

Codling Moth in Utah: Considerations and Strategies

Shawn A. Steffan

Dept. Of Biology

Utah State University

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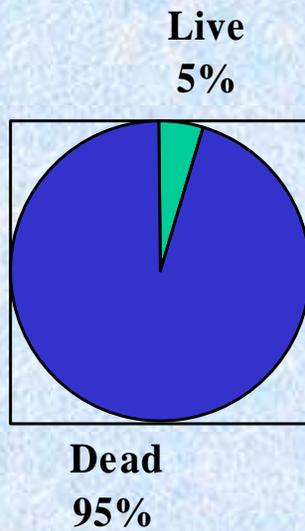
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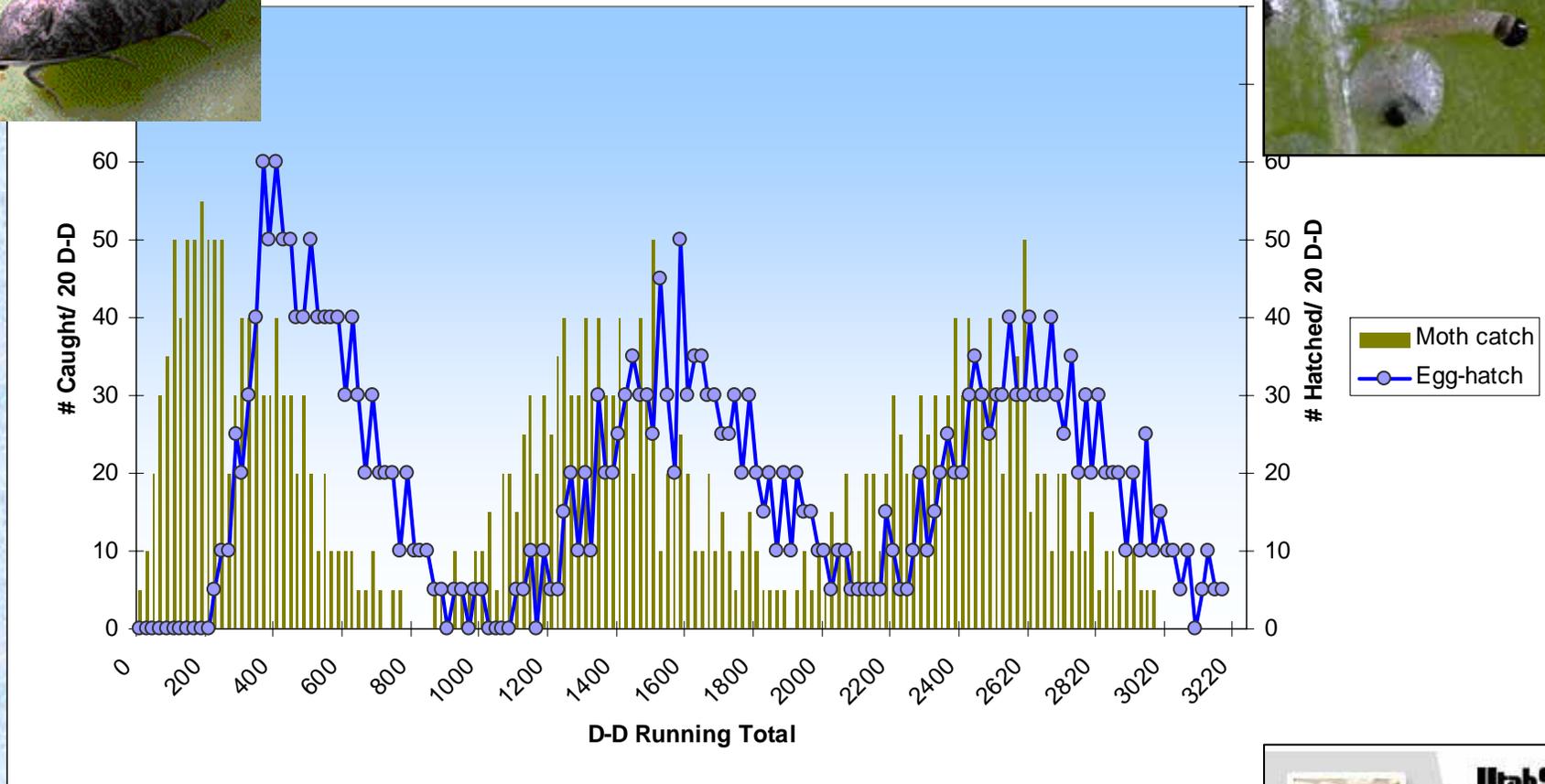
Topics for Today's CM Talk

- Biology of CM
- Optimal Treatment Timings
- Considerations for Orchard Management
- Insecticide Half-Lives
- Management Strategies for 2004 Season
- IPM Advisories

