California Avocado Research Symposium 2006

November 4, 2006
University of California, Riverside

California Avocado Commission
Production Research Committee

Our Mission: To provide California Avocado Growers a means to achieve optimum profitability, now and in the future, through focused research, global collaboration, and effective communication of results

Evaluation of Systemic Chemicals for Avocado Thrips and Avocado Lace Bug Management

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Funding from the California Avocado Commission

Objectives in 2005-06

1. Evaluate the uptake of neonicotinoid insecticides, applied systemically through irrigation systems, in commercial avocado trees in California

   Three core study sites near Temecula

2. Determine the impact of leaf residues of the neonicotinoids against avocado thrips and avocado lace bug (*Diaprepes*)

   Avocado thrips - young leaves

   Avocado lace bug - mature leaves

3. Evaluate tree uptake of imidacloprid in 24c treatments

   Data taken from 20 additional satellite sites

Why Evaluate Neonicotinoids?

- Operational reasons
  - More easily administered via irrigation systems
  - Avoid difficulties with helicopter applications, low mammalian toxicity
    - Difficulty with applications near urban areas
    - Problems with incomplete coverage
    - Delays in helicopter availability
- Resistance reasons
  - New mode of action for avocado pest management
  - Less reliance on one product (e.g., AgriMek)
- Based on preliminary trials, it kills avocado thrips and avocado lace bug

Steep Hillsides Are A Formidable Challenge For Effective Pesticide Application

Resistance Management on Avocados

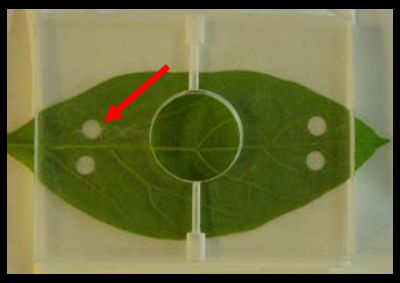
Avocado thrips	IRAC class	Class of chemistry	Registration status
AgriMek	6	Avermectin (macrocyclic lactone)	Registered in 2005 (Section 19 for 6 years 1999-2004
Success / Entrust	5	Spinosyn (macrocyclic lactone)	Registered in 1998 (Cross resistance potential to AgriMek?)
Veratran D	Near 3?	Two plant alkaloids	Registered in 1998 (Good for rotation), SLN in 1997
Admire	4A	Neonicotinoid	24c obtained in 2006, expires 4-1-07; Working to see if Bayer will renew
Persea mite			
AgriMek	6	Avermectin	Registered
Narrow Range Oil	--	Oil (suffocation)	Registered

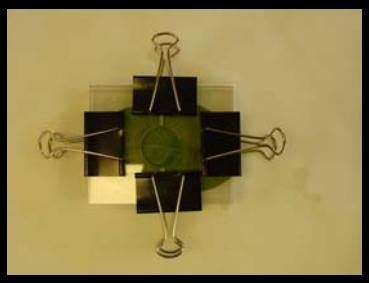
Key Points in Avocado Resistance Management

- We MUST not lose AgriMek to resistance over the next 3 years as new products are being registered
  - Must get by over the next 2-3 years by minimizing AgriMek use
  - Do not apply AgriMek in spring for avocado thrips and then again in summer for persea mite (hold to maximum of 1 application per season)
  - Use Veratran D in rotation for avocado thrips control
- Admire 24c in 2006
  - Data from 2006 trials suggests applications in irrigation water did not result in high levels of imidacloprid in mature trees
  - In 2007, would like to evaluate long term (3-4 weeks) impact on avocado thrips -- young trees without fruit or mature trees if they would not be oversprayed
  - Trunk injections are not registered -- do not use
- Suggest not using the foliar form of imidacloprid (Provado) when it becomes available (resistance management, secondary pest upset problems)

Bioassay Method

- Similar method with avocado thrips and lace bug
- Munger cells are needed to contain thrips
- Residues determined on bioassay leaves





