

Systemic Insecticides, Insect Growth Regulators, and Biological Controls against Ornamental Pests in Hawaii

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What will this presentation cover?

- * What are Neonicotinoids?
- * Properties of Neonicotinoids
 - UV sensitivity
 - Water solubility
 - Residual Activity
- * Spectrum of Insect Control
 - Sucking Insects: aphids, scale insects, mealybugs, whiteflies, lacebugs
 - Chewing Insects: beetles, caterpillars, grubs
- * Insect Growth Regulators
- * Tetric Acid Insecticide (spirotetramat)

What will this presentation cover?

- * Biological Control *(continued)*
 - Classical
 - Fortuitous
 - Augmentative
 - Inundative - flood
 - Inoculative - inoculate
- * Biological Control in Hawaii
- * Video of Natural Enemies in Action
- * Conservation of Natural Enemies
 - Minimize Use of Broad-Spectrum Insecticides
 - Environmental conditions detrimental to natural enemies (wind, drought)
- * Mass Releases of Biological Control Agents

Evolution of Insecticides

1940-50's

Chlorinated hydrocarbons

DDT, Chlordane, Dieldrin, Mirex, Heptachlor



1960-70's

Organophosphates & Carbamates

Dimethoate, Diazinon, Dursban, Orthene, Sevin



1980-90's

Pyrethroids (synthetic)

Mavrik, Tame, Tempo, Decathlon, Talstar



1990-2000's

Reduced-Risk Insecticides

Natural

Conserve, Avid, Neem, *B.t.*,
fungi, oil, soap

Tetronic Acid

Kontos, Movento

Insect Growth Regulators

Distance, Enstar, Talus

Neonicotinoids

Merit, Marathon,
Optigard Flex, Safari,
TriStar, Discus

NEONICOTINOID INSECTICIDES



Acetamiprid

*Optigard Flex Gel
Flagship*



thiomethoxan



Dinotefuran

**Arena®
INSECTICIDE**

clothianidin



imidacloprid



Marathon

imidacloprid



Premise

imidacloprid



**ADMIRE® PRO
Systemic
Protectant**

PROVADO™

imidacloprid

- * **Neonicotinoids** act on the **nervous system** of insects with very low toxicity to mammals and minimal environmental impact, and are therefore considered reduced-risk pesticides.
- * Neonicotinoids are among the most widely used insecticides worldwide.
- * The mode of action of neonicotinoids is similar to the natural insecticide **nicotine**. In insects, neonicotinoids cause paralysis which leads to death, often within a few hours.
- * Neonicotinoids bind at a specific site, the nicotinic receptor; there are no records of **cross-resistance** to the carbamate, organophosphate, or synthetic pyrethroid insecticides, thus making neonicotinoids important for management of insecticide resistance.

