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Suppression of Rhinoceros Beetle (*Oryctes rhinoceros*) by *Oryctes* Virus in Lakshadweep Islands : Current Status

MURALI GOPAL[1] and P.M. JACOB[2]

[1] Central Plantation Crops Research Institute
Kasaragod - 671 124, Kerala

and

[2] Central Plantation Crops Research Institute
Regional Station, Minicoy, Lakshadweep

The microbial pathogen, *Oryctes* virus (earlier *Baculovirus oryctes*) was introduced into Minicoy and Androth Islands of Lakshadweep in 1983 and 1988, respectively for the biological suppression of rhinoceros beetle, *Oryctes rhinoceros*, one of the major pests of coconut palm. Subsequently, within two years of its introduction, the pathogen could significantly reduce the beetle population, bring down the damage to the palms and increase the virus incidence in the pest. To assess the current status, follow-up studies conducted in 1999 (11 years past introduction) in Androth and in 2001 (15 years past introduction) in Minicoy revealed that 25.2% of leaves, 0.86% of spathes and 26.9% of spindles of the coconut palms were damaged in Androth, whereas 45.9% of leaves, 36% spathes and 16.1% of the spindles were damaged in Minicoy Island. The natural virus incidence in *Oryctes* grubs was recorded to be 36% at Androth and 29.0% at Minicoy. On comparison, it was observed that barring the spindle damage in Androth and spathe damage at Minicoy, the other damage parameters were well below the status that was present before the introduction of the virus in these Islands. The viral disease incidence was also recorded to be quite high during the follow-up studies. This indicates that in Island condition, the virus is capable of exerting a long-term suppression of the pest.

*(**Key words**: Coconut, Rhinoceros bettle, Orycles virus, Microbial pathogen)*

The coconut palm is an important plantation crop of India, particularly in the Lakshadweep Islands where it serves as one of the main sources of income to the Island inhabitants, besides fishing. The coconut varieties commonly growing here are the Lakshadweep Tall, Lakshadweep Micro, Lakshadweep Mini Micro, etc. All these cultivars are highly susceptible to the attack by the ubiquitous insect pest, rhinoceros beetle (*Oryctes rhinoceros L*). The adult beetle inflicts the damage by chewing unopened soft fronds and boring holes into the spathes resulting in loss of photosynthetic area and low inflorescence setting. Management of this pest could be successfully accomplished using a microbial control agent, *Baculovoirus oryctes* isolated first in Malaysia (Huger, 1996). This virus was also found to be occurring naturally in the pest population in Kerala (Mohan *et al.*, 1983) but not in the rhinoceros beetles of the Lakshadweep Islands. The Baculovirus was then introduced into Minicoy and Androth Islands of Lakshadweep in 1983 and 1988, respectively. Within a period of 2 years after its release the pathogen significantly reduced the damage to the coconut palm caused by the pest in these Islands (Mohan *et al., 1989*, Anon., 1991).

In order to evaluate whether the pathogen had sustained the pest suppressive capacity or has there been increased pest activity, a follow-up study was taken in 1999 in Adroth and in 2001 in Minicoy Island to assess the damage caused by this pest and the percentage of them carrying the virus infection.

MATERIALS AND METHODS

Assessment of damages

The observations such as total number of leaves in a palm, number of leaves damaged by rhinoceros beetle evident by the 'V' shaped cuts on leaves, fresh spindle damage and spathe damage were taken from a total of 104 palms covering all the four villages of Androth *viz.*, Keecherry, Mecherry, Chemancherry and Jetty area. Similarly, 138 palms representing all the 8 major areas of Minicoy were observed in detail for the damage.

Site occupancy by the pest

The natural breeding sites of the pest i.e., farmyard yard manure pits, dead and fallen coconut trunks and coir waste dumps present in the representative parts of the Islands were scoured for the presence of the pests in single brood or multiple brood conditions.

Oryctes virus incidence

The *Oryctes* grubs and adults collected from Androth and Minicoy were observed for the presence of virus disease through exopathological symptoms by dissection for presence of white fluid in midgut and by 3% Giemsa staining of midgut fluid and midgut epithelial cells. (Zelazny, 1978, Mohan *et al.*, 1983).

RESULTS AND DISCUSSION

Assessment of damages

The extent of damage caused by the rhinoceros beetle to coconut palms in Androth Island is given in Table 1. It indicates that from the total of 104 palms observed, 25.2 % of leaves, 0.86% of spathes and fresh spindle were damaged to the tune of 26.9%. In Minicoy Island, the palms having beetle damage was around 45.9%. The leaf damage was recorded to be 36.0%, spathe damage 16.1% and fresh spindle damage 25% (Table 2).