Threshold Imidacloprid Concentrations Recommended for Avocado Thrips Control

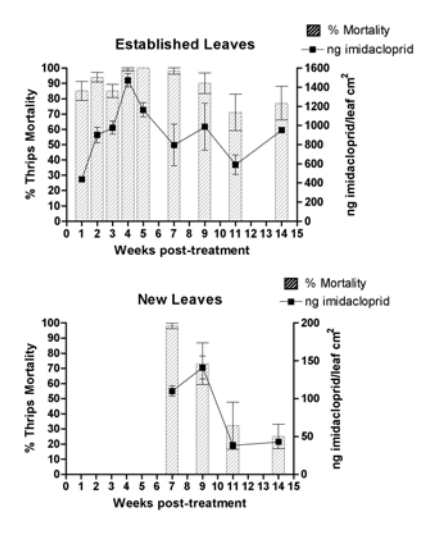
Threshold close to 100 ng/cm^2

Established leaves

- On tree at the time of treatment

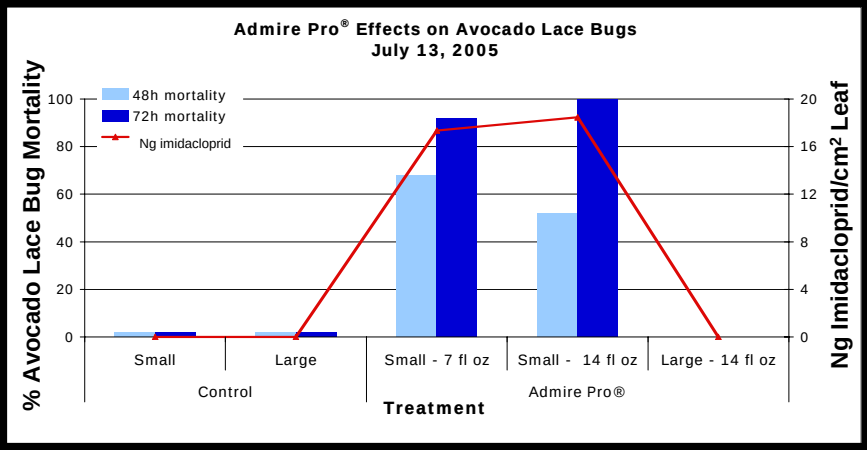
New leaves

- Fresh growth after treatment
- Favored by avocado thrips



Threshold Imidacloprid Concentrations Recommended for Avocado Lace Bug Control

Threshold close to 20 ng/cm^2



Light Leaf Litter Under Trees

Moderate Leaf Litter Under Trees

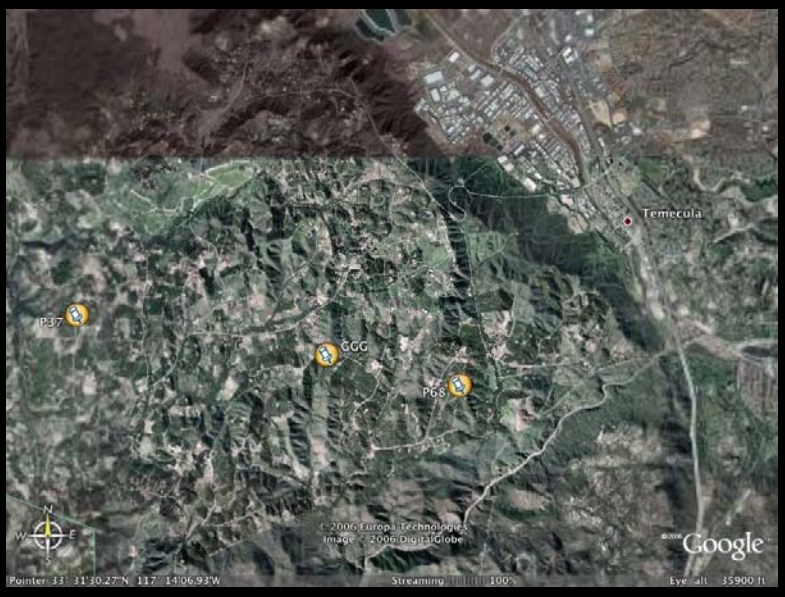
Field Study - 2006

AdmirePro® (imidacloprid)

•14 fl oz per acre

Three commercial groves in the Temecula Valley

3 groves in Riverside County - West of Temecula



Field Study - 2006

3 avocado groves in Riverside County - West of Temecula

Mature trees (> 20 years old)

Admire Pro at 14 fl oz/acre

Soil types:

P68: Lodo rocky loam

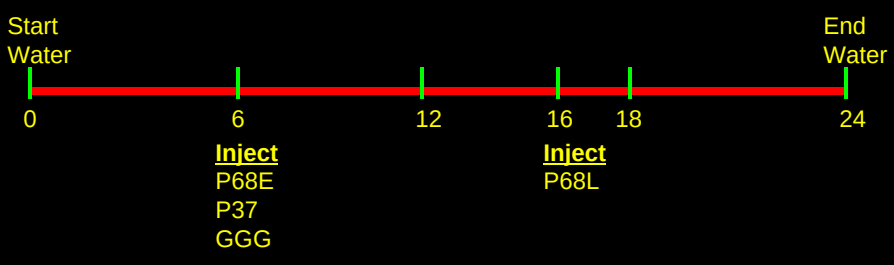
P37: Fallbrook rocky, sandy loam

GGG: Lodo rocky loam

Heavy organic layer at each site -- intentionally chose challenging sites

Details of 2006 Trial in Temecula Valley Groves

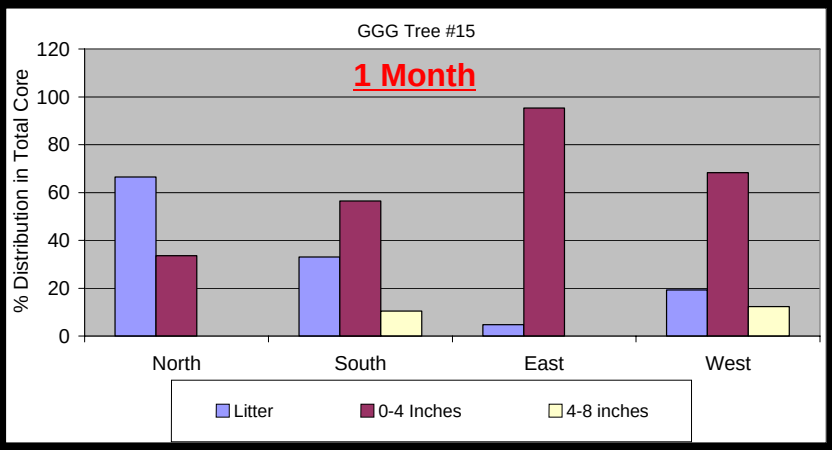
- Treated March 30/April 3 with 14 fl oz/acre Admire Pro
- Treated during a 24 hour irrigation cycle
  - 2 hour injection time
  - Compare early and late injections at one site
  - Raked heavy litter from under five trees at 2 sites
  - 1 and 3-month soil analyses at all 3 sites
  - Flower, nectar, and pollen study at two sites



Treatments applied by Ed Ishida and Manuel Jimenez of Bayer CropScience

Distribution of imidacloprid in litter and upper soil layer

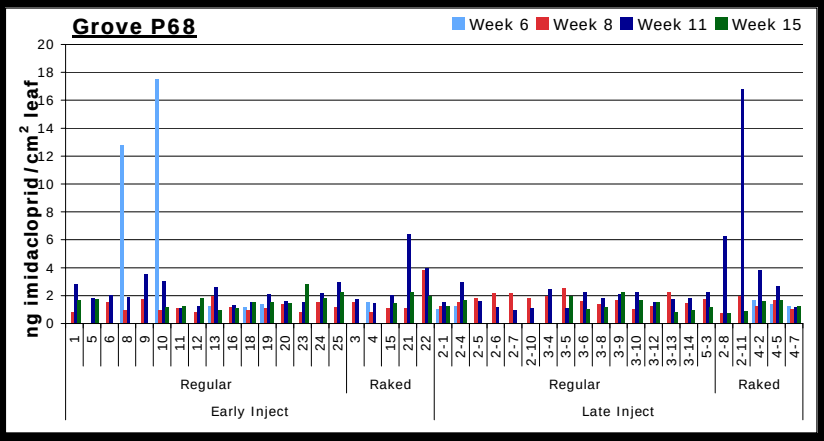
- Most insecticide in litter or top 4 inches of soil
- Very little penetration below 4 inch layer
- Imidacloprid clearly getting to the area where the roots are