Effects of Scaling

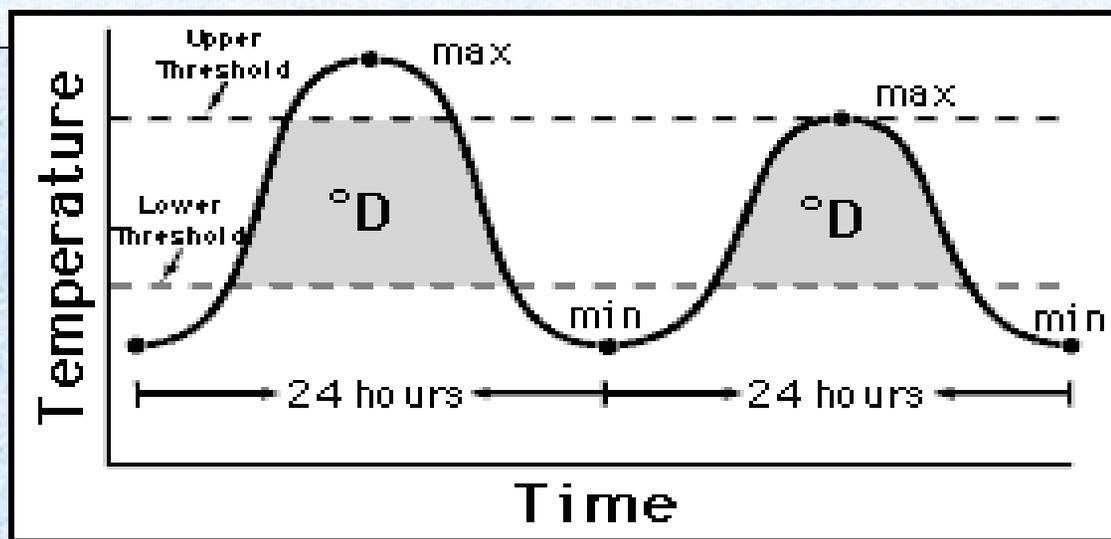


General Pattern of Codling Moth Flight and Egg-hatch, Relative to Degree-Days



Codling Moth Degree-Days

- Degree-days give us an indirect measurement of an arthropod's development.
- *How* are DDs calculated?
 - Time spent within a specific temperature range.
 - For codling moth, the *upper threshold is: 88*; the *lower is: 50*).



Important Stages in a Codling Moth's Life

- Pre-ovip. Flight: **58** DDs
 - Eggs: **158** DDs
 - Larval Feeding: **471** DDs
 - Pupae: **431** DDs
- Total for Generation: **1,118** DDs



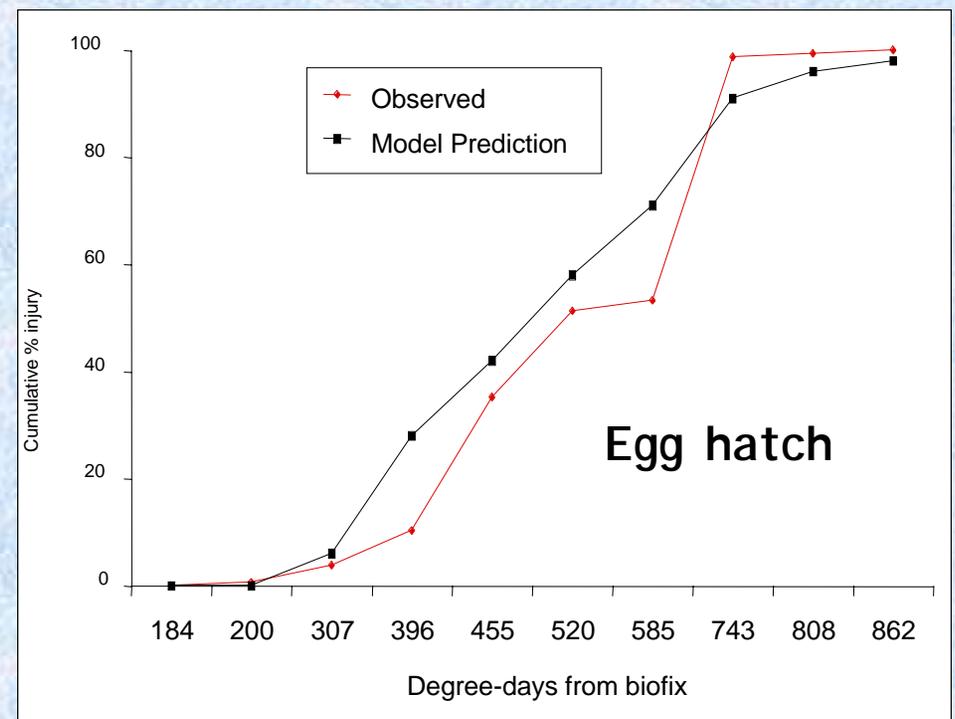
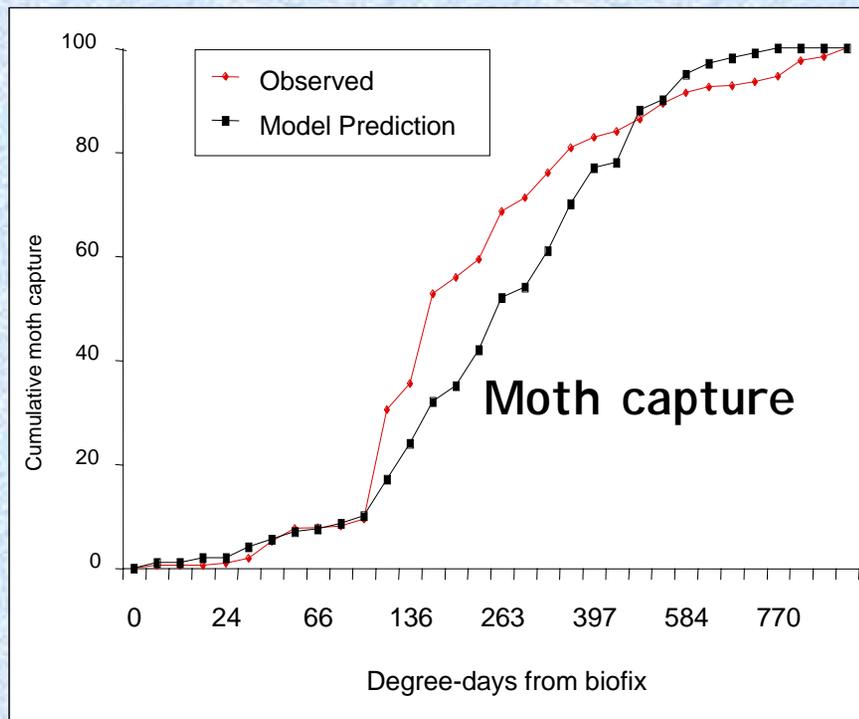
D-D Accumulations at Each Generation's Egg-hatch:

