Eco-Friendly IPM Approaches for Codling Moth Management

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Today's Topics:

- CM biology
- CM monitoring using lures and camera trap
- Biofix and Degree Days for Codling Moth
- Attract-and-Kill system for Codling Moth control
- Bio-control: Residual effect of *Bacillus thuringiensis* var. *kurstaki* (*B. t.)* against Codling Moth larvae

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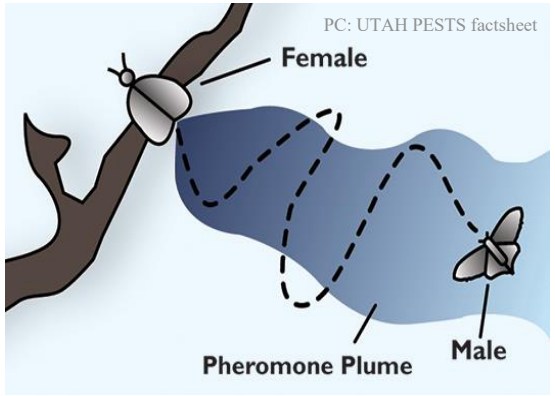
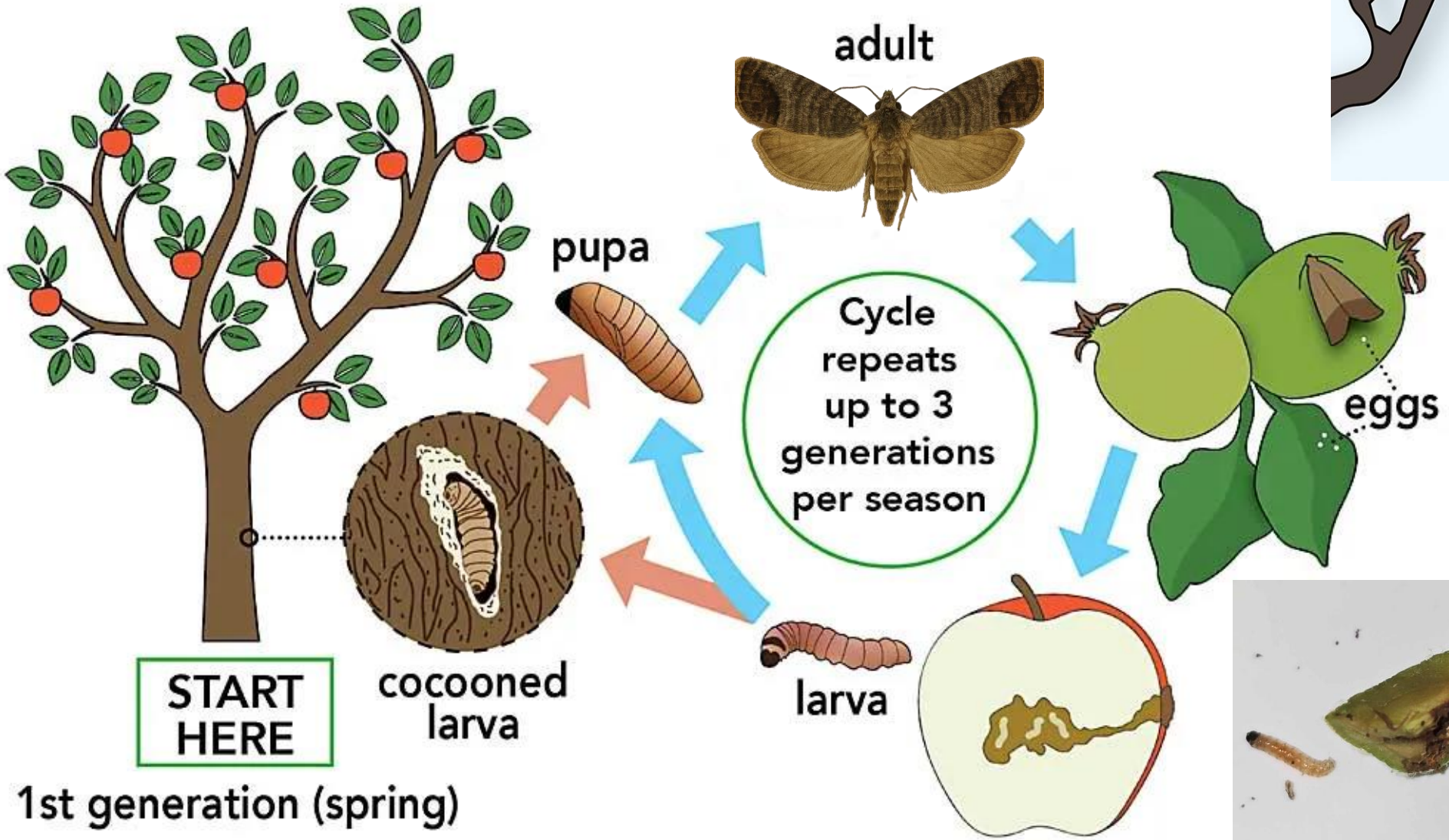
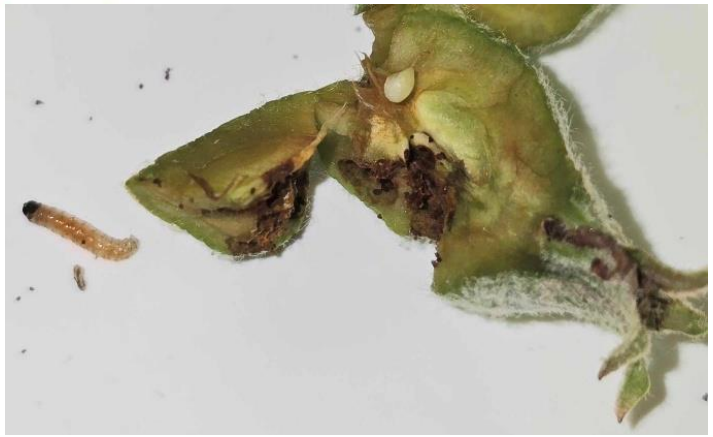
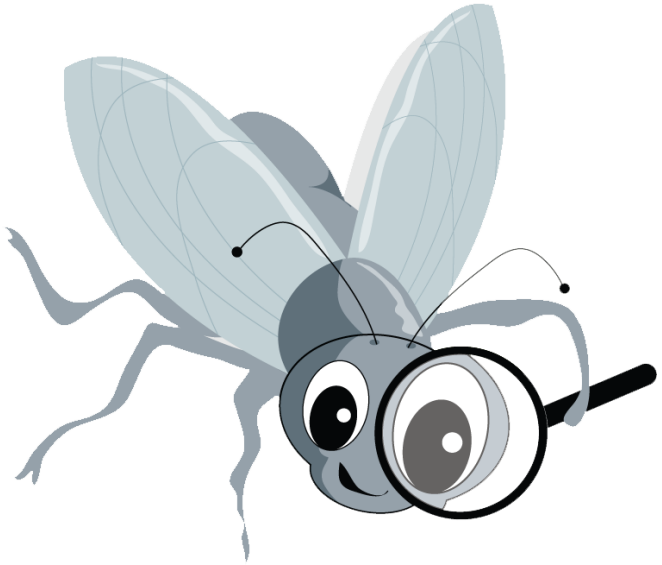
Codling Moth Biology







PC: Rebecca Richter, Monatana State University

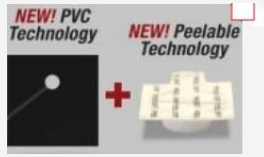


Monitoring for Codling Moths

Why monitoring?

- Detects infestations early for timely intervention.
- Promotes the use of targeted pest control methods.
- Reduce the need for broad-spectrum pesticides.

