Light Brown Apple Moth Management

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Overview

- Scouting and identification
- Monitoring with traps
- Pheromone mating disruption
- Insecticides
- Biological control
- Best Management Practices manual
- Future research

Scouting

Look for LBAM life stages and symptoms

LBAM life stages

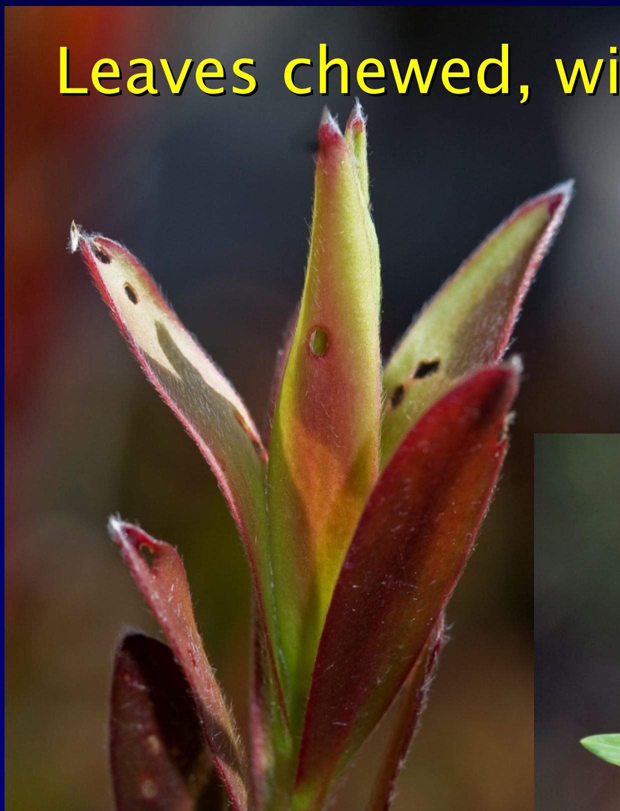
Adult moth

Egg mass

Pupa

Larva

Symptoms at shoot tips



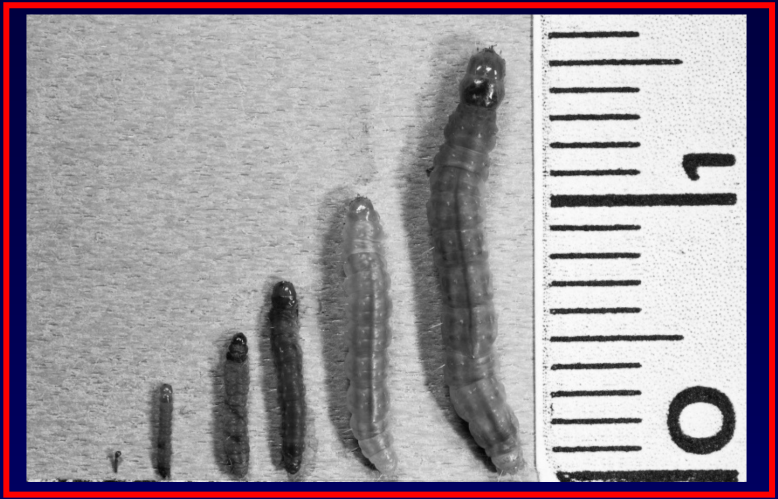
Leaves chewed, with holes

Leaves distorted

Leaves bound together with silk-like webs or threads

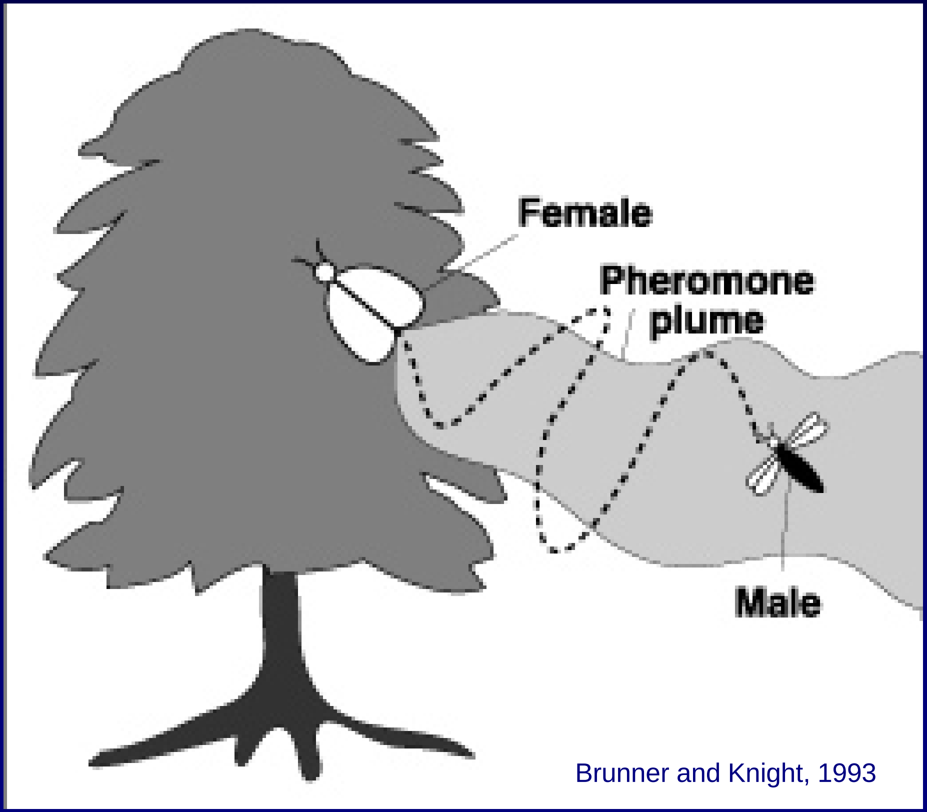
LBAM Larvae Field Identification

- 5 or 6 larva instars. Range in size from 2 mm to 18 mm (up to 0.75 inch)
- Light to medium green body
- Light yellow-brown head
- White hairs and light legs.
- Body darker on top.
- 3 distinct darker bands running the length of the body
- Prothoracic shield light green-brown
- Pre-spiracular pinaculum (3 hairs) and anal comb (7 or 8 prongs)



DNA testing is necessary for positive identification

Moth Pheromones



- Chemicals produced by female moths to attract a male of the same species.
- Male moths fly upwind, following a pheromone plume to locate a female.

