

Research in Support of the Guam Coconut Rhinoceros Beetle Eradication Project

Efficacy of Systemic Insecticide Injections Applied to Mature Coconut Palms

Report prepared by Aubrey Moore, University of Guam (aubreymoore@guam.net)

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Abstract

FronD samples were taken from twelve mature coconut palms that had been injected with systemic insecticide and twelve similar untreated coconut palms. A small, but significant reduction in leaf damage from chewing insects, and a reduction in whitefly infestation on fronds from injected palms was observed. In a bioassay were adult coconut rhinoceros beetles, *Oryctes rhinoceros*, were forced to feed on frond petioles from treated and untreated palms, no significant difference in mortality or bore hole volume was observed.

Introduction

Landscape Management Systems (LMS) has been pioneering the use of injectable systemic insecticides for protection of ornamental trees in tourist areas on Guam for the past two years. During this time mature coconut palms were injected with systemic insecticide to prevent leaf damage by a variety of insects including brontispid beetles and coconut flat moth. These insects chew holes in developing leaves before fronds unfurl. Systemic insecticides must be used because these insects feed in protected places unreachable by contact insecticide spray. Delivery of systemic insecticides by trunk injection has several advantages over traditional foliar or drench applications for several reasons.

- Can be used in beach front areas to prevent run-off or leaching into the ocean
- Can be used on hotel properties where spray drift onto cars, food, hotel equipment, and tourists must be avoided
- Because injection systems are contained systems they can be applied in safety with minimal protective equipment. This is an important consideration for pesticide application in Guam's hot, humid climate and in a busy tourist area where hotel guests may be alarmed by the sight of applicators in full protective gear.
- Injected systemic insecticides tend to have a long residual activity period which reduces the number of treatments over time

Prior to the first detection of the coconut rhinoceros beetle (CRB) on Guam on September 11, 2007, LMS had been treating adult coconut palms at the Hilton and Hyatt Hotels. Despite the fact that these hotel properties are within the CRB infestation area, no defoliation or bore holes caused by CRB have been found to date. This study was initiated to determine if injection treatments on these two hotel properties were protecting coconut palms from CRB damage.

Methods

Injection Treatment. Mature coconut palms growing at the Hilton and Hyatt Hotels in Tumon Bay, Guam were injected with systemic insecticide during the last week of May, 2007 and again on October 7, 2007. Treated palms were 30 to 40 feet tall and had trunk diameter at breast height was about 8 inches. On both dates, a Sidewinder® 12 volt pump injection system was used to inject 24 ml of insecticide into a single hole drilled at chest height. The insecticide formulation contained 5% imidacloprid and 1% abamectin (IMICIDE® and ABACIDE2®; Mauget Inc.).

Sampling. On March 14, 2008, we took plant samples from injected and uninjected coconut palms in Tumon Beach, Guam. The sample trees consisted of three treated palms at the Hilton Hotel, and three injected palms at the Hyatt Hotel, and six uninjected trees from San Vitores Road in the vicinity of the Hyatt (Table 1). Plant samples consisted of one circa 6 month old frond from each sample tree (Illustration 1).

Feeding Damage / Whitefly Infestation. Every tenth leaflet was cut from alternate sides of the petiole. Presence/absence of whiteflies was recorded and damage to each leaflet by chewing insects was assessed using a 0-5 subjective scale with 0 indicating no damage and 5 indicating total destruction of leaflet.

CRB Bioassay. Adult beetles were forced to feed near the bases of petioles by enclosing them individually in one inch diameter blocks of wood attached by screws (Illustration 2). Two blocks were attached to each petiole (Illustration 3). The hard petiole surface at the bottom of each hole was abraded to a depth of about 1 mm to help beetles start their bore holes. After seven days of confinement in an air conditioned laboratory (about 72 deg. F), beetles were removed to check for mortality (Illustration 4 & 5). Feeding damage was assessed by pouring water into each bore hole and measuring its volume. A section of each petiole was frozen for possible chemical assay in the future.

