

Biological Control, Systemic Insecticides & Insect Growth Regulators against Landscape Pests in Hawaii

Maui Association of Landscape Professionals
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What will this presentation cover?

* Biological Control

- Classical
- Fortuitous
- Augmentative
 - Inundative - flood
 - Inoculative - inoculate

* Biological Control in Hawaii

* Conservation of Natural Enemies

- Minimize Use of Broad-Spectrum Insecticides
- Environmental Conditions detrimental to natural enemies

* Biological or Microbial Insecticides

* Summary

- * What are Neonicotinoids?
- * History of Neonicotinoids
- * Properties of Neonicotinoids
 - UV sensitivity
 - Water solubility
 - Residual Activity
 - Systemic Movement to leaves and flowers
- * Spectrum of Insect Control
 - Sucking Insects: aphids, scale insects, mealybugs, whiteflies, lacebugs
 - Chewing Insects: beetles, caterpillars, grubs
- * Application Methods
- * Insect Growth Regulators
- * Spiraling whitefly outbreak in West Hawaii
- * Conclusions

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.

Erythrina Gall Wasp, A Successful Biological Control Project in Hawaii

Spread was like a wild fire



On O'ahu alone, nearly 2,000 trees died at city parks and golf courses

- * First described in 2004 causing severe damage in Taiwan and Singapore.
- * First found on Oahu in April 2005.
- * Found in Big Island, Kauai, and Maui in July 2005.

GALL WASP PREDATOR WINNING BATTLE

The state's battle with the gall wasp is making progress. A year after the introduction of *Eurytoma erythrinae*, a parasitic insect from Tanzania, the native wiliwili trees in Koko Crater Botanical Garden are making a comeback.

TIMELINE

April 2005 – Gall wasps discovered on O'ahu, then spread rapidly throughout state.

December 2005 – Exploratory entomologist Mohsen Ramadan travels to Tanzania in east Africa to track natural enemy of wasp, brings *eurytoma erythrinae* back to Isles.

2006-08 – Research, testing, monitoring and permitting to ensure that the new import would not attack any other insect or plants.

November 2008 – First of the tiny gall wasp predators released in stand of wiliwili trees in Honolulu.

2009 – Native wiliwili trees that were bare of leaves start recovering, sprouting full, green-canopies.



M. Tremblay, UH-CTAHR photo

THE BAD BUG

Erythrina gall wasp

Size: Female: 1.5 mm

Male: 1.0 mm

(about the size of a grain of salt)

THE GOOD BUG

Eurytoma erythrinae



Size: Female: 4.0 mm

Male: 2.5 mm

(about the size of a black sesame seed)



A Successful Example of Classical Biological Control



BEFORE INTRODUCTION: This photo taken on Dec. 3, 2008, shows a willow tree infested by gall wasps. Most of the tree's leaves are gone.



Hawai'i Dept. of Agriculture photos

1 YEAR AFTER INTRODUCTION: A year later, after introducing *eurytoma erythrinae*, a natural gall wasp predator, the leaves are back.

Spiraling Whitefly (SWF)

Aleurodicus dispersus

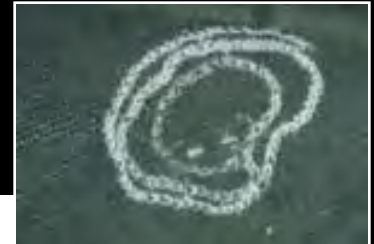
Egg to adult
34 to 41 days



Adult stage
39 days

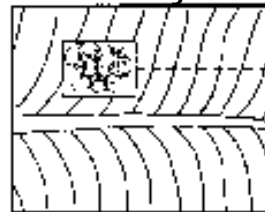


eggs 9 to 11 days



Eggs laid in spiral

>1549 eggs
in 37 days

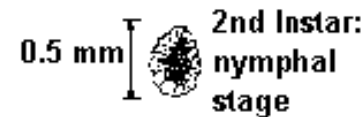


Spiral



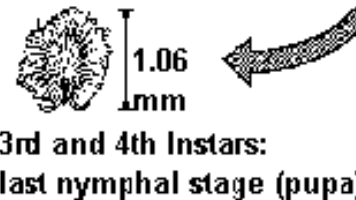
First Instar: eggs and
crawlers

1st instar 6 to 7 days



2nd Instar:
nymphal
stage

2nd instar 4 to 5 days



3rd and 4th Instars:
last nymphal stage (pupa)

3rd instar
5 to 7 days

Pupal stage
10 - 11 days



Nymphal stage

Adult

2 mm

Spiraling Whitefly (SWF)

- * First discovered in Hawaii in 1978.
- * Spiraling whitefly has been recorded on 38 genera of plants belonging to 27 plant families and more than 100 species.
- * Specific plants that are attacked include annona (cherimoya, atemoya, sugar-apple), avocado, banana, bird-of-paradise, breadfruit, citrus, coconut, eggplant, guava, kamani, Indian banyan, macadamia, mango, palm, paperbark, papaya, pepper, pikake, plumeria, poinsettia, rose, sea grape, ti and tropical almond.
- * Plumeria is probably the most preferred host of SWF.
- * SWF usually starts building up in June and continue through September. From October, population starts decreasing and by December is very low (Kumashiro, HDOA).
- * Prolonged drought may have accounted for the weakening of trees has led to the higher than usual SWF population during this past summer (Kumashiro, HDOA).

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**



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)



Plumeria at Keahole Ag Park (09/2010)



Immature Lady Beetle



No natural
enemies
present



Adult Lady Beetle



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

Conservation of Natural Enemies

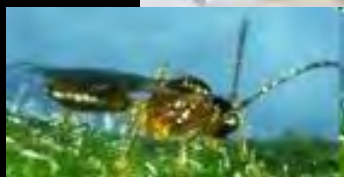
- * Recognize the natural enemies and know when the pest is parasitized. **Most Important!!!**
- * Avoid plantings in windy or ocean front areas, or extremely hot environments. Modify conditions to encourage natural enemies.
- * Avoid use of broad spectrum insecticides:
 - Organophosphates: Dursban, 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 (<i>Sevin</i>)	carbamate	Broad (insects, mites)	Moderate/ High	High	High	Long
chlorpyrifos (<i>Dursban</i>)	OP	Broad (insects, mites)	Moderate	High	High	Moderate
fenpropathrin (<i>Tame</i> similar to <i>Talstar</i>)	Pyrethroid	Broad (insects, mites)	High	High	High	Moderate Long for <i>Talstar</i>
Imidacloprid (<i>Merit</i> as a drench)	Neonico- tinoid	Narrow (sucking nsects)	-	Low	Low	-
Imidacloprid (<i>Merit</i> as a foliar)	Neonico- tinoid	Narrow (sucking insects)	-	Moderate	High	Short to moderate
Insecticidal Soap (<i>M-Pede</i>)	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



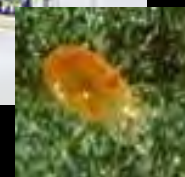
Parasite for
whiteflies



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)

Biological or Microbial Insecticide

- an *insecticide* in which the *active Ingredient* is a microorganism.