Monitoring tools for CM

Trade name	Attractant type	Lure replacement	Notes	Pictures
Trécé Pherocon CM Standard 1X	Male only	4 weeks	Red rubber septa for standard monitoring	
Trécé Pherocon CM Standard 10X	Male only	2-3 weeks	10X higher dose than standard for use in mating disrupted orchard	
Trécé Pherocon CM L2	Male only	8 weeks	Gray halo butyl rubber. L2 stands for long lasting. Can be loaded with higher rate of pheromone.	
Trécé Pherocon CM L2-P	Male only	12 weeks	Pheromone loaded in PVC material. L2 stands for long lasting, and P stands for PVC.	
Trécé Pherocon CMDA Combo-P	Male and Female.	12 weeks	The DA in CMDA is pear ester (a plant volatile/kairomone). The combo is Acetic acid (AA).	
Trécé Pherocon CMDA Combo-S	Male and Female.	8 weeks	The DA in CMDA is pear ester (a plant volatile/kairomone). The combo is Acetic acid (AA). S stands for Rubber Septa.	
Trécé Pherocon Megalure CM Dual 4K	Male and Female.	8 weeks	4K stands for 4 different Kairomones. Studies carried out in Massachusetts also showed its attraction to both sex of OFM.	
Scentry CM Lure	Male only	4-6 weeks	Red rubber septa for standard monitoring	

Delta traps

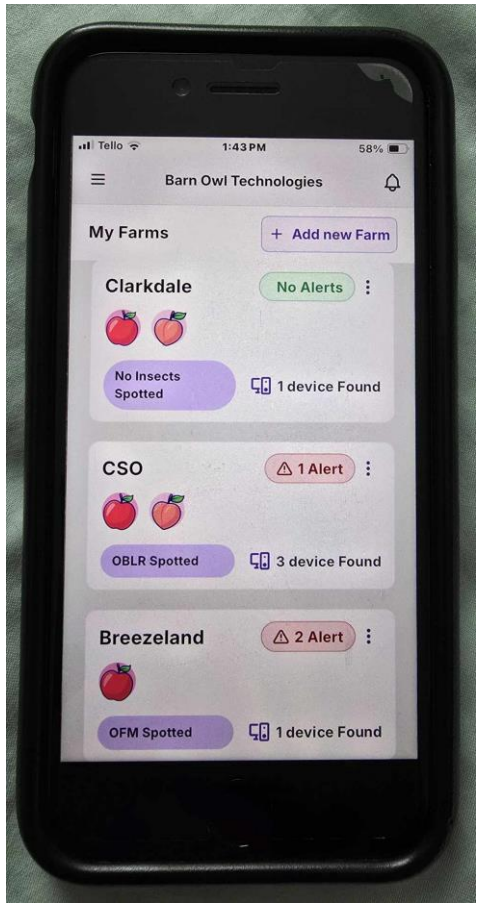
Wing traps

Bucket trap

Monitoring Codling Moth through camera trap

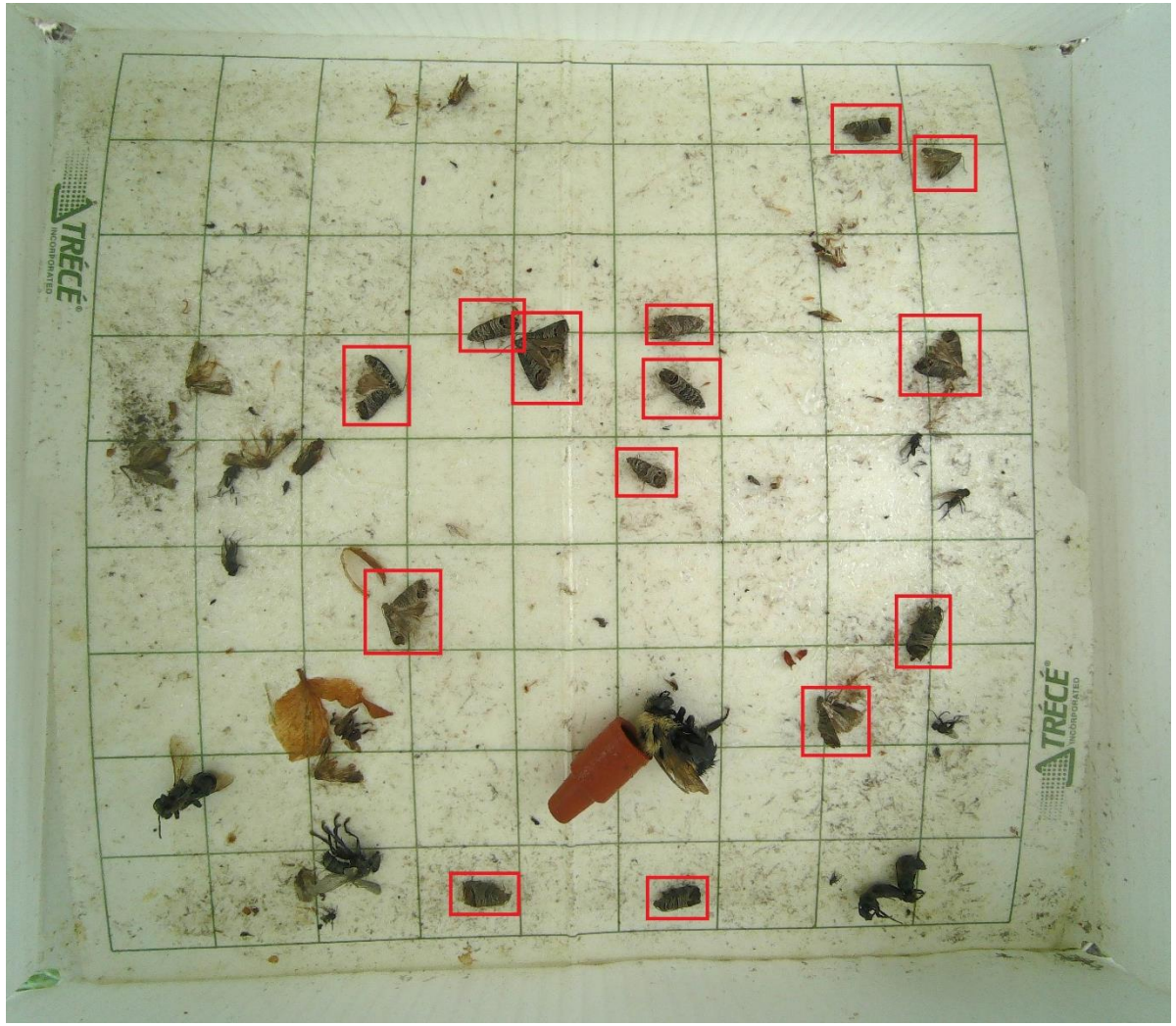
Camera trap

- Developed by **Barn Owl Technologies**
- Trapezoid shaped trap
- Camera mounted on top
- Rechargeable battery, lasts 12 weeks
- Sticky liner housed inside the trap