Data from Mark Lenz, Bayer CropScience

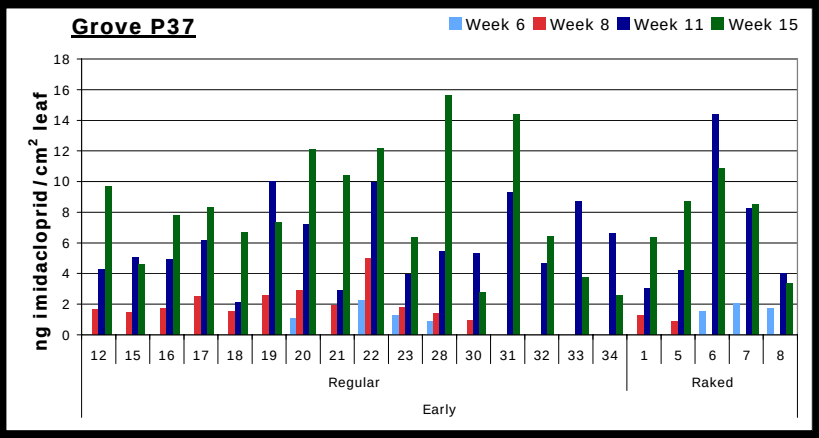
Grove P68 - Young (Avocado Thrips) Leaves

Timing of injection within a 24-hour irrigation cycle
Compare uptake when leaf litter removed before injection



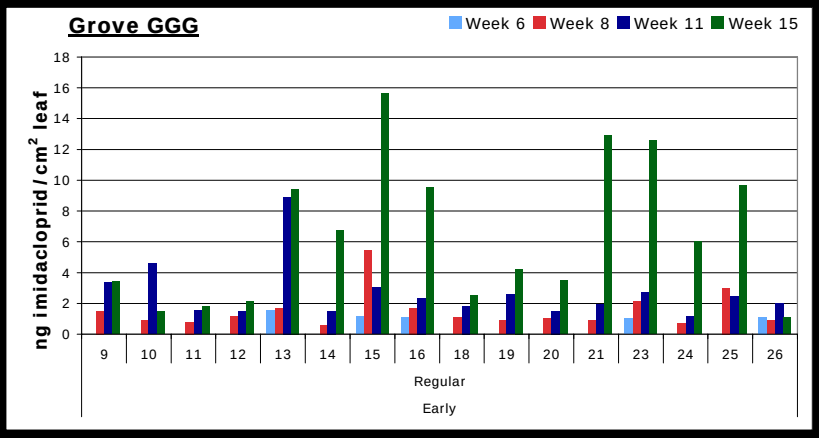
Grove P37 - Young (Avocado Thrips) Leaves

Admire Pro injection early in the irrigation cycle
Compare uptake when leaf litter removed before injection



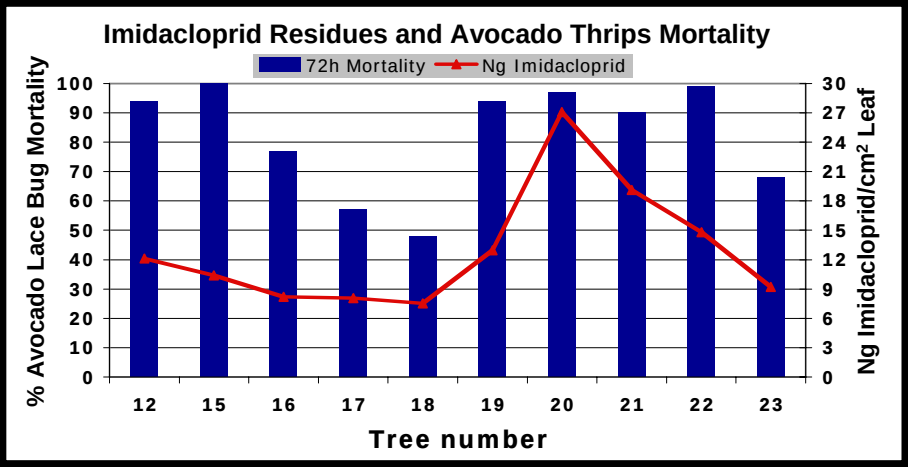
Grove GGG - Young (Avocado Thrips) Leaves