Biological insecticides include products based on:

Bacteria	(<i>Bacillus thuringiensis</i>) (Bt)
Fungi	(<i>Paecilomyces fumosoroseus</i>)
Nematodes	(<i>Steinernema carpocapsae</i>)
Viruses	(No products registered in Hawaii)

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) require very specific environmental conditions (very humid, moist conditions) for effectiveness.

Evolution of Insecticides

1940-50's

Chlorinated hydrocarbons

DDT, Chlordane, Dieldrin, Mirex



1960-70's

Organophosphates & Carbamates

Dimethoate, Diazinon, Dursban, Orthene



1980-90's

Pyrethroids (synthetic)

Mavrik, Tame, Tempo, Decathlon, Talstar



1990-2000's

Reduced-Risk Insecticides



Naturalytes

Conserve, Avid,
Ultiflora, Neem



Insect Growth Regulators

Distance, Enstar, Talus



Neonicotinoids

Merit, Marathon, Flagship,
Safari, TriStar

NEONICOTINOID INSECTICIDES



Acetamiprid

*Optigard Flex Gel
Flagship*



thiomethoxan

**Arena®
INSECTICIDE**

clothianidin



Dinotefuran



imidacloprid



imidacloprid

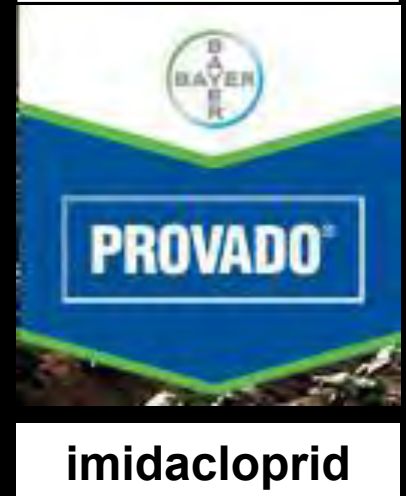
Marathon



imidacloprid

Premise

**ADMIRE® PRO
Systemic
Protectant**



imidacloprid

- * **Neonicotinoids** act on the **nervous system** of insects with very low toxicity to mammals and minimal environmental impact and therefore, considered a reduced-risk pesticide.
- * 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.
- * They bind at a specific site, the nicotinic receptor, and there are no records of **cross-resistance** to the carbamate, organophosphate, or synthetic pyrethroid insecticides, thus making them important for management of insecticide resistance.

Neonicotinoid Insecticides

Spectrum of Insect Control

Sucking insects

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

Chewing insects

Beetles
Borers
Mole Crickets
Gall Wasps
Grubs
Leafminers
Termites
Weevils

Neonicotinoids

Chloronicotinyls

Imidacloprid

Many...



Acetamiprid

(Assail)

(Tristar)

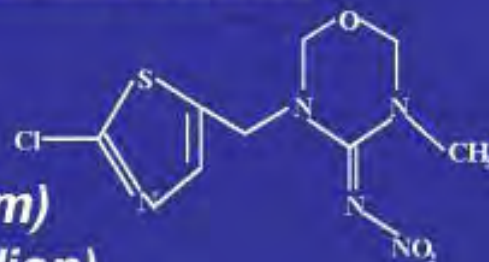


Thianicotinyls

Thiamethoxam

(Actara, Platinum)

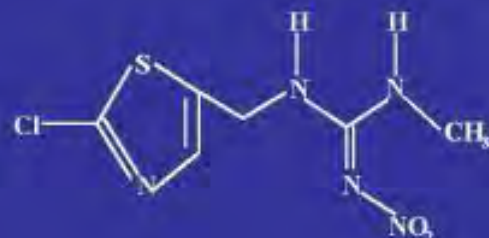
(Flagship, Meridian)



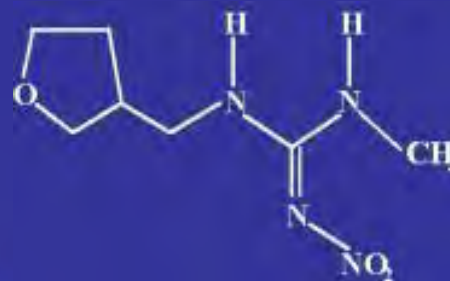
Clothianidin

(Poncho)

(Arena)



