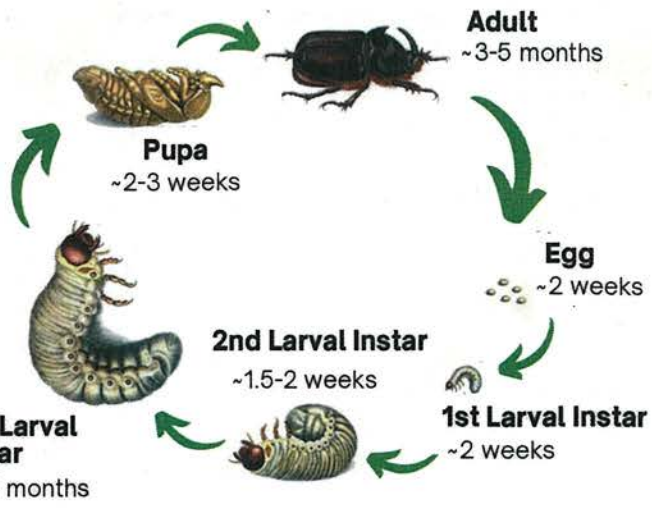
PREVENT THE SPREAD OF COCONUT RHINOCEROS BEETLE

Proper green waste management is one of the most effective ways to reduce CRB populations.



Once mulch cools below 115°F, it becomes an ideal habitat for coconut rhinoceros beetle (CRB). CRB spends most of its life in breeding material like mulch, compost piles, and decaying stumps—using it not only to develop but also to rest, hide, and reproduce between feeding on palm trees.

While a CRB may only spend about 42 days actively feeding on host plants, it can spend nearly 10 months of its life in breeding material.

FOLLOW THESE BEST PRACTICES:

Contain your mulch

Store mulch in a thick, sealed container to prevent CRB from laying eggs.

Install netting

If containment is not possible, cover pile with a fine mesh netting (1/2" eye) to keep beetles out.

Avoid stockpiling

Use mulch as soon as possible. Do not let material sit for more than 4 months.

Spread mulch thin

This may allow the material to dry out and for predators, like chickens, to find larvae.

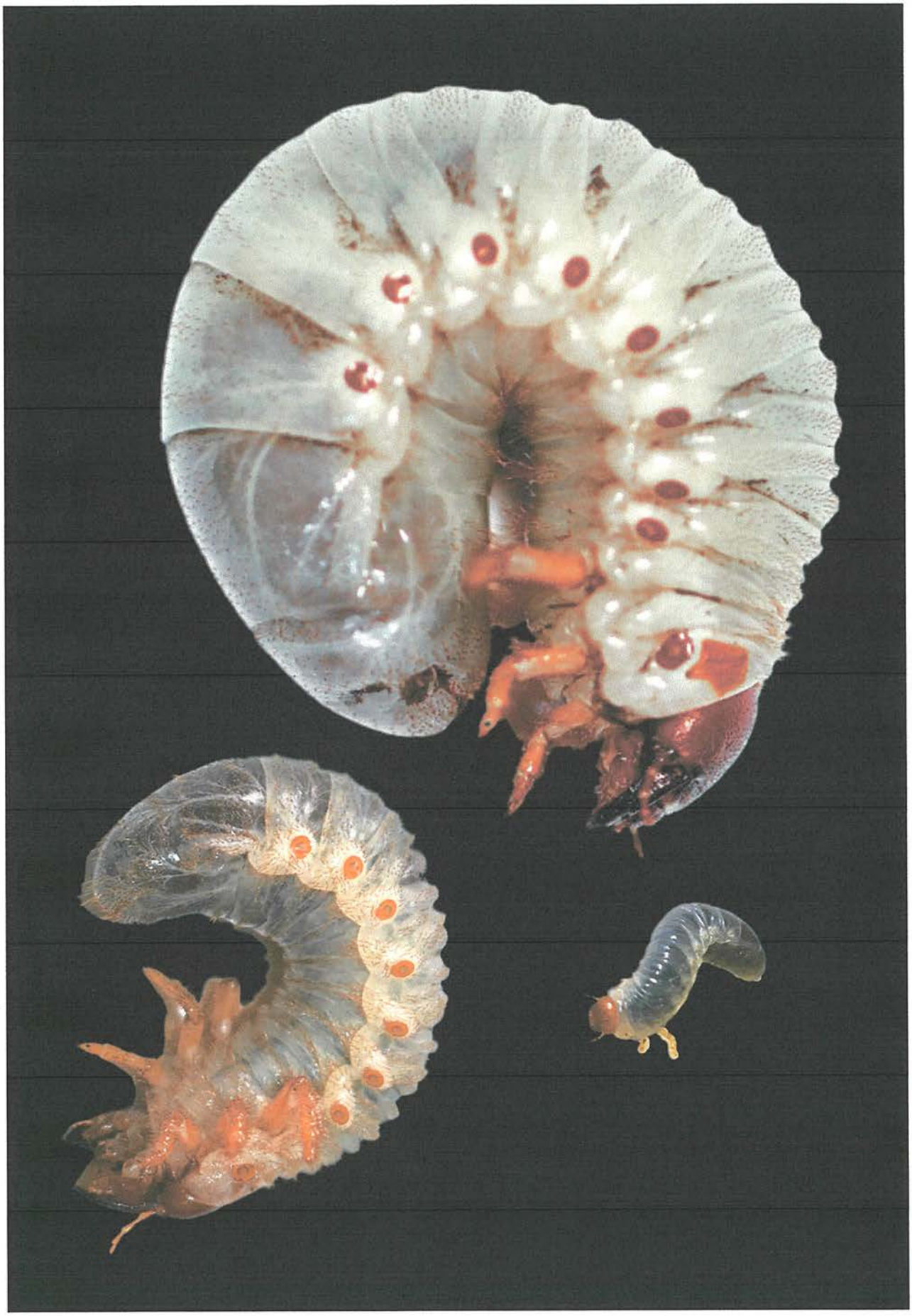
SEE SOMETHING? REPORT IT!

If you find suspect larvae, pupae, or adult beetles:
Take photos, contain the specimen(s) and please report it to the Big Island Invasive Species Committee.

Email: biisc@hawaii.edu
Phone: Text Jade (808) 731-9232
Instagram: @bigislandinvasivespecies
Facebook: @UHBIISC

BIISC
BIG ISLAND INVASIVE SPECIES COMMITTEE

Department of Agriculture
STATE OF HAWAII



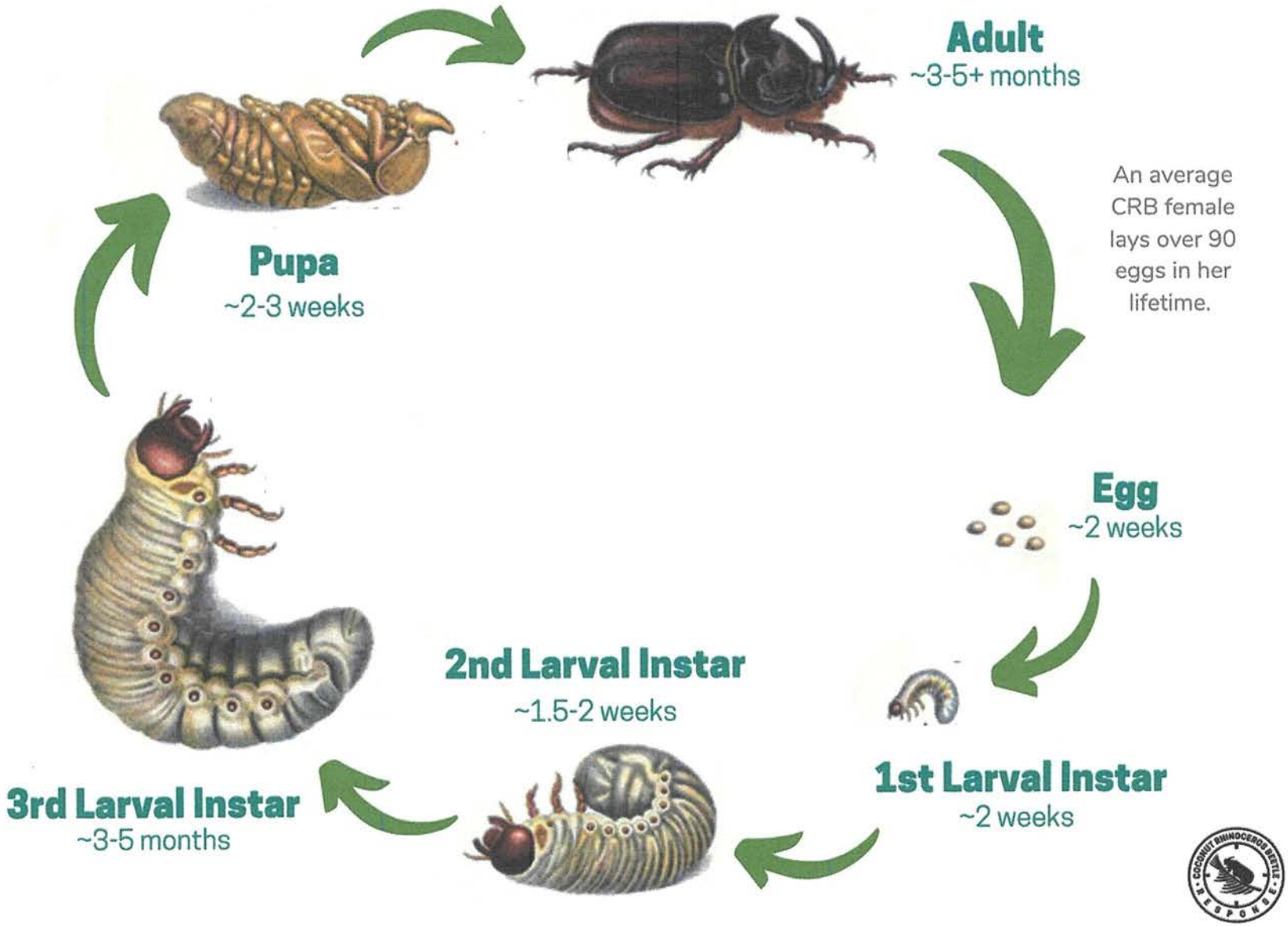
IDENTIFICATION

Adults

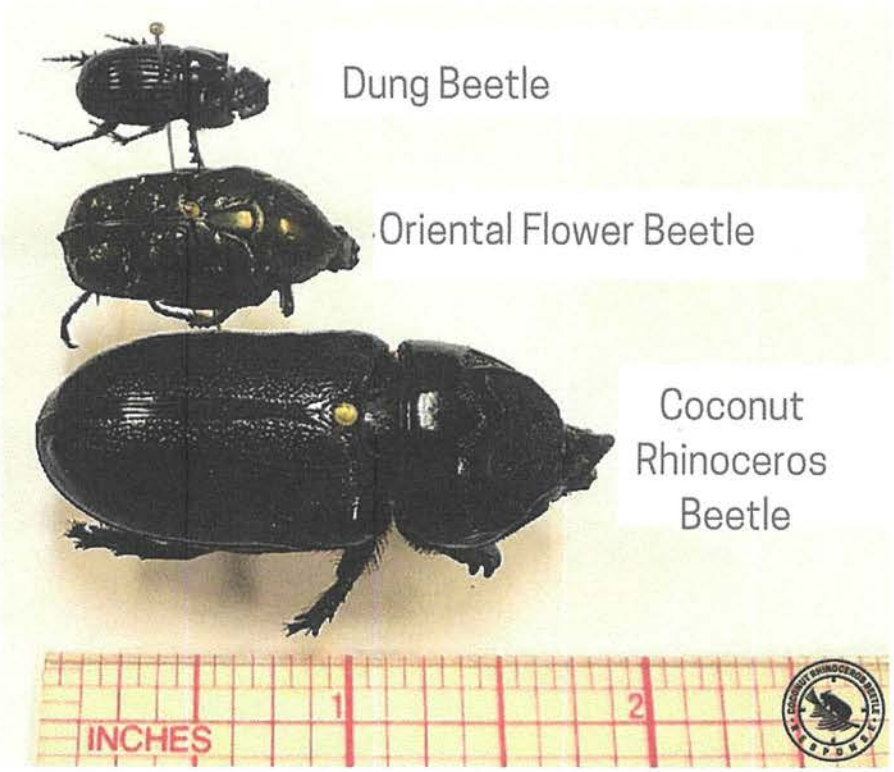
Adult coconut rhinoceros beetle (CRB) are black beetles averaging 2 inches in length with a visible horn. They are night-active and can fly.

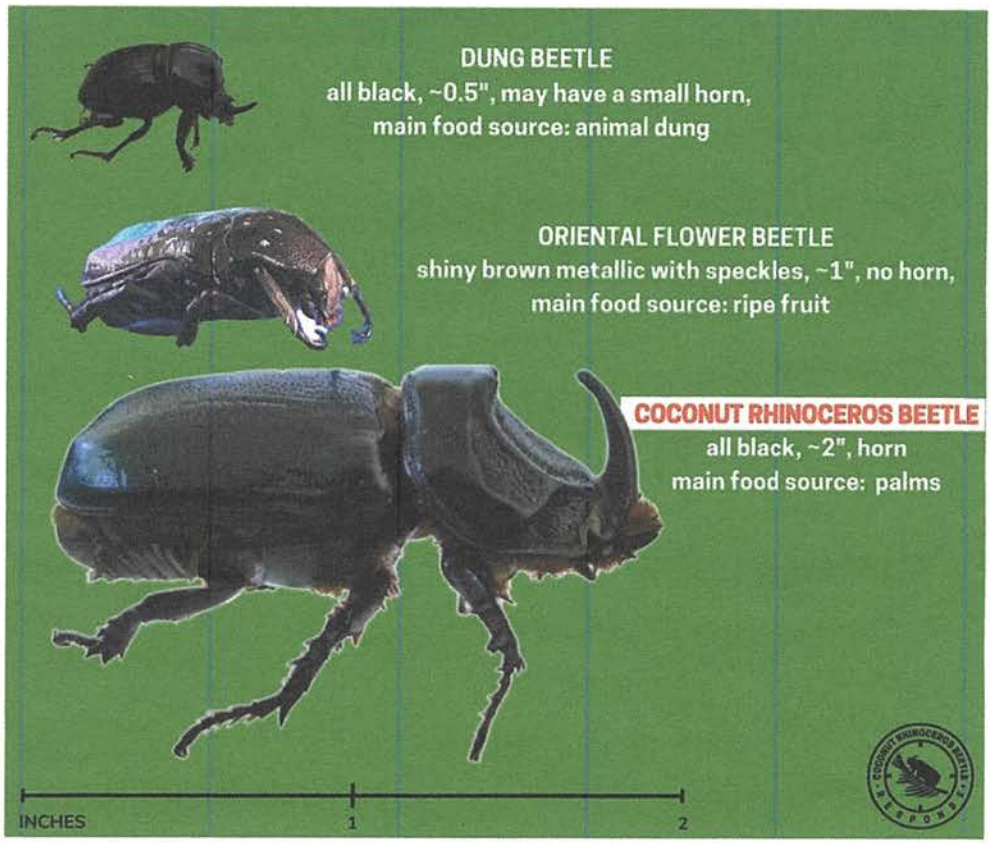
Larvae

CRB larvae can grow up to three inches before pupating. These larvae crawl on their side and curl into a "C" shape when handled. As larvae, they live and feed on decomposing plant material. CRB prefer coconut palm green waste but can survive in most decaying plant material.



