



Advanced IPM for UT Tree Fruit

Are there optimal spray timings?

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The Simple Answer

- **Yes, there are optimal spray timings.**
 - Optimal spray timings should reduce the overall quantity of pesticide applied (saves money, gets job done).
- **But, *optimizing* spray timing is context-dependent.**
 - Optimal “windows in time” vary with topography, weather, pest species, and pest control tactics.

First and Foremost

1. Identify and monitor the pest.
2. Monitor weather where pests exist (use DDs).
3. Time treatments based on pest development and nature of pesticide.

An Example for Pome Fruit

- Codling Moth (*Cydia pomonella*)
 - Pest of apples, pears, crabapples, hawthorn, serviceberries, quince.



Photo Courtesy Shawn Steffan
Utah State University Extension



Photo Courtesy Shawn A. Steffan
Utah State University Extension

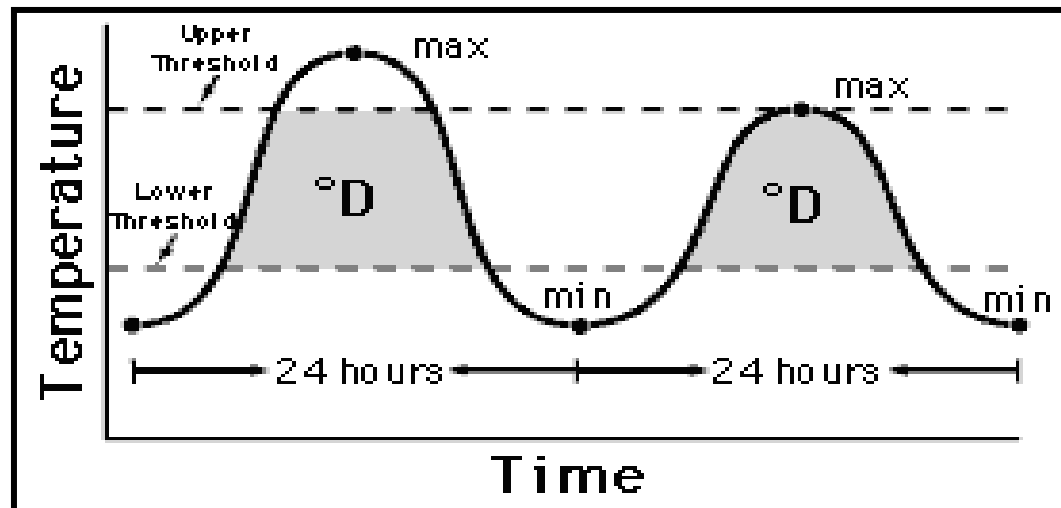
An Example for Stone Fruit

- Peach Twig Borer (*Anarsia lineatella*)
 - Targets peaches, nectarines, apricots, and plums (not cherries).



“Physiological Time”

- Degree-day (DD) = measurement of time as a function of temperature.
- By coupling field scouting with weather, we can estimate pest development with accuracy.



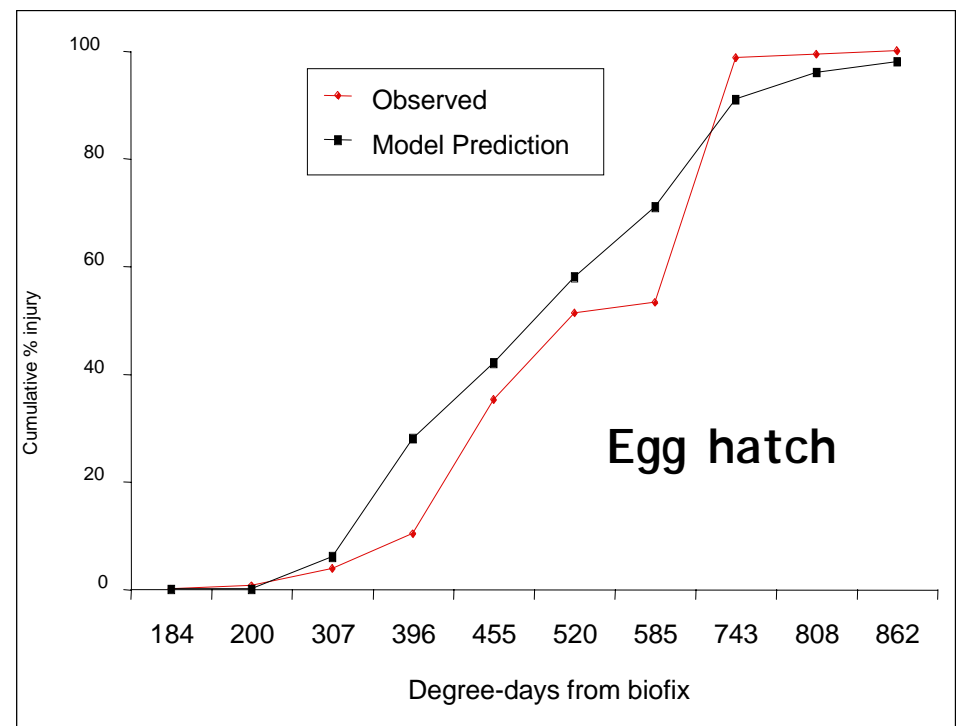
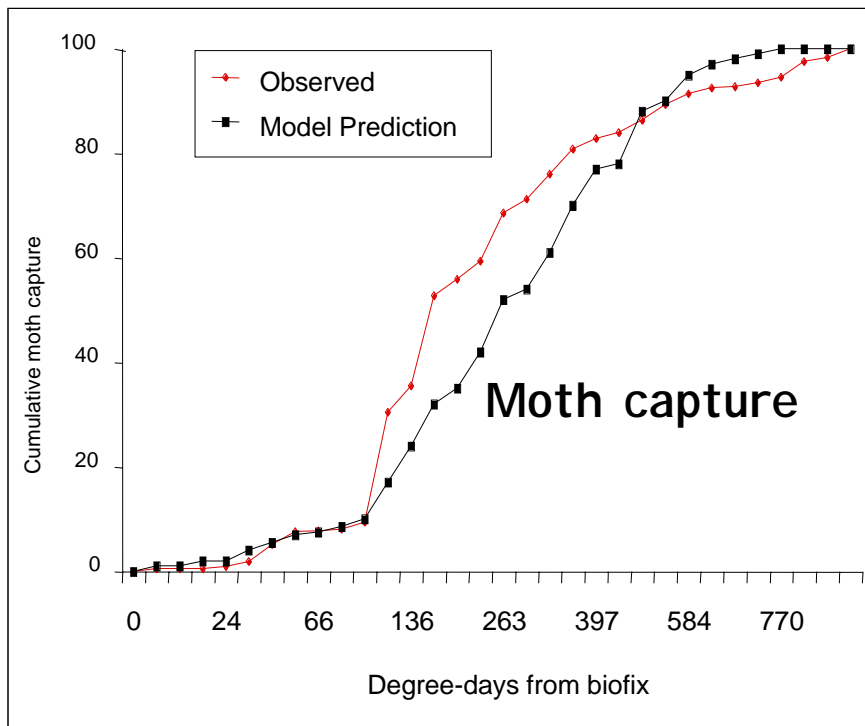


Codling Moth

- A tortricid moth—overwinters as a mature larva/pre-pupa.
- Spring presents opportunity to suppress a consolidated population.
- Codling moth development (independent of a biofix):
 - For female moths, ~ **60 DDs** spent in pre-ovipositional period.
 - For eggs, ~ **160 DDs** required to hatch.
 - For larvae, ~ **470 DDs** spent eating and growing.
 - For pupae, ~ **430 DDs** spent pupating.
 - Egg-to-adult: ~ **1060 DDs** for a generation.