Furanicotinyl



Dinotefuran

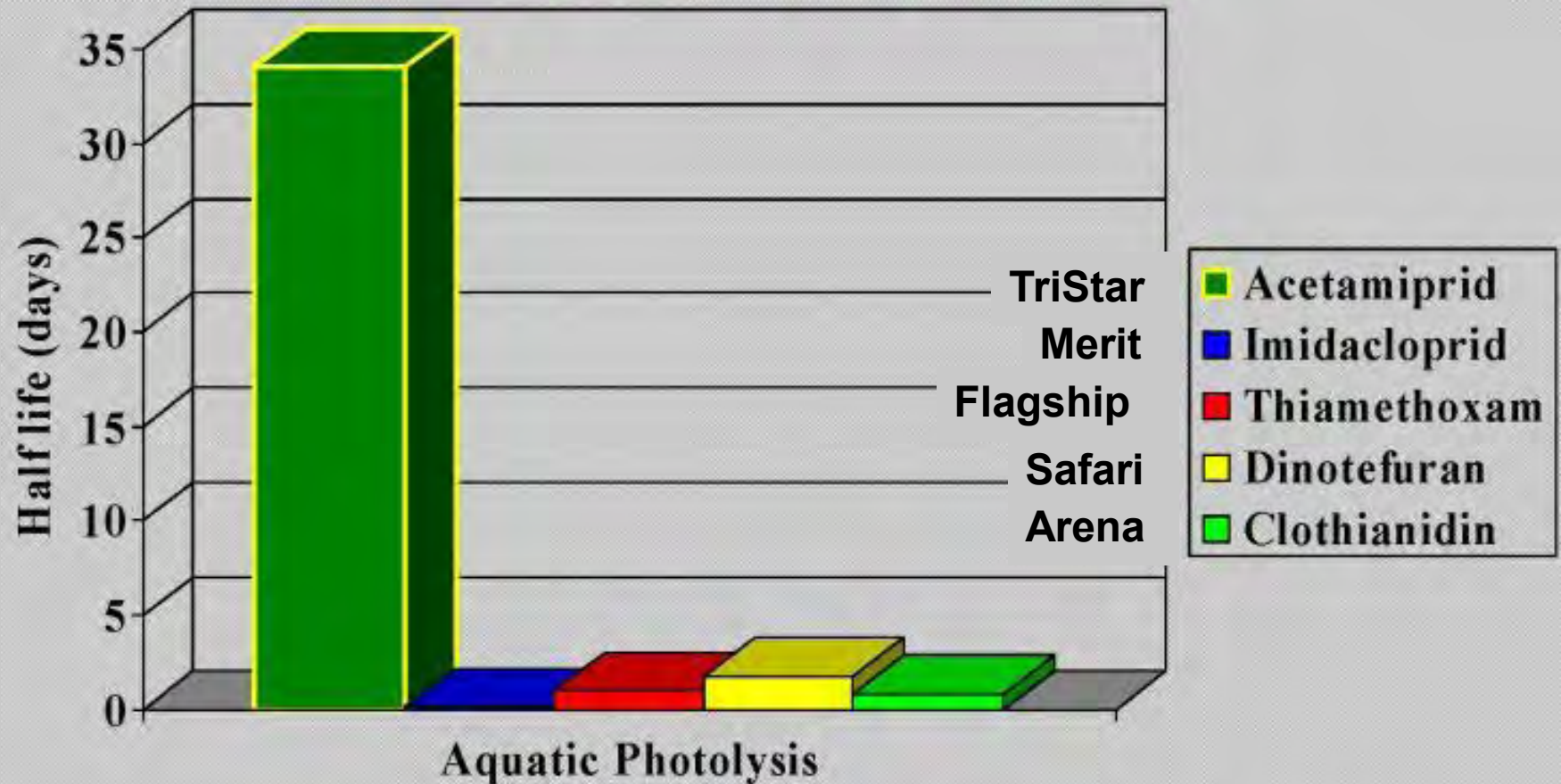
(Venom)

(Safari)

- * Different types of neonicotinoids have unique *UV* resistance, water solubility, binding with soil, and pest spectrum characteristics.

