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Enjoying coconut free from insect pest infestation

The Integrated pest management integrates all suitable techniques of pest management knowing the natural regulatory factors of environment and ecological principles, major insect pests of coconut can be effectively managed by adopting IPM packages developed. The integrated packages developed are eco-friendly and validation of these packages on large-scale at farmers' fields strengthens their belief in IPM. Biological control is very much successful in coconut, especially against black-headed caterpillar and inclusion of pheromone lures as a component of IPM opened new vistas in coleopteran pest management in this crop. The palm health achieved through better nutrient management practices stress the importance of agronomical practices in mite management.

COCONUT palm with incessant and plentiful provision of food, supports a wide range of chewing and sucking pests. Coconut palm, in spite of its hardy nature and adaptability to different soil conditions and vagaries of climate, often succumbs to different insect pest attack. The major insect pests on this important plantation crop are rhinoceros beetle which bores into unopened fronds and spathes, dreaded red palm weevil grubs which tunnel into the stem, coconut black headed caterpillar which feeds on functional leaf tissues, and eriophyid mite, reached epidemic proportions in recent times, affecting the production and productivity of coconut in many districts of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Odisha and West Bengal.

Rhinoceros beetle damage on young palm

Rhinoceros Beetle

Rhinoceros beetle (*Oryctes rhinoceros* L.) occurs throughout the year but peak occurrence being from June to September. The affected fronds, when fully opened, show characteristic geometric cuts. Usually one or two leaves show the cut marks but under severe conditions all leaves and tender portion of crown shows injuries made by the beetle; chewed fibrous material is present in crown or near bored hole and generally palms of 3–10 years age are more prone to infestation. More over, injured portion may attract insect pests such as red palm weevil and also pave way for fungal infection (bud rot). Repeated infestation to growing points may eventually lead to the death of seedlings.

Management

Sanitation: Remove and destroy all possible decaying debris and dead palms from plantation since these act as prolific breeding grounds for beetle.

Mechanical: The adult beetles can be extracted using curved beetle hooks from the palm crown, particularly during the peak period of population build-up. The holes made by beetles are to be filled with a mixture of neem-seed kernel powder 100g + 150g sand.

Prophylactic leaf axil filling: To protect the young palms from rhinoceros beetle attack, the innermost 2-3 leaf axils are to be filled with a mixture of neem-seed kernel powder 100g + fine sand (150g) per palm during May, September and December.

Biological: *Pathogens:* Baculovirus of *Oryctes* and green muscardine fungus cause diseases to immature and adult stages of beetle. The adult beetles can be inoculated either by feeding viral inoculum or by allowing the insect to crawl over the *Oryctes* baculovirus suspension. Release of such baculovirus inoculated beetles has to be done @ 10-15 beetles/ha of plantation periodically. The green muscardine fungus *Metarrhizium anisopliae* (Metch.) Sorokin can be mass cultured in rhinoceros grubs or broken maize grain or coconut water or on cassava chips and rice bran supplemented with a nitrogen source. Periodical spraying of fungus on manure heaps is to be done during monsoon season. The fungus should be inoculated @ 5×10^{11} spores/m^3 of the breeding material.

Impact of Pest Management Technology

The IPM for rhinoceros beetle which was developed and standardized is an effective management strategy and the demonstration of IPM technology at farmers' fields in Tamil Nadu, Andhra Pradesh and Maharashtra was carried out with the release of baculovirus inoculated beetles @ 15/ha at periodical intervals, application of *M. anisopliae* on farmyard manure heaps along with pheromone traps installation and placing of naphthalene balls in leaf axils near the crown resulted in a progressive decrease in incidence, leaf and spindle damage with in a period of one year in all the experimental locations (Table 1) validating the importance of IPM in the management of rhinoceros beetle. The beetle incidence reduced from 38.5 to 22.9, 50 to 11 and 83.64 to 13.33 per cent with similar decline in leaf and spindle damage in IPM Validation experimental plots in Tamil Nadu, Andhra Pradesh and Maharashtra. From the on-farm validation studies and results, it is evident that the two bioagents, *viz.* baculovirus and metarhizium fungus hold good promise for the management of the rhinoceros beetle. This biological control coupled with pheromone lures helps in the profitable, safe and viable management strategy against this pest.

