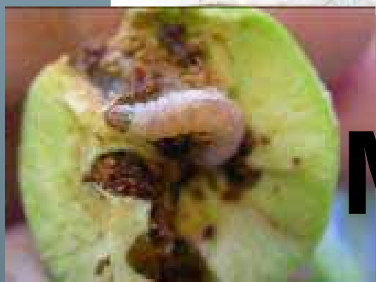
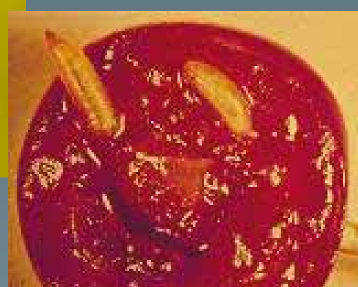


Updates on Monitoring and Management of Codling Moth

Cherry Fruit Fly Attractants



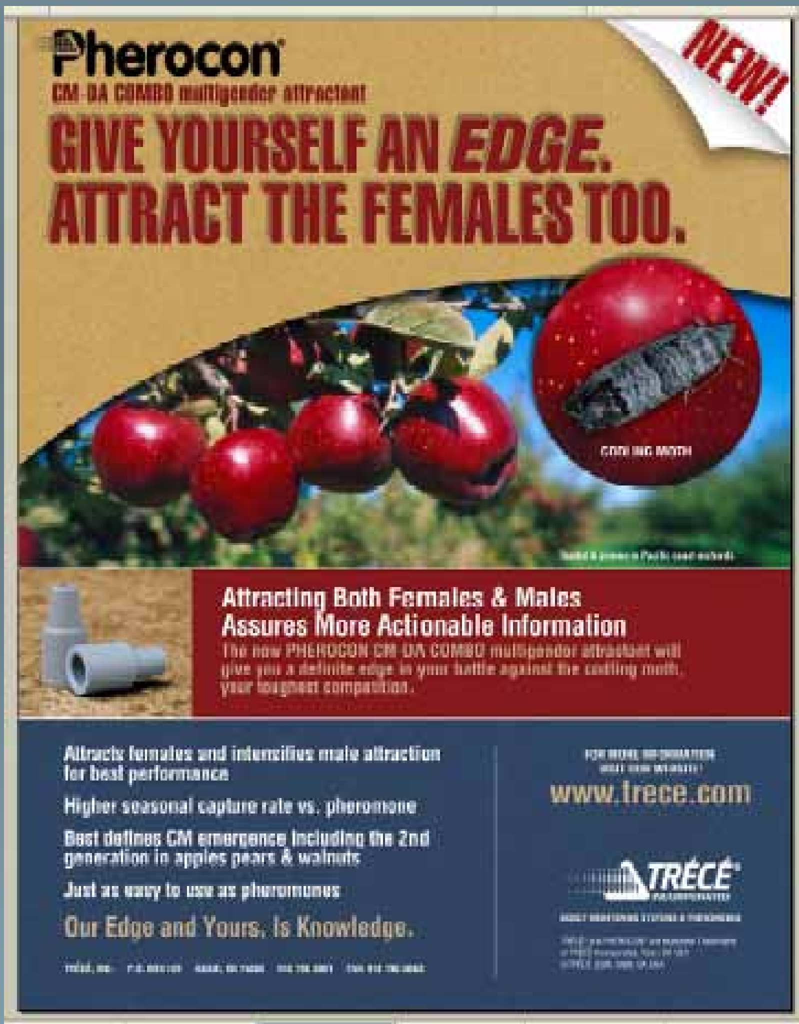
Diane Alston

Utah State University Extension

USHA Annual Convention

Jan. 30, 2007

Monitoring Codling Moth in Mating Disrupted (MD) Orchards



Standard 1X pheromone lure (4 wk)

- red septa, Biolure membranes

Long-life lures (8 wk)

- gray septa

10X pheromone lure (2-3 wk)

DA lure (pear ester – food attractant)

DA-Combo lure (pear ester + pheromone)

Trap Thresholds in MD Orchards

Using pear ester to monitor codling moth in sex pheromone treated orchards

EM 8904
February 2006
$4.50

A. Knight, R. Hilton, P. VanBuskirk, and D. Light

Advantages in using pear ester include:

- Tracking female flight patterns
- Improving prediction of first egg hatch
- Using action thresholds to optimize a spray program

Pear ester is a characteristic pear flavor attractive to codling moth (i.e., a kairomone). Traps baited with a pear ester lure can be used to monitor male and female adult codling moth activity.

Pear ester is a natural volatile produced by ripening pears. Male and female codling moths have specialized receptors on their antennae that can detect pear ester. Male moths respond to pear ester while searching for a host where female moths will be available for mating. Female codling moths also use the pear ester to locate the host, and mated females use the pear ester to locate specific sites to lay eggs near or on fruit. Other host-produced chemicals can affect the behavior of codling moth, but no other compound tested so far has proven to be as attractive and chemically stable as pear ester.

Growers' use of sex pheromones to disrupt codling moth mating strongly impacts male moth behavior but does not affect moths' responses to pear ester. Thus, pear ester can be an effective lure to use in orchards treated with sex pheromone. Many studies have been conducted to understand how to best use pear ester. This publication summarizes the current state of our knowledge regarding the use of pear ester; as additional information is gathered, recommendations for use will be updated.

How to monitor

Careful monitoring of codling moth in orchards treated with sex pheromone mating disruption is critical due to the influence of moth density on effective disruption and the potential for undetected moth immigration into treated orchards. Thresholds have been established both to minimize the unnecessary use of insecticides and to avoid failing to detect a within-orchard population. Growers' monitoring programs need to be standardized, and recommendations in this report are based on the best available data. Any changes in this program will likely influence the interpretation of trap counts and may affect the efficacy of your management program.

The pear ester lure often will catch fewer moths than a sex pheromone lure; this is particularly true in orchards that are not treated with sex pheromone and where densities of codling moth are high. However, in sex pheromone treated orchards with low populations of codling moth, the pear ester lure generally will catch similar numbers of moths as a standard (i.e., high load) sex

Alan Knight, research entomologist, U.S. Department of Agriculture Agricultural Research Service, Wapato, WA; Richard Hilton, senior research assistant, and Philip VanBuskirk, Extension horticulturist, both of Southern Oregon Research and Extension Center, Oregon State University; and Douglas M. Light, research entomologist, U.S. Department of Agriculture Agricultural Research Service, Albany, CA.