- ❖ **220 DDs**
(1st egg-hatch)
- ❖ **1,120 DDs**
(2nd egg-hatch)
- ❖ **2,160 DDs**
(3rd egg-hatch)



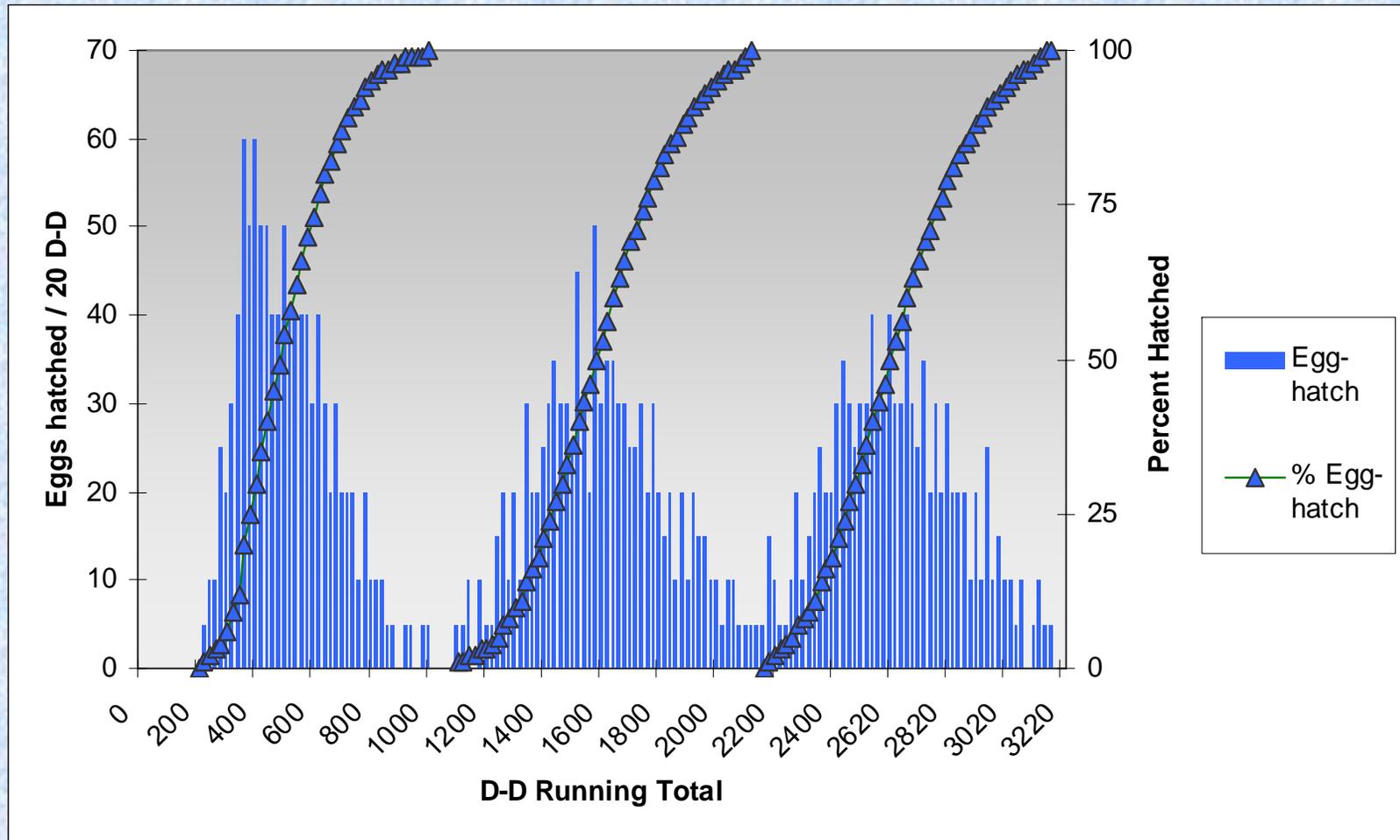
For the past 3 years the model has accurately predicted codling moth development (flight, oviposition, and egg hatch) in Wenatchee in unsprayed orchards.