Neonicotinoid Insecticides

Spectrum of Insect Control

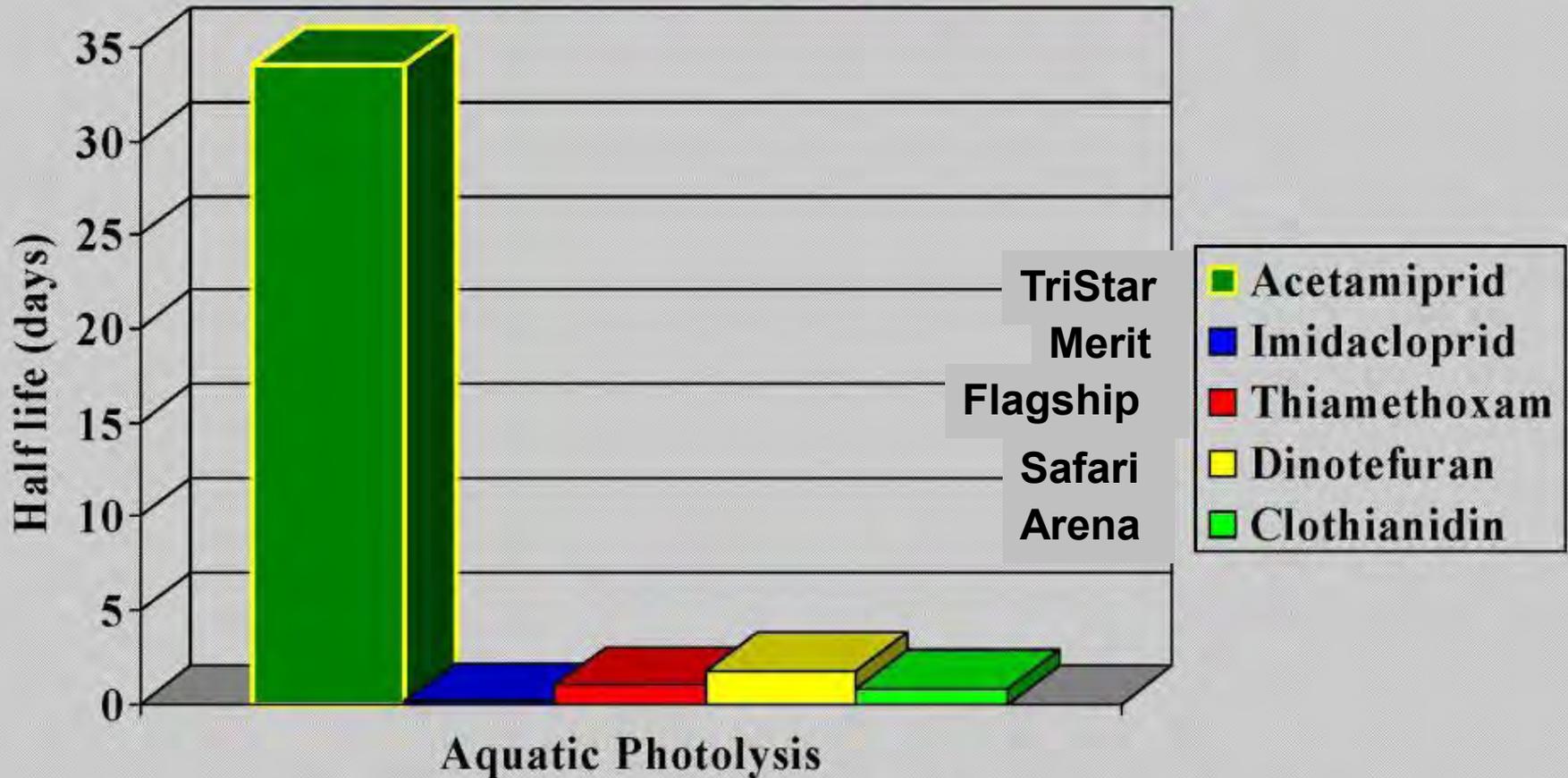
Sucking insects

Aphids
Lace Bugs
Leafhoppers
Mealybugs
Plant Bugs/Hoppers
Psyllids
Scale Insects
Spittlebugs
Thrips
Whiteflies

Chewing insects

Beetles
Borers
Mole Crickets
Gall Wasps
Grubs
Leafminers
Termites
Weevils

Comparison of UV Stability



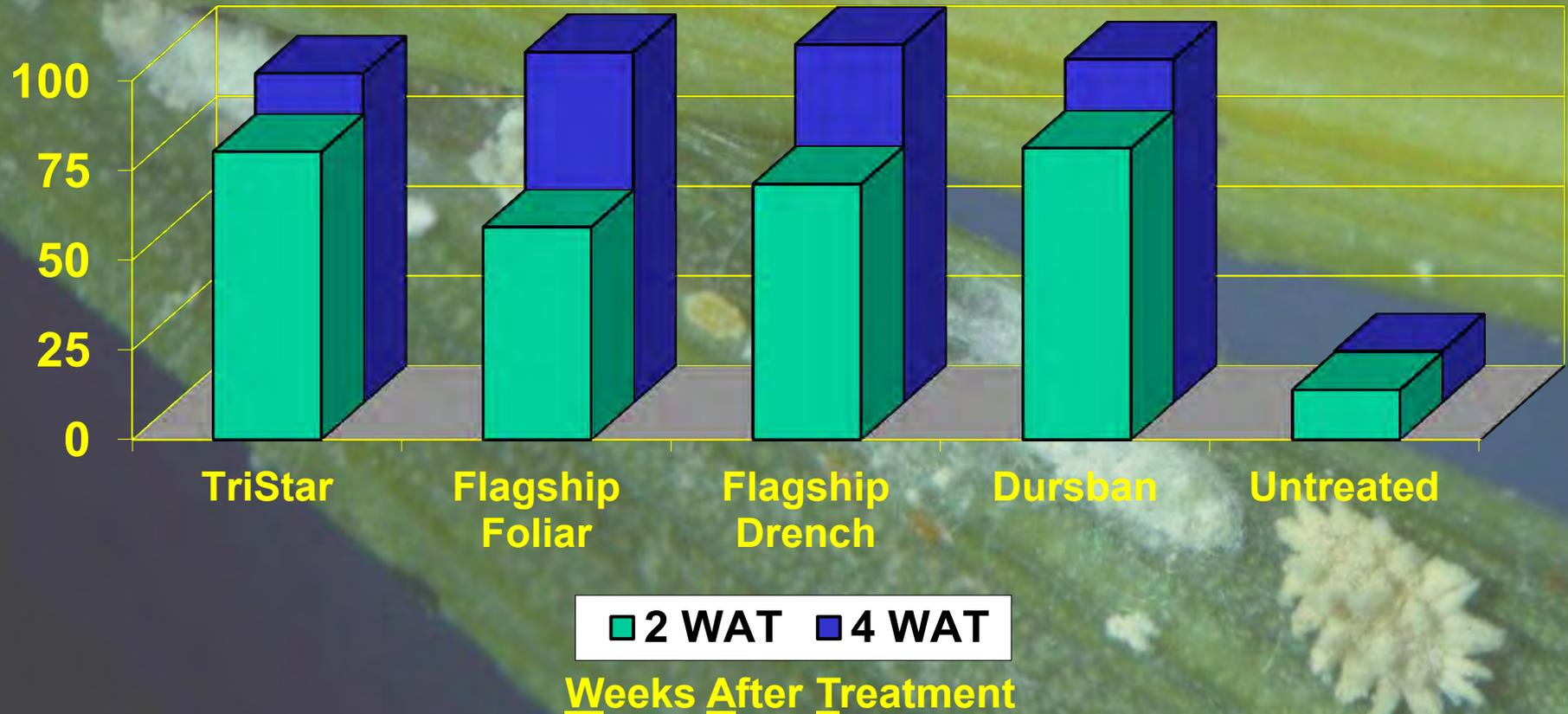
Data obtained from published EPA registration documents

Slide Credit: R. Fletcher

TriStar is registered for foliar use only and the most UV stable of all neonicotinoids.

