Research Update -- Avocado Thrips, Persea Mite, New Materials, Pesticide Resistance Management

Avocado Spring Seminar Series
Apr. 6-8 (SLO, Ventura, Temecula)

Joseph Morse, Deane Zahn, Alan Urena, and Lindsay Robinson
Department of Entomology, UC Riverside

Research Objectives – Avocado Thrips

Objective 1a. Screen new pesticides and continue evaluation of current materials (optimize methods of application, timing, use of oil and adjuvants)

- Veratran D (Feb. 1997)
- Success (1998), Agri-Mek (1999), Entrust (2003), Delegate (2007)
- Danitol (2010, 6 Field research trials in 2009)
- Search for new chemistries (Movento, Beleaf, Cyazypyr, NNI-0101, NAI-2303, others)

- General observation – avocado thrips levels vary from year to year and from grove to grove - monitoring by a knowledgeable grower or PCA is needed to determine if treatments are needed
  - Weather late winter / spring influences thrips severity
  - Presence of leaf flushes and young fruit favor avocado thrips buildup
  - High levels of predators help slow the buildup of avocado thrips

Monitoring is KEY -- Avoid unnecessary sprays

Monitoring for Avocado Thrips in Spring

- Avocado thrips do best under moderately cool temperatures (68-76 °F)
- Under hot conditions (> 90 °F), populations crash
- Smaller fruit are more susceptible to damage by avocado thrips
- As fruit become larger (1.5 inches or more in diameter) - large numbers of thrips are needed to cause significant levels of fruit scarring

Context of Chemical Control Research with Avocado Pests

Avocado Thrips, *Scirtothrips perseae*

- Worldwide, few examples of good biological control of pestiferous thrips species (chemical intervention is often required)
  - *Scirtothrips citri* (Citrus thrips)
  - *Scirtothrips aurantii* (South African citrus thrips)
  - *Scirtothrips dorsalis* (Chili thrips or yellow tea thrips)

- **ABAMECTIN - Agri-Mek 0.15 EC, generics**
  - Abamectin is relatively slow in killing avocado thrips
  - Quite persistent in leaves, with control persisting 6-10 weeks or more (increases the potential for resistance)
  - Also effective in suppressing persea mite populations (supplemental label in 2005)
  - pH of water should be 5-9, better above 6

- **SABADILLA – Veratran D (Dunhill Chemical)**
- 10-15 lb Veratran D 0.2% in 10-40 gpa by air or 20-100 gpa by ground; If 200 gpa is used, increase to 20 lb per acre; 24 h REI
  - Screen size should be 20 mesh or larger (to avoid plugging)
  - Acidify water to pH 4.5 (citric acid or other) prior to adding Veratran D to the tank
  - Do not use additives, especially nutritionals (is a stomach poison and may reduce thrips feeding activity)
  - More effective in warm weather (when thrips are actively feeding)
  - To increase thrips feeding on this bait, add unsulfonated molasses (1.5 gal/a) or sugar (10 lbs/a) to the spray tank

SPINOSAD – Entrust 80% / Success 2 SC

- Not as effective as Delegate (less persistent)
- Add 0.25% or more NR-415 oil by air or ground
- Entrust is approved for organic use
- 1.25-3 oz Entrust 80% + an organically approved oil

(http://www.omri.org/OMRI_brand_name_list.html)

- **SPINETORAM – Delegate (25%) WG (Dow)**
  - Similar chemistry as spinosad (Success, Entrust) but is a synthetic product (no organic use)
  - Registered on avocados (Tropical Tree Fruits) late in 2007
  - Use 4 - 7 oz/ acre + oil or adjuvent
  - 4 h REI, 1 day PHI
  - Toxic to bees, see label restrictions
  - More persistent and effective than spinosad (Success, Entrust)

Fenpropathrin – Danitol 2.4 EC (Valent)

- Registered on avocados (Tropical Tree Fruits) early 2010
- Synthetic pyrethroid (avocado label is on CDMS)
- Use 16 – 21.33 fl oz/ acre in 100 gpa or more by ground, 50 gpa or more by air
- On avocados, label specifies no more than 1 application per season (resistance management)
- 24 h REI and PHI
- Toxic to bees, see label restrictions
- Used in CA for control of citrus thrips since the late 1990's – resistance is a serious problem in some areas

IRAC Classification of Avocado Thrips Materials

Pesticide	Company	Pesticide Class	IRAC Class
Agri-Mek	Syngenta, generics	Avermectin, macrocyclic lactone	6
Success, Entrust, Delegate	Dow	Spinosyn, macrocyclic lactone	5 (apparent cross resistance to class 6)
Veratran D	Dunhill	Two plant alkaloids	Unclassified
Danitol (Feb. 2010)	Valent	Pyrethroid	3

Toxicity of avocado pesticides to honey bees [a]

Pesticide	UC Hazard rating (the label has precedence)
Agri-Mek	II = Apply only during late evening
Danitol	I = Do not apply to blooming plants
Delegate	III (Safe to bees 2h after spray has dried)
Envidor	I = Do not apply to blooming plants
Entrust	III (Safe to bees 2h after spray has dried)
NR Oil	III = = Apply only during late evening, night, or early morning
Veratran D	IV = Apply at any time with relative safety to bees

www.ipm.ucdavis.edu/PMG/r107302911.htm

[a] **MAKE SURE YOU FOLLOW ALL LABEL RESTRICTIONS.**

- **2009 Avocado Thrips Field Trials**
  - Agri-Mek (standard) vs. Delegate vs. Danitol (EUP allowed fruit harvest) (2 plots treated with each material per site)
  - 3 field trials in the south (Barcinas, Davis, Hand) and 3 in the north (Holden, Machiltt, Roberts)
  - 2 pre-bloom treatments by air (Davis, Hand), 2 treatments by air at 2/3 leaf expansion (Machlitt, Roberts), two treatments by ground (Barcinas, Holden)
  - Weekly thrips counts by the PCA cooperator, they set treatment timing; fruit scar counts were taken by Morse lab personnel (Robinson, Urena)

Treatments evaluated in Spring 2009 avocado thrips field trials with pest control advisor cooperators