Slide info from F. Byrne

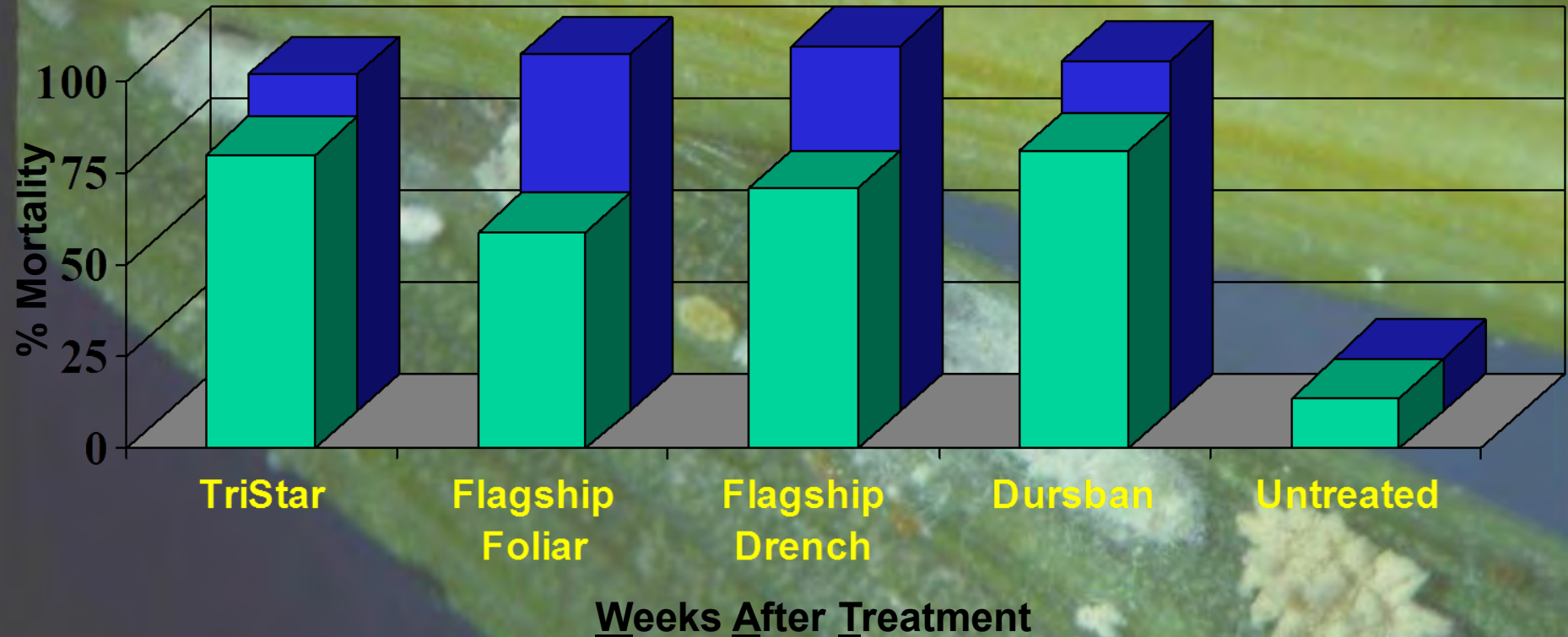
Comparison of UV Stability



Data obtained from published EPA registration documents

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

TriStar and Flagship Against the Coconut Mealybug, *Nipaecoccus nipae*



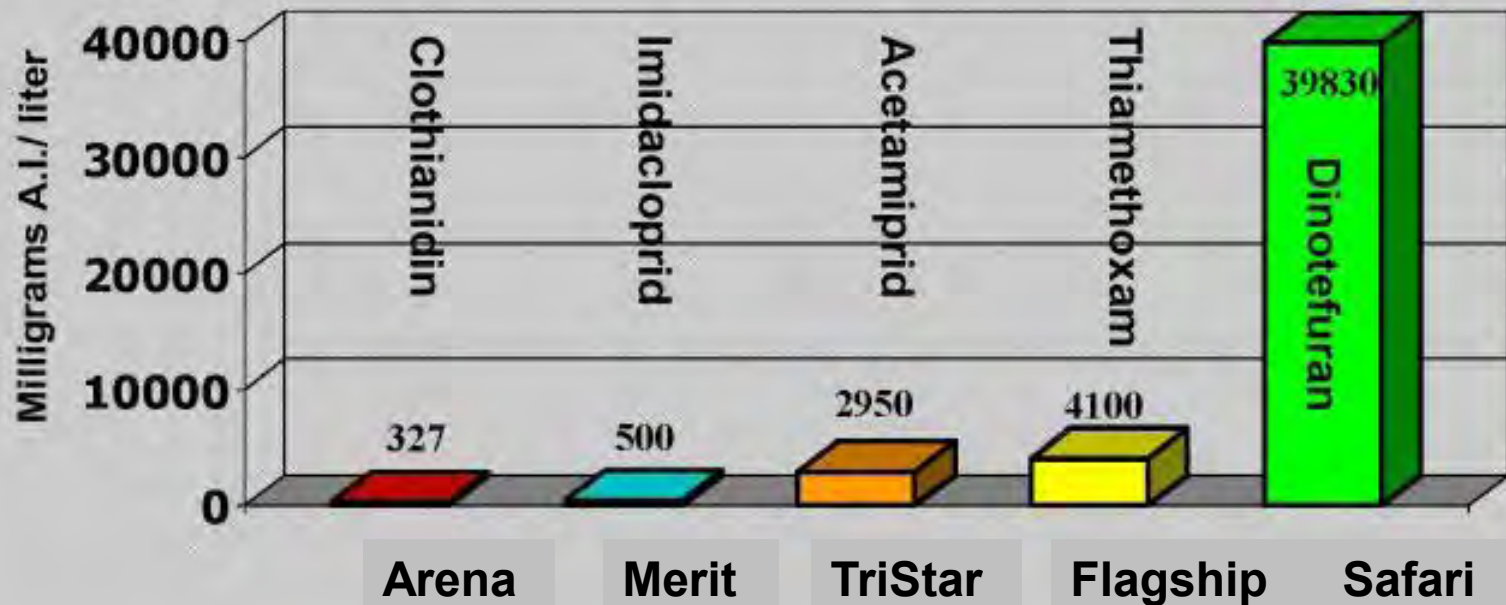
TriStar = acetamiprid

2 WAT 4 WAT

Flagship = thiamethoxam
(Not sold in Hawaii)

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

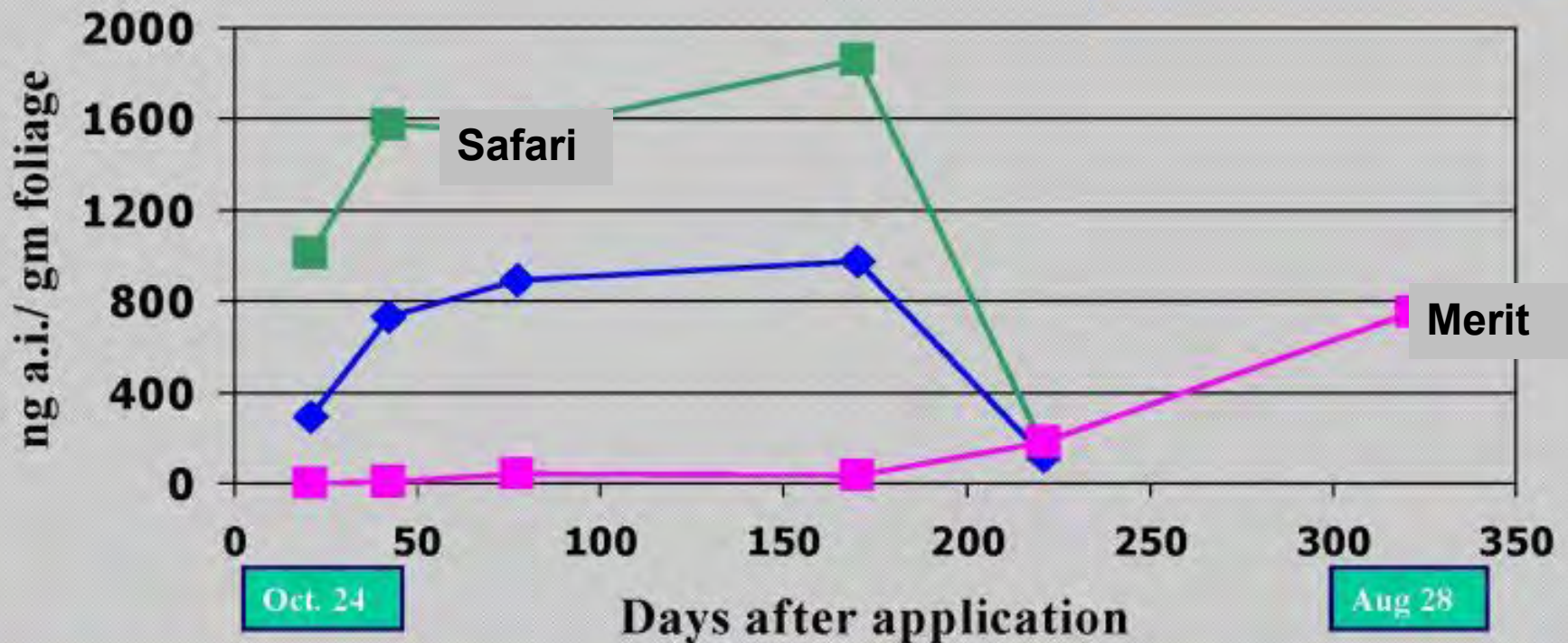
Slide information courtesy J. Chamberlin



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 more water-soluble for quicker systemic uptake in plants.
- * **Systemic activity is not as long-lasting.**
- * Effective against whiteflies, aphids, soft scale. wax scales, thrips, fungus gnats, similar to Merit.
- * **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