Coconut rhinoceros beetle life stages observed at 30 degrees Celsius. CRB breeding sites are typically established in decaying plant material like mulch, compost, decomposing stumps, or felled trees. After hatching from eggs, larvae begin feeding on the decomposing material. After growing through three larval stages, called instars, larvae pupate and emerge as an adult, leaving the breeding site. CRB spend roughly 5.5 months growing from an egg to an adult, and about 3 - 5 months as an adult.





Dung Beetles and Oriental Flower Beetles are a lot smaller than Coconut Rhinoceros Beetles. CRB will always be about 2 inches long. If it's a smaller beetle, it's most likely one of the look-alike species.

LOOK-ALIKES

Coconut Rhinoceros Beetle (CRB)

Invasive species

horn

~2-2.5 inches

Crawls on its side.
Larger head capsule.
Curls into C-shape.

Oriental Flower Beetle (OFB)

Nuisance

Crawls flat on its back.
Raster line on rear end.
Tucks head into midsection.

antennae

~0.75 inch

There are a few look-alike species that are similar to the coconut rhinoceros beetle. This graphic shows some of the key differences in characteristics of the Oriental Flower Beetle (OFB). OFB is a common wide-spread pest that feed on overripe fruit, flower nectar, pollen as well as sap from a variety of plants but their feeding doesn't appear to harm fruiting or flowering productivity.

Tree Bow Ties

Tree bow ties are assembled by taking a 3 ft x 3 ft piece of netting, place a 2 in rock (or anything that can weigh down the netting) in the center of the net, and tie 2–3 knots. Place the bow tie in between each pocket where the base of the frond attaches to the trunk of the palm tree, throughout the whole tree top. These traps will capture the beetles as they try and burrow their way into the tree to feed.

Figure 6. Tree bow tie with 2 in rock in the middle.

Figure 7. Bow tie placed into pockets where fronds attach to trunk.

Figure 8. CRB caught in bow ties.

CRB Trapping Tips

- Traps should be placed in open areas away from coconut and other palm trees to draw rhino beetles away from trees.
- Keep tekken netting free of weeds to be able to observe and service the CRB traps.
- Provide small holes 6 in from the bottom of the barrels, of a diameter no larger than 1/4 in to allow water to drain during rainy periods.
- Barrel traps should be inspected every month and more organic material added to each barrel as needed.
- Check solar lights weekly to ensure functionality as current solar powered uvLEDs have a high failure rate. To check, cover the solar panel with your hand and observe if the light turns on.
- Lures should be inspected weekly. Hang a new lure when the liquid in the plastic window dries up.

For More Information
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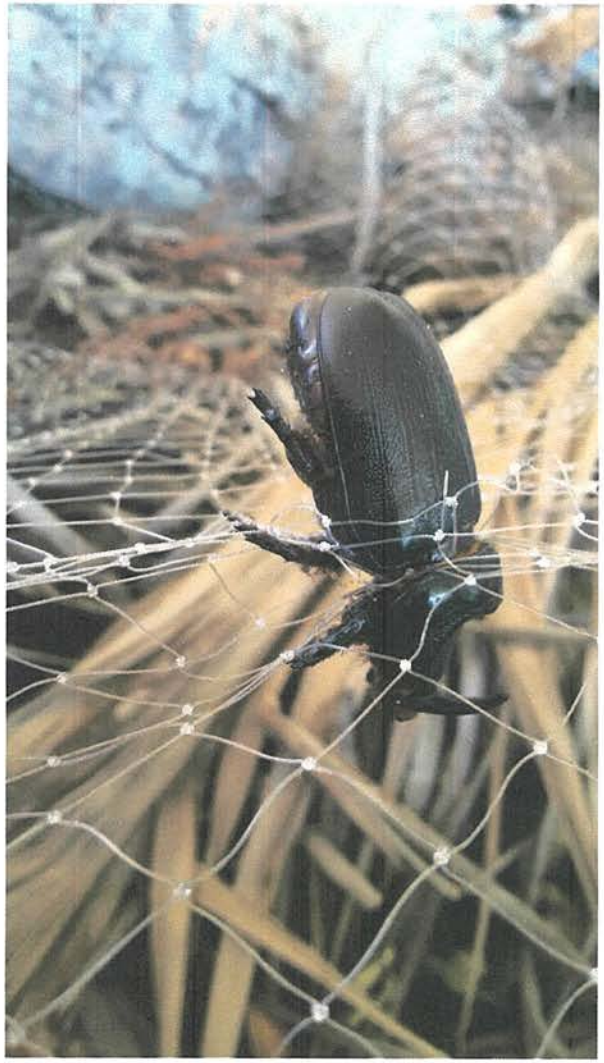
Trapping Methods

Coconut Rhinoceros Beetle



College of Natural & Applied Sciences
University of Guam | Unibetsedåt Guåhan

Principles of Coconut Rhinoceros Beetle (CRB) Management

Education	Learn the facts about CRB and the proper care of palm trees.
Monitoring	Observe CRB activities and damages in the area.
Sanitation	Maintain the areas' green waste and trees.
Trapping	Use traps to help prevent CRB from damaging your trees.

In the Past

The Standard Pheromone trap (Figure 1), was the best form of trapping for the Coconut Rhinoceros Beetle back in 2007, during the early eradication efforts. However, research has shown that these traps do not effectively attract the beetle enough to reduce or control its population.

Figure 1. Standard Pheromone Trap.

The Present

Recent trap developments now provide the community with improved trapping options that are simple to build, manageable, more economical, and more effective at attracting the coconut rhino beetles.

- **Tekken Netting**
- **Barrel Traps**
- **Tree Bow Ties**
- **DeFence Traps**

Tekken Netting

A gill net called "tekken" in Chamorro, with a 1 in mesh measured knot to knot, made from 0.25 mm nylon monofilament, should be laid over piles of green waste such as palm tree cuttings or decaying organic matter (Figure 2). Green waste piles are very attractive to rhino beetles looking for a mate and/or egg-laying sites. A beetle trying to get in or out of the pile will become trapped when the monofilament drops into the gap behind its prothorax (Figure 3), the same way that fish are caught in gill nets.

Figure 2. Tekken net covering a large pile in fresh organic material.

Figure 3. CRB caught in tekken netting.

Barrel Traps

Barrel traps can be built using recycled 55 gallon metal oil barrels, plastic barrels, or large heavy duty trash cans. Barrel traps are filled with decaying coconut or other organic material up to 6 in from the top. The barrel is then covered with a small piece of tekken netting, wrapped securely around a piece of garden hose cut to size to fit inside the barrel for more stability. A solar-powered ultraviolet light emitting diode (uvLED) and a CRB pheromone lure should be added to increase its effectiveness. If desired, traps can be painted decoratively to be more presentable.

Figure 4. CRB Barrel Trap.

DeFence Traps

The DeFence traps are simply constructed with a 12 ft piece of tekken netting, folded in half, and secured onto a fence line using zip ties. In the middle of the net, attach a solar powered uvLED light, and a CRB pheromone lure protected in a red Solo cup. This trap is currently the most effective because it does not require many materials and uses the least amount of space on the property.

Figure 5. CRB DeFence trap.

Rhinoceros Beetle in Coconut

Recognize the problem

The Rhinoceros beetle is a black-coloured horned beetle which is active at night and hides in feeding or breeding sites during the day. The beetle attacks the young leaf fronds which, when fully opened, show characteristic diamond shaped cuts. Repeated attack can destroy the top portion resulting in the death of the palm.

Diamond shaped cuts in fronds. (Photo by http://tnau.ac.in)

Triangular Cut

Background

The adult beetles from the manure pits or the nearby trees bore into the opened fronds of the young palms and cause damage. The rhinoceros beetle feeds on young growing tissue and eats the exuded sap. The grubs of the beetle are usually found in manure pits.

Management

- Wipe out the grubs in the manure pits by pouring 250 ml green muscardine fungus (*Metarhizium anisopliae*) culture mixed with 750 ml of water into manure pits
- Keep the coconut farm clean by chopping and burning the decayed and affected logs
- Hook out the beetle from the attacked palm using the beetle hook
- Place three naphthalene balls in the leaf axil at the top of the crown to repel the beetles
- Set up light traps following the first rains in summer and monsoon period to attract and kill the adult beetles
- Use pheromone traps with Rhinolure @ 12 /ha for trapping the adults, then destroy them
- Soak castor cake @ 1 kg/ 5 litres of water in small mud pots and keep them in the coconut gardens to attract and kill the adults
- Treat the longitudinally split tender coconut stem and green petioles of fronds with fresh toddy and keep them in the garden to attract and trap the beetles
- Apply a mixture of Neem Seed Kernel Powder + sand (1:2) @150g/ palm at the base of the 3 inner most leaves in the crown
- For nut bearing coconut, root feed with TNAU coconut tonic at 200ml/palm, once in six months. Apply 200 g of borax/ palm /year in two splits.

Rhinoceros beetle. (Photo by Joan Quintana (CC BY-SA))

Scientific name(s) > ***Oryctes rhinoceros***

The recommendations in this factsheet are relevant to: India

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Coconut rhinoceros beetle - Oryctes (108)

Common Name

Coconut rhinoceros beetle, rhinoceros beetle

Scientific Name

Oryctes rhinoceros. Several strains are recognised. In Pacific islands

Distribution

South and Southeast Asia, Oceania. American Samoa, Fiji, Hawaii, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, and Wallis & Futuna. Recently, the beetle has spread to Guam, Hawaii, mainland Papua New Guinea, Solomon Islands, and Vanuatu (under eradication).

Photo 1. Characteristic damage done by the coconut rhinoceros beetle, *Oryctes rhinoceros*, showing V or wedge-shaped sections missing from the fronds eaten by the adults as they tunnel into the crowns of mature palms. (Solomon Islands)

Hosts

Coconut is the most important host, but other palm species are attacked, including betel nut, sago palm and oil palm. Banana, *Pandanus*, sugarcane and tree fern are also hosts.

Photo 2. Severe damage to young fronds by adult coconut rhinoceros beetle, *Orytes rhinoceros*. (Palau)

Symptoms & Life Cycle

The adult beetle does the damage, boring into the crown of coconut palms, cutting across young fronds and flowers. When the leaves unfold the damage is seen as V or wedge-shaped areas missing from the leaflets (Photos 1-4). Holes in the base of the fronds may be obvious when beetle populations are high (Photo 5).

Oval eggs (3.5 x 4 mm) are laid one at a time, 5-15 cm, below the surface of moist organic materials, such as sawdust, manure, compost and garbage heaps, or above ground in tunnels, debris in axils of coconut fronds, in still-standing but dead and rotten coconut palms, and in the rotten ends of fallen coconut trunks (Photo 6). Logs and stumps of many other kinds of trees are also hosts (Photo 7). The eggs hatch in 8-12 days. The C-shaped larvae or grubs are white then creamy with brown heads (Photo 8). There are three stages lasting 80 to 200 days (depending on quality of the diet), with the third stage up to 100 mm long and 20 mm diameter. The last stage makes a hollow where it feeds, lining it with liquid faecal material, and then pupates. The two pupal stages last 25-40 days.

Photo 3. The damage from *Orytes rhinoceros* in Solomon Islands is so severe that palms are dying from the attack.

Adults remain in the ground for 2-3 weeks and then chew their way out. They are black with horns - those of the female often shorter than the male (Photos 9-12). Females live about 9 months, and lay about 50 eggs; males live about 5 months. The beetles are nocturnal, flying to the tops of coconuts where they use their mandibles, horn and strong forelegs to tunnel into the crowns. They do not eat the frass from the tunnels; instead, they drink the sap that comes from tunnelling.

Spread is on the wing, they are stronger flyers, and aboard ships and aircraft. They are attracted to lights.

Photo 4. Close up of characteristic shape of fronds eaten by adult coconut rhinoceros beetle, *Oryctes rhinoceros*. (Palau)

Impact

The damage caused by the beetle results in loss of leaf area, flowers dying, early nut fall and, ultimately, lower yields. Occasionally, the beetles bore through the midribs of fronds, which snap in the wind.

It is difficult to relate damage to lost production. One way is to prune leaves to simulate beetle attack and compare nut yields on healthy palms. Using the relationship between damage and yield calculated elsewhere, work in Samoa showed that a 25% reduction in leaf area resulted in a 25% reduction in nut yield.

Indirect damage also occurs. In Asia and parts of Papua New Guinea, *Oryctes* attack encourages invasion by *Rhynchophorus* sp. palm weevils (**see Fact Sheet no. 180**).

Detection & inspection

Look for large jet-black beetles up to 40 mm long with prominent horns. Look for tunnels in the crown of coconut palms with frass - often more than one per palm. Look for the V-shape damaged fronds. Use a hooked wire inserted into the tunnel to remove the beetle. Differences between the strains depends on molecular tests.

Management

Research into management of *Oryctes* started in the Pacific islands in the 1960s. Today, the key agent is a virus (*Oryctes rhinoceros nudivirus* - OrNV) originally from Malaysia. A fungus, *Metarhizium anisopliae*, from the Philippines is also used. Apply control measures if 3-5 beetles occur per ha up to 2 years after planting, and 15-20 beetles per ha thereafter.

BIOSECURITY

Vigilance is needed at seaports and airports against hitchhiking beetles. Establish pheromone traps and regularly inspect coconut palms growing nearby for frass and leaf symptoms. This is particularly important as new strains of the beetle have been found in Pacific islands in recent years, in addition to the original strain, CRB-S (also known as CRB-P), that has been present for more than 100 years. CRB-G is now present in Guam, Palau, Papua New Guinea, and Solomon Islands, and CRB-PNG in the islands of Papua New Guinea, Samoa, and Solomon Islands. The damage of all the strains is similar, but there has been speculation that CRB-G is tolerant to OrNV.

The FAO/IBPGR *Technical Guidelines for the Safe Movement of Coconut Germplasm* should be followed when coconut germplasm is transferred between countries (http://www.bioversityinternational.org/e-library/publications/detail/coconut/).

NATURAL ENEMIES

There are many general predators (pigs, rats, ants and other insects) and scoliid wasp parasites (e.g., *Scolia ruficornis*). The nudivirus infects larvae and adults. It was released in Fiji, Samoa and Tonga in the late '60s and early '70s. Adult beetles are dipped in a suspension of ground, infected grubs, and then released to infect grubs in breeding sites, and adults in feeding tunnels. In Guam, spores of *Metarhizium anisopliae* (imported from the Philippines) are dusted onto beetles, which then contaminate larvae (Photo 13), and other beetles in breeding sites.