Table 1 Pre-and post-treatment infestation levels of rhinoceros beetle in IPM implemented experimental garden

State	Acreage	Pre-treatment observational period April to June 2013			Post-treatment observational period January to March 2014		
		Incidence(%)	Leaf damage(%)	Spindle damage(%)	Incidence (%)	Leaf Damage(%)	Spindle damage(%)
Tamil Nadu	10 ha	39.50	35.40	38.50	29.20	29.70	22.20
	SE ±	4.90	4.20	9.90	3.20	3.60	9.50
Andhra Pradesh	10 ha	50.0	8.50	5.00	11.00	4.40	2.00
	SE ±	0.62	0.04	0.10	0.55	0.04	0.06
Maharashtra	165 palms	83.64	43.03	40.61	13.33	5.45	7.88
	SE ±	9.05	5.92	6.85	4.17	2.39	3.41

Periodical spraying of insecticide: Carbaryl 50 per cent W.P @ 3g/litre of water on farmyard manure heaps may be done to control immature stages of pest.

Traps for attraction: Establishment of rhinolure traps @1 trap/ha helps in effective trapping of adult beetles.

Red Palm Weevil

The red palm weevil (*Rhynchophorus ferrugineus* Oliver) is most destructive pest of coconut palm and is a serious threat to young coconut gardens (5-15 years). The symptoms of red palm weevil infestation become very clear in advanced stage by which time the crown of affected palm topples. On close monitoring, it can be seen that infested palms in early stage show yellowing and latter wilting of leaves of inner and middle whorls. Small circular pencil size holes can be seen on the trunk with a brownish viscous fluid oozing out. The bases of affected leaves sometimes split and extrusion of fiber is seen from the cracks/ holes. Gnawing and nibbling sound produced by the grub inside while feeding is audible in many cases.

Trapped red palm weevils in ferro lure trap

Management

For the management of red palm weevil an integrated approach involving all proven methods of control is effective which includes:

Cultural methods

- The palm crown has to be cleaned periodically to avoid decaying of organic debris in leaf axils. Dead palms which lodge various stages of the weevil should be removed, cut open and burnt so as to destroy all stages of the pest thereby preventing spread of the weevil to neighboring healthy palms.
- As far as possible, avoid making any cuts causing injuries to the palm through agricultural tools and implements as these will attract weevil for egg laying. The cuts or injuries if any treated with coal tar and imidacloprid.
- When fronds are to be removed from the palm, it should be cut leaving a petiole length of 120 cm. This will avoid entry of the pest into the trunk portion.
- Palms affected by bud rot and leaf rot disease and rhinoceros beetle may be properly treated with respective fungicides and insecticides.