Oregon State University | Extension Service

Brunner and Gut
10X pheromone traps:
4-10 moths

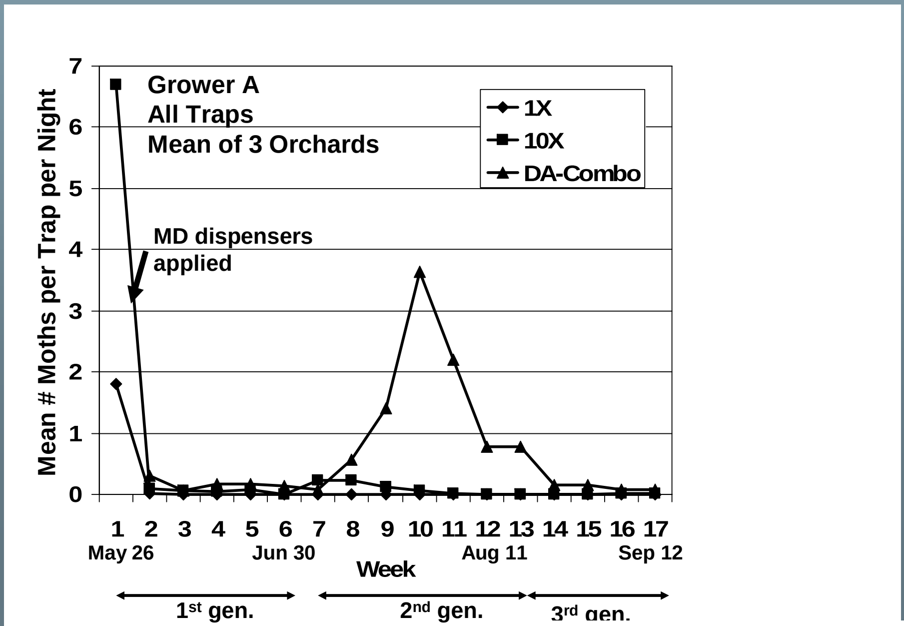
Knight *et al.* (OSU fact sheet)
DA traps:
2 moths or 1 female moth

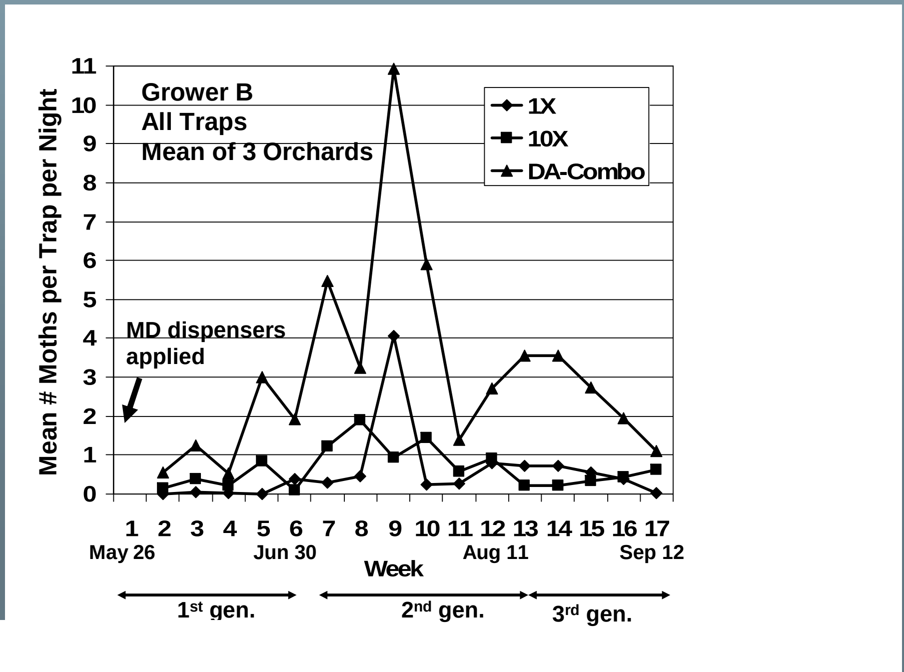
Trece recommendation
DA-Combo traps:
5-10 moths

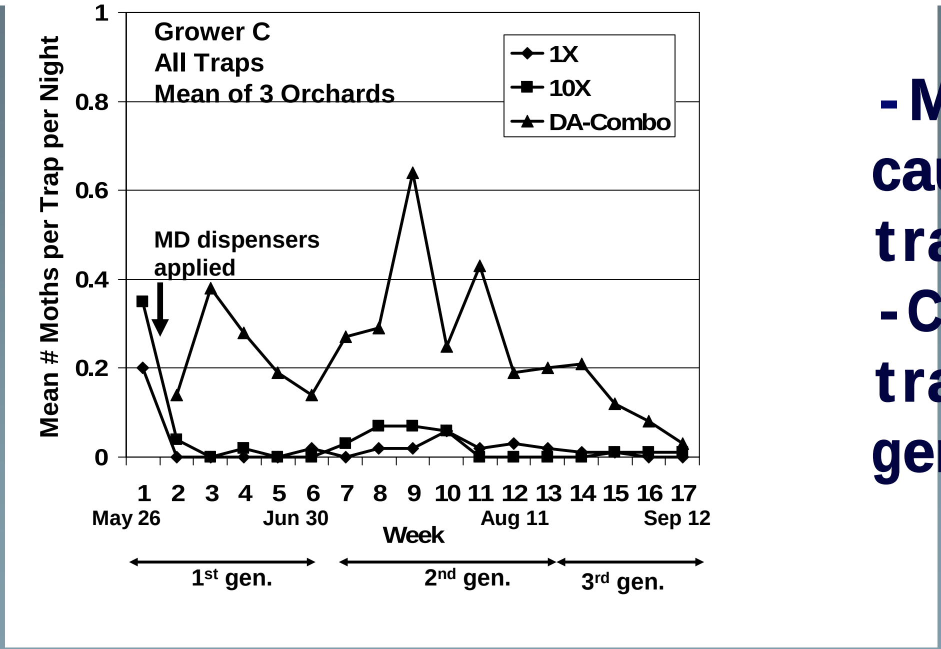
2006 CM Monitoring Study

- 3 lures in large Delta traps
  - 1X, 10X, DA-Combo
- 9 apple orchards using MD
  - Braeburn, 2 Fuji, 2 Gala, Golden Del., 2 Jonathan, Red Del.
- Payson, Santaquin, & Genola
- 2 replicates per orchard
  - 18 traps with each lure
- Mid May to mid Sept
- # moths caught & fruit injury
  - Per generation
  - 400 fruit per orchard per generation