Site occupancy by the pest

The percentage of sites occupied by the rhinoceros beetle and the brood conditions are given in Table 3. In Androth Island 32.2% breeding sites were found to be occupied as compared to 51% in Minicoy. The number of sites harboring multiple broods was also high in Minicoy.

Oryctes virus infection

From the Giemsa staining of the midgut epithelial cells the natural virus infection in *Oryctes* grubs was recorded to be 36.0% at Androth and 29.0% at Minicoy (Table 4).

The non-occluded virus *Baculovirus oryctes* was till recently considered as a part of the *Baculovirideae*, however from 1997 this pathogen has been removed from this group and put separately as *Oryctes* virus group (Evans and Shapiro, 1997). The *Oryctes* virus was introduced into Minicoy Island in 1983 and in Androth Island in 1988. Introduction of this pathogen had

Table 1. *Comprehensive areawise percent damage caused by rhinoceros beetle in Androth Island of Lakshadweep*

Area	No. of palms	Total leaves	Damaged leaves	Fresh spindle damage	Total spathes	Damaged spathes
Achada/ Ashigara	32	1106	328	12	273	4
Farm Store/ Mela site	42	1342	327	12	400	4
Saw mill	16	523	117	1	164	0
Kollikatt	14	433	86	3	98	0
Total	104	3404	858	38	935	8
% damage	-	-	25.2	26.9	-	0.86

Table 2. *Comprehensive areawise percent damage caused by rhinoceros beetle in Mincoy Island of Lakshadweep*

Area	No. of palms	Total leaves	Damaged leaves	Fresh spindle damage	Total spathes	Spathes damage
Central island	83	2638	1041	27	48	15
Light House	26	872	411	7	36	6
Kodi village	14	484	73	-	23	-
Kendiparty	7	260	33	-	12	1
Fallissery	1	34	2	-	2	-
Panchayat seedling farm	2	55	2	-	2	-
Met observatory	5	155	39	-	16	-
Total	138	4498	1601	34	138	22
% damage			36.00	25.00		16.00

Table 3. *Site occupied by rhinoceros beetle and the brooding details at Androth and Minicoy*

Island	Sites searched (no.)	Sites occupied by the pest (no.)	Site occupied %	Brood details	
				Single (%)	Multiple (%)
Androth	127	41	32.2	27 (66)	14 (34)
Minicoy	94	48	51.06	25 (52)	23 (48)

Table 4. *Percentage virus incidence in the pest in Androth and Minicoy Islands*

Islands	Grubs observed	Nos. with virus symptom (exo-pathological)	No. of grubs dissected	Details of microscopic examination	Grubs with confirmed viral infection	Percentage virus incidence
Androth	22	12	12	46 slide from 12 diseased grubs	8.00	36.00
Minicoy	90	32	32	127 slides from 32 diseased grubs	26.00	29.00

significantly reduced the damage caused by rhinoceros beetle and increased the viral incidence in the natural pest population in these two Islands in a matter of two years (Mohan *et al.*, 1989, Anon., 1991). It has been observed that the viral effect gets diluted due to many reasons (Gopal *et al.*, 2002) warranting frequent follow-up studies to monitor the pest/disease situation. The follow-up studies in Androth was taken up during 1999 and in Minicoy in the year 2001 after a gap of 11 and 16 years of last observations recorded, respectively. The current damage situation in Minicoy and Androth given in Tables 1 and 2 indicated that the rhinoceros beetle was active and was causing some damage to the coconut palms. A comparison of the damage/virus incidence before the introduction of the pathogen (situation 1), two years after the introduction (situation 2) and during the current follow-up studies (situation 3) is given in Tables 5 and 6 for both these places. The data denote that the damage to coconut was prevalent (situation 3), however barring the spindle damage in Androth and spathe damage at Minicoy the other parameters were well below the status than in situation 1. It could be surmised that the biocontrol agent has been effectively active in suppressing the population of the rhinoceros beetle and the damage caused by it to the coconut. Those beetles that contracted the disease became feeble and were unable to cause significant damage to palms. Their life span too decreases by 60% as compared to the healthy ones. The female beetles were generally rendered sterile and they laid non-viable eggs. The grubs died before molting into the pupa.