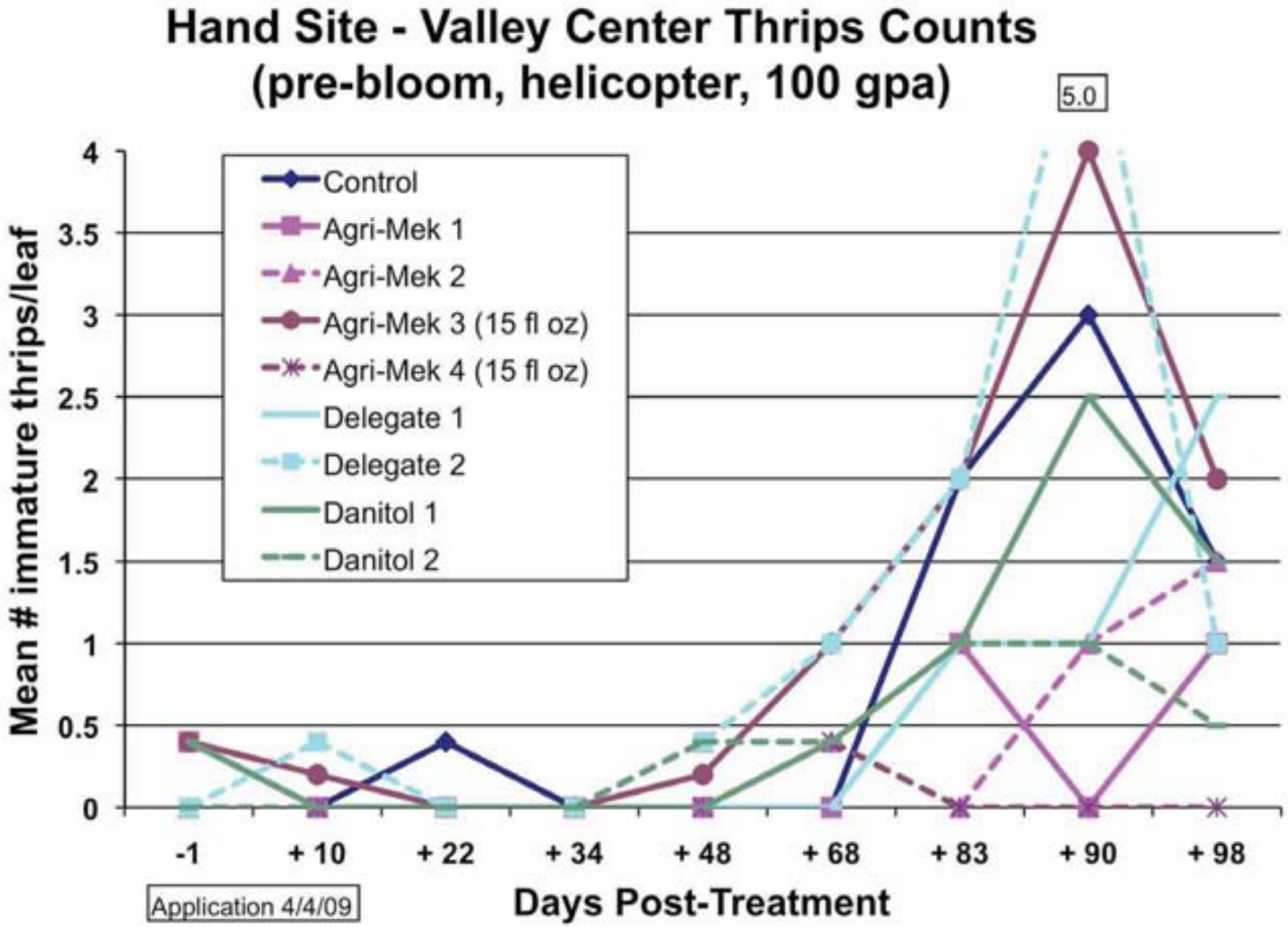
Treatment	Rate
Agri-Mek 0.15 EC + oil	20 fl oz/a + 1%
Delegate WG + oil	7 oz/a + 1%
Danitol 2.4 EC + oil	21.33 fl oz/a + 1%
Control (some sites)	Untreated

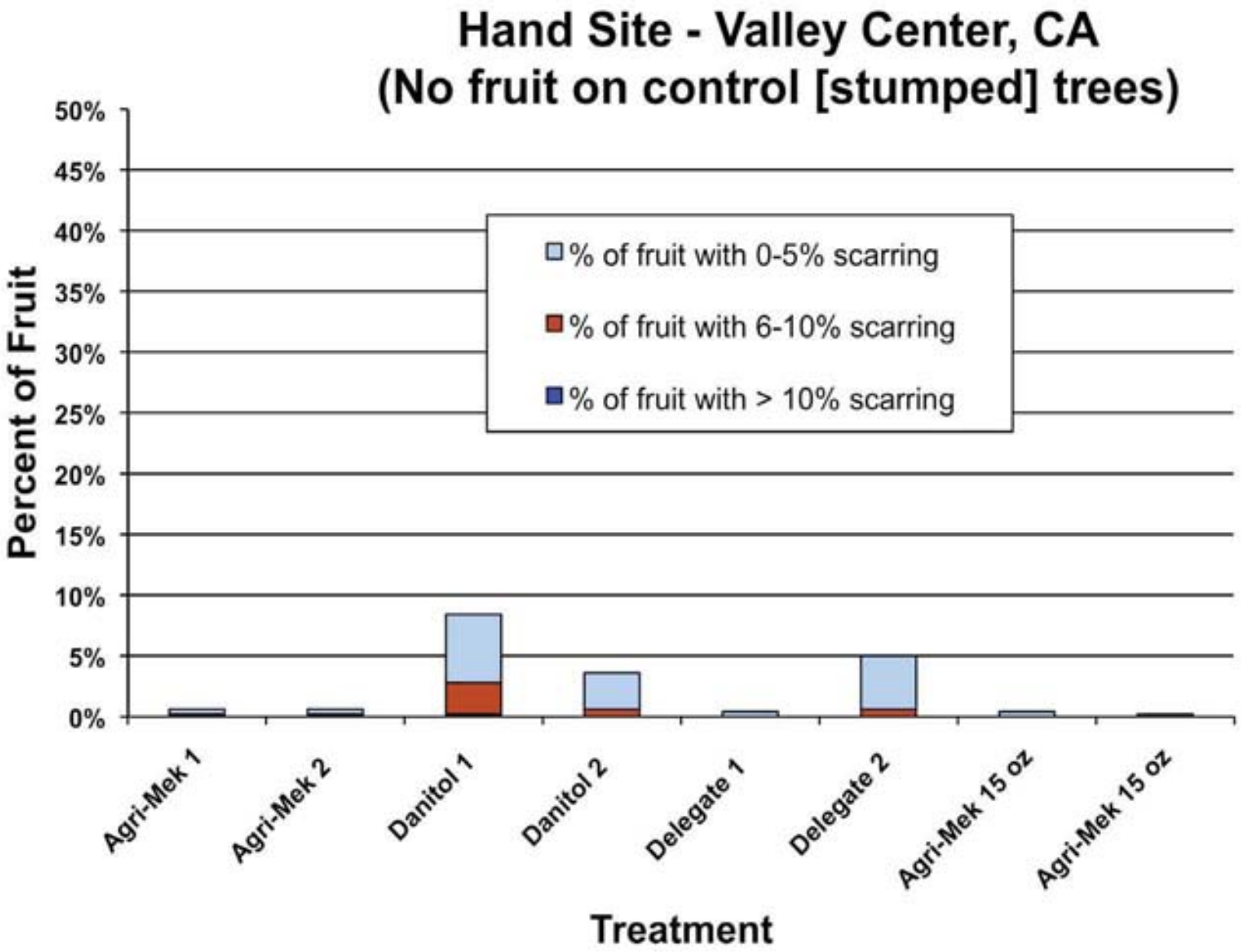
Each of the 6 field sites were divided into plots large enough to buffer the center monitoring area from adjacent treatments (2 plots for each treatment per site).

The PCA decided on the treatment timing, gallonage, and any additives (but all 3 treatments had the same gpa and additives).

