

Newer Approaches in the Integrated Pest Management in Coconut

CPR.Nair, B.Sathiamma
Chandrika Mohan and
Murali Gopal

Central Plantation Crops
Research Institute
Regional Station
Krishnapuram. P.O.
Kayangulam, Kerala-690533

Introduction

The coconut palm *Cocos nucifera* L., a perennial crop grown extensively in India is prone to infestation by a large number of insect and non-insect pests. These pests cause considerable damage to various parts of the crop during all stages of its growth. Kurian *et al.* (1979) enlisted a total of 547 species of insects and mites on coconut. The annual loss due to the pest complex in coconut in Kerala has been estimated to be 618.50 million nuts (Abraham, 1994). Research programmes carried out in India over the past few decades on the pest problems of coconut have been fruitful both in identifying the major pest problems and in formulating effective management strategies for the important pests. Increased awareness on the side effects of pesticides has resulted in the development of an integrated pest management strategy to combat the pest problems. The developments in the field of pest control in India and future thrust areas are discussed in this paper.

Major Pests of Coconut Palm

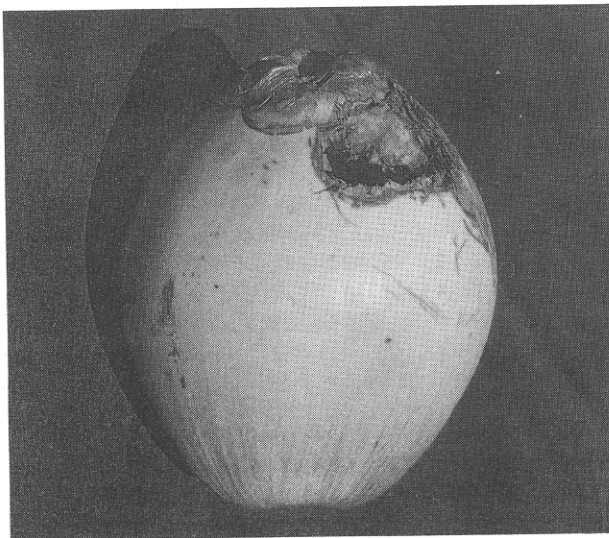
Considering the infestation severity and geographic distribution of various pests on coconut the major pests are the rhinoceros beetle (*Oryctes rhinoceros* L.), red palm weevil, (*Rhynchophorus ferrugineus* Fab.), leaf eating caterpillar (*Opisina arenosella* Wlk.) and white grub (*Leucopholis coneophora* Burm.). The rhinoceros beetle is a ubiquitous pest of coconut palm causing severe damage by boring through into the unopened fronds and inflorescence. Red palm weevil is a fatal enemy of the palm, particularly during the early period of its growth. The incidence of this pest is quite rampant in areas where palms are prone to fungal infections like bud rot or leaf rot and infestation by rhinoceros beetle. The black headed caterpillar incidence is more common in coastal and backwater areas and in the vicinity of water ways in the interior parts of the country. The poten-

tial rate of multiplication of this pest under favourable conditions makes its management more difficult at times. Infestation by the white grub mostly occurs in sandy and sandy loam areas.

Minor Pests and Emerging Pest Problems

The minor pests of coconut palm in India include the slug caterpillars which are of sporadic nature, scale insects, mealy bugs, coreid bug, termites and mites. Under favourable conditions the slug caterpillars multiply enormously and cause considerable damage on the foliage.

The seasonal changes in outbreak of agricultural pests have been the subject of study and it is widely known that climatic factors are the essential components of the environment which regulate the seasonal abundance of insects. Apart from this, changes occurring in the cropping patterns, adoption of modern agrotechniques and indiscriminate use of chemical pesticides also attribute to the instability in the ecosystem and hence, the emergence of new agricultural pest problems. Recent reports on the incidence of a few pests in coconut plantations in several parts of India present an alarming situation. The widespread occurrence of coreid bug in certain parts of Kerala, scale insects in Cumbum Valley and long green caterpillar *Turnaca acuta* W. problem in Periyar district of Tamil Nadu, increasing trends in population of mealy bugs in several parts



Rat damaged tender coconut

of Kerala and severe outbreak of nut infesting eriophyid mite hitherto unknown in India in central Kerala are some of the recently emerged problems in coconut cultivation. The wide spread occurrence agrees to the natural phenomenon that over years minor pests once not known for the severity emerge as potential pests of crop due to changing scenario in agriculture.

The present management technology for the above species of pests centers around chemical control. Though a wide range of indigenous natural enemies are recorded on these pests elaborate studies are required to utilise these natural enemies in an IPM package which is yet to be evolved against them.

