Codling Moth Identification & Organic Management

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Codling Moth IPM Webinar
Jan. 28, 2026

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

Adults (moths) are 1/2 inch long, mottled gray and brown

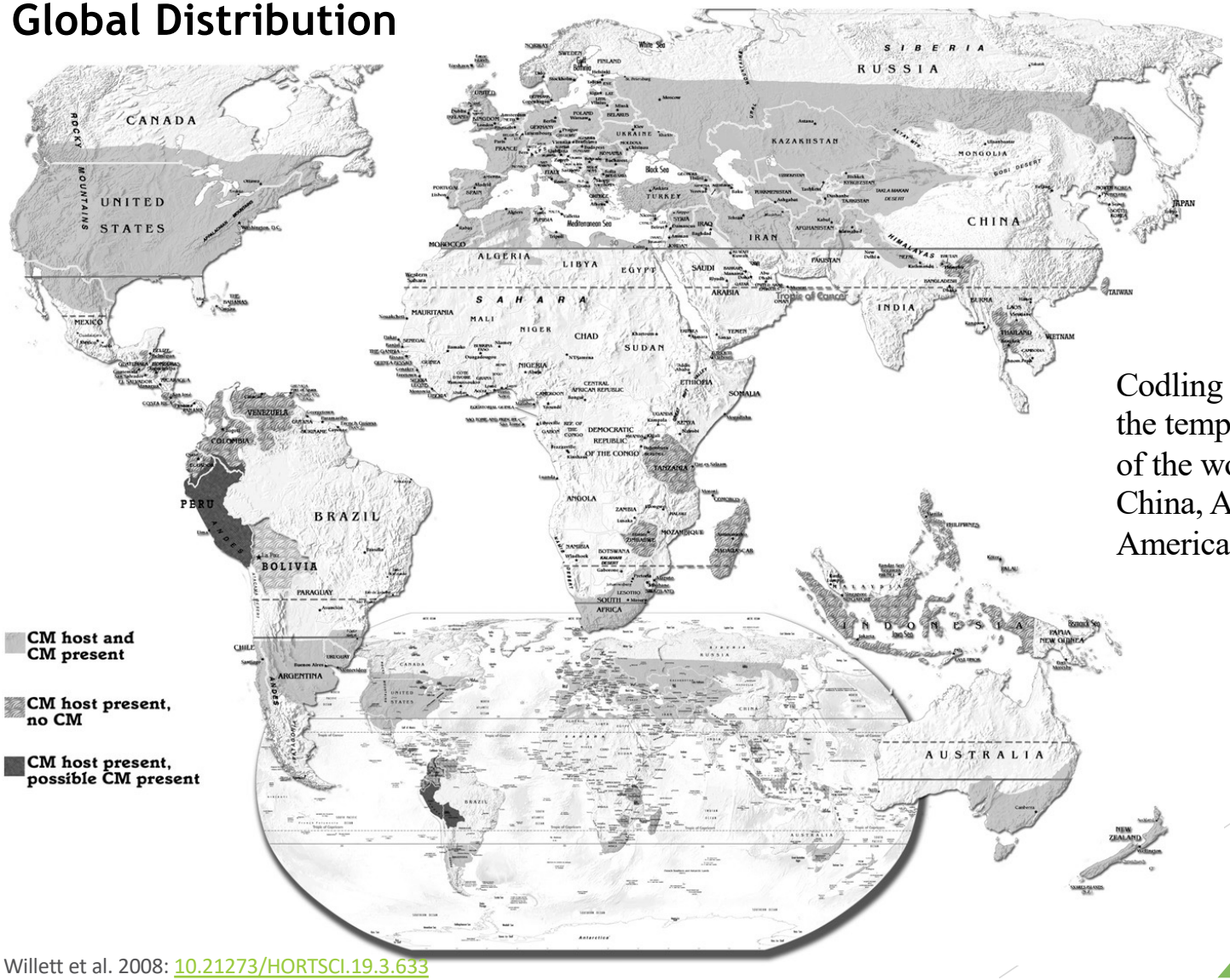
Damage to:

Apple

Pear

Walnut

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

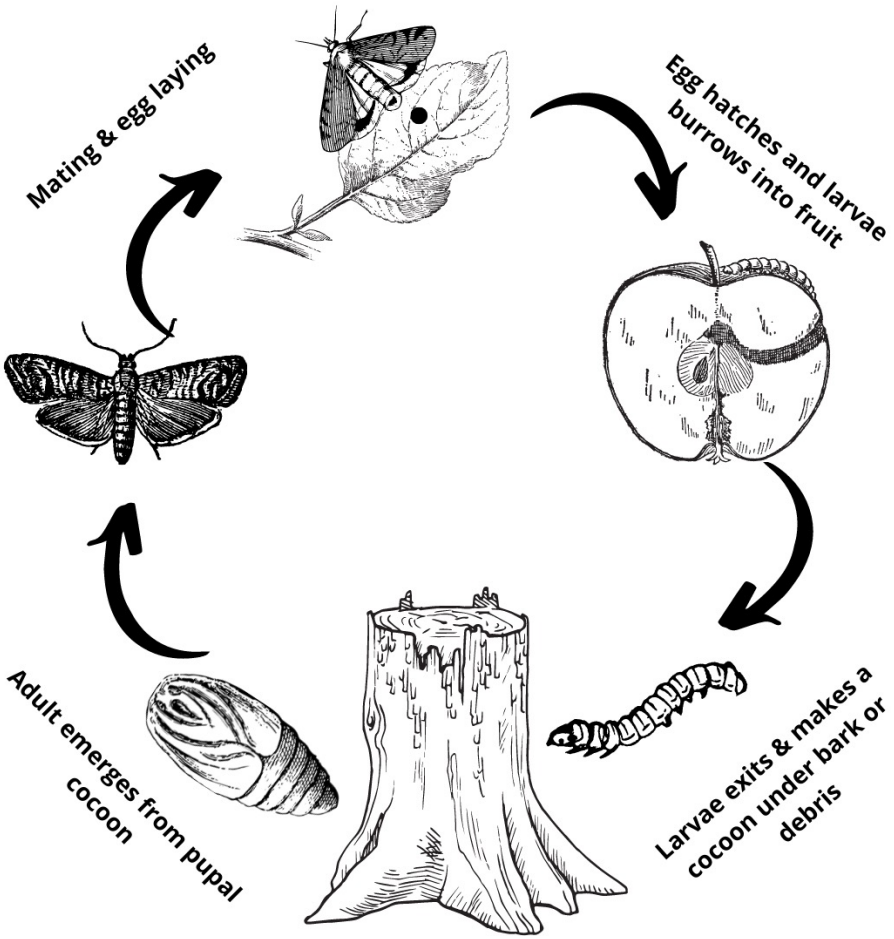
Willett et al. 2008: 10.21273/HORTSCI.19.3.633

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)
- 2-4 generations per year
- Larvae of all generations can be economically important for their host crops – apples and pears

3-4 generations/year

Life Cycle



https://www.homeorchardeducationcenter.org/arboretum-blog/codling-moth-in-organic-orchard

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

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.cahnrs.wsu.edu/postharvest-export/qpests/cm-id/

Pest monitoring

A. Predictions Models **B. Monitoring tools**

Predictions Models: Biofix and Degree Days

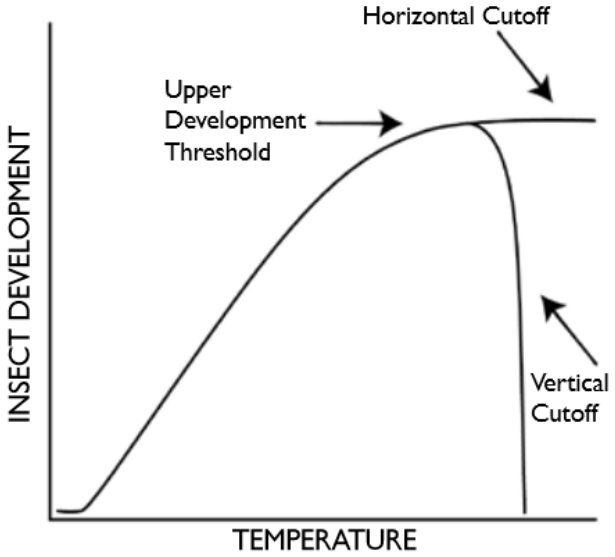
Biofix: The date at which biological event of a particular insect begins. Useful in **degree-days** calculation

Codling moth, biofix is the first date that moths are consistently found in traps and sunset temperatures have reached 62^0F

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

CM Monitoring

Under no-mating disruption:

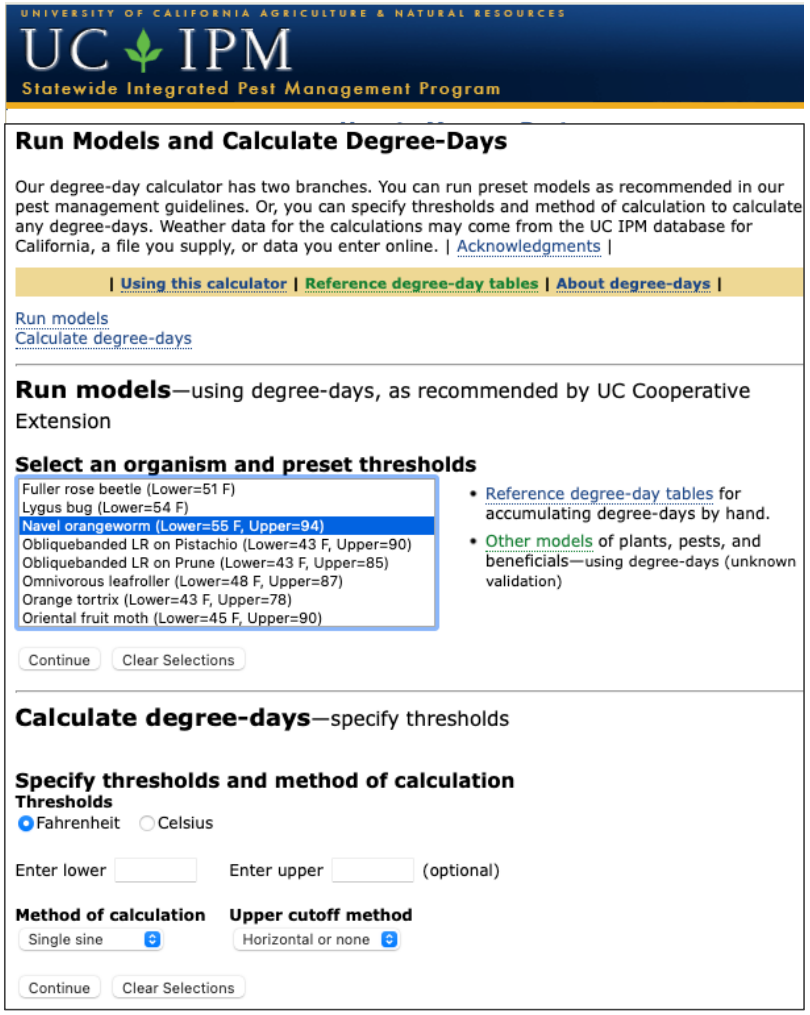
- **1 mg (1X) lure**, put traps (southeast side of the tree, 6-7 feet high), higher placement-more capture
- 1X lures has pheromone (codlemone), only attracts males

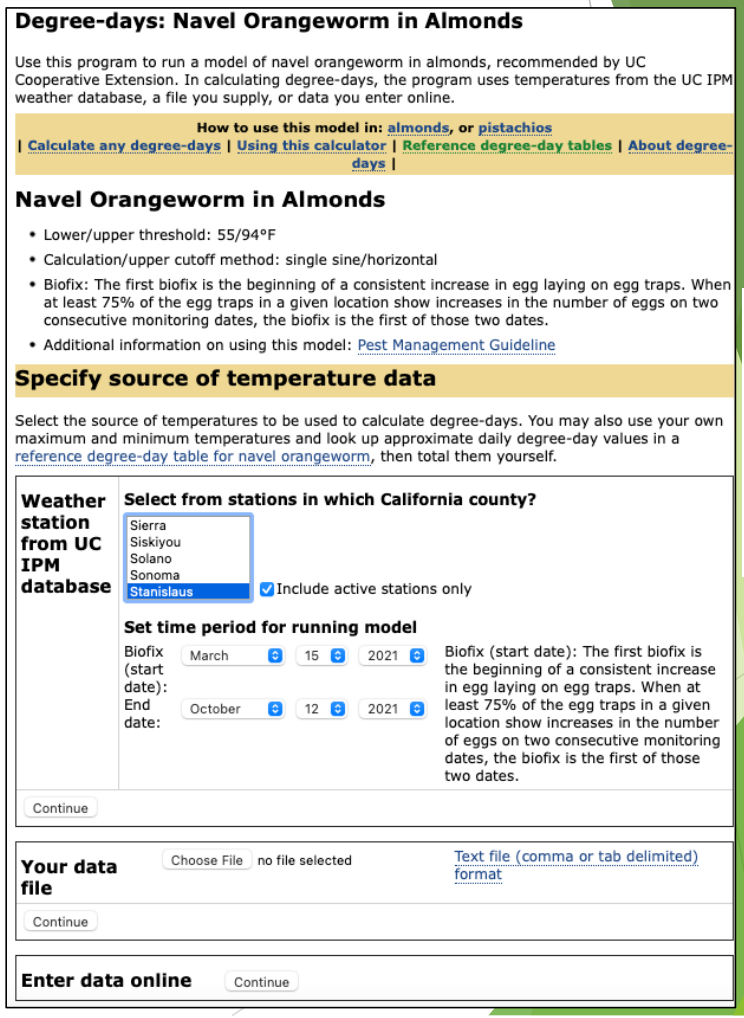
Under mating disruption or influenced by MD

