How to keep apple fruit worm-free

Celeste Welty, Extension Entomologist, Ohio State University

January 2009

For over 100 years, the codling moth has been the key insect pest of apple fruit in Ohio and throughout the world. For most of the past 60 years, the codling moth has been readily controlled by insecticides and has rarely caused problems in commercial orchards in which a standard organophosphate insecticide spray program has been used.

Since about 2003, a few Ohio apple growers have seen an increase in the incidence of wormy fruit at harvest. The problem seems to be increasing each year. In some cases, wormy fruit resulted because a second pest species, the Oriental fruit moth, has moved into the orchard, and the control program designed for codling moth does not control the Oriental fruit moth. The Oriental fruit moth is a common pest of peaches but is becoming more common in apples. In other cases, wormy fruit resulted because of operational factors such as poor timing of sprays or inadequate coverage due to low spray volume. In some cases, wormy fruit resulted because of the development of resistance to organophosphate insecticides. In this fact sheet, recommendations will be given for how to deal with each of these problems.

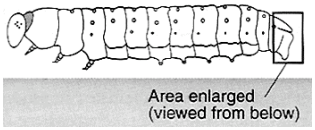
Part 1: background information

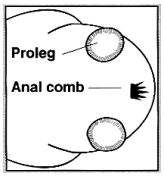
Key facts about the codling moth: The codling moth overwinters as fully grown larvae in cocoons under loose pieces of bark on apples trees, on the trunk or lower scaffold branches. Once temperatures warm up in the spring, the larvae enter the pupal stage, then emerge from cocoons as moths. The moths find mates by smell; the female codling moths emit a pheromone scent that is recognized by male codling moths. After mating, female moths lay eggs on leaves or fruit. Eggs hatch in 6 to 20 days, depending on temperature. Eggs hatch into tiny larvae that tunnel through the fruit and feed on fruit flesh and seeds in the core of the apple. In years with average temperatures, the codling moth has two generations: one generation begins with eggs in late May and the second generation begins with eggs in late July. In years that are warmer than normal, the two generations are earlier, and there is a third generation in late August or early September. In addition to apple, other hosts of codling moth are European pear, Asian pear, quince, Persian (English) walnut, and Japanese plum, as well as hawthorn and crabapple.

Key facts about the Oriental fruit moth: the Oriental fruit moth has four to five generations per year. It overwinters as larvae in cocoons under bark scales on the tree or in leaf litter on the ground. The larvae and pupae complete their development and begin to emerge as adults just before peach trees bloom, usually during April. The generations overlap and usually extend into October. The first brood of larvae bore into terminal twigs, causing the terminal to wilt, or "flag." Later-generation larvae enter the fruit near the stem end and burrow in the flesh, sometimes to the core, where they feed around, but not in, the seeds. The male and female adults find each other by pheromones.

A typical pattern of events in orchards that develop worm problems is that in one year, unusually high numbers of codling moths are caught in pheromone traps, but fruit quality at harvest seems fine. The next year, high traps counts are seen again, and moderate worm damage is found at harvest. The third year, traps counts are high and there is a large amount of fruit damage. Knowing that this sequence is common, any grower who notices unusually high trap catches should consider all of the recommendations given below so that the trends can be halted before they result in a large amount of culled fruit.

Part 2: Steps to take if worm problems begin to develop:





1) Verify which species is causing the problem by collecting larvae from fruit then examining them under magnification. The larvae of both the codling moth and the Oriental fruit moth are pale pink to white, with a brown head. The codling moth larva has speckles on the brown segment behind the head (picture on upper right), while the Oriental fruit moth larvae does not have these speckles (picture on lower right). The codling moth larva has no anal comb, but the Oriental fruit moth larva has an anal comb (see drawing below). The anal comb is near the tip of the abdomen; it is easily seen with a microscope but is difficult to see with a 15x hand lens. The lesser appleworm also has an anal comb. The larvae of Oriental fruit moth and lesser appleworm can be separated by counting the number of hooks on their anal prolegs; the Oriental fruit moth has more than 20 while the lesser appleworm has less than 20.
2) Verify which species is causing the problem by using pheromone traps to monitor the adult population. More details about trapping are given in Part 8. It is best to use three codling moth traps per orchard and three Oriental fruit moth traps per orchard. If the orchard is spread out over several separate locations, it is best to have a set of traps at each location. If moths are not caught in the Oriental fruit moth traps, their use can be reduced to one trap per orchard. Beware that the Oriental fruit moth pheromone traps commonly attract two species: the Oriental fruit moth and the lesser appleworm. The lesser appleworm is smaller than Oriental fruit moth and has gold color in its wings, while Oriental fruit moth is various shades of grey.


codling moth


Oriental fruit moth


lesser appleworm

3) Be sure that the timing of insecticide sprays is appropriate. The main difference between control programs for codling moth and Oriental fruit moth is the timing of sprays, not the choice of insecticide.

   a. Most insecticides work best if applied at the time that eggs are hatching. For codling moth, this is usually around the time of the first cover spray or second cover spray, but it varies with seasonal temperature. More on this in Parts 3 and 4.
   b. If Oriental fruit moth is present in the apple orchard, then timing of insecticides is different than for a codling moth control program. Oriental fruit moth has more generations and begins earlier than codling moth. More on this in Part 5.

4) Increase the spray volume to get more thorough coverage of the tree, especially the top third of the canopy. The amount of spray mixture needed depends on the size of trees and the capability of the sprayer, but should be at least 50 gallons per acre for small trees and at least 100 gallons per acre for larger trees and in blocks where worm problems are severe, especially late in the season.
5) Increase the number of sprays per generation. Orchards with high populations of codling moth require three sprays per generation, due to prolonged emergence of moths under typical conditions in Ohio. Orchards with low-density populations of codling moth (peak numbers of <10 moths per trap per week) can be adequately protected from codling moth injury by two sprays per generation. If relatively small populations have a fairly brief emergence (<3 weeks), then one spray is adequate. The second and third sprays should be applied at 14-day intervals.
6) Change insecticides to non-organophosphate alternatives. For resistance management, use one product for first generation and a product from a different chemical group for second generation. A list of insecticide options is shown in Part 6. Note on granulosis virus: Virus is most effective when applied every 7 days. In orchards with heavy pest pressure, virus products are best used either in alternation with conventional insecticides, or in an additional spray at the end of the generation. For example, if Assail is being used for first generation, Assail could be applied on day 1 and day 14, and virus could be applied on days 7 and 21.
7) Supplement the chemical control program with the strategy of pheromone mating disruption. This is most commonly done by manual application of dispensers such as Isomate-C Plus (for codling moth), Isomate-M 100 or Isomate-M Rosso (for Oriental fruit moth), or Isomate-CM/OFM TT (for combined codling moth and Oriental fruit moth). Mating disruption is highly effective for Oriental fruit moth, and moderately effective for codling moth. Mating disruption is particularly helpful in orchards with extremely high pest pressure.

Part 3: Details about timing of sprays for codling moth, first generation

The time that codling moth eggs begin to hatch can be predicted by a temperature model. Codling moth develops when the temperature is above a developmental threshold of 50°F and below 88°F.

The most common predictive model used in recent years is based on a 'biofix' date. Biofix is a way to synchronize the model to field conditions. The steps for this method are:

1) Use pheromone traps for codling moth, starting at bloom. Check traps at least 3 times per week. The first day that a trap catches a codling moth is chosen as the date called biofix. The original model used the date of the very first moth catch.

Many pest managers have preferred to define the biofix date as the first detection of 'sustained catch' rather than the very first catch. If there is a single moth in one trap on one day, and no other catch for a day or two, then that is not sustained flight. There is not a precise definition of sustained flight, but typically it would be at least 5 moths caught in 3 traps over a 7-day period.