Admire Pro injected early in the irrigation cycle
Leaf litter not removed



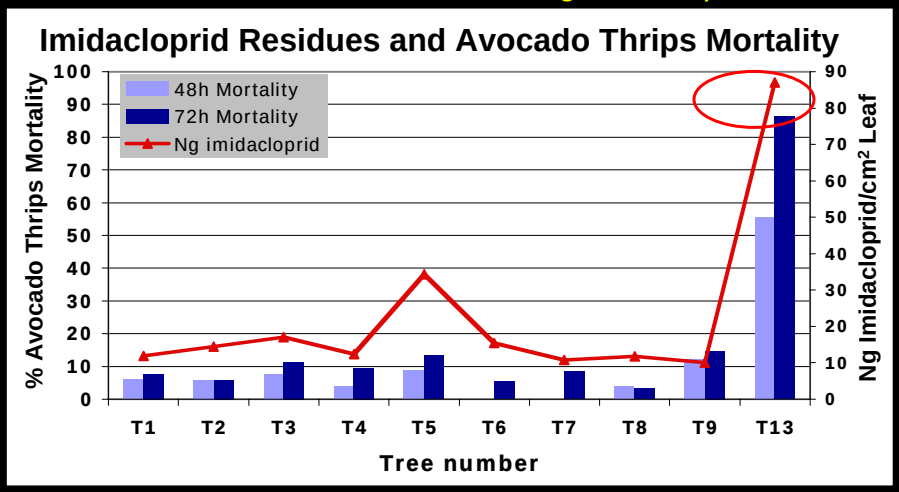
Efficacy of Imidacloprid Residues Against Avocado Lace Bug

Recommended residue level is 20 ng imidacloprid/cm^2 leaf



Efficacy of Imidacloprid Residues Against Avocado Thrips

Recommended residue level is 100 ng imidacloprid/cm^2 leaf



Conclusions

- Admire Pro struggling to get into young leaves on large trees
- 1-month soil cores show that imidacloprid is in the root layer -- 3-month samples show a similar trend
- Raking the leaf litter before injecting does not improve uptake
- Similar uptake results with early and late injections
- ALB threshold levels attainable
- Flower, nectar, and pollen samples in freezer awaiting analysis (Bayer vs UCR comparison)

24c Survey

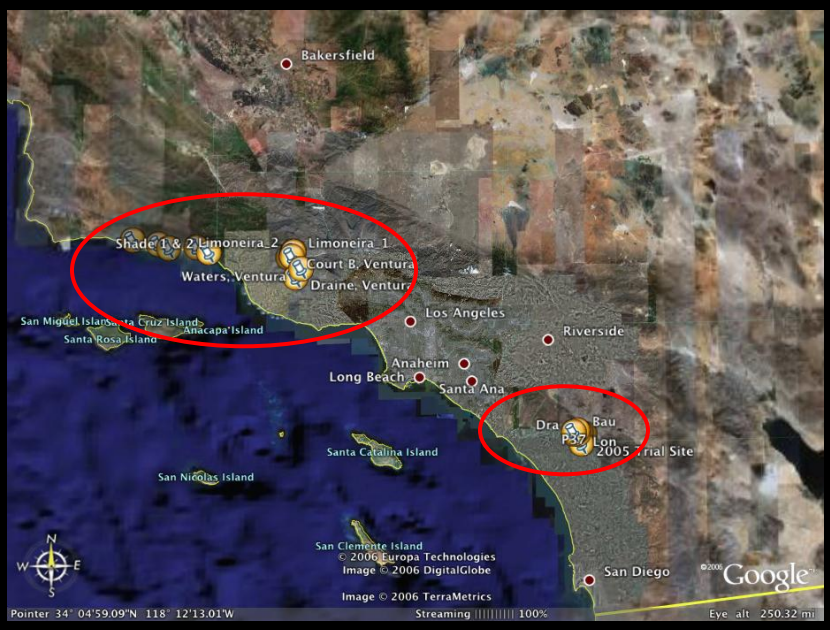
Emergency Registration

- Helicopter crisis
- 24c registration for Admire Pro use against Avocado Lace Bug with suppression of Avocado Thrips
- Survey groves where Admire Pro was used
  - Range of conditions, climate, soils, etc