- 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

Degree Days Calculation



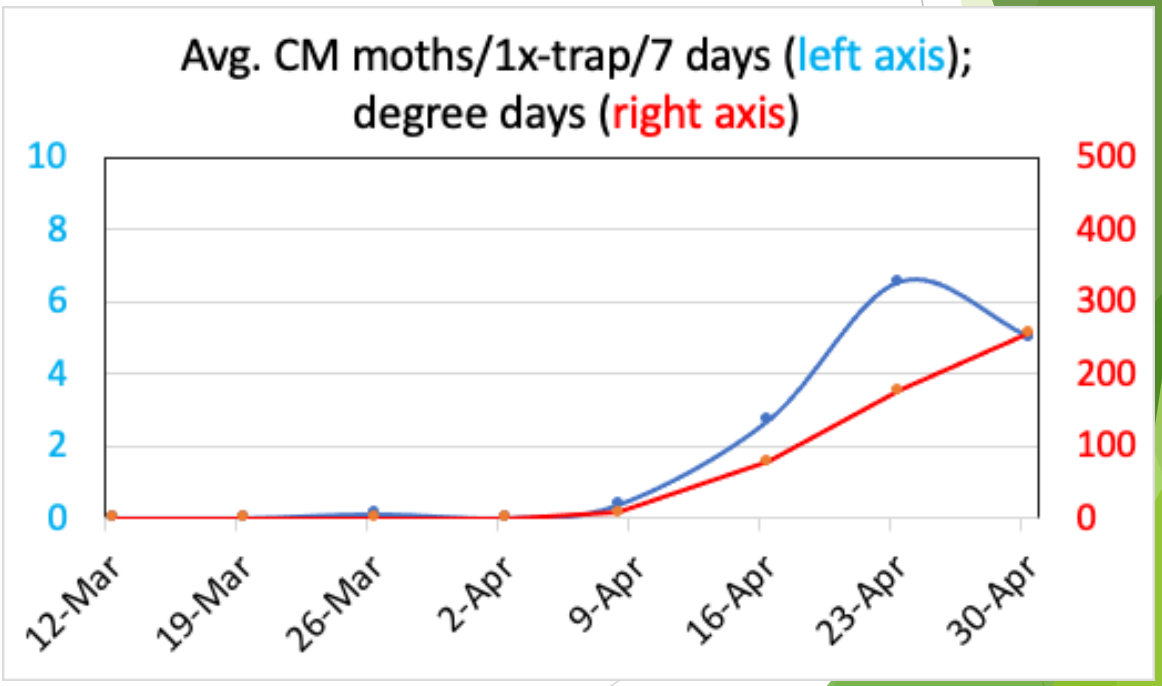


UCIPM Degree Days Calculation

Weather station: Denair_II.A (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_II.A. See retrieval table.