2) Starting on the biofix date, daily records of average temperature should be kept. The simplest way of doing this is to get the daily minimum and maximum temperature and calculate the daily average. An important exception is that if the real minimum temperature is less than 50°F, then 50°F should be substituted for the real minimum. Likewise, if the real maximum is higher than 88°F then 88 should be substituted for the real maximum. A more exact way to adjust for insect development when temperatures are below the threshold is to use a sine-wave model; more on this below.
3) The daily degree-day count is calculated by subtracting the minimum developmental threshold temperature for codling moth (50°F), from the average temperature. Daily degree-days = daily average temperature – 50
   = ([daily maximum + daily minimum] / 2) – 50
4) Cumulative degree-days are updated by adding each day's degree-days to the previous count. For example, here are temperatures over a 5-day period:

Day	Temperature maximum (°F)	Temperature minimum, actual (°F)	Temperature minimum, adjusted if <50 (°F)	Temperature average (°F)	Degree days (base 50°F)	Cumula-tive degree days (base 50°F)
1	62	52	52	57	7	7
2	66	50	50	58	8	15
3	58	54	54	56	6	21
4	70	56	56	63	13	34
5	60	46	50	55	5	39

5) A short-cut for steps 2 and 3 is to use the look-up chart on page 9 for codling moth. Look along the top of the chart for the day's minimum temperature, and along the left side of the chart for the day's maximum temperature, and where that column and that row meet is the degree days for that day. For example, if the minimum temperature was 54 degrees and the maximum temperature was 76 degrees, then 15 degree-days resulted.
6) A short-cut for steps 2 to 4 is to put your data into a computer model found on the Univ. of California website (http://www.ipm.ucdavis.edu/WEATHER/ddretrieve.html). You can load your own weather data into this model and it will calculate the cumulative degree days. On the opening screen of the website, you need to choose Fahrenheit or Celsius, you need to enter the lower threshold (50 for Fahrenheit or 10 for Celsius), the upper threshold (88 for Fahrenheit or 31 for Celsius), the method of calculation (single sine), and the upper cutoff method (horizontal), then hit the 'calculate' button. On the next screen, you enter the start and end dates, and the

name of your data file. Your data file can be an Excel spreadsheet with just 3 columns: one for the date, one for minimum temperature, and one for maximum temperature, saved as a .csv file (comma separated value file). Then hit the 'continue' button.

7) When the cumulative degree-day count reaches the target number, then the insecticide should be applied. For many insecticides used for codling moth control, the target is 250 DD (base 50°F), which is when the first 3% of eggs hatch. Products that are best when applied at 250 DD are Imidan, Guthion, Altacor, Belt, Delegate, pyrethroids, and granulosis virus. Some insecticides use an earlier target, for example, Rimon is applied after only 50-75 DD because it is best for eggs to be laid on top of the residue; Intrepid is applied after 150 DD; and neonicotinoids (Assail, Calypso, clutch) are applied after 200 DD. These targets are summarized in Part 7 below.
8) The second spray for control of first-generation codling moth is 14 days after the first spray, for most products under average weathering conditions. If the weather has been unusually rainy or hot, then the interval can be shortened to 10 days.

A new version of the temperature-based predictive model ignores traps and ignores the biofix date, but uses simply the degree-day count starting on January 1st (this is described in a recent article: *Jones, V. P, M. Doerr, and J. F. Brunner. 2008. Is biofix necessary for predicting codling moth emergence in Washington State apple orchards? Journal of Economic Entomology 101(5): 1651-1657*). Insecticide is applied 250 degree days after the predicted emergence of the first moth, which is 96 degree days, base 10°C (=173 degree days base 50°F) after 1st January. This method is particularly useful in orchards with low density populations in which moth flight is not easily detected. Because this method uses temperature data from months with low temperatures, it needs to use a sine-wave model for calculating degree days rather the simple average temperature adjusted for the developmental threshold, as described in step 6 above.