CULTURAL CONTROL

- Destroy fallen dead palms (split, allow to dry and burn); compost dead leaves and grass; and turn manure and sawdust heaps regularly and remove the grubs. Treat compost and manure with *Metarhizium* or insecticides. Note, in Samoa, the cutting of recently dead trunks has been questioned as a policy: the standing dead palms are (i) a valuable source of *Oryctes rhinoceros nudivirus*, and (ii) can be processed for fence posts, and other uses.
- Catch adults by covering breeding sites - heaps of fronds or other organic matter - with gill nets (Photo 14); the beetles get caught in the gill net when entering or leaving the breeding site. A method developed at the University of Guam.
- Catch adults with pheromone (ethyl 4-methyloctanoate) attached to bucket traps (15-17) spaced at 1-2 km (at beetle 'hot-spots'). Traps should be inspected at about every 3 month, beetles removed, and reloaded with pheromone.
- Make artificial breeding sites coconut logs containing organic material (chicken manure, sawdust, rotting coconut fibre, oil palm bunches) and laced with spores of *Metarrhizium anisopliae*.
- Grow a legume ground cover (e.g., *Pueraria phaseoloides*) over logs or stumps, and other potential breeding sites that cannot be destroyed easily. Note, that in Solomon Islands such covers did not prevent large infestations establishing in windrowed oil palms.
- Use a hooked wire to extract and destroy adult beetles feeding in the crowns of palms.

CHEMICAL CONTROL

Chemical control is not recommended: it is uneconomical because of the low value of coconuts per unit area; additionally, it is impractical to apply insecticides except to young palms. If insecticides are needed, use synthetic pyrethroids. Traps with the attractant ethyl 4-methyloctanoate have been used to monitor populations and to give economic control in some countries. Use one trap per 2 ha.

When using a pesticide, always wear protective clothing and follow the instructions on the product label, such as dosage, timing of application, and pre-harvest interval. **Recommendations will vary with the crop and system of cultivation. Expert advice on the most appropriate pesticides to use should always be sought from local agricultural authorities.**

Photo 5. Holes made by adult coconut rhinoceros beetle, *Oryctes rhinoceros*, in the base of fronds. Presumably, the holes were made when the leaves were much younger as the beetle tunnelled into the crown of the palm. (Palau)

Photo 6. Larvae of coconut rhinoceros beetle, *Orytes rhinoceros*, in a rotten coconut trunk. A favourite breeding site, especially in still standing but decaying palms (Fiji).

Photo 7. Larvae of coconut rhinoceros beetle, *Orytes rhinoceros*, under a log of unknown tree species.

Photo 8. Close-up of the larva of a coconut rhinoceros beetle, *Orytes rhinoceros*. Note that the C-shape grubs or larvae grow up to 100 mm.

Photo 9. The adult is jet-black, up to 40 mm long with a prominent horn. Both male and female beetles vary in size, and size cannot be used to distinguish the sexes.

Photo 10. Close-up of the head end of the coconut rhinoceros beetle, *Oryctes rhinoceros*. Male (right), female (left).

Photo 11. Underside of adult coconut rhinoceros beetle, *Oryctes rhinoceros*, to show the fuzzy group of hairs at the rear

end of the female (left) compared to the male (right).

Photo 12. Close-up of the hind end of the coconut rhinoceros beetle, *Oryctes rhinoceros*. Female, with abundant hairs at the tip (left); male (right).

Photo 13. The grub or larva of a coconut rhinoceros beetle, *Oryctes rhinoceros*, infected by the fungus *Metarhizium* (Guam). The green areas are where the fungus is sporulating.

Photo 14. Trapping coconut rhinoceros beetle, *Oryctes rhinoceros*. Breeding sites are heaps of old fronds or other organic matter; they are covered by a gill net, and the beetles get caught in the mesh when entering or leaving the heaps.

Photo 15. Bucket traps for coconut rhinoceros beetles, *Oyctes rhinoceros*, with chicken-wire covers and pheromone (Fiji).

Photo 16. Bucket traps for coconut rhinoceros beetles, *Oyctes rhinoceros*, placed above ground. About 2 m above ground is ideal.

Photo 17. Bucket trap with catch of coconut rhinoceros beetles, *Oryctes rhinoceros*.

Photo 18. An artificial breeding site inoculated with spores of *Metarhizium anisopliae*, in order to infect larvae of the rhinoceros beetle, *Oryctes rhinoceros* (Fiji).

AUTHOR Grahame Jackson

Information from Waterhouse DF, Norris KR (1987) *Oryctes rhinoceros* (Linnaeus). *Biological Control Pacific Prospects*. Inkata Press, Melbourne; and Mark Schmaedick (2005). Coconut rhinoceros beetle. Pests and diseases of American Samoa, Number 8. American Samoa College Community & Natural Resources Cooperative Research & Extension. (https://www.ctahr.hawaii.edu/adap/ASCC_Landgrant/Dr_Brooks/BrochureNo8.pdf); and from USDA APHIS (undated) Coconut rhinoceros beetle. Hungry Pests. (https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat/coconut-rhinoceros-beetle/hp-crp). Photos 7-13 Mark Schmaedick, Land Grant Program, American Samoa Community College. Photos 2,4,5 Joel Miles, Bureau of Agriculture, Republic of Palau. Photo 14 Aubrey Moore University of Guam. Photos 6&15-18 Nitya Singh, Ministry of Agriculture, Fiji.

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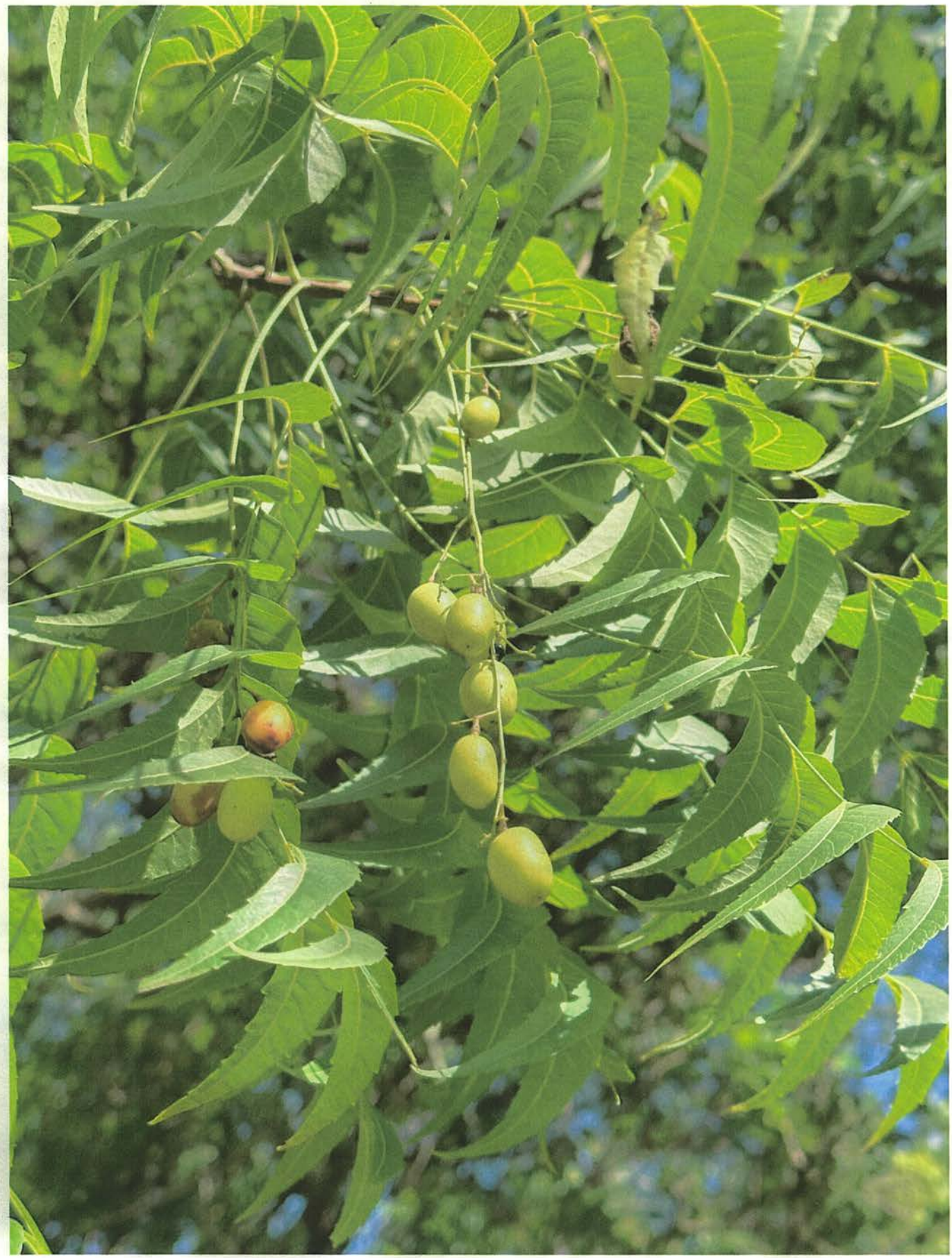
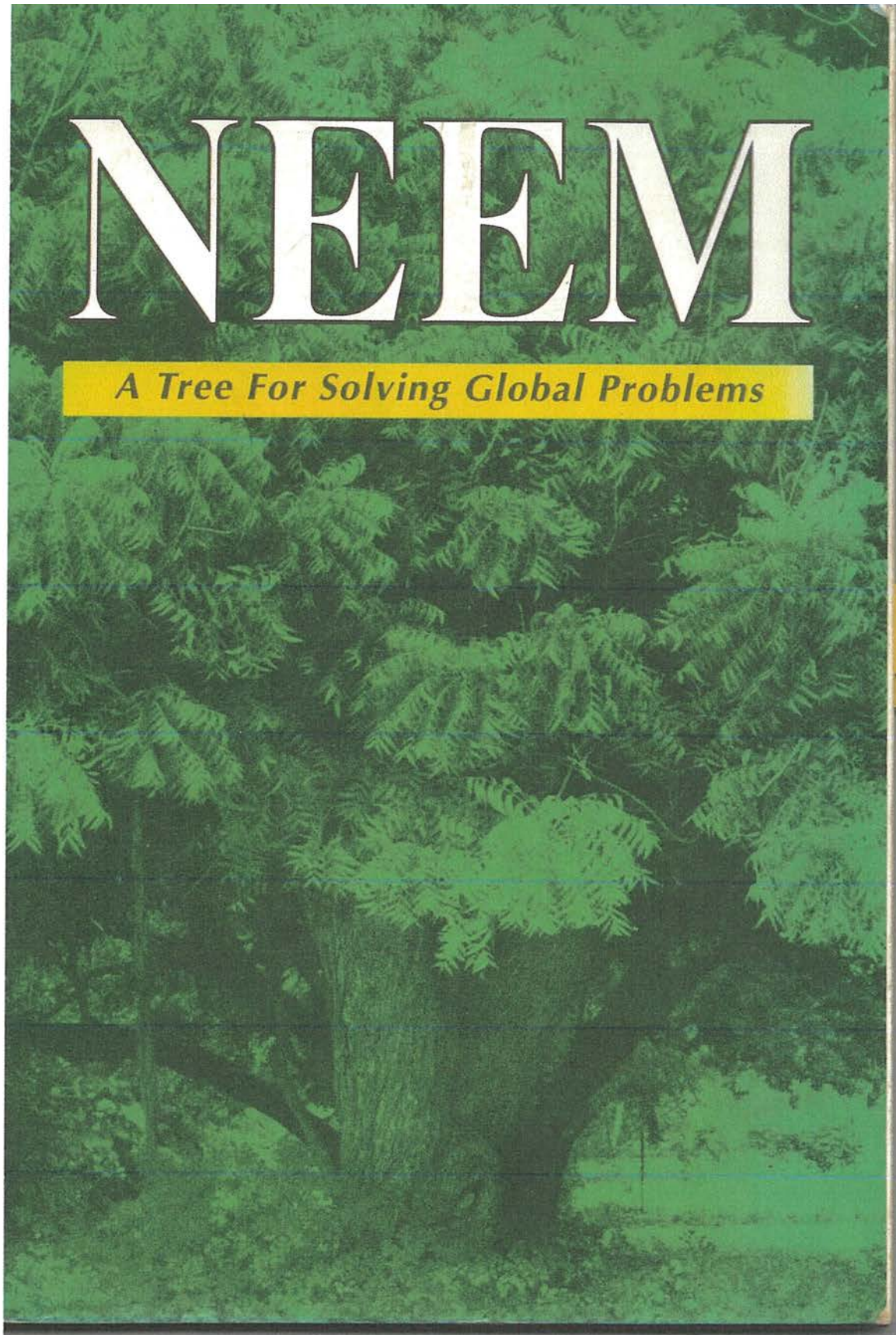



NEEM
A Tree For Solving Global Problems

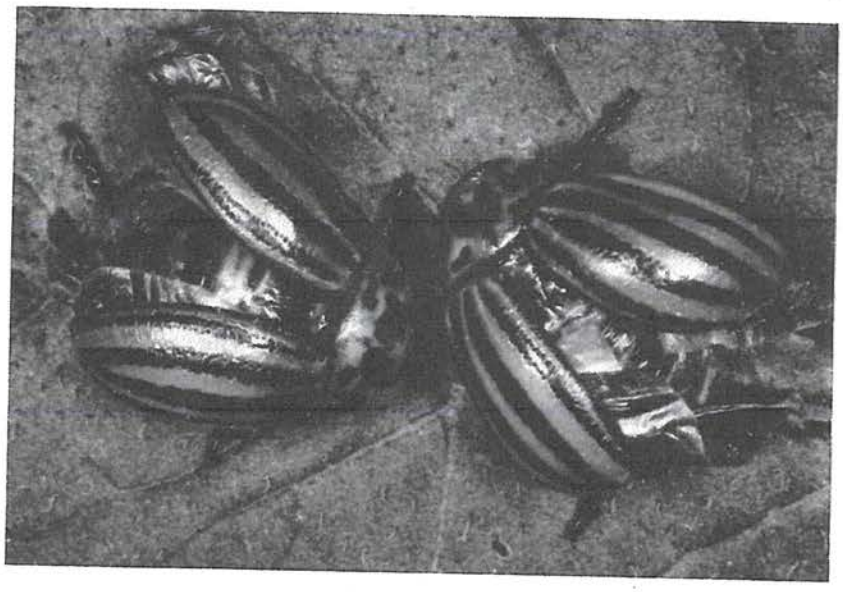
The Breakthrough

Although thousand-year-old Sanskrit medical writings mention neem's usefulness, the tree's exciting potential for controlling insects has only recently become clear.

Neem's ability to repel insects was first reported in the scientific literature in 1928 and 1929. Two Indian scientists, R.N. Chopra and M.A. Husain, used a 0.001-percent aqueous suspension of ground neem kernels to repel desert locusts. Not until 1962, however, was the real significance demonstrated. That year, in field tests in New Delhi, S. Pradhan ground up neem kernels in water and sprayed the resulting suspension over different crops. He found that, although locusts landed on the plants, they refused to eat anything, sometimes for up to 3 weeks after the treatment. Furthermore, he noted that neem kernels were even more potent than the conventional insecticides then available and that neem's repellency was as important as its toxicity. In neighboring insecticide-treated fields, for instance, the insects also died, but not before consuming the crops.