Trap Monitoring

Synthetic Pheromone

Migrating male LBAM moth attracted and killed on sticky boards

Pheromone can be purchased

- Suterra (Bend, Ore.)
- ISCA Technologies (Riverside, CA.)

Other Trapping Methods

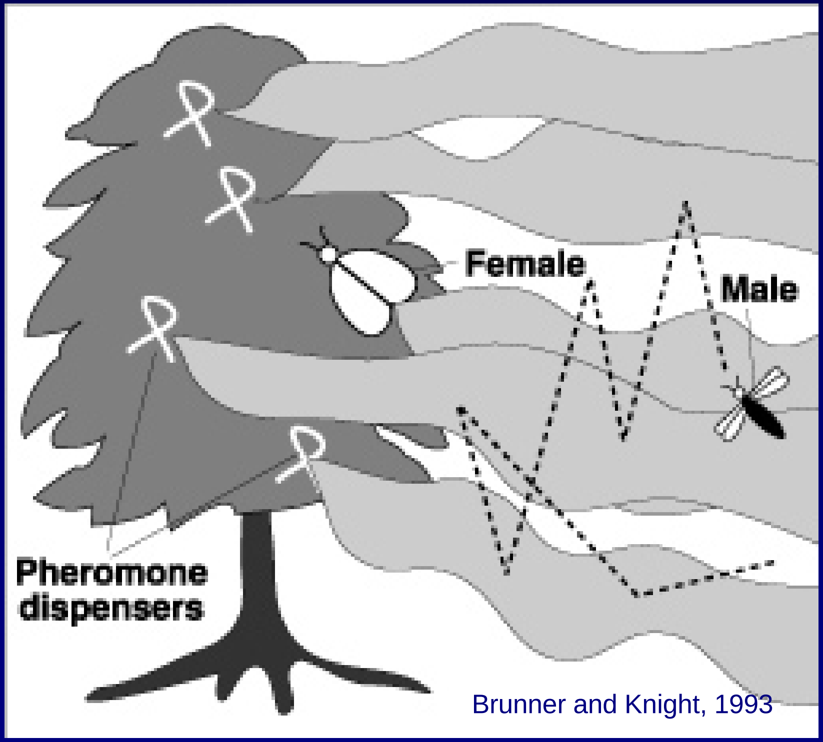
Bucket traps **(3 effective bait solutions)**

1. Terpinyl acetate and brown sugar
2. Vinegar (acetic acid)
3. Port wine

Ultraviolet-light trap

Pheromone Mating Disruption

Management Theory



- Synthetic pheromone is applied in mass in dispensers.
- Male moth can not orient to female and does not successfully mate.
- Conventional recommendation is to use in large (> 10 A) and uniform contiguous areas.

Pheromone Mating Disruption in Nurseries

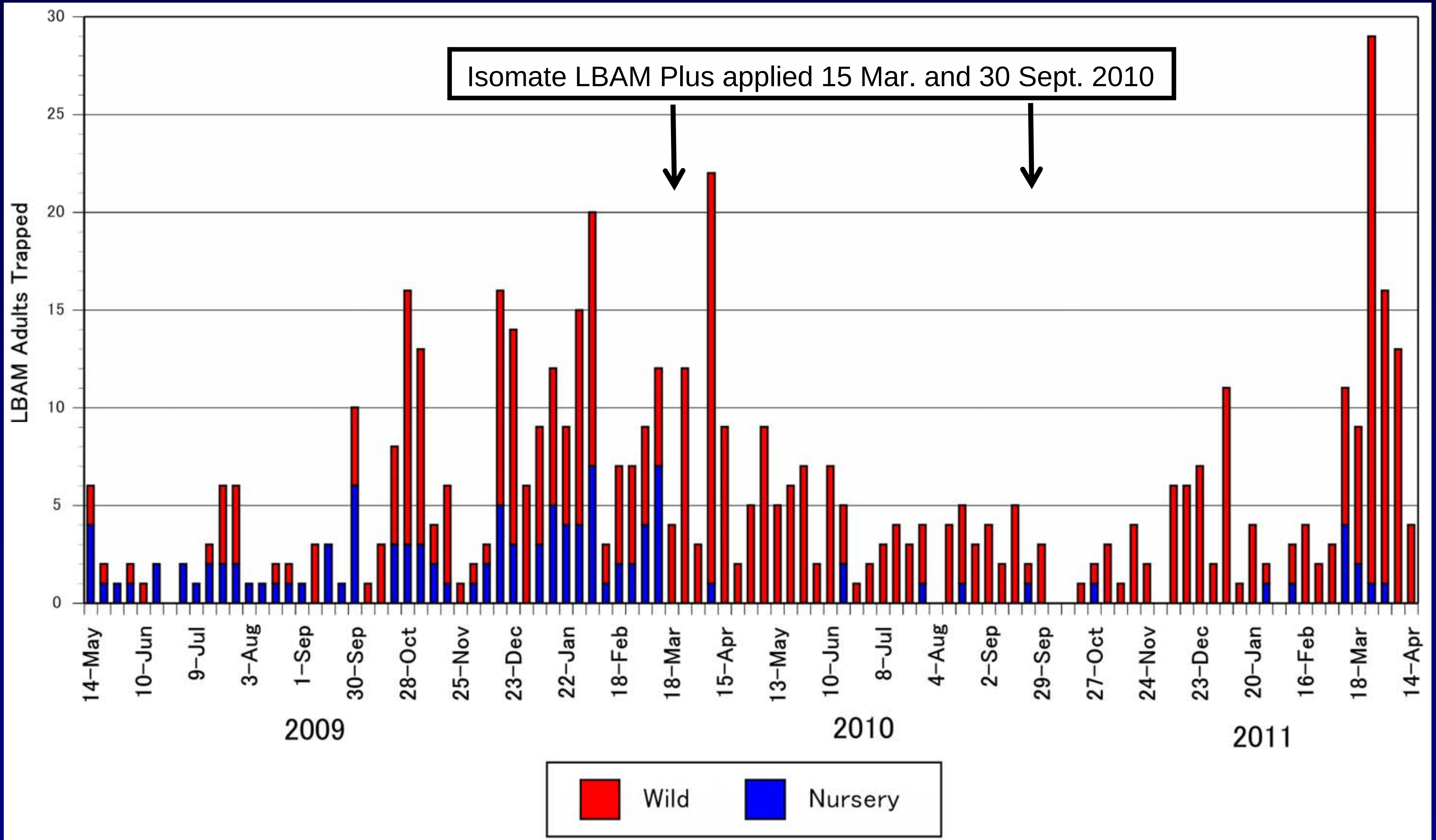
- Pheromone twist ties available from USDA.
- But how to use them in nurseries, and is the practice effective?