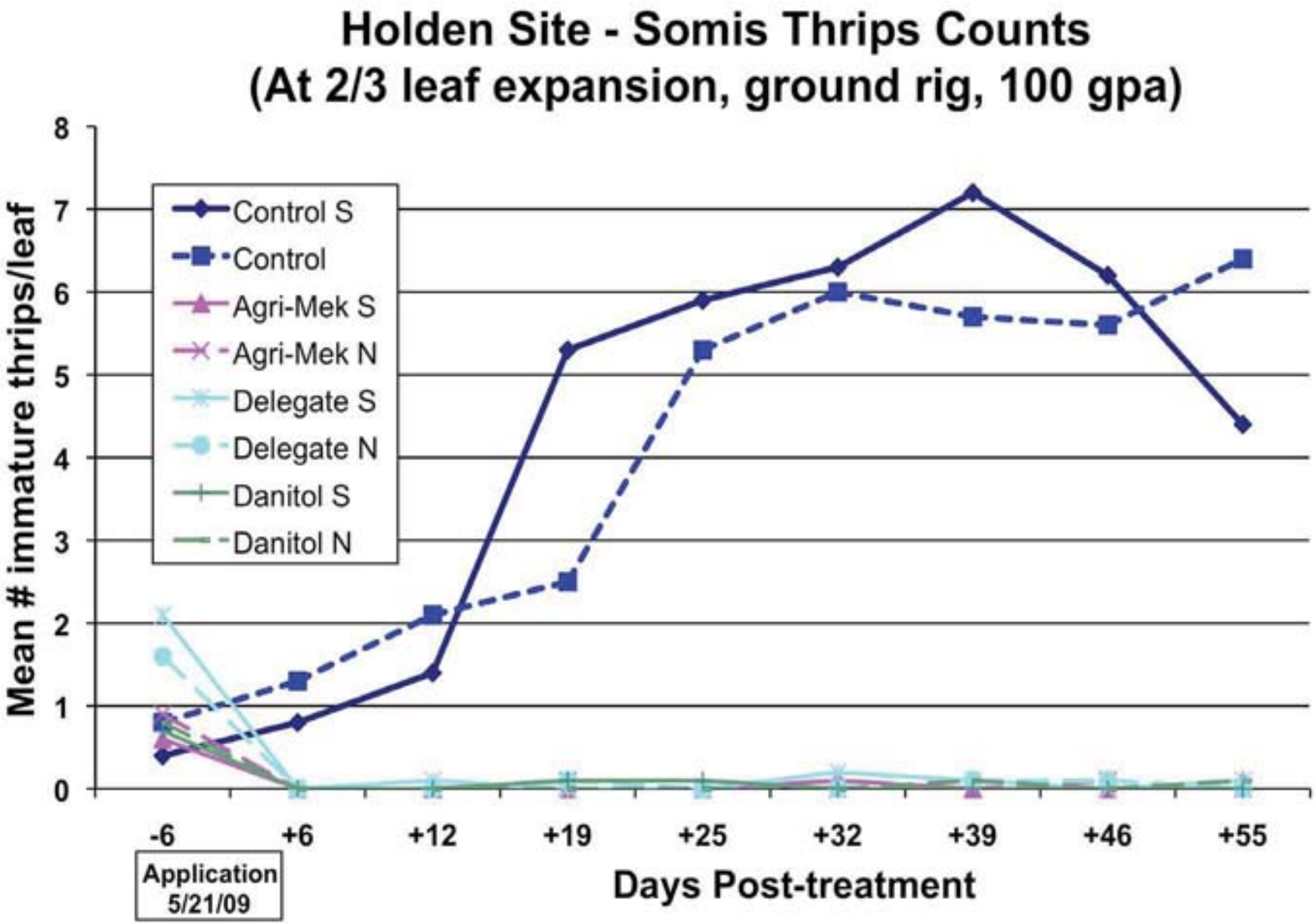
We estimate that especially for early scar counts (3 sites), economic thrips scarring was ca. 10% of the fruit surface area scarred.

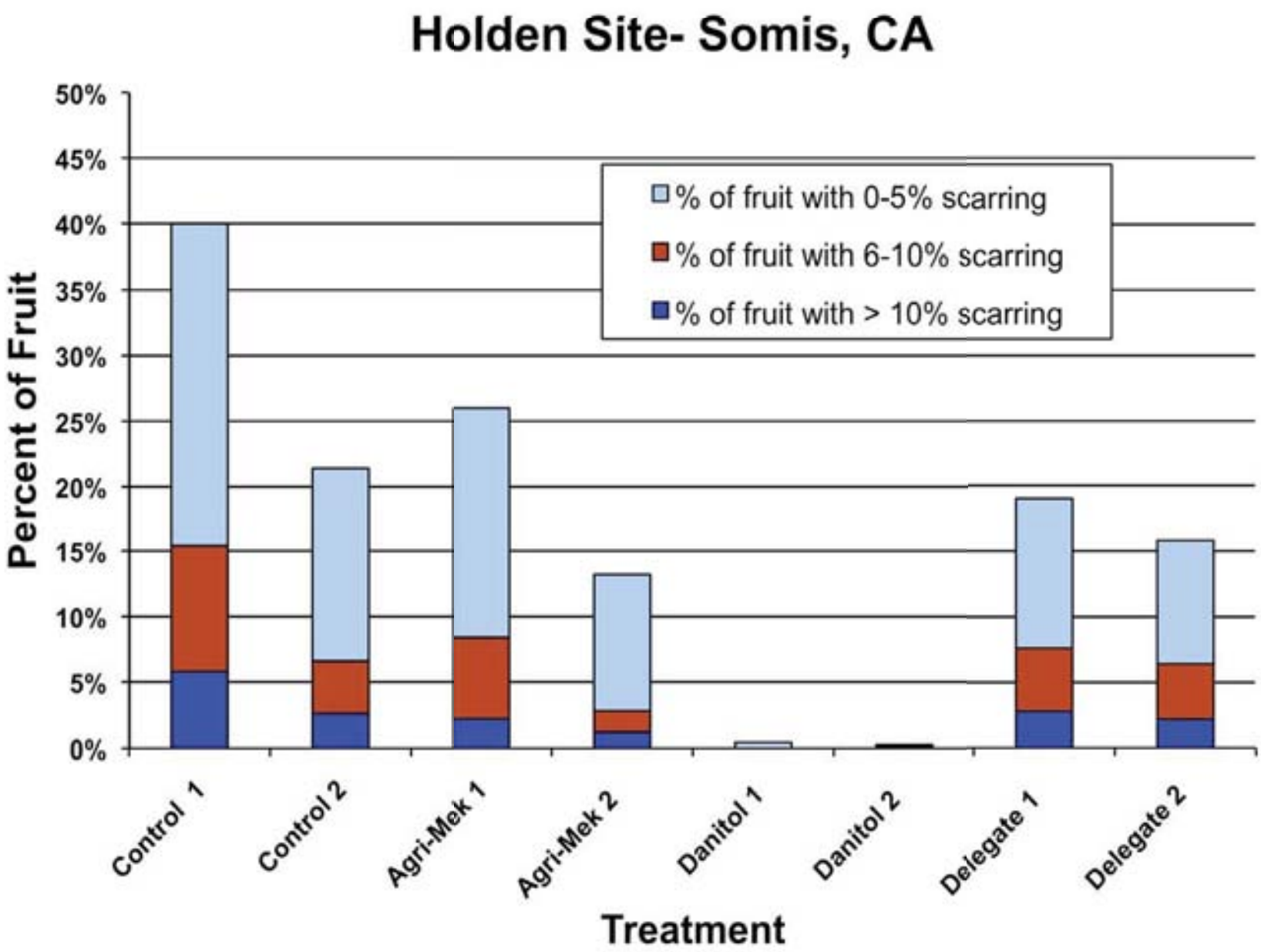

Matt Hand Site
Valley Center, CA


Hand Site - Valley Center Thrips Counts
(pre-bloom, helicopter, 100 gpa)
5.0
Mean # immature thrips/leaf
4
3.5
3
2.5
2
1.5
1
0.5
0
Control
Agri-Mek 1
Agri-Mek 2
Agri-Mek 3 (15 fl oz)
Agri-Mek 4 (15 fl oz)
Delegate 1
Delegate 2
Danitol 1
Danitol 2
-1
+ 10
+ 22
+ 34
+ 48
+ 68
+ 83
+ 90
+ 98
Application 4/4/09
Days Post-Treatment