Neem's insect-growth-regulating (IGR) effects were independently observed in England and Kenya in 1972. In England, L.N.E. Ruscoe, at that time an employee of the ICI Company, tested azadirachtin on insect pests such as cabbage white butterfly (*Pieris brassicae*) and cotton stainer bug (*Dysdercus fasciatus*) and noted IGR effects in each case. The azadirachtin was provided by D. Morgan, a Keele University chemist who had been the first to isolate azadirachtin. In Kenya that same year, K. Leuschner, a German graduate student working at the Coffee Research Station in Upper Kiambu, observed that a methanolic neem-leaf extract controlled the coffee bug (*Antestiopsis orbitalis bechuana*) by growth-regulating effects. Most fifth-instar nymphs treated with the extract died during subsequent molts and the few that survived to adulthood had malformed wings and thoraxes.

Neem's fecundity-reducing effects were first recorded by R. Steets (another graduate student) and H. Schmutterer in Germany. Applying methanolic neem-kernel extract and azadirachtin to the Mexican bean beetle (*Epilachna varivestis*) and the Colorado potato beetle (*Leptinotarsa decemlineata*) they found that females almost stopped laying eggs. Some females had been completely sterilized, and the effect was irreversible.



NEEM PRODUCTS AGAINST COCONUT INSECT PESTS

By

S. Sadakathulla[1]

ABSTRACT

Three field experiments were conducted to find out the efficacy of neem products against the damage of rhinoceros beetle to coconut palm and termite damage to coconut palm and plaited leaves. The application of cither neem seed powder + sand (1:2) or neem seed kernel powder + sand (1:2) @ 150 g mixture per palm in the bases of three leaf axils in the crown, were found more effective against rhinoceros damage. Spraying of neem oil 5% or neem seed kernel extract 20% from the base and up to, 2 m height on the truck protected the palm from termites. Spraying with copper sulphate 1% and-then neem oil 5% or copper sulphate 1% and then neem seed kernel extract 20% on plaited coconut leaves was found efficacious in protecting plaited coconut leaves for more than six months even when the plaited leaves were kept on the bare ground having persistent live termite colony throughout the year.

INTRODUCTION

Among the major insect pests of coconut (*Cocos nucifera Lin*), rhinoceros beetle (*Otyctes rhinoceros* L.) was found attacking palms in serious proportion with persistent occurrence in ail countries where coconut is grown. Besides coconut, rhinoceros beetle attacks pineapple, sugarcane, palmyrah, date palm, red oil palm, tali pot palm and royal palm. But coconut has been found to be the most favored of ail palms by the beetle (Dhileepan, 1986. Sundara Babu, 1986).

The adult rhinoceros burrows and remains in leaf axils of the spindle leaves in the crown of the palm causing damage to, the developing leaves resulting in characteristic "V" or wedge shaped appearance in unfolded leaves. Though the damage was prevalent throughout the year to, varying degrees, significantly greater damage was recorded during May, June and August months as against the least in February (Sakadathulla and Ramachandran, 1991-b). The beetles also bore into the soft tissues of the bud/cabbage. More fronds; were attacked by a single beetle in older palms, since they have more compact crown. The beetle attacks the unopened spathes and can cause up to 10% reduction in yield. The injury and the bore h le made by this beetle also serve as points of entry of other equally important pest viz., the red palm weevil, *Rhynchophorus ferrugineus* F. The conventional control of the damage by HCH 10% + sand (1:1) mixture in three leaves axil bases found effective (David and Kumaraswami, 1982). The integrated management of this pest was reviewed by Sundarababu (1986), Sadakathulla and Ramachandran (1990-b; 1990-c) found the application of naphthalene balls or phorate 10% G + sand (1:2) equally effective as that of the conventional method.

The subterranean pest termite, *Odontotermes obesus Ramb*, is an important pest of coconut seedling in the nursery, newly planted, seedling, growing palms in the plantation and plaited coconut leaves. The incidence will be more in sandy loam soils and on soils other than sandy, this pest appears to be attracted by the husk of the seednut in the nursery and the dry under-composed organic wastes; applied to the main plantation. As early as 1958. Nirula *et al* estimated 20% loss of coconut seedlings due to termite attack. In older palms, the earthen gallery extends up to 3 to 4 m height of the trunk during summer. In young plantations, the termite galleries even reaches the leaf bases in the crown and damage them, resulting the premature shedding of functional leaves. The damage to the bark of the tree renders it prone to the infestation of bark borer beetle *Xyleborus sp.*, the worst enemy

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of grown up palms. The termites also attack the plaited leaves in the thatched roof and skeletonize them. The alternate hosts of termite are sugarcane, groundnut, chillies, guava (Prasad and Rao, 1988).

In view of the considerable loss caused to the palm by these insects pests three experiments were conducted at Coconut Research Station, Veppankulam during 1990-92 to find out the efficacy of neem products against the rhinoceros beetle and termite damage.

MATERLALS AND METHODS

a. Rhinoccros beetle (*O. rhinoceros*)

The field experiment was laid out at Coconut Research Station, Veppankulam in randomized block design, replicated four times with eight treatments; comprising four plant products and 3 chemicals viz., neem seed powder (NSP) + sand (1:2 ratio). Neem seed kernel powder (NSKP) + sand (1:2) (g- 150 g/palm, neem cake powder (NCP) + sand (1:2) 100 g/palm. neem cake powder (NCP) + sand (l:2) @ 150 g/palm, Klorocin (SBP = Standard Bleaching Powder) + sand (1:3) @ 200 g/palm, HCH 10% + sand (1:1) @150 g/palm, Napthalene balls @ 3 nos/palm and untreated control. The coconut palms which where constantly attacked by rhinoceros beetle where screened and selected for the experiment and recorded, total number of leaves in the crown and leaves attacked by the rhinoceros beetle prior to imposing the treatments. The individual chemical mixture was applied in the leaf bases of 3 innermost leaves in the crown. Three napthalene balls per palm were applied to the base of 3 innermost leaves in the crown @ each per leaf base. The treatment with naphthalene balls alone was repeated 45 days after the first round. Periodical observations on the damage of leaves in the crown by *O. rhinoceros* were continued for three months and the percent damage is different treatments assessed.

b. Termite (*O. obesus*)

Two field experiments Where conducted during 1991- 1992 summer season at Coconut Research Station. Veppankulam.

i) The experiment on palms was laid out in randomized block design, replicated thrice with seven treatments viz. 1) aldrin 30 EC @ 0.15%; 2) HCH 50% WP, 0.25%; 3) Chlordane 20 EC @ 0.1%. 4) Neem oil (NO) 5%, 5) Neem seed kernel extract (NSKE) 20%; 6) Cashewnut shell oil (CNSO) 80% and 7) untreated control. Each treatment consisted of 10 palms of 22 years old showing five carthen gallery of *O. obesus* both on the base and trunk of the palms to varying heights at the time of experiment layout. The spraying was done using a hand operated high volume rocker type of sprayer by drenching to the point of run off from the base of the palm and soil around and the trunk up to 2 m height from ground level. Periodical observations at fortnightly intervals after the treatment were recorded up to seven months.

The cashewnut shell oil cannot be sprayed as such with a sprayer; hence one part of kerosine was added to four parts of cashewnut shell oil for aiding smooth spraying as suggested by Pillai *et al* (1983). For other treatments, teepal was added @ 1 ml per l of spray fluid.

ii) The experiment on plaited leaves Was laid out in randomized block design replicated thrice with 11 treatments, viz. 1) aldrin 0.15%, 2) HCH 0.25%, 3) Chlordane 0.1%, 4) neem oil 5%, 5) neem seed kernel extract 20%, 6) cashewnut shell oil 80%, 7) copper sulphate ($CuSo_4$) 1%; 8) copper sulphate 1% and neem oil 5%; 9) copper sulphate 1% and neem seed kernel extract 20%, and 10) copper sulphate 1% and cashew nut shell oil 80% and 11) untreated check. For each treatment, five numbers of plaited coconut leaves (1 m length x 0.4 m width each) were used. The emulsion sprays for the treatments l to 7 were sprayed on both the sides of the plaited leaves. For the treatments 8-10, copper sulphate l % was sprayed first on the plaited leaves and air dried in shade for 30 minutes. The individual treatment (T8-T10) was sprayed. These plaited coconut leaves after treatments were

individually kept on the bare ground, where the live termite colony was persistent throughout the year. Periodical observations at fortnightly interval on the termite infestation on the plaited leaves under treatment were recorded.

RESULTS AND DISCUSSION

a) Rhinoceros:

All the chemical treatments were found significantly superior against rhinoceros damage. Among them, the treatment i0th the application of three naphihalene balls in three leaf bases in the crown was found more effective recording significantly lesser damage (8.6%). The results agree with the earlier findings of Gurmit Singh (1987) and Sadakaihulla and Ramachandran (1990-b: 1990-c). The next best treatment was the application of HCH 10% + sand mixture (9.9%). closely followed by the treatment with neem seed powder + sand (10.1%) and neem seed kernel powder + sand (10.7%) (Table 1). Since Klorocin + sand mixture (10.1%) caused phytotoxicity in the leaves at the points of contact of the chemical, this cannot be recommended though it is on par with neem seed powder + sand and neem seed kernel powder + sand and neem seed kernel powder + sand mixture application for the efficacy.

The mixture of neem seed powder or neem seed kernel powder + sand 91:2) can be well utilized as it is locally available and cheaper for the effective management of rhinoceros beetle in coconut palm.

b) For termite control both in the nursery and planted seedlings, cultural and chemical measures have been suggested (Beal and Smith 1964): Bees *et al.*, 1966). Application of 2-3 aluminium phosphidc tablets in the hole of the termitarium and plugging the hole air tight to kill the entire colony including, the queen also found effective (Rangajaran *et al*, 1985). Sirkar (1486) advised the painting, of the trunk up to l m height of older coconut palms with coal tar or lime. Sadakathulla and Ramachandran (1990a; 1991a) found out the efficacy of either aldrin 0.15% or HCH 0.25% or chlordane 0.1% spray against the termite both on the palm and plaited coconut leaves.

The results of the present studies indicated the best efficacy of spraying, with cither neem oil 5% or neem seed kernel extract 20% treatment as that of the spray with aldrin 0.15%, HCH 50% WP 0.25% and chlordane 0.1 % on the base and up to 2 m height of the trunk of the coconut palm and spraying cither with copper sulphate 1% and then cashew nut shell oil 80% or copper sulphate 1% and then neem oil 5% or copper sulphate 1% and neem seed kernel extract 20% on the plaited coconut leaves against *O. obesus* for more than 6 months even when the treated plaited leaves were kept on the bare ground having, the persistent live termite colony throughout the year (Table 2).

Spraying with $CuSo_4$ 1% and neem oil 5% or $CuSo_4$ and neem seed kernel extract 20% was found equal in efficacy as that of the treatment with $CuSo_4$ 1% and then cashewnut shell oil 80%. The neem products can be easily and cheaply substituted in the place of cashewnut shell oil for the protection of palm and preservation of plaited coconut leaves from the ravages of the termites,

CONCLUSION

The locally available cheaper plant product neem seed powder + sand 0:2) or neem seed kernel powder + sand (1:2) @ 150 g mixture in the leaf base of three inner most leaves in the crown was effective and may be well fitted in the integrated pest management programme of the rhinoceros beetle in coconut plantation.

Spray of neem oil 5% or neem seed kernel extract 20% on the base of up to 2 m height of the trunk of coconut palm was found as effective against termites as that of spraying with either aldrin 0.15% or HCH 0.25% or chlordane 0.1%.

Spraying with $CuSo_4$ 1% and neem oil 5%, or $CuSo_4$ 1% and neem seed kernel extract 20% on plaited coconut leaves was found equal in efficacy as that of the spraying with $CuSo_4$ 1% and then cashewnut shell oil 80% in the presentation of plaited coconut leaves.

REFERENCES

Beal, R.H. and Smith, V. K. (1996) Progress report of granular formulations of insecticides for controlling termites *J. Econ. Entomol*. 57:771

Bees, H. A., Ota, A. K. and Kawanishi, C. (1966) Persistence of soil insecticides for control of subterranean termites. *J. Econ. Enthomol*. 59:911 - 915.

David. B N. and Kurmaraswami, T. (1982). Coconut pests *Elements of Economic Entomology.* Popular Book Dept. Madras p. 92 - 98

Dhileepan. K. 1986. Pests of oil palm and their management strategies in India. Trg. & Prdn. Tecbnology of oil palm. CPCRI. Kasaragod. p. 11- 13

Gurmit Singh (1987) Naphthalene balls for the protection of coconut and oil palm against *Oryctes rhinoceros*. The Planter 63: 286 - 292

Nirula, K. K., Antony. J and Menon. K. P. V. (1958) Some investigations on the control of termites. Indian Coconut J. 7: 26 - 29

Pillai. C. K. S., Venkataswamy, M. A., Satyanarayana, K. G. and Rahatgi, P. K. (1983) Preserving coconut leaf thatch: A simple method. *Indian Coconut J.* 14 (8):3 - 6

Prasad, P. R. and Rao. K. P. (1988). How termites ravage fields. *The Hindu* dt. Dec. 7th 1988: p 24

Rangarajan. A. V. Chelliah. S. and Javaraj, S. (1985). Pest management in ficid crops and stored products. *Techl. Extn. Bull*. TNAU. Coimbatore. pp. 32

Sadakathulla, S. and Ramachandran. T. K. (1990-a) Evaluation of insecticides against termite. *Odontoterines obesus Romb*. (Termitidae: Isoptera) attacking palm and plated leaves of coconut. *Indian Coconut J.* 21 (1). 11 - 13

Sadakathulla. S. and Ramachandran. T. K. (1990-b). A novel method to control rhinoceros beetle. *Orives rhinoceros L.* in coconut. *Indian Coconut J.* 21 (7 & 8): 10 - 12

Sadakathulla, S. and Ramachandran, T. K. (1990-c) Efficacy of naphthalene balls in the control of rhinoceros beetle attack in coconut. *Cocos* (Sri Lanka) 8: 23 - 25.

Sadakathulla, S. and Ramachandran, T. K. (1991-a) Termites should no longer worry you in coconut plantations. *Indian Hort*. 36 (3): 24.

Sadakathulla, S. and Ramachandran, T. K. (1991-b) Management of rhinoceros in coconut plantations *The Planter* 67 (782): 197 - 199.

Sirkar, B.B. (1986). Control of coconut pests of North Eastern Hill region. *Indian Coconut J.* 16 (2): 3 - 8.

Sundarababu, P.C. (1986). Coconut rhinoceros beetle and its management. *Pest and Disease Management* (Ed. S. Javaraj) TNAU, Coimbatore. pp. 76 - 80.