Isomate® LBAM Plus

Application in Nurseries

300 twist ties per acre = 13 X 13 foot square

Nursery 1 (8.0 acres, Santa Cruz County) LBAM moths trapped



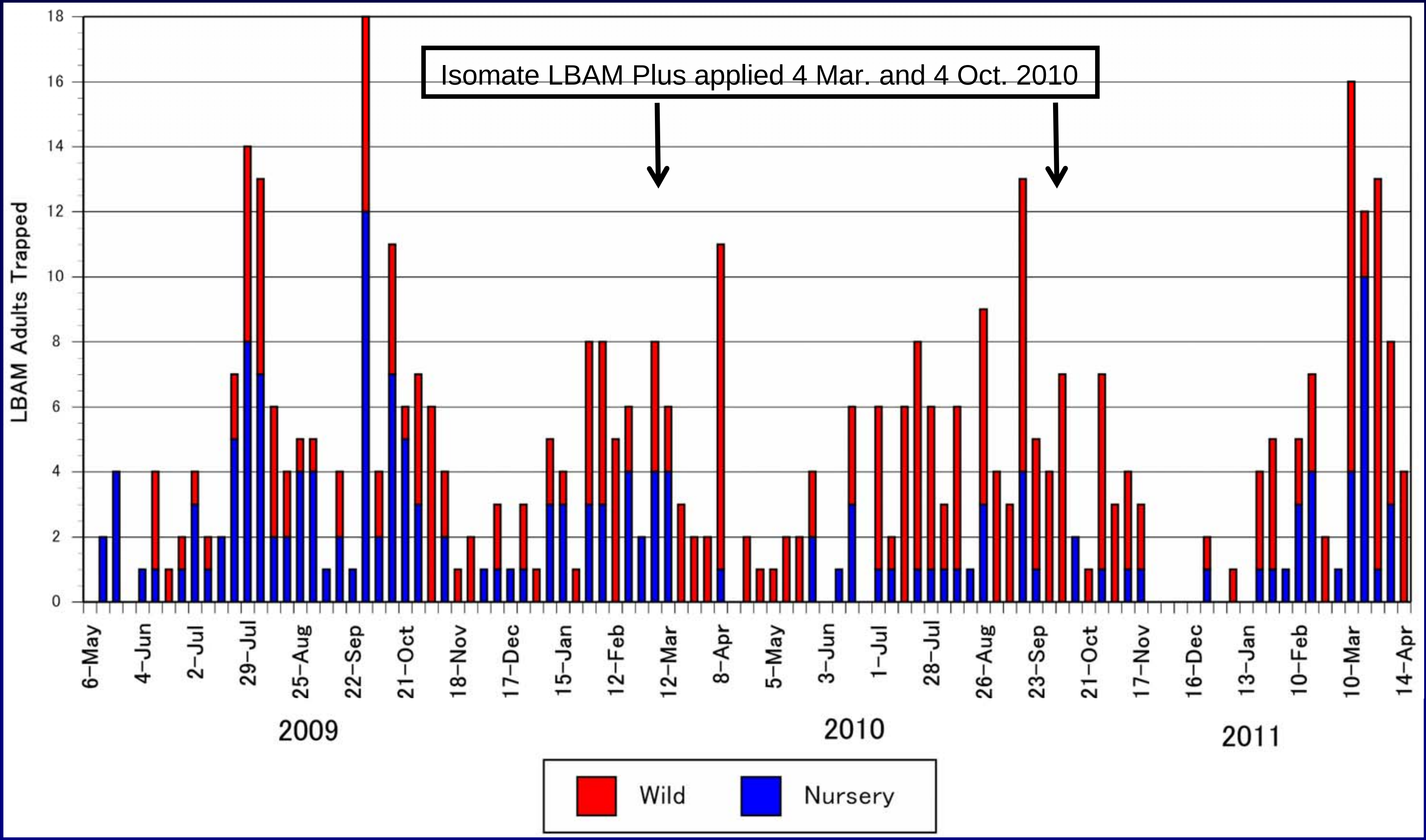
USDA Positive LBAM Larval Finds

Post Mating Disruption Implementation

March 2010 to September 2010

★ Nine positive finds during this period

