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THE STATE UNIVERSITY OF NEW JERSEY

What's In An Insect Model and How To Use One In NEWA

Optimizing and Reducing Insecticide Use

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- Insect have different stages of development.
- Insects are cold blooded.
- Insect development is dependent on temperature.
- Temperature accumulation measured in (DD).
- Insects have developmental thresholds (T).
  - Lower T at which they don't develop.
  - Upper T at which they don't develop.
- Different stages take different times to develop.
- Different insecticides work best on different insect life stages.
- Biofix times are used to start most models.
- Insecticides are expensive – so target them.

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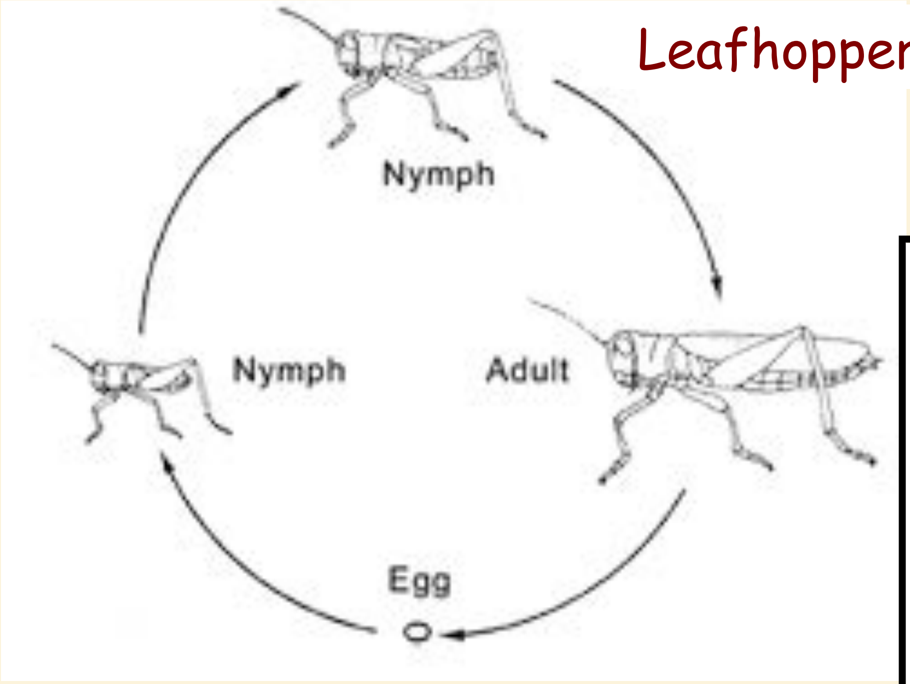
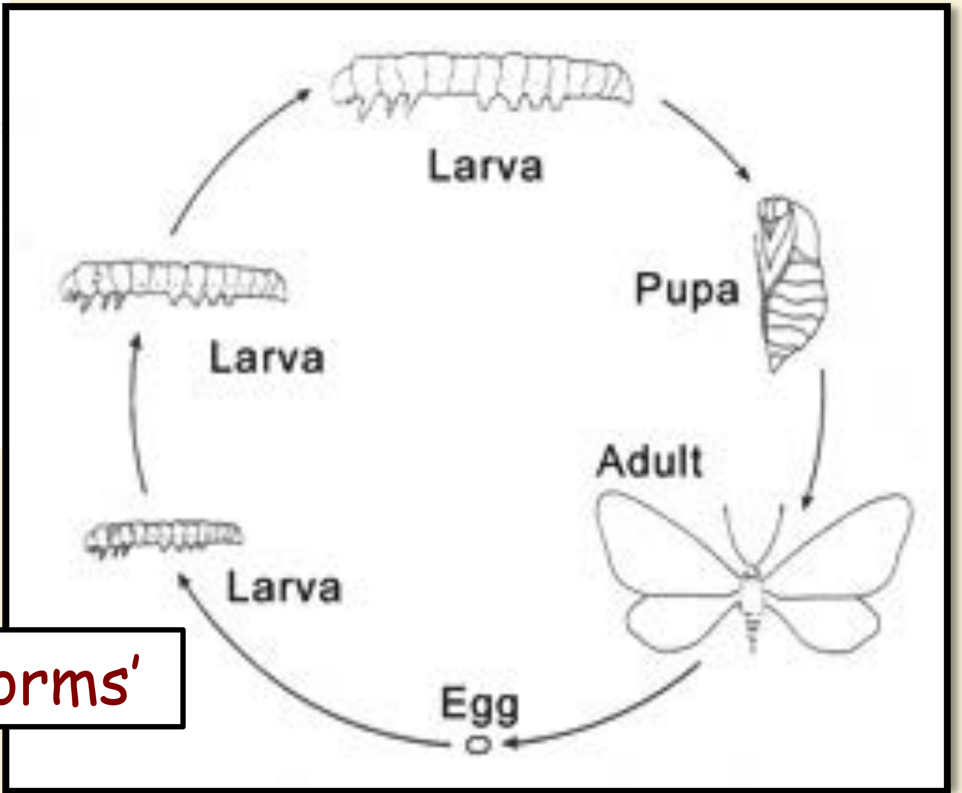
Life Stages
Incomplete vs. Complete Metamorphosis