Trap Catch





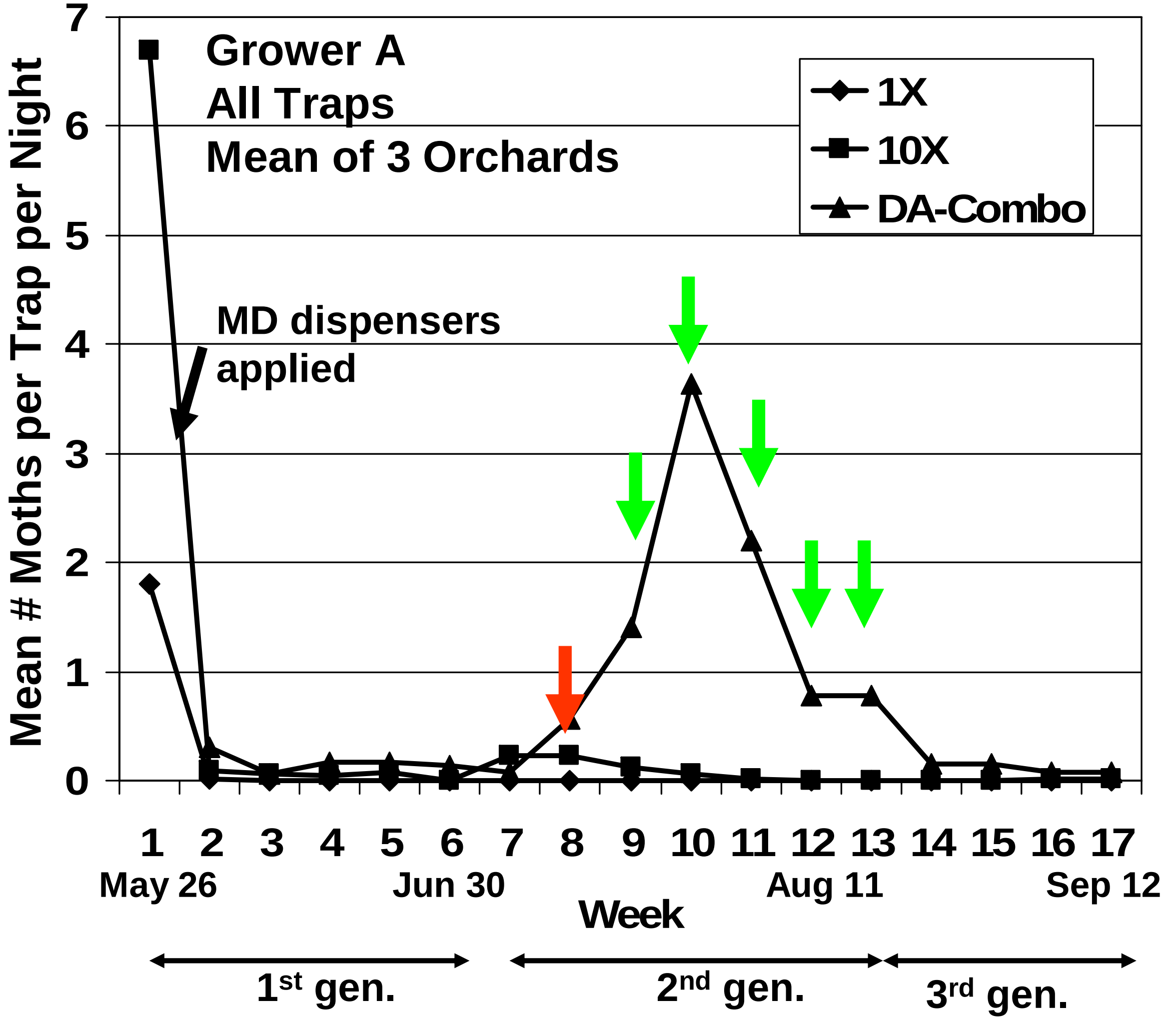


Trap catch was averaged across 3 orchards for each grower

- More moths were caught in DA-Combo traps
- Catch in DA-Combo traps followed generation periods

Comparing Trap Catch Thresholds to Number of Recommend Sprays and Fruit Injury

Grower A



Trap thresholds:

10X trap:
4 moths

DA-Combo:
5 moths

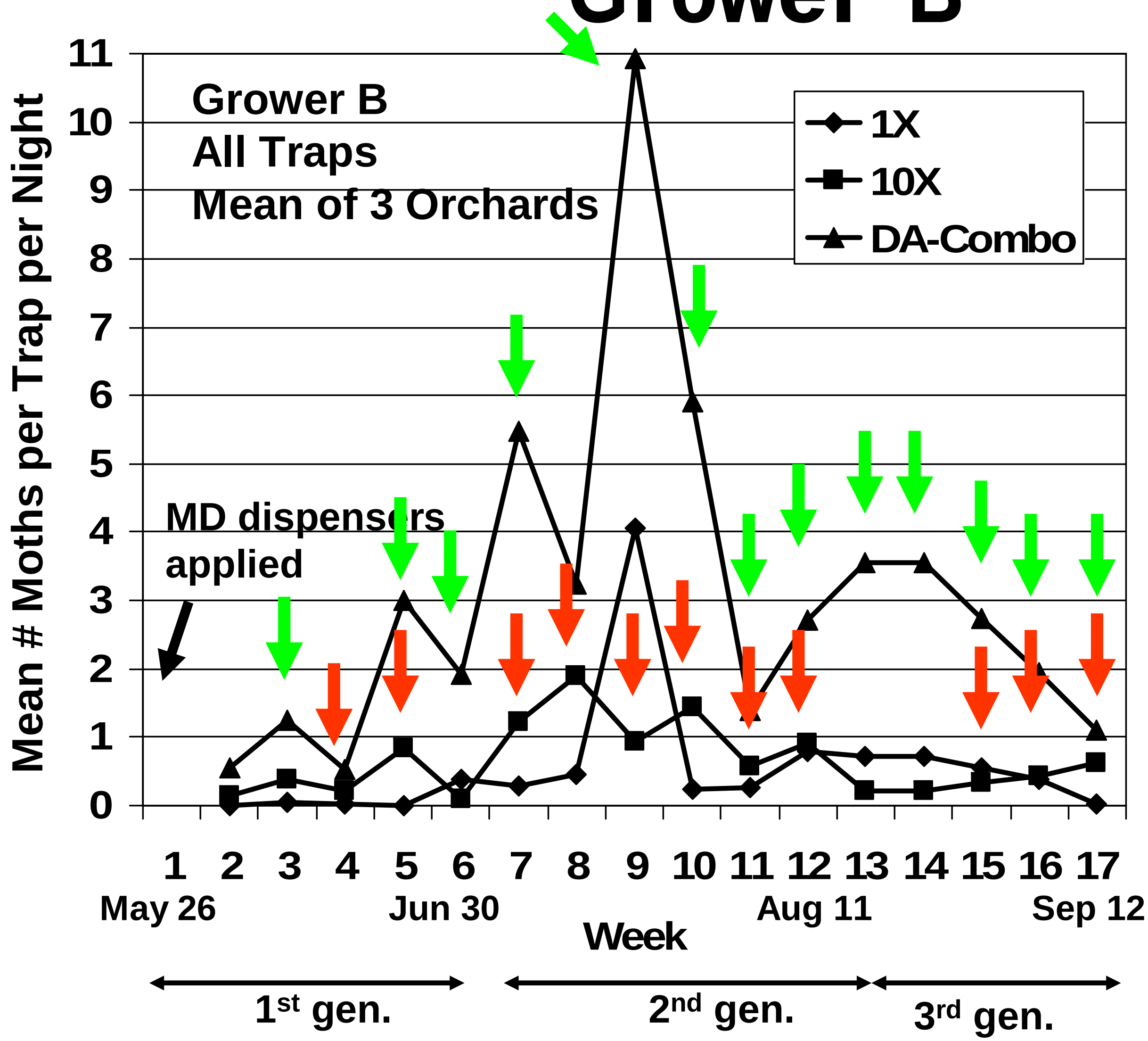
Fruit Injury:

Braeburn	3.8%*
Fuji	2.5%
Jonathan	21.0%
Mean	9.1%

***Larval entries on Jul 5 & Aug 23**

Comparing Trap Catch Thresholds to Number of Recommend Sprays and Fruit Injury

Grower B



Trap thresholds:

10X trap:
4 moths

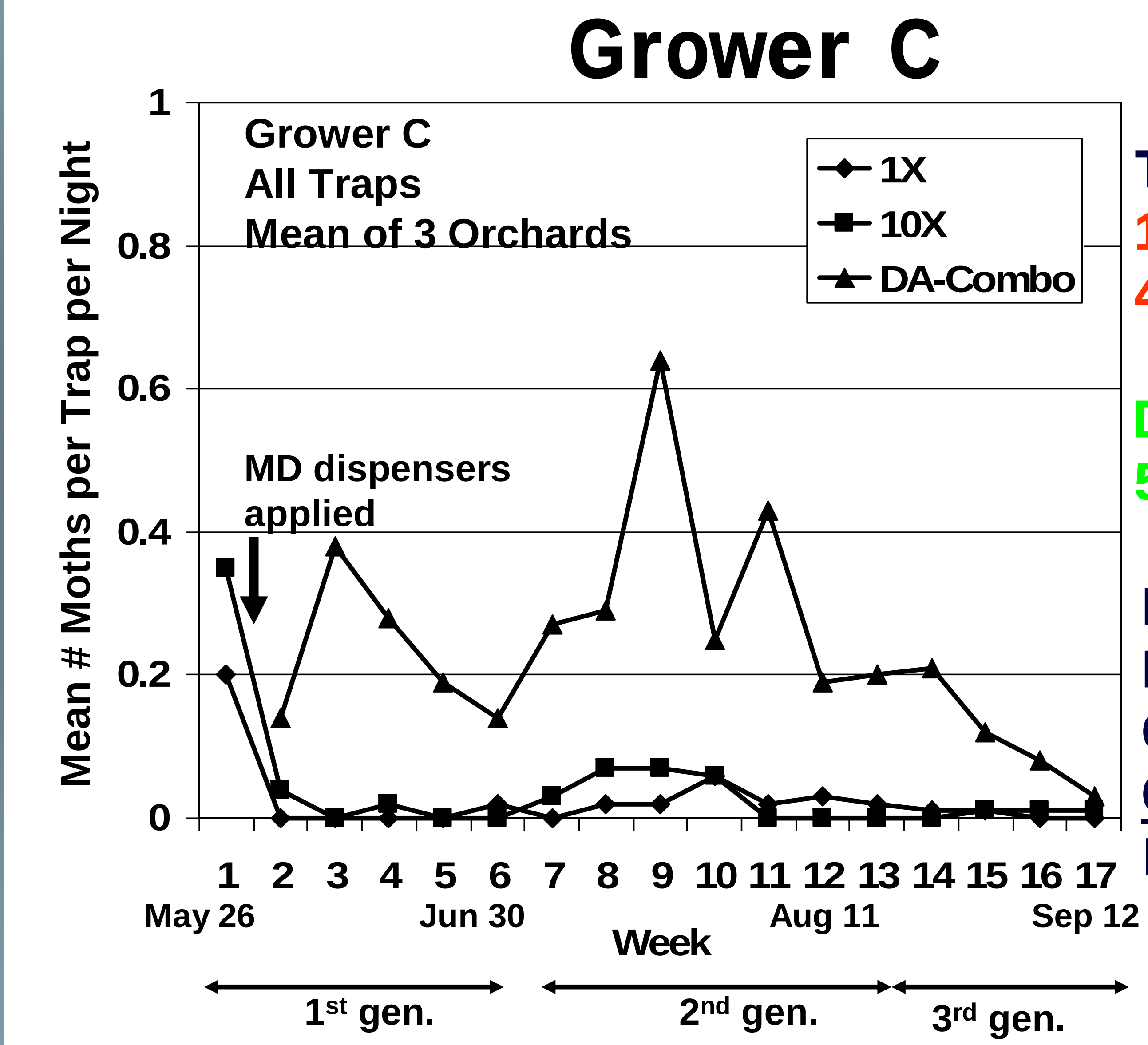
DA-Combo:
5 moths

Fruit Injury:

Gala	6.8%*
Jonathan	27.3%
Red Del.	32.3%
Mean	22.1%

*Larval entries on Jul 5 & Aug 23

Comparing Trap Catch Thresholds to Number of Recommend Sprays and Fruit Injury



Trap thresholds:

10X trap:
4 moths

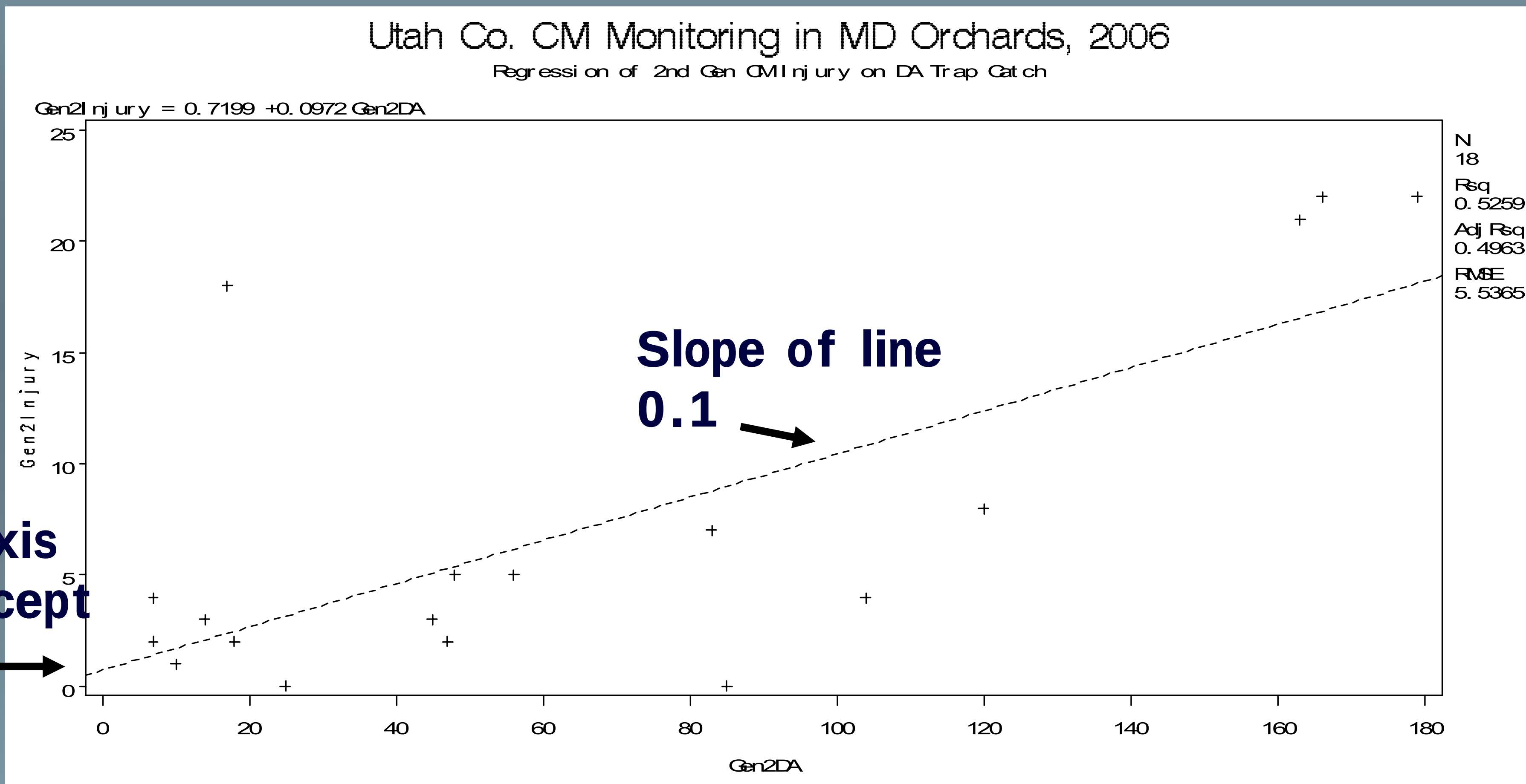
DA-Combo:
5 moths

Fruit Injury:

Fuji	1.5%*
Gala	1.3%
Golden Del.	4.5%
Mean	2.4%

*Larval entries on Jul 5 & Aug 23

Regression of % fruit injury on cumulative moth catch in DA-Combo traps for 2nd generation



Slope of line 0.1

X- axis intercept 0.7

Approximately 0.1% larval entries for every moth caught

5 moths → 0.5% injury, 10 moths → 1.0% injury

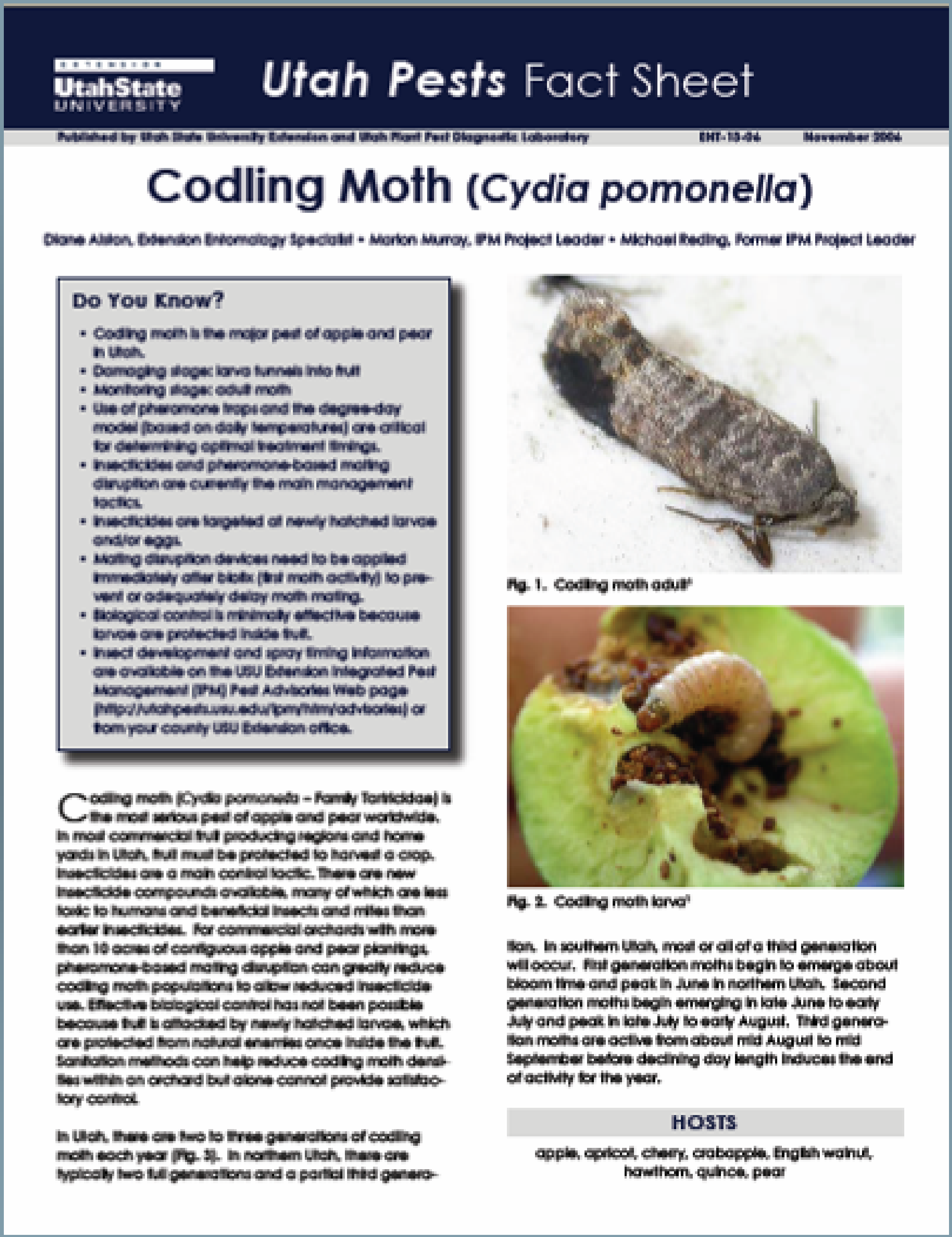
Relation of 1st to 2nd Generation Codling Moth Fruit Injury

Orchard (Apple Variety)	% fruit with injury			
	1st generation*		2nd generation^	
	Stings	Entries	Stings	Entries
Braeburn	7.0	1.0	1.5	2.8
Fuji	7.3	1.5	2.0	1.0
Fuji	1.8	0.5	0.5	1.0
Gala	0	0	0.8	1.3
Gala	2.3	2.5	1.3	4.3
Golden Del.	1.5	1.5	0.3	3.0
Jonathan	7.5	8.5	0.3	12.5
Jonathan	2.5	5.8	3.0	21.5
Red Del.	3.0	12.0	1.5	20.3

*July 5 ^August 23

2006 was a tough year for codling moth injury

- High populations
- Even with MD, supplemental insecticide sprays were needed
- Resistance & cross-resistance to insecticides
- Hot weather, 3 generations
- Insecticide timing issues
- Full monitoring program!
- No room for error



UtahState UNIVERSITY

Utah Pests Fact Sheet

Published by Utah State University Extension and Utah Plant Pest Diagnostic Laboratory ENT-13-06 November 2006

Codling Moth (*Cydia pomonella*)

Diane Alston, Extension Entomology Specialist • Marion Murray, IPM Project Leader • Michael Reding, Former IPM Project Leader

Do You Know?