Date	Air temperatures (°F) Min	*	Max	*	Degree-days Daily	Accumulated	Notes
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	1	85	1	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	A	76	A	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	A	79	A	15.50	320.66	
May 07 2024	52	A	80	A	16.00	336.66	
May 08 2024	54	A	81	A	17.50	354.16	
May 09 2024	53	A	80	A	16.50	370.66	
May 10 2024	52	A	81	A	16.50	387.16	

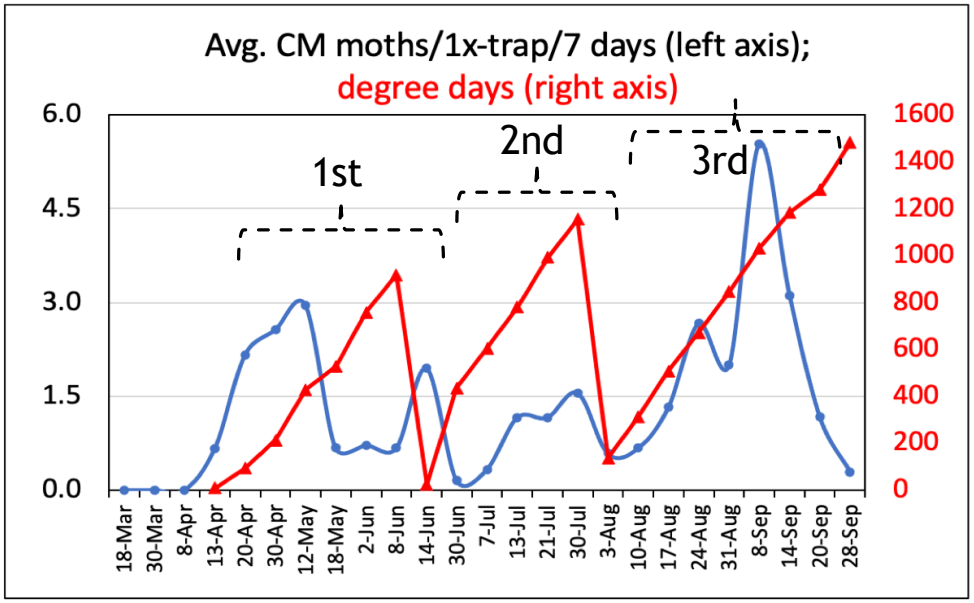
- 2024 Codling Moth (CM): Biofix 8 April; Modesto



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*



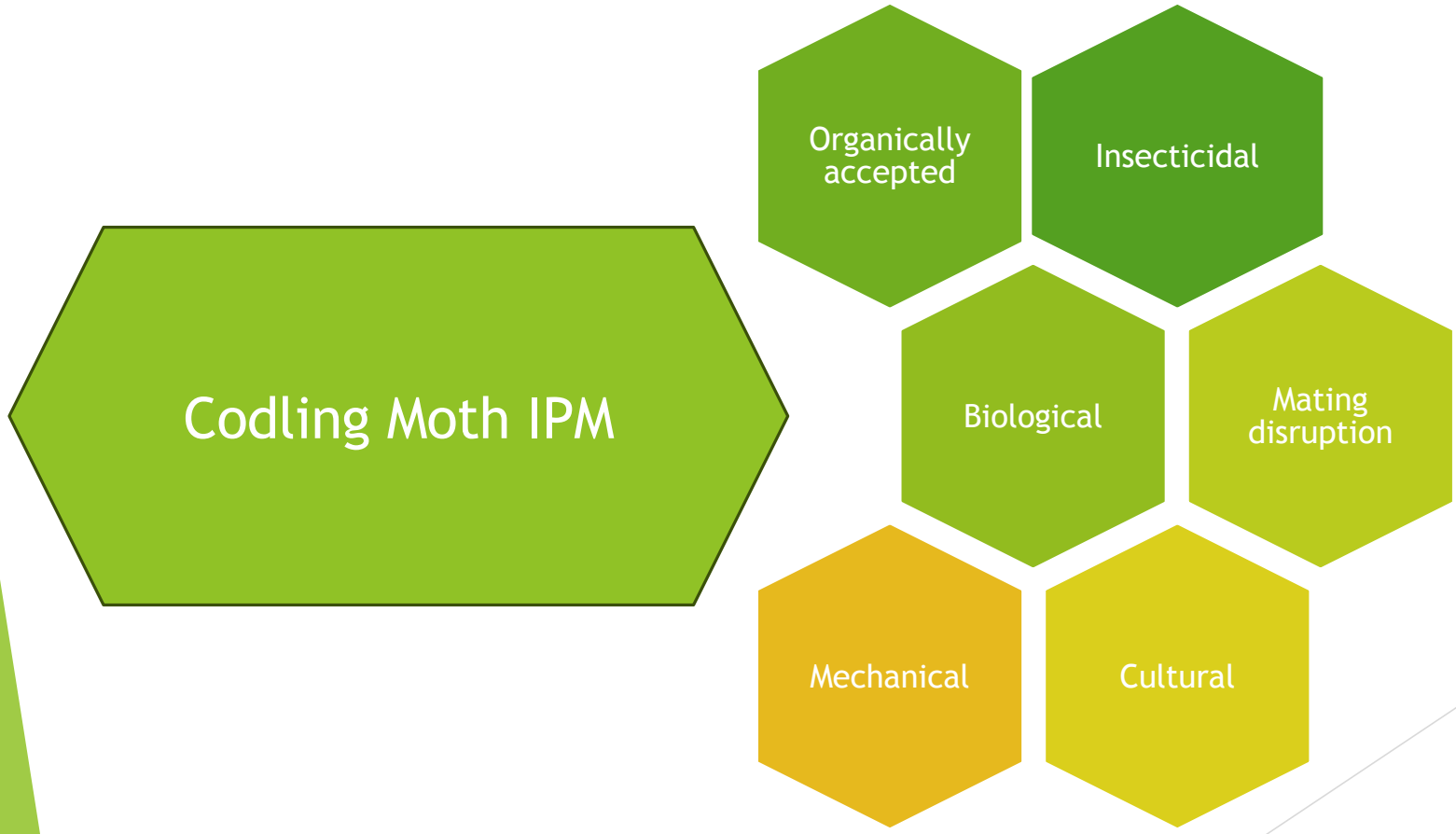
Typical generation periods and spray timing