The main reason for this longterm effect could be attributed to the restricted land area of the Islands, which provided the diseased beetles, and its virus filled excreta with repeated chances to come in contact with healthy counterparts in the breeding and feeding sites resulting in higher virus perpetuation. Whereas, in mainland the opposite effect was seen i.e., dilution of viral inoculum occurred as there were vast areas with many breeding/feeding sites, where the possibility of contact of diseased rhinoceros beetle with healthy insects dwindled. Diseased beetles visiting some of these sites may find no healthy counterparts occupying these locátions. Excretion of virus at such unoccupied sites rendered the pathogen non-viable. Moreover, the presence of another fungal pathogen *Metarhizium anisopliae* and occurrence of mycosis to all the stages of the pest in the mainland, especially during monsoon period suppressed the virus activity briefly (Hochberg and Waage, 1991, Gopal *et al.*, 2002). In recent years, an opportunistic bacterial pathogen *Pseudomonas alcaligenes* also has been recorded to undermine the production of virus inoculum in nature and limit the field perpetuation of this biocontrol agent (Gopal and Gupta, 2002). Absence of both the entomofungal pathogen, *M. anisopliae* and the opportunistic bacterial pathogen, in Lakshadweep Island also played a significant role in keeping the virus incidence high without drastic dilution, which had given the viral pathogen appropriate prevailing conditions for controlling the beetle population.

Table 5. *Comparison of the damage status in Androth since the release of the* Oryctes *virus*

Situation	Year of observations	Damage status (%)			Virus Disease incidence
		Leaf damage	Spathe damage	Spindle damage	
Situation 1* (pre-release)	April 1988	55.00	7.30	23.50	0.00
Situation 2* (post release)	Feb. 1992	7.69	0.32	0.00	85.19
Situation3 (follow-up study)	April 1999	25.2	0.86	26.9	36.00

*Data of situation 1 and situation 2 from Anon. (1991)

Table 6. *Comparison of the damage status in Minicoy since the release of the* Oryctes *virus*

Situation	Year of observations	Damage status (%)			Virus Disease incidence
		Leaf damage	Spathe damage	Spindle damage	
Situation 1* (pre-release)	April 1983	55.83	25.90	29.56	0.00
Situation 2* (post release)	Sept. 1985	12.89	1.61	2.90	68.91
Situation 3 (follow-up study)	Nov. 2001	36.0	22.0	34.0	29.00

*Data of situation 1 and situation 2 from Mohan *et al.* (1989)

However, when situation 3 is compared with situation 2 (Tables 5 and 6) the data showed that the damages have amplified while the viral disease incidence had come down to half. Fall in the virus incidence could be attributed to the increased availability of breeding sites because of cutting down of coconut palms and clearing of coconut gardens for construction works in the Islands. The dead fallen coconut logs were left as such in the fields that became the location of new breeding sites for the pest. Increase in large number of such breeding sites provided more chances for the diseased and healthy beetles not to come in contact with each other resulting in waste of the virus inoculum. For the obligate pathogenic virus to remain viable and effective it must enter the body of healthy beetles/ grubs within 24 to 48 h of its release in the environment by the diseased host, since with lapse of this time this could be rendered non-viable in nature (Zelazny, 1976). Non-maintenance of clean coconut gardens and its surroundings in these Islands particularly in central and southern areas of Minicoy resulted in increased rhinoceros beetle activity.

Site occupancy of the pest and the incidence of viral infection were interrelated (Zelazny and Alfiler, 1986). It is evident from the data given in Tables 3 and 4 that percentage of breeding sites occupied by the pest was less and the disease incidence was high in Androth and *vice-versa* in Minicoy. It has been reported that areas having high density of breeding sites were expected to have low incidence of disease due to the reduced chances of multiple visits by beetles to the same sites (Mohan *et al.*, 1989). Another reason could be the difference in the time elapsed since the introduction of the virus in both these Islands. It was natural that in the place where the virus was introduced more recently its suppressive effects on beetle population could still be higher than in the place where it was introduced much earlier as in the case of Minicoy. The presence of more multiple broods (site including more than one developmental stage of the pest) in Minicoy also pointed to increased beetle population when compared with Androth.

Overall, it revealed from the follow-up studies that the *Oryctes* virus was an efficient biocontrol agent for the management of rhinoceros beetle in the Islands. A long term effective suppression of the pest could be achieved due to the restricted land space, which provided opportunities for higher virus disease contraction in the insect population. However, dilution of viral inoculum with increase in beetle populations and damage to coconut palms were taking place over a period of time due to local factors that warrants augmentation of the pathogen.

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