Mobile app: FarmBugReport

- Beta version
- Only for iOS as of now
- Uploads 3 HD pictures a day



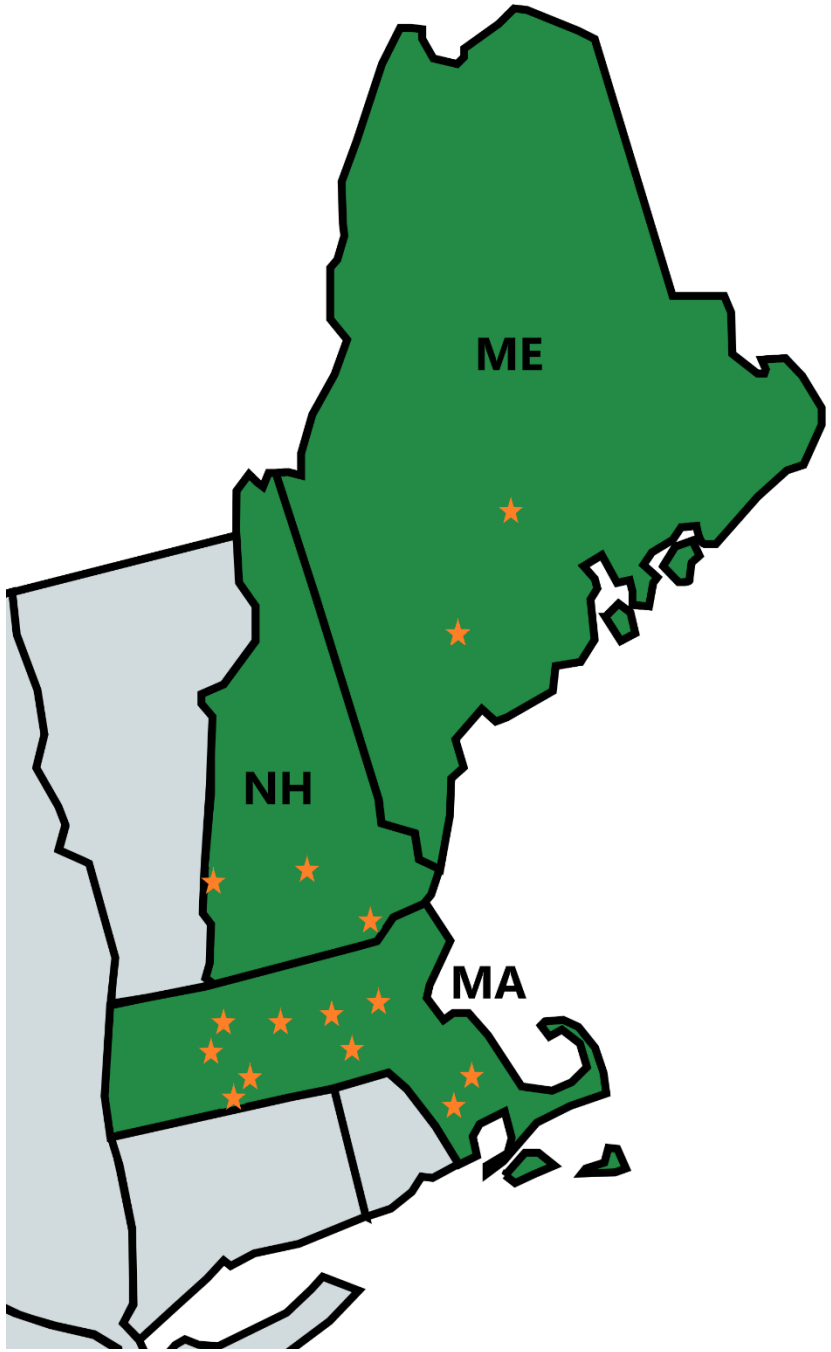
Uploaded picture

- Currently, identification is performed manually
- Automated identification is under development, incorporating custom-designed graphs

Advantage of monitoring with camera trap

- Remote monitoring
- Accurate daily capture records
- Temporal activity insights
- Precision in **Biofix** establishment

15 locations across 3 states



Biofix and Degree Days for Codling Moth

Biofix:

The time when pest development tracking begins, often marked by first consistent moth capture in traps or reaching a temperature threshold.

Why it matters:

Establishing biofix helps synchronize pest monitoring with the biological development of the insect, making it easier to predict subsequent life stages (like egg-laying or larval emergence).

What is the Degree Days Model?

Degree Days (DD) measure the accumulation of heat units above a base temperature. (50°F for codling moths).

Insects like codling moths develop faster as temperatures increase.

The formula: Degree Days = ((Max temp + Min temp) / 2) - Base temp

For example:

On May 13 max temp is 75 °F and Minimum is 45 °F, then

DD accumulation for May 15 = ((75+45)/2) – 50

= 60 – 50

= 10.

Therefore, on May 13, 10 DD is accumulated.

First CM capture (Biofix)

Date	Daily DD	DD accumulation
May 12	0	0
May 13	10	10
May 14	12	22
May 15	11	33

Application in Codling Moth Management:

- By knowing the **biofix** and tracking **degree day accumulation**, growers can forecast the best times for monitoring and intervention.
- For example:
  - At around **100 DD** after biofix, most codling moth eggs start to hatch.
  - At around **200** - **250 DD**, larval activity peaks, which may be the ideal time for targeted insecticide applications to control larvae before they enter the fruit.

This combination allows for more precise pest management, reducing the need for unnecessary chemical applications and improving crop protection efficiency.

NEWA | Network for Environment and Weather Applications

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Get started by selecting your nearest weather station.

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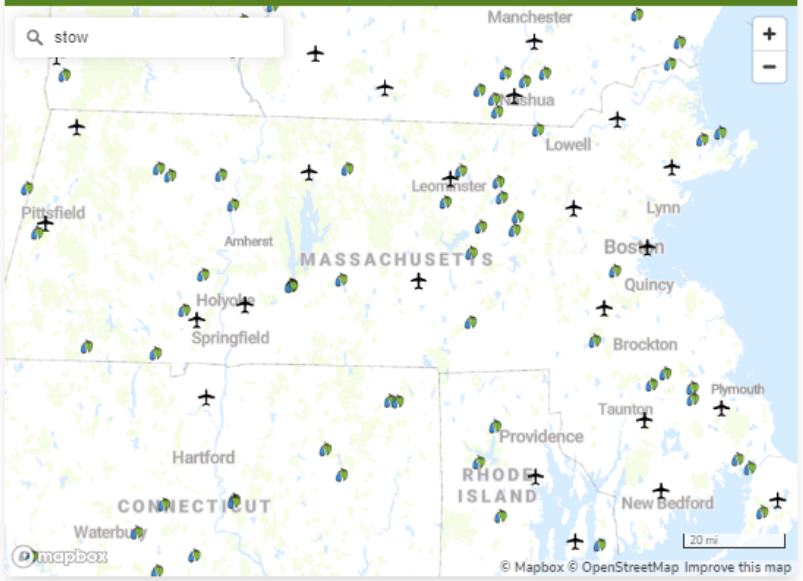
Stow, MA

Click or tap on a station marker to load its overview



Stow Overview

Courtesy of NEWA in Massachusetts

At 11:00 AM today

74 °F

Base 50°F Degree Days since January 1	2578
Relative Humidity	53 %
Dew Point	55.6 °F
Wind Speed	0.4 mph