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

Fruit Sampling for Damage

- 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.

Codling Moth Management Options



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

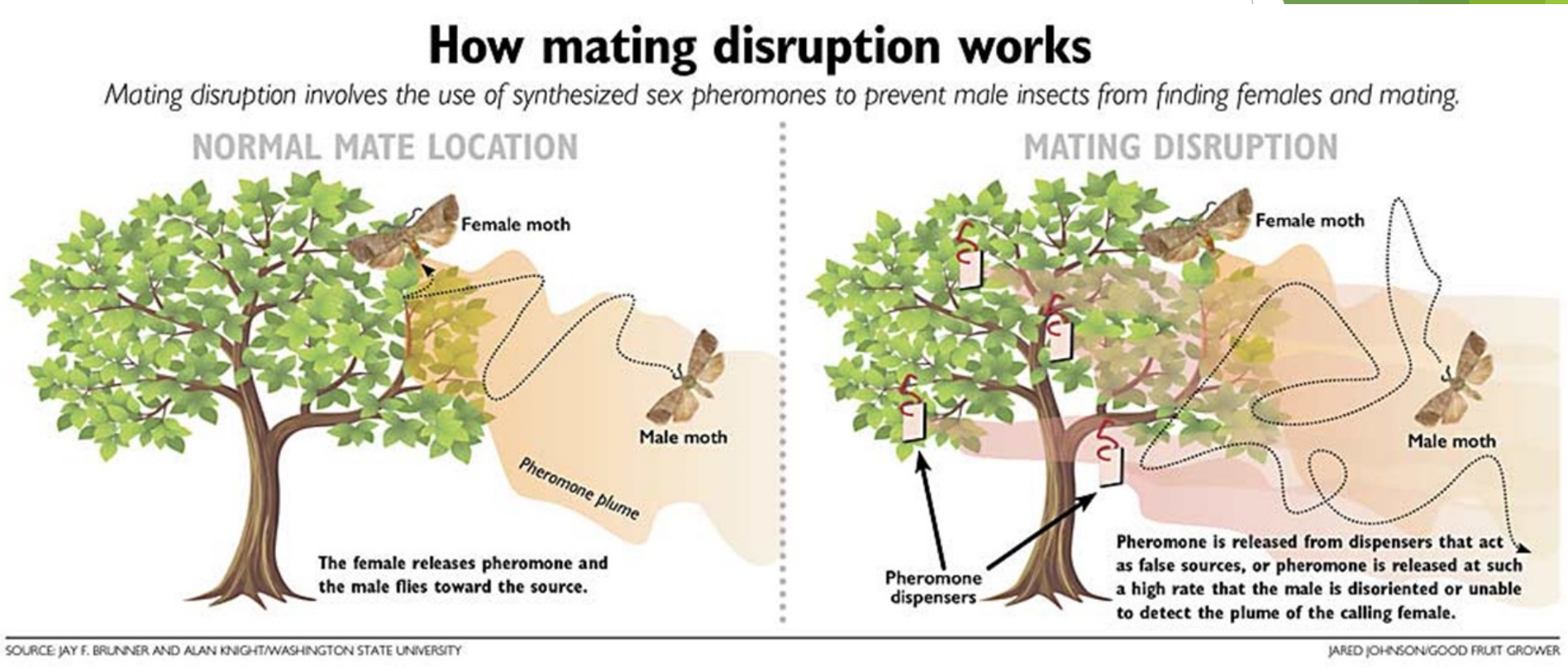
https://www.cityfruit.org/managing-for-codling-moth/