TriStar and Optigard Flex Against the Coconut Mealybug, *Nipaecoccus nipae*

% Mortality

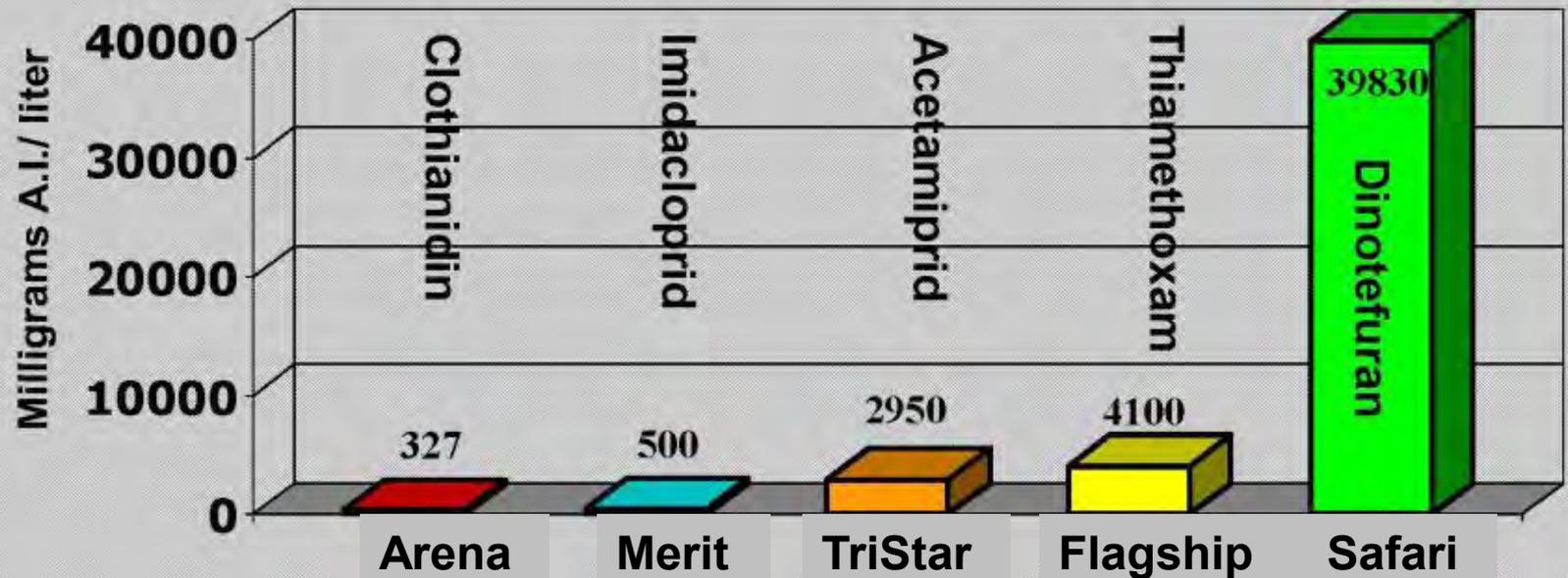


TriStar = acetamiprid

Flagship = thiamethoxam = Now available in Hawaii Optigard Flex
(Not sold in Hawaii) (For landscape ornamental plants)

Relative Water Solubility of Neonicotinoids:

Water Solubility (Active Ingredient)



Information sources

*Clothianidin (Celero), Acetamiprid (Tristar), Dinotefuran (Safari) – EPA Pesticide Fact Sheet
Imidacloprid (Marathon), thiamethoxam (Flagship) – MSDS for Products*

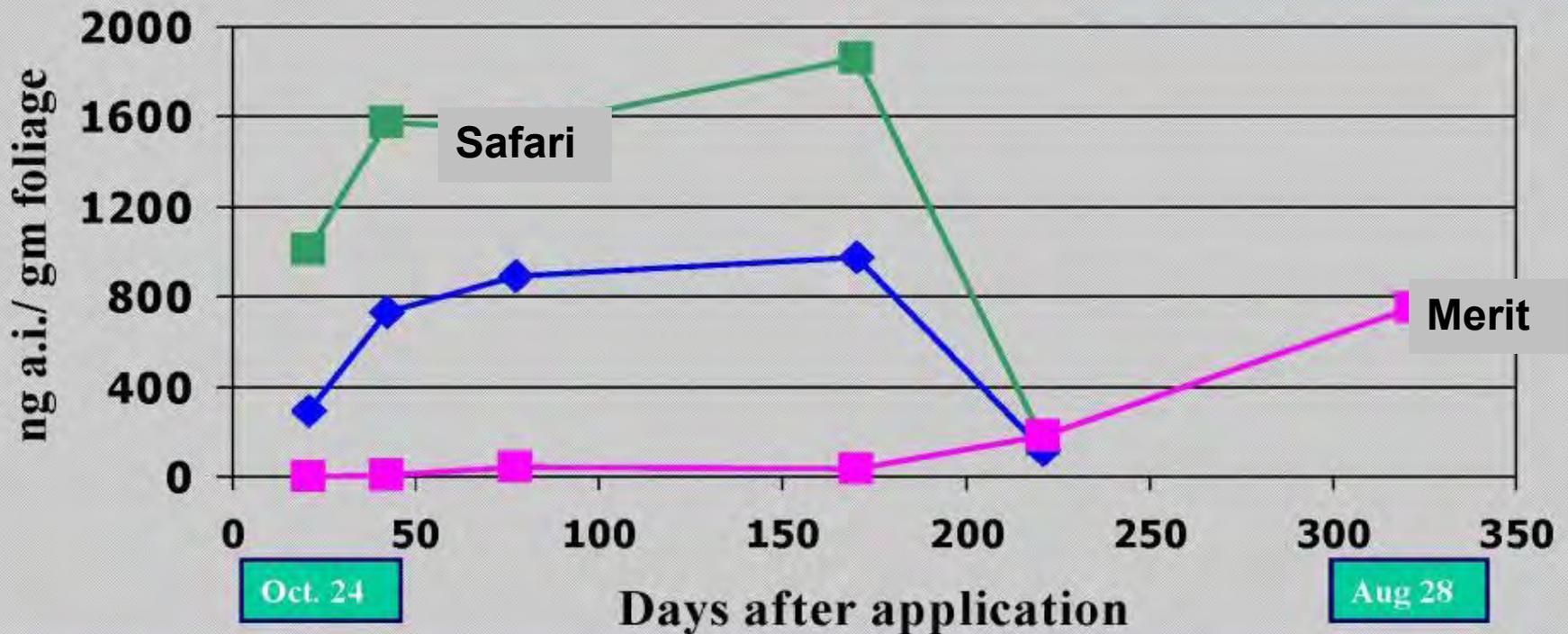
Slide information courtesy J. Chamberlin