Results

Feeding Damage / Whitefly Infestation. Insect feeding damage from chewing insects was significantly lower on treated palms (damage index on treated palms: 1.98 ± 0.18 [mean \pm SEM]; on untreated palms: 2.84 ± 0.26 ; $p = 0.013$ [Monte Carlo simulation with 10,000 iterations]). Whitefly infestation was also significantly lower on treated palms (proportion of leaflets infested on treated palms: 0.18 ± 0.11 ; on untreated palms: 0.56 ± 0.12 ; $p = 0.021$ [Monte Carlo simulation with 10,000 iterations]).

CRB Bioassay. One of twelve beetles fed on petioles from injected palms for seven days was dead (Table 2). Three of twelve beetles fed on uninjected palms were dead. Clearly, there is no indication of mortality from injection treatments.

Bore hole volumes excavated by beetles feeding on petioles from injected palms was not significantly different from those made by beetles feeding on uninjected palms (injected: 9.9 ± 1.2 ml, $n = 11$; 13.3 ± 3.2 ml, $n = 9$; t-test p -value = 0.3375). Note that we included only bore holes made by beetles surviving the seven day experiment. There was no difference in the volume of bore holes made by males and females (female: 15.2 ml; male 11.0 ml.; t-test p -value = 0.51).

Discussion

Results of the bioassay provide no evidence that injected systemic insecticides protect mature coconut palms from attack by adult coconut rhinoceros beetles. However, more research needs to be done before injection delivery system technology is rejected as a potential tactic for inclusion in the Guam coconut rhinoceros beetle eradication project. Injection technology has significant advantages over traditional pesticide application methods as outlined in the introduction. These advantages are of high value to the Guam CRB eradication project, where plants needing protection are growing in a beach side tourist environment.

Recent observation indicate that mass trapping cannot be relied upon as a stand-alone eradication tactic. Some palms in mass trapping areas are apparently more attractive to the beetles than the oryctalure traps and these are being attacked. For this reason, tree climbers are currently being employed to apply liquid and granular insecticides directly to the crowns of susceptible palms growing within the infested area. Trunk injection may be a more efficient delivery method.

Future research should focus on answering these questions:

- Which is the best choice of injectable product, active ingredient, and dosage for CRB?
- How long between trunk injection and protection of the crown from CRB attack and how long does the protection last?
- Are beetles likely to leave protected crowns before receiving a lethal dose?
- What is the most efficient application method (capsules or high pressure injection)?
- What is the risk of tree damage from injection wounds?
- Does injected systemic insecticide kill attacking beetles before significant (mortal) damage is done?

If RCB adults can be reliably killed when they attack protected palms, then injection of all susceptible plants with the infestation area may drive the population to extinction.

Acknowledgments

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Table 1: Sample locations.

Treated	Sample	Location	Latitude	Longitude
Y	1	Hilton	13.50414	144.78618
Y	2	Hilton	13.50414	144.78618
Y	3	Hilton	13.50581	144.78473
Y	4	Hyatt	13.51172	144.80536
Y	5	Hyatt	13.51172	144.80536
Y	6	Hyatt	13.51172	144.80536
N	7	San Vitores Rd.	13.51126	144.80576
N	8	San Vitores Rd.	13.51126	144.80576
N	9	San Vitores Rd.	13.51126	144.80576
N	10	San Vitores Rd.	13.51115	144.80576
N	11	San Vitores Rd.	13.51115	144.80576
N	12	San Vitores Rd.	13.51115	144.80576