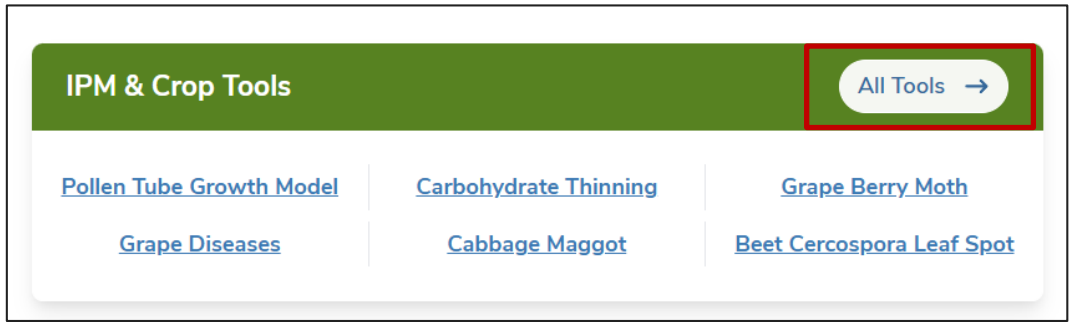
Yesterday

Precipitation: 0.01 in | High Temp: 80 °F | Low Temp: 52 °F

Today as of 11:00 AM

Precipitation: 0 in | High Temp: 74 °F | Low Temp: 47°F

5-Day Weather Forecast



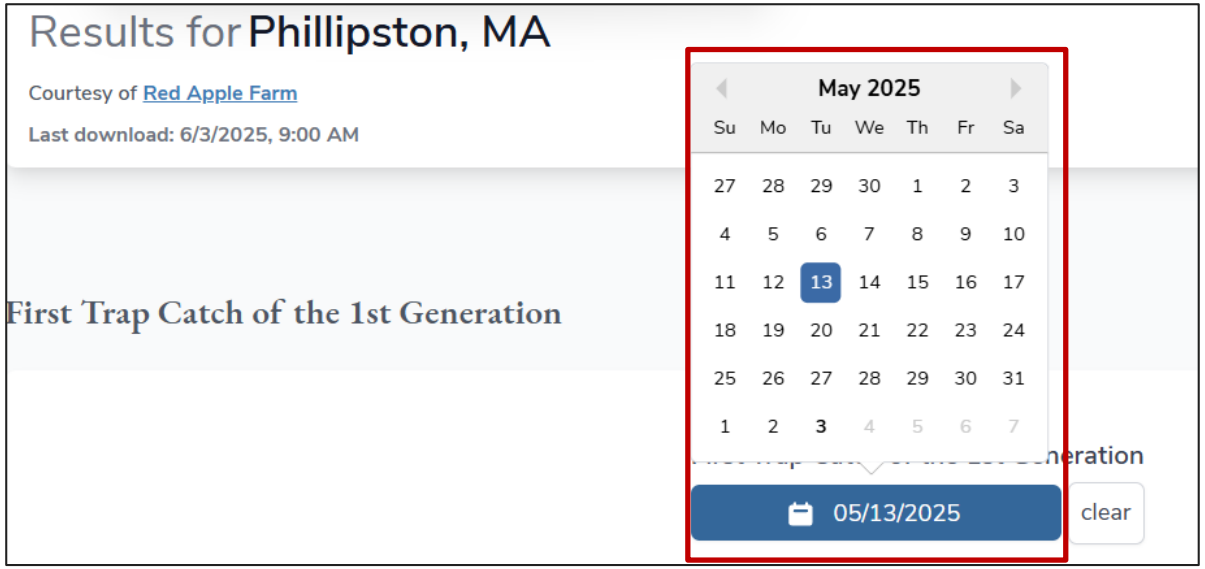
Apple Insect Pests

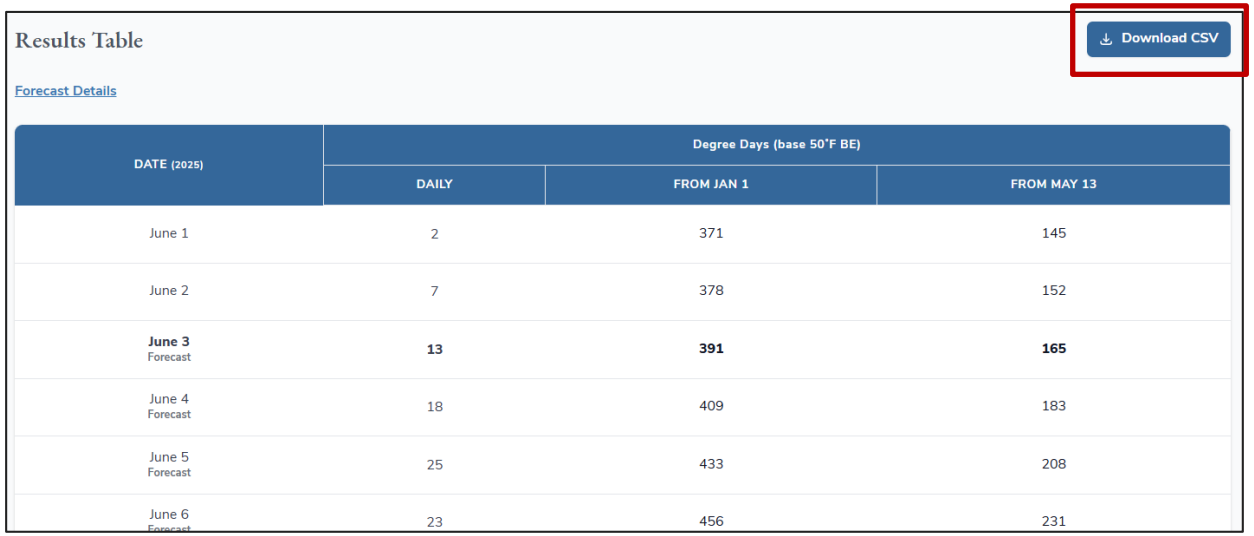
Apple Maggot. This degree day model tracks base 50° F BE degree days to time red sphere trap deployment to manage apple maggot (*Rhagoletis pomonella*).

Codling Moth. This tool predicts codling moth (*Cydia pomonella*) life stages with base 50° F BE degree days to identify treatment windows with management guidelines.

Obliquebanded Leafroller. Using base 43° F BE degree days, this tool delineates obliquebanded leafroller (*Choristoneura rosaceana*) development, sampling strategies, and management guidelines.

Oriental Fruit Moth. This degree day tool (base 45° F BE) tracks oriental fruit moth (*Grapholita molesta*) development across three generations, identifies treatment windows, and provides management information.





DATE (2025)	Degree Days (base 50°F BE)		
	DAILY	FROM JAN 1	FROM MAY 13
June 1	2	371	145
June 2	7	378	152
June 3 Forecast	**13**	**391**	**165**
June 4 Forecast	18	409	183
June 5 Forecast	25	433	208
June 6 Forecast	23	456	231

Biofix

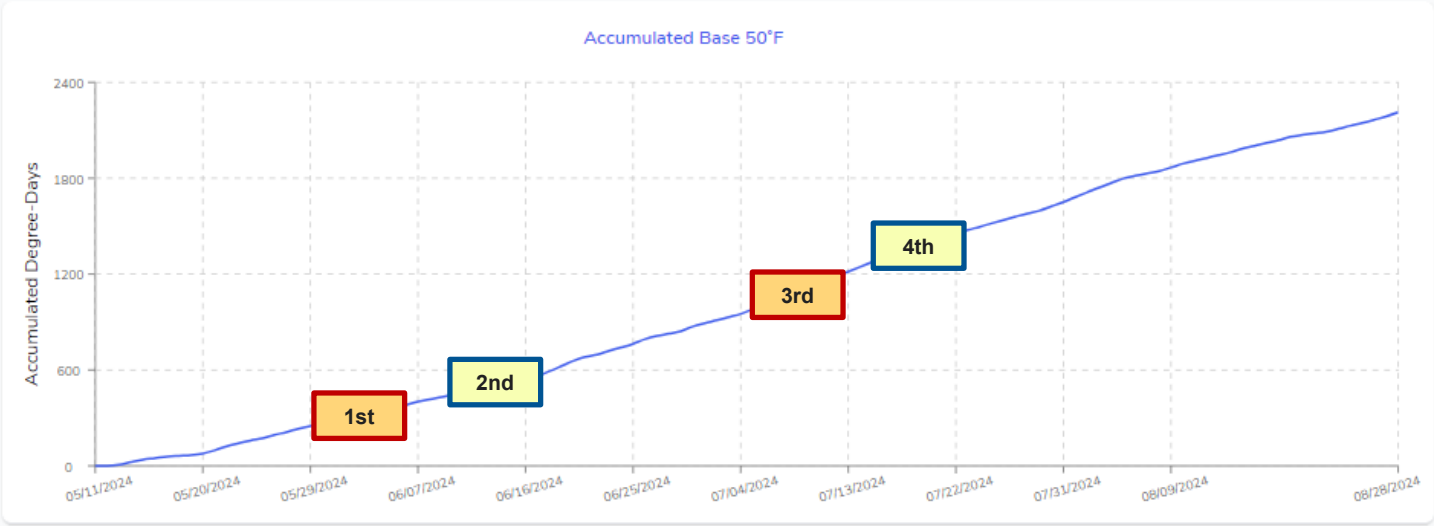
Forecast Details

DATE	DAILY	FROM MAY 11
May 11	0	0
May 12	0	0
May 13	7	7
May 14	17	24
May 15	15	39
May 16	9	48
May 17	10	58
May 18	5	63

