Utah State
UNIVERSITY
EXTENSION

Orchard IPM Series HG/Orchard/08

Codling Moth

Cydia pomonella

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Adult Codling Moth

Do You Know?

- Major pest of apple and pear in Utah.
- Damaging stage: larva tunnels into fruit.
- Monitoring stage: adult male moth.
- Use of pheromone traps and the degree-day model are critical for determining the best time to control.
- Insecticides are currently the major control tactic.
- Sprays are targeted at newly hatched larvae.
- Apply first cover spray at 250 degree-days after biofix. General spray dates for your area can be obtained from your county USU Extension office.
- Biological control is minimally effective because larvae are protected inside fruit.

Codling moth is the most serious pest of apple and pear worldwide. If fruit is not protected, up to 95% injury can occur. Insecticides are currently the major control tactic. Effective biological control has not been possible because fruit is attacked by newly hatched larvae, which are protected from natural enemies once inside the fruit. Use of pheromones to disrupt mating behavior is a new and promising control tactic. While the cost of using pheromones is declining, the cost cannot yet compare to pesticides if no other incentives, such as insecticide resistance or loss of effective chemicals, are involved. The typically small size of apple and pear blocks in Utah (5-10 acres) and the high codling moth populations cause pheromone-based mating disruption to be generally less effective in Utah than in other regions of the Northwest. Sanitation methods can help reduce codling moth densities within an orchard but alone cannot provide satisfactory control.

In Utah, there are typically two generations of codling moth per year. In southern Utah and in years with a long and warm summer, a partial third generation can occur. First generation moths begin to emerge about bloom time and peak in late May to mid-June in northern Utah. Second generation moths begin emerging in early July and peak in mid-July to early August.

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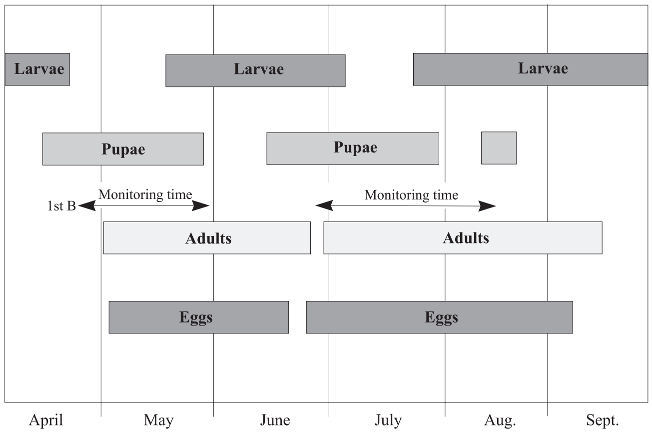
Larva tunnels to the core to feed on developing seeds.

Wing style pheromone trap is used to monitor adult male activity.

Hosts

apple
pear
English walnut
hawthorn
crabapple
cherry
quince
apricot

Codling Moth Life History



The arrows indicate when adults should be monitored with pheromone traps (1st B = first bloom).
To determine biofix, traps should be set out prior to moth flight. The arrow on the right represents monitoring for areas that use thresholds to determine the need for late season treatments.

Life History

Larva—Overwintering Stage

- **Size and Color**: $^{1}/_{2}$-$^{3}/_{4}$ inch long when full grown, creamy white to tan
- **Where**: in silken cocoons under loose bark on tree, in protected areas at base of tree, in fruit bins, or in orchard trash piles
- Develop to pupal stage when spring temperatures exceed 50^{o} F in late February and early March

Pupa

- **Size and Color**: $^{1}/_{2}$ inch long, brown
- **Where**: pupate inside silken cocoons
- 7–30-day development period depending on temperatures

Adult—Monitoring stage

- **Size:** $^{1}/_{2}$ inch long
- **Color:** mottled gray moth; bands of alternating gray and white on wings with a bronze to copper spot on the tip of each forewing
- **Where:** camouflaged against tree bark during the day with wings held tent-like over body
- Become active when evening temperatures exceed 55-60°F. (After emerging, male moths can be caught in pheromone traps at 55°F and above.)
- Peak moth activity is a few hours before and after twilight
- Mated female moths can lay 30–70 eggs

Egg

- **Size and Shape:** pinhead sized, flat, oval
- **Color:** translucent when first deposited, later turning white; just before hatching, the black head of the larva is visible
- **Where:** laid singly on fruit or on upper surface of leaves near fruit; difficult to spot in the orchard
- Hatch occurs in 6–20 days depending on temperatures