Neonicotinoid Uptake in Hemlock

12-24" DBH Hemlock, Cashiers, NC

Applied October 3, 2006
Drench volume: 1 qt/ indbh



—■— Safari 20SG 1.2 gmai/indbh (Drench)

—◆— Safari 2G 1.2 gmai/ indbh (Granule)

—■— Merit 75WP 1.5 gmai/indbh (Drench)

Safari (dinotefuran) as compared with Merit (imidacloprid)

- * Safari is similar to Merit/Marathon, but is more water-soluble for quicker systemic uptake by plants.
- * Safari's systemic activity is not as long-lasting.
- * Both effective against whiteflies, aphids, soft scale, wax scales, thrips, fungus gnats.
- * Safari is also effective against armored scales and mealybugs.
- * Apply as a foliar or drench application.

Safari (dinotefuran) against Mealybugs at a Hilo nursery



Brassia



Begonia Escargot



Medinilla



longtail mealybug



Ming Aralia



Dracaena



Dwarf fishtail fern



citrus
mealybug



Leather leaf fern



Xanthosoma



Dieffenbachia



Osmoxton



Cissus

Foliar and drench applications of Safari tested at the labeled rate on these infested plants.

Results of Safari Trial

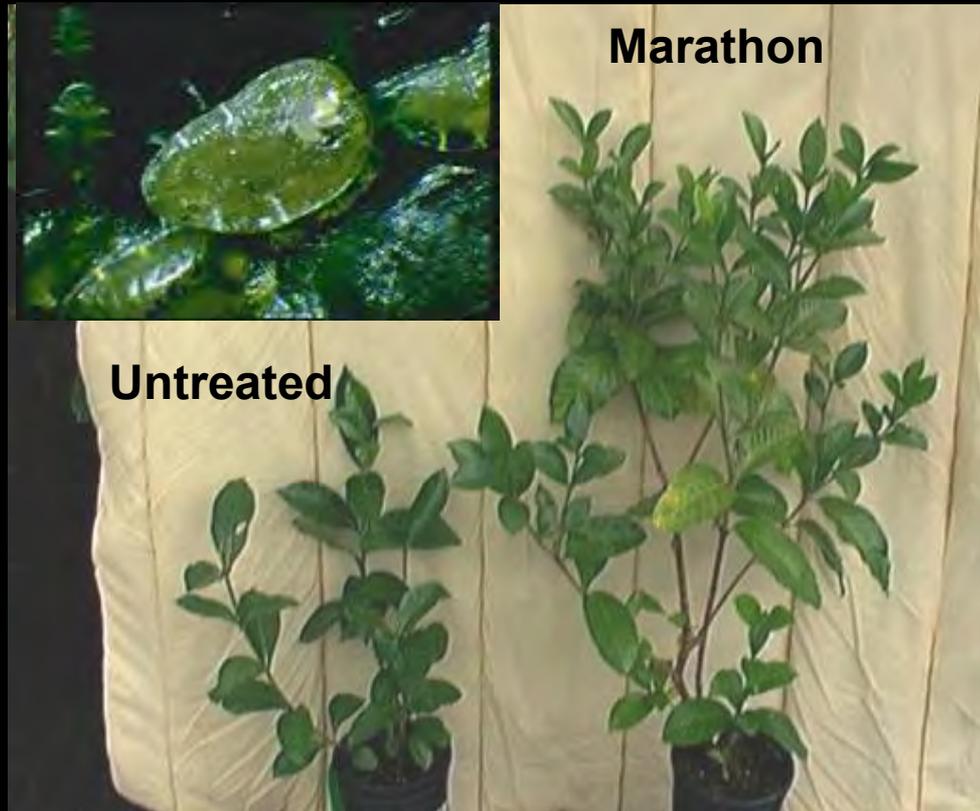
Jan 2005

- * Foliar application resulted in mealybug-free marketable plants 6 weeks after application in 8 of 10 plant cultivars tested.
- * Drench application resulted in mealybug-free marketable plants 6 weeks after application in 10 of 10 plants cultivars tested.

Merit (Marathon) is highly effective against aphids, Chinese rose beetle, azalea lacebug, soft scales and whiteflies. Moderately effective against mealybugs.

Green scale, *Coccus viridis*

- Applied as a drench, by 21 DAT >90% mortality of green scales observed on gardenia plants. Control lasted for approximately one year.
- Growth difference of gardenia due to control of green scale.