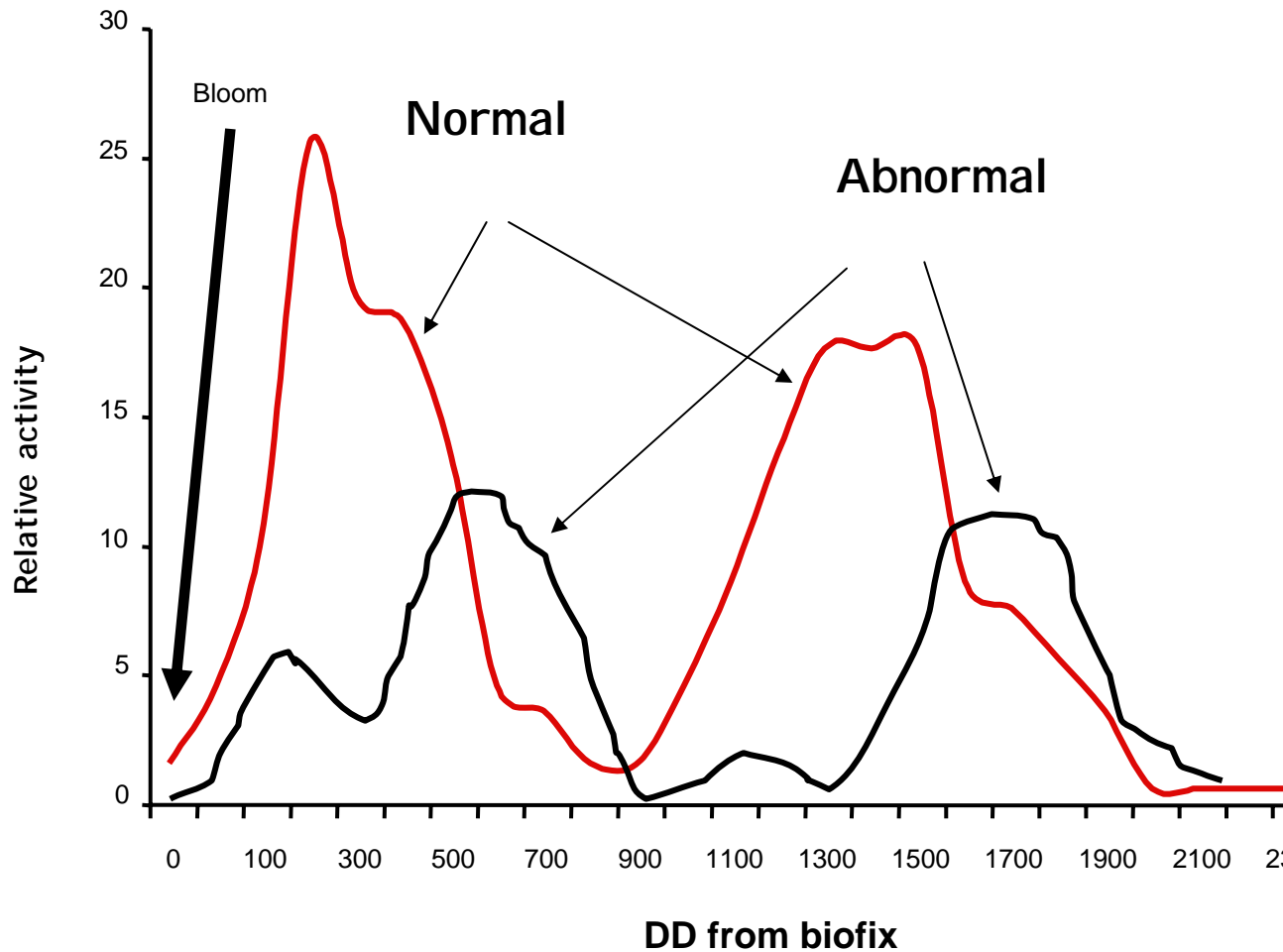
For the past 3 years the model has accurately predicted codling moth development (flight, oviposition, and egg hatch) in Wenatchee in unsprayed orchards.

2002 actual activity and model predictions - 1st generation



Courtesy Brunner et al., WSU, TREC, Wenatchee, WA

Aberrant patterns of development



We have observed "abnormal" patterns in commercial orchards. Must respond to these to achieve successful control of codling moth.

The only way to detect "abnormal" activity is to monitor the insect with pheromone traps.

Courtesy Brunner et al., WSU, TREC, Wenatchee, WA

Optimal Treatment Timings Depend on Materials Used

- *Key Questions: What materials will be used? How much development has been allowed by local temperatures?*
- For **larvicides**, *egg-hatch* is the critical window.
- For **ovicides**, *pre-oviposition* and *oviposition* is the critical window.
 - 1st generation: egg-laying begins by 60 DDs post-biofix
 - 2nd generation: egg-laying begins by 920 DDs post-biofix
- For **mating disruption**, dispensers must be set up as soon as possible following the biofix.

CM Insecticides: Mode-of-Action

- Ovicides
 - Usually IGRs, dissolve into egg
 - IGR = Insect Growth Regulator
 - generally endocrine disruptors
- Typical CM Larvicides
 - Usually neuro-transmission disruptors (eg, nicotinoids, pyrethroids, OPs).
 - Sometimes endocrine disruptors, viruses
 - IGRs, viruses must be ingested.
- Adulticides (contact kill)
 - Neuro-transmission disruptors.
- Mating Disruption
 - Checkmate membranes, Isomate ties/tubes
 - Delays mating by confusing males, leading them on false trails, and/or habituating them to sex pheromone.