Table 1
Efficacy of neem seeds against Rhinoceros beetle

S. No.	Treatments	Pooled mean Damage (%)
1.	Neem seed powder (NSP) + sand (1:2)	10.2
2.	Neem seed kernel powder (NSKP) + sand (1:2)	10.7
3.	Neem cake powder alone	16.7
4.	Neem cake powder (NCP) + sand (1:2)	15.3
5.	Klorocin (SBP) + sand (1:3)	10.1
6.	HCH l0% + sand (1:1)	9.9
7.	Naphthalene balls @ 3 balls/palm	8.6
8.	Untreated control	19.4
	CD (P = 0.05)	1.2

Table 2
Efficacy of chemicals against termite damage

S.No.	Treatments	Mean Protection on (%)	
		Palm Trunks	Plaited leaves
1.	Aldrin 30% @ 0.15%	100.0	97.3
		(90.0)	(80.6)
2.	HCH 50% WP @ 0.25%	100.0	96.7
		(90.0)	(79.6)
3.	Chlordane 20% EC @ 0.1%	100.0	97.1
		(90.0)	(80.3)
4.	Neem Oil (NO) 5%	94.6	80.0
		(75.6)	(63.4)
5.	Neem seed kernel extract (NSKE) 20%	92.7	79.0
		(74.6)	(62.7)
6.	Cashew-nut shell oil (CNSO) 80%	68.6)	79.7
			(63.2)
7.	Copper Sulphate (CuSo4 1%)	-	75.6
			(60.4)
8.	$CuSoE_4$ 1%; NO 5%	-	99.7
			(87.3)
9.	$CuSo_4$ 1%; NSKE 20%	-	98.2
			(82.4)
10.	$CuSo_4$ 1 %; CNSO 80%	-	100.0
			(90.0)
11.	Untreated control	0	0
		(4.8)	(4.8)
	CD (P = 0.05)	2.72	5.46

- Treatment not included Figures in parenthesis are arc sine transformed values.

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Efficacy of biorationals and Chlorantraniliprole against coconut rhinoceros beetle (*Oryctes rhinoceros* Linn.)

SM Wankhede, VV Shinde, SL Ghavale, A Joseph Rajkumar and HP Maheswarappa

Abstract
A novel botanical cake and paste developed by ICAR-CPCRI, neem cake admixed with sand, naphthalene balls and chlorantraniliprole sachets were evaluated against coconut rhinoceros beetle (*Oryctes rhinoceros*) on a three-year old juvenile palms (GBGD variety) at Ratnagiri during 2016-2019. Leaf damage by the pest during pre-treatment observation ranged from 10.2% to 16.2%. Palms treated with chlorantraniliprole (0.4%) GR @ 6g per palm and botanical cake and paste @ 15 g palm^{-1} registered lowest leaf damage of 7.0% and 8.5%, respectively. With respect to spear leaf, chlorantraniliprole and botanical cake and paste-treated palms recorded least damage of 8.3% and 12.2%, respectively. The study revealed supremacy of botanical cake and paste in the suppression of coconut rhinoceros beetle and is comparable with chlorantraniliprole treatment.

Keywords: Black beetle, botanical cake, eco-friendly pest management, naphthalene balls, neem cake

Introduction
Coconut (*Cocos nucifera* Linn.) is an important plantation crop grown in Konkan region of Maharashtra cultivated in a traditional manner with local varieties utilizing limited available resources. It has great socio–economic significance fostering livelihood security to more than 12 million marginal and small farmers globally. It provides basic needs such as food, drink, shelter, fuel, furniture, medicine, decorative materials to mankind [10]. Though, aptly eulogized as *Kalpavriksha*, it is depredated by a wide array of insect pests cussing severe crop loss. Coconut rhinoceros beetle (*Oryctes rhinoceros* Linn.) is a ubiquitous and cosmopolitan pest which causes tremendous damage to spear leaf and ultimately affect the palm health and nut yield. The adult beetles feed on the soft tissues of the growing region and make burrow holes on unopened fronds. The opened leaves show a characteristic 'V' shaped geometric cut and of late the pest incidence is quite severe on juvenile palms impairing good establishment during initial phase [7, 9]. Furthermore, attack on juvenile palms resulted in stunted growth and delayed flowering [5, 11]. A loss in yield of 5.5–9.1% due to beetle attack was estimated in Kerala, India [12]. Damage to spathe further cause reduction in coconut yield up to 10% in India [8]. The rhinoceros beetle attack leads to the secondary attack by red palm weevil and other pathogens which causes more severe damages or eventually leads to death of palm [1]. Since the initial establishment of juvenile palms is very critical for timely flowering and attaining good yield, the present investigation was carried out to evaluate different biorationals and chlorantraniliprole against rhinoceros beetle.

Materials and Methods
A field experiment was conducted at RCRS, Bhatye, Dist. Ratnagiri (M.S.) during 2016-19 to evaluate different biorationals and chlorantraniliprole against coconut rhinoceros beetle infesting juvenile palms. A total of 100 palms of three year old GBGD variety were selected for the experiment. Five treatments with four replication were imposed *viz.*, T1-Botanical cake (June, Oct and Feb) + paste (August, December and April) @ 15g/palm, T2-Neem cake + sand (150 g each) to be filled in the innermost leaf axils - once in 4 months (June, Oct, Feb), T3-placement of naphthalene balls on the innermost leaf axils @ 12g/palm once in 2 months (June, Aug, Oct, Dec, Feb, April), T4-placement of chlorantraniliprole (0.4%) GR in perforated sachets in the innermost leaf axils @ 6g per palm once in 4 months (June, Oct, Feb)

and T5-untreated control in randomized block design. The observations on rhinoceros beetle incidence in term of leaf (Infested leaf x100/ total leaf) and spindle damage (Infested spindle x100/ total palm spindle) were recorded one day before as pre-treatment observations. The post-treatment observations were observed in the month of June, September, December and March at every year. The generated data were subjected to ANOVA and means are separated by Least Significant Difference.

Results and Discussions

The data presented in Table 1 revealed that the pre-treatment observation on leaf damage in different treatments ranged from 10.1% to 16.2%. During March 2017, the minimum leaf damage was observed in palms treated with botanical cake with paste (6%) followed by T4 chlorantraniliprole-treated palms (7.2%) which was significantly superior to other treatments. Placement of two tablet shaped botanical cakes on the top most leaf axils reduced leaf damage by 54 per cent and was found superior to chlorantraniliprole sachets (34%)-treated palms in subduing rhinoceros beetle attack in Kerala. The botanical cake and paste swiped on the spear leaf @ 10g/palm was found to safeguard juvenile palms for about two months from rhinoceros beetle attack [3]. All the treatments registered non-significant pest reduction during June 2017. Palms treated with chlorantraniliprole recorded minimum leaf damage (8.9%) and was found significantly superior over control (27.6%). However, it was on par with placement of botanical cake and smearing of paste (9.8%), followed by naphthalene balls (14.41%) and neem cake (21.1%) noticed in September, 2017. Observations recorded during December, 2017 indicated that chlorantraniliprole-treated palms showed 8.3 per cent leaf followed by botanical cake and paste (15.9%). The naphthalene balls and neem cake-treated palms recorded 16.9 and 22.8 per cent leaf damage, respectively. During March, 2018, palms treated with chlorantraniliprole registered the least leaf damage (5.8%) which was significantly superior over control (10.6%) and on par with botanical cake and paste (7.3%), neem cake (8.5%) and naphthalene balls (8.8%). Similar trends of effectiveness of treatments were noticed during June, September, December 2018 and March, 2019. The overall mean data of three year indicated that the palms treated with chlorantraniliprole registered the least leaf damage (6.9%). This agrees with the findings that placement of chlorantraniliprole 0.4% GR insecticides admixed with 100-150g sand registered least leaf and spindle damage in coconut [6]. It was also found significantly superior over neem cake + sand (12.9%) and untreated control (17.8%) and on par with botanical cake and paste (8.4%) and naphthalene balls (11.2%). The high rate of mortality of the rhinoceros grubs was recorded in neem cake followed by *A. squamosa* powder under semi field condition [18]. The next effective treatment was found as botanical cake + paste (8.4%) which was significantly superior over untreated control (17.8%). Among the different insecticides tested in farmers fields, chlorpyriphos (1.5%) DP and chlorantraniliprole (0.4%) GR insecticides along with 100-150 gram of sand were found effective in reducing the leaf and spindle damage and comparable with phorate 10 G insecticide [16]. Palms treated with naphthalene balls and neem cake with sand recorded 11.2 and 12.9 per cent leaf damage. It was further indicated that significant control of rhinoceros beetle was observed on palms when five naphthalene balls were placed in top most leaf axils [15]. Placement of naphthalene balls @ 10 to 12 g per palm in the innermost leaf axil once in 45 days could manage the rhinoceros beetle damage successfully [17].

Table 1: Effect of biorationals with Chlorantraniliprole for the Management of Coconut Rhinoceros beetle in Maharashtra during 2016-19

Treatments	Leaf Damage (%) by rhinoceros beetle										
	Dec. 2016 (PTC)	March 2017 (3 MAT)	June 2017 (6 MAT)	Sept. 2017 (9 MAT)	Dec. 2017 (12 MAT)	March 2018 (15 MAT)	June, 2018 (21 MAT)	Sept, 2018 (24 MAT)	Dec, 2018 (27 MAT)	March, 2019 (30 MAT)	Mean
T1 - Botanical cake 2-3 + paste@ 15g each/palm	10.2 (18.5)	6.0 (12.1)	15.6 (22.1)	9.8 (17.3)	15.9 (23.3)	7.3 (15.7)	8.3 (15.9)	6.4 (14.3)	3.7 (10.7)	3.2 (10.3)	8.4 (15.7)
T2 - Neem cake+ sand @150 g each/ palm	12.2 (20.4)	11.7 (18.9)	24.1 (28.0)	21.1 (26.9)	22.8 (28.4)	8.5 (16.9)	12.5 (20.2)	7.0 (15.3)	4.3 (11.9)	4.7 (12.4)	12.9 (19.8)
T3 -Naphthalene balls @12g/palm	16.2 (23.7)	10.4 (17.8)	25.5 (29.7)	14.41 (21.0)	16.9 (23.8)	8.8 (16.7)	10.1 (17.2)	6.9 (15.2)	3.7 (11.1)	4.5 (12.2)	11.2 (18.3)
T4 -Chlorantraniliprole 0.4GR @ 6g/palm	11.8 (20.0)	7.2 (13.1)	15.3 (22.9)	8.9 (15.8)	8.3 (11.8)	5.8 (13.8)	8.2 (14.2)	4.0 (11.4)	2.8 (8.3)	2.3 (8.6)	6.9 (13.3)
T5 – Control	12.4 (20.5)	13.1 (20.4)	30.7 (33.5)	27.6 (31.6)	25.6 (30.1)	10.6 (19.0)	15.3 (23.0)	11.7 (19.9)	13.0 (21.3)	13.4 (21.1)	17.8 (24.4)
S.E ±	2.23	4.1	4.32	3.6	3.7	1.59	3.50	1.12	1.6	0.97	2.06
CD at 5%	N.S.	N.S.	N.S.	11.07	11.20	4.92	N.S.	3.47	5.02	3.00	6.41

(Figures in parenthesis are arc sine transformed value)

With regard to spindle damage, the pre- treatment observation ranged from 30 to 40 per cent among different treatments. During March, 2017, the lowest spindle damage was observed with chlorantraniliprole-treated palms (20%), followed by botanical cake with paste (25%), neem cake (30%) and naphthalene balls (35%). Maximum spindle damage was noticed in control (40%). There was no significant difference among the treatments in June, 2017. The minimum spindle damage (5%) was observed in chlorantraniliprole treated palms which was found to be significantly superior over neem cake (25%) and untreated control (35%). The next effective treatments were botanical cake with paste and naphthalene balls which recorded 10% and 15% spindle damage, respectively in September 2017. The application of oil cakes of neem (*Azadirachta indica,* Meliaceae) or marotti (*Hydnocarpus wightiana,* Bixaceae) in powder form @ 250 g mixed with equal volume of sand, thrice a year to the base of the spindle leaf of coconut palm is an effective prophylactic method against rhinoceros beetle and red palm weevil [4]. Mixture of either neem seed powder + sand (1:2) at 150 g per palm or neem seed kernel powder + sand (1:2) at 150 g per palm applied in the base of three innermost leaves in the crown effectively controlled RB damage [13]. During December, 2017, the lowest spindle damage (5%) was

recorded in chlorantraniliprole sachet treated palms which was on par with botanical cake and paste (10%) and neem cake (15%). Palms treated with naphthalene balls recorded 25 per cent spindle damage. All the treatments were significantly superior over untreated control (35%). The palms treated with chlorantraniliprole recorded minimum spindle damage (5%) followed by botanical cake with paste (10%), naphthalene balls (15%) and neem cake (25%). Similar trends of effectiveness of treatments were noticed during June, September, December 2018 and March, 2019. The overall mean data of three years revealed that the chlorantraniliprole treated palms registered the least spindle damage (8.3%) which was significantly superior over control (32.7%). It was at par with botanical cake + paste (12.2%), naphthalene balls (18.8%) and neem cake (20.5%). The repellant action of naphthalene balls was significantly superior over conventional insecticides such as HCH (10%), Carbofuran or Phorate [14]. Chlorantraniliprole was reported as an effective component of integrated pest and pollinator management programs on woody ornamentals [2].

Table 2: Effect of biorationals with Chlorantraniliprole for the Management of Coconut Rhinoceros beetle in Maharashtra during 2016-19

Treatments	Spear leaf damage (%) by rhinoceros beetle										
	Dec. 2016 (PTC)	March 2017 (3 MAT)	June 2017 (6 MAT)	Sept. 2017 (9 MAT)	Dec. 2017 (12 MAT)	March 2018 (15 MAT)	June, 2018 (21 MAT)	Sept, 2018 (24 MAT)	Dec, 2018 (27 MAT)	March, 2019 (30 MAT)	Mean
T1 - Botanical cake 2-3 + paste@ 15g each/palm	35.0 (35.7)	25.0 (29.1)	10.0 (13.2)	10.0 (9.8)	10.0 (13.2)	15.0 (19.1)	10.0 (9.8)	15.0 (16.4)	10.0 (13.2)	5.0 (6.6)	12.2 (14.4)
T2 - Neem cake+ sand @150 g each/ palm	30.0 (32.6)	30.0 (32.9)	15.0 (19.9)	25.0 (25.9)	15.0 (19.9)	25.0 (25.9)	20.0 (23.0)	25.0 (26.2)	20.0 (23.0)	10.0 (13.2)	20.5 (23.3)
T3 -Naphthalene balls @12g/palm	40.0 (39.2)	35.0 (36.0)	10.0 (13.2)	15.0 (19.9)	25.0 (29.7)	15.0 (16.4)	20.0 (23.0)	20.0 (23.0)	15.0 (19.9)	15.0 (16.4)	18.8 (22.0)
T4 -Chlorantraniliprole 0.4GR @ 6g/palm	30.0 (32.9)	20.0 (26.5)	5.0 (6.6)	5.0 (6.6)	5.0 (6.6)	5.0 (6.6)	15.0 (16.4)	5.0 (6.6)	10.0 (13.2)	5.0 (6.6)	8.3 (10.6)
T5 – Control	35.0 (35.7)	40.0 (39.2)	20.0 (23.0)	35.0 (32.3)	35.0 (35.7)	35.0 (32.3)	30.0 (32.9)	40.0 (38.9)	30.0 (29.1)	30.0 (32.9)	32.7 (32.9)
S.E ±	2.7	2.5	7.6	5.8	4.4	7.8	6.0	8.5	9.0	7.7	6.1
CD at 5%	N.S.	7.5	N.S.	17.0	13.2	24.0	18.3	26.1	N.S.	23.2	18.4

(Figures in parenthesis are arc sine transformed value)

Conclusion

Among the treatments, palms treated with chlorantraniliprole was found to be most effective in reducing leaf and spindle damage by coconut rhinoceros beetle. However, among the biorationals attempted in the study, botanical cake and paste treated palms was found to be effective in pest suppression which is also an eco-friendly alternative for the prophylactic management of the rhinoceros beetle in coconut.