Imidacloprid against Chinese Rose Beetle



Chinese rose beetles
dying after feeding on rose
plant drenched with Merit
about 2 weeks earlier.



New growth with no
beetle damage

Melon Aphid, Papaya Mealybug on a Native Hibiscus (Hilo, HI)



Application of Merit as a “Tablet”

* Insert the “pill” in the pot media and solve your pest problem.



Placing tablet 2” below media surface



Thrips



Whitefly

- * >20 weeks of whitefly control
- * >12 weeks of thrips control

Anthurium Whitefly in Costa Rica

We don't want this whitefly in HI!



New Class of Insecticide

Tetronic / Tetramic Acid



Crop Use

Vegetables

Fruits

Nuts

Key Pests:

Aphids

Mealybugs

Whiteflies

Scales

Spider mites

Psyllids/Psylla



- * Movento or Kontos (spirotetramat) moves up and down within the plant to provides excellent pest control in dense crop canopies and on plant roots.
- * High level of residual efficacy and protection of new plant growth.
- * Minimal risk to natural predators when used as directed, making it an ideal addition to Integrated Pest Management (IPM) programs.

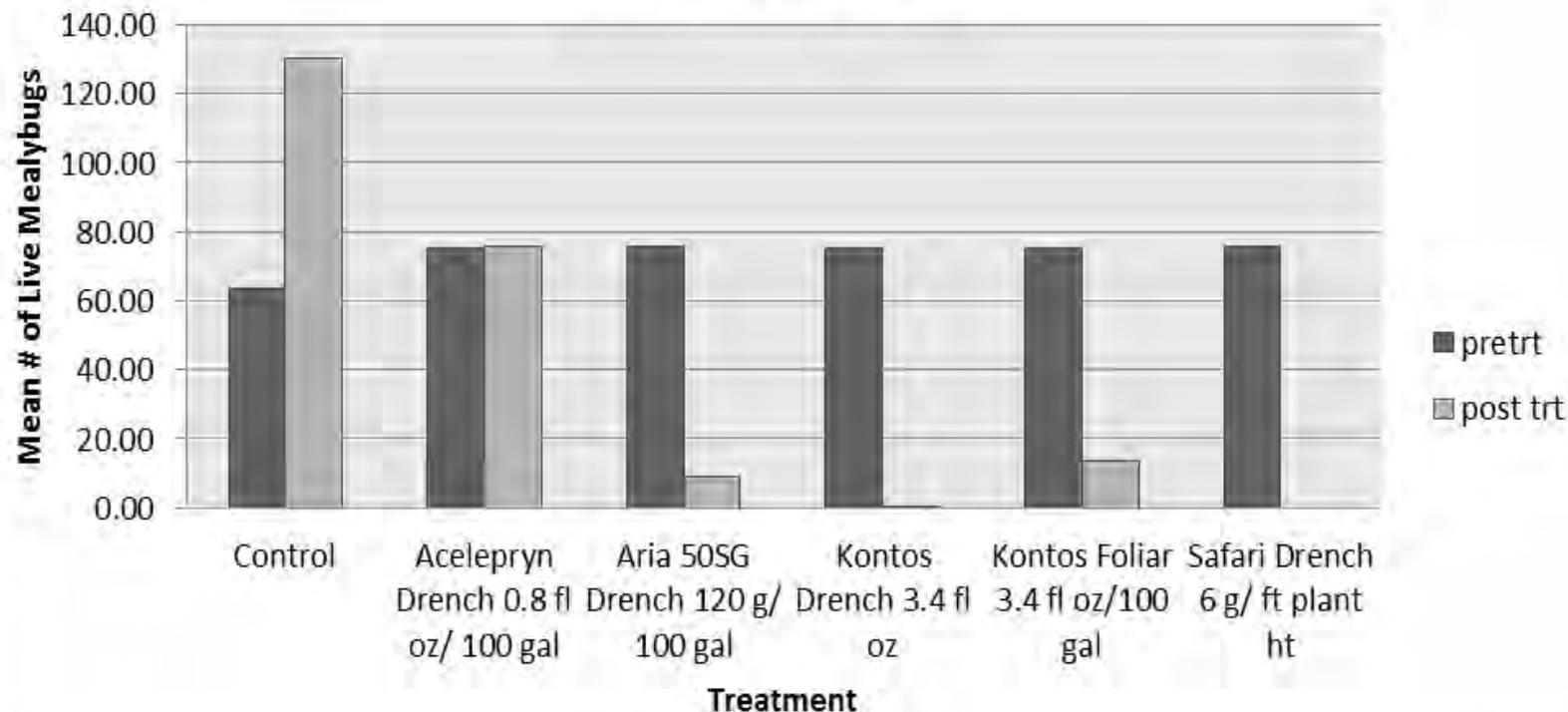
Ornamental use:

Greenhouse

Field grown
ornamentals

Outdoor
ornamentals

Insecticide Efficacy Trial: Root mealybug Control on Rhapsis Palm



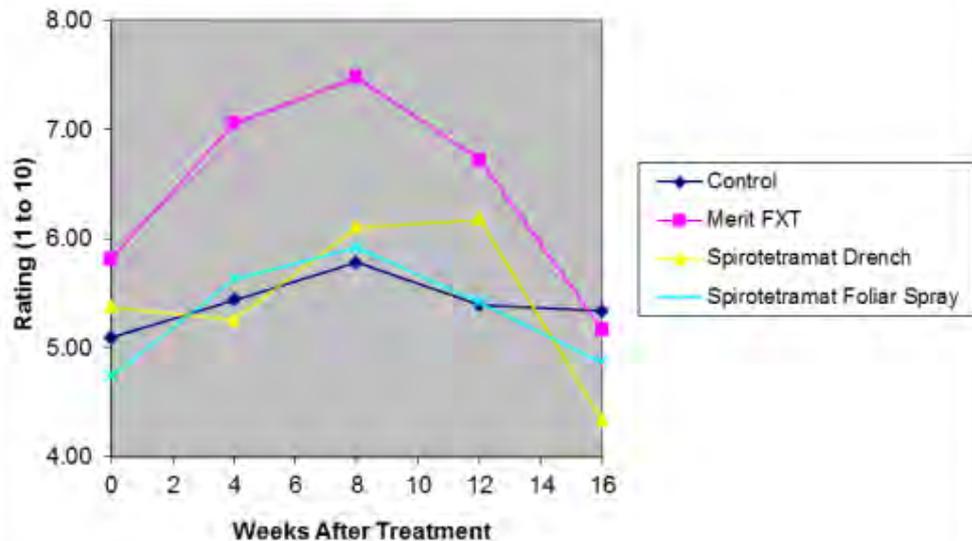
Acelepryn (**chloranthraniliprole**) = grubs, weevils, caterpillars

Aria (**flonicamid**) = aphids, mealybugs, thrips

Kontos (**spirotetramat**) = aphids, leafhoppers, mealybugs, whiteflies, mites

Safari (**dinotefuran**) = aphids, whiteflies, scale insects, mealybugs, midges, thrips, caterpillars

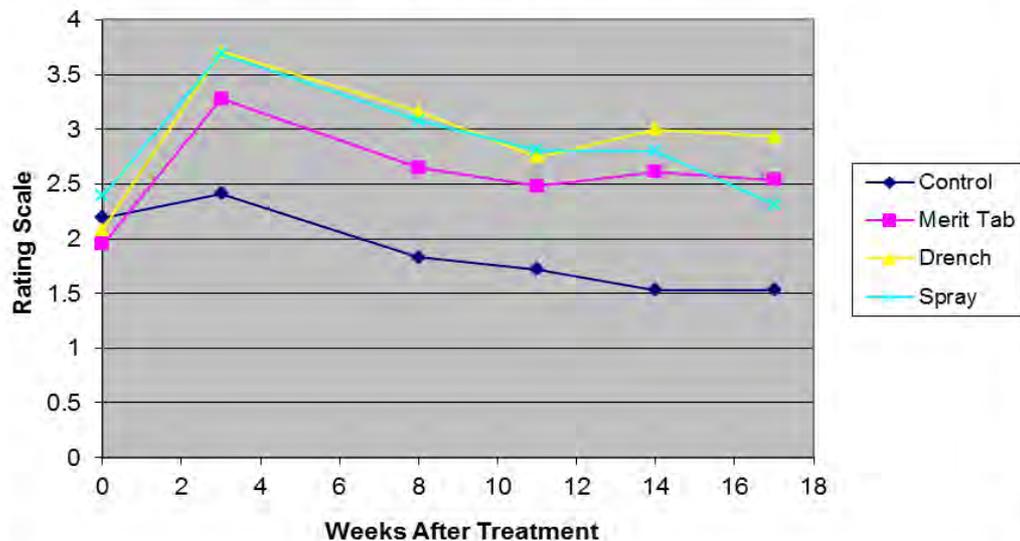
Thrips on M. Seefurth



- Merit FXT or Coretect (imidacloprid) tablets were effective against anthurium thrips.
- Spirotetramat was not effective.

- Merit FXT or Coretect (imidacloprid) tablets and spirotetramat drench and foliar applications were effective against anthurium whiteflies.

Efficacy of Treatments to Control Whitefly on Anthurium



Types of Insect Growth Regulators

1. *Juvenile hormone (JH) mimics*

Enstar (kinoprene)

Distance (pyriproxyfen)

Precision (fenoxycarb)?

2. *Ecdysone inhibitors*

Azadirachtin = Aza-Direct, Azatin and Ornazin

3. *Chitin synthesis inhibitors*

Citation (cyromazine) - leafminers

Adept (diflubenzuron)

Pedestal (novaluron)

Talus (buprofezin)

Buprofezin

Insect growth regulator

Talus = ornamentals, Sepro

Applaud = food crops, Nichino



- * Inhibits chitin synthesis which interrupts molting, suppresses oviposition, and reduces egg viability.
- * High level of activity against most homopteran insect pests including whiteflies, mealybugs, soft scales, armored scales, leafhoppers and planthoppers.
- * Vapor activity allows buprofezin to reach the undersides of leaves and new growth.

Whiteflies

Silverleaf

Greenhouse

Sweet potato

Ash

Mealybugs

Longtailed

Citrus

Mexican

Obscure

Comstock

Soft Scales

Black

Brown

Hemispherical

Wax

Tessellated

Armored Scales

Coconut

Cockerell

Fern

Boisduval

White peach

Cycad

Pests of Ornamentals in Hawaii

Distance (Juvenile Hormone mimic) is effective against whiteflies

Untreated 27 Days After Treatment Treated

Adult whiteflies present



No adult whiteflies present;
Dead nymphs (black centers)



Also effective against fungus gnats and armored scales

Definition of Biological Control

Biological Control - reduction of pest populations by natural enemies (predators, parasites or diseases).