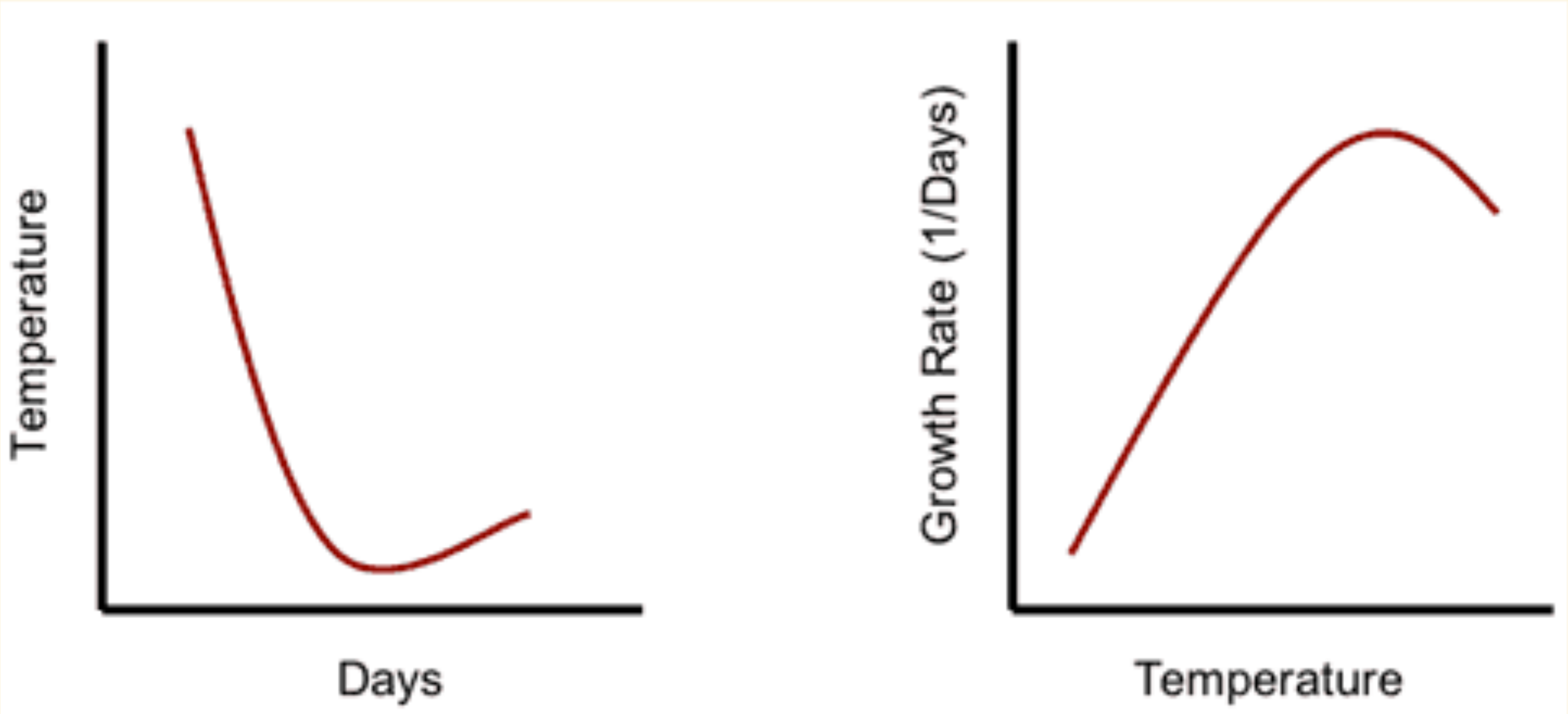


Leafhoppers, plant bugs, stink bugs

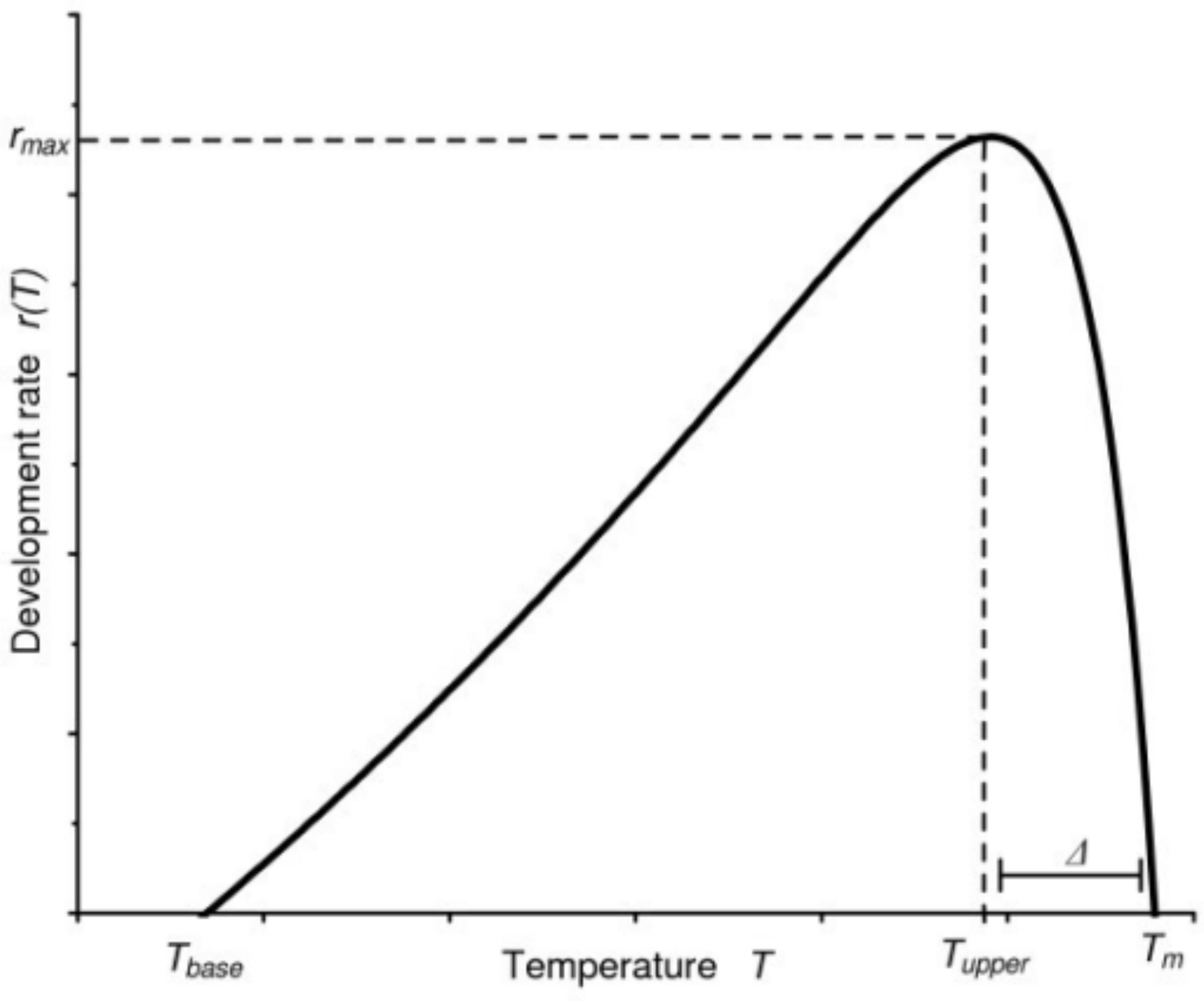


Codling moth & other 'worms'

As T^0 decreases development slows; As T^0 increases growth rate speeds up, to a point.



