RHINOCEROS BEETLE (*ORYCTES RHINOCEROS* L.) AND ITS BIOCONTROL AGENTS

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

(Indian Council of Agricultural Research)

REGIONAL STATION, KAYANGULAM - 690 533, KERALA, INDIA

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(Indian Council of Agricultural Research)
REGIONAL STATION, KAYANGULAM - 690 533, KERALA, INDIA
Phone : Head : 0479 - 442004, PABX : 442160, 442104, KVK : 449268
Fax : 0479 - 445733, E-mail : cpcrikgm@vsnl.com

Published by

V. Rajagopal
Director
CPCRI
Kasaragod - 671 124

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Text by

CPR Nair
A. S. Sukumaran
Murali Gopal and
Chandrika Mohan

Edited by

Rohini Iyer

Photographs :

E. R. Ashokan

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Coconut palm damaged by rhinoceros beetle (inset : beetle)

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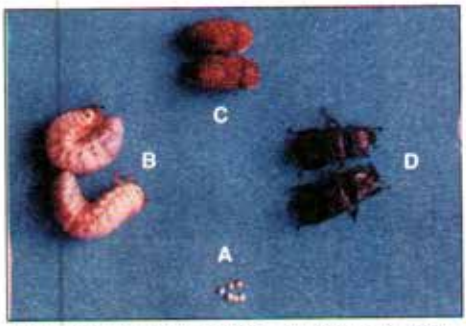
Introduction

Rhinoceros beetle has a wider distribution in all coconut growing regions of India. The pest is also reported from many countries in the southeast Asian region. The beetle is the destructive stage of the pest. In addition to coconut the beetle also feeds on several species of palms including oil palm, date palm, areca palm, palmyra palm, etc.

Biology of the pest

The adult beetle lays eggs in the decaying organic matter like cowdung pits, dead palm trunks, compost heaps, etc. In areas of coir processing the beetle also breeds on heaps of coir pith. Egg



Life stages : A. Eggs, B. Grabs, C. Pupae, D. Adults

period lasts for 8-14 days. The grubs feed on the decaying organic matter and the grub period lasts for 74-191 days with an average of 130 days. The moisture content in the breeding medium plays a vital role in the grub duration. The full-grown grub is yellowish white with brownish hairs on the body and has a brown head. Pupation takes place in a cocoon in the lowest strata of the breeding material and is completed in about 25- 30 days. The adult is a stout black beetle with a characteristic dorsal cephalic horn which is prominent in the males.

Nature of damage

The beetle bores through the unopened leaves and inflorescence. Damage on leaves causes 'V' shaped geometric cuts in the lamina and the damage on inflorescence results in the


Spathe damaged by rhinoceros beetle

drying up of the floral parts. Fresh chewed up fibers in the innermost leaf axils indicate fresh feeding and presence of the beetle inside the spindle leaf. The beetle damage also paves way for entry of the red weevil and also fungal diseases. Damage of spathe causes direct crop loss extending to the tune of 5.7%

on an average. Leaf damage results in indirect crop loss by reducing the photosynthetic efficiency of the palm due to reduced leaf area.

Management

An integrated pest management (IPM) approach is highly feasible and economical for managing the pest. Sanitational methods and biological suppression using pathogenic microorganisms are effective tools in the IPM package of the pest. Prompt disposal of prolific breeding grounds is the sanitational method that can be adopted by the farmers. Regular monitoring and disposal of breeding materials prevents enormous build up of the pest.

Biological control

The entomogenous fungus *Metarhizium anisopliae* (Metch) & Sorokin causes green muscardine disease in rhinoceros beetle population. The fungus is more prevalent during the high humid period from June to January. The pathogen is highly virulent and causes epizootics in the grub population in the breeding material. Mass culture of the fungus is possible and the fungal spores can be applied to the breeding material to prevent the pest population.

Stages of *Metarhizium* infection on *Oryctes* grubs

Infection by a Baculovirus disease also is prevalent in nature. Baculovirus of *Oryctes* has been described as a classical microbial control agent for the biosuppresssion of the beetle in many countries in southeast Asian and Pacific region. Use of these microbial control agents is advantageous because they are relatively host specific, do not cause environmental pollution, safe to humans and cattle and are compatible with other control methods.