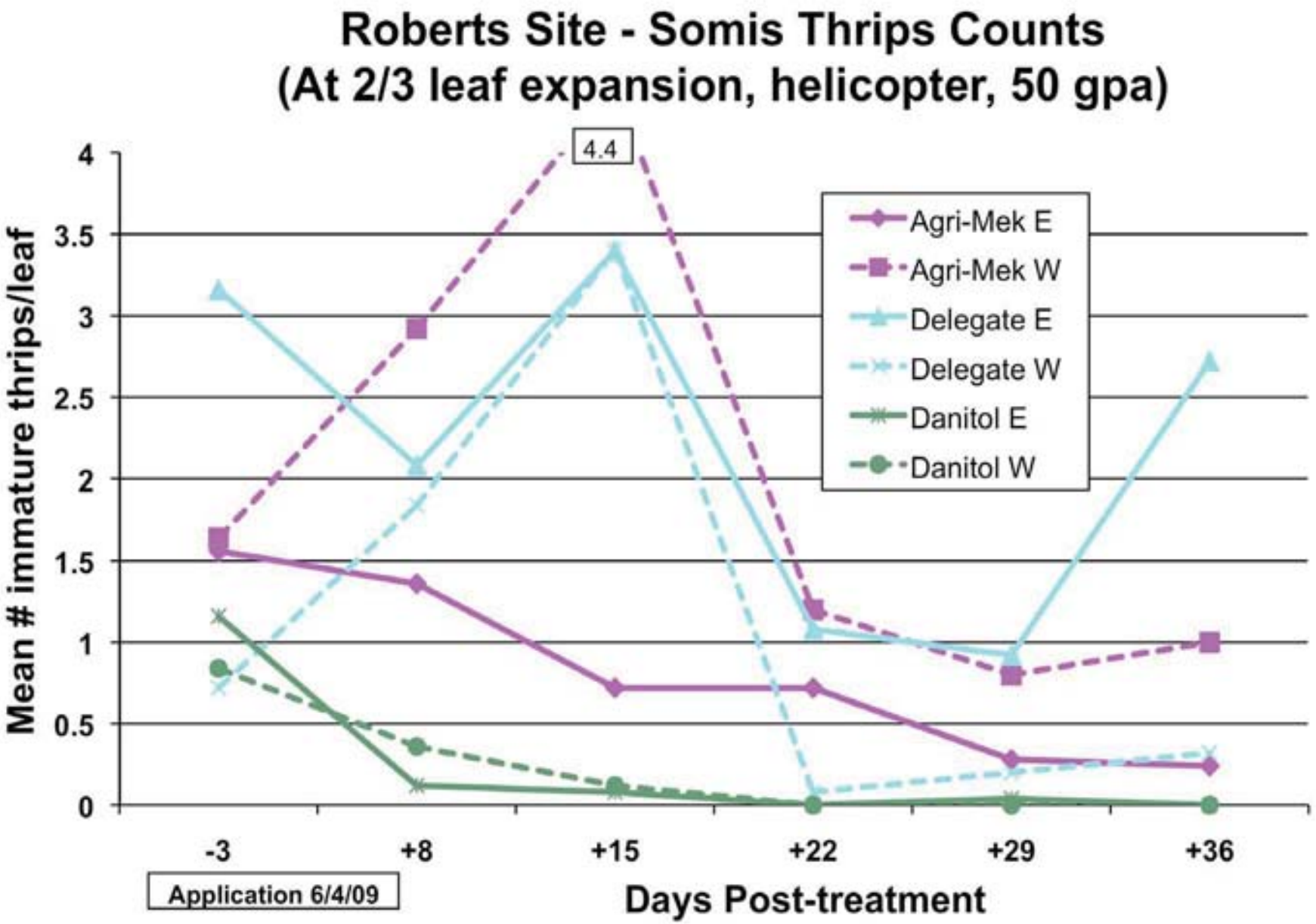

Hand Site - Valley Center, CA
(No fruit on control [stumped] trees)
Percent of Fruit
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
% of fruit with 0-5% scarring
% of fruit with 6-10% scarring
% of fruit with > 10% scarring
Agri-Mek 1
Agri-Mek 2
Danitol 1
Danitol 2
Delegate 1
Delegate 2
Agri-Mek 15 oz
Agri-Mek 15 oz
Treatment

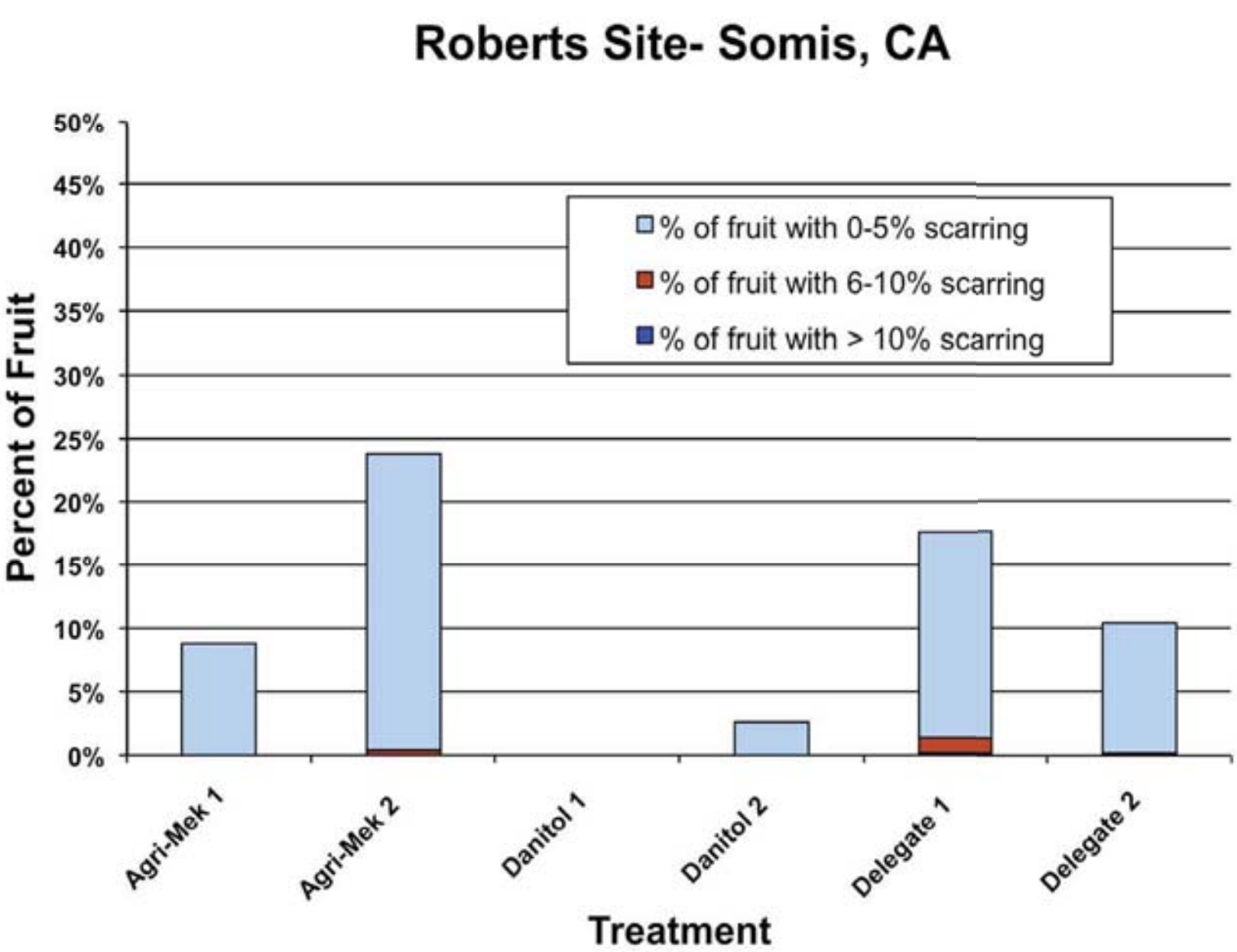
David Holden Site
Somis, CA


Holden Site - Somis Thrips Counts
(At 2/3 leaf expansion, ground rig, 100 gpa)
Mean # immature thrips/leaf
0
1
2
3
4
5
6
7
8
Control S
Control
Agri-Mek S
Agri-Mek N
Delegate S
Delegate N
Danitol S
Danitol N
-6
+6
+12
+19
+25
+32
+39
+46
+55
Application
5/21/09
Days Post-treatment