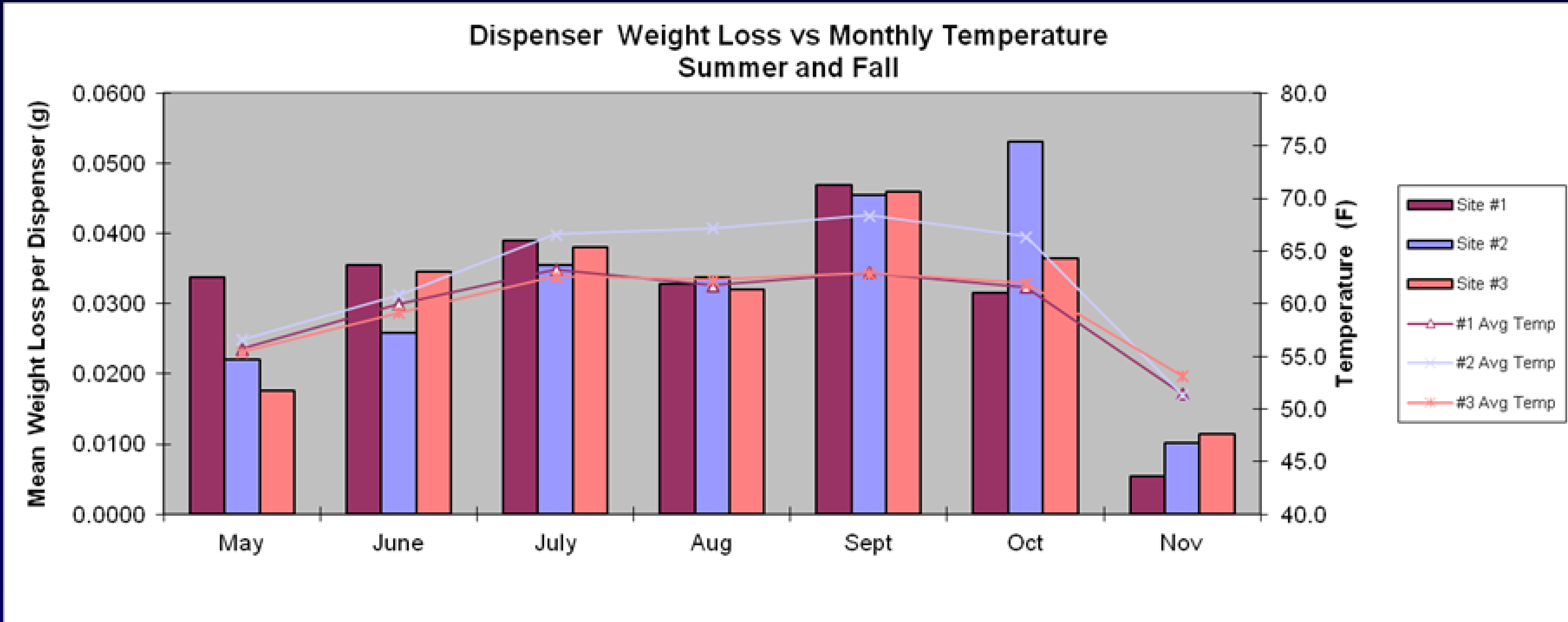
Nursery 2 (2.2 acres, Santa Cruz County) LBAM moths trapped

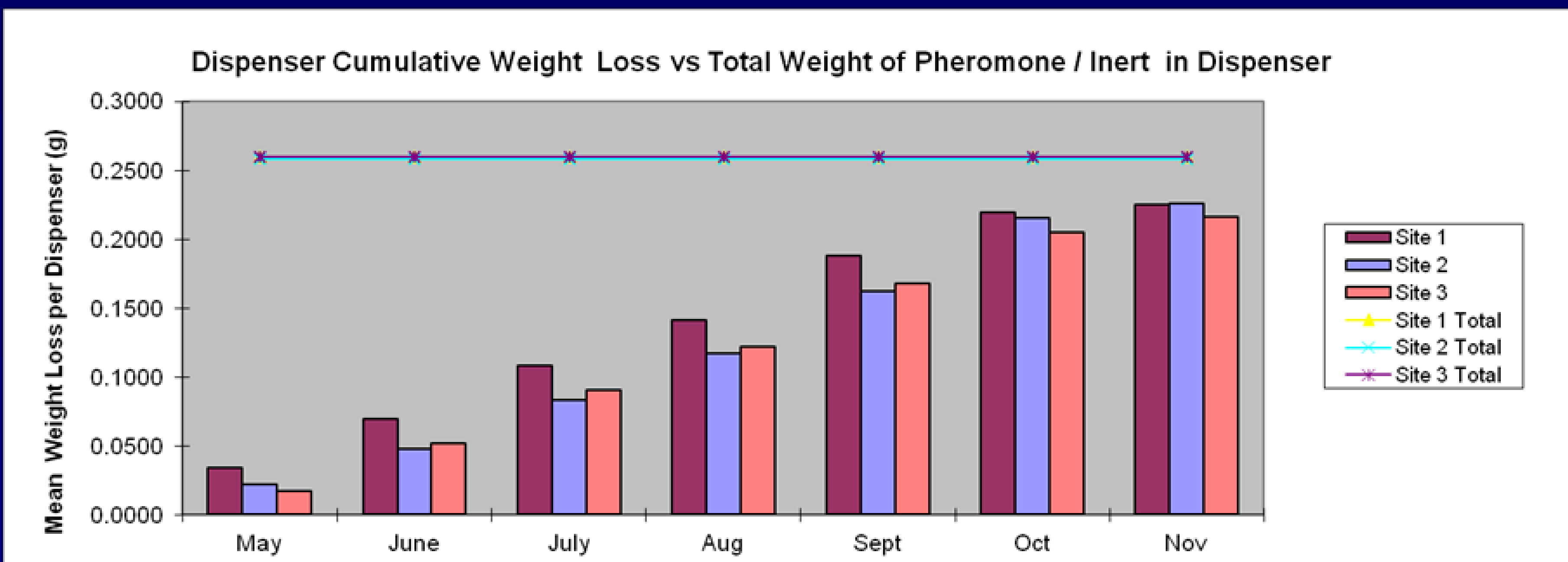


Suspect LBAM Larvae Detection in Raspberries

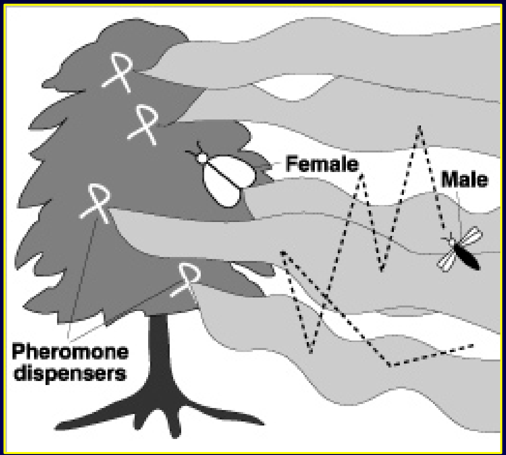
RED   number of leaf rolls picked per section.

BLUE number of larvae found per section.