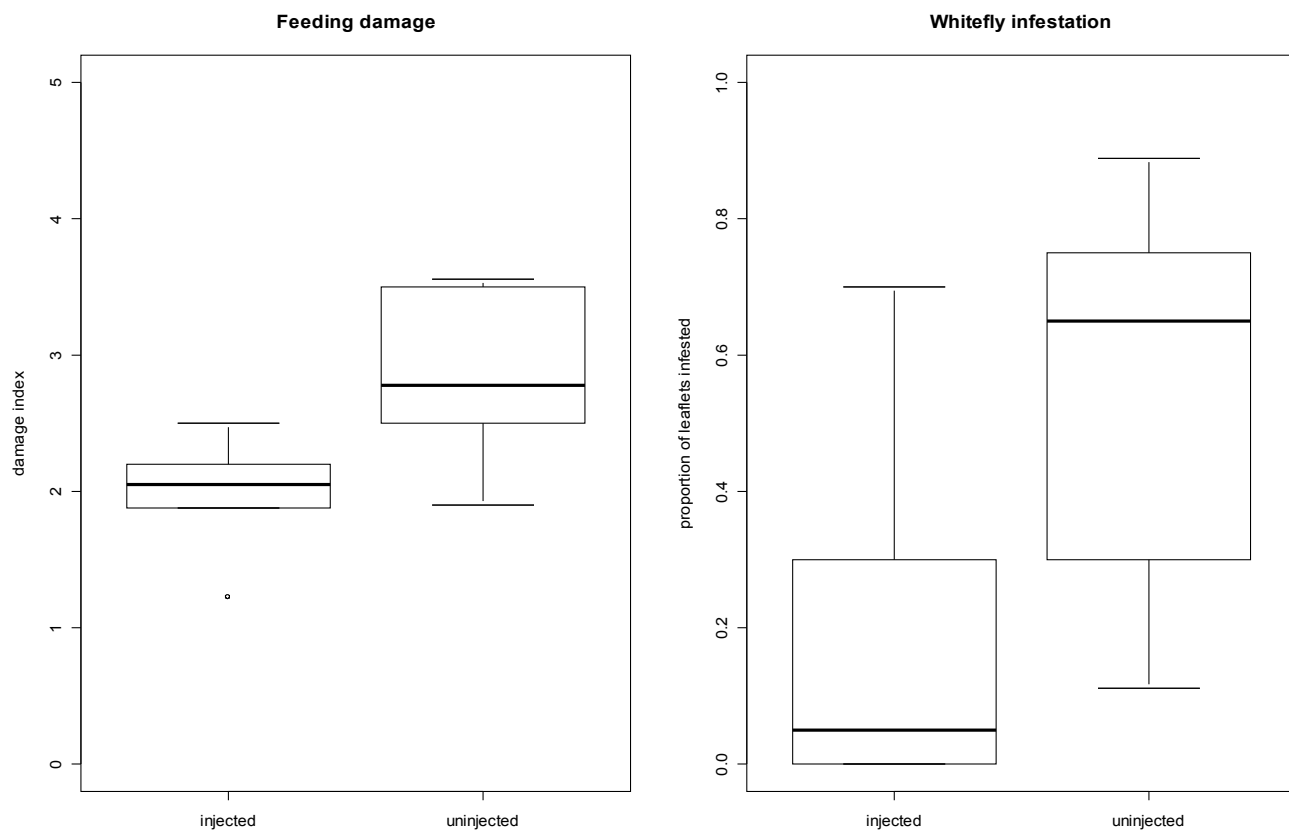


Fig. 1. Feeding damage from chewing insects and whitefly infestation levels on injected and uninjected coconut palms.



Illustration 1: Sampling a frond from a coconut palm.