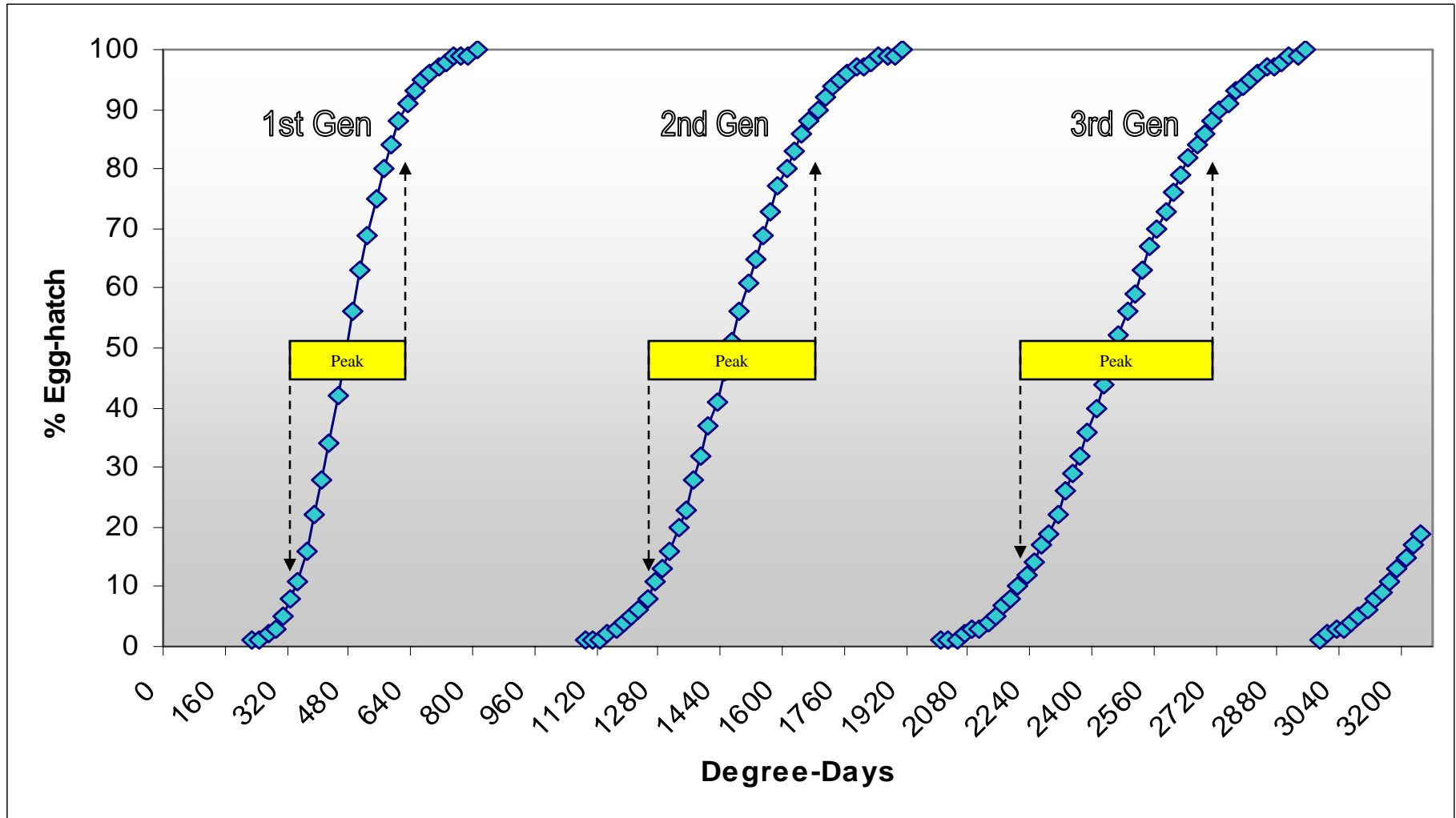


Materials for Codling Moth Control

- Ovicides
 - Esteem, **Intrepid**, **Rimon**, Oil
- Typical Larvicides
 - **Assail**, Avaunt, **Calypso**, Cyd-X, **Danitol**, Esteem, **Guthion**, **Imidan**, **Intrepid**, Success, Virosoft
- Adulticides (contact kill)
 - Danitol, Guthion, Imidan
- Mating Disruption
 - Checkmate membranes, Isomate ties/tubes



Generalized Pattern of CM Egg-Hatch



Moth Flight & 1st Generation Egg-Hatch *Relative to DDs*

DD Total	% moth flight completed	% egg hatch completed
0	1	0
60	7	0
220	45	1
250	51	2
340	67	12
660	98	82
720	99	89
960	-	99

CM Developmental Benchmarks



- Some important DD totals (for spring):
 - 240-260 DDs (*from March 1st*) => typical spring emergence of moths.
 - Biofix = RESET button

1st Generation:

- 50-60 DDs (*post-biofix*) => egg-laying should begin.
- 200-220 DDs (*post-biofix*) => 1st gen. egg-hatch begins.
- **340-360 DDs (*post-biofix*) => peak egg-hatch starting.**
- **640-660 DDs (*post-biofix*) => peak egg-hatch declining.**
- 920-980 DDs (*post-biofix*) => 1st gen. egg-hatch finishing.



2nd Generation Benchmarks

- Some important DD totals for mid-summer:

2nd Generation

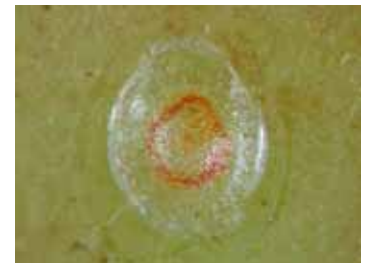
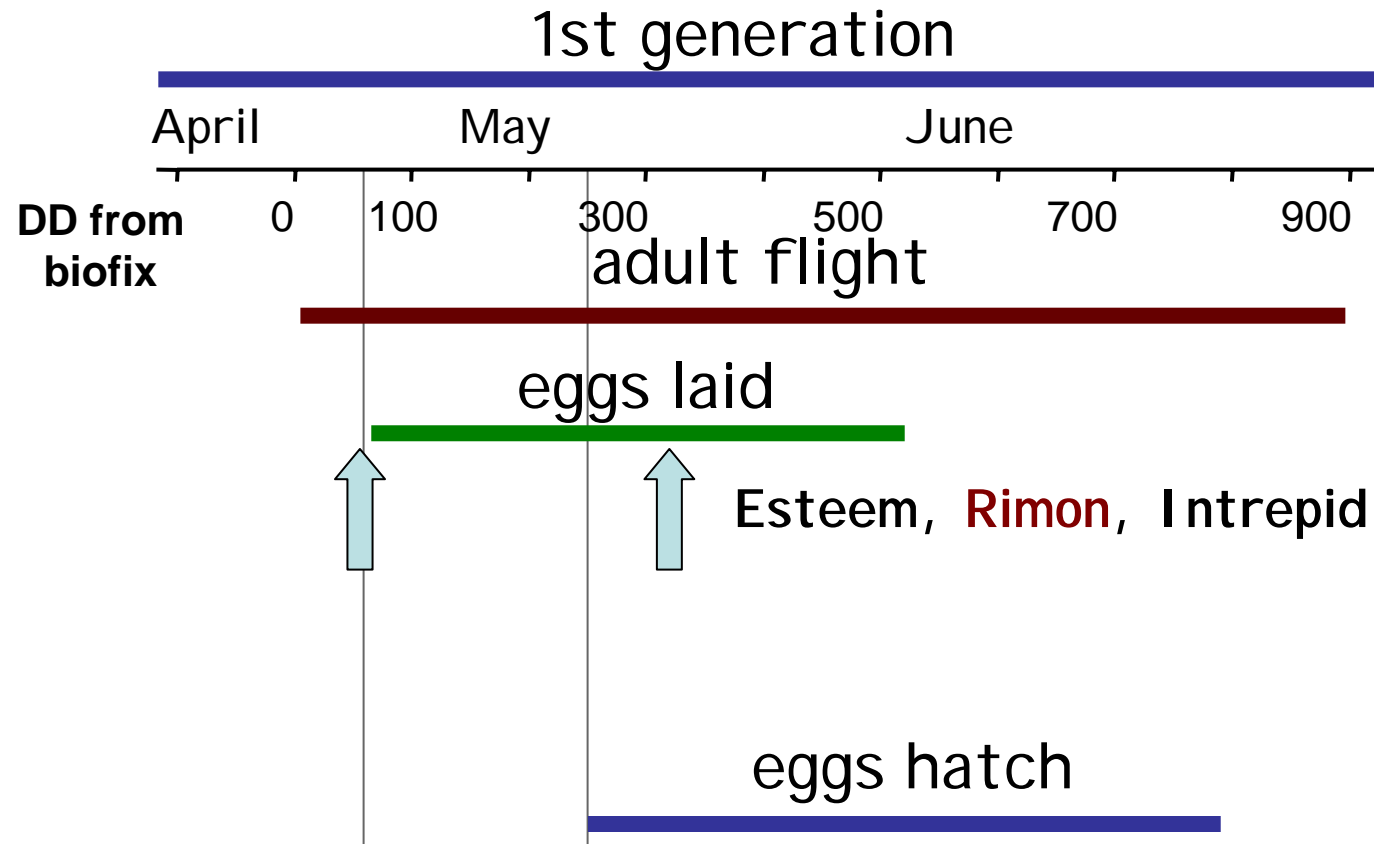
- 920 DDs (*post-biofix*) => egg-laying should begin.
- 1,100 DDs (*post-biofix*) => 2nd gen egg-hatch begins.
- **1,320-1,340 DDs (*post-biofix*) => peak egg-hatch starting.**
- **1,780-1,800 DDs (*post-biofix*) => peak egg-hatch declining.**
- 2,100-2,140 DDs (*post-biofix*) => 1st gen. egg-hatch finishing.

Materials for Codling Moth Control

- Ovicides
 - Esteem, Intrepid, Rimon
- Typical Larvicides
 - Assail, Avaunt, Calypso, Cyd-X, Danitol, Esteem, Guthion, Imidan, Intrepid, Success, Virosoft
- Adulticides (contact kill)
 - Danitol, Guthion, Imidan
- Mating Disruption
 - Isomate ties/tubes, Checkmate membranes