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

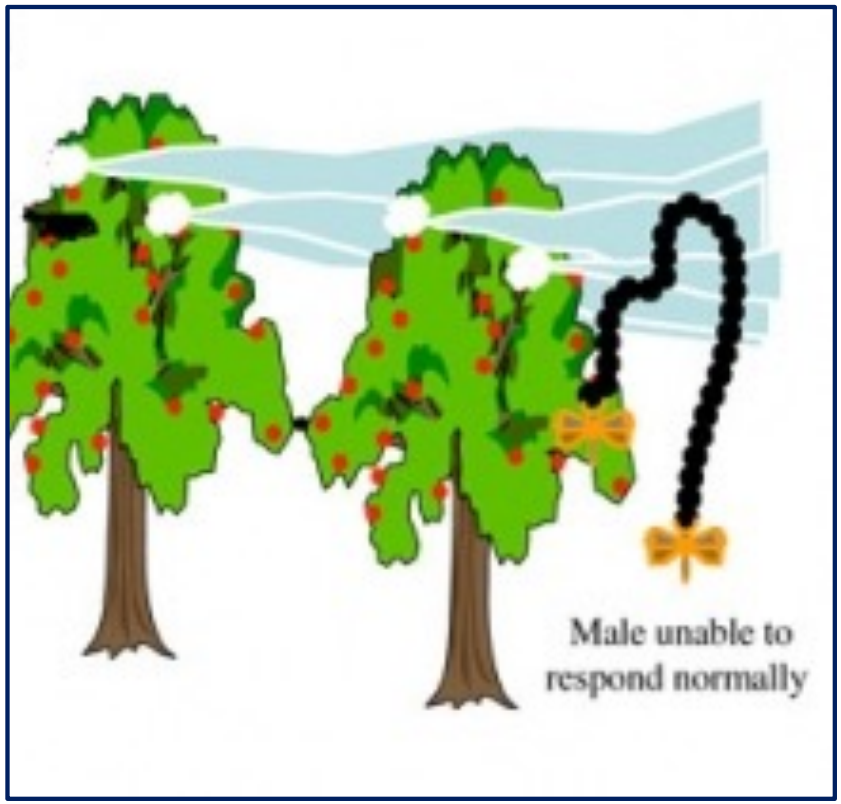
Mating Disruption

- Uses synthetic sex pheromones to interfere with mate-finding
- Reduces mating success, egg-laying, and larval damage
- Successfully used against key tree-crop moths, including:
  - Codling moth (*Cydia pomonella*) – apples, pears, walnuts
  - Navel orangeworm (*Amyelois transitella*) – almonds, pistachios, walnuts
  - Peach twig borer (*Anarsia lineatella*) – stone fruits and almonds
  - Oriental fruit moth (*Grapholita molesta*) – peaches, apples
- Most effective with area-wide adoption and low–moderate pest pressure
- One time application (most products)
- Selective, residue-free, and compatible with IPM programs

