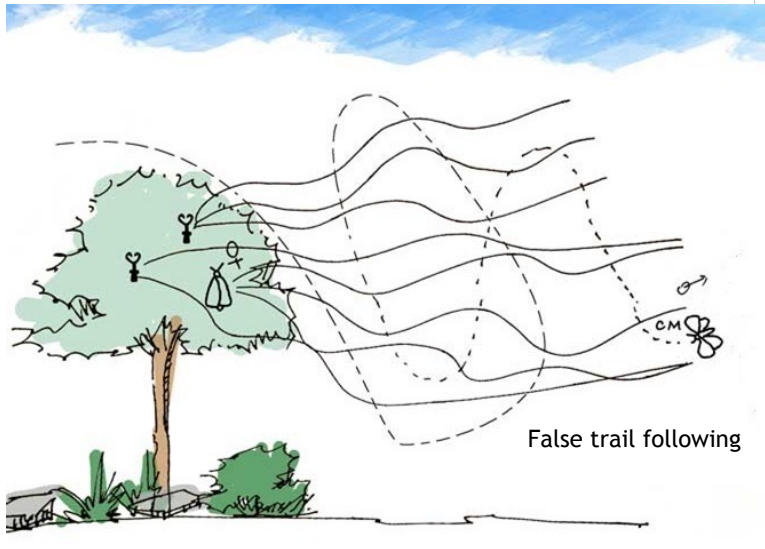
<https://entomology.ca.uky.edu/ef218>

<https://www.cityfruit.org/managing-for-codling-moth/>

<https://www.oksir.org/backyard-tree-care/cardboard-banding/z>

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Mating Disruption



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Mating Disruption

1. Sprayable liquid formulations

- Tiny microcapsules release pheromones
- Easy to apply
- Short residual (2-3 weeks); multiple applications



2. Plastic (hand-applied) dispensers

- 20 to 200 units/acre
- Season-long passive release
- Small and moderate-sized orchards



3. Aerosol dispensers

- 1.5 to 2 units/acre
- Released pheromone at programmed intervals

Notes: Attach dispensers to branches in the upper third of tree canopies. Apply before the first biofix in the spring. Large-sized, uniform blocks are better



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Insecticide Options

Moderate to High Codling Moth Pressure

- spinetoram (Delegate WG)
- chlorantraniliprole (Altacor)
- cyantraniliprole (Exirel)
- lamda-cyhalothrin (Worrier II with Zeon)

Moderate to Low Codling Moth Pressure

- Acetamiprid (Assail 70 WP)
- phosmet (Imidan 70 W)
- Methoxyfenozide (Intrepid 2F)
- SpearLep+Lep-protect (Bt)

Organic/biologicals

- Cydia pomonella Granulosis virus (Cyd-X, and other trade names)
- spinosad (Entrust)
- Narrow-range oil
- Kaolin clay (Surround)
- Sterile insect release (SIR)

<https://ipm.ucanr.edu/agriculture/pear/codling-moth/#gsc.tab=0>

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Summary

- Codling moth is an important pest of apple, pear, walnut and others in the world
- Understanding the pest and its biology is important for IPM adoption.
- Many monitoring tools are available
- Management tools are available and need to be used with IPM as a priority
- Utilize cultural, mechanical and biological control options is possible.
- Mating disruption supplemented by insecticides can be used

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Thank you for your attention!

Disclaimer:

Insecticides and other products mentioned in this presentation could be based on recent and ongoing research. These products may not have been registered for commercial and household use. Information presented here is for educational purposes only and should not be taken as a recommendation. Always follow the product label for appropriate use. A label is the law!