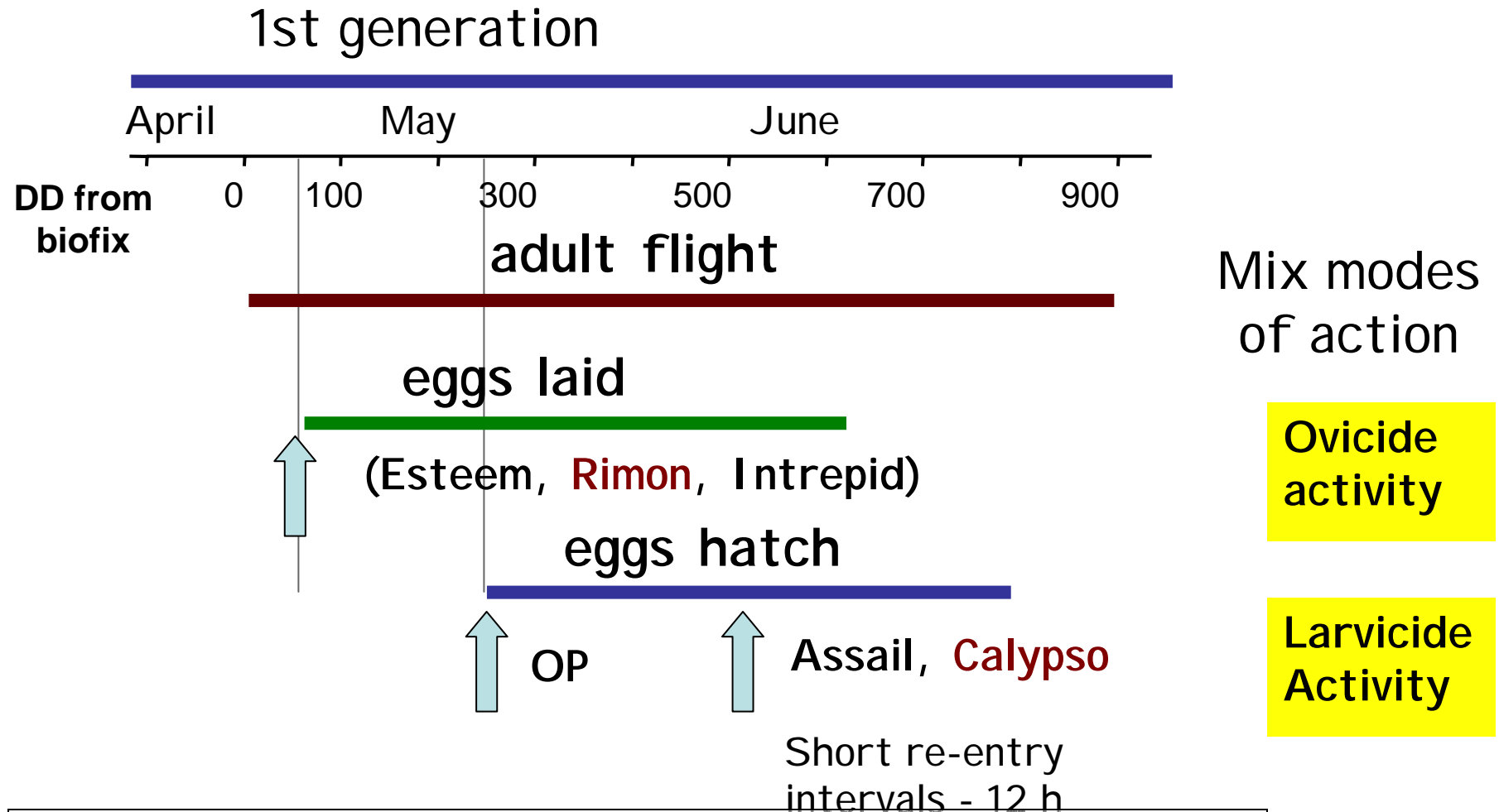


Codling Moth Management - **Ovicides**



Courtesy Brunner et al., WSU, TREC, Wenatchee, WA

Pest Management Programs



Courtesy Brunner et al., WSU, TREC, Wenatchee, WA

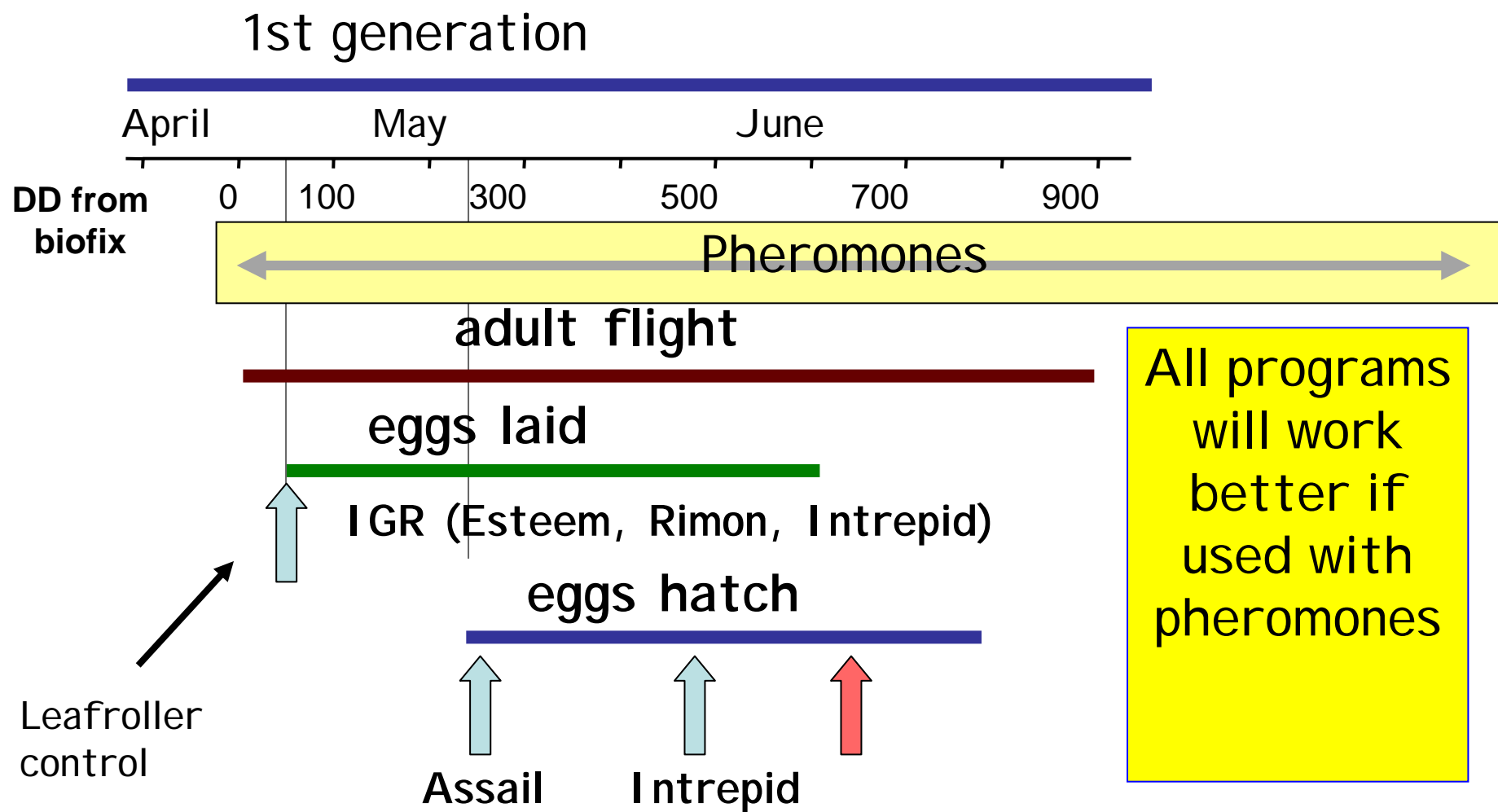
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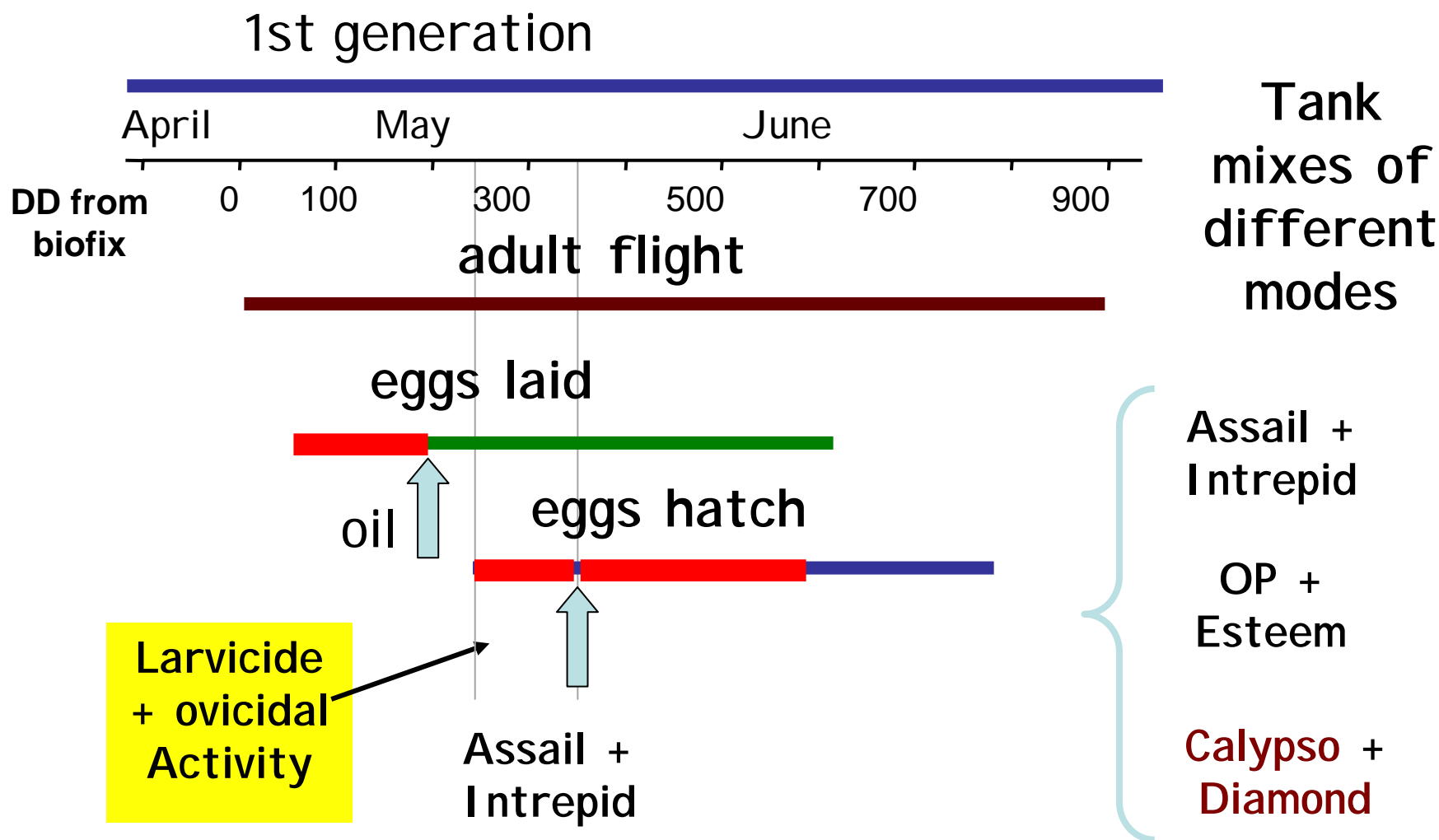
Courtesy Brunner et al., WSU, TREC, Wenatchee, WA