2002 actual activity and model predictions - 1st generation



Courtesy Dr. Jay Brunner, WSU, Wenatchee

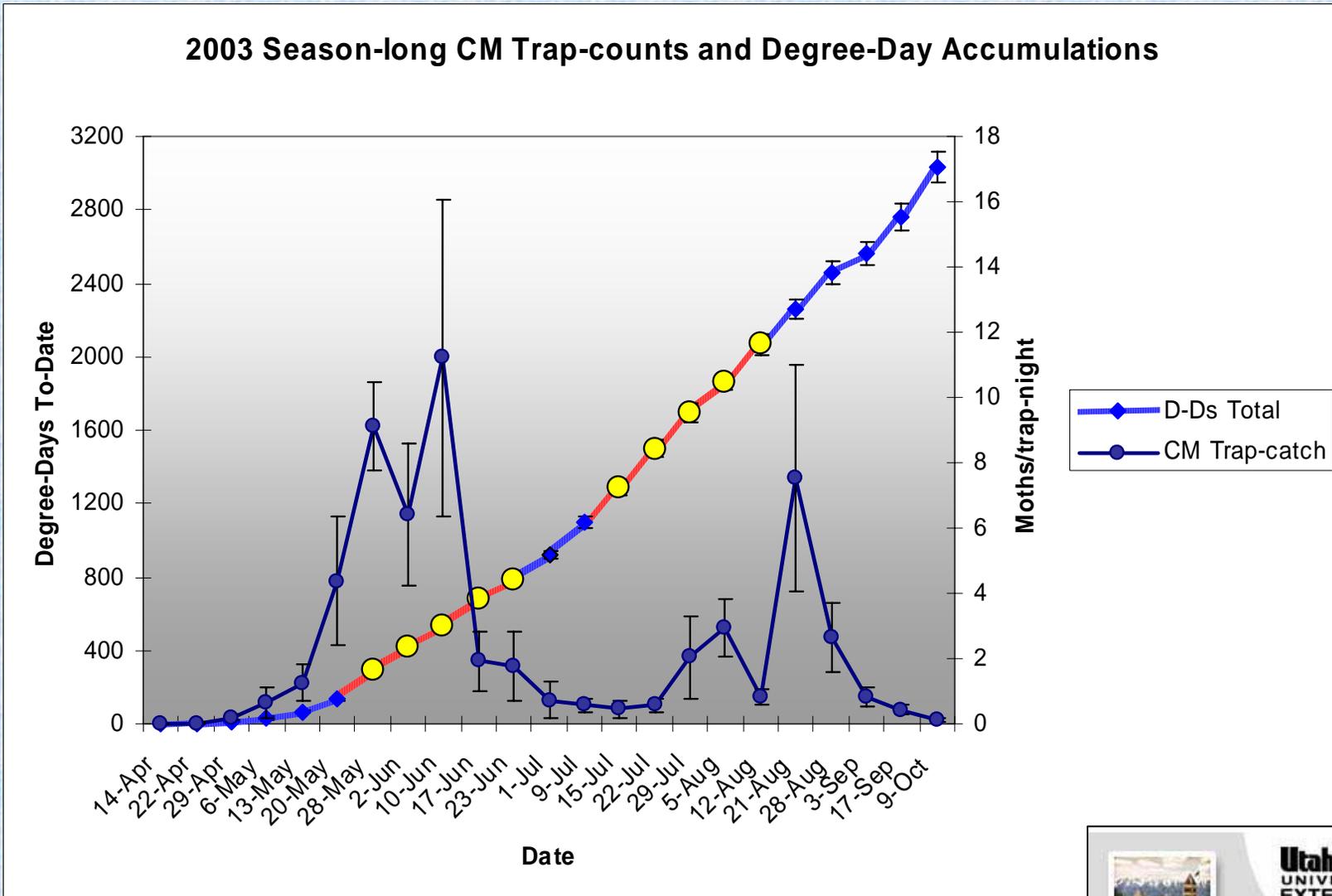
Peaks of Egg-Hatch*



*Based on Degree-Day/Development Tables in *Orchard Pest Management: A Resource Book for the Pacific Northwest*. E.H. Beers, J.F. Brunner, M.J. Willett, and G.M. Warner [eds.], Good Fruit Grower, Yakima, WA.

2003 Flight Data and D-D Accumulations

2003 Season-long CM Trap-counts and Degree-Day Accumulations



Broad-Stroke Strategy for CM Management

- Set traps in early spring (around bud break).
- At first biofix, hang mating disruption dispensers asap.
- Keep track of accumulated DDs using IPM Advisory or your own weather monitoring system.
- Make treatments based on DD accumulations (time sprays for egg-hatch periods).
- Continue to monitor traps and fruit.



Improve the Odds



- **Achieve better coverage** by using higher gallonages and verifying uniformity within the canopy.
- **Sanitation** (remove infested apples from orchard).
- **Rotate insecticide classes** (implications for spray timing).
- **Use Pheromone mating disruption** to *reduce the egg load*.



Mating Disruption Works

- Here's how:
 - It **delays the mating** of females.
 - Late mating means fewer eggs deposited.
 - The dispensers work **24-7** for months.
- Some of the nuts-n-bolts:
 - **Dispensers** (ties, tubes, ropes, membranes, puffers, etc.)
 - Applied relative to CM phenology, biofix.
 - Function is independent of sprays, tree growth.



Apple Growth and CM Phenology

- *How does fruit growth affect CM management?*
- *How do surface area (SA) dynamics correspond with particular CM biological events?*
- *What is the role of insecticide degradation in CM management?*
- Profound changes in fruit SA are coincident with critical phenological events.