Green muscardine fungus (*Metarhizium anisopliae*)

M. anisopliae var *major* is highly pathogenic to the *Oryctes* grubs. Due to fungal infection, the infected grubs become sluggish, stop feeding and die in about 10 to 15 days. The body of the infected grub becomes hard and a white powdery fungal colony appears on the body surface. Subsequently in a weeks time green coloured fungal spores are produced, the cadaver becomes black and mummified and the body disintegrates. The fungal infection results in the production of toxins affecting the host metabolism and final death of the host larva.

Mass multiplication of the fungus

Using coconut water as the medium a mass multiplication technique was developed in CPCRI. Coconut water supports better mycelial growth and sporulation of the fungus. The farmers themselves can adopt this method with some amount of training on the culturing of the fungus.

***Coconut water method*:**

1. Take 25-30 ml coconut water from mature nuts in flat-sided glass bottles, plug the mouth with cotton and sterilize them properly and transfer *M. anisopliae* spores into the bottles.
2. Incubate the bottles at room temperature or 28±2°C by keeping them flat on the incubator rack. After 25-30 days green coloured spore mass is produced.
3. Mix the spore mass in sterile water and spray it on the rhinoceros beetle breeding sites.

Metarhizium culture multiplied in coconut water

Field application:

Inoculam at the rate of $5x10^{11}$ spores/m^3 of breeding area of *Oryctes* gives a successful establishment of this fungus. Once the fungus establishes itself, it will survive in the breeding site for more than two years.

The cost of fungal inoculum required for the treatment of the breeding site works out to be Rs. 53.00 per cubic meter. It may be noted that once a breeding site is treated the grubs present there take up the infection and the spores of the fungal pathogen will survive in the breeding material for longer period up to two years.

***Oryctes* Baculovirus (OBV)**

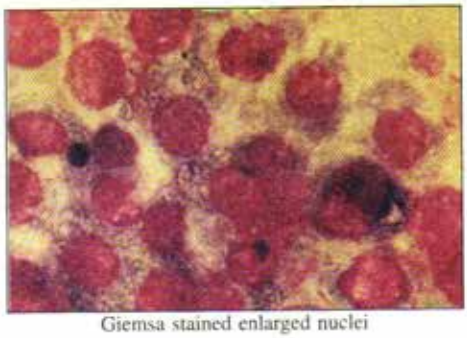
In the native rhinoceros beetle population 54% baculovirus infection was reported for the first time in India from Kerala. The infection by OBV results in reduction in the longevity of the beetles by about 40% and the total reduction in the fecundity of the beetles. Introduction of the pathogen in the natural habitat of the pest causes epizootics in the pest population, leads to significant reduction in the larval population in the breeding sites and resultant reduction in the beetle damage on the coconut palms. The OBV infection in beetle shall maintain the pest population at a very low level for 10-15 years. In India success stories have been documented on the efficacy of the

pathogen by suppression of the beetle in Laskhadweep Islands, Andaman Islands and also in places like Chittilapally, Kayamkulam and Kasaragod in the main land in Kerala.

The virus mainly infects the nuclei of the midgut epithelium and fat body. Larvae and adults of the beetle are susceptible to infection. Pupae are not generally affected. Mode of entry of the pathogen is only by oral injection of virus-contaminated food.

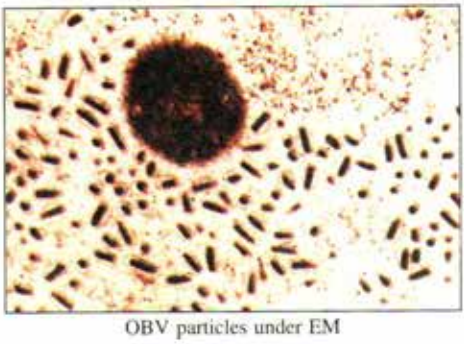
Diagnostic symptoms of the disease in the grubs:

The infected larvae become lethargic and stops feeding. As the virus multiply in the midgut epithelium, fat body disintegrates and the haemolymph content increases. This causes translucency of the thoracic region,



Giemsa stained enlarged nuclei

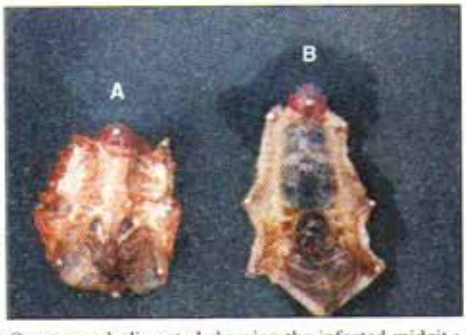
which is an important exopathological symptom for the identification of the disease. In certain cases increased turgour pressure may cause the



OBV particles under EM

extroversion of the rectum. On dissection, the midgut filled with white fluid is clearly seen in advanced infection stage. The infected grubs die within 15-20 days and they do not pupate.