Osmoxylon



Cissus

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

Results of Safari Trial

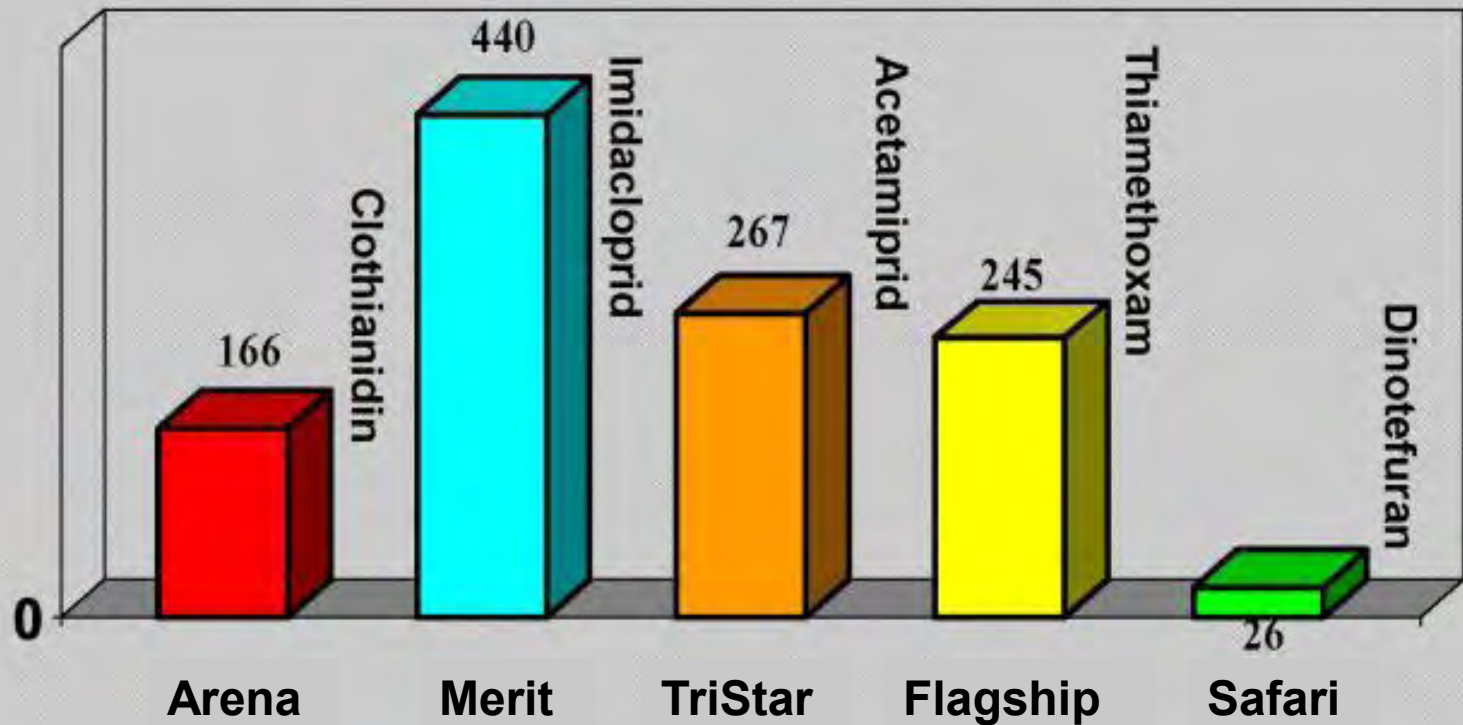
Jan 2005

- * 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.

Soil Adsorption Coefficient

A measure of how tightly the pesticide binds or sticks to soil particles.

K_{oc} Values of Neonicotinoids:

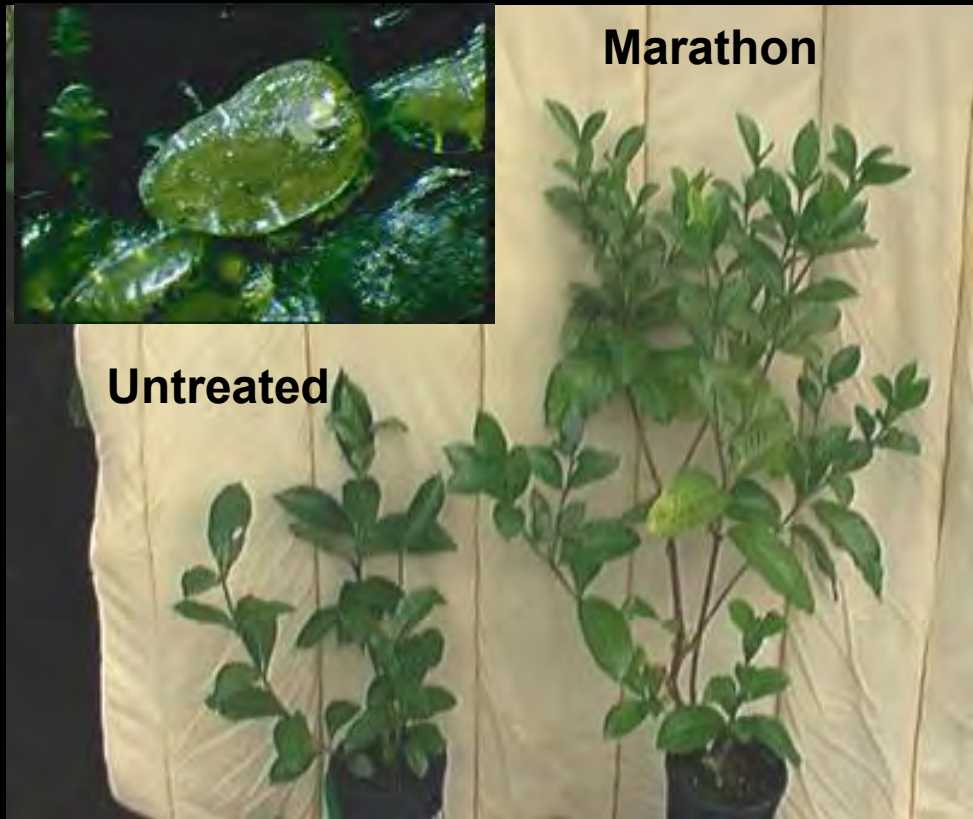


High value means it is strongly adsorbed onto soil and organic matter and does not move throughout the soil (Source: EPA Pesticide Fact Sheets).