Larva—Damaging Stage

- **Size and Color:** $^{1}/_{10}$ inch long upon hatching, creamy white with a black head; $^{1}/_{2}$–$^{3}/_{4}$ inch long when full grown, tan to pink with a brown head
- **Where:** occasionally feed on terminal leaves and bore into shoots before seeking fruit
- Bore into fruit within 24 hours after hatching, then tunnel to core where they feed on developing seeds
- Pass through five larval instars inside fruit in 3 to 5 weeks
- After completing larval development, exit from fruit by entry hole or by a new exit hole and crawl to a protected site for pupation
- Entrance and exit holes are filled with frass (excrement) and are usually conspicuous
- Fruit attacked early in the spring often drops; larval development can be completed in the fallen fruit
- Larvae usually pupate and emerge as second-generation adults; some remain larvae until the following spring
- Larvae of the second generation overwinter except for a few that develop into a small third generation in warm years

Host Injury

Deep Entries

- Larvae tunnel to center of fruit to feed on seeds
- Brown frass (excrement) extrudes from entry and exit holes
- Fruit attacked during the first generation often drops prematurely

Stings

- Shallow entries by larvae

Timing Control

Proper timing of insecticidal sprays is critical for control with the least number of sprays necessary. In order to ensure proper timing, a combination of pheromone trap catches and a degree-day (DD) model should be used. For counties with major fruit production, general spray dates may be obtained from the county USU Extension office.

Pheromone Traps

Trap Placement

- Wing style pheromone traps can be used to monitor adult male activity.
- Traps dispense the female sex lure or pheromone.
- Place traps in orchards by first bloom (about mid-April) or based on degree-day (temperature) accumulations (see Table 1).
- Place traps within the upper third of the tree canopy (preferrably 6-7 ft. high) making sure the trap entrance

Table 1. Major Events in Codling Moth Management Program
Based on Accumulated Degree Days

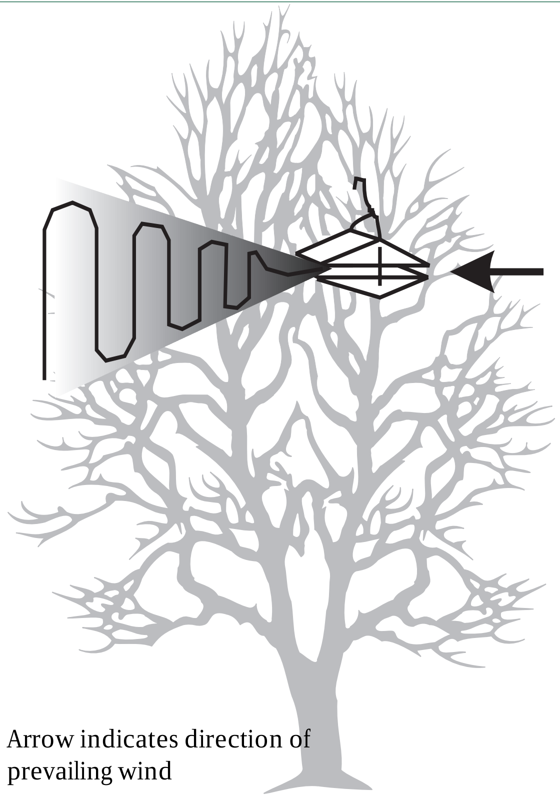
Degree Days(DD)	Adults Emerged %	Eggs Hatched %	Management Event
100 (beginning January or March[a])	0	0	Place traps in orchards
150-200 (beginning January or March[a])	First moths expected	0	Check traps every 1-2 days until biofix is determined
First Generation			
0 (biofix)	First consistent moth catch[b]	0	Reset DD to 0
250 (after biofix)	50	3	Apply first cover spray by this time
-	-	-	Apply second cover spray 21 days later[c]
Second Generation			
1260 (after biofix)	33	6	Apply third cover spray by this time
-	-	-	Apply fourth cover spray 21 days later[c]
Third Generation			
If temperatures are still high in September and the degree-day model predicts a third generation, apply a fifth cover spray 21 days after the fourth spray or based on expected fruit harvest date.[d]			

[a] Begin accumulating degree days after temperatures begin to exceed 50° F, typically on January 1 for southern Utah or March 1 for northern Utah.

[b] Biofix = at least two moths caught on two or more consecutive nights.

[c] Spray interval depends on protection interval of material used, typically 21 days for Guthion and Imidan.

[d] Check preharvest interval of material used to ensure that final spray is not too near harvest.



Arrow indicates direction of prevailing wind

- Place traps within the upper third of the tree canopy making sure the trap entrance is not blocked and that it is parallel to the prevailing wind direction.
- Dark line indicates moth flight trail up the pheromone plume to the trap

Figure 1. Proper placement of pheromone trap.

is not blocked and that it is parallel to prevailing wind direction (See Figure 1).