Vertebrate Pests

Among vertebrate pests rodents are the major threat to coconut all over the world. In India 10 species of rodents are known to coexist in coconut and its intercrops. The arboreal black rat *Rattus rattus wroughtoni* causes damage on tender nuts in all coconut growing states. The burrowing rodents namely *Bandicota bengalensis*, *B. indica* and the gerbil *Tatera indica* make extensive burrows in soil and damage the coconut seedlings by eating away the cabbage portion.

An integrated approach consisting of mechanical barriers, farm sanitation trapping and chemical methods is generally followed for rodent management. The use of single dose anticoagulant rodenticide, bromadiolone is effective in the management of *Rattus rattus wroughtoni*. The burrowing rodents are effectively controlled by poison baiting using zinc phosphide (Bhat and Sujatha, 1993).

Current Pest Management Strategy

The work carried out by various agencies in India (CPCRI & State Agricultural Universities)

has resulted in the formulation of different pest control methods. A major component evolved initially to combat the pest problem was the use of chemical pesticides. Increased awareness on the side effects of such chemical pesticides has led to the formulation of alternate pest management systems. Bio-control programmes have taken a long way in the management of key pests like rhinoceros beetle and leaf eating caterpillar. Though the concept of integrated pest management (IPM) system for the control of coconut pests had been fully conceived long back by various research organisations, the recommendation for a particular pest varied widely. Recently a uniform package of practices was formulated based on the recommendations of these organisations. (Nair *et al.* 1997)

IPM Schedule Evolved for Major Pests

The IPM package for rhinoceros beetle consists of extraction of beetles using a beetle hook during peak period of pest abundance (June - September) from the crown of palms, treatment of all possible breeding sites of the beetle with 0.01 per cent carbaryl, proper disposal of breeding grounds of beetle and biological suppression using the microbial agents like baculovirus of *Oryctes* and *Metarhizium anisopliae*. (Pillai *et al.* 1993)

In the case of red palm weevil prevention of pest entry is a major step to be adopted in the IPM package. This is possible by avoiding injuries on the palm and by treating the wounds, if any, with coal tar + carbaryl. Prophylactic crown treatment with insecticide sand mixture (25gm of sevidol 8G in 200g of fine sand) in May, September and December and curative treatment with 0.1 per cent endosulfan/dichlorvos or 1 per cent carbaryl are effective in the management of the pest (Nair *et al.* 1997). Trapping of the float-

ing population of the weevil using coconut logs treated with fermenting toddy is also recommended. Maintenance of field sanitation by removal and burning of dead palms helps a lot in reducing fresh incidence of weevil attack. Adoption of the above methods under an IPM package has yielded encouraging results in the farmers garden. (Abraham *et al.* 1989)

The leaf eating caterpillar can be well managed by biological control methods. However, an IPM method is to be adopted in an epidemic outbreak. During such instances cutting and burning of badly infested outer leaves/leaflets, spraying with a less toxic insecticide like 0.02 per cent dichlorvos if the pest is in the active larval stage and subsequent release of stage specific parasitoids at fixed norms and interval would bring down the population of the pest. (Sathiamma, 1993a)

Deep ploughing and digging of soil during pre and post monsoon periods, collection and destruction of adult beetles during peak emergence period in May - June, setting up of light traps to attract adult beetles and insecticidal application with phorate 10G @ 100g per palm during May - June and September - October are the components involved in the IPM schedule for white grubs. (Chandrika Mohan & Vidyasagar 1993, CPCRI, Annual Report 1991-92)

Lead Areas in the IPM

1) Biocontrol strategy

Investigations at Central Plantation Crops Research Institute clearly proved that biocontrol strategy could be effectively implemented in the IPM of the rhinoceros beetle and leaf eating caterpillar. Eco-friendly and biologically effective components viz, pathogens, parasites and predators could be utilised for the control of these two major pests. In both the cases use of hazardous insecticides could be eliminated

from the schedule and sustainable management of the pests could be achieved. Use of baculovirus of *Oryctes*, a landmark example of a pathogen ever employed for the control of an insect pest (Caltagirone, 1981) in coconut plantations in the island conditions of Lakshadweep, Minicoy (Mohan *et al.* 1989) and Androth (Sathiamma, 1993b) and Andamans (Jacob, 1990) clearly proved the efficiency of the pathogen, where baculovirus disease was introduced. It was also demonstrated in cultivators' gardens at Chitilapally, Trichur, Kerala where the disease in beetle population was already present. This technology could be used for achieving more than 80% control of rhinoceros beetle damage to palms and significant reduction in the population of the beetle in the breeding sites (Biju *et al.* 1995). The pathogen is very effective in that it kills the grub in 15-20 days of infection and the longevity and fecundity of the adult beetles are reduced. The efficacy of this viral pathogen is being tested in all the co-ordinating centres located in different states under the All India Co-ordinated Research Project on palms.