- Codling moth is the major pest of apple and pear in Utah.
- Damaging stage: larva tunnels into fruit
- Monitoring stage: adult moth
- Use of pheromone traps and the degree-day model (based on daily temperatures) are critical for determining optimal treatment timings.
- Insecticides and pheromone-based mating disruption are currently the main management tactics.
- Insecticides are targeted at newly hatched larvae and/or eggs.
- Mating disruption devices need to be applied immediately after biofix (first moth activity) to prevent or adequately delay moth mating.
- Biological control is minimally effective because larvae are protected inside fruit.
- Insect development and spray timing information are available on the USU Extension Integrated Pest Management (IPM) Pest Advisories Web page (http://utahpests.usu.edu/ipm/htm/advisories) or from your county USU Extension office.

Codling moth (*Cydia pomonella* – Family Tortricidae) is the most serious pest of apple and pear worldwide. In most commercial fruit producing regions and home yards in Utah, fruit must be protected to harvest a crop. Insecticides are a main control tactic. There are new insecticide compounds available, many of which are less toxic to humans and beneficial insects and mites than earlier insecticides. For commercial orchards with more than 10 acres of contiguous apple and pear plantings, pheromone-based mating disruption can greatly reduce codling moth populations to allow reduced insecticide use. Effective biological control has not been possible because fruit is attacked by newly hatched larvae, which are protected from natural enemies once inside the fruit. Sanitation methods can help reduce codling moth densities within an orchard but alone cannot provide satisfactory control.

In Utah, there are two to three generations of codling moth each year (Fig. 3). In northern Utah, there are typically two full generations and a partial third generation. In southern Utah, most or all of a third generation will occur. First generation moths begin to emerge about bloom time and peak in June in northern Utah. Second generation moths begin emerging in late June to early July and peak in late July to early August. Third generation moths are active from about mid August to mid September before declining day length induces the end of activity for the year.

Fig. 1. Codling moth adult[1]

Fig. 2. Codling moth larva[2]

HOSTS

apple, apricot, cherry, crabapple, English walnut, hawthorn, quince, pear

Updated the Codling Moth Fact Sheet

http://utahpests.usu.edu/ipm

Includes:

- Monitoring in MD orchards
- Lure types
- Timing insecticides that target multiple life stages
- Revised DD and “management events” table
- Insecticide options
- Mating disruption

Degree-day Model

The Degree-day Method

- The development of codling moth, like all insects, can be predicted based on accumulated heat over time, called degree days (DD). Use of the codling moth phenology model based on DD will help to more accurately time insecticide applications and reduce the number of applications to a minimum.
- Codling moth development occurs between the lower and upper temperature thresholds of 50° F and 88° F.
- Starting March 1 in northern Utah or January 1 in southern Utah, begin accumulating DD for an individual location by:
  - collecting representative daily maximum and minimum air temperatures and using the DD look-up table (Table 2), or
  - obtaining the information provided by USU Extension on the IPM Pest Advisories Web page (http://utahpests.usu.edu/ipm/htm/advisories) or from your county extension office.
- Place pheromone traps in orchards when 100 DD have accumulated. The first moths are expected by 150 - 200 DD.
- Once biofix (first consistent moth catch) has occurred, accumulated DD are reset to zero (Table 1).

Timing Sprays

- If mating disruption (MD, see page 6) is used in an orchard, dispensers should be hung immediately after biofix to prevent mating and egg-laying. Supplemental insecticide treatments are usually necessary even when MD is used. The first cover spray is often the most important to apply as this timing should suppress the first generation and thus the following generations.
- Depending on the type of insecticide used, the first cover spray should be applied as follows:

DD after biofix	Timing/Target	Examples
50 - 75	pre-egg-laying	Rimon
100 - 200	early egg-laying	Horticultural oil, Esteem, Intrepid
200 - 250	first egg hatch (emergence of larvae)	Assail, Asana, Calypso, Carbaryl, Diazinon, Guthion, Codling Moth Granulosis Virus, Imidan

- Reapply insecticides based on the residual period (i.e., protection interval) of the product used. Keep fruit protected throughout each generation (Table 1).
- As harvest date approaches, consider the pre-harvest interval (required time interval between insecticide application and harvest) in planning late season treatments.

Table 1. Major events in a codling moth management program, based on accumulated degree days

Degree Days	% Adults Emerged	% Egg Hatch	Management Event
100 *	0	0	• Place traps in orchards
150 - 200	First moths expected	0	• Check traps every 1-2 days until biofix is determined
First Generation			
0 (biofix)†	First consistent catch	0	• Reset degree days to 0
50 - 75	5 - 9	0	• First eggs are laid • Apply insecticides that need to be present before egg-laying
100 - 200	15 - 40	0	• Early egg-laying period • Apply insecticides that target early egg-laying period
220 - 250	45 - 50	1-3	• Beginning of egg hatch • Apply insecticides that target newly hatched larvae
340 - 640	67 - 98	12 - 80	• Critical period for control, high rate of egg hatch • Important to keep fruit protected during this period
920	100	99	• End of egg hatch for 1st generation
Second Generation			
1000 - 1050	5 - 8	0	• First eggs of 2nd generation are laid • Apply insecticides to target early egg-laying
1100	13	1	• Beginning of egg hatch • Apply insecticides that target newly hatched larvae
1320 - 1720	46 - 93	11 - 71	• Critical period for control, high rate of egg hatch
2100	100	99	• End of egg hatch for 2nd generation
Third Generation			
2160	1	15	• Beginning of egg hatch • Keep fruit protected through September 15 • Check pre-harvest interval of material used to ensure that final spray is not too near harvest.

*Begin accumulating degree days after daily temperatures begin to exceed 50°F, typically on January 1 for southern Utah or March 1 for northern Utah.

† Biofix is when at least 2 moths are caught on consecutive nights.

Major events in a codling moth management program, based on accumulated degree-days (DD)

Recommended timing for insecticides based on their mode of action

2006 Reduced Risk Insecticide Trial

Kaysville Research Orchard

Table 1. Insecticide treatment applications and timings.