Dispenser Weight Loss vs Monthly Temperature
Summer and Fall
Mean Weight Loss per Dispenser (g)
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
Temperature (F)
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
May
June
July
Aug
Sept
Oct
Nov
Site #1
Site #2
Site #3
#1 Avg Temp
#2 Avg Temp
#3 Avg Temp


Dispenser Cumulative Weight Loss vs Total Weight of Pheromone / Inert in Dispenser
Mean Weight Loss per Dispenser (g)
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
May
June
July
Aug
Sept
Oct
Nov
Site 1
Site 2
Site 3
Site 1 Total
Site 2 Total
Site 3 Total

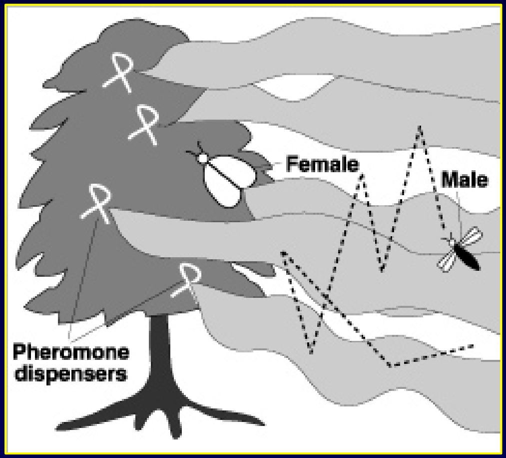
Pheromone Mating Disruption



- Mating disruption in a typical nursery is effective-- but not completely.

- Pheromone twist ties
  - Uniform and widely distributed
  - Maintain them that way
  - Extend distribution beyond nursery perimeters

Pheromone Mating Disruption



- Pheromone twist ties
  - Apply at or slightly above plant canopy.
  - Don’t let plants over grow them.
  - Apply at maximum registered rate, every 6 months.
  - Twist ties are available, at no cost, through several Agricultural Commissioners’ offices.

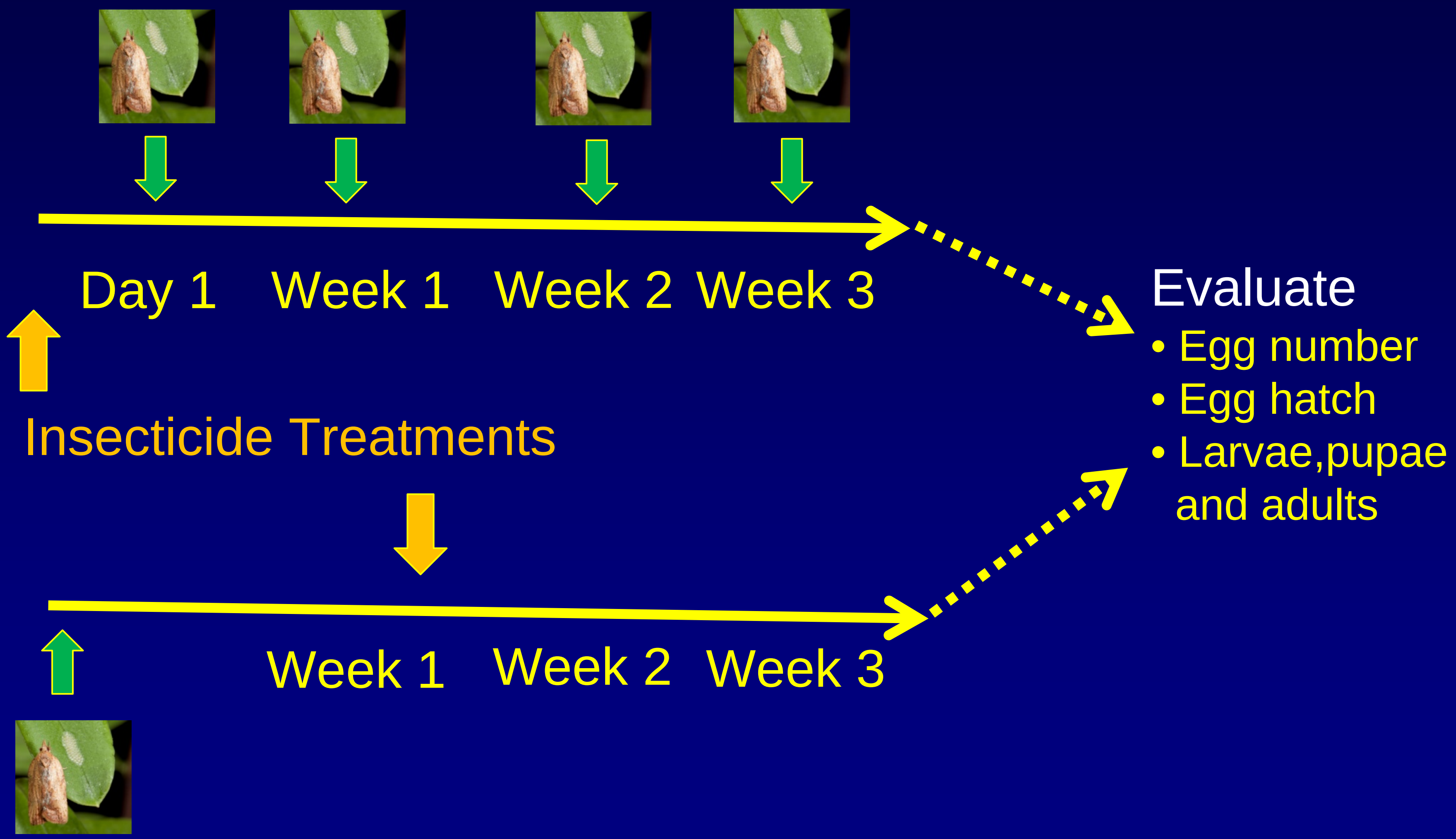
Field Evaluation of LBAM Insecticides

Fall 2010 to Spring 2011
Summer 2011 to Fall 2011

- Evaluate many of the CDFA approved insecticides in field conditions.
  - Several chemical modes of actions
  - Chemical + horticultural oil “for eggs”
- Evaluate affect on egg laying.
- Evaluate residual insecticidal action.

