

# Semiochemicals in management of coconut rhinoceros beetle and red palm weevil

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## Introduction

Being a perennial crop coconut palm is subjected to attack by array of pests round the year. Pests attack all parts of palm viz., leaves, stem, root, inflorescence and the nuts.

An alternative to conventional pesticides in pest management is the use of semiochemicals that deliver behavioral messages between organisms. Semiochemicals include pheromone (that aid in finding mates, food and habitat resources), allomone (favour the producer) and kairomone (favour the receiver).

In coconut production the major pests that influence the crop yield are rhinoceros beetle, *Oryctes rhinoceros*, red weevil, *Rhynchophorus ferrugineus*, Black headed leaf eating caterpillar, *Opisina arenosella*, eriophyid mite, *Aceria guerreronis* and white grub and *Leucopholis coneophora*. Chemoecological approaches are well exploited in management of key coleopteran pest of coconut viz., coconut rhinoceros beetle and red palm weevil.

## Coconut rhinoceros beetle, *O. rhinoceros*.

Coconut rhinoceros beetle, *O. rhinoceros* L. (Dynastidae : Coleoptera) is a major pest of coconut, *Cocos nucifera* L. and oil palm, *Elaeis guineensis* Jacq in South and South – East Asia and the Western Pacific Islands. Adult beetle feeds on the unopened fronds

of young and mature palms. The pest occurs round the year with a spike in population from June to September.

Large scale replanting program in root wilt disease affected districts of Kerala in Southern India has led to increased number of felled palms that are left in the field without being cleared or burnt. The decaying palms serve as suitable sites for egg laying and larval



Food bait in trap

feeding and such situation results in rise of the pest load. Damage by adult feeding on unopened fronds, reduces the photosynthetic area and renders them unsuitable for thatching purpose, spathe when damaged cause a crop loss upto 10 per cent. Previous host plant attack by *O. rhinoceros* facilitates lethal secondary attack by red palm weevil *Rhynchophorus ferrugineus*.

Removal and destruction of

dead and decaying palms eliminate the breeding site of beetles. Application of insecticide is effective, but in gardens with high densities of planting (175palms./ha) this operation increases the cost of labor and chemical. Using bioagents viz., *Metarhizium anisopliae* in breeding pits was effective but the requirement of RH in breeding pits to induce mycosis on grubs is a limiting factor in its use. Introduction of baculovirus *Rhabdinovirus Oryctes* had limited success. Exploiting the ethology of insect by using semiochemical is accepted as a component in insect pest management, as they are species specific and do not leave residues in the environment.

Adults of rhinoceros beetle aggregate in breeding site viz., decaying organic debris / compost / decaying palm trunk palm trunks to mate. This confirmed the volatile mediated attraction of the beetles to host volatiles or aggregation or sex pheromones.

Semiochemical based communication in rhinoceros beetles involve both aggregation and sex pheromone. Aggregation pheromone was effective when used in mass trapping. Male *O. rhinoceros* produce ethyl 4 - methyloctanoate and sex-specific compounds, ethyl 4-methylheptanoate, and 4-methyloctanoic acid both of which are least attractive in trapping the beetles at field level. They were less



bucket trap for Red weevil

effective compared to ethyl chrysanthemumate. Ethyl dihydrochrysanthemumate used in metal vane trap attracted *O. rhinoceros*.

Male produced aggregation pheromone ethyl 4- methyl octanoate is used as lure in buckets of 18 lit. capacity having black painted metal vanes. The pheromone sachet is hung on the diamond shaped hole made in the vane. The trap is hung on a pole at 3-4 cm above the ground level. Coconut petioles are placed in the bucket trap for better attraction of beetles. A collapsible bucket trap has been used for trapping rhinoceros beetles. The success of area wide trapping of rhinoceros beetle in Kerala, Karnataka, Tamilnadu and Andhra Pradesh has been demonstrated. The catches in the pheromone trap is female biased. As bucket traps are difficult to be handled at field level, the PVC traps baited with pheromone traps are being used currently. The PVC traps baited with ethyl 4- methyl octanoate are used @ one trap per ha.

The aggregation pheromone, ethyl 4- methyl octanoate is loaded into dispensers made of polymer

membrane/ sponges/ polypropylene / capillary tube for the release of the compounds. Polyethylene high density (PEHD) bag loaded with 800 mg of ethyl 4- methyl octanoate had a release rate of 4 – 12 mg/ day for first two months and it sharply declined to 0.12 mg/ day in fourth month and this necessitated replacement of lures every three months. Novel dispensing techniques involving the pheromone cum insecticide dallops have been used for attracting and killing the rhinoceros beetle. The pheromone traps are to be placed away from the young seedling.

### Coconut red palm weevil, *R. ferrugineus* (Oliver).

The red palm weevil (RPW), *R. ferrugineus* (Oliver) is distributed in Asia and Europe. The host range of the weevil includes coconut, oil palm, date palm and sago. The adult female oviposit on young, damaged, stressed and healthy palms. On hatching, the larvae bore into the palm and develop into adult in two months. The eggs, larvae and pupae of RPW are concealed and well protected, while the adults have a hard exoskeleton making it difficult for biocontrol agents.

Spatial distribution studies based on surveillance pheromone trap captures in coconut agroecosystems of Goa, have shown that RPW population is highly aggregated,

indicating that plantations in and around heavily infested gardens are prone to RPW attack and need to be protected. The major components of the IPM programme for RPW recommended in coconut are: surveillance, maintaining plant and field sanitation, preventive chemical treatment of wounds, filling the leaf axils of young palms with a mixture of insecticide and sand, curative chemical treatment of infested palm, cutting and burning of severely infested palms, trapping adults using food attractants (coconut log traps), cutting of leaves at a distance of one meter away from the leaf base and educating farmers and agricultural workers on palm weevil management.