Degree days accumulation

Accumulated Degree Days

Download PNG



1st spray: 200-250 DD targeting 1st CM generation

2nd protective spray (500-600 DD or 10-14 days after 1st spray), only if CM pressure is severe

3rd spray: 1000-1260 DD targeting 2nd CM generation

4th protective spray 10-14 days after 3rd spray, only if CM pressure is severe

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Key events in CM life cycles estimated by use of Biofix and subsequently accumulated degree days. These estimates are adapted from Michigan State University and Cornel University

Event	Approximate Degree Days Required following Biofix	Spray timing
Biofix (1st sustained capture of moths in pheromone traps)	On this date we start accumulating DD base 50°F	……
Egg hatch begins (calculated after Biofix has been established)	• 100 (against eggs) • 220-250 (against larvae)	1st spray (after the petal fall)
Peak period of 1st generation egg hatch/critical control period	500-600	Timing for 2nd spray (against larvae) if monitoring indicates a treatment is needed. An 'easier' recommendation: in high-pressure blocks, 2nd spray goes 10-14 days after 1st spray
End of first-generation egg hatch	Approx. 920	……..
First egg hatch, 2nd generation	1000-1260	3rd spray (4th spray after 10-14 days only if CM pressure is severe)
Peak period of 2nd generation egg hatch/critical control period	1320-1720	……
End of 2nd generation egg hatch	2100	……..

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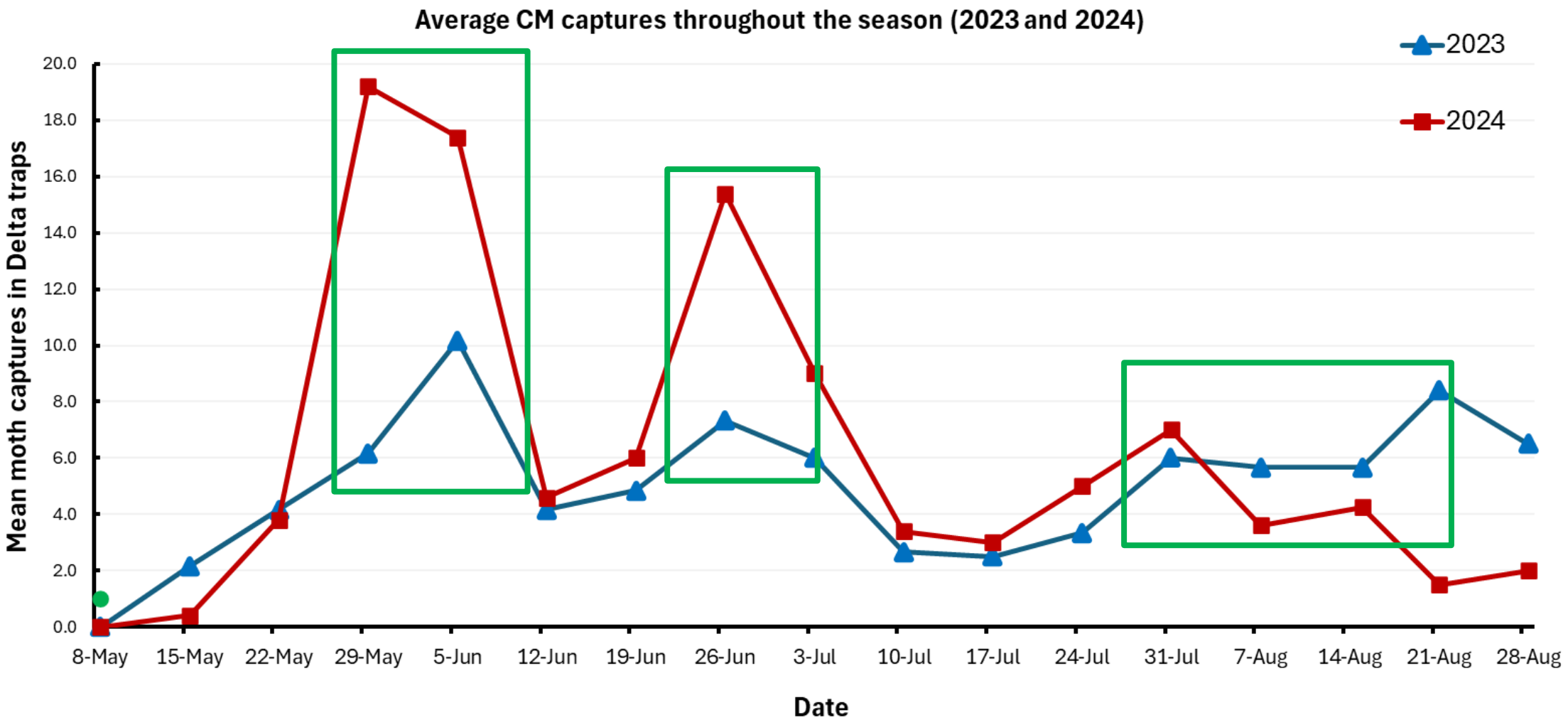
Codling Moth population dynamics in Massachusetts orchards



Codling Moth population dynamics in New England orchards (2025)

Data from Camera trap

Location	13-May	14-May	15-May	16-May	17-May	18-May	19-May	to	25-May	26-May	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	Total	DD June 2	DD June 7
Amherst, MA	1	0	2	5	2	1	0	..	0	0	0	0	0	0	0	0	0	11	180	282
Easthampton, MA	0	0	3	1	1	1	0	..	0	0	0	1	0	2	3	0	0	12	169	273
Belchertown, MA	0	0	0	0	0	0	0	..	0	1	1	2	0	1	0	0	0	5	75	171
Warren, MA	0	0	0	0	0	0	1	0	0	0	1	1	2	0	1	0	0	6	NA	NA
Phillipston, MA	1	1	1	1	8	1	0	..	0	0	1	4	2	7	2	0	0	29	152	241
Leominister, MA	0	0	0	2	0	0	0	..	0	0	0	2	0	5	2	0	0	11	139	243
Stow, MA	0	0	1	0	1	1	0	..	0	0	0	0	0	0	0	0	0	3	174	279
Northborough, MA	0	0	0	0	0	0	0	..	0	0	0	0	0	0	0	0	0	0	NA	NA
Hollis, NH	2	0	1	1	3	4	0	..	0	0	4	10	0	1	5	0	0	31	195	298
Concord, NH	0	0	0	0	0	0	0	..	0	0	0	0	0	0	0	0	0	0	NA	NA
Lebanon, NH	0	0	0	1	0	0	0	..	0	0	0	0	2	0	1	0	0	4	139	231

First capture
Following captures
No captures

- Most of the orchard are in the range **220 to 250 DD** later this week for 1st spray against CM larvae.
- 2nd spray might be needed around **500 to 600 DD**, if your orchard has the high CM pressure later after a cold period from May 19 to May 26.