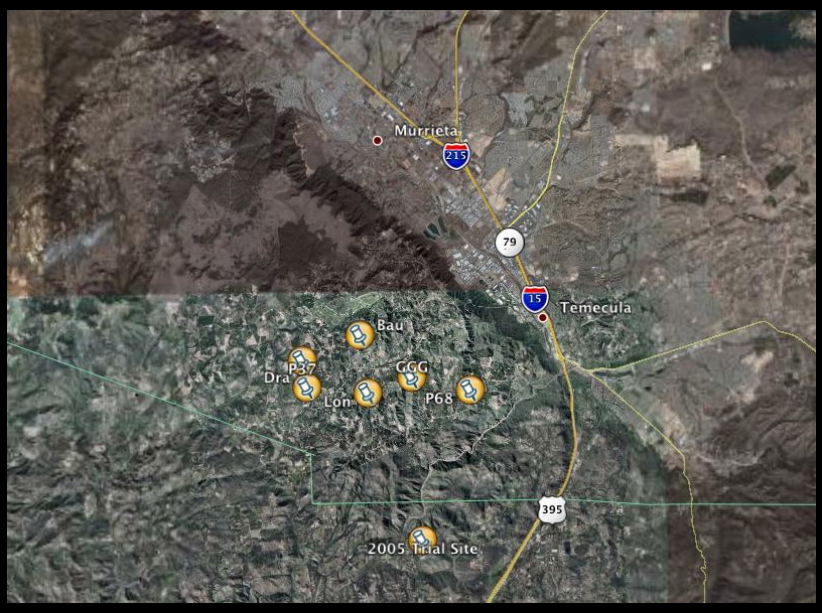
Total Admire Pro Data Sites (24)

- Riverside County (7)
- San Diego County (1 in 2005)
- Ventura County (6)
- Santa Barbara County (10)

