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## INTEGRATED CONTROL OF RHINOCEROS BEETLE

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### ABSTRACT

The rhinoceros beetle, *Oryctes rhinoceros* L. is one of the key pests of the coconut palm. Adoption of mechanical, cultural, chemical and biological methods in an integrated manner is feasible for the effective management of the pest.

Release of the reduvid predator *Platyeris laevicollis* can also be combined with the above operations, provided the crown treatment with insecticide is eliminated from the schedule.

The entomogenous fungus *Metarhizium anisopliae* produces epizootics in *Oryctes* population. Baculovirus of *Oryctes* is one of the most successful microbial control agents employed for the biosuppression of the pest in several countries. Success achieved from the introduction of baculovirus in Minicoy and Androth in Lakshadweep and the impact of re-release of baculovirus to an already infected contiguous area are also highlighted.

### INTRODUCTION

The rhinoceros beetle, *Oryctes rhinoceros* L. is a ubiquitous pest of the coconut palm. The beetle bores through into the unopened fronds and inflorescences causing severe damage resulting in substantial reduction in the yield of palms. Field control trials carried out in a heavily infested tract in farmers' fields had revealed substantial reduction in the intensity of pest infestation on palms and the consequent increase in yield to the extent of five to eight nuts per palm per year (Sahasranaman, 1969). As the beetle breeds in cattle dung, farmyard manure, dead coconut logs and stumps and other decaying organic debris, tackling the immature stages of the pest in its breeding sites is feasible.

Monitoring of the beetle population on the crowns of palms and detection of all possible breeding sites of the pest are essential components of the pest management technology. The intensity of damage could be assessed in terms of the number of infested palms, leaf damage, spathe damage, fresh incidence on

the spindle and the number of beetles present on the crowns of palms. Management of the pest by adoption of mechanical, cultural/sanitational, chemical and biological methods had yielded encouraging results.

### FIELD CONTROL

A field experiment was laid out in farmers' fields at Thamarakulam, Alappuzha District, Kerala (India) during 1964 to 1971 with a view to assessing the combined efficacy of beetle control operations such as mechanical, cultural, sanitational and chemical methods in bringing down the pest incidence on the crowns of palms. An area comprising 172 plots having a palm population of 2867 was selected for the study and the data were collected from 10 per cent sample palms (285 numbers) selected as per stratified random sampling technique. The treatments included:

1) Extraction of beetles from the crowns of palms during the peak period of pest abundance.

2) Treatment of all possible breeding sites of the pest in and around the area with aldrin 0.01 per cent in January, April, July and October.

3) Filling the innermost leaf axils of the border palms with 225 g 5 per cent HCH/Chlordane dust and sand mixture in April–May and October–November corresponding to pre- and post-monsoon periods.

4) Provision of beetle traps containing decaying organic debris treated with aldrin 0.1 per cent suspension.

5) Maintenance of field sanitation by disposal of accumulations of decaying organic debris, so as to prevent multiplication of the pest in the experimental area.

The data collected from the sample palms and the general observations of all palms are presented in Tables 60.1 and 60.2. The leaf damage had come down to 4.80 from 26.25 per cent, spathe damage to one from 38 and fresh incidence to 15 from 45 per cent of the pre-treatment condition. The reduction in pest incidence and crop damage recorded in the annual observations of all palms also showed similar trend (Anonymous, 1969). Leaf damage had come down to 8.75 from 24.56 per cent, spathe damage to 65 from 771 per cent and fresh incidence to 59 from 436 per cent of the pre-treatment condition. It was observed that quicker reduction in pest incidence and crop damage was obtained in the integrated control experiment than obtained by the individual method of insecticide treatment to the breeding places of the pest. In Sasthamkotta, where the chemical treatment of the breeding places alone was carried out the leaf damage came down to 8.38 from 20.5 per cent, spathe damage to one from 17 and fresh incidence to 27 from 96 per cent of the pre-treatment condition (CPCRI unpublished data).

### NATURAL ENEMIES

The insect and mite predators/parasites associated with the breeding sites of the beetle also exert some degree of suppression of the pest. The presence of

indigenous predators such as *Santalus parallelus*, *Scarites* sp., *Harpalus* sp., *Pheropsophus* spp., *Agrypnus* sp. nr. *bifoveatus* etc. was recorded. However, evaluation of the predatory potential of these revealed that they exert only very meagre pest suppression. As such, no attempt has been made for mass multiplication and release of the indigenous predators.