Cold blooded insects develop faster at higher T^0 until a maximum T^0 is reached



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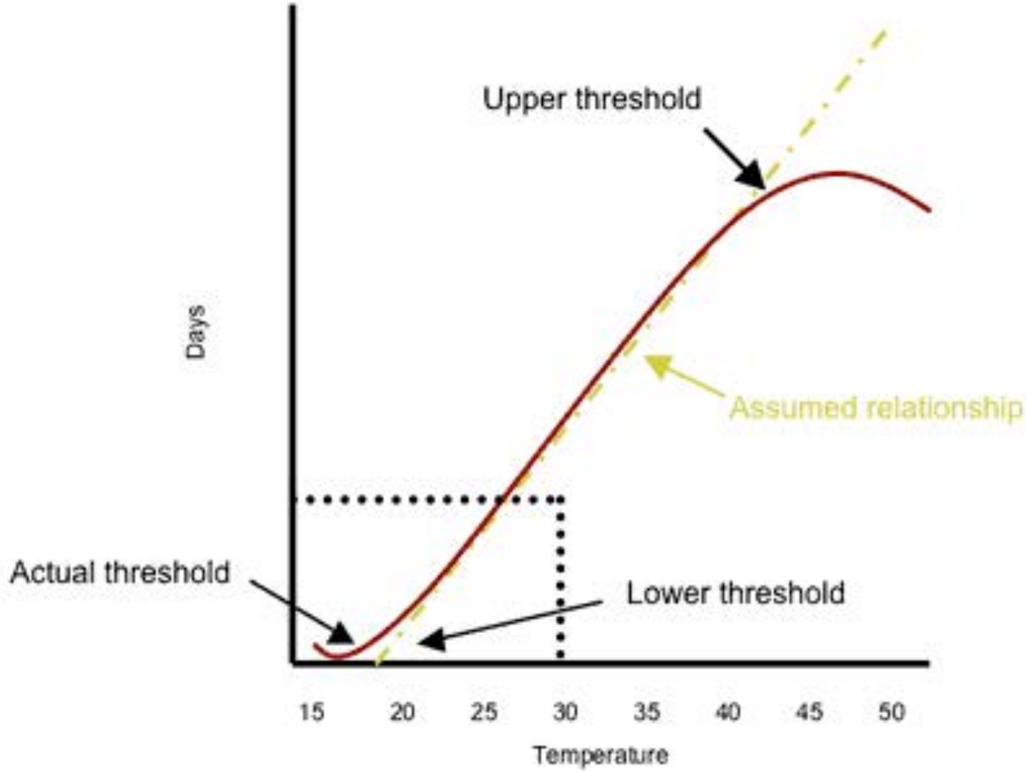
There are minimum and maximum developmental T^0 thresholds.

Minimum or lower developmental threshold is the temperature below which insect development is negligible. The lower threshold differs among insect species. It is used as a base for calculating degree days.

Maximum or upper developmental threshold is the temperature at which insect growth stops. Upper developmental thresholds also vary among insects.



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For example T^0 for the 2 major internal worms in apples & peaches -

Codling Moth:

Max – 88^0F

Min - 50^0F

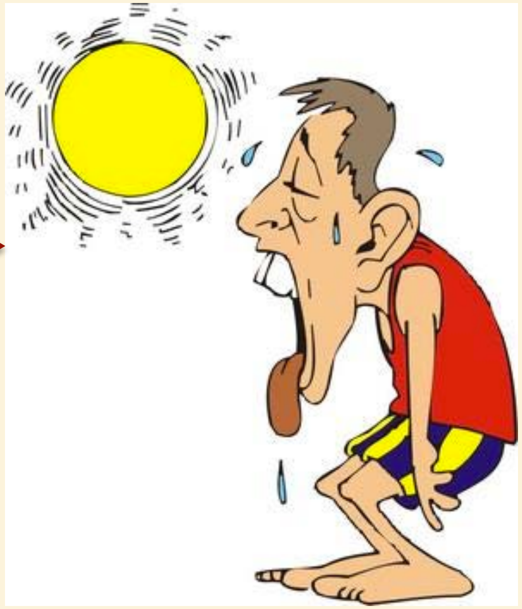
Oriental Fruit Moth:

Max – 45^0F

Min – 90^0F

Degree Days Are Calculated Using Minimum & Maximum Developmental Temperatures

Development happens between these 2 temperature points.



Calculating Degree Days (DD)
Old & simple but not too accurate

$$\left(\frac{\text{Maximum + Minimum temperature}}{2}\right) - \text{Minimum threshold}$$