Trt	1st generation CM				2nd generation CM			
1	Rimon 50-75 DD May 15	Rimon 14 d later May 30	Assail 14 d later Jun 12		Rimon 1000 DD Jul 6	Rimon 14 d later Jul 22	Assail 14 d later Aug 2	
2		Rimon + Assail 250 DD May 24	Rimon 14 d later Jun 7	Calypso 7 d later Jun 14		Rimon + Assail 1200 DD Jul 12	Rimon 14 d later Jul 26	Calypso 13 d later Aug 8
3	Esteem 100 DD May 18	Assail 350 DD May 30	Intrepid 14 d later Jun 12		Esteem 1050 DD Jul 6	Assail 1380 DD Jul 22	Intrepid 16 d later Aug 7	
4	Oil 150-200 DD May 19	Intrepid 350 DD May 30	Assail 14 d later Jun 12		Oil 1100 DD Jul 10	Intrepid 1380 DD Jul 22	Calypso 16 d later Aug 7	
5		Guthion 250 DD May 24	Assail 14 d later Jun 7	Calypso 7 d later Jun 14		Guthion 1200 DD Jul 12	Calypso 16 d later Jul 28	Calypso 11 d later Aug 8
6								

Mean apple fruit injury

Trt #	Insecticides*	% fruit with injury (Jun 28)			% fruit with injury (Aug 17)		
		Stings	Entries	Total	Stings	Entries	Total
1	Ri-As-Ri	1.8 c	3.0 ab	4.8 bc	1.1	1.9 b	3.0 b
2	Ri+As-Ri-Ca	2.0 bc	2.5 abc	4.5 bc	1.4	0.8 b	2.2 b
3	Es-As-In	2.3 c	1.8 bc	4.0 c	2.1	3.3 b	5.4 b
4	Oi-In-As/Ca	5.0 ab	2.8 abc	7.8 ab	2.5	4.1 b	6.6 b
5	Gu-As/Ca-Ca	2.3 c	1.3 c	3.5 c	1.3	1.0 b	2.3 b
6		6.0 a	4.5 a	10.5 a	2.1	12.8 a	14.9 a
P>F		0.04	0.05	0.01	0.61	0.005	0.01

*Insecticides applied for each CM generation: As = Assail, Ca = Calypso, Es = Esteem, Gu = Guthion, In = Intrepid, Oi = Oil, Ri = Rimon

Non-target effects on mites

Trt #	Insecticides*	Mean # mites per 20 leaves				
		Phyto Mites^	Phyto Mite Eggs	Pred Mites~	Pred Mite Eggs	Thrips
1	Ri-As-Ri	33.8	8.8	67.8 bc	11.8	0.3
2	Ri+As-Ri-Ca	4.3	0.3	36.5 c	1.8	0.0
3	Es-As-In	0.3	0.0	153.3 ab	9.8	0.3
4	Oi-In-As/Ca	0.0	1.0	51.0 bc	1.7	0.0
5	Gu-As/Ca-Ca	1.5	5.5	331.8 a	31.3	0.3
6		1.0	2.5	162.3 ab	14.5	0.0
P>F		0.13	0.76	0.01	0.11	0.8

***Insecticides applied for each CM generation: As = Assail, Ca = Calypso, Es = Esteem, Gu = Guthion, In = Intrepid, Oi = Oil, Ri = Rimon**

^Phyto Mites = phytophagous mites (two spotted spider mites, brown mites, and rust mites)

~Pred Mites = predaceous mites (*Typhlodromus* and *Zetzellia*)

New CM Products

- Insecticides (broad spectrum)
  - Battalion (deltamethrin) – 5th gen. synthetic pyrethroid, less mite flare, Arysta LifeScience Corp.
  - Altocor (rynaxypyr) – new class, "anthranilic diamide", interferes with calcium gates in muscles, affects movement, DuPont Crop Protection
  - Delegate (spinetoram) – new spinosyn insecticide, Dow AgroSciences
  - Belt and Synapse (flubendiamide) – new class, "phthalic acid diamides", disruption of cellular calcium balance, Bayer CropScience

New CM Products

- Pheromone MD products
  - CideTrak DA-Combo dispenser – pear ester + pheromone in dispenser, Trece
  - CideTrak DA MEC – micro-encapsulated, sprayable pear ester MD product, Trece
  - SPLAT – flowable pheromone dispenser, MD and attract-&-kill if insecticide added, ISCA Technologies
  - Pheromone flakes & fibers – applied in sticky glue, not commercially available

Update on Guthion Registration

- Apple, Pear, Sweet & Tart Cherry
  - Registration will end in 2012
  - Phase-down of allowed pounds per acre for the season
  - 60 ft buffer from treated orchards to bodies of water
  - 60 ft buffer from orchards to human occupied buildings
  - Lengthy PHI for U-pick orchards

Cherry Fruit Fly Attractants

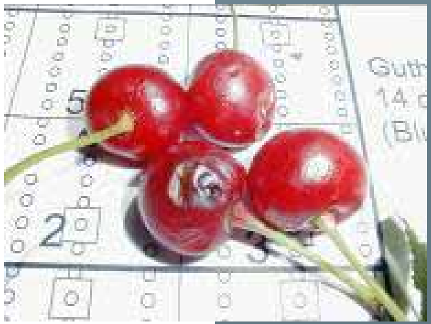
- GF-120 (bait + 0.2% a.i. spinosad)
  - Bait is not that attractive
  - Foraging adults encounter droplets and eat them
  - Spinosad is highly toxic upon ingestion
- Interest in developing a more attractive bait
- Ammonium materials
  - Ammonium carbonate
  - Ammonium acetate