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 Red Ginger Pests



WEEKS OF EFFECTIVE CONTROL (>95%):		
<u>FIELD TREATMENT</u>	<u>MEALYBUGS</u>	<u>BANANA APHIDS</u>
MERIT (1 APPL.)	17	53
DURSBAN (3 APPL.)	3	4

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

Application Methods for Systemic Insecticides

- Injecting** – invasive to trees; create wounds for entry of pathogens.
- Drenching** – Must reach feeder roots with adequate moisture.
- Bark Treatment** – Must penetrate bark to move into the vascular system.
- Tablets** – More suitable for potted plants



Drilling



Injecting

Applying Treatments



Trenching



Drenching

- * **Drench application** must be applied to the feeder roots that have **adequate soil moisture**.
- * Subsequently must be **irrigated** to assure uptake.
- * Liquid fertilizer added to insecticide may assist uptake.
- * Competition by groundcovers or turf contributes to effective uptake.



“Is doing something better than doing nothing?”

Giant Whitefly, *Aleurodicus dugesii*

- * First discovered in HI heavily infesting hibiscus, fiddlewood, plumeria in May 2002.

Merit drench – (Best Guess)

- * Applied to infested fiddlewood trees by City in Chinatown.
- * Not effective (improper application at base of trunk and not canopy drip line to feeder roots).
- * No reports of Merit being highly effective.



R. Heu, HDOA

Injection Systems Evaluated



Sidewinder Tree Injector



Mauget Tree Injectors

Bark Application of Safari to King Protea for
mealybugs at 18 oz/ gallon




Bark application of
Safari to Telopea sp.
for armored scales,
Pseudaulacaspis brimblecombei



A mealybug *Delottococcus confusus* infesting King protea, *Protea cynaroides*, Kula, Maui, HI




- * First discovered in CA in Nov. 2006 on *Leucadendron argenteum* tree and soon after in Hawaii (2009).
- * Infestations also on mink protea in Kula, HI.
- * Infested flowers are unmarketable due to sooty mold and feeding damage to bracts.
- * Mealybug destroyer, *Cryptolaemus* observed under bracts with mealybug infestations.
- * Control strategies: Control ants & systemic insecticides: Safari, Kontos, Tri-Star, Discus as a drench, bark, or foliar (Kontos) application for mealybugs


A close-up photograph of a protea bract showing several white, oval-shaped egg sacs attached to the surface.

Egg sac

09/01/11

A photograph of a protea flower bud with a person's hand holding it. The bracts of the bud show significant red, necrotic damage from mealybug feeding.

feeding damage

A photograph of a protea flower head that is heavily covered in a dark, fuzzy growth of sooty mold. Small ants are visible crawling on the mold.

sooty mold and ants

Papaya Mealybug

Paracoccus marginatus

- * First discovered in HI in June 2004 on Maui.
- * Native to Mexico and found on Guam, Florida, Caribbean Islands.
- * Mealybug injects a toxin as it feeds and causes chlorosis, stunting, deformation, leaf and fruit drop.
- * Heavy infestations observed on papaya, hibiscus, jatropha; also, avocado, citrus, tomato, eggplant, peppers, beans, peas, sweet potato, mango, plumeria.
- * Lady beetles found feeding on the papaya mealybug on Maui and the Big Island.
- * A parasitic wasp, *Anagyrus loecki*, has provided excellent biological control on in HI.



Papaya Mealybug 2004



Reduced-Risk Insecticides Against Papaya mealybug



Foliar applications

- Applaud (buprofezin; 12 oz/acre)
- Provado (imidacloprid; 8oz/acre)

Drench Application

- Admire (imidacloprid; 32 oz/acre) was applied in 5 gal of water to the tree roots by applying the solution to the area 3ft in all directions from the base of the tree.

Bark Application

- Pentra-Bark surfactant (2% of solution) and Admire (imidacloprid; 32 oz/acre), which was applied to the tree trunks with a sprayer until runoff (200ml/tree).

PENTRA-BARK®

BARK PENETRATING SURFACTANT

PRINCIPLE FUNCTIONING AGENTS:

Alkylphenol ethoxylates, polyacrylate polymers, copolymers, glycol	99.9%
NONIONIC SURFACTANT POLYMER AS A SPRAY ADJUVANT	0.2%
TOTAL	100.0%

Net weight 50 lb (22.7 kg) per 50 lb bag, net weight 100 lb (45.4 kg) per 100 lb bag.

CAUTION

KEEP OUT OF REACH OF CHILDREN

Harmful if swallowed. Causes moderate eye irritation. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and water after use.

Personal Protective Equipment: Wear protective eyewear, long-sleeved shirt and long pants, shoes plus socks when mixing or applying PENTRA-BARK®.

FIRST AID

If Swallowed: Call a physician or Poison Control Center immediately. Do not induce vomiting. Unless told to do so by a poison control center doctor. Have person sip a glass of water if able to swallow.

If on Skin: Remove contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

If in Eyes: Flush with water for at least 15 minutes. Remove contact lenses if possible after the first 5 minutes. Then continue flushing eyes. Call a poison control center or doctor for treatment advice.

If Irritated: Move person to fresh air if person is not breathing, call 911 or an ambulance. Then provide first aid as indicated on label if possible.

GENERAL INFORMATION

PENTRA-BARK® is a surfactant wetting agent, designed for improving penetration through films of water based basal applications. PENTRA-BARK® may be used in agriculture, horticulture, industrial, and forestry operations. It is designed for fast spreading, uniform distribution and absorption of spray on leaf and stem surfaces. PENTRA-BARK® may be used with most pesticides and fertilizer products (see cautionary statements on label directions for use). Optimum application and consequent effects can be influenced by many factors. It is recommended that the spray be observed and adjusted when it is applied accordingly. During application, insure thorough coverage without excessive runoff.

DIRECTIONS FOR USE

PENTRA-BARK® is a nonionic organosulfone wetting agent designed for use in certain agricultural and horticultural uses where a nonionic surfactant is recommended. Suggested Rates for the use with various categories of chemicals are as follows:

Depend on PENTRA-BARK® to add per 100 gal. of spray mixture

Chemical Group	
Fungicides, Miticides & Pesticides	5 to 30 fl. oz.
Insecticides	12 to 34 fl. oz.
Defoliant Formulations of Broadleaf herbicides	12 to 34 fl. oz.
Defoliant & Desiccants	12 to 34 fl. oz.
Fertilizers & Micronutrients	4 to 30 fl. oz.

