Update on Control of the Erythrina Gall Wasp

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Erythrina = Wiliwili Gall Wasp

Spread was like a wild fire

- First described in 2004 causing severe damage in Taiwan and Singapore.
- First found on Oahu in April 2005.
EGW Life Cycle – Egg to adult in 21 days

Eggs hatch in < 3 days

6 days after oviposition larva is observed

12 day old larva

7 days after egg laying

20 days after egg laying

Adult emergence after 21 days

14 day old larvae

Yalemar, Nagamine, Heu HDOA
Summary of the Life Cycle of EGW

- **Life cycle**
  - egg to adult – 21 days

- **Ovipositional preference**
  - female lays eggs in young terminal growth

- **Sex ratio**
  - $7\text{♂} : 1\text{♀}$, more males emerge first

- **Adult longevity**
  - without honey: $\text{♂}$ and $\text{♀}$ = about 2-3 days
  - with honey (nectar): $\text{♂}$ =10 days, $\text{♀}$=6 days

- **Fecundity**
  - female wasp emerges with about 85 mature eggs

Yalemar, Nagamine, Heu and Ramadan HDOA
HOSTS

tiger's claw, Indian coral tree

tall erythrina, tall wiliwili

Erythrina crista-galli common coral tree
Most Threatened Species in Hawaii

Native wiliwili

*Erythrina sandwicensis*

Healthy

Gall Wasp Injury
Major Control Strategies

Short Term:
Chemical Control
Drenches and Injections

Long Term:
Biological Control
Natural Enemies from Africa
Cultural Control
Remove & Replace
## CHEMICAL CONTROL

<table>
<thead>
<tr>
<th>Application</th>
<th>Tradenname</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foliar</td>
<td>Sevin</td>
<td>carbaryl</td>
</tr>
<tr>
<td>Systemic</td>
<td></td>
<td></td>
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<tr>
<td>Drench &amp; Foliar</td>
<td>Merit</td>
<td>imidacloprid</td>
</tr>
<tr>
<td></td>
<td>Safari</td>
<td>dinotefuran</td>
</tr>
<tr>
<td></td>
<td>Orthene</td>
<td>acephate</td>
</tr>
<tr>
<td>Injection</td>
<td></td>
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<tr>
<td>Maujet</td>
<td>Imicide</td>
<td>imidacloprid</td>
</tr>
<tr>
<td></td>
<td>Abacide</td>
<td>abamectin</td>
</tr>
<tr>
<td>Wedgle</td>
<td>Pointer</td>
<td>imidacloprid</td>
</tr>
<tr>
<td>Sidewinder</td>
<td>Imicide</td>
<td>imidacloprid</td>
</tr>
<tr>
<td>Arborjet</td>
<td>IMA-jet</td>
<td>imidacloprid</td>
</tr>
</tbody>
</table>
First Study Site in Pearl City, HI
*Tall wiliwili* 5-12” diam 20-30” tall
Injection and Drench Treatment: Aug 03, 2005
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imicide 10% injection (imidacloprid)</td>
<td>4 ml per capsule; no. of capsules = in diam/2</td>
</tr>
<tr>
<td>Merit 2 F drench (imidacloprid)</td>
<td>0.2 fl oz per 1 in trunk diam Delivered in 10 gal drench</td>
</tr>
<tr>
<td>Safari 20 SG drench (dinotefuran)</td>
<td>4oz/tree in 10-gal drench</td>
</tr>
<tr>
<td>Abacide 1% injection (abamectin)</td>
<td>2 ml per capsule; no. of capsules = in diam/2</td>
</tr>
</tbody>
</table>
Applying Treatments

Drilling → Injecting

Trenching → Drenching
Mean Emerged Wasps per Gram of Gall Tissue

Wasps per Gram of Tissue

Months After Treatment

- Imicide (Injection)
- Abacide (injection)
- Merit (drench)
- Safari (drench)
- Untreated
Approx 2 Months after Treatment

Untreated

Imidacloprid injection, only effective treatment, drenches failed.

Untreated
Factors Contributing to Effective Drench Treatment

* Evidently wiliwili root systems make it difficult to get good systemic uptake. Roots are often sparse and spread across a large area.
* Drenches of roots may be best for containerized trees, trees with confined irrigated root systems, or small establishing trees. Liquid fertilizer added to insecticide may assist uptake.
* Competition by neighboring plants or turf increase the uptake problem.
Injection Systems Evaluated

Sidewinder Tree Injector

Mauget Tree Injectors
FACTORS AFFECTING INJECTION EFFICACY

- These injection systems have a steep learning curve to get positive repeatable results.
  * Major problem is failed uptake, due to inaccurate chemical placement or bleeding at injection location.
  - Bark thickness affects critical depth of injection into the active cambium area for uptake.
  - Trees under water stress and/or no functional leaves will not translocate injected insecticide with lots of “bleeding”.