Oryctes grubs : A - virus infected, B - healthy



Oryctes grub dissected showing the infected midgit : A - virus infected, B - healthy

The healthy grubs on the other hand are active and feed vigorously and remain in the lower part of the feed. Their thoracic region does not show

translucency but show a dark midgut line showing the gut filled with feed.

Giemsa staining (3%) of infected midgut fluid and its epithelial tissue for 45-60 minutes show pink coloured enlarged nucleus with vacuoles under light microscope. In the advanced stage of infection dark pink coloured rings are also observed around the nucleus of the infected cells. The viral particles are seen only under the electron microscope.

Effect on adults

The affected beetles become inactive. The midgut of the affected beetle is filled with white coloured fluid as in the case of grubs. The infected adults disseminate the virus through their feacal matter into the surroundings.

Mass production of the virus

Method of mass production of the virus is by rearing the grub on virus inoculated food such as sterilized cow dung, saw dust, coir pith etc. or by mouth feeding the healthy grubs with viral suspension.

1. Select OBV infected host, anaesthetize with chloroform, dissect out the midgut and transfer it to a mortar
2. Add 3-5 ml of sterile phosphate buffer (pH 7) and homogenize it using pestle and mortar.
3. Draw the midgut suspension with a syringe and carefully mouth feed the healthy grubs with 1-2 drops of the suspension.
4. Put the inoculated grubs in a plastic rearing box containing 200-250 g of sterilized food material. The feeding medium is kept sufficiently moist. Proper ventilation may be given to the box by providing holes on the lid.
5. Monitor for the production of the OBV symptom on the grubs and the whole procedure is repeated for infecting more number of healthy grubs to maintain the viral culture in the host. The cadaver of the infected grub can be stored indefinitely at –40°C.

Field release of OBV:

Ten to fifteen healthy adult rhinoceros beetles are allowed to crawl

Inoculation of OBV to *Oryctes* adult : Oral feeding

in a suspension of baculovirus infected midgut taken in a glass trough. (1g-midgut/100ml buffer) for half an hour.

The beetles are then kept in plastic boxes under starvation for 12-24 hours. The beetles are released preferably at dusk in the heavily infested coconut gardens at the rate of 12-15 beetles per hectare.

The cost of inoculum required to treat 15 beetles works out to be Rs. 30.00. Following first release one more release may be required in sum cases. Once the beetles are released they would visit the breeding sites in the vicinity of the released area and due to the auto transmissible

Inoculation of OBV to *Oryctes* adult : Wading through the viral suspension

nature of the pathogen the dissemination will take place at a faster rate.

Impact of the release

The percentage of the petiole damage and spathe damage show significant reduction after 6-8 months of the release of the infected beetles. Reduced site occupancy of the pest in breeding places, reduction in the pest incidence in the field and presence of Baculovirus infected grubs with typical visual symptoms of the viral infection in the breeding grounds are indicators of the establishment of the viral pathogen in the introduced area. Baculovirus was introduced in 1983 in the Minicoy Island where the native rhinoceros beetle population was totally free form the virus infection. The beetle damage on the palms was very severe with 56.6% leaf damage, 31.1%spathe damage and 39.2% fresh infestation on the spindles. Post release observations after eight months of the baculovirus introduction indicated the establishment of viral pathogen in the native beetle population and their breeding sites and this resulted in significant reduction in the pest damage on coconut. Similar results were obtained by the introduction of the viral pathogen in Androth island of Lakshadweep and also in the Andaman Islands. Impact of re-release of the Baculovirus in the mainland of west coast of India has also been studied in detail. In Chittilappally of Trichur district of Kerala, significant reduction in pest infestation could be achieved by the re-release of Baculovirus in the native rhinoceros population. The above success stories point out scope for utilizing Baculovirus as an effective biological tool for the management of the rhinoceros beetle affecting coconut and oil palm.

Source of nucleus culture of the bioagents:

Entomology Laboratory, Central Plantation Crops Research Institute, Regional Station, Kayangulam, Krishnapuram- 690 533, Kerala, India.