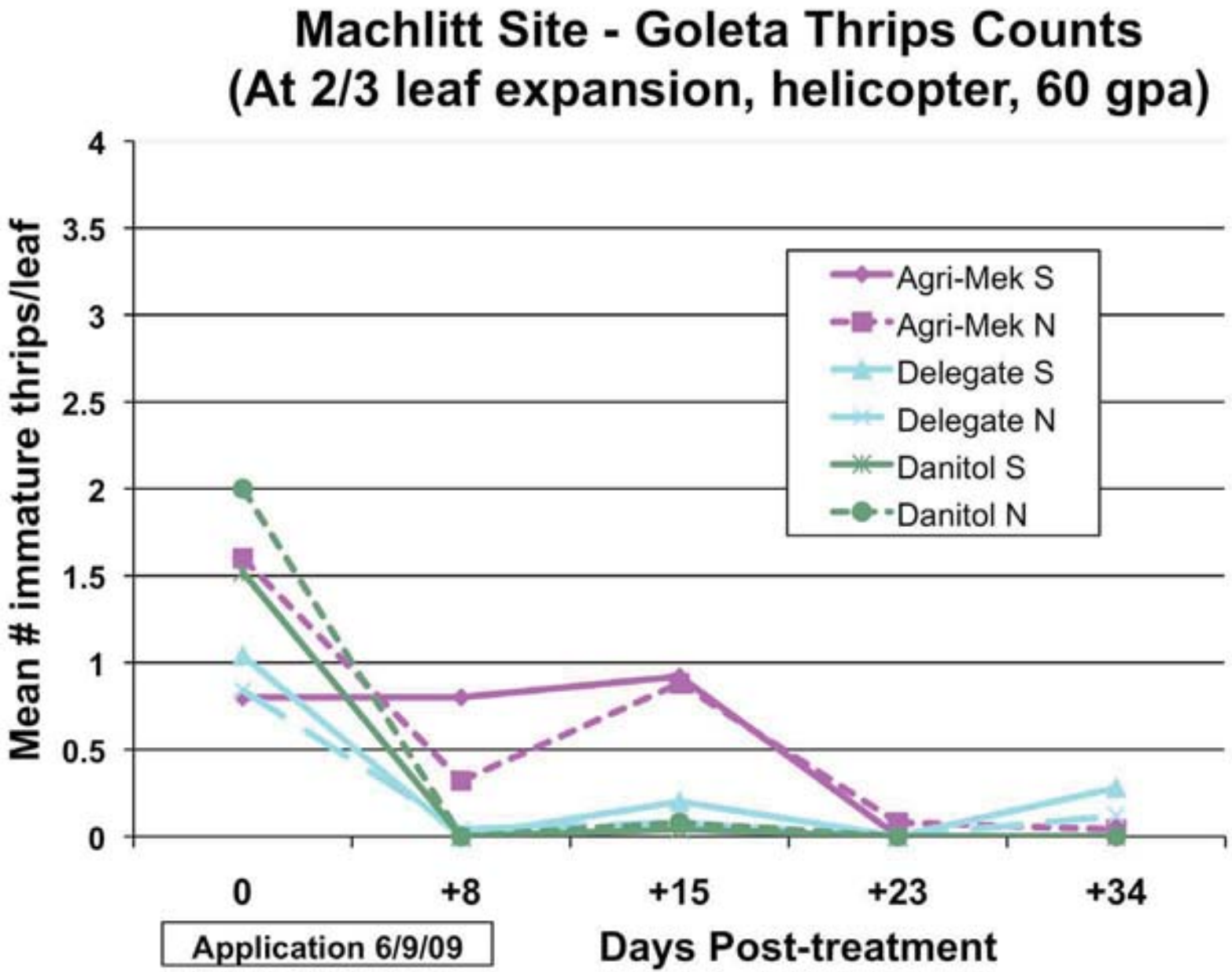

Holden Site- Somis, CA
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Percent of Fruit
% of fruit with 0-5% scarring
% of fruit with 6-10% scarring
% of fruit with > 10% scarring
Control 1
Control 2
Agri-Mek 1
Agri-Mek 2
Danitol 1
Danitol 2
Delegate 1
Delegate 2
Treatment

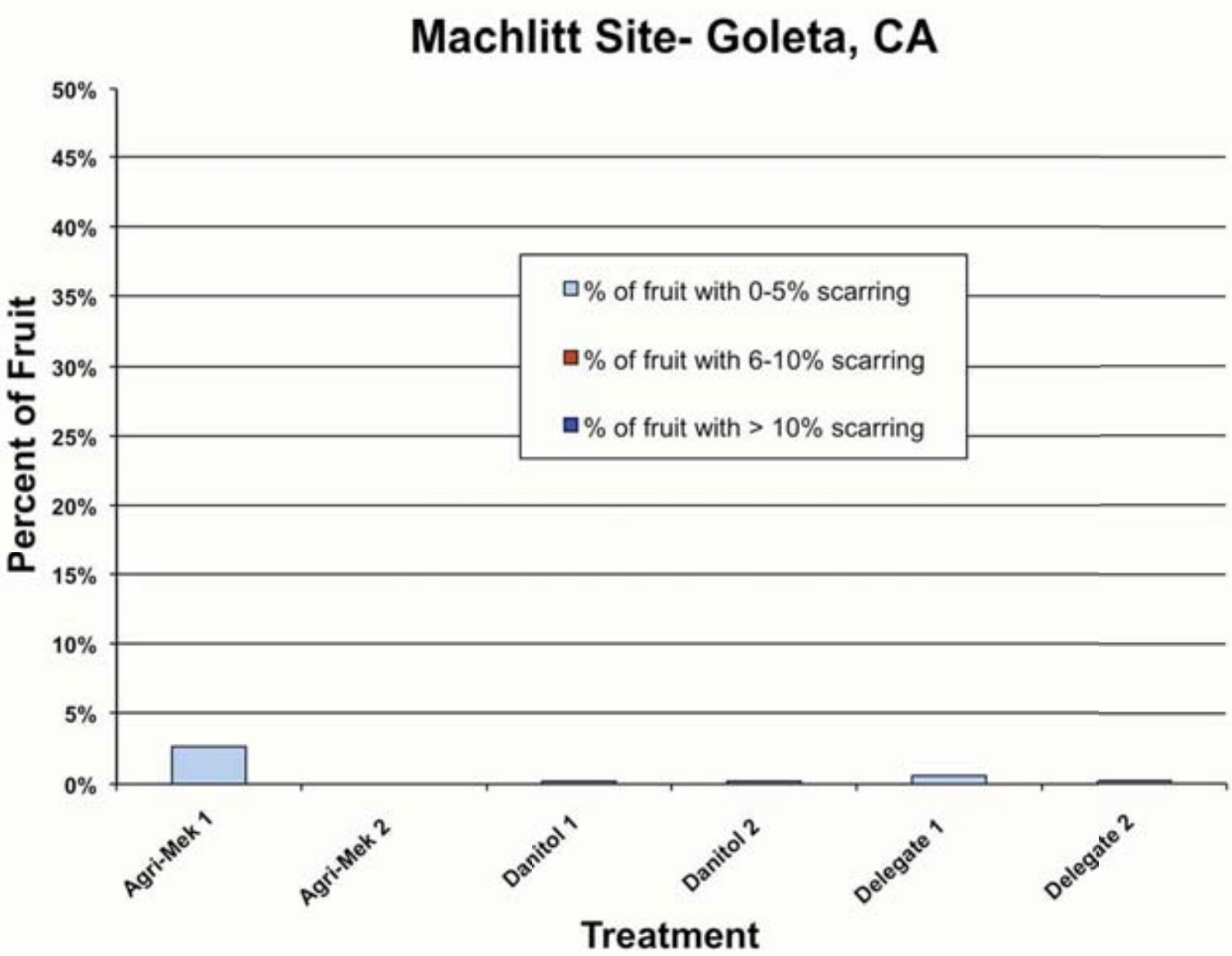
Tom Roberts Site
Somis, CA


Roberts Site - Somis Thrips Counts
(At 2/3 leaf expansion, helicopter, 50 gpa)
Mean # immature thrips/leaf
4
3.5
3
2.5
2
1.5
1
0.5
0
4.4
Agri-Mek E
Agri-Mek W
Delegate E
Delegate W
Danitol E
Danitol W
-3
+8
+15
+22
+29
+36
Application 6/4/09
Days Post-treatment