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References

1. Bedford GO. Biology, ecology and control of palm rhinoceros beetle. Annual Review of Entomology 1980;25:309-339.
2. Carl T Redmond, Daniel A Potter. Chlorantraniliprole: Reduced-risk insecticide for controlling insect pests of woody ornamentals with low hazard to bees. Arboriculture & Urban Forestry 2017;43(6):242-256.
3. Chandrika M, Joseph Rajkumar A. In: ICAR-CPCRI, 2016. Annual Report, ICAR-Central Plantation Crops Research Institute Kasaragod – 671124, Kerala, India, 2016, 210.
4. Chandrika M, Nair CPR, Rajan P. Scope of botanical insecticides in the management of *Oryctes rhinoceros* (Linn.) and *Rhynchoporus ferrugineus* (Oliv.) affecting coconut palm. Entomon 2001;26:47-51.
5. Howard FW, Moore D, Giblin-Davis RM, Abad RG. Insect on palms. CAB International, London 2001, 400
6. Joseph Rajkumar A, Chandrika M, Rajan P, Regi JT, Chandramohanan R, Jacob PM. Pest Management in Coconut Nursery. Technical Bulletin No. 73. Central Plantation Crops Research Institute Kasaragod, Kerala 2012, 16.
7. Josephrajkumar A, Chandrika Mohan, Krishnakumar V. Management of rhinoceros beetle. Indian Coconut J 2015;58(7):21-23.
8. Nair MRGK. Insects and mites of crops of India. Indian Council of Agricultural Research, New Delhi 1986, 83.
9. Nirula KK. Investigations on the pests of coconut palm. Part II. *Oryctes* rhinoceros Linn. Indian Coconut J 1955;8:161-180.
10. Punchihewa PG, Arancon RN. Coconut Post-harvest Operations. Asian and Pacific Coconut Community (APCC) www.apcc.org.sg 1999, 2.
11. Rajan P, Chandrika Mohan, Nair CPR, Josephrajkumar A. Integrated pest management in coconut. Technical Bulletin 55. ICAR-CPCRI, Regional Station, Kayamkulam 2009, 20.
12. Ramachandran CP, Kurian C, Mathew J. Assessment of damage to coconut due to *Oryctes rhinoceros* Linn.- Nature and damage caused by the beetle and factors involved in the estimation of loss. Indian Coconut J 1963;17:3-12.
13. Ramaraju K, Pretheep Kumar P. Controlling rhinoceros beetle in coconut: India. Tamil Nadu Agricultural University, Coimbatore, In: The Hindu" July 7th, Chennai, India. http:/ / www.hindu.com/seta/2005/07/07/stories/ 2005070700121700.htm.
14. Sadakathulla S, Ramachandran TK. Efficacy of naphthalene balls in the control of rhinoceros beetle attacks in coconut. COCOS 1990;8:23-25.
15. Singh G. Naphthalene balls for the protection of coconut and oil palms against *Oryctes rhinoceros*. Planter 1987;

63:286-292.
16. Srinivasan T, Shoba N. Evaluation of alternate insecticides for the management of rhinoceros beetle (*Oryctes rhinoceros* L.) in coconut ecosystems. Madras Agricultural Journal 2017;104(1-3):68-71.
17. Srinivasan T, Rajamanickam K, Chandrika M, Maheswarappa HP. Validation of integrated pest management strategy against coconut rhinoceros beetle, *Oryctes rhinoceros* L. (Scarabaeidae: Coleoptera). Journal of Plantation Crops 2018;46(1):8-11.
18. Suhasini V, Balamurugan G, Arivudainambi S. Efficacy of Certain botanicals against the grubs of coconut rhinoceros beetle, *Oryctes rhinoceros* (L). (Scarabaeidae: Coleoptera). International Journal of Entomology Research 2017;2(3):01-03.

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Efficacy of Certain botanicals against the grubs of coconut rhinoceros beetle, *Oryctes rhinoceros* (L). (Scarabaeidae: Coleoptera)

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Abstract
To manage the grubs of *O. rhinoceros* which are developing in Farm yard manure an experiment was conducted in Semi field condition using neem emulsion, neem oil emulsion, neem seed kernel extract, neem cake and leaf powder of *Annona squamosa* L. (Sugar apple) at various concentrations. High rate of mortality of the grubs was recorded in Neem cake followed by *A. squamosa* powder under semi field condition.

Keywords: rhinoceros beetle, neem emulsion, neem oil emulsion, neem seed kernel extract, neem cake and *a. squamosa*

1. Introduction
Oryctes rhinoceros L. is an important pest of the coconut palm (Catley, 1969) [1]. Coconut palm is growing in more than 90 countries of the world. Traditional area of coconut cultivation in India are the states of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Orissa, West Bengal, Maharashtra the islands of Lakshadweep and Andaman and Nicobar (Coconut development board, 2015) [2]. Larva of *O. rhinoceros* develops in manure pit but adults bore into the unopened fronds and spathes. The fully opened fronds showing characteristics of diamond shaped or V-shaped cut. Frequent infestation results in stunting of trees and death of growing point (Sadakathulla and Ramachandran, 1990) [7]. It also attacks inflorescence and causes 26% loss of the fruits in a bunch (Ponnamma *et al.*, 2001) [5]. Management of larval stages by using insecticides is laborious process and addition of insecticides to the farm yard manure may not support organic farming. Hence Botanicals were tested.

In the present study Neem products and *A. squamosa* (Annonaceae) were tried against larvae of *O. rhinoceros* under semi field conditions.

Different parts of *A. squamosa* is used in folkloric medicine for the treatment of various diseases (Suresh *et al.*, 2006) [9]. It is commonly called custard apple (Raj Sobiya *et al.*, 2009) [6].

2. Materials and Methods
Azadirachtin (0.15% ppm) based neem emulsion, neem oil emulsion and neem cake were obtained from the commercial markets.

Neem seed kernel extract was prepared using standard method (TNAU, agriportal, 2016) [10]. The fresh leaves of *A. squamosa* was collected, washed, dried and made into fine powders. These procedure and prepared botanicals were tested against 3rd instar larvae of *O. rhinoceros* under semi field conditions in the pot culture yard of Department of Entomology, Faculty of Agriculture, Annamalai University. *O. rhinoceros* larvae were obtained from laboratory culture.

2.1 Culturing of *O. rhinoceros*
To start the culture, around 50 numbers pupae of *O. rhinoceros* were collected from the heaps of farmyard manure at the animal house, Department of Animal Husbandry, Annamalai University. Collected pupae were placed into round plastic basins of 30cm diameter and 10cm deep, which contained 1kg of a mixture of powdered cow dung and coir pith dust @ 5:1ratio and the mouth of the basins were covered using khada cloth and secured tightly by elastic bands. The culture was maintained under the laboratory at 26±2°C temperature and 70±5% relative humidity. From pupae to adult, it took an average of 34 days. Emerged adults were differentiated based on the abdominal characters such as presence of fuzzy hairs at the tip of the abdomen (female) and smooth and shiny abdomen (male). The sexed adults were released @ 1:1 ratio into transparent round plastic rearing containers of 20 x 20cm in size (diameter and height). Two pairs of adults were introduced per container and ten such containers were maintained in the laboratory. The mouths of the containers were closed with perforated lids. The rearing containers were filled with a layer (3cm thick) of fine sand then by a layer (5cm thick) of coir dust before the introduction of adults. Fresh pieces of coconut frond and pineapple slices were provided as food for adults and reared until death.The average longevity of adults under the laboratory condition was seventy days. After ten days, two cups (100g capacity each) of semi dried farmyard manure were kept per container, as the substrate for egg laying. Once in a week the containers were cleaned. The contents were examined carefully and the eggs laid were separated and incubated until hatching. The eggs were observed under 10x. Average fecundity recorded was 52 eggs/ female. It took an average of 10 days to hatch.

Newly hatched grubs were reared in the laboratory for ten days on semi dried farmyard manure, and then transferred to the heaps of farm yard manure maintained in the pot-culture yard to rear the grubs under semi field conditions. Farmyard manure heaps were prepared for a height of 2.5 feet with a diameter of

3 feet and covered all the sides using nylon mesh. Water was sprinkled daily over the heaps to maintain optimum moisture. Grubs were maintained under semi field conditions until pupation and then recycled as described earlier. Whenever needed grubs of same ages were used in the experiments.

2.2 Bioassay [Semi field]

Round cement pots of 60 x 60cm were filled with two kilograms of semi dried farmyard manure and mixed with selected botanicals at various concentrations such as 20 and 25% of neem emulsion, neem oil emulsion, NSKE (each 50 and 100ml/kg of feed), neem cake 100, 150 and 200g kg of feed and *A. squamosa* 150 and 200g kg of feed. Five numbers of third instar were released in each pot and entire pot was covered using nylon mesh and secured. Each treatment was replicated three times. Observations were done once in 48h and mortality was recorded up to 30 days after treatment. Then the cumulative mortality was worked out.

2.3 Statistical analysis

Analysis was done with ANOVA under completely randomised block design and the means values were compared by following Duncan's multiple range test (DMRT) AT P = 0.05 (Gomez and Gomez, 1984) [3]. Necessary data transformation was made before analysis and the computer based OPSTAT package was used for the calculation.

3. Results and Discussion

The cumulative larval mortality in this experiment is observed higher in neem cake followed by *Annona squamosa*.

In which the highest dose in neem cake @ 200g/kg of feed and in *A. squamosa* @ 200g/kg of feed recorded maximum per cent of cumulative larval mortality.

The third effective botanical was NSKE. Neem oil and azadirachtin based neem emulsion were less effective among all the botanicals.

Our findings are partially in accordance with the finding of Mohan and Padmanaban (2013) [4] who reported LC_{50} (96hours) for the larvae of *O. rhinoceros* were 29.5% for neem cake powder, 24.5% for neem oil and 14.9%.

And for the other botanicals our findings are in corroboration with the report of Sreelatha and Geetha (2012) [8] who explained *A. squamosa* Leaf powder as an effective material in causing larval mortality, pupal mortality and adult formation.

Table 1: Efficacy of selected doses of botanicals against 3rd instar of *O. rhinoceros*

Treatment	Dose/kg of feed	*Percent Cumulative mortality
T_1	Neem emulsion @ 100ml (20%)	46.67 (43.07)^b
T_2	Neem emulsion @ 100ml (25%)	50.33 (45.17)^c
T_3	Neem oil emulsion @ 100ml (20%)	45.67 (42.50)^b
T_4	Neem oil emulsion @ 100ml (25%)	52.67 (46.51)^d
T_5	NSKE (20%) @ 100ml	53.33 (46.70)^d
T_6	NSKE (25%) @ 50ml	51.33 (45.75)^{cd}
T_7	NSKE (25%) @ 100ml/kg	63.00 (52.52)^g
T_8	Neem cake @ 100g	55.67 (48.23)^e
T_9	Neem cake @ 150g	68.33 (55.74)^h
T_{10}	Neem cake @ 200g	79.67 (63.18)^j
T_{11}	*A. Squamosa* @ 150g	58.67 (49.97)^f
T_{12}	*A. Squamosa* @ 200g	72.33 (58.26)^i
T_{13}	Control	0.00 (0.00)^a
	SEd	0.56
	CD(0.05)	1.16

* Mean of 3 replications

Values in parenthesis are arc transformed (x + 0.5)

Values with various alphabets differ significantly.

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5. Reference

1. Catley A. The coconut rhinoceros beetle *Oryctes rhinoceros* (L.) [Coleoptera Scarabaeidae: Dynastinae]. Pest Articles and News Summaries. 1969; 15(1):18-30.
2. Coconut Development Board. Coconut Cultivation". Coconut Development Board, Government of India, 2017b, www. https://en.wikipedia.org/wiki/Coconut. Acc essed on 03 March, 2017.
3. Gomez KA, Gomez AA. Statistical procedures for agricultural Research. John Wiley & Sons Singapore, 1984, 680.
4. Mohan K, Padmanaban AM. Biotoxicity assay of neem (*Azadirachta indica*) products and distillery effluent on the third instar larvae of coconut rhinoceros beetle, *Oryctes rhinoceros*. International Journal of Pharmacology and Bio Sciences. 2013; 4(4):102-110.
5. Ponnamma KN, Rethinam P, Lalitha N, Khan AS. Nature and extent of damage by rhinoceros beetle on oil palm bunches. International journal of Oil Palm. 2001; 2(2):31-33.
6. Raj Sobiya D, Vennila Jannet J, Aiyavu C, Panneerselvam. The heapato protective effect of alcoholic extract of *Annona squamosa* leaves on experimentally induced liver injury in swiss albino mice. International Journal of Integrative Biology. 2009; 5(3):182-186.

7. Sadakathulla S, Ramachandran TK. Efficacy of naphthalene balls in the control of rhinoceros beetle attacks in coconut. *COCOS.* 1990; 8:23-25.
8. Sreelatha C, Geetha PR. Pesticidal effects of *Annona squamosa* L. on male *Oryctes rhinoceros* Linn. (Coleoptera: Scarabaeidae) in relation to reproduction. *Current Biotica.* 2012; 6(1):8-21.
9. Suresh K, Mamoharan S, Panjamurthy K, Kavitak. Chemopreventive and antilipidperoxidative efficiency of *Annona squamosa* bark extract, Pakistan journal of Biological sciences. 2006; 9(14):2600-2605.
10. TNAU. Agriportal, 2017. Vikaspedia: www.http://vikaspedia.in/agriculture/agri-inputs/bio-inputs/production-of-ipm-inputs/neem-seed-kernal-extract-nske. Accessed on 01 April 2017.

COOPERATIVE EXTENSION
UNIVERSITY OF HAWAI'I AT MĀNOA
COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES

Preliminary Trials on Use of Essential Oils for IPM of Coconut Rhinoceros Beetle

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December 2023

BACKGROUND

Coconut Rhinoceros Beetle (*Oryctes rhinoceros* L., CRB) was first detected on O'ahu in 2013 but since then has become a major pest of coconut and palm species. CRB eat the meristem (e.g., growing tissue) located in the middle of the palm crown, causing either leaf damage or possibly complete crown death. Management of CRB can take an integrated pest management (IPM) approach of various preventative, cultural, physical, biological, or chemical practices. Current management focuses on the palm tree to target adults with the use of synthetic insecticide sprays, injections, or soil drenching. However, practices to control CRB can be limited for certain growers who do not use synthetic insecticides.

Essential oils have been reported in India to cause mortality of CRB larvae and adults. Preliminary trials on O'ahu indicated that essential oils have the potential to be used as an IPM practice for CRB management (Fig. 1). Below are results from preliminary trials for use of essential oil on CRB control.