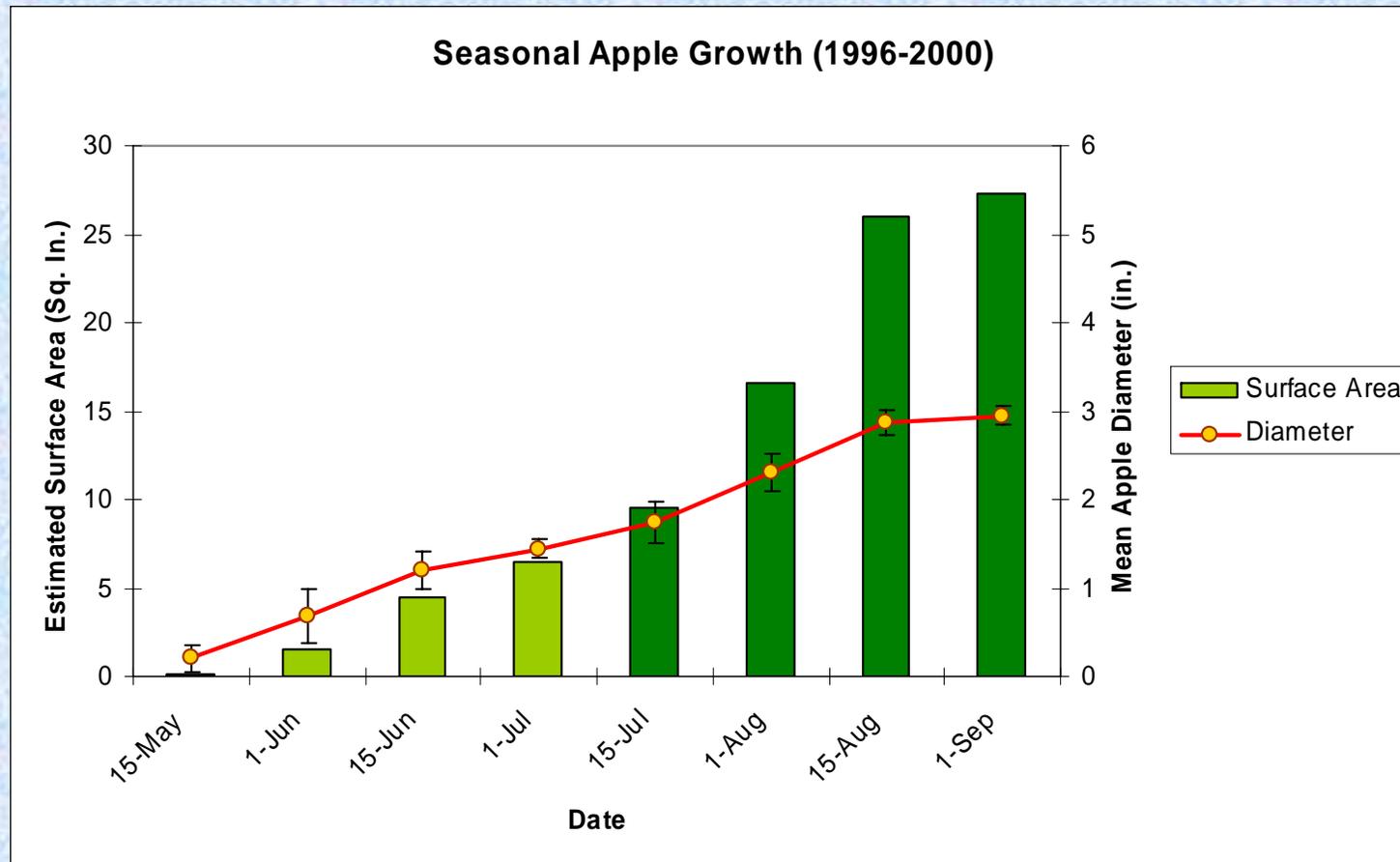


Fundamentals & Assumptions

- Apples tend to grow at a relatively linear rate through the season.
- An increase in fruit diameter translates into an increase in surface area.
- Assuming a somewhat spherical apple, its surface area (SA) can be approximated using the formula , $4\pi r^2$.
- Since SA is a function of the square of the radius, any increase in diameter allows for **exponential rise** in SA [\(graph\)](#).