Similarly, the 'Green Muscardine Fungus' *Metarhizium anisopliae* M. is another pathogen which kills the pest in conditions of low temperature and high humidity. Natural mortality to the grubs and adults occurs during rainy seasons. This fungus could easily be mass multiplied using cheaper substrates, both solid and liquid and the spores could be harvested and treated in the breeding materials @ 10^{11} spores/m³ of cattle dung (Mohan & Pillai 1982, Danger *et al.* 1991). Once applied these spores will infect the host grubs in the breeding grounds and effect control of the pest within a fortnight. Survival of the fungal spores was observed in the treated sites for more than two years.

With regard to *O. arenosella*, biological pest suppression using

indigenous parasitoids proved to be one of the most effective management techniques bringing about 90% control of the pest in the field. Release of the promising parasitoids at fixed norms and intervals after assessing the target stage of the pest is the best way of checking the build up of the caterpillar pest (Sathiamma *et al.* 1987). In the past the easily bred parasitoids such as *Bracon brevicornis* Wesm. and *Trichospilus pupivorus* Ferr. were released in large numbers for the suppression of the pest. But these parasitoids could not effect successful control of the pest in endemic areas as the former species is male dominated and the latter aestivates during the summer season which is the peak period of the pest. Studies revealed that success could be achieved by releasing stage specific parasitoids at definite intervals till the pest population is reduced to a significant level. The bethylid *Goniozus nephantidis* (Mues.) is one of the late larval parasitoids present in almost all *Opisina* infested locations with a female preponderance and capable of surviving the summer condition. It could easily be mass multiplied in the laboratory on larvae of *O. arenosella* and *Corecya cephalonica*. The elasmid *Elasmus nephantidis* Roh. parasitises the pre-pupal stage. This is a stage specific and host specific parasitoid and could be multiplied only using the pre-pupal stage of *Opisina*. Pupal parasitoids such as *Brachymeria nosatoi* H. is another sturdy parasitoid having a distribution in all *Opisina* infested tracts. They are readily available in the field even in summer in abundance and uniformly distributed in all *Opisina* infested locations. *Brachymeria nosatoi* could be multiplied on fresh pupae of *Opisina*. These three parasitoids namely bethylid, elasmid and chalcidid released at fixed norms at 20.5, 49.4 and 31.9%, respectively, at fortnightly

intervals depending on the larval, pre-pupal and pupal stages of the pest in the field could effectively bring down the pest population below the economic injury level. Follow-up observations also clearly showed that the pest incidence remains at a low level and no further releases were needed for the past three years.

There are other dominant parasitoids such as *Xanthopimpla punctuata* and *X. nana nana* parasitising the pupae of *O. arenosella*. These parasitoids are located in certain pockets only. But, wherever they are present they are capable of checking the *Opisina* population (Pillai and Nair, 1989). Selection of parasitoids could thus be made depending on specific locations in which they occur.

In addition to these late stage parasitoids there are certain braconid parasitoids such as *Apanteles taragamae* W. parasitising the early stage (first or second instar) larvae of *Opisina*. Parasitism is very much prevalent in the infested coconut palms during the early stage of pest build up. Studies are in progress to assess the efficacy of these parasitoids so as to check the pest at the early stage of infestation before it can cause any leaf injury.

Hitherto, spraying or injection of toxic pesticides were thought to be the best method for the control of *O. arenosella*. The insecticides mostly destroyed the natural enemies, the parasites and predators especially the large number of predacious spider fauna present in the coconut ecosystem. The reduction in the natural enemies gives a boost to the multiplication of the pest and causes an outbreak situation. Even where an insecticide application is required, usage of a less residual insecticide, which is not deleterious to these beneficial fauna is recommended.

Preliminary investigations carried out at CPCRI has indicated

the presence of entomophilic nematodes (EPN) in association with rhinoceros beetle, red palm weevil and white grubs. Recent attempts on isolating native strains of EPN revealed the presence of *Rhabditis* sp. and *Heterorhabditis* sp. in the natural population of the pest. Preliminary trials with commercial formulation of *Heterorhabditis* and *Steinernema* against red palm weevil and rhinoceros beetle have also given positive results. (CPCRI Annual Report 1995-96). In depth studies are required to develop a pest management measure to utilise these native isolates of EPN.

2) Regulation on the use of hazardous pesticides

The chemical pesticides recommended for the management of major pests of coconut till recently were chlorinated hydrocarbons like HCH, chlordane and heptachlor. These chemicals have been eliminated from the package of practices in the nineties by undertaking elaborate field trials using newer pesticides. Replacement of chlorinated hydrocarbons by less hazardous chemicals like sevidol and thimet could be achieved through recent trials carried at CPCRI. Atmospheric pollution by the agrochemicals is caused by the indiscriminate use of pesticides, their mode of application and also by the persistent nature of the chemicals. Studies on the field control of rhinoceros beetle and red palm weevil have shown that placement of 5g of phorate 10G in two perforated polythene sachets @ 2.5g per sachet in the leaf axils surrounding spindle provide protection from the infestation by these two pests (CPCRI Annual Report, 1996-97).