Trapping the floating adult RPW population forms an effective component of the IPM strategy. Baiting coconut logs treated with coconut toddy, yeast and acetic acid were effective for trapping RPW. The difficulty faced in this technique is that they are labour intensive, require frequent replacement and their attractiveness varies considerably with environmental conditions.

Evidence of male produced aggregation pheromone was established in laboratory bio assay. Ferrugineol (4-methyl-5-nonanol) a major aggregation pheromone in RPW was synthesised and is being used in conjunction with 4-methyl-5-nonanone in trapping programmes. The pheromone lures are used to monitor the weevil incidence in newer areas, to mass trap in endemic areas and to assess the population level.

*R. ferrugineus* weevils are opportunistic oligophages to early fermentation volatiles like ethanol emanating from wounded host, on

feeding the palm tissue they produce an aggregation pheromone (4 methyl 5 nonanol) that attract their conspecifics. Food volatiles strongly enhance the attraction of *Rhynchophorus* species to aggregation pheromone.

In addition to aggregation pheromone the palm esters were identified as kairomones for palm weevils. The palm weevil adults are attracted to odors of variety of plant tissues (pineapple, banana and coconut) that are used as baits in traps. Among the complex pattern of odorants emitted by host plants, only a few key compounds are used to locate the host. The identification of natural volatiles emitted by host plants aided in development of synthetic blends (rhynchophorol + host volatiles) to trap *R. palmarum*.

Racemic nonanoic lactone and 4 hydroxy 3 methoxy styrene from the steam volatiles of coconut bark caused electrophysiological response of *R. ferrugineus* antennae. Ethyl acetate, and ethyl isobutyrate synergized attraction of *R. cruentatus* to cruentol. None of the palm esters tested in combination with the pheromone is as attractive as palm or sugarcane tissue. Coconut petioles in traps attracted maximum weevils when they were 2 - 5 days old, the catch declined thereafter as volatile profile changed due to fermentation. The proportional change in volatile from fermenting palm is attributed to abiotic conditions and microflora present. Fermented plant tissues produce a spectrum of odorants that are significantly different from those released by healthy plants. Fermented sap exuding from dead or wounded palms was highly

attractive to weevils. Moist fermenting tissue from various palm species, fruits, sugarcane, pineapple and molasses are similarly attractive to palm weevils. The efficiency of the kairomones in attracting insects depends on the odour quality and/or the amount released. Timing of volatile trapping to identify the compounds and their ratios in their matrix is essential to formulate an effective pherosynergistic blend.



PVC trap for rhinoceros

Acetoin a volatile product of anaerobic fermentation with ethyl acetate is an effective synergist with aggregation pheromone of *R. palmarum*. Stimulation by plant volatile blends excited three olfactory receptor neurons. Pheromone baited traps containing plant volatile blends attracted twice as many *R. palmarum* as that of control. Odors from plant tissue along with the aggregation pheromone that attract and orient the weevil from longer distances needs to be explored. Under a CDB

funded research project, efforts are underway to identify the volatiles from the food host that enhances the attraction of the red palm weevil pheromone.

Bucket traps containing pheromone lure and insecticide treated food bait is widely used to manage RPW in coconut plantations. Five litre capacity high density polyethylene buckets with four windows (1.5 x 5cm) cut equidistantly below the upper rim of the bucket are used as traps. Coconut fibre tied on the outer surface of the trap provide grip to the attracted weevils and facilitate their entry into the trap. The pheromone loaded in polymer membrane sachet is hung to the bucket lid from inside with a piece of wire. In the bucket trap the food bait mixed in one litre of water and to this the insecticide is added. The food volatiles released from the bait act synergistically with ferrugineol released from the pheromone sachet to enhance weevil captures. A trap density of 1 trap/ha is recommended for mass trapping, however, in endemic pockets, 2 traps/ha is recommended to be maintained.

Dispensers made of polymer membrane cardboard blocks and capillary tubes are used for loading RPW lure. The dispensers made of polymer membrane have release rate ranging from 3- 10 mg/day. Commercial lures are loaded in polymembrane dispensers and they have a release rate ranging from 2 - 20 mg / day. Dallops that attracts and kill the weevils when placed on palm trunk or its parts is developed. In an attempt to reduce the loss of the pheromone compound smart delivery devices are being developed at CPCRI.

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Though rhinoceros beetle and red palm weevil pheromone have been a success in attracting the pest, there are a few conditions to be satisfied for effective use of the lure. Avoid placing pheromone traps in close proximity to young palms, if placed adequate prophylactic measures are to be taken up. In case of red palm weevil the food bait placed in the bucket along with the lure is to be serviced at regular intervals.

Absence of water and insecticide / soap mix in the trap will allow the weevils entering into the bucket to escape. The traps are to be regularly monitored to collect and destroy the beetles and weevils trapped. In case of red palm weevil a community approach of using the traps to attract and kill the weevils is to be adopted for effective control.

Semiochemicals are a vital tool for monitoring and mass trapping in

plantation crops. Coconut being perennial crop, the pest occurs round the year. To depend on pesticides alone is a difficult task to contain the pest in terms of application in the target area and the frequency at which they have to be taken up. Using pheromone traps for monitoring and mass trapping are an eco friendly tool in IPM strategy that can be used with ease to contain the pest.