Part 4: More detail about timing of sprays for codling moth, 2nd & 3rd generations

The first spray for control of the 2nd generation of codling moth larvae is 1200-1250 DD after biofix. Alternatively, a new biofix can be determined by watching for a surge in trap catch; the spray should be applied 250 DD after the surge, for materials such as Imidan or Altacor, or earlier for other materials such as Rimon, as discussed for control of the first generation. The second spray for control of 2nd generation codling moth larvae should be 14 days after the first spray.

Similarly, the first spray for control of 3rd generation codling moth larvae is 2350 DD after biofix. Alternatively, a new biofix can be determined by watching for a surge in trap catch; the spray should be applied 250 DD after this, for materials such as Imidan or Altacor. The second spray for control of 3rd generation codling moth larvae should be 14 days later. See the summary of timing in Part 7.

Part 5: More detail about timing of sprays for Oriental fruit moth

A temperature model with a trap-based biofix date is also used for Oriental fruit moth, but the threshold temperature is 45°F (rather than 50°F used for codling moth). The look-up chart for Oriental fruit moth is on page 10. The best time to spray

insecticide to target hatching eggs for the first generation Oriental fruit moth for standard insecticides is 150 to 200 DD (base 45°F) after biofix. The 2nd generation of Oriental fruit moth is partially controlled by sprays directed at 1st generation codling moth. The 3rd generation of Oriental fruit moth is usually controlled by sprays directed at 2nd generation codling moth.

Part 6: Insecticides for codling moth and Oriental fruit moth control in apples

Chemical group	IRAC group	*Product*	*Pre-har-vest inter-val (days)*	*Limit per year when used at maximum rate*	*Efficacy rating for codling moth control on apple*	*Efficacy rating for Oriental fruit moth control on apple*
Insect growth regulators, chitin disruptors	15	Rimon	14	4 applications	excellent	excellent
Insect growth regulators, molting disruptors	18A	Intrepid	14	4 applications	good	good
Ryanodine disruptors	28	Altacor	14	4 applications	excellent	excellent
		Belt	14	3 applications	excellent	excellent
Spinosyns	5	Delegate	7	4 applications	excellent	excellent
		Spintor	7	3 applications	poor	poor
Neonicotinoids	4A	Assail	7	4 applications	good	excellent
		Calypso	30	2 applications	good	good
		Clutch	7	1 application	fair	fair
Pyrethroids	3	Baythroid	7	1 application	good	excellent
		Mustang	14	6 applications	good	excellent
		Danitol	14	2 applications	good	excellent
		Asana	21	7 applications	good	excellent
		Decis	21	2 applications	good	excellent
		Proaxis	21	4 applications	good	excellent
		Warrior	21	5 applications	good	excellent
Organophosphates	1B	Guthion	14/21	2 applications	excellent	excellent
		Imidan	7	8 applications	good	good
Carbamates	1A	Lannate	14	5 applications	good	good
		Sevin	3	8 applications	fair	good
Other	22	Avaunt	14	4 applications	good	good
	11	BT	0	none	poor	poor
	7	Esteem	45	2 applications	fair	good
	6	Proclaim	14	3 applications	fair	fair
	2	Thionex	21	2-3 applictns	poor	poor
Granulosis virus	-	Cyd-X	0	none	excellent	fair
		Virosoft-CP4	0	none	excellent	fair
		Carpovirusine	0	none	excellent	fair