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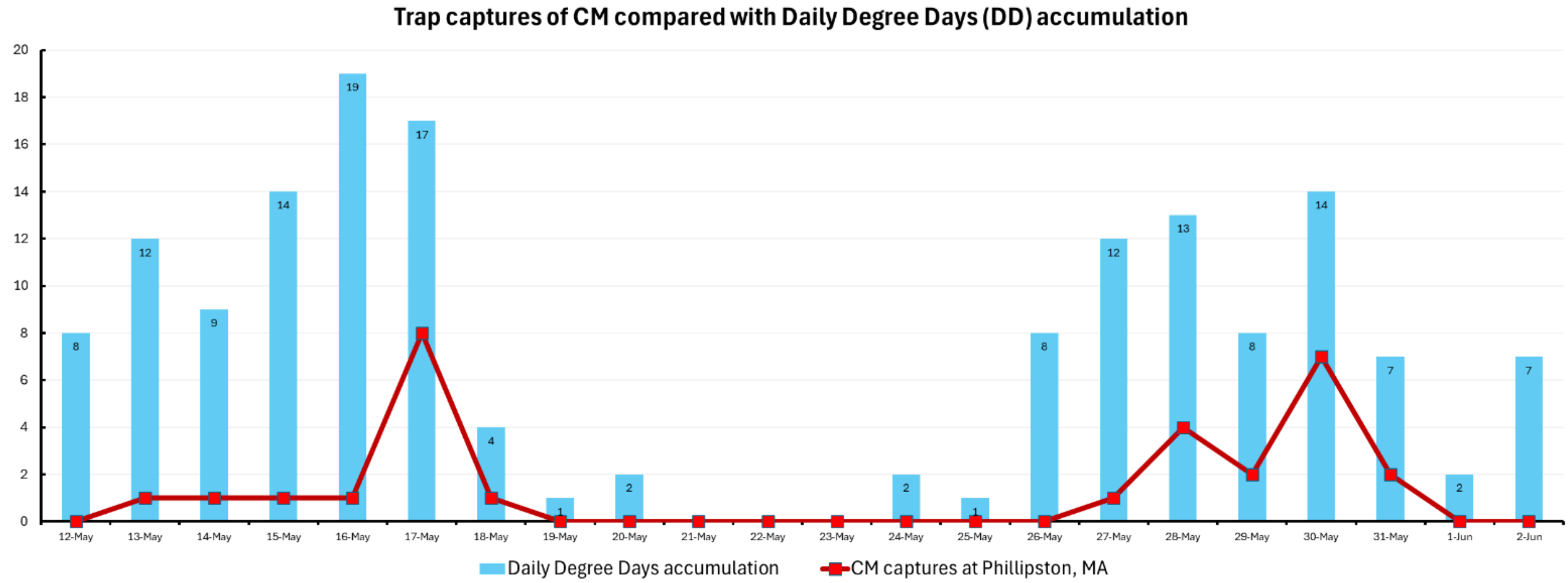
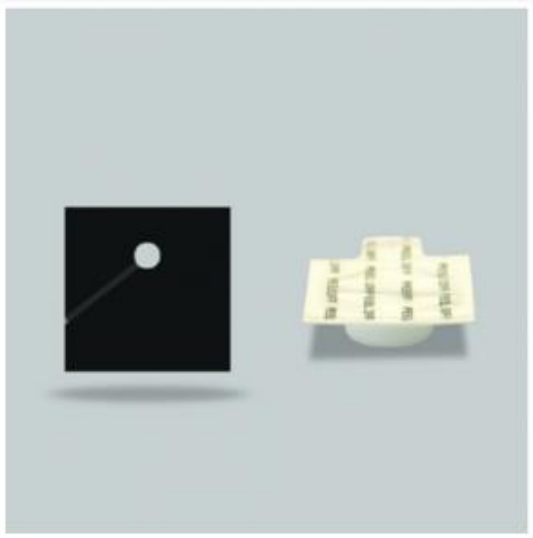
Data from Camera trap



Attract-and-Kill system for Codling Moth control

Objective

To evaluate the efficacy of an attract-and-kill strategy involving **lures** as an attract component and the **biopesticide** Dipel (*B.t*) as the kill component to manage codling moth in apple orchards.



TRÉCÉ PHEROCON MEGALURE CM DUAL 4K, 3/CS

GL/TR-5115-03

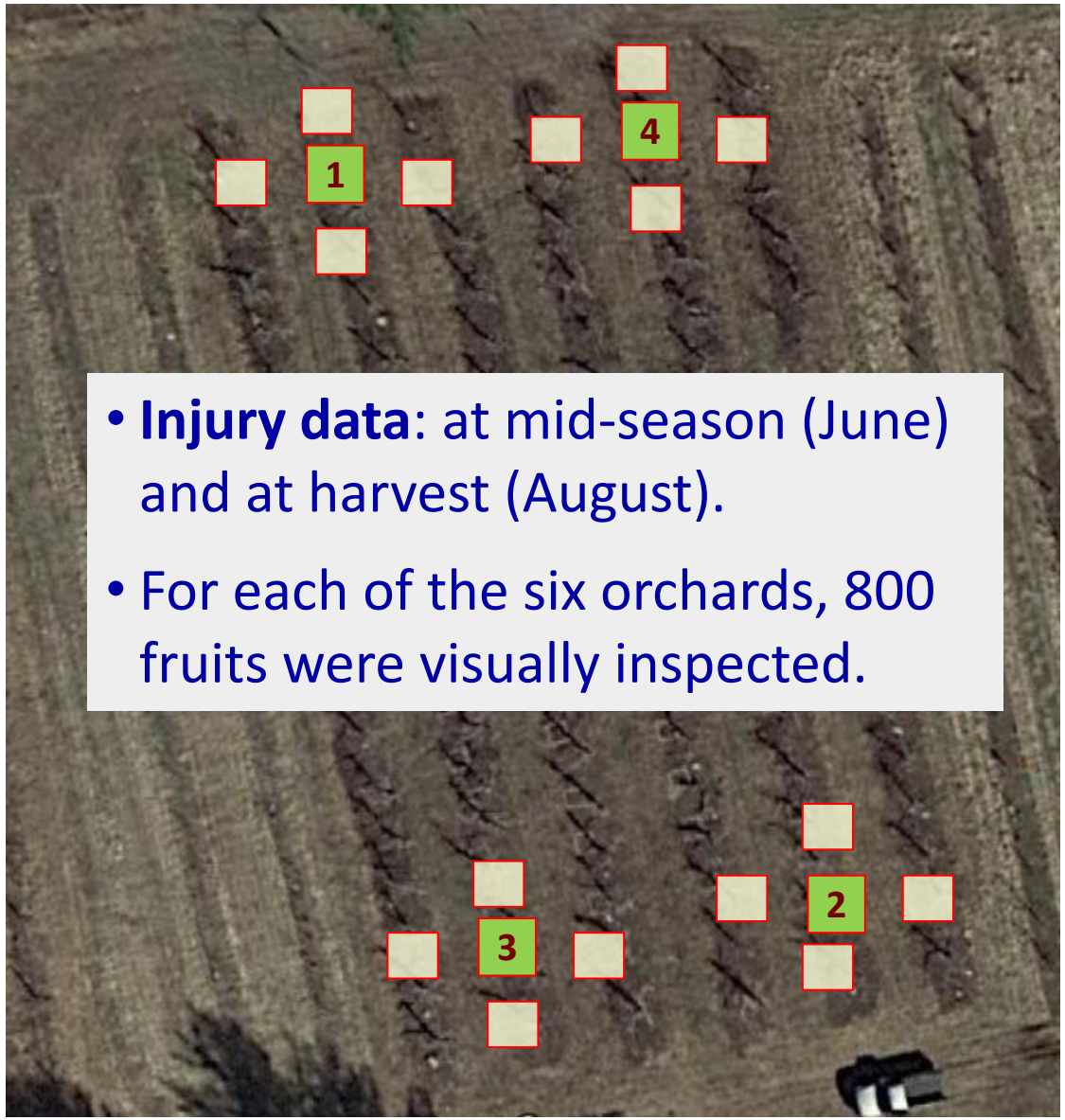
A PVC and cup lure with insect pheromones used for monitoring. Any unused lures may be stored in the freezer for the following season.

Orchards and treatments

Study sites: 6 apple orchards (3 organic and 3 conventional)

Lures were deployed in early May 2022

1. **Megalure and B.t.**
2. **Megalure and no B.t.**
3. **No Megalure and B.t.**
4. **No Megalure and no B.t.**



- **Injury data**: at mid-season (June) and at harvest (August).
- For each of the six orchards, 800 fruits were visually inspected.