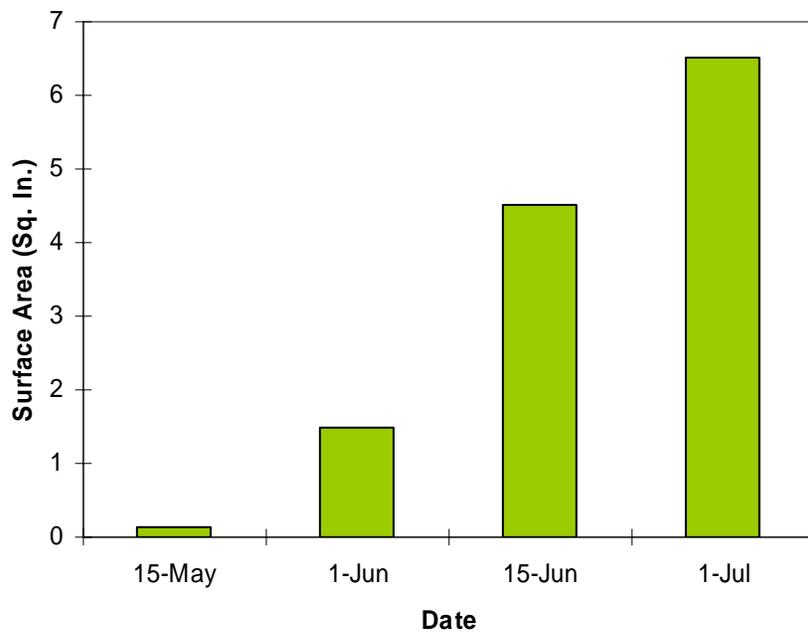


Fruit Growth Pattern in Northern Utah and Corresponding SA Values

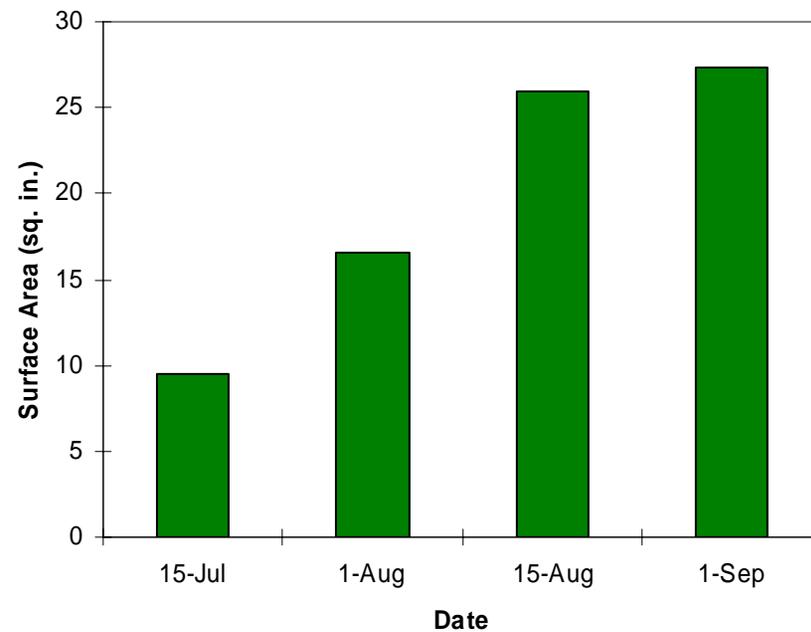


A Closer Look at Apple SA

Apple Surface Area: *Mid-May to Late-June*



Apple Surface Area: *July to Sept*



Changes in SA at 2-week intervals

Date	SA	<i>Multiplier</i>
5/15	0.13	11.5
6/1	1.49	3.1
6/15	4.52	1.4
7/1	6.53	1.5
7/15	9.48	1.7
8/1	16.62	1.6
8/15	25.96	



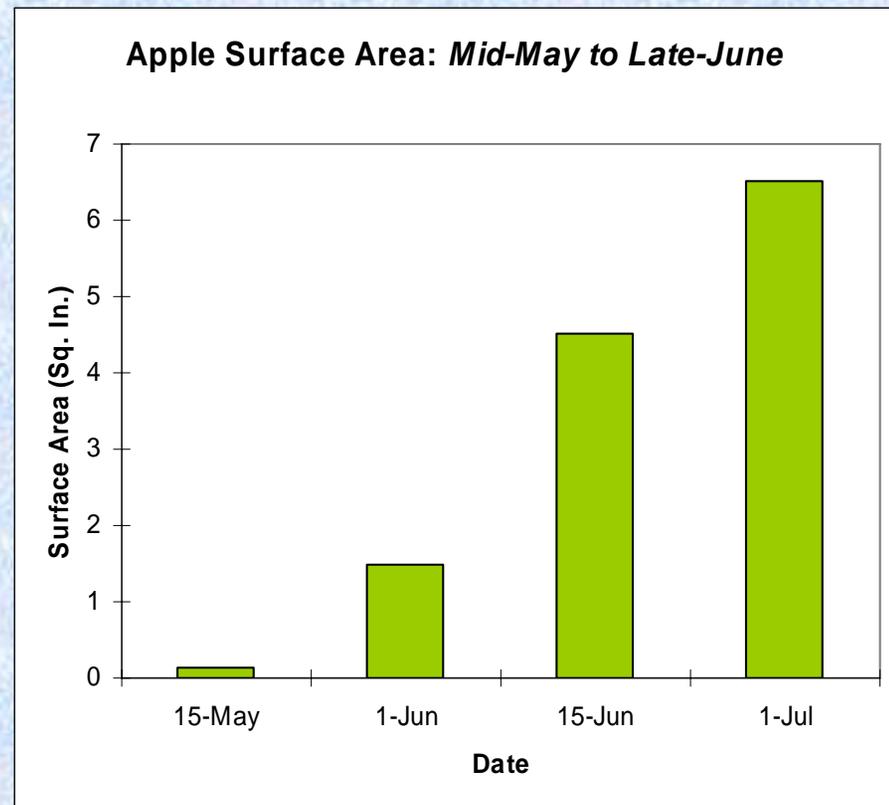
A Key Point in CM Development

- **1st Generation Egg-Hatch.**
 - The success/failure of 1st gen. larvae set the stage for the remainder of the season.