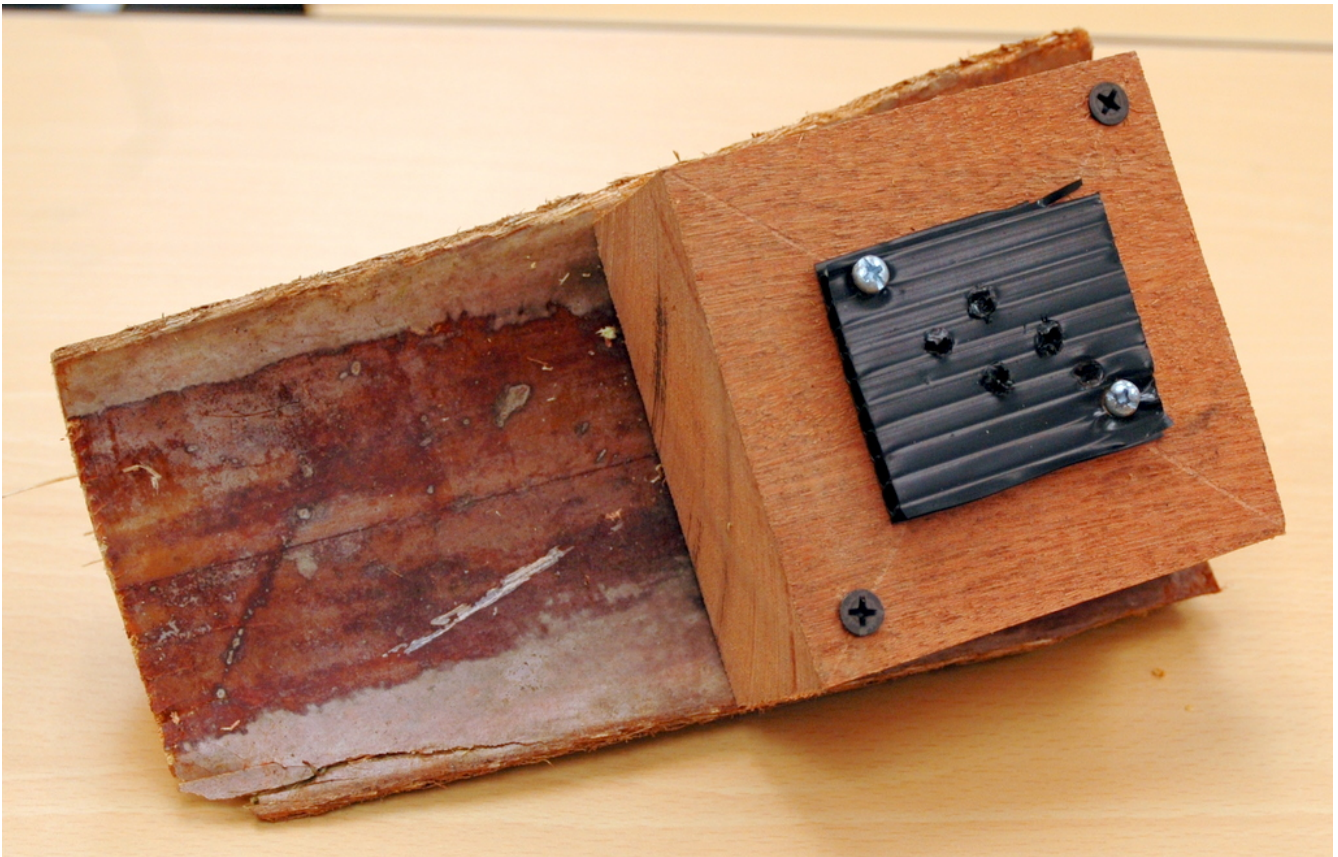


Illustration 2: Solitary confinement device for bioassays with adult rhino beetles. A beetle is placed in a 1 inch diameter hole beneath the black Corroplast(r) cover.



Illustration 3: Bioassay of petioles from injected and uninjected coconut palms.