Classical Biological Control - introduction of natural enemies (from the pest's native home) to a new locality where they do not occur naturally.

Fortuitous Biological Control – “Do nothing”; natural enemies unintentionally arrive with pest to new locality or already in new locality.

Augmentative Biological Control - Supplemental release of natural enemies.

Innoculative Release: Release mass numbers of natural enemies to prey or parasitize target pest

Inundative Releases: Release a few individuals and rely on their natural reproduction by preying or parasitizing target pest.

Biological Control in Hawaii

- * Hawaii's government has been practicing classical biological control by purposely introducing and liberating natural enemies, for over a 100 years.
- * Attempts to control pests through the introduction of animals into Hawaii were made by private citizens as early as 1865 (mongoose and mynah bird).
- * In 1890, 25 years later, procedures of biological control were regulated and supported by the Hawaiian government.
- * Of the 243 natural enemies purposely introduced (1890-1985), 86.4% have been recorded to prey on or attack about 200 pest species.
- * No purposely introduced species, approved for release in the past 21 years, has attacked any native or other desirable species.

Factual Story about the Mynah Bird in Hawaii

- * The mynah bird was brought to Hawaii from India in 1865 by Dr. William Hillebrand, a physician-naturalist to feed on armyworms in pastures.
- * Accused as a major factor in the extinction of many native Hawaiian birds (based on speculation). Other scientists believed that the mynah had little or nothing to do with the extinction of native birds.
- * Also implicated as playing a role in the dissemination of noxious weeds, (e.g., Lantana, a pasture weed), by feeding on berries and spreading undigested seeds via droppings.



True Story of the Mongoose and Rat in Hawaii



Indian
Mongoose



Rat

- * The 1800's was a huge century for sugarcane plantations and many were started on tropical islands, including Hawaii and Jamaica.
- * **With sugar cane came rats and lots of crop loss.**
- * Attempt to control the rising rat populations, a manager introduced the Indian Mongoose from Calcutta to Jamaica in 1872.
- * **The manager praised the results and local Hawaiian plantation owners, in 1883, brought 72 mongooses from Jamaica to the Hamakua Coast on the Big Island.**
- * Issue: Mongoose are diurnal and rats are nocturnal.
- * **Diet of mongoose includes insects, small cats, frogs, seeds, nuts, fruit, ground nesting bird eggs.**

Classical Biological of the Spiraling Whitefly

- * First discovered in Hawaii in 1978.
- * Heavy Infestations in Hawaii on over 100 plant species, of which guava, banana, plumeria, mango, and sea grape were most preferred.
- * Importation of ladybeetles and whitefly parasites from Trinidad brought it under control.
- * Heavy infestations are now only observed where these natural enemies are not present due to insecticide or windy, ocean salt condition.



Nephaspis



Encarsia

**Heavy Spiraling
Whitefly Infestation
Mauna Lani
09/2010**



**Stems infested with
White Peach Scale** →



2010/09/28

Spiraling Whitefly in West Hawaii



Parasitized Whitefly
Nymph



Parasitic wasp very
effective against
spiraling whitefly in
windy, coastal areas
in Hawaii
(Kumashiro HDOA)

Eulophid parasitic wasp,
Aleuroctonus vittatus



Parasitoid Emergence Hole

Spiraling Whitefly heavily parasitized by parasitic wasps (Note 4th Instar pupae with round exit holes)

4/27/2011 2:22:00 PM



Plumeria at Keahole Ag Park (09/2010)