NOTE: Consult manufacturer's specific directions concerning use of surfactant. When using PENTRA-BARK® in spray tank mixes, it may be used with a pesticide or fertilizer mixture. However, it is not specifically recommended, but not prohibited by the manufacturer, for use in applications where such mixtures are not recommended. A final determination of a surfactant's use of that use. For a full and complete list of possible applications, consult the label.

Basal Bark Treatment: PENTRA-BARK® is specially designed to aid penetration of herbicides, nutrients, insecticides, fungicides, and nematocides through the bark. Use 1% to 2-10% PENTRA-BARK® by volume of spray solution. Consult pesticide label for specific use rates and application method, or contact your Quest Representative.

Aerial Application: When applying aerially, use a preformed basal solution including minimum stated volume per acre. Do not substitute PENTRA-BARK® for other required by the pesticide label.

Irrigation Injection: Applications of PENTRA-BARK® through irrigation systems are strongly prohibited. Do not exceed use rates and always follow National Sanitation Code, and always quarantine are followed.

Water Penetration of Hard-to-Wet Soils: For most efficient water penetration of hard-to-wet soils and the overall distribution of applied chemicals, use 1 pint per 100 gallons of water as a spot or area treatment.

NOTE: Not for use with aquatic applications in the State of Washington.

MIXING

Ready mixing and application equipment must be cleaned according to cleaning directions on pesticide label before application.

To mixtures and help prevent foaming, fill tank 20 to 34 full of water. Add pesticides and/or fertilizer as directed by label in the following sequence: 1) Micronutrients and fertilizers; 2) Dry to soluble and dispersible pesticides; 3) Soluble insecticides; 4) Soluble pesticides; 5) Emulsifiable concentrates.

Always mix with PENTRA-BARK® and mix tank to 2 minutes with lower end mixing equipment. Continue filling tank, maintaining minimum agitation. For most effective results, apply within 30 hours after mixing.

STORAGE AND DISPOSAL

Do not discharge water, food or feeding storage or disposal. Do not store near heat or open flame. Store in original container.

Pesticide: Treatments resulting from the use of this product may be disposed of on a list of an approved waste disposal facility.

Container: Triple-rinse containers. Then offer for recycling or to combuster, or purchase and dispose of in a sanitary landfill, or incineration.

NOTICE TO BUYER

To the extent permitted by law, all conditions and warranties and liability or other rights of action which buyer or any other user may have against Quest Products Corp. are hereby excluded. Quest Products Corp. hereby gives notice to buyer and other users that it will not accept responsibility for any indirect or consequential loss arising from reliance on product information provided by Quest Products Corp. even to the extent that it is established that such information or advice was provided negligently and that the product has been used strictly as directed. Quest Products Corp. shall be liable in all circumstances be limited to replacement of product or a refund of the purchase price thereof.

PENTRA-BARK® is a registered trademark of Quest Products Corporation. (USA) (patent)

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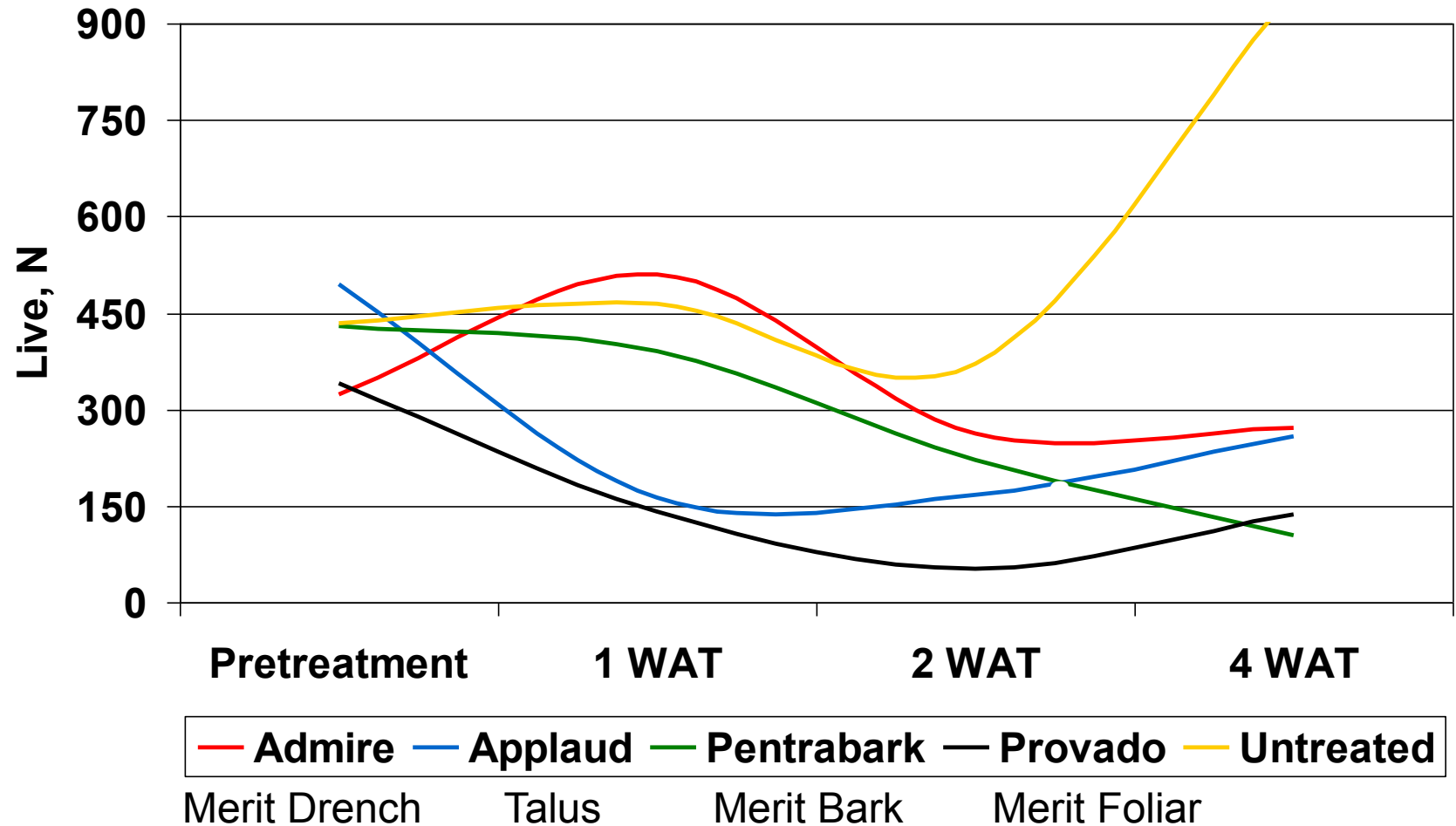
* Pentra-Bark surfactant (2% of solution) & Admire (imidacloprid; 32 oz/acre)