Pest Management Program - NO OPs



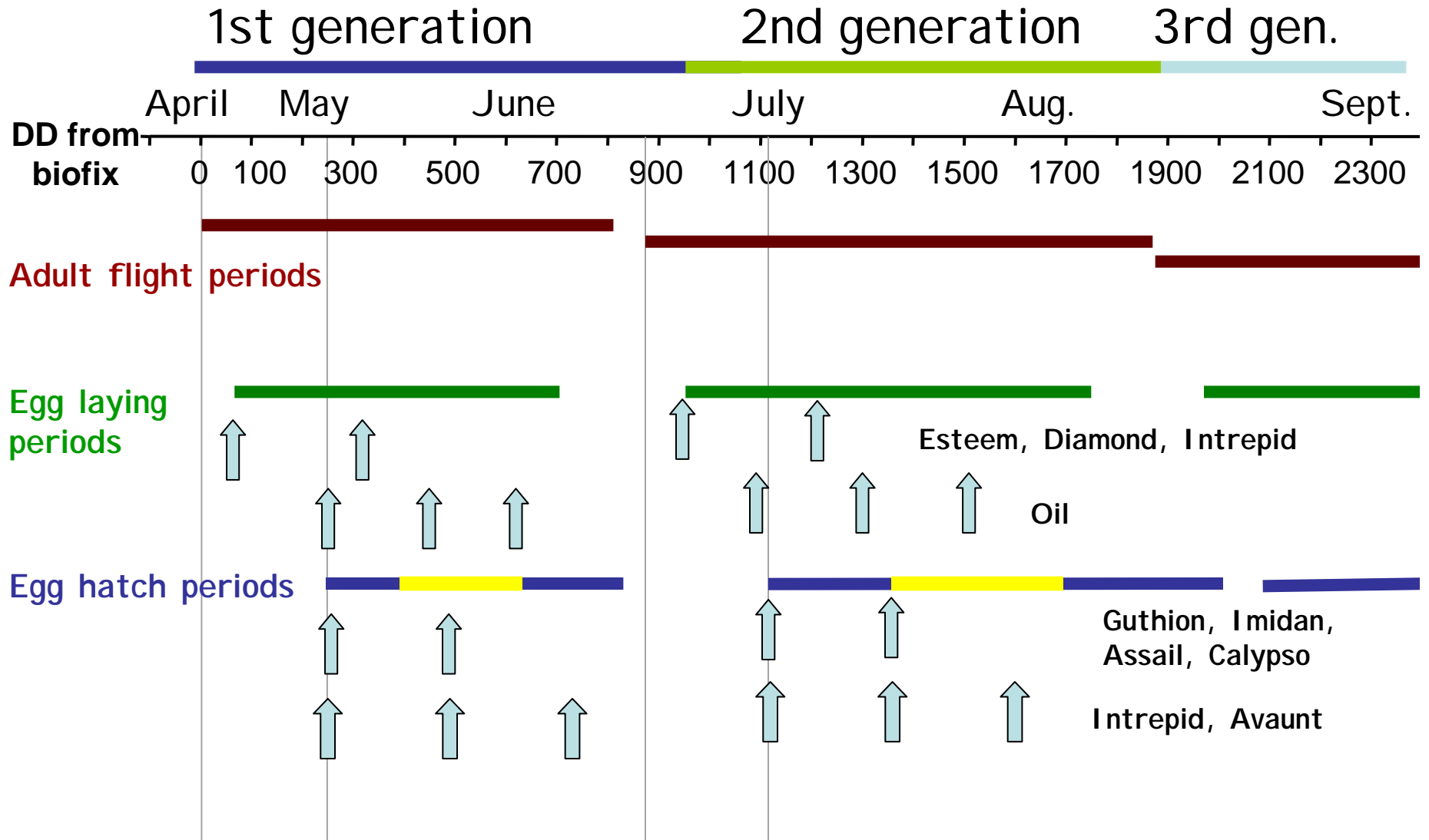
Courtesy Brunner et al., WSU, TREC, Wenatchee, WA