Table 60.1: Observations of 285 sample palms of the integrated control experiment at Thamarakulam centre (1964 to 1971)

Observations	Percentage of leaf damage	Number of spathes damaged	Number of palms with fresh incidence
Pre-treatment	26.25	38	45
Post-treatment			
first round	26.28	14	36
second round	17.00	4	35
third round	10.29	1	31
fourth round	9.11	0	19
fifth round	5.58	1	20
sixth round	4.82	1	23
seventh round	8.15	12	40
eighth round	7.68	0	22
ninth round	6.95	0	13
tenth round	5.77	3	17
eleventh round	7.93	6	14
twelfth round	7.29	3	15
thirteenth round	4.74	4	5
fourteenth round	4.80	1	15

Table 60.2: Annual general observations of 2867 palms of the integrated control experiment at Thamarakulam centre (1964 to 1971)

Observations	Percentage of leaf damage	Number of spathes damaged	Number of palms with fresh incidence
Pre-treatment			
July–Sept. 1964	24.56	771	436
Post-treatment			
1965	15.71	97	274
1966	9.99	99	177
1967	7.84	69	93
1968	6.70	76	108
1969–1970	7.74	89	71
1971	8.75	65	59

The exotic reduvid predator *Platymenis laevicollis*, introduced from Zanzibar, was mass multiplied and released in the field (Antony et al., 1979). Even though the predator exerted some degree of pest suppression, as revealed by the presence of a higher proportion of dead beetles on the crowns of palms, there was no build up of the predator population in any of the release

sites. In an adaptive research programme carried out by the Department of Agriculture in Kollam district, Kerala State an integrated approach including mass multiplication and field release of *P. laevicollis* was made. When the component of predator release was also incorporated, the leaf axil filling treatment with insecticide had to be eliminated from the schedule.

### BIOSUPPRESSION

The entomopathogen *Metarhizium anisopliae* produced epizootics in the natural population of *O. rhinoceros* when climatic factors such as low temperature and high relative humidity conditions prevailed. Nirula *et al.* (1955) recorded a high degree of infection of the fungus during the monsoon period. Conditions were ideal for the mycosis when the moisture levels of the breeding medium were 30 per cent and temperature 29°C and below (Sundarababu *et al.*, 1983). A method has been developed to mass culture this fungus on a cheaper substrate like cassava chips and rice bran supplemented with waste fish meal extract or urea as a source of nitrogen in specially designed large aluminium vessels (Mohan and Pillai, 1982). Cattle dung pits or farmyard organic refuse heaps in farmers' homesteads can be inoculated with the fungal preparation at approximately  $5 \times 10^{11}$  spores per m<sup>3</sup> of the heap by thorough mixing. The fungal propagules established in the medium survived for longer periods and infected the grubs. Dangar *et al.* (1991) used still cheaper and easily available agricultural waste material like coconut water

Table 60.3: Growth (g dry wt/100 ml medium) and spore production ( $\times 10^6$ /ml) of *M. anisopliae* in different media on different days

Medium	Growth (days)				Spore production (days)			
	10	20	30	Mean	10	20	30	Mean
Autoclaved CW (pH 5.5)	0.73	1.00	1.46	1.06	5.55	24.25	34.68	21.49
Filter-sterile CW (pH 5.5)	0.65	0.83	1.45	0.98	10.75	27.18	41.03	26.32
Aseptically drawn out CW (pH 5.5)	0.50	0.97	1.56	1.04	9.56	29.74	46.66	28.65
Autoclaved CW (pH 6.5)	0.60	0.91	1.33	0.95	4.32	24.07	33.62	20.60
Potato dextrose broth (pH 6.5)	0.50	0.79	1.15	0.81	4.48	7.17	18.72	10.12
Mean	0.62	0.90	1.39	0.97	6.93	22.48	34.90	21.22
SE/plot	= 0.04				0.078			
CV (%)	= 3.96				2.650			
CD (P = 0.05) for medium	= 0.026				0.571			
CD (P = 0.05) for days	= 0.200				0.442			
CD (P = 0.05) for medium x days	= 0.045				0.089			

(CW) from the copra making industry for mass production of the fungus. This medium supported better mycelial growth and sporulation of the fungus than the conventional potato and dextrose (Tables 60.3 and 60.4). This method can be adopted by the farmers themselves with easily available local resources. The fungal spores cultured can be applied to the breeding sites at approximately  $10^{9-11}$  spores per  $m^3$  of breeding material.