Bark thickness

“Bleeding”
<table>
<thead>
<tr>
<th>Injection System</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Cost of System Cost per Tree (20” dia)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ArborSystems Wedgle Direct-Inject</strong></td>
<td>Least wounding of tree trunk among systems. Injection has no waiting period for uptake.</td>
<td>Bleeding of chemical during injection. The least quantity of AI is applied of any system.</td>
<td>$605 for Wedge Direct-Inject Pointer $305/ 120ml (5% AI) $28-41</td>
</tr>
<tr>
<td><strong>Arbor jet</strong></td>
<td>Injects the largest volume of insecticide through the fewest injection sites. Able to see chemical uptake.</td>
<td>Requires drilling. Longer injection time (usually 15-20min can be up to 1 hr). System not as portable for remote forest situation.</td>
<td>$699 for 2 tree IVs &amp; kit; $315 for each additional IV IMA-jet $175/ 500ml (5% AI) $56</td>
</tr>
<tr>
<td><strong>Mauget Ready to use 3ml Micro injector Capsules</strong></td>
<td>Formulation ready for injection. Able to see chemical uptake.</td>
<td>Requires drilling. Passive system; tree does not always uptake product. Some bleeding.</td>
<td>Imicide $116 for 24, 3ml capsules (10% AI) $48</td>
</tr>
<tr>
<td><strong>Sidewinder Tree Injectors Backpack Tree Injector</strong></td>
<td>Complete unit is carried on the back and includes drill and injection equipment. No waiting for uptake.</td>
<td>Requires drilling. Occasional bleeding. Difficult to assure the entire dose was administered.</td>
<td>$1584 for Backpack Injector System. Insecticide is from other manufacturers following their labeled rates.</td>
</tr>
<tr>
<td>Treatment Formulation/Equipment</td>
<td>Rate AI/Inch Diameter</td>
<td>Galling Severity Rating</td>
<td>Emerged Wasps/g Tissue</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-----------------------</td>
<td>-------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Untreated</td>
<td>0.00 ml</td>
<td>5 a</td>
<td>21 a</td>
</tr>
<tr>
<td>Imicide/ Mauget Capsules 10%AI</td>
<td>0.15 ml</td>
<td>3 ab</td>
<td>9 bc</td>
</tr>
<tr>
<td>Pointer/ ArborSystems Wedgle 5% AI</td>
<td>0.026 ml</td>
<td>3 ab</td>
<td>5 c</td>
</tr>
<tr>
<td>Merit 200 SL/ Arbor Jet Tree IV 17.1%AI</td>
<td>0.77 ml</td>
<td>3 ab</td>
<td>9 bc</td>
</tr>
<tr>
<td>IMA-jet/ Arbor Jet Tree IV 5% AI</td>
<td>0.40 ml</td>
<td>2 b</td>
<td>1 c</td>
</tr>
<tr>
<td>Merit 2/ Root Drench 2% AI</td>
<td>1.28 ml</td>
<td>4 a</td>
<td>16 ab</td>
</tr>
</tbody>
</table>

Means in a column followed by different letters are significantly different by Tukey’s multiple comparison procedure (P<0.05).
Tall or Windbreak Erythrina 12 Weeks After Injection with and without Imidacloprid

Untreated

Treated trees showing concentration effect with different injection system and imidacloprid formulations
*Full expanded undamaged leaves on lower portion of imidacloprid injected tree.
*Translocation of Imidacloprid visually observed with undamaged leaves progressing up the tree within weeks.
Summary of Chemical Control Trials

* Effective drenching of wiliwili trees has not been consistent probably because of its root system; roots are often sparse and spread across a large area.
* Injection systems have a steep learning curve to get positive repeatable results. Must be used properly.
* Major problem is failed uptake, due to inaccurate chemical placement or bleeding at injection location.
* Imidacloprid injection can be highly effective if an adequate dose is delivered by the injection system.
* Another application technique to be tested is the use of a bark penetrant with imidacloprid for systemic deliver into the vascular system.
Long Term Control of EGW
Classical Biological Control

*Failed containment efforts evolve to biological control.
*Practiced in Hawaii for over 100 years by Hawaii Dept. of Agriculture (HDOA).
*Over 680 species of biological control organisms released in Hawaii since 1890.
*Over 36% have established attacking over 200 pest species.
*No biological control agent approved for release in the past 35 years has been recorded attacking any native or desirable species.

(Funasaki et al. 1988)
Tanzania & South Africa
HDOA Exploratory Entomologist, Dr. Mohsen Ramadan has discovered and imported promising parasitic wasps the HDOA quarantine lab.

South Africa & Kenya
UH - CTAHR Cooperators w/ HDOA Drs. Messing, Wright, Rubinoff recently returned from Africa.

Search for Natural Enemies of the Gall Wasp in Africa

Heu, Nagamine, Yalemar
HDOA

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Biological Control Agents for Against the Gall Wasp

*The biology and host specificity testing for three potential biological control agents has been completed by the Hawaii Dept of Agriculture (HDOA) and UH-CTAHR.

*A best case scenario will be for releases to begin in Sept or Oct 2007.

*This eurytomid wasp was collected by HDOA exploratory entomologist Mohsen Ramadan. HDOA entomologists are cautiously optimistic that it will have a dramatic impact on the gall wasp populations. Eurytomids may encounter negative impacts such as other parasitoids (hyperparasitoids) preying on them.
Long Term Cultural Control of EGW

*Replacement Species for windbreak = Panax? Others

Bill Durston of Leilani Nursery in Waimanalo, Hawaii suggested this variety of Panax to replace tall wiliwili
Long Term Cultural Control of EGW

*Tolerant or resistant species of *Erythrina* spp.

* A tolerant species observed on the UH-Manoa Campus and on Lanai by Criley, Leonhardt and Nagata of UH-CTAHR.

*Cuttings have been made to preserve and propagate germplasm of this unidentified species.
Susceptible and Tolerant Coral Trees at Lanai Fairway Terrace, Manele, Lanai

Photo by Norman Nagata