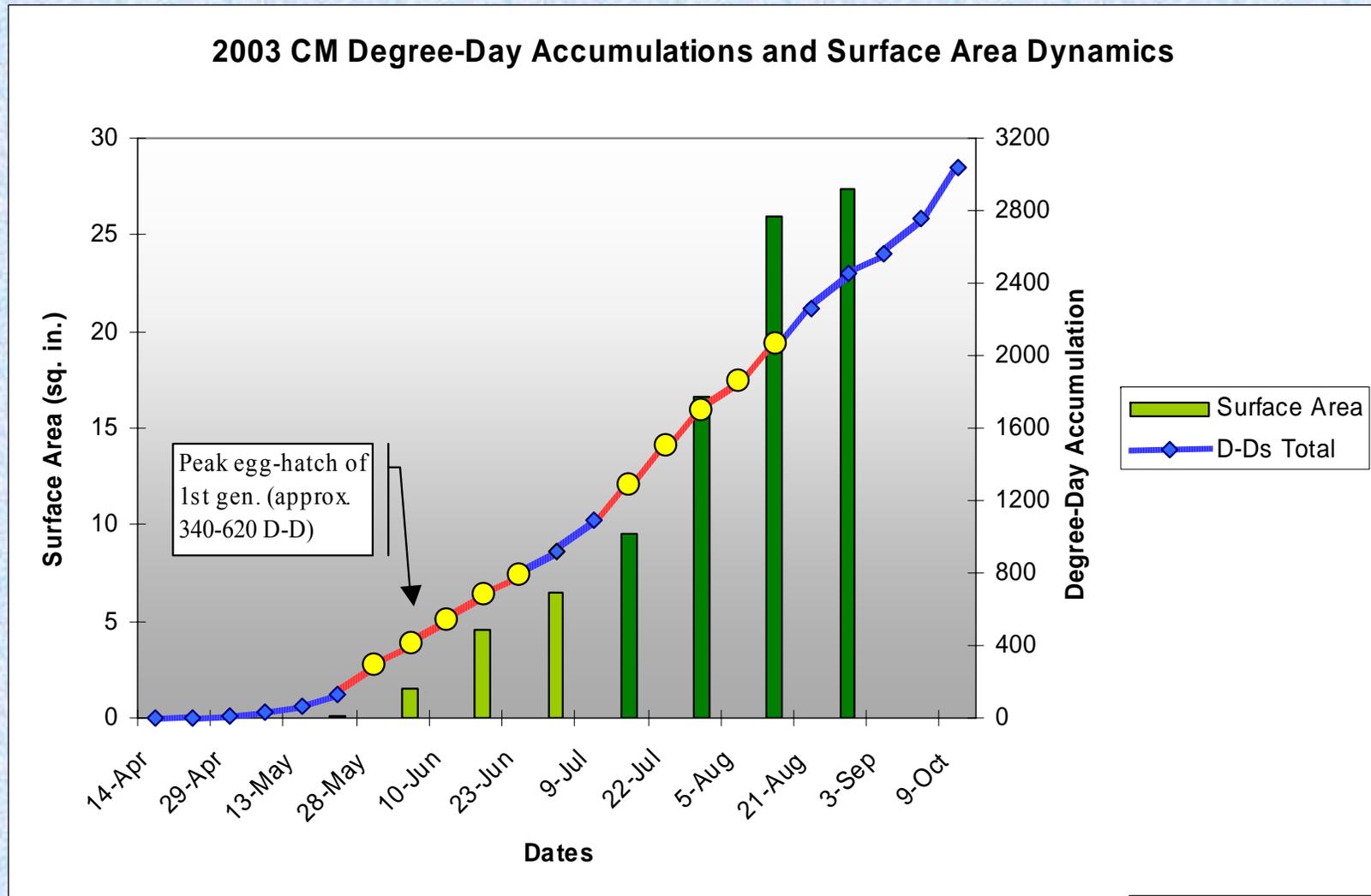


CM Egg-Hatch and Fruit Growth Patterns

- *Egg-hatch*:
 - 220 DD through 900 DD (3-98% egg-hatch)
- *Peak egg-hatch*:
 - typically between **340** and **650 DD**.
 - These numbers correspond respectively to *late-May* and *late-June* for much of northern Utah.



2003 DD Accumulations Vs. Fruit Growth



Annual Phenomena



- Greatest increase (shortest doubling-times) in SA occurs at approximately 200-800 DDs.
- Peak 1st gen egg-hatch will likely be between 340 and 620 DD.
- During the highest intensity larval hatch-out, apples are experiencing a dramatic increase in SA.



Effects of Insecticide Decay:

% residual remaining after n days

Half-life	7 days	10 days	14 days	21 days	28 days
1 day	0.8	0.1	trace	trace	trace
2 days	8.8	3.1	0.8	0.1	trace
3 days	19.9	10.2	3.9	0.8	0.2
4 days	29.7	17.7	8.8	2.6	0.8
5 days	37.9	25.0	14.4	5.4	2.1
7 days	50.0	37.1	25.0	12.5	6.2
10 days	61.5	50.0	37.9	23.3	14.4
14 days	70.7	61.0	50.0	35.4	25.0
20 days	78.4	70.7	61.6	48.3	37.9
28 days	87.5	78.1	70.7	59.5	50.0
50 days	90.8	87.1	82.4	74.7	67.8

- Computed using the following formula: $100 \cdot (0.5)^{n/t}$
 - where n = number days of decay; $t_{1/2}$ = material half-life; 100 is conversion factor for %



Material Half-lives

Material	Half-life (in days)		Trade-Names	Toxicity Class
	On leaf/bark	In soil		
azinphos-methyl	3-6	5	Guthion	I
Bt	0.5	2	DiPel	III
carbaryl	4-10	7-28	Sevin	II
chlorpyrifos	3-4	11-141	Lorsban	II
diazinon	6-14	14-28	Diazinon	II
endosulfan	3-7	50	Thiodan	I
esfenvalerate	14-28	15-90	Asana	II
imidacloprid	39	26-229	Provado	II
malathion	1.5	1-25	Malathion	III
methoxyfenozide	77	173	Intrepid	III
permethrin	4-5	30-38	Ambush	II
phosmet	7	4-20	Imidan	II

Sources: *Extension Toxicology Network*, <http://ace.orst.edu/info/extoxnet/pips/ghindex.html>
Spectrum Chemical Factsheets, <http://www.speclab.com/compound/>
Crop Protection Handbook 2003, Meister Publishing Company



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Possible Scenario

- Short half-life material (Guthion = 3-6 d)
- Gallonage: 50 gpa
- 1st cover spray applied at 250 DD from biofix
- No MD used
- 21 d spray interval

2 weeks after the spray:

- Apple SA has quadrupled
- Degradation of residual after 14 days: 4-20% of initial amount
- Spray coverage: 80%