Research financial support: USDA APHIS

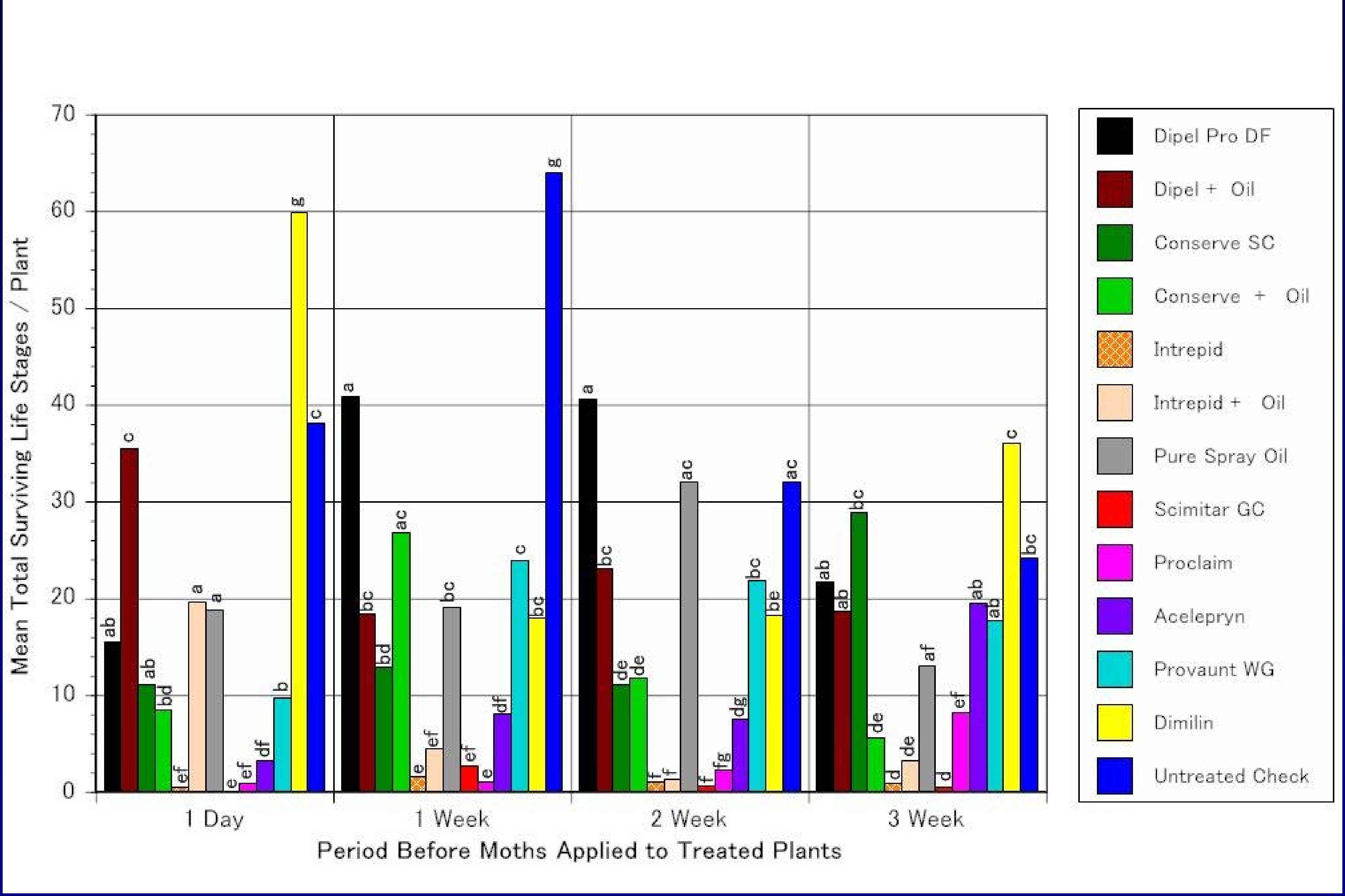
Insecticides Applied Before and After Egg Laying
2 experimental protocols



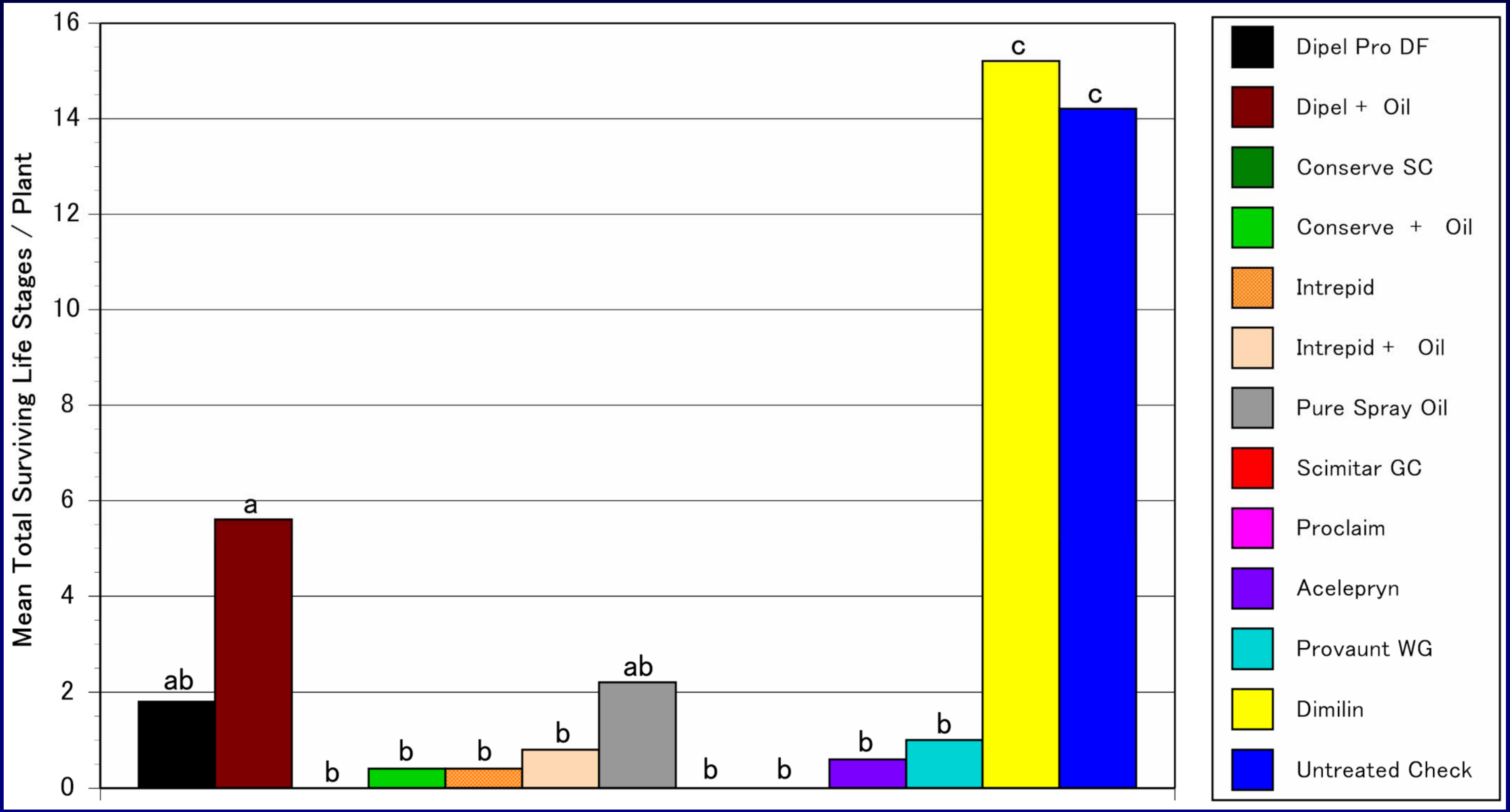
Treat #	Active ingredient	Products	Rate Product / 100 G
1	Bacillus thuringiensis ssp. kurstakii	Dipel Pro DF	16 oz.
2	B.t. ssp. kurstakii + horticultural oil	Dipel + Oil	16 oz. + 1 gal.
3	spinosad	Conserve SC (Entrust)	12 fl. oz.
4	spinosad + horticultural oil	Conserve + Oil	12 fl. oz. + 1 gal.
5	methoxyfenozide	Intrepid	8 fl. oz.
6	Methoxyfenozide + horticultural oil	Intrepid + Oil	8 fl. oz. + 1 gal.
7	horticultural oil (petroleum oil)	Pure Spray Oil	1 gal.
8	lambda-cyhalothrin	Scimitar GC	5 fl. oz.
9	emmamectin benzoate	Proclaim	4.8 oz.
10	chlorantraniliprole	Acelepryn (Coragen)	4 fl. oz.
11	indoxacarb	Provaunt WG (Avaunt)	2.5 oz.
12	difluobenzuron	Dimilin	4 fl. oz.
13	Untreated Check	Untreated Check	