Part 7: Summary of target degree-day timing for insecticide sprays

Pest	spray	Timing for Rimon	Timing for Intrepid	Timing for Assail, Calpso, Clutch	Timing for Imidan, Guthion, Altacor, Belt, Delegate, pyrethroids
codling moth, 1st generation	1st	75 DD (base 50°F)	150 DD (base 50°F)	200 DD (base 50°F)	250 DD (base 50°F)
	2nd	14 days later			
	3rd	14 days later, if moths still detected in traps			
codling moth, 2nd generation	1st	1075 DD (base 50°F)	1150 DD (base 50°F)	1200 DD (base 50°F)	1250 DD (base 50°F)
	2nd	14 days later			
	3rd	14 days later, if moths still detected in traps			
codling moth, possible 3rd generation	1st	2175 DD (base 50°F)	2250 DD (base 50°F)	2300 DD (base 50°F)	2350 DD (base 50°F)
	2nd	14 days later			
	3rd	14 days later, if moths still detected in traps			
Oriental fruit moth, 1st generation	1st		75 DD (base 45°F)		175 DD (base 45°F)
	2nd	14 days later			
Oriental fruit moth, 2nd generation	1st		850-950 DD (base 45°F)		1,150 to 1,200 DD (base 45°F)
	2nd	14 days later			
Oriental fruit moth, 3rd generation*	1st		1800-1900 DD (base 45°F)		2,100 to 2,200 DD (base 45°F)
	2nd	14 days later			
Oriental fruit moth, 4th & 5th generations	1st & 2nd	Spray if there are more than 7 moths per trap per week.			

* note, 3rd generation of Oriental fruit moth is usually controlled by sprays directed at 2nd generation codling moth.

Part 8: How to use pheromone traps to monitor codling moth & Oriental fruit moth

1. Trapping season: for codling moth, trap from early bloom (mid-April) until harvest (mid-September); about 20-22 weeks. For Oriental fruit moth, trap from apple half-inch green (early April) until harvest (mid-September); about 22-24 weeks.

2. Number of traps: 3 traps per pest per orchard.

3. Trap supplies needed: Use delta traps (such as Trécé's 'Pherocon VI') plus 10-20 sticky bottom panels per trap OR use a bucket-style trap such as the 'MultiPher-1' made by Bio-Contrôle, plus 2 or 3 DDVP fumigant strips (such as Hercon Vaportape, 1 x 1/2 inch) per trap.

4. Lures needed every year: five standard pheromone lures (each lure lasts 4 weeks), or three long-life lures (each lure lasts 8 weeks). In orchards where pheromone mating disruption is being used, it is better to use a 'mega-lure' for codling moth, which is 10 times stronger than a standard lure. There is no mega lure available for Oriental fruit moth.

As a supplemental monitoring method for codling moth, a trap baited with the 'CM-DA' or 'combo' lure can be used; this contains the standard pheromone as well as an extract from pear fruit that attracts female as well as male codling moths. We do not have enough experience with the CM-DA lure to use it as a substitute for the standard lure. Moths caught in the CM-DA trap can be examined to determine the gender. The tip of the abdomen of the female has a hairy, copper-brown heart-shaped oviposition pad, while the male abdomen has a blunt, bullet shaped tip. A pair of claspers extend from the male abdomen when squeezed; these form a line where they fold together (photos from U. California).

5. Trap maintenance: Check traps at least twice per week, and more often during the critical time around petal-fall. Keep a record of the number of moths caught in each trap. Any moths caught in Oriental fruit moth traps should be examined under a magnifier to determine whether they are Oriental fruit moth or lesser appleworm; see pictures on page 2. For sticky traps, change the sticky panel once it becomes covered with debris, usually every week during peak flight or every 2-3 weeks during non-peak flight. The moths can be scraped off of the sticky panel as they are counted so that the panel can continue to be used. Change lures every 4 weeks for standard lures or every 8 weeks for long-life lures.

6. Expected trends in trapping:

- the *first* codling moth is usually caught at petal-fall, which is usually in the first week of May in central Ohio, but it can be any time between late April and late May. In northern Ohio it is a few days later, and in southern Ohio it is a few days earlier.
- *peak* catch of codling moth from the overwintering generation is about 2 weeks after full bloom. In central Ohio, peak catch is any time from mid-May to mid-June, but usually around the first week of June. In years with average temperatures, the peak catch of the 2nd flight is in early August.
- the first Oriental fruit moth is usually caught at the time of peach bloom, which is at about the early pink bud stage on apples. The first Oriental fruit moth is usually caught about 2 weeks before the first codling moth.