Pest Management Program

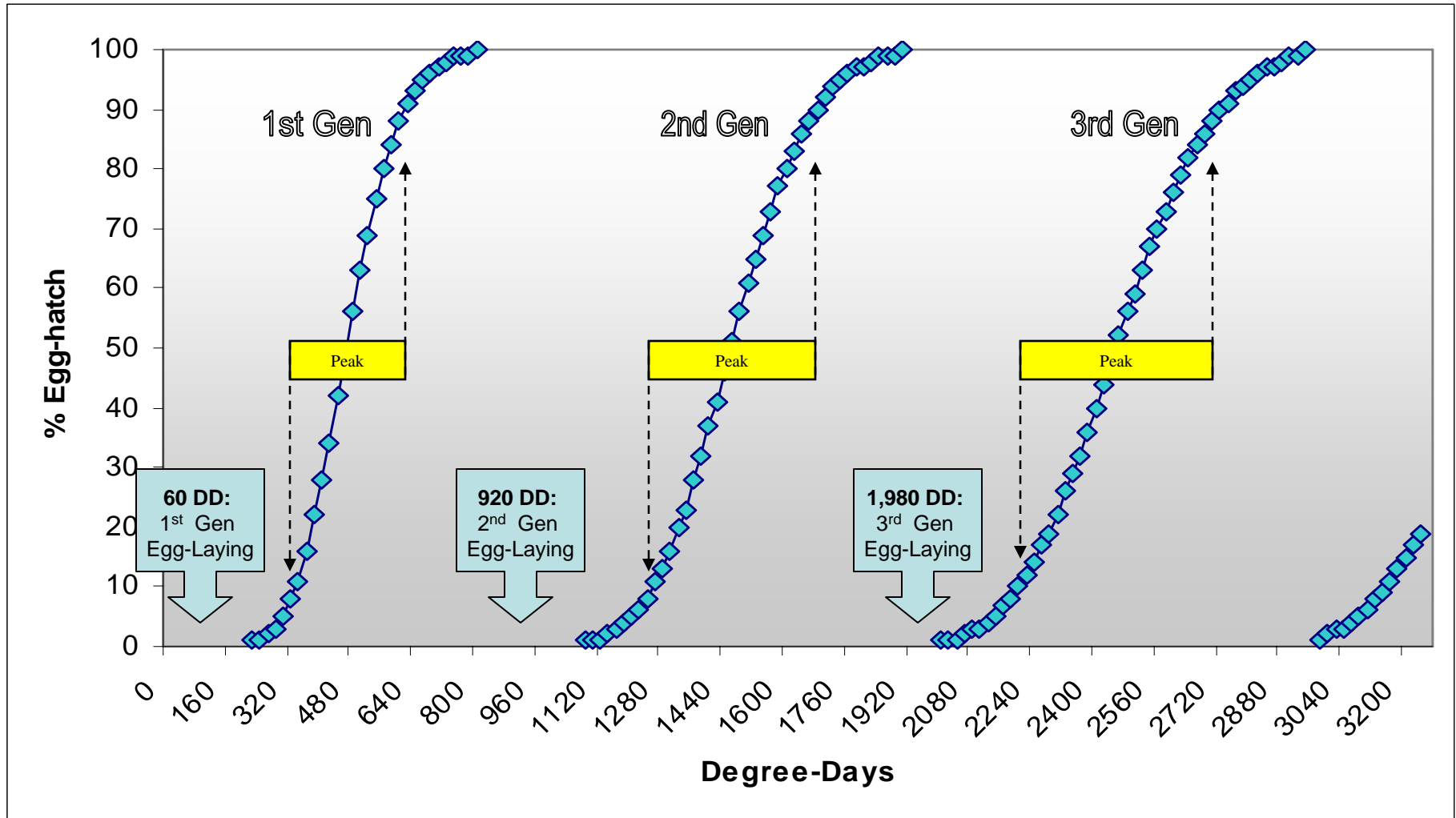


Courtesy Brunner et al., WSU, TREC, Wenatchee, WA

Codling Moth Management Options

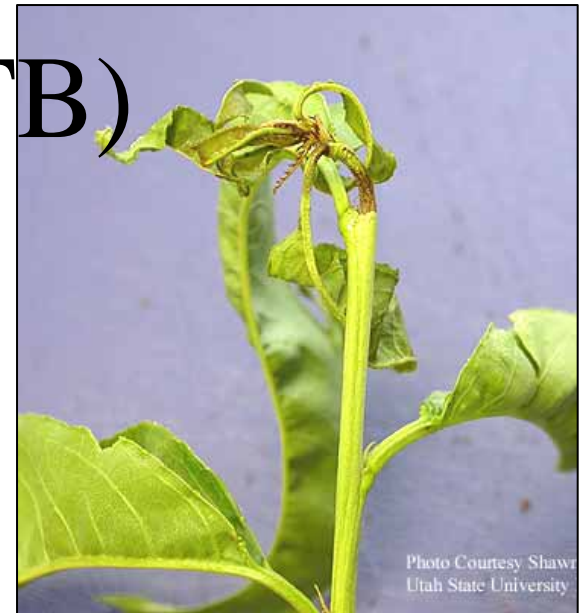


CM Egg-Laying and -Hatch



Peach Twig Borer (PTB)

- A gelechiid moth—feeds on shoots and fruit.
- Spring population more “spread out” than CM.
- PTB development (independent of a biofix):
 - For female moths, ~ **50 DDs** spent in pre-ovipositional period.
 - For eggs, ~ **165 DDs** required to hatch.
 - For larvae, ~ **465 DDs** spent eating and growing.
 - For pupae, ~ **290 DDs** spent pupating.
 - Adult-to-adult: ~ **1080 DDs** for a full generation.



Peach Twig Borer Biology

- Overwinters as a larva (caterpillar) in small “galleries” created within the tree cambium.
- In spring, as leaf and flower buds open, the PTB larvae emerge to feed on young leaves and flower petals.
- Must feed before pupating in spring (as opposed to codling moth, which merely has to complete pupation).



PTB Shoot Strikes



Peach twig borer larvae generally require **3 to 5 shoots** to complete their development

PTB Feeding Patterns

- In **early to mid-season**, PTB is more interested in *new shoots* than fruit.
- By mid- to late-season, most shoots form a terminal bud, and the tree puts its resources into fruit growth.
- Fewer succulent shoots and ripening fruit = hungry larvae more interested in fruit.



Typical Fruit Damage



PTB: Optimizing Treatment Timings Depends on Materials Used

- *What materials will be used for PTB? What development has been allowed by local temperatures?*
- For **larvicides**, *egg-hatch* is the critical window *in-season*.
 - However, delayed-dormant and/or bloomtime treatments can be highly effective.
 - Egg-hatch begins at 220 DDs, but material generally applied closer to 300-400 DDs.
- For **ovicides**, *oviposition or pre-oviposition* is the critical window.
 - 1st generation: egg-laying begins by 50 DDs post-biofix
 - 2nd generation: egg-laying begins by 920 DDs post-biofix
- For **mating disruption**, dispensers must be set up as soon as possible following the biofix.