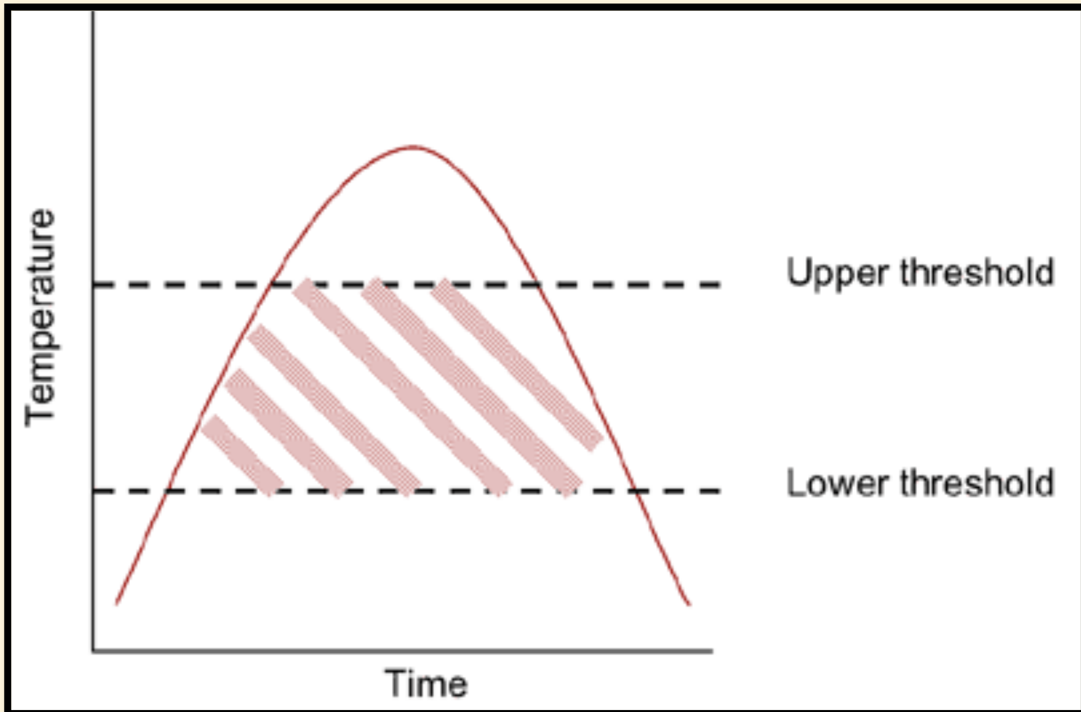
* If minimum temperature < minimum threshold, set minimum temperature = minimum threshold.

* If maximum temperature > maximum threshold, set maximum temperature = maximum threshold.

Example: When T^{min}=50 & T^{max}=88, and min temp day 1=45, max=80, day 2 min=51, max=90

Day 1: (80+50)/2=65.0-50=15.0DD
Day 2: (88+51)/2=69.5-50=19.5DD
Total 34.5.DD

Common accurate model calculations use a Sine Wave curve for T^0 and record every hour (or more).



If the daily max and min temperatures are > 95,
then the degree days for that day are = 95 - lower threshold.

If the daily max and min temperatures are < lower threshold,
then the degree days for that day are = 0,

If the daily max and min temperatures are between 95 and the lower threshold,
then the degree days for that day are = daily mean - lower threshold.

If the daily max and min temperatures are > 95,
then the degree days for that day are = 95 - lower threshold.

If the daily max and min temperatures are < lower threshold,
then the degree days for that day are = 0,

If the daily max and min temperatures are between 95 and the lower threshold,
then the degree days for that day are = daily mean - lower threshold.

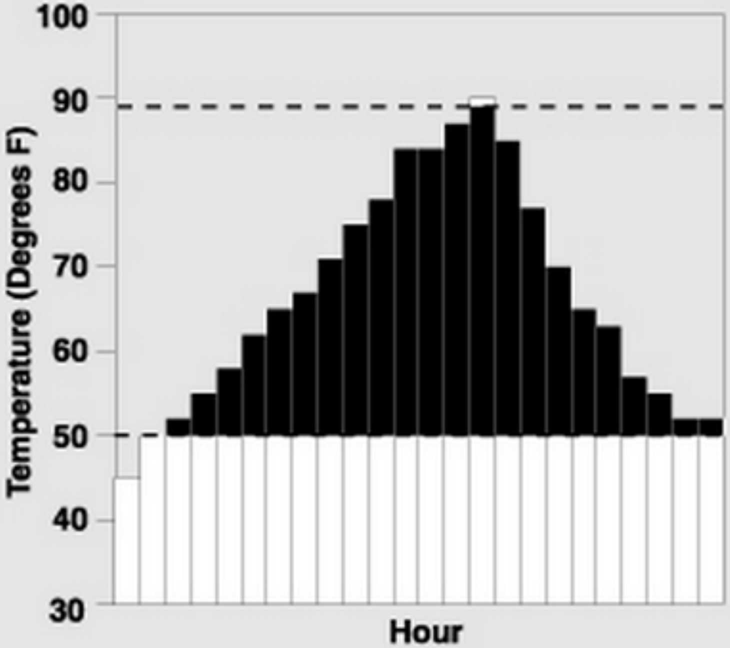
Repeated Sine calculations become:
Example: When T^{min}=50 & T^{max}=88, and min temp day 1=45, max=80, day 2 min=51, max=90

Day 1:	(80+~~50~~ 45)/2=~~65~~.0 62.5-50=~~15~~.0	12.5DD
Day 2:	(88+51)/2=69.5-50=	19.5DD
Total	~~34.5~~.DD	32.0DD