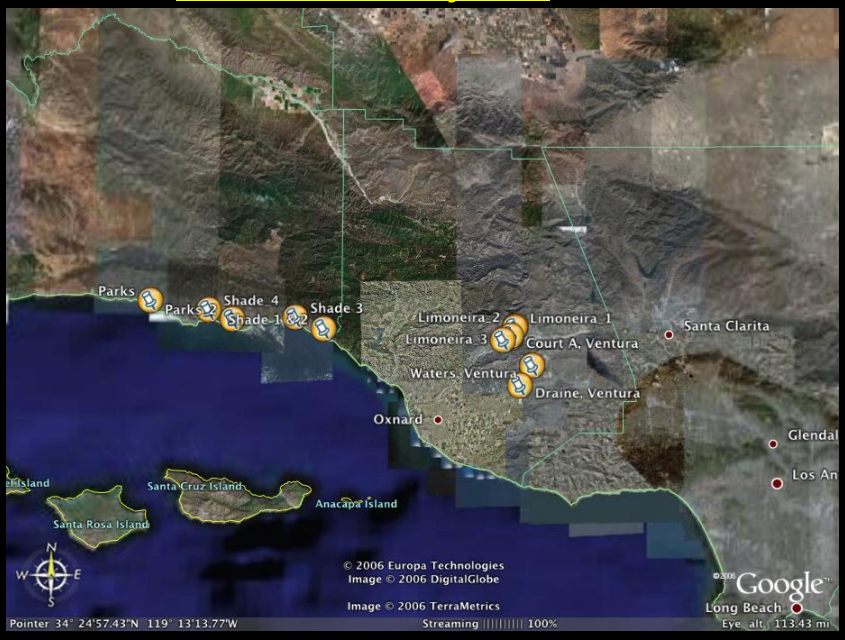
Admire Pro Survey Sites



Admire Pro Survey Sites - South



Admire Pro Survey Sites - North

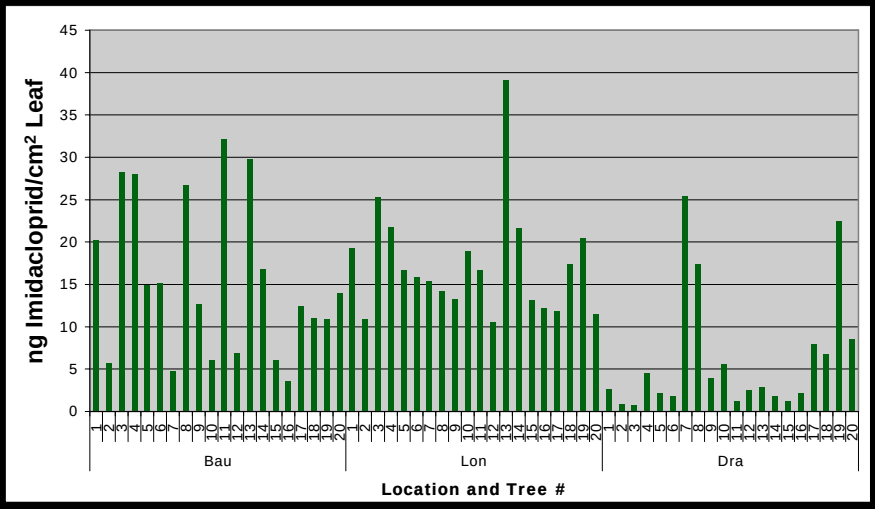


Admire Pro Survey Sites

Imidacloprid uptake at 3-4 weeks
Young leaves - below recommended levels

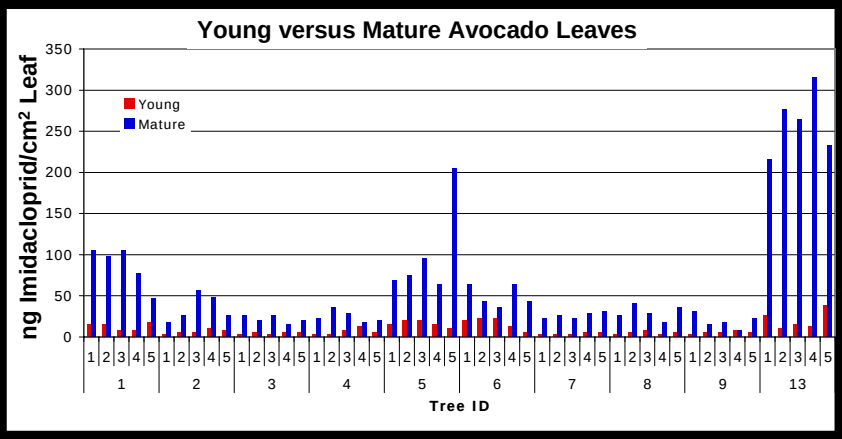
Tree Ages

Bau: 6 yrs
Lon: 3 yrs
Dra: 4 yrs



Admire Pro Survey Sites

Lon: 3 yr old trees
Young versus Mature Leaves
Most insecticide is in the mature leaves



Conclusions

A race between the rate of growth of the new flush leaves and the rate of uptake of imidacloprid through the roots

Solution may be to use a more soluble neonicotinoid which can keep pace with the rate of leaf growth - thiamethoxam (x8) & dinotefuran (x40)

Use of Admire on **mature** trees effective against ALB (and adult *Diaprepes*?); residues toxic to avocado thrips are not consistently attainable

Neonicotinoid levels in avocado trees

Priorities for 2007

- Assess more soluble neonicotinoids
- Alternate application methods
- Trunk injections (effective vs. Emerald Ash Borer)
- Continue to monitor 24c groves

Additional Objective for Spring 2007

Flower study to determine possible non-target impacts

- Important for registration purposes
- Post-bloom applications are prohibited (expires 4-1-07)
- Bees must be removed during bloom

Biology, Management, and Resistance Management of Avocado Thrips and Persea Mite

Persea Mite

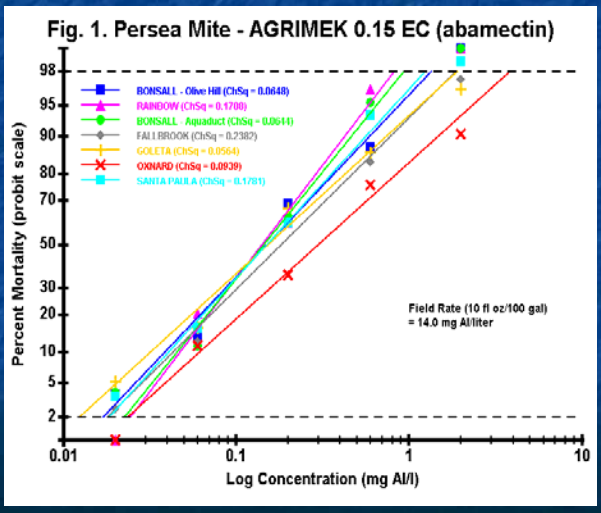
Oligonychus perseae (Acari: Tetranychidae)

Persea mite nests

Recent Research Publications

- Humeres, E. C. and J. G. Morse. 2005. Baseline Susceptibility of Persea Mite (Acari: Tetranychidae) to Abamectin and Milbemectin in Avocado Groves in Southern California. Experimental & Applied Acarology 36: 51-59.
- Humeres, E. C. and J. G. Morse. 2006. Resistance of Avocado Thrips (Thysanoptera: Thripidae) to Sabadilla, a Botanically Derived Bait. Pest Management Science 62: 886-889.