The experimental trees and four adjacent trees (□) were inspected for codling moth injury (potential spillover effect)

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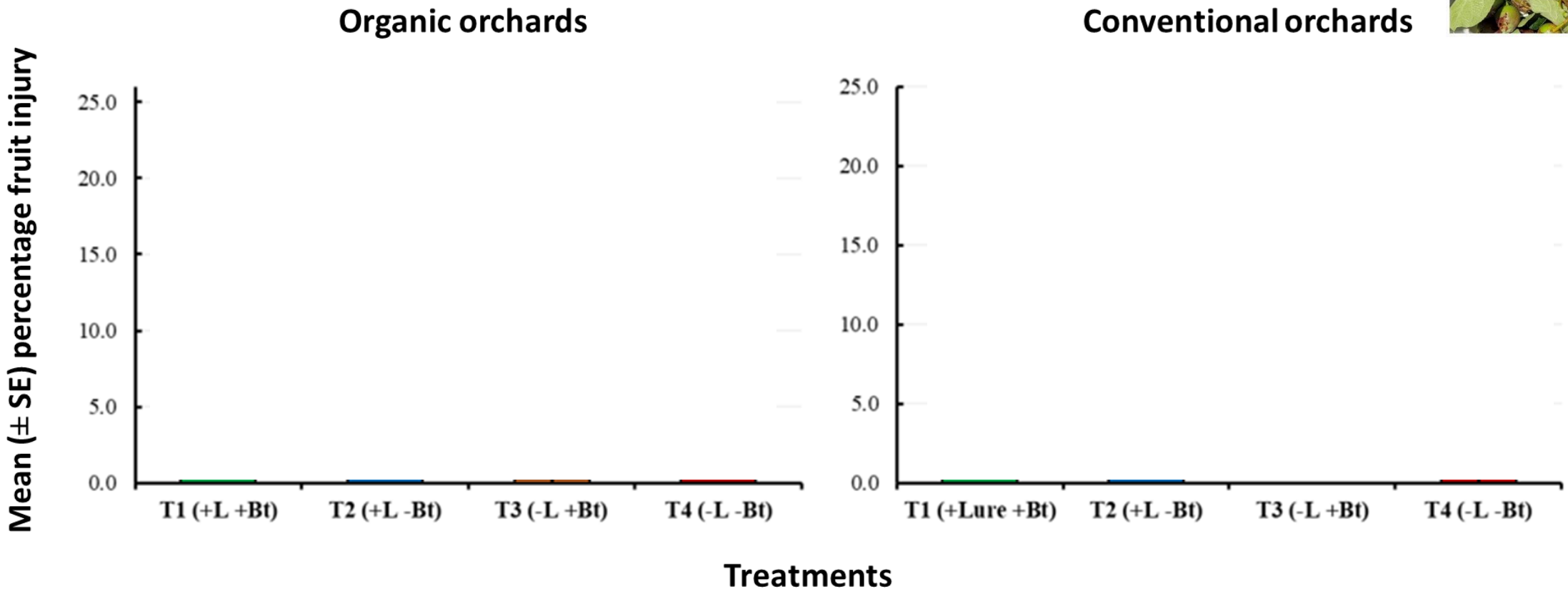
B.t. applications

Based on **degree-day model** that is based on heat accumulation, to predict when CM eggs will hatch for each generation

Table 1: Biofix date and *B.t* sprays timing based on degree days model.

Biofix date	First generation sprays	Second generation sprays
May 20, 2022	June 1-3 (228-266 DD)	August 8-10 (1568-1621 DD)

Results: Mid-season (6.23.22) fruit injury on trap trees



Mean percentage injury on fruits by codling moth larvae sampled at mid-season.

Means in same bar graph followed by the same letter do not differ significantly at odds 19:1.

Results: Fruit injury on trap trees at harvest (late August 2022)

Treatments	Organic orchards	Conventional orchards
T1 (+L +Bt)	1.7 a	0.0 a
T2 (+L -Bt)	9.0 a	1.3 a
T3 (-L +Bt)	0.3 a	0.0 a
T4 (-L -Bt)	0.3 a	0.7 a

Conclusion

Trap trees baited with Megalure attract codling moths to the trap tree and they be killed by applying *Bacillus thuringiensis* (= Dipel).

Residual effect of *Bacillus thuringiensis* var. *kurstaki* (*B. t.)* against Codling Moth larvae

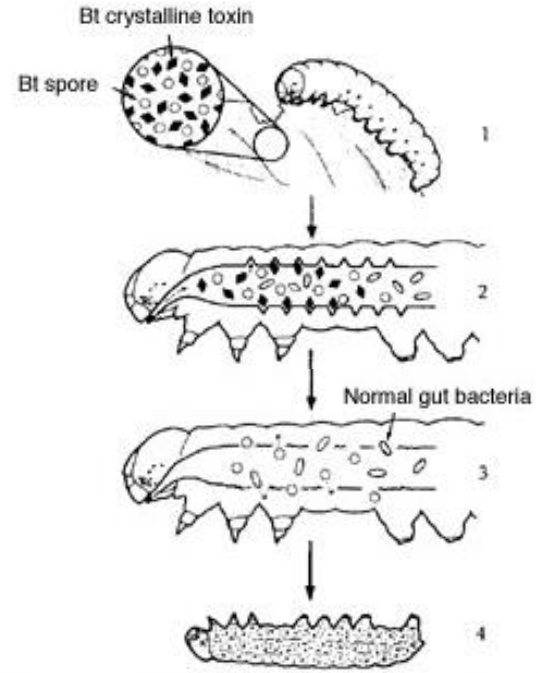
How does the *B.t.* kills codling moth larva?