Calculating Degree Days from Hourly Temperatures

Hour	Temp.(F)	Hourly heat units	Adjusted values
1	45	-5	0
2	50	0	0
3	52	2	2
4	55	5	5
5	58	8	8
6	62	12	12
7	65	15	15
8	67	17	17
9	71	21	21
10	75	25	25
11	78	28	28
12	84	34	34
13	84	34	34
14	87	37	37
15	90	40	38
16	85	35	35
17	77	27	27
18	70	20	20
19	65	15	15
20	63	13	13
21	57	7	7
22	55	5	5
23	52	2	2
24	52	2	2
		Total	402

Divided by 24 hours = 16.75 degree days

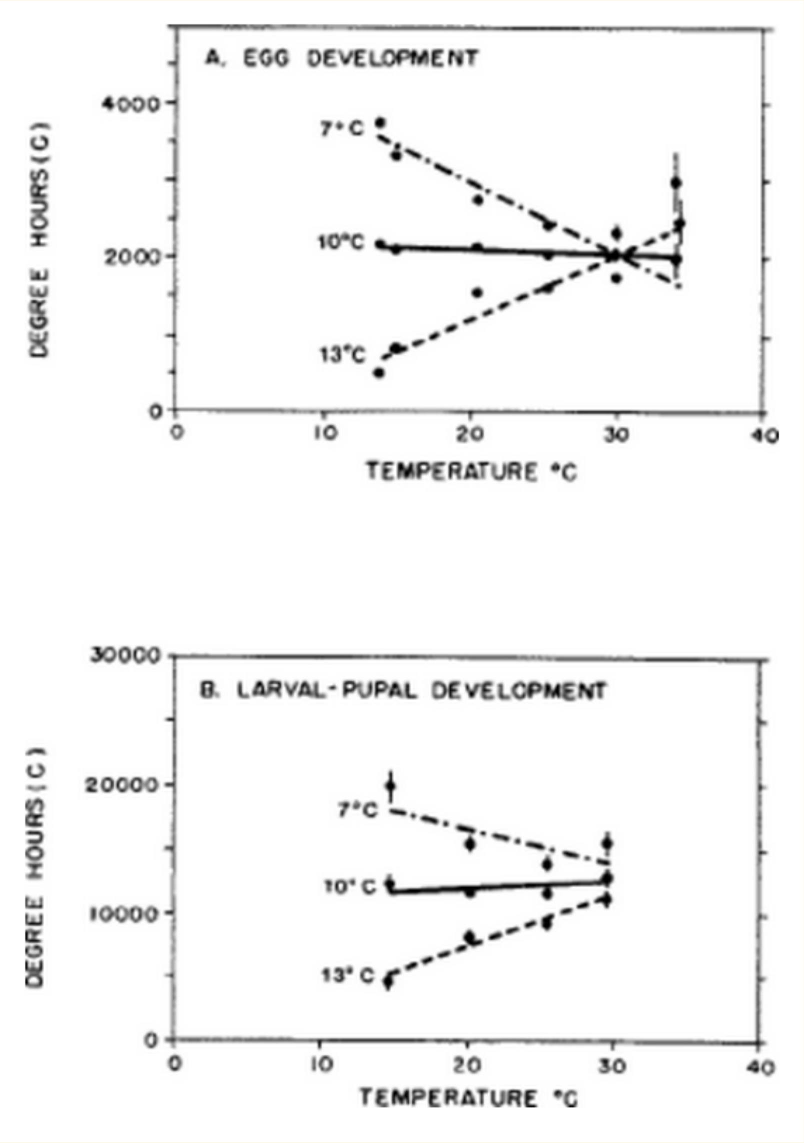


Upper threshold 88, lower threshold 50

To calculate degree days from hourly temperatures, subtract the lower threshold (50F) from hourly temperature to arrive at hourly heat units. Adjust negative values to 0. For temperatures above the upper threshold (88F), subtract the di fference between the hourly reading and the upper threshold from the hourly heat units. For example, if the temperature reading is 90'F, subtract 2. Add the adjusted values for the 24 hours and divide total by 24.