Biological Control of Coconut Black-Headed Caterpillar

The incidence of coconut black headed caterpillar was observed on the fish pond bund coconut trees in the N. Ragavulapeta Village, S. Yanam and pure coconut gardens in Dwarapudi villages in East Godavari and in Undrajvaram village in West Godavari districts of Andhra Pradesh in first, second and third quarters of the year 2012. The average larval population was found to be ranging from 68.9 to 168.9 larvae/10 leaflets in these villages. Inundative release of coconut headed caterpillar larvae parasitoids (65,000 numbers of *B. hebetor*, 4,500 numbers *G. nephantidis* and 600 numbers of *B.nosatoi* parasitoids and 50,000 numbers of predator *C.exiguus*) has resulted in decrease of average larval population to 47.4, 23.2 and 5.0 per 10 leaflets, respectively after one, two and three months after parasitoid release in the pest affected gardens at N. Ragavulapeta Village. In S. Yanam and Dwarapudi villages in East Godavari and in Undrajvaram village in West Godavari, the pre-release larval population was found to be ranging from 68.9 to 76.8 larvae/10 leaflets and a total of 100000, 40000, 63000 numbers of *B. hebetor* parasitoids, 15500, 2000, 6000 numbers of *G. nephantidis* parasitoids, 800, 200, 600 number of *B.nosatoi* parasitoids and 75,000, 100,000, 100,000 number of predator *C.exiguus*, respectively were released in these gardens and it has resulted in decrease of larval population to 30.5, 55.6 and 19.3 per 10 leaflets, respectively after one month 7.7, 42.8 and 9.7 per 10 leaflets, respectively after two months and to 19.3, 9.7 and nil population, respectively after three months. After three months of release about 97 per cent at S.Yanam and N. Ragavulapeta, hundred per cent at Undrajvaram and 62.8 per cent control at Dwarapudi village.

Insecticidal treatment

- Treat wounds with a slurry of mud and insecticide to prevent egg laying by weevil.
- Fill leaf axils with neem seed kernel powder 100g + fine sand (150g)
- Treat bud rot infected palms with copper oxy chloride fungicides (3g/l of water).

Curative treatment: The affected palms in early stages of infestation could be saved by root feeding with Azadirachtin 5% WSC @ 10ml + 10 ml water. Chisel out affected trunk region and burn it and smear the wounded portion with coaltar. After cleaning fill the tunneled portion of trunk with cement and sand mixture to give strength to the palm.

Mechanical

- Expose different stages of the pest present inside dead trees and burn them
- Trapping the adults: Use of traps is an important tool under Integrated Pest Management practices. The mass trapping programme of palm weevil using lures helps to capture and destroy a sizeable amount of floating weevils.

Pheromone trapping: The pheromone lure is to be hung inside from the lid of the bucket which is filled with 100g pineapple/sugarcane, 2g yeast and 2g carbaryl in one litre of water as food bait which is necessary to orient the weevil into the trap. The trap at a height of 1 –1.5 m above the ground level in the field @1 trap per hectare. A study on comparative efficacy of various lures against red palm weevil carried out for 18 months in Vakkalanka,Munganda and Pullitekuru villages in Andhra Pradesh and Golap, Lanja and Bhatye villages in Maharashtra.

The trap catches in the gardens revealed that nanoporomatrix (NPM) CPCRI lure effectively trapped more number of weevils in Andhra Pradesh (1,240 numbers) and Maharsahtra (243 numbers) as against Pest Control India (PCI) lure which trapped 730 weevils in Andhra Pradesh and 105 weevils in Maharashtra (Table 2). Thus, pheromone lures can be effectively used in red palm weevil infested gardens for effective trapping and as a component of IPM.

Biological control of black-headed caterpillar in Tamil Nadu

The infestation of black-headed caterpillar was noticed in Sethumadai village of Anaimalai block of Coimbatore district on a severe scale (100%) and in Harur block of Dharmapuri district, in outbreak proportions (66.7%) in 2014. However, due to inundative release of parasitoids (7,06000 numbers of *B. hebetor*, 80000 numbers *G. nephantidis*) the pest population has completely reduced in three months thus biological control proved very effective in managing this pest.