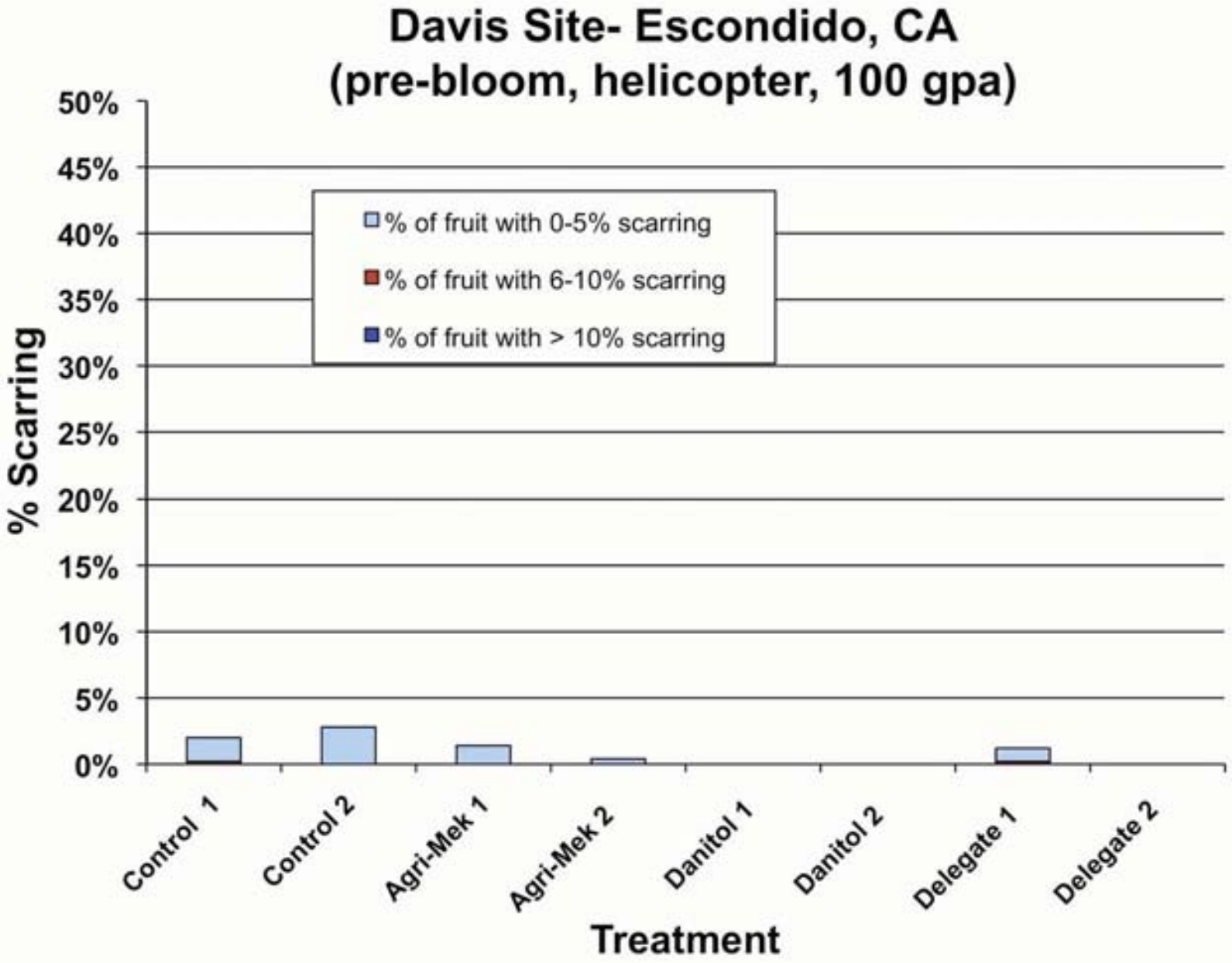

Roberts Site- Somis, CA
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Percent of Fruit
% of fruit with 0-5% scarring
% of fruit with 6-10% scarring
% of fruit with > 10% scarring
Agri-Mek 1
Agri-Mek 2
Danitol 1
Danitol 2
Delegate 1
Delegate 2
Treatment

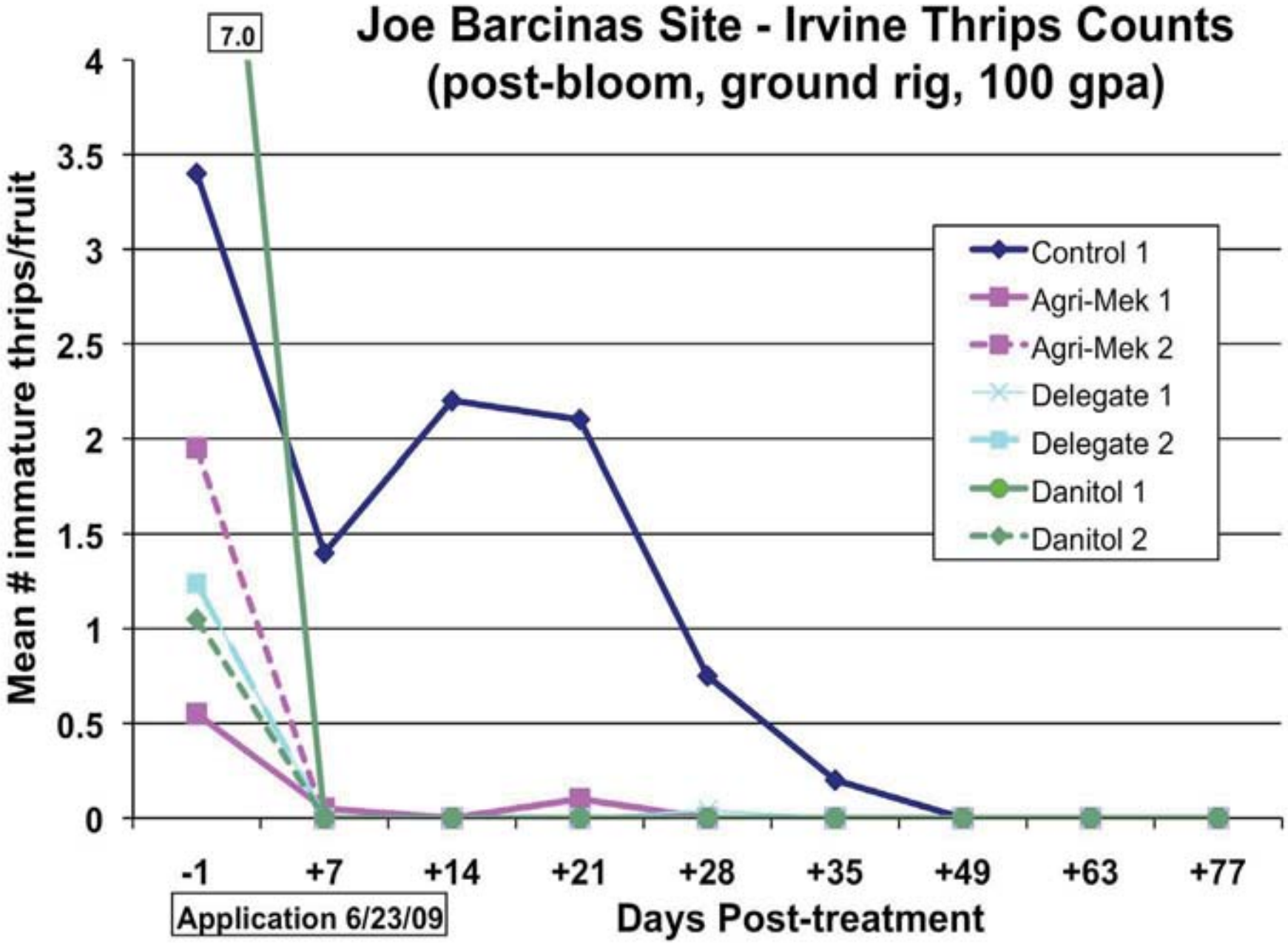
Dave Machlitt Site
Goleta, CA


Machlitt Site - Goleta Thrips Counts
(At 2/3 leaf expansion, helicopter, 60 gpa)
Mean # immature thrips/leaf
4
3.5
3
2.5
2
1.5
1
0.5
0
Agri-Mek S
Agri-Mek N
Delegate S
Delegate N
Danitol S
Danitol N
0
+8
+15
+23
+34
Application 6/9/09
Days Post-treatment