Jones & Brunner, 1993

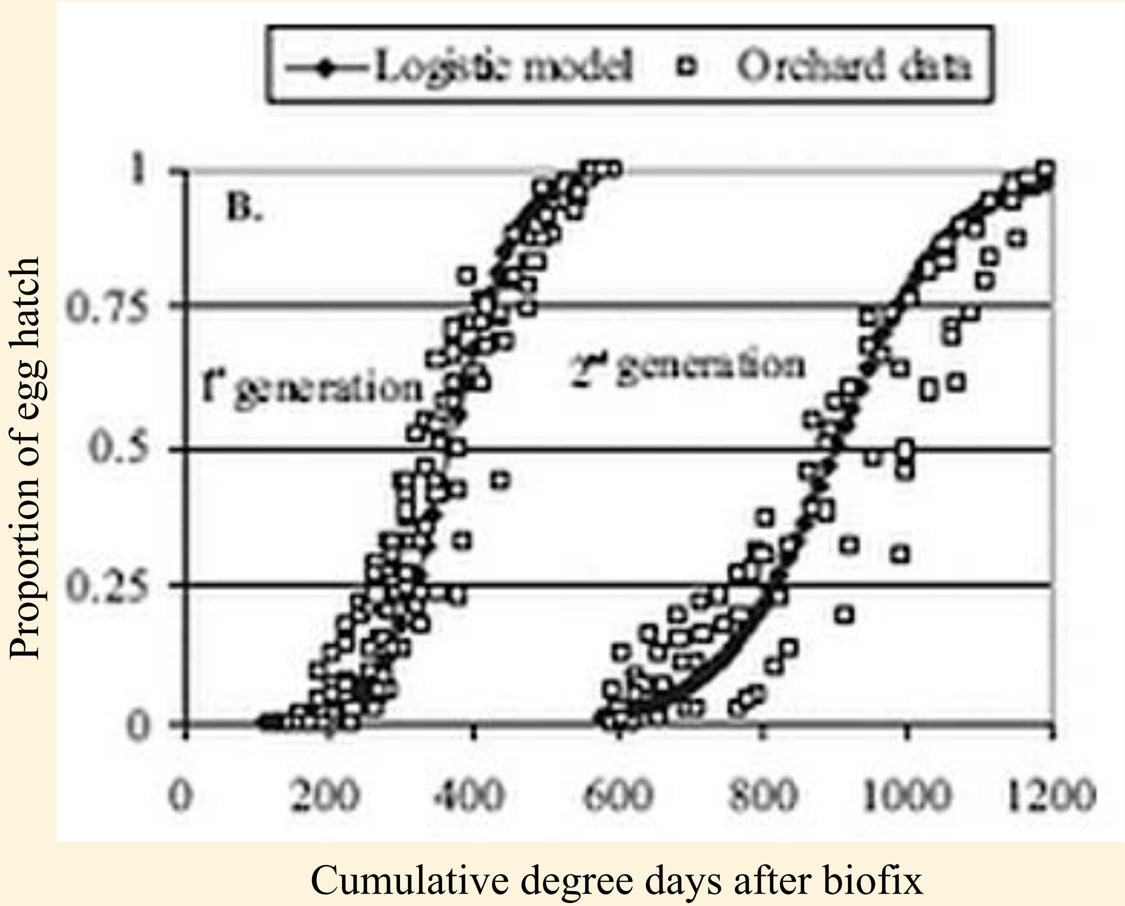
Different stages may take different times to develop



As T^0 increases, it takes less degree hours for eggs to to develop until 31^0C (88^0F).

As T^0 increases, it takes less degree hours for larvae and pupae to to develop until 31^0C (88^0F), but a longer time than eggs to develop.

DD Needed for Oviposition and Hatch



Knight, 2007 Env.Ent

Codling Stages & Developmental Times

Event	DD
Generation Time (egg to egg)	880
Generation Time (50% egg hatch to same)	1096
1% egg hatch (1st gen)	220
20% egg hatch (1st gen)	360
50% egg hatch (1st gen)	484
75% egg hatch (1st gen)	610
95% egg hatch (1st gen)	800
5% Adult emergence (2nd gen)	1000
7% egg hatch (2nd gen)	1260
30% egg hatch (2nd gen)	1460
50% egg hatch (2nd gen)	1580
75% egg hatch (2nd gen)	1750
95% egg hatch (2nd gen)	2000

1st 1st gen. spray (250)

1st 2nd gen. spray (1250)

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Different insecticides work best on different life stages

What life stage do you have & when?

What insecticides do you use for what life stage?

IRAC Class	Chemical Class	Common Name	Trade Name	Target Stage	1st Gen. DD Timing
1A	Carbamates	carbaryl, methomyl	**Sevin, Lannate**	**Larvae, Adults**	**Biofix+250**
1B	Organo-phosphates	phosmet, diazinon, malathion, chlorpyrifos	**Imidan, Diazinon, Malathion, Lorsban**	**Larvae, Adults**	**Biofix+250**
3A	Pyrethroids	lambda-cyhalothrin, beta-cyfluthrin, esfenvalerate, fenpropathrin, deltamethrin	**Warrior, Baythroid, Asana, Danitol, Decis**	**Larvae, Adults**	**Biofix+250**
4A	Neonicotinoids	acetamiprid, thiacloprid, clothianidin	**Assail, Calypso, Belay**	**Larvae, Eggs (covered)**	**Biofix+ 200-250**
5	Spinosyns	spinetoram	**Delegate**	**Young larvae**	**Biofix+250**
6	Avermectins	amamectin-benzoate	**Proclaim**	**Young larvae**	**Biofix+ 200-250**
15	Benzoylureas	novaluron, diflubenzuron (IGR)s	**Rimon, Dimilin(pear)**	**Eggs (under), young larvae**	**Biofix=100-150**
22A	Oxadiazines	indoxacarb	**Avaunt**	**Larvae, Adults**	**Biofix+250**
28	Diamides	Rynaxypyr, flubendiamide	**Altacor, Belt**	**Eggs, larvae**	**Biofix=150**