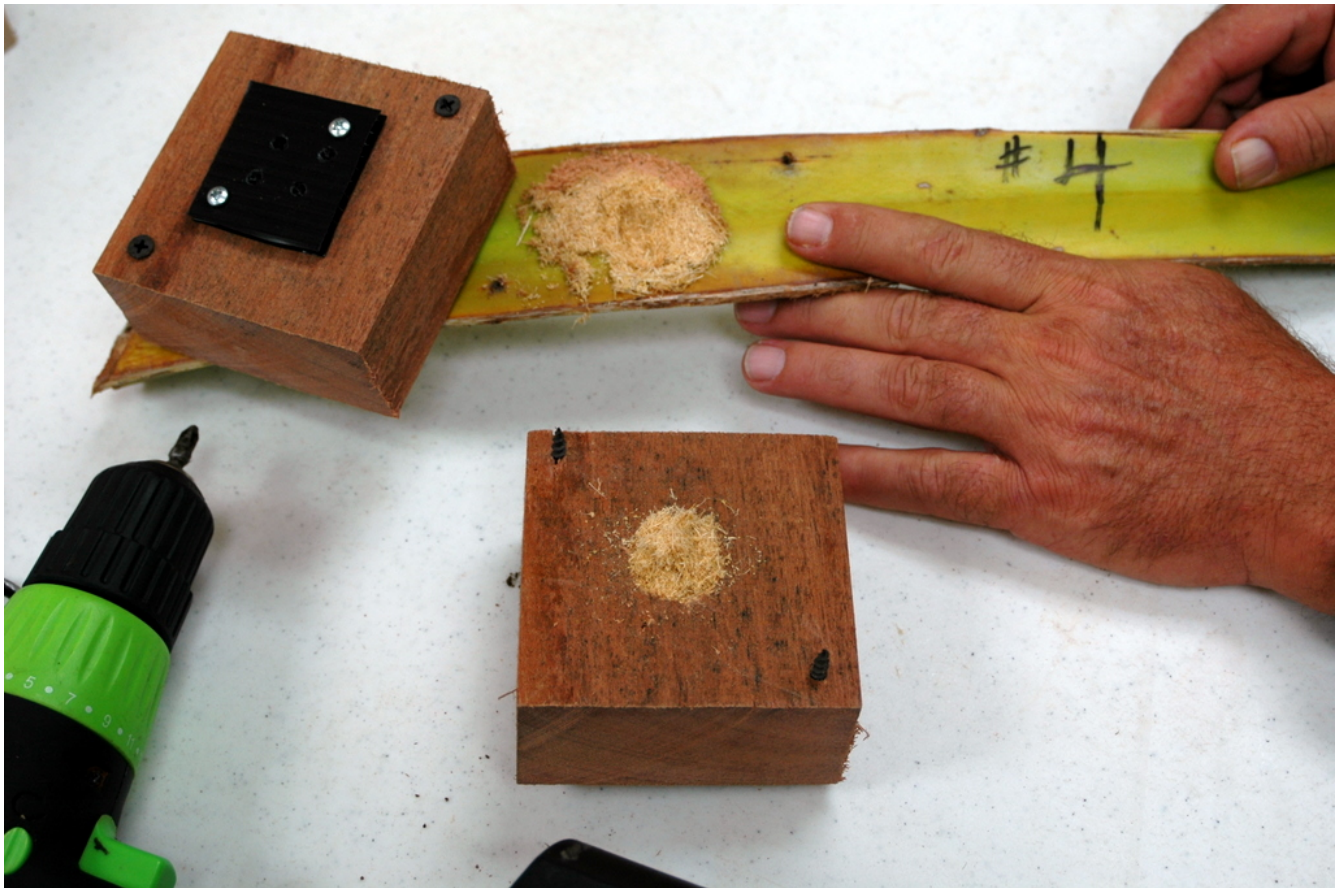


Illustration 4: Removal of block at end of a 7-day bioassay. In this case, the beetle had backed up into the hole in the block and was surrounded by coconut material.



Illustration 5: Petiole split to show two deep bore holes.

Table 2: Results from seven day CRB bioassay.

Treatment	Leaf Sample	Beetle ID	Sex (M=male; F=female)	Alive or Dead (A=alive; D=dead)	Bore Hole Volume (ml)
injected	1	1a	M	A	11
		1b	M	A	11
	2	2a	M	A	8
		2b	F	D	5
	3	3a	M	A	11
		3b	F	A	18
	4	4a	M	A	9
		4b	F	A	1
	5	5a	F	A	10
		5b	F	A	8
	6	6a	F	A	11
		6b	F	A	11
Uninjected	7	7a	M	A	8
		7b	F	A	5
	8	8a	F	A	11
		8b	F	A	30
	9	9a	M	A	12
		9b	F	D	1
	10	10a	M	A	12
		10b	F	D	1
	11	11a	F	A	28
		11b	M	A	12
	12	12a	M	D	1
		12b	F	A	2