Machlitt Site- Goleta, CA
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Percent of Fruit
% of fruit with 0-5% scarring
% of fruit with 6-10% scarring
% of fruit with > 10% scarring
Agri-Mek 1
Agri-Mek 2
Danitol 1
Danitol 2
Delegate 1
Delegate 2
Treatment

Jim Davis Site
Escondido, CA


Davis Site- Escondido, CA
(pre-bloom, helicopter, 100 gpa)
% Scarring
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
% of fruit with 0-5% scarring
% of fruit with 6-10% scarring
% of fruit with > 10% scarring
Control 1
Control 2
Agri-Mek 1
Agri-Mek 2
Danitol 1
Danitol 2
Delegate 1
Delegate 2
Treatment


Joe Barcinas Site - Irvine Thrips Counts
(post-bloom, ground rig, 100 gpa)
7.0
Mean # immature thrips/fruit
4
3.5
3
2.5
2
1.5
1
0.5
0
Control 1
Agri-Mek 1
Agri-Mek 2
Delegate 1
Delegate 2
Danitol 1
Danitol 2
-1
+7
+14
+21
+28
+35
+49
+63
+77
Application 6/23/09
Days Post-treatment

Summary – 2009 Avocado Thrips Field Trials

- 2009 appeared to be a relatively light thrips year at most locations (scar counts not yet done at one site)
- Agri-Mek appeared to be the most effective pre-bloom material at one site, perhaps Danitol at the other
- Danitol applied at 2/3 leaf expansion was extremely effective in reducing thrips scarring
- Delegate applied at 2/3 leaf expansion appeared as effective as Agri-Mek, if not more so (beginnings of loss of susceptibility to Agri-Mek at some sites?)
- Methods appear sound - Try additional studies in 2010

Graduate Student Research – Ms. Deane Zahn

- Efficacy of soil treatments of *Beauveria bassiana* on pupae of avocado thrips versus citrus thrips
  - Lab screening of 6 strains of the fungus against the two thrips species
  - Fairly effective against citrus thrips but not avocado thrips
- Impact of pesticides used for control of avocado thrips on the predaceous mite *Euseius hibisci*

Thrips Pesticides – Impacts on *Euseius hibisci*

- The following materials and per acre rates were evaluated using a dilution rate of 300 gallons per acre

1. Water Control
2. Danitol 2.4 EC at 21.33 fl oz/a
3. Agri-Mek 0.15 EC + NR-415 Oil at 20 fl oz/a + 1%
4. Delegate 25 WDG + NR-415 Oil at 7 oz/a + 1%
5. Veratran D 0.2% + sugar at 20 lb/a + 5 lbs

Experimental Design

- On various dates post-treatment, 20 adult female *Euseius hibisci* were placed on each of 5 avocado leaves field-treated with each material
- Preliminary field trial 9 November 2009 (repeat in 4 weeks)
  - Treatments applied using a hand spray bottle
  - Comparative trial - applied a thin mist to each tagged leaf
  - Leaves were allowed to weather in the field (Riverside)
- Laboratory bioassay
  - Leaves were ringed with wet felt to prevent mite escape
  - Mortality readings were taken after 1, 2, 3, 4, & 5 days


Flagged Leaf

Summary – Preliminary *E. hibisci* Trial

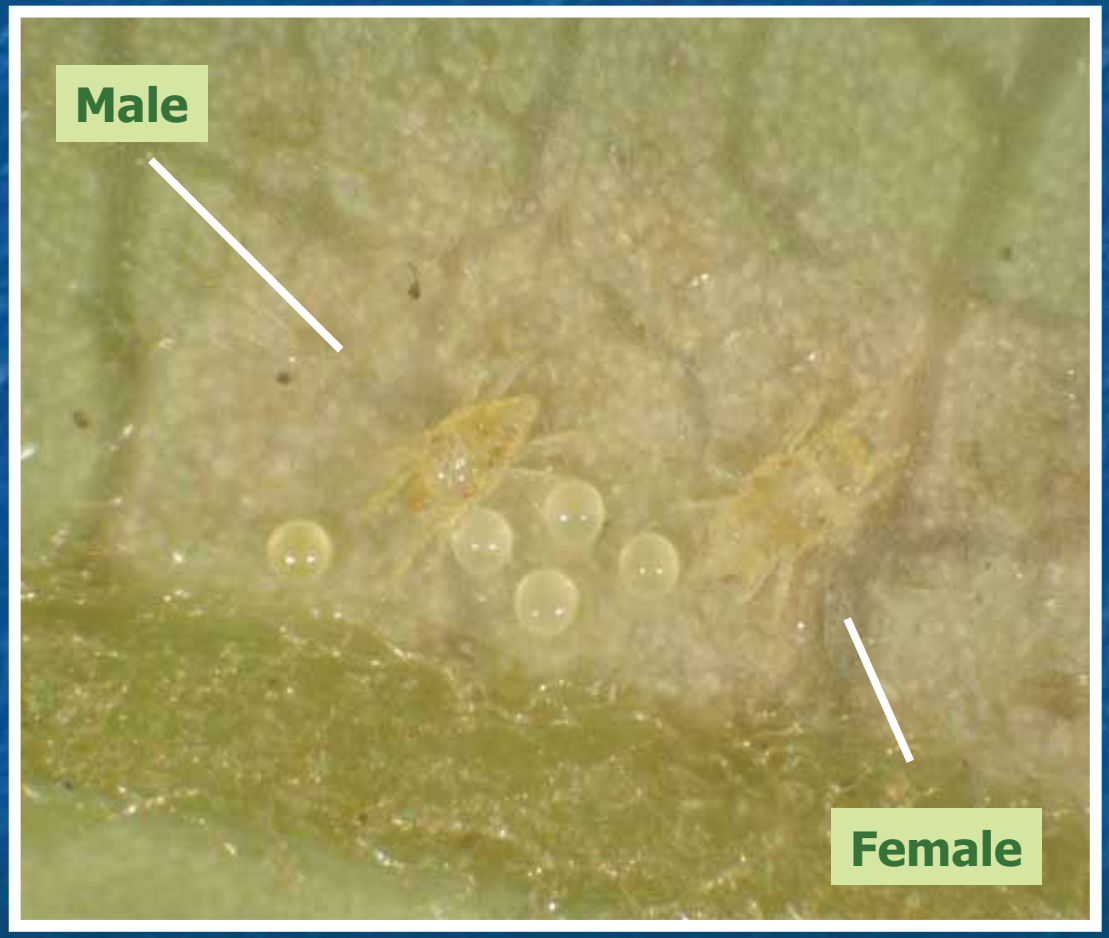
- Some results were not at all what was expected
  - Repellent impact of Delegate for 14 d
  - Mortality caused by Veratran D for 14 d (feeding?)
- Persistent impact of Danitol on predaceous mites (>90 d)
- Minimal impact of Agri-Mek after 7 d
- Additions to the next study:
  - Also place Delegate leaves with mites inside a Munger cell to observe mortality (can't suicide in wet felt)
  - Expose Agri-Mek and Delegate leaves to UV light

Research Objectives – Persea Mite

Objective 1b. Screen new pesticides and continue evaluation of current materials (5 field trials run since 2005)