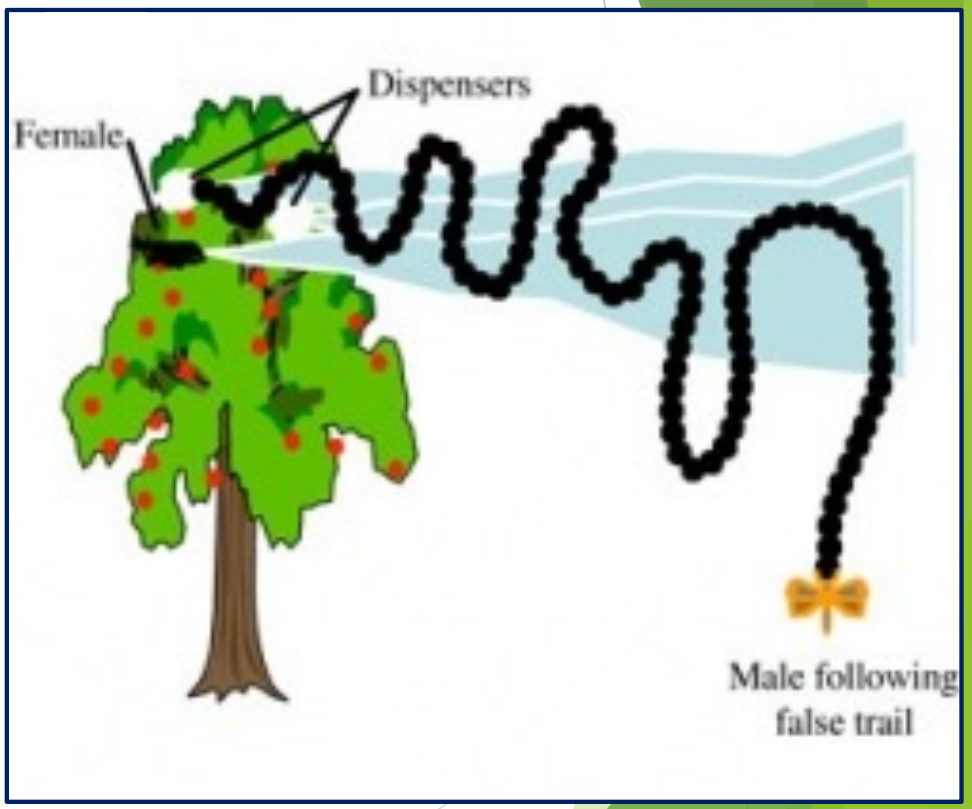
Mating Disruption



Mating Disruption Mechanisms



Non-competitive
(e.g. Oriental fruit moth)



Competitive - False Trail Following
(e.g. Codling moth)

Photo: Michigan State University

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

Natural Enemies/Biological Control

Insectivorous birds
pick larvae and pupae in cocoons from bark crevices,

Egg parasites
Egg parasite Trichogramma

Larval/pupal parasites
Many species of parasitic wasp attack codling moth larvae and/or pupae.

Predatory insects
Earwigs, predatory mirid, anthocorid bugs feed on CM eggs and young larvae.

Entomopathogenic fungi
Many species of entomopathogenic fungi, notably Beauveria bassiana, cause significant mortality in overwintered larvae and pupae.

Virus diseases
Codling moth granulovirus is usually associated with biocontrol applications though the virus can overwinter from one year to the next at a low level.

Biological Control

- Natural enemies alone may not be insufficient to suppress codling moth below economic thresholds in commercial setting
- Augmentative releases of the egg parasitoid *Trichogramma platneri* have been evaluated
- Research shows limited effectiveness in reducing codling moth populations
- Commercially available, but expensive

Other considerations:

- Enhance natural enemy effectiveness (resident and released)
- Avoid broad-spectrum, persistent insecticides (toxic to natural enemies)
- Control ants that attack beneficial insects
- Plant insectary flowers to provide nectar and pollen
- Reduce dust that interferes with natural enemy activity

Trichogramma spp.

Trichogramma parasitized CM eggs

Viruses for Codling Moth Control

- Codling moth granulovirus (CpGV) is a host-specific viral biopesticide, (eg. Cyd-X, MadexHP, Carpovirus, ViroSoft). Multiple variants/isolates
- Infects larvae after ingestion, causing mortality before pupation
- Highly selective – safe for beneficial insects, pollinators, and humans
- Most effective against early instar larvae; requires good spray timing
- UV-sensitive and short residual → may require multiple applications
- Widely used in organic and IPM programs, often combined with mating disruption
- Rotate CpGV with other insecticides, such as spinosad or mating disruption techniques.
- Avoid tank-mixing with copper fungicides, lime sulfur or Bt products

Insecticide Options for Conventional Orchards

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)

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

Other Insecticide Options

- Spinosad (Entrust)
- Summer oil (different application rate and purity than dormant oil) kills codling moth eggs by smothering them)
- Kaolin clay (Surround)
- Sterile insect release (SIR)

Reapplication might be necessary in most insecticides. Label is the law – follow the label directions

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

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!