- Check traps every 1–2 days until the first moth is caught.

Biofix

- Once the first moth is caught, check traps daily. When the first consistent moth flight occurs (at least two moths caught on two or more consecutive nights), the “biofix” is said to have occurred.
- After biofix, traps should be checked every 4–5 days and the number of moths recorded.

Trap Servicing

- Change pheromone caps every 3-4 weeks and change trap bottoms after catching 20–30 moths or after dust and debris have collected on the sticky surface.
- Zero trap catches does not necessarily mean there are no moths in the orchard. Evening temperatures below 60° F are not conducive to moth flight, and a lack of wind in the evening means the trap cannot create a pheromone plume, which lures moths inside (see Figure 1).
- A minimum of two traps should be placed in each orchard. Place one trap on the edge and one near the center of the orchard. Suspected “hot spots” within the orchard should be monitored separately.
- By having traps in the center of the orchard, you will be able to determine whether moths are migrating in from outside or are coming from within.
- If the orchard is large and moths are only found in border traps, treating 4–5 border rows may markedly reduce the amount and number of insecticide applications. This tactic is primarily used after first and second cover sprays have been applied.
- Keep a record of trap catches for each orchard (see Codling Moth Sampling Form). This information can be used to monitor moth emergence to start degree-day accumulations, to assist with determining optimal spray timings, to determine the relative size of the moth population, and to help in evaluating the success of your control program.

Table 2. Degree-day Look-up Table for Codling Moth and Peach Twig Borer*

Lower development threshold: 50°F Upper development threshold: 88°F

Minimum Daily Temperature in °F

Maximum Daily Temperature in °F	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81
51	0	0	0	0	0	0	0	0	0	0	0	0											
54																							
57	1	1	1	1	1	2	2	2	2	2	3	3	4	5									
60																							
63	3	3	3	3	4	4	4	4	4	5	5	6	8	9	11	12							
66																							
69	5	5	5	5	6	6	6	7	7	7	8	9	11	12	14	15	17	18					
72																							
75	8	8	8	8	8	8	9	9	10	10	11	12	14	15	17	18	20	21	23	24			
78																							
81	10	10	10	10	11	11	12	12	13	13	14	15	17	18	20	21	23	24	26	27	29	30	
84																							
87	12	12	13	13	13	14	14	15	16	16	17	18	20	21	23	24	26	27	29	30	32	33	35
90																							
93	14	14	15	15	16	16	17	17	18	18	19	20	22	23	25	26	28	29	30	31	33	34	36
96																							
99	16	16	16	16	17	17	18	18	19	20	21	21	23	24	26	27	29	30	31	32	34	35	36
102																							
105	17	17	17	18	18	18	19	20	20	21	22	23	24	25	27	28	30	30	32	33	35	35	36
108																							
111	18	18	18	19	19	20	20	21	21	22	23	24	25	26	27	29	30	31	32	34	35	36	37
114																							

* To find total degree-days for a day, locate the low and high temperatures and follow the column and row to where they intersect. Interpolate for temperatures between given numbers. This chart can be photocopied for easy reference in the field.

Degree-day Model

The Degree-day Method

- Use of the codling moth degree-day (DD) model will help to more accurately time insecticide applications and reduce the number of applications to the minimum necessary.
- The lower and upper temperature thresholds for codling moth development are 50° F and 88° F.
- Degree-day accumulations can be determined for an individual location by using the look-up table (see Table 2) or by obtaining information provided by the USU Extension office. (Contact your county USU Extension office to find out if information on degree-days and spray timing is available.)
- If you are accumulating degree-days with the look-up table, daily maximum and minimum air temperatures must be available.
- Starting March 1 in northern Utah or January 1 in southern Utah, begin accumulating degree-days using one of the methods described above.
- Place pheromone traps in orchards when 100 DDs have accumulated (see Table 1).
- Once biofix (first consistent moth catch) has occurred, the codling moth model is started and accumulated DDs are reset to zero.
- If biofix is immediately followed by several days of cold temperatures (daily maximum below 50° F), ignore the first moth catch and restart the model when biofix occurs a second time.

Timing Sprays

- Apply the first cover spray at 250 DDs after biofix (see Table 1). This coincides with approximately 3% egg hatch of the first generation and the first possible fruit entry. This timing will provide optimum control of larvae and suppress adult populations. Sprays applied earlier will be wasted, or later will allow egg hatch and fruit injury.
- Apply the second spray based on the residual period (i.e., protection interval) of the product used, typically 10 to 21 days. If the second spray is applied 21 days or more following the first, then only two sprays are needed to protect fruit from each codling moth generation.
- Apply the third cover spray, targeting the second generation, at 1,260 DDs after the biofix is established for the first moth flight (see Table 1).