OIL TYPES AND RESULTS FROM PREVIOUS STUDIES

Previous research from India (Ravindran et al, 2019) revealed that essential oils extracted from basil (*Ocimum basilicum*), eucalyptus citriodora (*Eucalyptus citriodora*), ajowan (*Trachyspermum ammi*) and thyme (thymol oil derived from *Thymus* sp.) caused electrophysiological response in the antennae of O. rhinoceros adults. Behavioral response of beetles was tested in 'Y' tube olfactometer having a choice between an odor arm containing essential oil and a control arm without essential oils. Over 70-85% of the beetles moved towards the control arm, indicating the potential of these essential oils to repel CRB. The same essential oils caused over 90% mortality when beetles were placed in containers lined with a 6% essential oil solution for 48 hours (Figure 1).

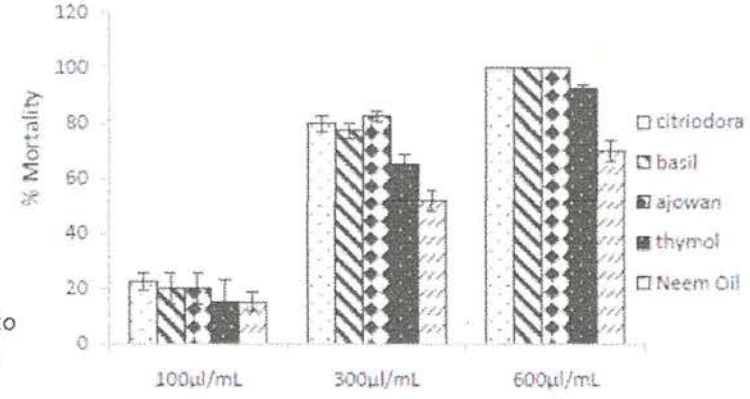

Fig. 1. Contact toxicity of essential oils to adult O. rhinoceros (Ravindran et al, 2019)

TRIALS IN OAHU

O'ahu County Cooperative Extension ran preliminary and controlled trials to evaluate the efficacy of the oils studied in India on CRB found in Hawaii.

PRELIMINARY FIELD TRIALS: EUCALYPTUS OIL SPRAYED AT COCONUT PALM CROWNS

On 11/02/2023, several coconut trees with CRB symptoms on the North Shore of O'ahu were trimmed and sprayed with a solution of 6% *Eucalyptus citriodora* oil and Excel 90 spreader-sticker at manufacturer's recommended rate (1/2 ounce per gallon). A 1-gallon pump sprayer was used to spray directly inside holes bored by CRB and to cover palm frond stems (Figure 2). Two beetles retreated from the crown of one palm. One beetle appeared dead once collected from the ground, while the second beetle was still alive and active. The beetles were transferred to an uncovered container and sprayed with the solution. Both beetles were dead 2 hours after sprayed with 6% solution of eucalyptus.

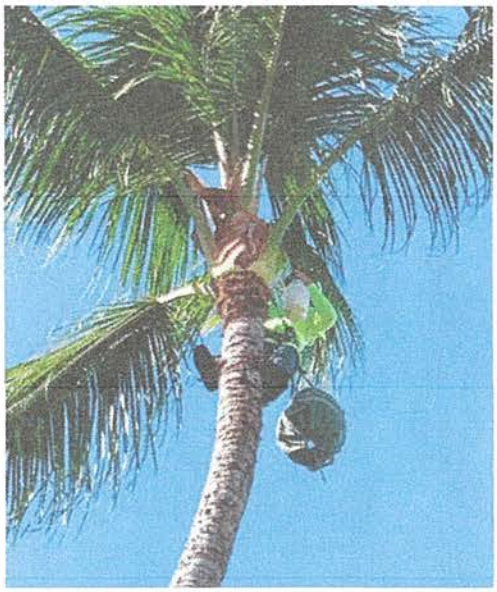

Fig. 2. Tree climber spraying the crown of a coconut palm crown with CRB damage using a pump sprayer.

On 11/16/2023, five coconut palms at the Department of Urban Forestry nursery in Waipi'o were trimmed and searched for CRB adults. Only one adult was found, placed on a jar, and lightly sprayed with 6% ajowan oil. The CRB beetle sprayed with 6% ajowan oil was reported dead 4 hours after spray.

CONTROLLED CONDITIONS TRIAL: CRB ADULTS AND LARVAE SPRAYED WITH BASIL AND EUCALYPTUS OIL

On 11/07/2023, CRB adult and larvae were collected from a mulch pile in Wai'anae. The mulch pile was approximately 40" tall, with a mix if chipped wood and leaves (Figure 3). Pitchforks and rakes were used to graze though the mulch. Most of the larvae were found in the bottom layer near ground level, in fine mulch and compost. Adults were mostly found in coarse mulch in the upper half of the pile. The collected CRB were kept with mulch, overnight, indoors, in coolers and buckets.

Fig. 3. CRB adults and larvae were collected from a mulch pile in Wai'anae, on the west side of O'ahu.

Adults and larvae were sorted and placed in containers for treatment approximately 18 hours after collection (Figures 4 and 5). At this point, less than 2.5% of adults (1 of 40) and larvae (2 of over 100) were dead (note: most of the dead specimens had signs of injury from collection).

CRB were sorted into 3 growing stages:

- Larvae 1st to 2nd instar, 5 larvae per container
- Larvae 3rd instar, 5 larvae per container
- Adults, 3 beetles per container

Treatments (3 repetition each):

- Control (tap water only)
- Basil essential oil 6% + spreader-sticker
- Eucalyptus citriodora essential oil 6% + spreader-sticker

Fig. 4. Trial setup.

Fig. 5. Larvae 1st to 2nd instar (left), larvae 3rd instar (center), and adults (right), ready for treatment.

Each container was treated with 3 sprays of the respective solution. Beetle mortality was assessed at 5, 10, and 30 minutes, and 1, 2, 3, 4, and 24 hours after treatment. Larvae mortality was assessed at 30 minutes, and 1, 2, 3, 4, and 24 hours after treatment.

On 11/09, 48 hours after the initial treatment, live beetles and larvae were treated again. They were transferred to a clean container, sprayed 5 five times to ensure the beetles were coated with the solution, and then transferred to the same container they were kept before, with clean mulch from the same mulch pile added to the containers. This was to simulate a beetle fully coated with the solution that retreated from the bored hole in the coconut crown then hid into mulch. The beetles and larvae were evaluated 3 hrs, 24 hrs, and 96 hrs after treatment.

Results from trial in controlled conditions

Larvae in 1st and 2nd Instar

Larvae in the 1st and 2nd instar sprayed with basil and eucalyptus oil had 73% and 100% mortality rate after 30 minutes, respectively, in the first treatment. Basil caused 100% mortality rate after 1 hr, also in the first treatment. Control treatment caused no mortality after 4 hours (all larvae in the control treatment remained alive).

Larvae in 3rd Instar

All larvae in the 3rd instar remained alive 48 hours after the first treatment. After 96 hours in the second treatment, basil caused 20% mortality rate (1 per replicate), and one larvae died in one of the control treatment replicate.

Beetles

All beetles remained alive 48 hours after the first treatment. This was unexpected, since previous research and preliminary field trials indicated that beetles were supposed to die. One hypothesis is that beetles were not sprayed with enough solution to cause their death. After the second and heavier treatment, all beetles in the control treatment remained alive and active after 96 hours. Basil caused 22% and 66% mortality rate after 24 hours and 96 hours (second treatment), respectively (figures 6 and 7). Eucalyptus oil caused only 1 beetle to die 24hrs after treatment. These results indicate that basil essential oil has the potential to be part of an Integrated Pest Management for control of CRB in Hawai'i, and further studies are necessary to confirm its efficacy and applicability to field use.

96 HRS Grouping Information Using the Tukey Method and 95% Confidence

Treatment	Mortality Mean	Grouping
Basil	66 %	A
Eucalyptus	11%	A B
Control	0	B

Means that do not share a letter are significantly different.

Fig. 6. CRB Adults mortality 96 hours after second treatment.

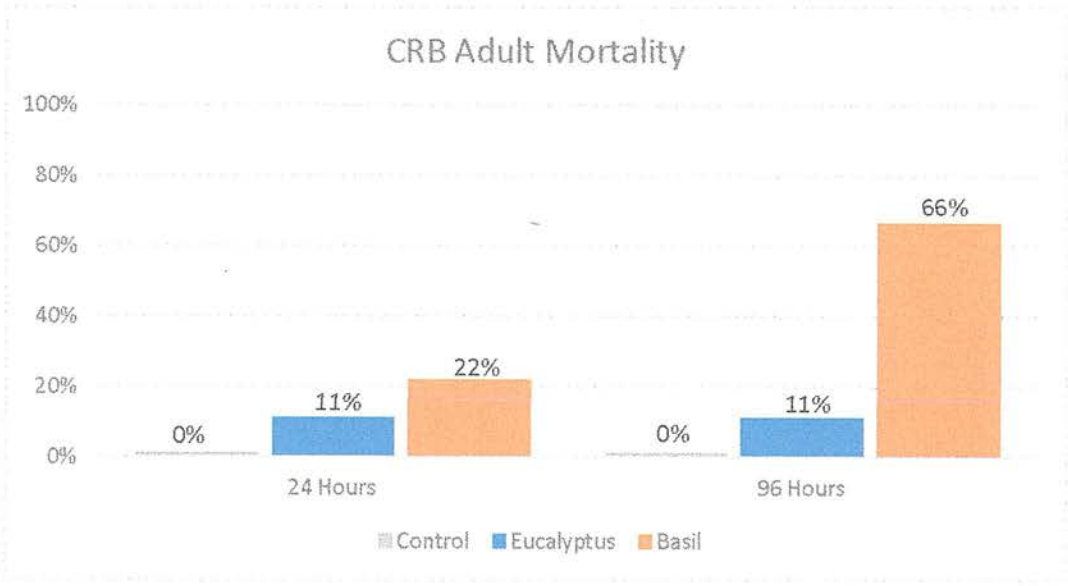

Fig. 7. CRB Adults mortality 24 and 96 hours after second treatment.

FUTURE WORK

As essential oil use is only one practice of an integrated pest management approach and *this is the first time it was evaluated in Hawai'i, future research is looking into field applications,* optimal concentration rates, and methods of application. Other products and essential oils must be tested to compare effectiveness, including clove, thyme, insect repellents, and pesticide rotation studies. Be on the lookout for news of these other IPM approaches in the pipeline.

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REFERENCES

Ravindran, P., Subaharan, K., Venugopal, V., Chandran, K. P., Prathibha, P. S., & Sujithra, M. (2019). Essential oil in management of coconut rhinoceros beetle Oryctes rhinoceros L. In Indian Journal of Entomology (Vol. 81, Issue 3, p. 603). Diva Enterprises Private Limited. https://doi.org/10.5958/0974-8172.2019.00136.6

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Efficacy of Naphthalene Balls in the Control of Rhinoceros Beetle Attacks in Coconut

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ABSTRACT

Different formulations of pesticides were applied to the base of inter-space of leaf sheath of the top-most three leaves in the crown of 42-month-old coconut seedlings to provide protection against attacks of rhinoceros beetle. Application of naphthalene balls (weighing 3.5 g each) at the rate of three balls per palm, one each to the base of three top-most leaf sheath, at 45-day intervals was found give 100% protection against the pest attacks. The repellant action of naphthalene was significantly superior to that given by conventional insecticides such as HCH 10%, Carbofuran or Phorate.

INTRODUCTION

The rhinoceros beetle, *Oryctes rhinoceros* L. (Scarabaeidae; Dynastinae) is one of the serious and important pests of coconut in all coconut growing countries. This beetle is widespread in all coconut growing areas of India. Besides coconut, it attacks and damages pineapple, sugarcane, palmyrah, date palm, African oil palm, tali-pot palm and royal palm. The adult beetle burrows and remains between leaf sheaths near the crown and cuts the leaf in the folded stage thereby causing permanent damage. When the attack is on the unopened spathe, the inflorescence becomes badly damaged and can cause 10 per cent annual reduction in yield. Frequent infestation results in reduction of leaves and stunting of trees. The damage can cause death in seedlings and young palms but adult palms can withstand infestations.

The practice of application of an insecticide/sand mixtures (1:1) containing insecticides such as chlordane 5% or aldrin 5% once in three months in the top-most three leaf axil inter-spaces, is yet effective. Although several workers (Abad *et al.*, 1982; Jayaraman, 1985) have reported the efficiency of newer insecticides, Singh (1987) obtained significant control of rhinoceros beetle on coconut and oil palm replants when naphthalene balls were inserted at the rate of five balls/plant into the frond axils. Use of biocontrol agents such as the virus, *Baculovirus oryctes* and the fungus, *Metarhizium anisopliae* have also been effective in some countries (Bedford, 1986; Zelazny, 1983).

This paper reports the work done on comparing the efficacy of naphthalene balls with some insecticides in controlling rhinoceros beetle attacks.

MATERIALS AND METHODS

The experiment was carried out at the Coconut Research Station of the Tamil Nadu Agricultural University, Veppankulam during 1988-89, in 3 1/2-year old coconut seedlings which were regularly attacked by rhinoceros beetle. The trial was laid out in RBD, replicated four times with seven treatments *viz.*, (1) HCH 10% and fine sand (1:1), (2) Carbofuran 3 g and fine sand (1:2), (3) Phorate 10 g + fine sand (1:2), (4) Carbofuran 3 g in empty gelatine capsule @ 3 capsules per seedling, (5) Phorate 10 g in empty gelatine casules @ 3 capsules/seedling, (6) Naphthalene balls @ 3 balls per seedling and (7) Untreated control.

Details of treatments

The mixtures of HCH 10% + fine sand (1:1) and granular insecticide + fine sand (1:2) were prepared using 50 g and 10 g of the insecticide, respectively. In the case of capsules, the empty gelatine medical capsules (weighing 0.11 g each) were procured and filled with 1 g of the granular insecticide per capsule and tightly closed with its cap. Three such capsules/seedling were applied. The diameter and weight of the naphthalene balls were 1.5 cm and 3.5 g respectively and were used at the rate of 3 balls per seedling. The naphthalene balls were replaced at 45-day intervals.

The treatments were applied to the base of the inter-space between the leaf sheaths of the three top-most leaves in the crown. Periodical observations at fortnightly intervals of the damage by the beetle *O. rhinoceros* were recorded and the cumulative protection computed.

RESULTS AND DISCUSSION

The degree of pest damage expressed as cumulative mean per cent protection, in the different treatments is given in Table 1.

Table 1- *Effect of different formulations against rhinoceros beetle*

Treatment	* *Cumulative mean per cent protection*	
HCH 10% + Fine sand (1:1)	92.3	(82.5)
Carbofuran 3G. @10g + fine sand (1:2)	85.5	(67.5)
Phorate 10G. @10g + fine sand (1:2)	85.5	(67.5)
Carbofuran 3G. @ 1g in capsule @ 3 capsules/palm	85.5	(67.5)
Phorate 10G. @ 1g in capsule @ 3 capsules/palm	85.5	(67.5)
Naphthalene balls @ 3 Nos./palm	100.0	(90.0)
Untreated (control)	6.7	(15.0)
LSD (P=0.05)	18.8	

Figures in parenthesis are transformed values. * mean of four replications.