7. Sources of traps and lures:

- Great Lakes IPM, Inc.: 10220 Church Road NE, Vestaburg MI 48891; phone (989) 268-5693 or (800) 235-0285; fax (989) 268-5311; internet: www.greatlakesipm.com
- Gempler's: P.O. Box 44993, Madison WI 53744; phone 800-382-8473; fax 800-551-1128; internet: www.gemplers.com
- GreenStar Cooperative, Inc. (formerly Salem Fruit Growers Cooperative Association): 12093 Lisbon Rd., P.O. Box 3, Greenford OH 44422; phone 330-533-3328, 800-423-3609; fax 330-533-0736; internet: www.greenstarcoop.net

Daily degree days for codling moth at various daily min and max temperatures
(lower threshold 50F, upper threshold 88F)

MIN >	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
MAX v																												
48	0																											
49	0	0																										
50	0	0	0																									
51	1	1	1	1																								
52	1	1	1	2	2																							
53	2	2	2	2	3	3																						
54	2	2	2	3	3	4	4																					
55	3	3	3	3	4	4	5	5																				
56	3	3	3	4	4	5	5	6	6																			
57	4	4	4	4	5	5	6	6	7	7																		
58	4	4	4	5	5	6	6	7	7	8	8																	
59	5	5	5	5	6	6	7	7	8	8	9	9																
60	5	5	5	6	6	7	7	8	8	9	9	10	10															
61	6	6	6	6	7	7	8	8	9	9	10	10	11	11														
62	6	6	6	7	7	8	8	9	9	10	10	11	11	12	12													
63	7	7	7	7	8	8	9	9	10	10	11	11	12	12	13	13												
64	7	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14											
65	8	8	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15										
66	8	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16									
67	9	9	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17								
68	9	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18							
69	10	10	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19						
70	10	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20					
71	11	11	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21				
72	11	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22			
73	12	12	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23		
74	12	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	
75	13	13	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25
76	13	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26
77	14	14	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26
78	14	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27
79	15	15	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27
80	15	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28
81	16	16	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28
82	16	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29
83	17	17	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29
84	17	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30
85	18	18	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30
86	18	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31
87	19	19	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31
88	19	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32
89	19	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32
90	19	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32
91	19	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32
92	19	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32
93	19	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32
94	19	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32
95	19	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32

Daily degree days for Oriental fruit moth at various daily min and max temperatures
(lower threshold 45F, upper threshold 90F)

MIN >	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
MAX v																												
43	0																											
44	0	0																										
45	0	0	0																									
46	1	1	1	1																								
47	1	1	1	2	2																							
48	2	2	2	2	3	3																						
49	2	2	2	3	3	4	4																					
50	3	3	3	3	4	4	5	5																				
51	3	3	3	4	4	5	5	6	6																			
52	4	4	4	4	5	5	6	6	7	7																		
53	4	4	4	5	5	6	6	7	7	8	8																	
54	5	5	5	5	6	6	7	7	8	8	9	9																
55	5	5	5	6	6	7	7	8	8	9	9	10	10															
56	6	6	6	6	7	7	8	8	9	9	10	10	11	11														
57	6	6	6	7	7	8	8	9	9	10	10	11	11	12	12													
58	7	7	7	7	8	8	9	9	10	10	11	11	12	12	13	13												
59	7	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14											
60	8	8	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15										
61	8	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16									
62	9	9	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17								
63	9	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18							
64	10	10	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19						
65	10	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20					
66	11	11	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21				
67	11	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22			
68	12	12	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23		
69	12	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	
70	13	13	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25
71	13	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26
72	14	14	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26
73	14	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27
74	15	15	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27
75	15	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28
76	16	16	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28
77	16	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29
78	17	17	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29
79	17	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30
80	18	18	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30
81	18	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31
82	19	19	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31
83	19	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32
84	20	20	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32
85	20	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33
86	21	21	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33
87	21	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	34
88	22	22	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	34	34
89	22	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	34	34	35
90	23	23	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	33	34	34	35
91	23	23	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	33	34	34	35
92	23	23	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	33	34	34	35
93	23	23	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	33	34	34	35
94	23	23	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	33	34	34	35
95	23	23	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	33	34	34	35