- Apply the fourth cover spray based on the protection interval of the product used.
- In years with a long warm summer, a partial third generation can occur. Apply an additional cover spray based on the protection interval of the product used and expected fruit harvest dates.

Management

Insecticides

Synthetic insecticides have been the major control tactic used since the 1940s. Current insecticide choices include synthetic materials, microbial and botanical insecticides, and petroleum oils. The choice depends on numerous factors including the crop's market destination, grower preferences, size of orchard, codling moth pressure in the area, and the surrounding habitat. Regardless of the type of insecticide used, it is critical for optimal control that sprays be accurately timed to coincide with early egg hatch. Use of pheromone trapping in combination with the degree-day model are highly recommended. (For more information on the degree-day model, see the Timing Control section above.)

Synthetic Insecticides

Recommended chemicals:

- azinphosmethyl (Guthion)
- diazinon (Diazinon)
- phosmet (Imidan)

Consider the protection interval, preharvest interval, codling moth pressure, and past use history when deciding on a material that is best for your situation.

Other choices:

- carbaryl (Sevin)
- esfenvalerate (Asana)
- chlorpyrifos (Lorsban), apples only

Secondary choices are not preferred because of their lower efficacy or greater toxicity to beneficial and nontarget arthropods.

Soft Insecticides

Use of soft pesticides alone has not generally provided satisfactory control of codling moth. However, intensive use of combinations of soft pesticides has proven adequate in some cases. Combinations of soft chemicals and pheromone-based mating disruption have proven effective.

- Microbial insecticides: *Bacillus thuringiensis* and codling moth granulosis virus have not provided satisfactory control even when applied weekly.
- Botanical insecticides: rotenone, pyrethrum, and ryania (apples only) have variable control effectiveness. They may provide satisfactory control of low codling moth population levels but can be harsh on beneficials thus allowing other pest insect populations to increase.
- Petroleum oils: highly refined, superior-type oils (i.e., summer oils) have been successful in preventing egg hatch by suffocation. Applications beginning at first egg hatch have provided successful control of codling moth on pear alone and in combination with a mating disruption program. There are concerns about negative effects on fruit finish.

Mating Disruption

- Shows promise for satisfactory codling moth control.
- Place small dispensers containing the female sex pheromone in large numbers throughout the orchard before first moth flight.
- The size of orchard, proximity to outside sources of codling moth, and dispenser placement and application rate can all influence the success of this tactic.
- The typically small size of apple and pear blocks in Utah (5-10 acres) and the high codling moth populations reduce the effectiveness of mating disruption in Utah as compared to other areas of the Northwest.
- If synthetic insecticide applications are reduced, populations of other lepidopterous pests can increase.

Sanitation

- Remove or treat host trees within a quarter mile (450 yards) of orchard to destroy outside codling moth sources, including abandoned orchards and wild hosts.
- Strip fruit remaining after harvest in young, unharvested orchards or on pollinator trees.
- Remove or destroy piles of culled fruit in orchards.
- Remove additional pupation sites from orchards such as fruit bins, brush, woodpiles, and other debris.
- Fruit infested during the first generation typically drop to the ground in June or July. Remove or destroy (e.g., flail) dropped fruit to reduce second generation densities.

Trunk Banding

- Place corrugated cardboard bands (2-3 inches wide) with fluted sides down around trunks of trees in May to collect first generation larvae or in August to collect overwintering larvae that are moving to the trunks to pupate.
- Remove and destroy bands before moths emerge in mid- to late June (for first generation) or in late October to November (for overwintering generation).
- Method is most effective on smooth-barked varieties and in smaller, isolated orchards.

Biological Control

- Recent efforts to introduce parasitoids from native habitats of codling moth in Eurasia are promising.
- Natural enemies currently present in orchards do not provide satisfactory control.
- Use of more selective and soft insecticides enhances populations of beneficials.
- Release of the egg parasitoid *Trichogramma* has shown potential especially in combination with other "soft" tactics.

Codling Moth Sampling Form

Pheromone Trap Catch Record

Orchard Block________________________Scout________________________Year________

Description of Trap Locations:

Trap ID Number	Trap Location*	Date trap set out

*Record location of trap in orchard (e.g., 5th row from north, 5th tree into block)

Number of Codling Moths per Trap							
Date	Trap #_____	Trap #_____	Trap #_____	Trap #_____	Trap #_____	Moths /Trap	Comments
Moths/day							
Moths/day							
Moths/day							
Moths/day							
Moths/day							
Moths/day							
Total							

Moths/day = moths captured/days since trap last checked:
Example: 10 moths captured between June 5-June 10 = 10 moths/5 days = 2 moths/day.