- The beginnings of Persea Mite loss of susceptibility to AgriMek was observed in a Ventura Co. avocado grove



Recent Research Publications

- Morse, J. G. 2004. Avocado Thrips Resistance: A Real Concern for the Future. Mission Avocado Update, December 2004.
- Morse, J. G. and G. W. Witney. 2005. Avocado thrips – Resistance to Pesticides. AvoResearch, Spring 2005, Calif. Avoc. Commission, Irvine, CA. 2 pp.

- General observation – avocado thrips and persea mite levels vary from year to year and from grove to grove - monitoring by a knowledgeable grower/ PCA needed to determine if treatments are needed -- Contrast 2005 versus 2006
  - Hot, dry weather depresses avocado thrips
  - Presence of leaf flushes and young fruit favor avocado thrips buildup
  - High levels of predators help slow buildup of both avocado thrips and persea mite

Monitoring is KEY -- Avoid unnecessary sprays

- Good treatment decisions are tricky - several factors are involved:
  - Tree size and health (vigor), grove topography
  - Timing (leaf flushes), weather
  - Natural enemy levels
  - Grower tolerance for fruit scarring (short-term economics versus natural enemy and thrips susceptibility maintenance)
  - Leaf drop tolerance for persea mite feeding (increases when > 7.5-10 % of the leaf surface is damaged)
  - Spray equipment availability
- Many groves do not require an avocado thrips or persea mite treatment in a particular year

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

Pesticides available for avocado thrips

- **ABAMECTIN** - AgriMek 0.15 EC + Oil
- **SPINOSAD** - Success 2 SC + Oil
  - Entrust 80% + Organic Oil
- **SABADILLA** - Veratran D 0.2% + Molasses or Sugar
- **IMIDACLOPRID** - Admire Pro (2006 24c) -- efficacy concerns on large trees, more work needed on young trees

Hand Spraying With Drag Hoses

- Ca. $2500 for a small spray tank and drag hose pulled behind a truck or ATV on drive rows
  - 300 foot drag hose
  - 150 gallon or larger tank (ours is 110)
  - Treatment at 300-500 gpa
  - Benefits -- excellent coverage and timing possible; possibility of spot treatments (e.g, on March or early April flush)
  - Problems -- labor can be expensive and treatment difficult on \ steep hillsides

Anticipated Future Persea Mite Control Materials

Pesticide	IRAC class	Class of chemistry	Registration status
AgriMek	6	Avermectin	Registered
Zeal	10B	Phenetole	CAC/Valent funding obtained IR-4 start in 2006; Out 2009? Earlier with industry pressure??
Envidor	23	Ketoenole (same as spirotetramat)	Witney obtained A ranking for IR-4 in 2007 - out 2010?
FujiMite	21	Electron transport inhibitor	Submit to IR-4 for 2008 - out 2011 if successful?
Acramite	25	Neuronal inhibitor (unknown mode)	2012?

Anticipated Future Thrips Control Materials

Pesticide	IRAC class	Class of chemistry	Registration status
AgriMek	6	Avermectin	Registered
Success	5	Spinosyn	Registered (Cross resistance potential to AgriMek?)
Veratran D	Near 3?	2 Plant alkaloids	Registered (Good for rotation)
Admire	4A	Neonicotinoid	24c in 2006
Danitol	3	Pyrethroid	IR-4 work done; Out 2008? (EPA delay in re-registration of pyrethroids)
Platinum	4A	Neonicotinoid	In IR-4 in 2006; Out 2009?
Venom	4A	Neonicotinoid	2010? (registered on grapes)
spirotetramat	23	Ketoenole	2011? (citrus 2009?)
NNI-0101	??	Unknown	2011 IF it clears environmental screen (12-06)

Avocado Thrips Management

- AgriMek is a remarkably effective material for avocado thrips control (even by air) with minimal detrimental impact on natural enemies
- Effective alternative control materials are coming but for 2007, we have limited options
- We must conserve avocado pest susceptibility
  - Limit Agri-Mek sprays to once per year maximum
  - Industry pressure needed to accelerate the availability of Zeal for persea mite and Danitol for avocado thrips