Effect of Insecticides on Surviving Larvae, Pupae and Adults

Treatments Applied Before Eggs Deposited



Effect of Insecticides on Total Surviving Life Stages
Treatments Applied After Eggs Deposited



See CAPCA Adviser
October 2011

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Field Evaluation of Insecticides to Control Light Brown Apple Moth

Steve Tjosvold, Environmental Horticulture Farm Advisor; and Neal Murray, Staff Research Associate, UCCE, Watsonville, CA.

Introduction and Goals

The light brown apple moth (LBAM), *Epiphyas postvittana* is an important quarantined pest in California, currently detected in 16 counties and having a wide host range of native, ornamental, and crop hosts. The quarantine has greatly affected the ornamental nursery stock industry along the central coast and other areas where LBAM is established in native and ornamental vegetation surrounding the nurseries where it is left unmanaged. This makes it difficult to keep LBAM from migrating into nurseries and re-infesting the production areas even with judicious control efforts in the nursery. Regular official inspections occur at nurseries shipping nursery stock outside of the regulated areas. If LBAM is found in a nursery, insecticide treatments are usually required until LBAM is no longer found with follow-up inspections. (See references for the CDFA official regulatory manual). Many similar tortricid larvae occur in ornamental crops and they are often difficult to distinguish morphologically from LBAM larvae, and therefore insecticides are often used proactively against any suspect larvae found by nursery staff or pest management scouts. (See Figure 1.)

Experiments at the South Australia Research and Development Institute (SARDI) screened insecticides including horticultural oils for ovicidal activity against LBAM using dip bioassays of exposed egg masses. Likewise, at the USDA Otis Lab (Buzzards Bay, MA), several insecticides targeting LBAM larval stages were screened in a laboratory environment. This information has been used by the California Department of Food and Agriculture (CDFA) to establish an official list of approved insecticide treatments for agricultural operations when required. (See references at the end of this article). Nursery operators usually choose to minimize the time lag between treatment and re-inspection so that the quarantined plants can be released for sale as quickly as possible. Usually the grower's preferred treatment has been the officially designated "ovicidal" treatment containing one active product that targets larvae *and* a horticultural oil that targets eggs. So far there have been no studies to evaluate the efficacy of these insecticides and the prudence of combining the products in the field. Moreover, growers need to know how long these insecticides remain effective in the field so they can make good judgment as to how often spray treatments need to be applied. Since nurseries can often be re-infested by migrating moths, an important management strategy might be to target oviposition (egg laying), egg eclosion (egg hatch), and the development of the brood to the next generation. The goal of this experiment was to determine the efficacy and residual action of many of the approved treatments and other new insecticides in preventing or retarding oviposition, egg development, egg hatch, larva and pupa development in field conditions. Ultimately these experiments will aid in the development of an insecticide treatment strategy, with rotating chemical classes, to manage LBAM and prevent insecticide resistance in nurseries. This trial is being repeated in the summer of 2011 to strengthen our findings.

Figure 1: LBAM female adult and egg mass. Photo S.Tjosvold

Materials and Methods

Plant material: Pacific wax myrtle (*Myrica californica*) in 1 gallon pots were obtained from a commercial nursery in Watsonville, California. In Santa Cruz County, it is a common host of LBAM in the landscape. Plants received no pesticides at least 2 months before the experiment began and no supplemental fertilizer during the experiment. The plants were moved into quarantine field cages covered with 32 x 32 sq mesh/inch Lumite Saran insect screen at a secure-access facility in Watsonville, California. Plants were pinched to create uniform plants and stimulate branching supportive of LBAM larval development, and held for two weeks before treatments. Temperature data was recorded inside one caged plant and degree day accumulation was calculated using a LBAM developmental model and temperature thresholds to help assess the development of the insects and time the treatments, moth infestations, and evaluations in this experiment.