1. Ingestion: The insect must ingest the *B.t.* bacteria to be affected.

2. Paralysis: The toxins paralyze the gut wall cells, allowing the gut contents to enter the insect's body cavity.

3. Starvation: The insect stops feeding within minutes.

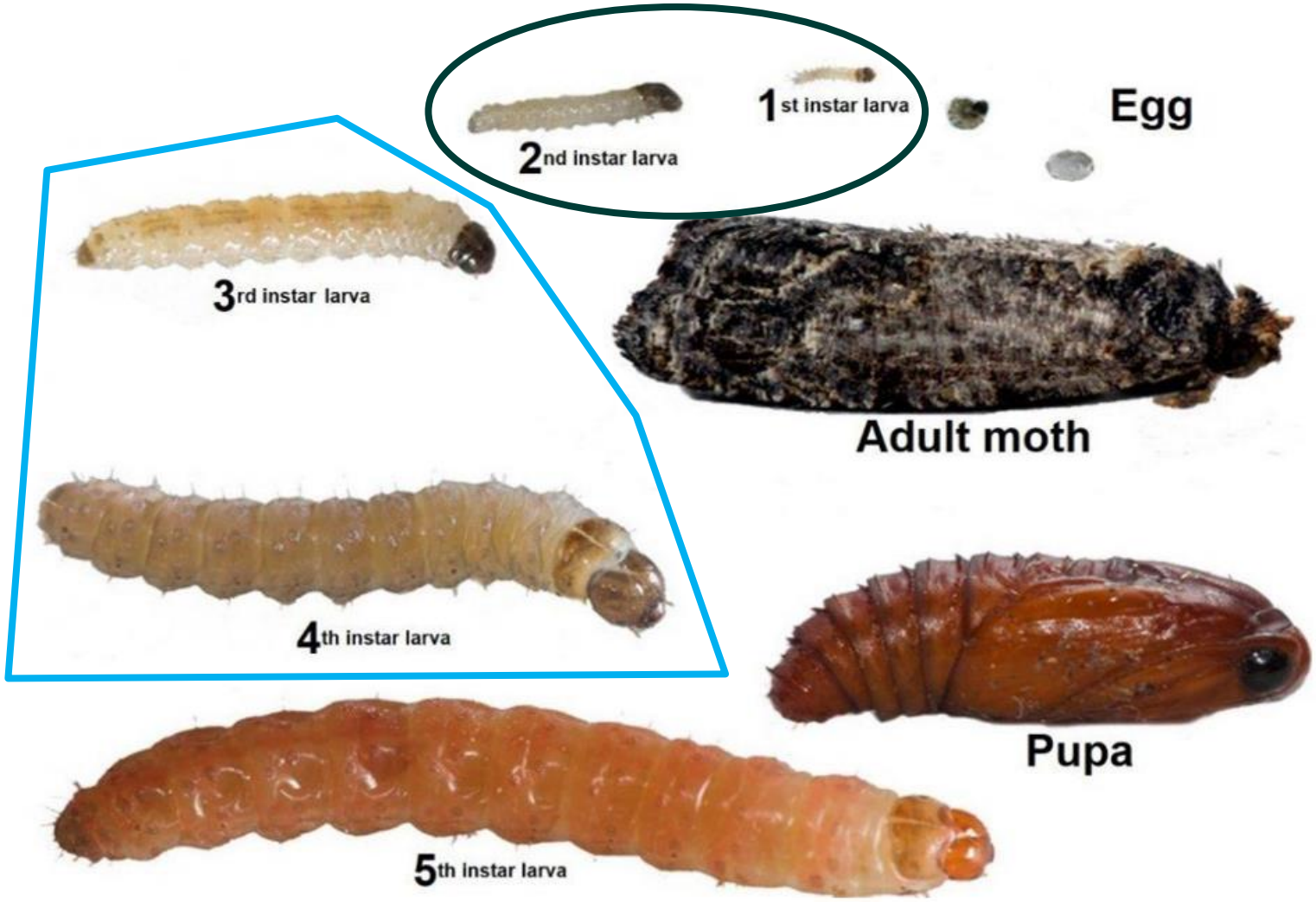
4. Death: Larva dies from starvation in about 2 to 5 days.



Larval instar group:

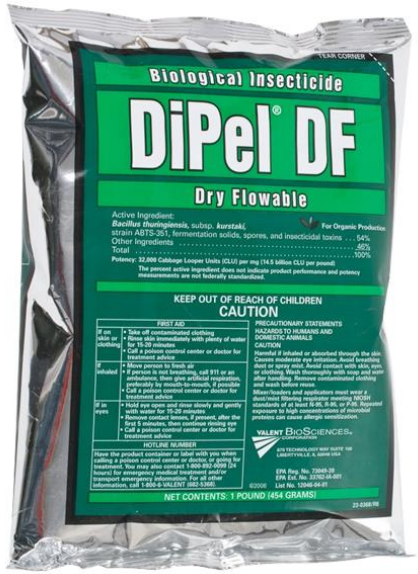
- 1-2 instars (4-10mm)
- 3-4 instars (11-16mm)

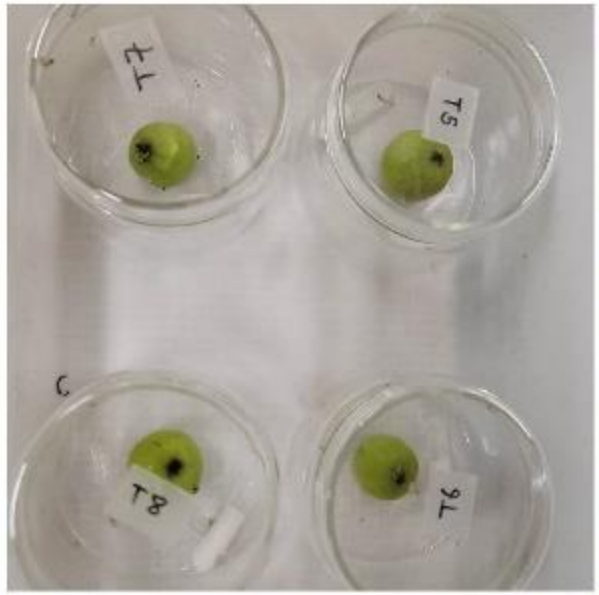
Immature apple (≈ 2 cm diameter)



Codling moth life cycle (PC: Andermatt madumbi)

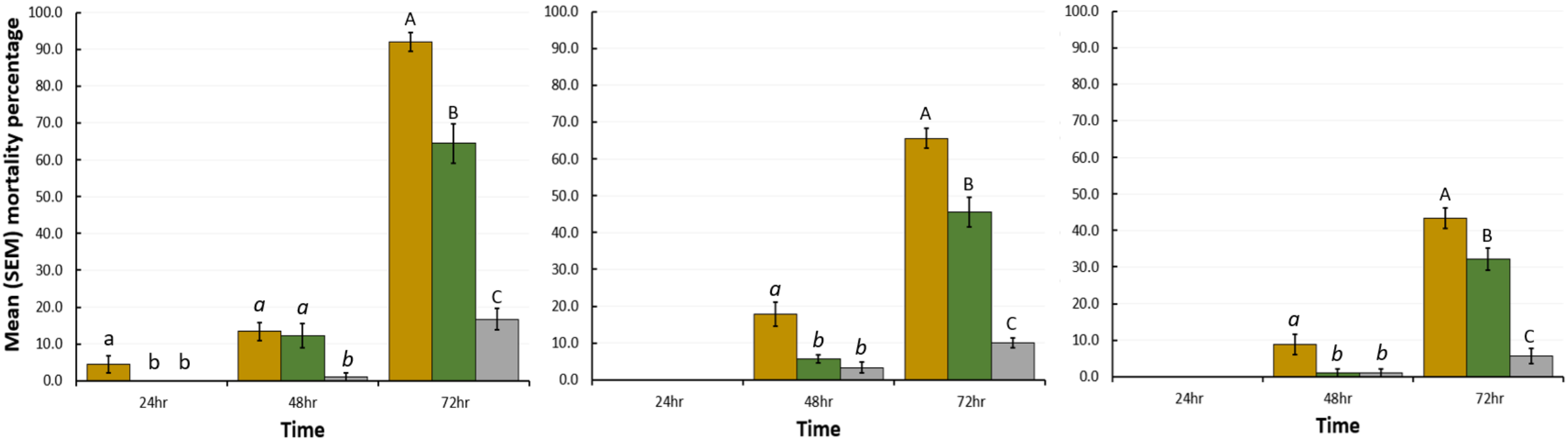
- *B.t.* dose (2.38 g/L)





- For each treatment, 10 CM larvae were exposed to *B.t.* treated apples 1, 3, and 7 days after *B.t.* application.

- Mortality data were taken at 24 hrs., 48 hrs., and 72 hrs. after exposure.

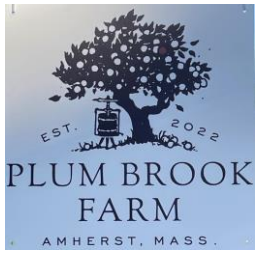


Mean percentage CM larval mortality at 24 hr, 48 hr, and 72 hr after exposure to B.t. treated apples. The same letter above the bar do not differ significantly according to Fisher LSD tests, $P<0.05$.

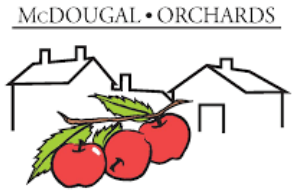
Conclusion

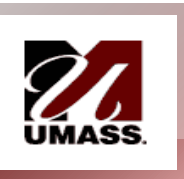
- *Bacillus thuringiensis* effectively kills up to 90% of early-instar codling moth larvae within 3 days
- Dipel is more effective at killing early-instar larvae compared to late-instar larvae.

Acknowledgements



NICEWICZ FAMILY FARM





THANK YOU!