* Applied to the tree trunks with a hand sprayer until runoff (200 ml/tree)

<http://www.questproducts.us/>

Live Papaya Mealybugs On Leaf Subsection

Samples consisted of one “finger” (approx 12 inch²) from mature palmate papaya leaves.



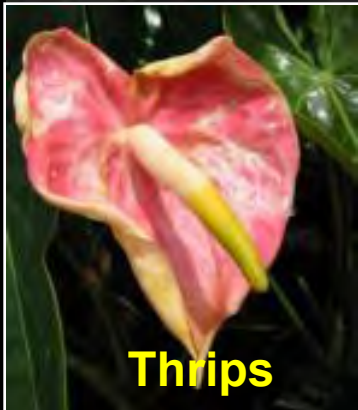
Application of Merit as a “Tablet”



* 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

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)

Adept (diflubenzuron)

Pedestal (novaluron)

Talus (buprofezin)

Buprofezin

Insect growth regulator

Talus = ornamentals, Sevro

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

New Class of Insecticide

Tetronic / Tetramic Acid



Crop Use
Vegetables
Fruits
Nuts

Key Pests:

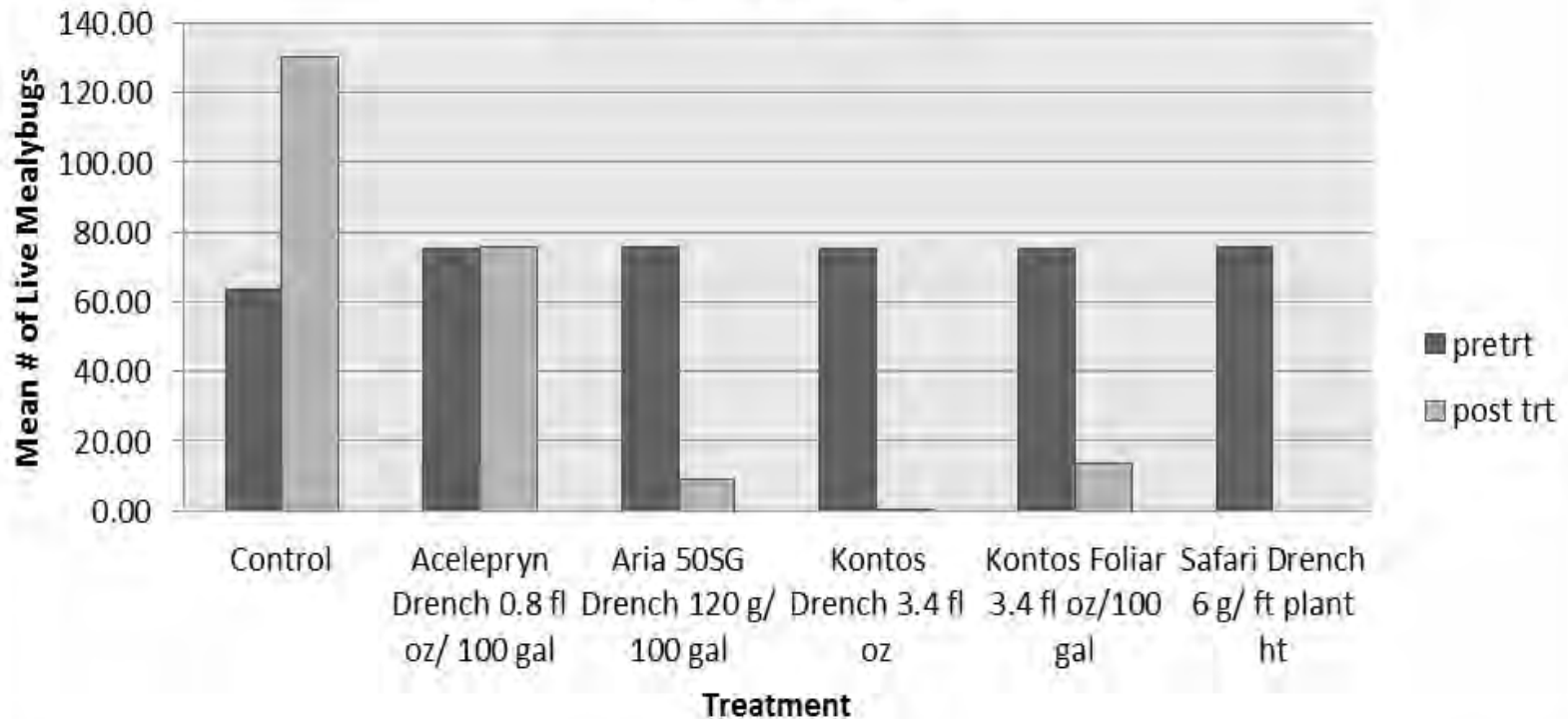
Aphids
Mealybugs
Whiteflies
Scales
Spider mites
Psyllids/Psylla



- * Movovento or Kontos (spirotetramat) moves up and down within the plant to provide 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 Rhapis 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

Summary

- * Most Importantly, recognize natural enemies (parasitic wasps and predators) of whiteflies.
- * 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), 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.
- * Continuously monitor whitefly infestations for natural enemies.

Conclusion

Comments from Insect Taxonomist, Bernarr Kumashiro, HDOA

“Plumeria is probably the most favorite host of Spiraling Whitefly (SWF).”

“Plumeria is also a favorite host of papaya mealybug, many other mealybugs, scales, whiteflies, and aphids which love to feed on plumeria.”

“We should encourage resort landscapers to choose other plants, since planting plumeria is just asking for trouble.”

A BIG THANK YOU!

For assistance:

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