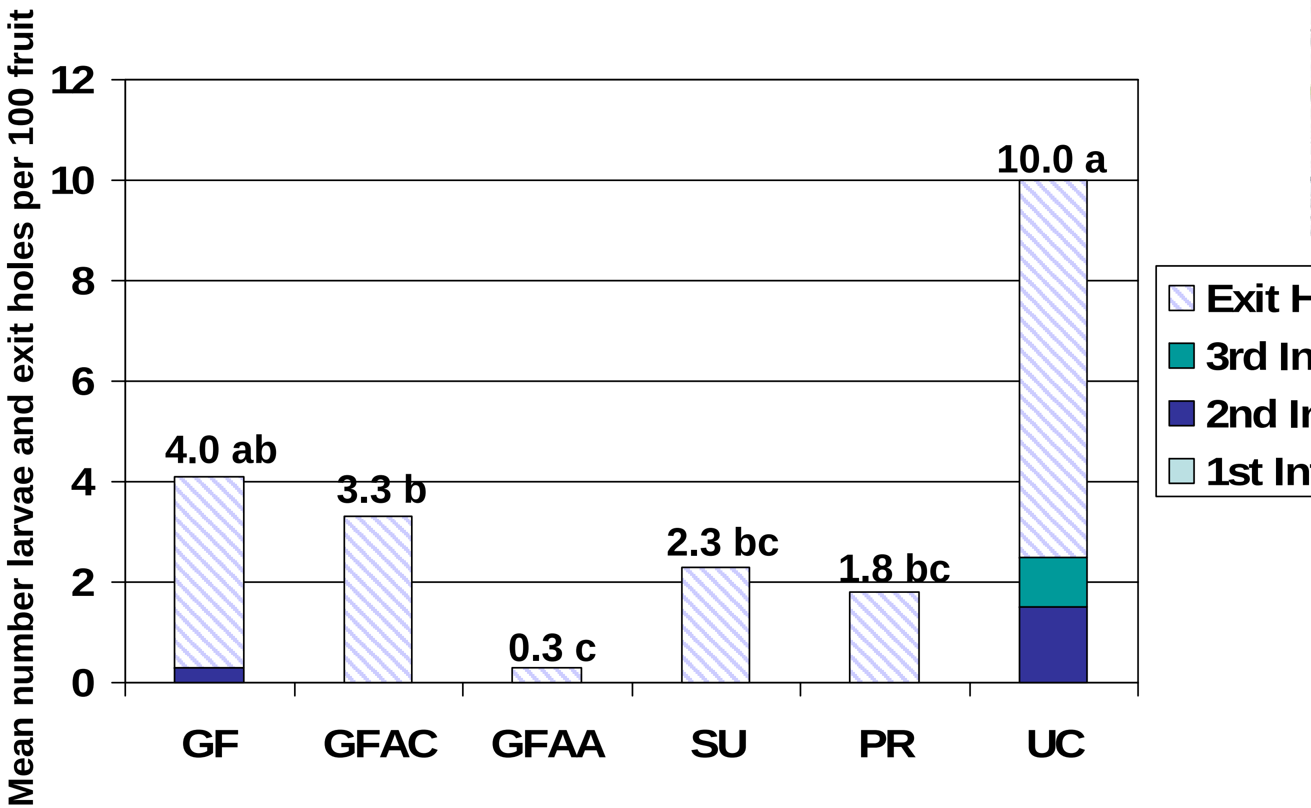
2006 Trial at Kaysville

- GF-120 (1:4, 100 fl oz per acre)
  - Applied 8X
- GF-120 + 10% Amm. Carbonate (AC)
  - Applied 8X
- GF-120 + 10% Amm. Acetate (AA)
  - Applied 8X
- Success (6 oz per acre)
  - Applied 6X
- Provado 1.6F (8 oz per acre)
  - Applied 3X
- Untreated Control

Fruit Injury at Harvest

Figure 3. Fruit infestation at harvest (Jul 13) presented by age of larvae and exit holes per 100 fruit. GF=GF-120, GFAC=GF-120+10% ammonium carbonate, GFAA=Gf-120+10% ammonium acetate, SU=Success, PR=Provado, and UC=untreated control.

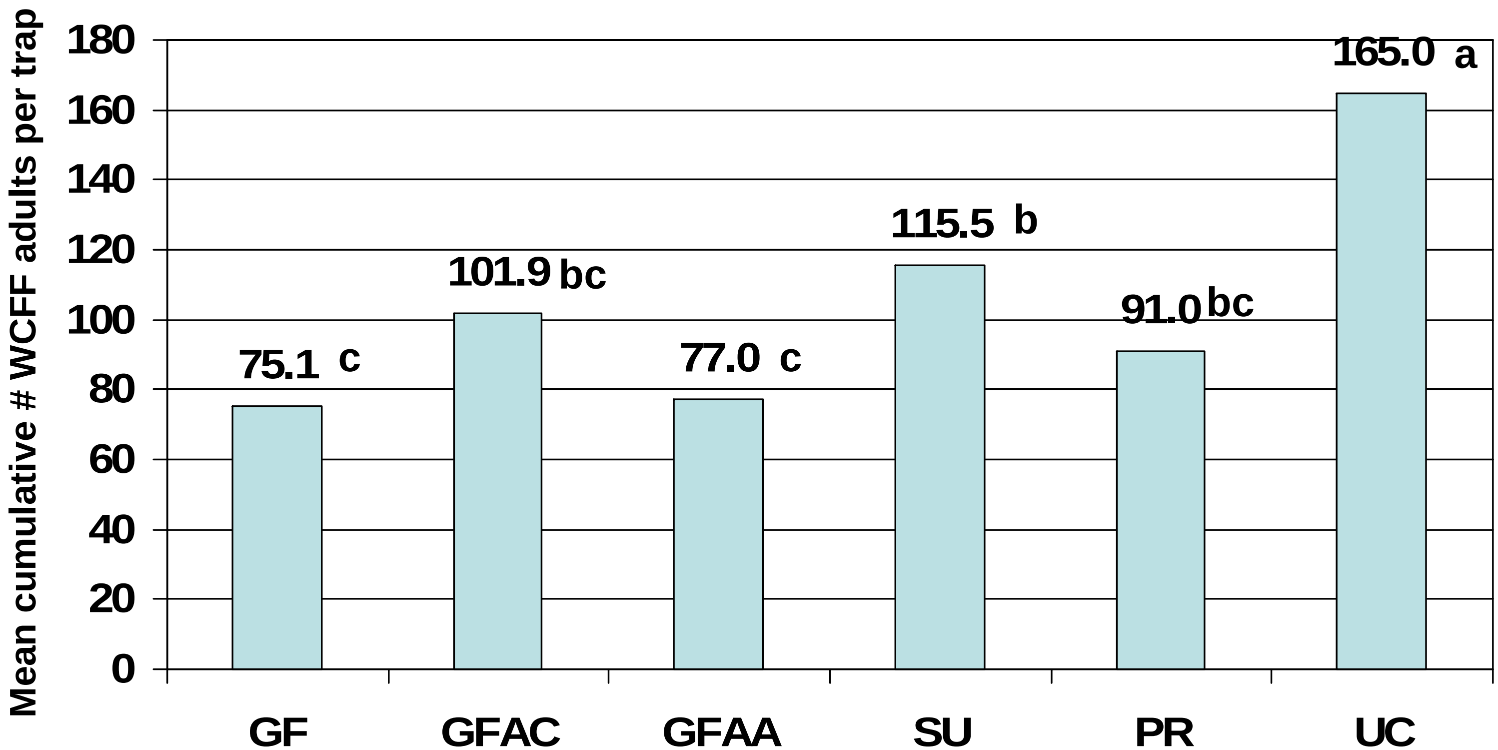




Values above bars are total numbers of larvae and exit holes.
Means followed by different letters are significantly different (LSD test; $p \geq 0.05$).

Adult Trap Catch

Figure 2. Mean cumulative number of adults per trap (Jun 1 – Aug 17) as influenced by insecticide treatments. GF=GF-120, GFAC=GF-120+10% ammonium carbonate, GFAA=GF-120+10% ammonium acetate, SU=Success, PR=Provado, and UC=untreated control.



Means followed by the same letter are not significantly different (LSD test, $p \geq 0.05$)

Acknowledgements

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