During the last week of a 21 day spray interval:

$$0.8\% < C < 4.0\%$$

$$[(0.25)(0.04)(0.8) = 0.008]$$

$$[(0.25)(0.20)(0.8) = 0.040]$$

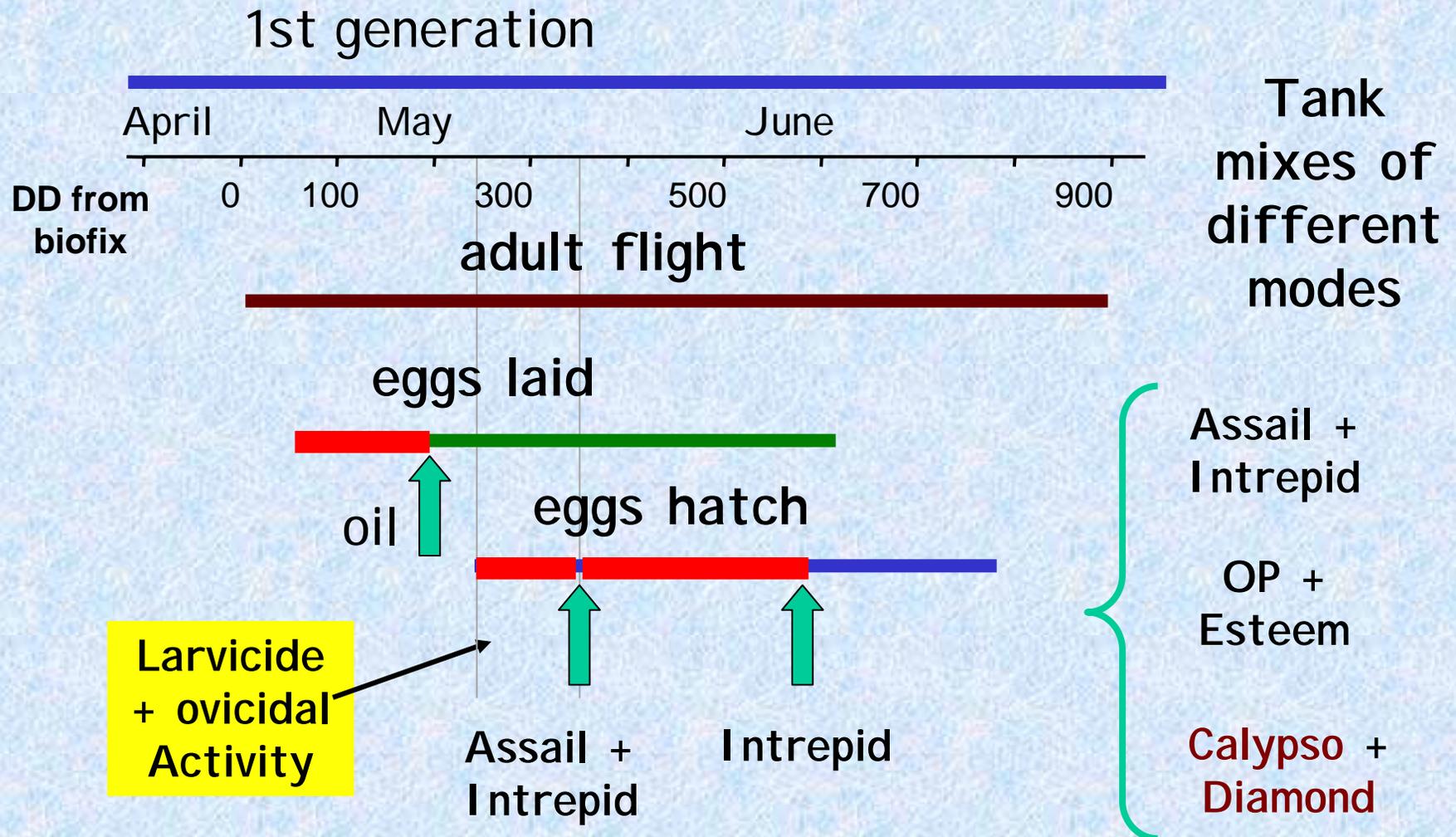


Specific Management Options

- *Ovicides*
 - Intrepid, Esteem, Diamond
 - Horticultural Oil
- *Larvicides*
 - Guthion, Imidan
 - Assail, Calypso, Provado
 - Danitol, Asana, Warrior
 - Intrepid, Esteem
 - Success, Bt, GpGV



Pest Management Program



Courtesy Dr. Jay Brunner, WSU-Wenatchee

Options & Combinations

- 1st Generation:
 - Mating disruption right after biofix
 - @ 60-100 DDs: ovicide (Intrepid, Esteem)
 - @ 200-220 DDs: oil (Volck Supreme, Orchex 796)
 - @ 340 DDs: Nicotinoid (Assail) + IGR (Diamond)
 - @ 520-600 DDs: OP (Imidan) + oil
 - (Mating disruption should be running entire time)
- 2nd Generation: typically begins ~ 1,100 DDs



Some Good Links & Resources

- Shawn Steffan, 435-797-0776, steffan@biology.usu.edu, www.extension.usu.edu/ipm
- Diane Alston, 435-797-2516, dianea@biology.usu.edu
- Mike Pace, 435-734-9945, ext. 263
- Code-a-Phone, 801-370-8533 (Utah Co.)
- www.extension.usu.edu/ipm/SlideShowIndex.htm
- Tools and materials:
 - www.ipmtech.com
 - www.homeharvest.com
 - www.greatlakesipm.com