The virus disease of *O. rhinoceros* caused by baculovirus of *Oryctes* is documented as one of the most successful microbial control agents employed for the biosuppression of coconut rhinoceros beetle in several countries including South Pacific islands, Fiji, Mauritius, Seychelles and Papua New Guinea (Cattagirone, 1981). Recent studies revealed the occurrence of baculovirus disease in the natural population of beetles collected from Kerala, India (Mohan et al., 1983). The viral infection resulted in reduction in the longevity of beetles by 40 per cent and total reduction in the fecundity of the beetles. Wherever the virus was introduced into the habitat of the pest an initial epizootic decimated the larval and beetle populations resulting in drastic reduction in larval population at the breeding sites leading to substantial reduction in pest incidence and crop damage. The easy and rapid transmission of the virus disease could maintain the pest population at lower levels for many years. This viral pathogen was successfully introduced in Minicoy, Lakshadweep in April 1983 and a significant reduction in pest population was obtained (Mohan et al., 1989). The data collected during December 1988 revealed 7 per cent leaf damage, negligible spathe infestation and fresh incidence on spindles (only four to five cases per 2000 palms), as against 56.6, 31.1 and 39.2 per cent respectively, of the pre-release condition. Sixty-two per cent of the beetle population collected from different parts of the island revealed baculovirus disease incidence, as against none during the pre-release condition (Table 60.4).

Table 60.4: Performance of baculovirus at Minicoy, Lakshadweep

Date of survey	Per cent infestation			Baculovirus disease incidence (%)
	Leaf	Spathe	Spindle	
<i>Pre-release</i>				
Apr. 1983	56.6	31.1	39.2	0.0
<i>Post-release</i>				
Jan. 1984	44.9	6.4	5.0	50.0
Nov. 1984	20.4	2.3	5.1	25.9
Sep. 1985	17.5	1.6	9.2	43.3
May. 1986	10.0	0.5	1.2	50.0
Dec. 1988	7.0	Negligible*		62.0

\* Only four to five cases recorded per 2000 palms.

Baculovirus of *Oryctes* was introduced to Androth, Lakshadweep in April 1988. Post-release observations recorded during January 1990 revealed that

the viral pathogen had established in the natural population of the pest and exerted a considerable degree of pest suppression and consequent reduction in crop damage (Table 60.5). Leaf damage had come down to 13.5 from 55 per cent, spathe damage to 3.2 from 7.3 per cent and fresh incidence on spindle to 5.9 from 23.5 per cent of the pre-release condition. The observations on the site occupancy of the pest in breeding places revealed that the grub population had come down from 80 to 5, pupae from 17.8 to 0.02 and adults from 2.1 to 0.3 per site (Table 60.6). The population of baculovirus-infected grubs with typical visual symptoms also had increased from zero to 11.4 per site.

Table 60.5: Performance of *Oryctes baculovirus* in Androth island of Lakshadweep

Date of survey	Per cent infestation			Baculovirus disease incidence (%)
	Leaf	Spathe	Spindle	
<i>Pre-release</i>				
Apr. 1988	55.0	7.3	23.5	0.0
<i>Post-release</i>				
Dec. 1988	43.0	3.0	15.7	35.6
Jan. 1990	13.5	3.2	5.9	60.6

Table 60.6: Site occupancy of the pest in breeding sites at Androth, Lakshadweep

Date of survey	Total no. of sites	No. per site			Diseased grubs (visual symptoms) per site
		Grubs	Pupae	Adults	
<i>Pre-release</i>					
Apr. 1988	50	80.1	17.8	2.1	0.0
<i>Post-release</i>					
Dec. 1988	45	7.4	0.1	0.6	0.5
Jan. 1990	58	5.4	0.02	0.3	11.4

Baculovirus was introduced to Andamans in May 1987. There was establishment of the pathogen in the natural population of the beetles which effected remarkable reduction in frond damage, spathe damage and crown infestation (Jacob, 1990). In the Maldives, the virus was totally absent and its introduction during 1984/1985 resulted in significant reduction of *O. rhinoceros* population (Zelazny *et al.*, 1989).

Release of the infected beetle is the most economical, effective and easy method for dissemination of the inoculum into the natural population of the beetles. Baculovirus of *Oryctes* could be one of the effective components in the integrated control programme.