Insecticide treatments: included many of those from the CDFA officially approved insecticide treatments, which represent a wide range of chemical classes with different modes of action. Several of the commonly used treatments by growers-- spinosad, *Bacillus thuringiensis*, and methoxyfenozide—were applied alone, or combined with horticultural oil. All products were registered for ornamental nursery stock except emmamectin benzoate (registered for vegetables), chlorantraniliprole (registered for turf and landscape), and indoxacarb (registered for turf and landscape) (see Table 1). To insure thorough coverage of all treatments a non-ionic surfactant (modified vegetable oil and organosilicone blend at 3 pints/100 G) was added to all insecticides and the control, and all were applied at 200 G/A. (See Table 1.)

Pre-oviposition bioassay: To access the treatments' residual efficacy, the insecticide treatments were applied to plants and fertile moths were caged around them up to 21 days later as described below. The insecticide treatments were applied on 24 August, 2010 and the plants were infested with fertile moths as described below.

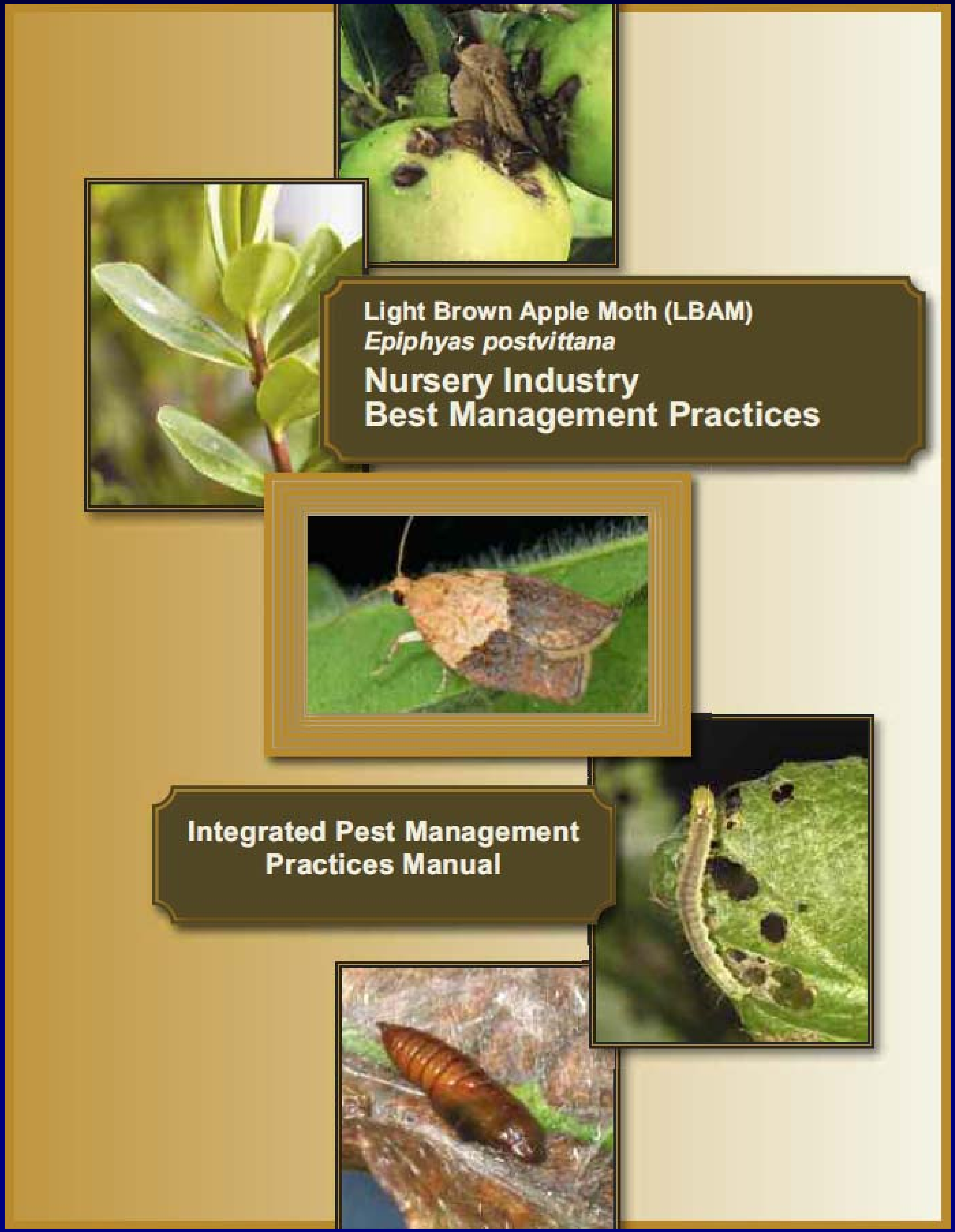
Post-oviposition bioassay: To access the treatments' efficacy when applied to recently laid egg masses, the insecticide treatments were applied after 10 days (225 degree days accumulated, 1 October, 2010) when most egg masses were laid and adults had died and infested with fertile moths as

Table 1. Insectide Treatments and Rates

Active ingredient	Formulation	Rate product / 100 gal.
Bacillus thuringiensis ssp. kurastakii	54% DF	16 oz.
B. t. ssp. Kurastakii + horticultural oil		16 oz + 1 gal.
spinosad	11.6 % SC	12 fl. oz
spinosad + horticultural oil		12 fl. oz. + 1 gal.
methoxyfenozide	22.6 % F	8 fl. oz
methoxyfenozide + horticultural oil		8 fl. oz. + 1 gal.
horticultural oil (petroleum oil)	98%	1 gal.
lambda-cyhalothrin	9.7 % GC	5 fl. oz.
emmamectin benzoate	5% Powder	4.8 oz
chlorantraniliprole	18.4% SC	4 fl. oz.
indoxacarb	30% WDG	2.5 oz.
diflubenzuron	40.4 % SC	4 fl. oz.
Untreated Check		

Biological Control

- Augment biological control with releases of commercially available *Trichogramma platneri* at nursery perimeters or within nursery.



Resources

www.cdfa.ca.gov/LBAM

Research needs

- LBAM Identification and symptom field guide
- Host range
  - Perimeter natives and weeds
  - Sentinel ornamentals or low risk hedges
- Reducing moth migration from outside of nursery perimeter
  - Bait or pheromone trapping
  - Extension of pheromone mating disruption
  - Biological control, *Trichogramma platneri*
- Systemic insecticides
- Use of Degree Day models in field
- Others?

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