Delayed-Dormant Sprays for PTB

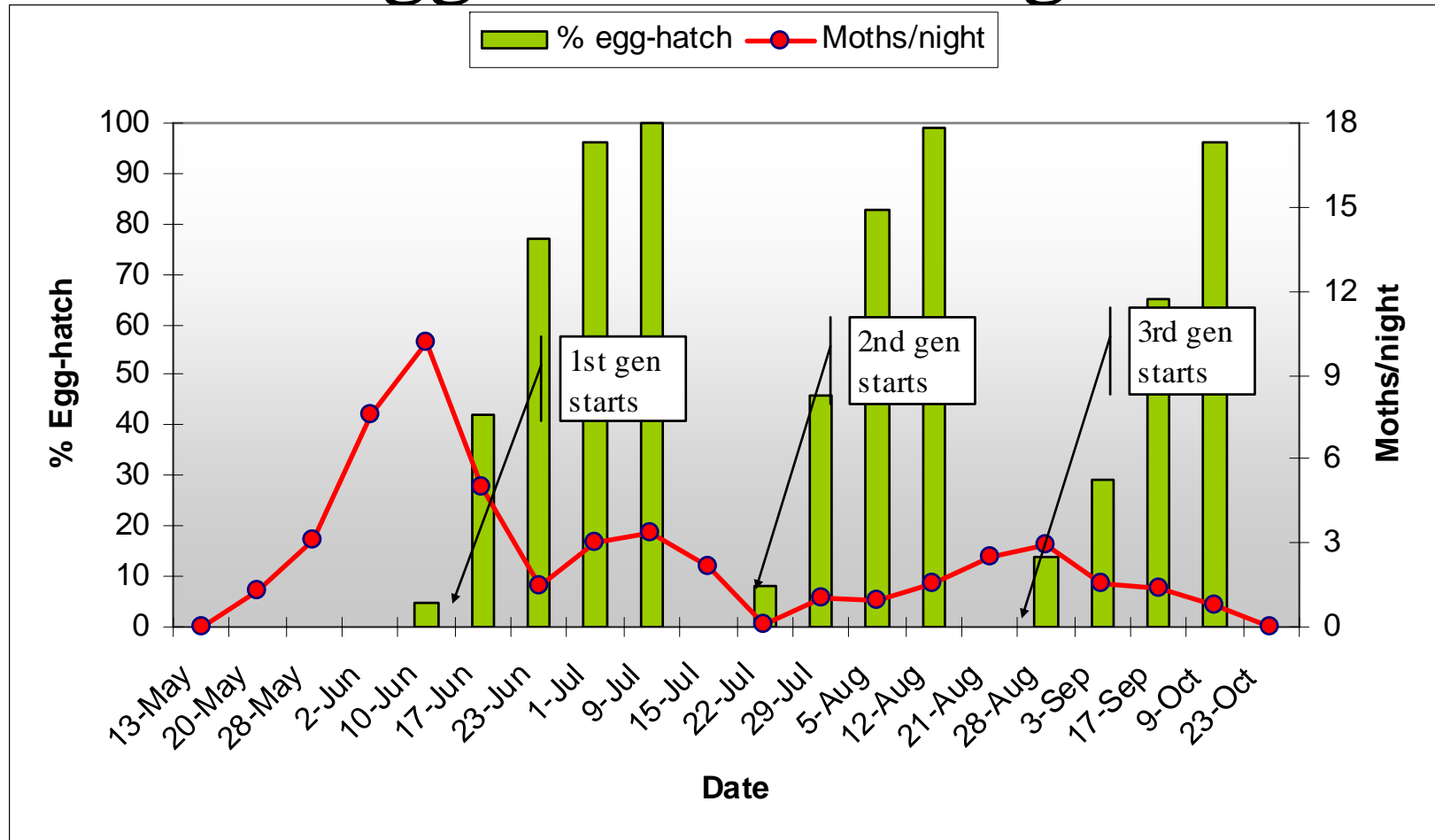
- Dormant oil (*Volck Supreme, horticultural mineral oil*) + Insecticide (*Asana* or *Lorsban*).
- Operates on larvae as they emerge from winter galleries.
- For many growers, this spray is standard protocol for PTB management.

Bloom Sprays for PTB

- Bt, spinosad, or diflubenzuron are all good for this timing.
- Two (2) Bt or spinosad (*Success/Entrust/Ferti-lome*) sprays at bloom
 - 1st shot at early bloom (10-20% bloom)
 - 2nd shot at full bloom (before petal fall)
- Or, one (1) application of diflubenzuron (*Dimilin*) around early-/mid-bloom (10-50% bloom).
- For many growers, these sprays may be the most important of the year because of issues with canopy coverage and in-season timing.

In-Season Patterns of PTB

Egg-Hatch and Flight



PTB Developmental Benchmarks



(Degree-Days post-biofix)

1st Generation

- 60 DD => egg-laying begins
- 220 DD => egg-hatch begins
- **320 DD => peak egg-hatch starts**
- **600 DD => peak egg-hatch winds down**
- 740 DD => egg-hatch essentially over

2nd Generation

- 920 DD => egg-laying begins
- 1080 DD => egg-hatch begins
- **1240 DD => peak egg-hatch starts**
- **1660 DD => peak egg-hatch winds down**
- 1840 DD => egg-hatch essentially over

PTB Moth Flight & 1st Generation Egg-Hatch *Relative* to DDs

DD Total	% moth flight completed	% egg hatch completed
0	1	0
60	4	0
220	49	1
320	81	8
400	94	28
600	100	88
720	-	98
800	-	100

Effective Materials for PTB Control

- **Azinphosmethyl** (*Guthion*, can buy until Aug. 31st, use through 2005)
- **Bt** (*DiPel*, *Crymax*)
- Carbaryl (*Sevin*)
- Cyhalothrin (*Warrior*)
- Diazinon
- **Diflubenzuron** (*Dimilin*)
- Endosulfan (*Thiodan*)
- **Esfenvalerate** (*Asana*)
- Imidacloprid (*Provado*)
- Malathion
- Methoxyfenozide (*Intrepid*)
- Permethrin (*Pounce*, *Ambush*)
- **Pheromone Mating Disruption** (*Checkmate*, *Isomate* dispensers)
- **Spinosad** (*Success*, *Entrust*, *Conserve*)
- **Phosmet** (*Imidan*)



Take-Home Points on Optimizing IPM

- Use pheromone-baited traps to verify the presence of a given pest and the flight pattern of the adult.
- Determine a *site-specific biofix* and use DDs to quantify the developmental status of the local population.
- Decide upon a management strategy that:
 - targets the pest during its most vulnerable stages.
 - times treatments to suit the insecticide's mode-of-action.
 - is non-disruptive to tree health, beneficial insects.
 - is economical (minimizes material inputs).

Take-Home Points, part 2

- Apply *mating disruption* dispensers as soon as possible following the biofix.
- Apply *ovicides* before (Rimon, Intrepid) or during (hort. oil, Intrepid) egg-laying periods.
- Apply *larvicides* at the beginning of and/or during egg-hatch periods.
- Apply *adulticides* (Imidan, Thiodan, Guthion, Danitol, Asana) at or soon after peak flight.
- Mix or alternate insecticides' modes-of-action.
- Deploy materials at label rates and ensure thorough coverage, particularly with the IGRs.
- Scout for evidence of material efficacy

Contacts & Resources

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- USU Extension
 - www.extension.usu.edu/cooperative/ipd
- CDMS site
 - www.cdms.net
- UDAF Pesticide Index
 - www.kellysolutions.com/UT/pesticideindex.htm