Application of naphthalene balls at the rate of three balls per seedling to the base of leaf axils and repeated at 45-day interval was found to be the best treatment and was significantly superior ($p< 0.05$). This finding is in agreement with that of Singh (1987) wherein he used five naphthalene balls per palm. HCH 10% + fine sand (1:1) was the next best and all other treatments had similar effect.

This experiment clearly shows the efficacy of naphthalene balls in controlling rhinoceros beetle attacks. Application of naphthalene balls is quite easy and economical, compared to insecticide mixtures and affords effective protection against the rhinoceros beetle. The growers can apply naphthalene balls easily, even in the homegardens.

REFERENCES

Abad, R G., Gallego, C E and Aterrado, E D (1982) Evaluation of leaf axil placement of six granular insecticides against rhinoceros beetle (*Oryctes rhinoceros* L.) in young coconut palms. *Philip. J. Coc. Studies* 7(1-2): 23-27.

Bedford, G (1986) Biological control of rhinoceros beetle Agriculture, *Ecosystem and Environment* 15(2/3): 141-147.

Jayaraman, V (1985) Study on repellant action of phorate against rhinoceros beetle, *Oryctes rhinoceros* Lin. *In* Behavioural and Physiological Approaches in pest management". (Eds. A. Regupathy & S Jayaraj). Tamilnadu Agricultural University, Coimbatore; pp 116-119.

Singh G, (1987) Naphthalene balls for the protection of coconut and oil palms against *Oryctes rhinoceros*. *Planter* 63: 286-292.

Zelazny, B (1983) *Oryctes rhinoceros* damage on coconut palms in Maldives *FAO Plant Prot. Bull.* 31(3): 119-120.

Position Paper on Injecting Imidacloprid

I have been closely following the discussion around the use of neonicotinoids—particularly imidacloprid—for coconut rhinoceros beetle (CRB) management in Hawai'i. While I understand that trunk injection can be less harmful to non-target species than foliar sprays or soil drenches, I remain concerned about the scale and frequency of proposed applications. Injecting thousands of trees every six months for years could result in persistent residues in soils, potential leaching into coastal aquifers, and exposure risks for native and managed pollinators—especially if flower removal protocols are inconsistently applied. Hawai'i's unique biodiversity makes these risks particularly consequential.

I believe an effective CRB strategy can protect high-value and culturally important coconut palms while minimizing ecological trade-offs. I support targeted, temporary use of trunk-injected neonicotinoids under strict protocols—limited to documented cases or irreplaceable trees, with mandatory flower removal, and public reporting of pesticide use and monitoring results.

While trunk injection is more contained, a decade of biannual Imidacloprid treatments could lead to harmful consequences—notably to pollinators, soil microbes, aquatic life, and potentially entire ecosystems. Its systemic nature and long environmental persistence make it far from harmless, especially with repeated use.

How to Kill CRB with a Biological Insecticide

Biological insecticides are organisms that attack and kill insects, including the Coconut Rhinoceros Beetle (CRB).

The most available and effective biological insecticide for CRB in Hawaii are a living fungi called ***Metarhizium anisopliae*** (MA for short).

MA is widely used in agriculture, hydroponics, and gardening to reduce insect pests. Fungi like these are some of the most important natural enemies of beetles, especially when beetles get out of control, as they are in Hawaii today. These fungi help keep beetle populations balanced in the wild, but MA has become depleted in modern soils. Thus, we replenish them so they can do what they naturally do—kill beetles.

MA has been extensively tested in Hawaii against CRB and is highly effective, killing both adults and larvae in 3-10 days.

CRB spend most of their lives (11 months) in mulch piles and decaying vegetation. They spend only about 42 days in trees, feeding of heart of palm. So MA is applied to their home, the mulch and decaying vegetation, where they spend the large majority of their lives. You can spray it on your trees as well, but it likely won't get established there as it needs a damp, decaying place to thrive.

How MA Works

- Spores land on an beetle's body.
- The fungus penetrates the cuticle, grows inside the CRB, and produces toxins.
- The CRB dies in about a week, and the fungus emerges from the body, making new spores.
- This cycle can repeat, spreading naturally in mulch or soil.

Why We Like MA for CRB Control

- **Natural & organic**: Often certified for organic production (check the product label).
- **Safe for non-targets**: Doesn't harm bees, butterflies, earthworms, or humans.
- **Self-sustaining**: Can persist in soil and mulch for weeks to months under moist, shady conditions.

- **IPM-friendly**: Fits into Integrated Pest Management — can be combined with traps, mulching practices, or essential oil systems.

💡 How to Use MA for Controlling CRB

- Buy MA on Amazon or elsewhere. A one-pound bag of spores costs around $50 and goes a long way. On Amazon search for "MET MAER Metarhizium anisopliae" for instance. [There are other online providers, and some of them provide syringes of MA, useful especially if you'd like to propagate MA yourself.]
- Mix about 3 teaspoons of the spore powder per gallon of water into a pump sprayer, available for $15-$25 on Amazon.
- Spray everywhere on your land except where there's vegetation, except lawns. CRB loves regular garden soil and will even bore into bags of garden soil and lay their eggs.
- It will kill not only CRB but other beetles, like Japanese beetle and their larvae. Plus it kills ants, termites.
- Repeat the spray every month or so, to help MA get established. Once it's established, it will likely persist and provide protection for years.
- Form a hui with your neighbors and share the MA and the sprayer.

🌿 Why Isn't the State Using and Promoting MA

Multiple strains of MA are naturally present in Hawaiian ecosystems. Multiple studies prove this, and prove that MA is effective against CRB in Hawaii. And yet the State of Hawaii still says that MA is "Effective but not available/registered in Hawaii".

MA has been used by Hawaii gardeners and nurseries for decades (though, because it's not registered, nurseries can't advertise they use it).

MA is used to control CRB in every country in South Asia (where CRB originated). It is also used in Samoa, Tonga, and Fiji. It is technically "not approved" in Guam but it is known and used there as well. In Samoa "Introductions [of MA] dating back to 1913 still persist; growers sometimes re-apply local isolates, although products are not formally registered."

So, you decide, given the glacial pace of government, whether you'd like to wait a few years, or save your coconut trees today.

Repelling one breeder prevents hundreds of future beetles.

CRB Action Kaua'i
CRBAction.com

Essential Oil Deterrent Formula for Protection from CRB

Courtesy of Brown Cannon, SaveHawaiianPalms.com

This natural deterrent helps protect coconut palms by masking the odors that attract Coconut Rhinoceros Beetles (CRB) and making crown tissue unpleasant to chew or enter. Essential oils such as basil, clove, and neem overwhelm beetle scent receptors and interfere with attraction to palm sap or decaying tissue. Capsaicin, derived from hot-pepper extract (oleoresin capsicum), provides a mild irritant effect that discourages boring. The addition of a sticker or light oil helps the mixture cling to fronds, forming a temporary scent and texture barrier. While it does not kill beetles, regular use can interrupt their breeding cycle and reduce crown attack success when combined with sanitation, netting, and traps.

Essential Oil Recipe - Per 1 gallon of spray solution

- 3 oz. Basil Oil
- 1 oz. Clove Oil
- 1 oz. Neem Oil
- 60 drops of Premium Oleoresin Capsicum Extract
- 1 teaspoon Hi-Yield spreader sticker (or substitute with 1 tsp Castile soap plus 1-2 tbs melted or fractionated coconut oil)

Mixing Instructions - 1 Gallon Batch

1. Start with 1/2 gallon of water in a clean bucket.
2. Add basil, clove, and neem oils (see Safety note below)
3. Add capsicum drops.
4. Agitate for ~10 seconds, until the mixture turns cloudy.
5. Add Hi-Yield Spreader Sticker or 1 tsp Castile soap plus 1-2 tbs melted or fractionated coconut oil.
6. Add the remaining 1/2 gallon of water.
7. Stir or shake thoroughly before each application.

Application

- Spray the crown, frond bases, and upper trunk, avoiding heavy runoff.
- Apply early morning or late afternoon to minimize evaporation and avoid tissue stress.
- Reapply every 1–3 weeks, especially after rainfall or new frond emergence.
- Rotate essential oils occasionally (basil, clove, peppermint, lemongrass) to maintain potency.

Safety & Storage

- Essential-oil mixtures *should not* exceed a 6% concentration. Higher levels increase risk of phytotoxicity and offer *no* added benefit.
- Wear gloves and eye protection; capsaicin can irritate skin and eyes.
- Store in a cool, dark place away from heat and sunlight.

Please note:
Hi-Yield Spreader Sticker increases "stick" and shine, helping oils adhere to fronds and crown surfaces. It can slightly increase heat load on tissue if over-applied, so use it sparingly on coconut palms — about 1 teaspoon per gallon, less than general label rates. You do not need a separate emulsifier because neem oil naturally contains azadirachtin, limonoids, and natural saponins, which act as mild emulsifiers, allowing the essential oils and capsicum to blend smoothly into water when combined with a non-ionic surfactant such as Hi-Yield or coconut oil.

Best Results

This deterrent performs best when used as part of an Integrated Community Strategy that includes:

- Green-waste sanitation
- Crown netting or physical barriers
- Beetle trapping
- Neighborhood coordination

Why would Neem work?

Various neem extracts are known to act on various insects in the following ways;

- Disrupting or inhibiting the development of eggs, larvae, or pupae
- Blacking the molting of larvae or nymphs
- Disruption mating and sexual communication
- Repelling larvae and adults
- Deterring females from laying eggs
- Sterilizing adults
- Poisoning larvae and adults
- Deterring feeding
- Blocking the ability to"swallow"(that is, reducing the motility of the gut
- Sending metamorphosis awry at various stages
- Inhibiting the formation of chitin

KNF Food Fermented Plant Juice

Food is the king of all medicine. It perfectly mimics plant exudates. By combining multiple foods together the biology thinks there is a polyculture growing above it and avoid the problem of monoculture sickness.

Step 1: **Gather one species of plant material.**

Multiple species confuse microbes during fermentation. Do not wash off plant material, shake off any excess dirt. If you are interested in ample growth hormones gather only the growing tips and do this at dawn before the morning dew evaporates.

Step 2: **Mix as if in a cement mixer with 1/3-1/2 the weight of the plant material of sugar**

More sugar is needed if the material is sweeter and less if it is not sweet. Add sugar and stir to create enough osmotic pressure which is visible as the plants start to look like they are wilting/cooking, but not too much sugar to retard fermentation.

Step 3: **Pack tightly 2/3 into an appropriate vessel**

such as a jar or 5-35 gallon bucket.

Step 4: **Allow to ferment around room temperature for 3-4 days** or longer if the temperature is cooler.

Smell will change from fresh plant material to sweeter "slight alcohol smell" or mold will develop on the surface when fermentation is complete.

Step 5: **Collect the liquid and supersaturate**

for preservation by pouring off the liquid then adding sugar and stirring until a slight ring develops on the bottom of sugar settling out from over saturation.

Store in a cool place out of sunlight similar to wine or liquor for up to one year.

Which plants to choose?

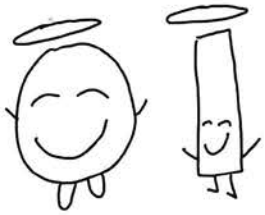
Want vegetative growth? Make food from tips of something that grows very vigorously. *Banana suckers, bamboo suckers*
Want to support the flowering stage? Make food from flowers or unripe fruits. *Banana flowers, unripe fallen fruits*
Want a food for the fruiting stage? Make food from one or three types of fruit with the same recipe but increase the amount of sugar to equal weight because fruits are so sweet.
Want something that is general purpose? Make food from a dynamic accumulator. *Comfrey, weeds native in your area*
Want to concentrate certain nutrients such as silica? Choose a plant that is high in that nutrient, such as horsetail for silica, then ferment that and use that extract!
Want to boost one particular plant? Make food from the same kind of plant!

Disgustingly Cheap Microbes

50 Gallon Recipe

A Terribly Low Cost Solution

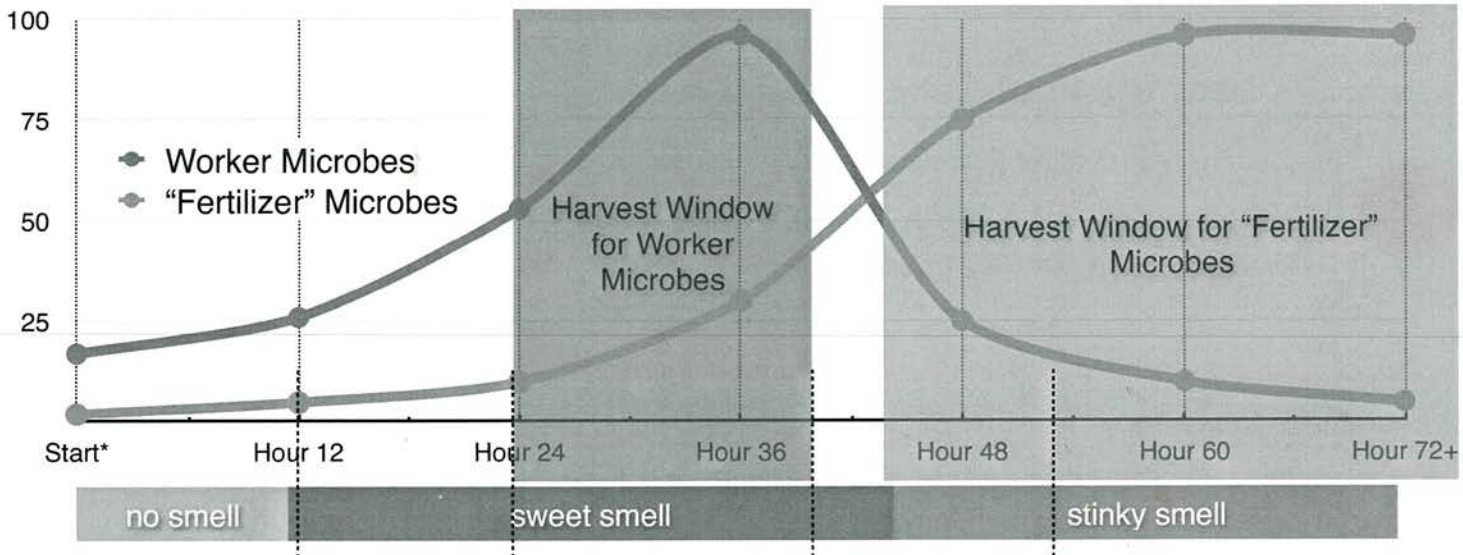
This recipe breeds Indigenous Soil Biology to be used in a liquid form

Water	Microbes	Food	Minerals
			
5 gallons of water	1 cup of rich indigenous soil	1 cup of boiled potato or starch	20 grams of sea salt

Recipe: Blend the above ingredients together. Ferment 24-40 hours* for worker microbes or 45+ hours* for fertilizer microbes. Dilute with 1:10 with water. Use immediately!!!

KNF

* Time will vary by temperature and type of starch used.



Bubble rings will appear on the surface and smell will change corresponding with microbial populations