Immature Lady Beetle



No natural
enemies
present



Adult Lady Beetle



2010/09/29

Biological Control of Mealybugs

Mealybug destroyer



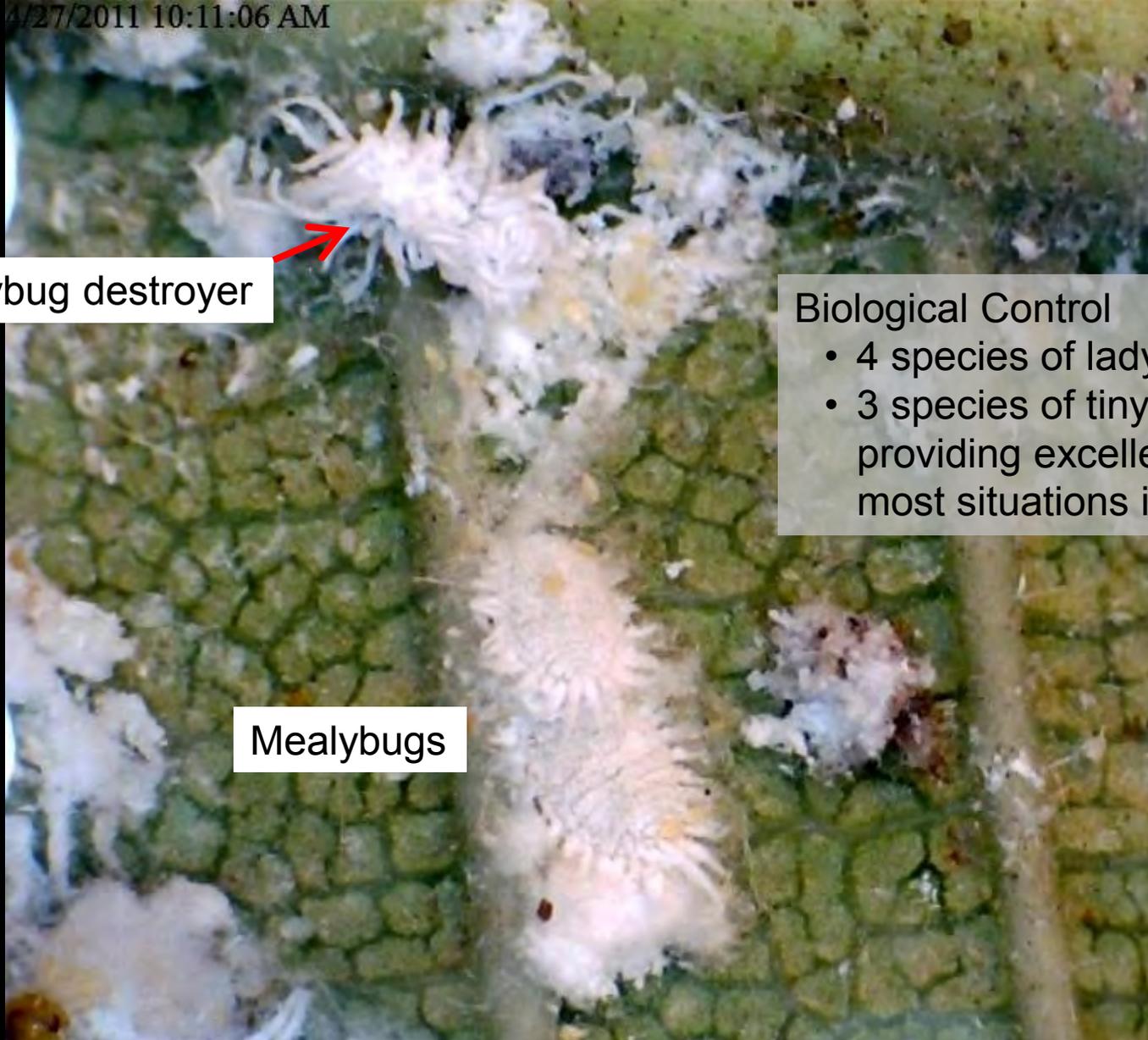
Immature ladybeetles



<http://www.youtube.com/watch?v=l69sltGaZW0>

Mealybug Destroyer, Ladybeetles, Parasitic wasps working on Papaya Mealybug on Plumeria

4/27/2011 10:11:06 AM



Mealybug destroyer

Mealybugs

Biological Control

- 4 species of ladybeetles.
- 3 species of tiny parasitic wasps providing excellent control in most situations in Hawaii.

4/26/11

Biological Control of Aphids

- * No male aphids occur in Hawai,,i.
- * One aphid develops into an entire colony of aphids.
- * Aphids are under excellent biological control in HI by:

Aphids parasitized by wasps



Mummified aphids



Ladybug



Syrphid maggot



Lacewing



Pseudoscorpion



**Video of Natural Enemies
in Action!**

Conservation of Natural Enemies

- * Recognize the natural enemies and know when the pest is parasitized. *Most Important!!!*
- * Avoid plantings in windy or ocean front areas, or extremely hot environments. Modify conditions to encourage natural enemies.
- * Avoid use of broad spectrum insecticides:
 - Organophosphates: Dursban, Malathion
 - Carbamates: Sevin (carbaryl)
 - Pyrethroids: Talstar (bifenthrin)

Insecticide Toxicity to Natural Enemies

Common name (trade name)	Class	Selectivity (affected groups)	Predator Mites	General Predators	Parasites	Duration of impact to natural enemies
carbaryl (Sevin)	carbamate	Broad (insects, mites)	Moderate/ High	High	High	Long
chlorpyrifos (Dursban)	OP	Broad (insects, mites)	Moderate	High	High	Moderate
fenpropathrin (Tame) similar to (Talstar)	Pyrethroid	Broad (insects, mites)	High	High	High	Moderate Long for Talstar
Imidacloprid (Merit DRENCH)	Neonico- tinoid	Narrow (sucking insects)	—	Low	Low	—
Imidacloprid (Merit FOLIAR)	Neonico- tinoid	Narrow (sucking insects)	—	Moderate	High	Short to moderate
Insecticidal Soap (M-Pede)	soap	Broad (insects, mites)	Moderate	Moderate	Moderate	Short to none

Inundative Biological Control

Live Biological Control Agents for Sale in Mainland U.S.



Parasite for
aphids



Parasite for
whiteflies



Ladybeetle
for mealybugs



Nematodes for
root weevils



Predatory
Mite

- * Inundative releases work best in totally enclosed greenhouses.
- * **Most of these parasites, predators already occur naturally in HI**
- * Importation and sale in HI requires HI Dept of Ag permit, approval.
- * **Expensive, e.g. 3,000 whitefly parasites for \$97.95 (ARBICO Organics)**

Summary

- * Don't blame mongoose and mynah bird on Hawaii Dept. of Ag.
- * **Biological Control in Hawaii has controlled over 200 invasive pests.**
- * Biological Control has provided sustainable control of many invasive pests with no negative environmental impact.
- * **Avoiding the use of broad-spectrum insecticide, such as OP's carbamates and pyrethroids, will conserve natural enemies.**
- * Use more selective insecticides and application methods, such as drench application of neonicotinoids (Merit, Safari), insect growth regulators (Distance, Talus), biological insecticides (*Bt*) to avoid negative effects on natural enemies.
- * **Use of commercial biological control agents in mass numbers is only effective in enclosed greenhouses and requires permit.**
- * Biological or microbial insecticides (fungi, nematodes) requires very specific environmental conditions (very humid, moist conditions) for effectiveness.

A BIG THANK YOU!

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