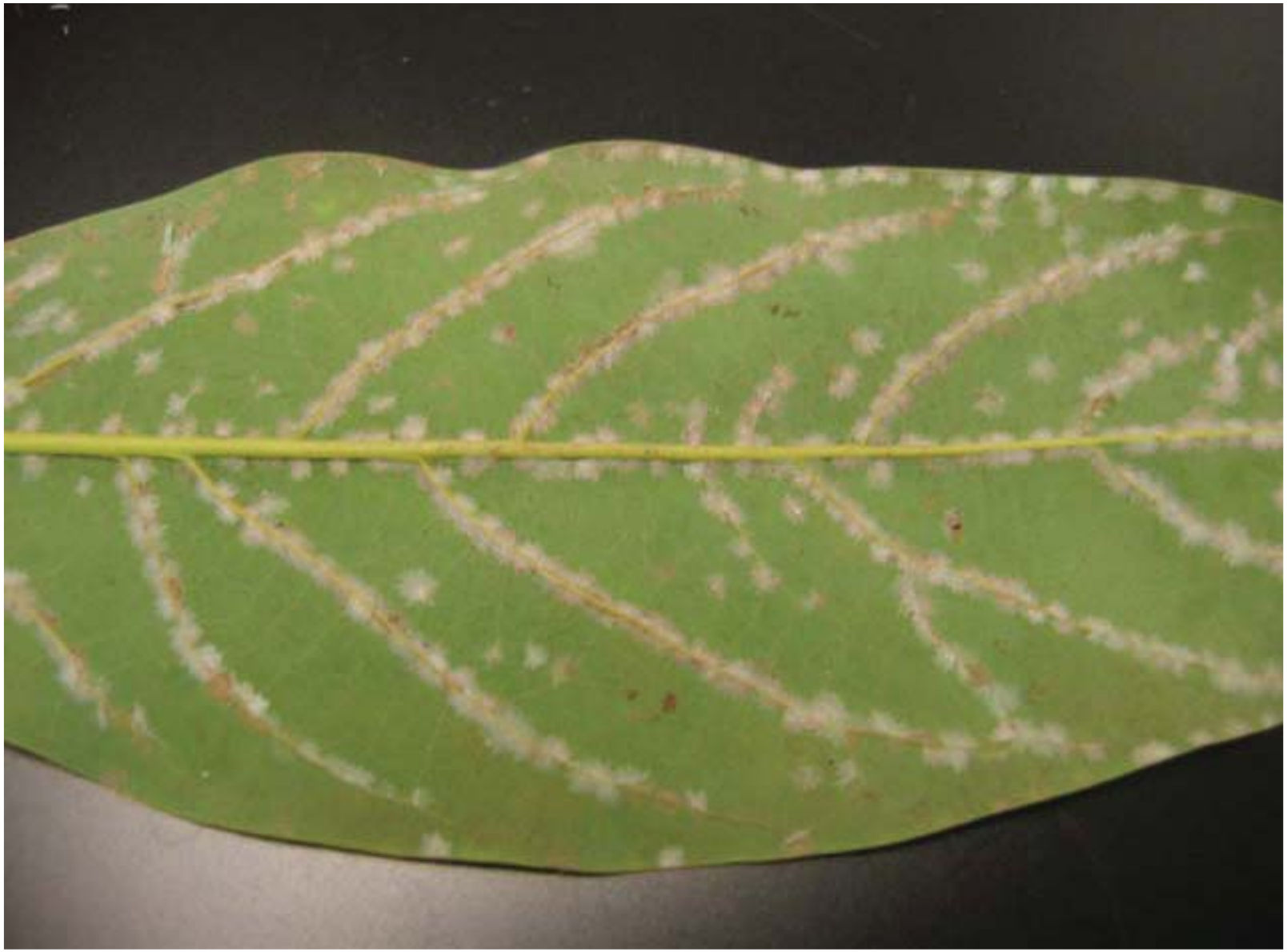
- Narrow range oils registered (Steve Peirce)
- Agri-Mek (1999)
- Danitol (2010)
- Envidor expected June 2010
- Zeal expected second quarter of 2011 (submission delay)
- Fuji-Mite expected perhaps 2012

Persea Mite



Oligonychus perseae (Acari: Tetranychidae)

Avocado persea mite



- Many groves do not require a persea mite treatment in a particular year

  - Monitor persea mites on mature leaves
  - In some groves, populations appear cyclical -- high for 2 years or so and then lower
  - Leaf drop tolerance for persea mite feeding (increases when > 7.5-10 % of the leaf surface is damaged) (Hoddle et al.)

Spirodiclofen – Envidor 2 SC (Bayer)

- Expected EPA registration for avocados (Tropical Tree Fruits) April 2010 and CA 2-6 weeks later (June 2010)
- Class 23 chemistry (inhibitor of lipid synthesis)
- Citrus label: Use 12-20 fl oz/a when oil is not used and 18-20 fl oz when it is (oil may reduce efficacy)
- Expect label will specify no more than 1 application per season (resistance management) and allow air application
- Guessing (from citrus label) - 12 h REI and 7 day PHI
- Toxic to bees, see label restrictions

IRAC Classification of Persea Mite Materials

Miticide	Company	Pesticide Class	IRAC Class
Agri-Mek	Syngenta, generics	Avermectin, macrocyclic lactone	6
Danitol (Feb. 2010)	Valent	Pyrethroid	3
Envidor (ca. June 2010)	Bayer	Ketoenole	Class 23
Zeal (second quarter 2011)	Valent	Phenetole	Class 10B
Fujimite (2012?)	Nichino	Mitochondrial electron transport inhibitor	Class 21

Obj. 2. Resistance Management

- Bioassay for resistance at field sites reporting poor control against avocado thrips or persea mite
  - Veratran D resistance in avocado thrips confirmed at two field sites
  - Loss of Agri-Mek susceptibility confirmed in a persea mite field population
  - Citrus thrips resistance to Agri-Mek in Ventura lead to a reduction in Success susceptibility
  - Flower thrips resistance to Success in Australia lead to reduction in Agri-Mek susceptibility
- Resistance of avocado thrips and/or persea mite to Danitol expected if this material is overused (use only once every OTHER year)

Key Points in Avocado Resistance Management

- Don't overuse Agri-Mek in 2010
  - Do not apply Agri-Mek in spring for avocado thrips AND THEN AGAIN in summer for persea mite (hold to a maximum of 1 application per season)
- Do not use imidacloprid or other trunk injections until they are registered and have been shown to be effective (Admire Pro CANNOT be injected - this formulation will not work)
- Feb. 2010, Danitol was registered and Envidor should be in June
- Avocado thrips -- rotate Agri-Mek/Delegate, Danitol, Veratran D
- Persea mite – rotate in Envidor during 2010, Zeal in 2011
- Danitol resistance VERY LIKELY if this material is over-used -- appears effective against both avocado thrips and persea mite but should be used only once EVERY OTHER YEAR
- Better if everyone didn't use Danitol in spring 2010 – prioritize use where Agri-Mek has been used heavily in the past

Future Research Priorities (Feedback Please)

- Field tests of new avocado thrips and persea mite materials
- Compare the impact of various products on a range of natural enemies (*E. hibisci*, then a parasitoid)
- Screening of Movento (scale, thrips, and mite activity; systemic movement; possible use during bloom) and other products possibly useful against armored scales
- Pesticide resistance monitoring and management strategies
- Screening for new avocado thrips pesticides
- Other ??

- Screening for new persea mite pesticides

Cooperation Requested (Morse & Stouthamer project)

Monitoring armored scales and parasitoids in CA

- If you see armored scales in your avocado grove, contact Lindsay Robinson so we can come out and take samples (determine which species) and collect parasitoids
  - Her contact information is on the handout
  - Have pickers/others look on fruit during harvest
- We are looking for groves with moderate levels of LIVE armored scales (a key objective is also parasitoids)

Acknowledgments and Thanks!

Grower cooperator field trials:

- Grower cooperators
- Pest control advisors Joe Barcinas, Jim Davis, Matt Hand, David Holden, Dave Machlitt, and Tom Roberts
- Dow, Syngenta, and Valent

Technical assistance:

- Alan Urena, Lindsay Robinson, Pamela Watkins

Powerpoint graphs:

- Lindsay Robinson and Deane Zahn