Apples

Welcome to the NEWA Apple Home Page

Apple Insects

Apple Insect Phenology Models and IPM Forecasts
Degree-Day Accumulations Table (Historical dates and degree day periods for tree fruit pest/phenology events)

The following pest phenological models are covered:

Insect	Base T
Codling Moth	50 F
Oriental Fruit Moth	45 F
Obliquebanded Leafroller	43 F
Plum Curculio	50 F
Spotted Tentiform Leafminer	43 F
Apple Maggot	50 F

Keep Track of These Biofix Dates

Apple Biofix Table

Important Biofix Dates to Track

Pest	Base T	Biofix
Apple Scab	32 F	50% Green Tip Mac's
Fire Blight	65 F	First Blossom Open
Sooty Blotch & Flyspeck	*NA	Estimate based on DD accumulations correlated with historical observations.
Codling Moth	50 F	First Sustained Trap Catch
Oriental Fruit Moth	45 F	First Sustained Trap Catch
Obliquebanded Leafroller 1st summer generation	43 F	First Sustained Trap Catch
Plum Curculio	50 F	Petal Fall
San Jose Scale	50 F	March 1
Spotted Tentiform Leafminer 2nd generation	43 F	First Sustained Trap Catch
Apple Maggot	50 F	January 1

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NEWA Apple Insect Models

Select a pest:
Codling Moth

Weather Station:
Terhune Winery, NJ

Accumulation End Date:
05/30/2014

Calculate

Map | Results | More info

Codling Moth Results for Terhune Winery

First Trap Catch: 5/13/2014

First Trap Catch date above is estimated based on degree day accumulations or user input. Enter the actual date for blocks of interest and the model will calculate the protection period after first trap catch more accurately.

Accumulated degree days (base 50°F) first trap catch through 5/30/2014: 241 (0 days missing)

Pest stage: Moth catches increasing and eggs begin to hatch

The pest stage above is estimated. Select the actual stage and the model will recalculate recommendations.

Pest Status	Pest Management
Eggs usually begin to hatch about 220 DD after the first catch, and catches of adults should be increasing in pheromone traps.	Apply the first spray for control of overwintering CM at 250 DD after first catch. In some seasons, Plum curculio will still be active at this time and a broad spectrum material should be selected to control both of these pests at this time in high risk PC orchards. If internal worm damage has been observed in past years in an orchard, CM populations may be resistant to organophosphate and synthetic pyrethroid insecticides and other classes of materials may be more effective.

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NEWA Apple Insect Models

Select a pest: Codling Moth

Weather Station: Terhune Winery, NJ

Accumulation End Date: 07/18/2014

Calculate

Map | Results | More info

Codling Moth Results for Terhune Winery

First Trap Catch: 5/13/2014

Second Generation Flight Start: 7/9/2014

The dates above are estimated based on degree day accumulations or user input. Enter the actual dates for blocks of interest and the model will calculate the protection period more accurately.

Accumulated degree days (base 50°F) second generation flight start through 7/18/2014: 246 (0 days missing)

Pest stage: Moths flying & egg hatch begins

Change the pest stage above and the model will recalculate recommendations.

Pest Status	Pest Management
Eggs from the second generation of CM have started to hatch.	Apply insecticides to control newly hatching larvae. In order to manage insecticide resistance, it is best to apply a different class of materials to control this second generation of CM than was used earlier in the season against the overwintering generation. Insecticides applied at this time to control CM will also control the second generation of OFM. The summer generation of OBLR may also be active at this time and materials should be applied that are active against both internal Lepidoptera and leafrollers. Pesticide information

Disclaimer: ***These are theoretical predictions and forecasts.*** *The theoretical models predicting pest development or disease risk use the weather data collected (or forecasted) from the weather station*

- Plan…you insecticide program.
- Trap and record the biofix date.
- Enter the date in NEWA.
- Plan your DD target for the insecticide (class) you intend to use.
- Execute as close to recommended time as possible.


Any Questions?