Black Headed Caterpillar

The black headed caterpillar (*Opisina arenosella* Walker) infestation starts on the outer whorls of leaves and palms of all ages are susceptible to infestation. Due to the attack, the photosynthetic efficiency especially of

Table 2 Comparative efficacy of different lures against red palm weevil in coconut (2012-13)

Period of catches*	Total number of weevils trapped in four traps					
	Nanoporomatrix (NPM) CPCRI lure		Pest Control India (PCI) lure		Blank trap	
	Ambajipeta (Andhra Pradesh)	Ratnagiri (Maharashtra)	Ambajipeta (Andhra Pradesh)	Ratnagiri (Maharashtra)	Ambajipeta (Andhra Pradesh)	Ratnagiri (Maharashtra)
April 2012 to March 2013	639	139	457	50	00	00
June 2013 to December 2013	601	104	273	55	08	00

*New lures installed in June 2013 after old lures exhausted in April 2013

the lower fronds is impaired, thus the nut development in lower bunches is particularly affected. During sporadic out breaks it feeds on the green surfaces of the petioles, spathes and nuts also. If the pest occurs severely in the nurseries or on newly planted young palms, infestation may lead to the death of seedlings. Loss of chlorophyll in the entire foliage ultimately leads to yield losses in subsequent years. Peak occurrence of the pest was recorded in winter months from November to January and persisting up to April, May months. In the ecosystem where coconut palms are grown on the fish pond bunds, the occurrence of the pest was observed round the year including the severe hot and dry months. Periodic out breaks of this pest can be successfully managed by adopting IPM strategies.

O.arenosella damage on fish pond bund coconut trees at S.Yanam village

O.arenosella recovered garden at S.Yanam village

Management

The pest problem can be brought under check by an Integrated Pest Management programme comprising;

Mechanical: Early to mild stages of infestation can be reduced by cutting and burning the badly infested leaves/ leaflets.

Biological: Among the parasitoids, larval parasitoids, *Bracon hebetor, Goniozus nephantidis,* prepupal parasitoid, *Elasmus nephantidis* Rohw and pupal parasitoid, *Brachymeria nosatoi* are most promising ones. These parasitoids are being mass multiplied and released in fixed norms in *O. arenosella* affected coconut plantations. In addition to above parasitoids other effective parasitoids that are being observed and collected in the infested gardens under east coast conditions are the larval parasitoid, *Apanteles taragamae* and pupal parasitoids, *Xanthopimpla punctata, Trichospilus pupivora, Tetrastichus israeli* etc., bacterium *Serratia marcescens* kills the pest during the rainy seasons.

Insecticidal: In severely infested gardens, spray the palms once with dichlorvos 0.02 per cent. Spray the under surface of the leaves to give a thorough coverage to the galleries of the pest.

Coconut Eriophyid Mite

The coconut eriophyid mite, *Aceria (Eriophyes) guerreronis* Keifer was first reported on coconut in the state of Guerrero in Mexico in 1960. In India, its incidence was first noticed during 1998 in Ernakulam of Kerala. The mite sucks sap with their needle like mouth parts from the tender regions of nuts covered by perianth, and usually 2–4 months nuts are most preferred as they contain soft, young growing tissue underneath the bract. The initial symptom of attack is manifested by appearance of elongated white streaks below the perianth which later appears as pale yellow triangular patch turning gradually to brown colour. As the nut grows, this injury leads to warting and longitudinal fissures on the surface. In many cases, when perianth is removed, a pinkish band can be seen on its inner side. About two months after pollination, the patch develops fully and becomes more conspicuous. During this period, some buttons also show browning and necrosis on the periphery of the perianth. The discoloration can also be in the shape of stripes.

The Integrated pest management package is recommended for the management of coconut eriophyid mite.

- Phytosanitary measures.
- Root feeding of Azadirachtin 10000 ppm @ 10 ml + 10 ml water

The treatments is given three times in a year, i.e. December–February, April–June, September–October

- Recycling of organic waste
- Raising of green manure crops in the basin.
- Application of recommended dose of fertilizers
- Recommended level of irrigation
- Husk burial in basin
- Soil moisture conversation measures.

The large-scale validation of the IPM technology with and without root feeding Azadirachtin 10000 ppm @10 ml + 10 ml water reveals that in all the three states of Tamil Nadu, Andhra Pradesh and Maharashtra, adaptation of IPM package even with out root feeding had significant impact on per cent mite infested nuts and mite mean damage grade index.

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