Young and Longworth (1981) reported successful control of *O. rhinoceros* in Tonga for seven years after its first and only release in 1970, whereas, in Western Samoa, a resurgence of the pest was noticed at low levels of virus

incidence, four years after the viral epizootic. Subsequent re-release of a small number of diseased beetles brought about substantial reduction in pest population and crop damage (Marschall and Ioane, 1982).

In order to evaluate the impact of re-release of baculovirus in an already infected contiguous area an experiment was initiated at Chittillappilly, Thrissur district, Kerala, during July 1989.

After two years of re-release of baculovirus, there was a drastic decline in percentage of infested palms, leaf damage, spathe damage and fresh incidence on spindles (Table 60.7).

Table 60.7: Impact of re-release of baculovirus at Chittillappilly, Thrissur, Kerala

Date of survey	Per cent infestation			
	Palms	Leaves	Spathes	Spindle
<i>Pre-release</i>				
Jul. 1989	100	34.44	12.5	68.18
<i>Post-release</i>				
Feb. 1990	64.29	23.76	0	50.00
Jul. 1990	64.71	27.07	0	17.65
Mar. 1991	89.47	33.96	6.52	0.00
Jul. 1991	68.18	27.38	1.89	13.63

According to Zelazny *et al.* (1989) there was the possibility of development of resistance to baculovirus in population of *O. rhinoceros*. In Indonesia (North and South Sulawesi), East Java, Philippines (South Luzon), Maldives etc. the conditions are more or less similar for the build up of populations of *O. rhinoceros*. Differences exist in the population level and there has been a negative correlation between the presence and prevalence of the virus and the damage by the beetle. The disease was prevalent in East Java and South Sulawesi, but occurred rarely, probably suggesting the possibility of host resistance to the virus in these locations.

To overcome the problem of resistance it is necessary to use efficient strains of the pathogen against the pest. Screening of strains prevalent in different tracts would be beneficial for isolating quick acting virulent strains of the pathogen which could be utilised for biosuppression of the pest. More detailed studies on these lines are desirable.

## OTHER METHODS

Use of attractant traps, metal vane traps or coconut cap traps treated with ethyl dihydro chrysanthemumate (chislure) or commercially available ethyl chrysanthemumate (rhinolure), were found effective for collection and destruction of beetles in the South Pacific (Barber *et al.*, 1971; Bedford, 1973; Maddison *et al.*, 1973).

Vegetative barriers such as growing cover crops like *Pueraria javanica* restrict the feeding of the beetle on the crowns of palms, conceal the breeding

grounds and act as physical barriers to impede flight of the beetles from their breeding sites. This method was suggested as one of the effective and inexpensive methods to check the pest damage on young palms in Malaysia and Ivory Coast (Owen, 1961; Wood, 1969; Julia and Mariau, 1976). However, in areas where cattle dung, farmyard manure and other decaying organic debris form the major breeding material of the pest, this method may not be practicable.

Irradiation using gamma rays affected egg fertility (Hurpin, 1970). Chemosterilants such as derivatives of aziridin reduce the longevity and competitiveness of males as compared to those of the normal males (Hurpin, 1972) and juvenile hormone mimics such as methoprene affect the adult emergence (Dhondt *et al.*, 1976).

Under the IPM programme for the coconut rhinoceros beetle in the Pacific Islands, Zelazny *et al.* (1985) had envisaged:

- 1) Planting legumes as cover crops to conceal the potential breeding sites of the beetle.

- 2) Treatment of breeding places of the beetle with the entomopathogen *M. anisopliae*.

- 3) Promoting the spread of the virus by leaving some dead standing palms.

- 4) Increasing the prevalence of the virus by releasing virus infected beetles.

To sum up, maintenance of field sanitation, extraction of beetles during the peak period of pest abundance on the crowns of palms, mass multiplication and release of *M. anisopliae* to the breeding sites and re-release of baculovirus of *Oryctes* are some of the methods which can be adopted for the efficient management of rhinoceros beetle.

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## DISCUSSION

*T.P. Sreeharan*: Exotic predators did not do well in Sri Lanka. Can the possible reasons be given?

*G.B. Pillai*: Exotic predator *Platyeris laevicollis* has been tried in several countries. Even though there was some degree of pest suppression, there was no build up of the predator in any of the release sites in India.

*L. Diehl*: What was the effect of the beetle control on yield of nuts?

*G.B. Pillai*: In one experiment, the yield was increased by five to eight nuts per palm per year by adoption of beetle control operations.