Use of systemic insecticides like monocrotophos by stem implantation or root feeding makes an alarming situation when it is used for the management of red palm weevil and black headed

caterpillar in yielding palm. In such cases all mature nuts should be harvested before administering the chemicals and in places where tender coconut is used as a soft drink harvest should be strictly forbidden up to 45 days after treatment of pesticides.

Botanical Pesticides and Eco-Friendly Chemicals

Studies carried out at CPCRI and TNAU have indicated that prophylactic method of leaf axil filling with naphthalene balls at 12.0g per palm once in 45 days has been effective in the management of rhinoceros beetle. Recent studies on the management of rhinoceros beetle and red palm weevil using powdered oil cakes showed that application of 250g of marotti oil cake mixed with 200g of fine sand in the leaf axils surrounding spindle in May, September and December provided prophylactic control of these pests (CPCRI Annual Report, 1996-97). Preliminary studies on plant species like clerodendron, vitex and commercial formulations like nemazal, anona extract etc. being carried out at CPCRI indicate their potential role in the future pest management in coconut.

Attractants and Pheromones

Attractants like toddy and castor oil cakes have been used in the management of red palm weevil and rhinoceros beetle. Fresh coconut logs, 50cm long, split longitudinally and the cut surfaces treated with fermenting toddy act as an effective trap for capture of red palm weevil adults (Kurian *et al.* 1984). Rotting castor cake exposed in mud pots has been found to be effective in trapping adults of rhinoceros beetle (TNAU, 1985).

Use of pheromone traps for management of coconut pests has added new vistas in pest management in coconut. An aggregation

pheromone has been tested in various countries (Oehlschlager *et al.* 1993 and Rochat *et al.* 1993). Studies on the pheromone trap against red palm weevil carried out at CPCRI has shown encouraging results. However, more studies have to be made to ascertain its feasibility in view of the probable behavioral changes of the pest that can happen in the long run.

Importance of Surveillance in IPM

Population build up of any pest is dependent on the biotic and abiotic factors of the environment. Research carried out on the bioecology of major pests like leaf eating caterpillar, rhinoceros beetle, red palm weevil and white grubs have thrown more light on the population dynamics of these pests. In case of pests with long duration life cycle proper management strategies can be resorted as calendar of operations against candidate pests. But in cases of outbreak pests like black headed caterpillar, slug caterpillars, scale insects, mealy bugs and eriophyid mite which have comparatively short life cycle, periodic monitoring of the pest population in the field will be required to gear up the pest management programmes.

Need for Community Effort

Integrated pest management programme advocates a community effort to bring down the population growth of any pests. In case of coconut, as the plantations are contiguous and the pests are capable of migrating considerably long distance, adoption of a pest management strategy in a cooperative area wise manner is required. This is more applicable in case of chemical, cultural and sanitational methods of pest management that play a pivotal role in the management of certain pests like red palm weevil and white grubs.

Future Thrust

Though IPM technologies have been formulated for major pests efforts are to be continued to refine the technology to make them more eco-friendly and farmer-friendly. Determination of pesticide residue in the crop and its products, efficient use of bio-pesticides and synthetic pheromones, formulation of biocontrol methods for important pests and emerging pests, cheaper and efficient pesticide application method etc. are some of the priority areas requiring immediate attention of researchers.

Large scale field demonstration of the current IPM technologies to make them more farmer-acceptable is an important task in the development programme of coconut. Such demonstration programmes covering larger areas of farmlands under the IPM umbrella is in the current programme of Central Plantation Crops Research Institute.

Acknowledgement

The authors express their gratitude towards The Director, CPCRI Kasaragod, Head, Crop Protection Division and Head CPCRI Regional Station Kayangulam for their encouragement. Services of Mr. B. Anilkumar, Technical Assistant for word processing of this manuscript is duly acknowledged.

References

Abraham, C.C. 1994. Pests of coconut and arecanut. pp 709-726. In: *Advances in horticulture - Plantation Crops and Spices Crops Part 2*. Eds. K.L. Chadha and P. Rethinam. Malhotra Publishing House, New Delhi, India

Abraham, V.A.; Koya, K.M. Abdulla and Kurian, Chandu. 1989. Integrated management of red palm weevil (*Rhynchophorus ferrugineus* F.) in coconut gardens. *J. Plantn. Crops* 16(Suppl.):159-162.

Bhat, S.K. and Sujatha, A. 1993. Rodent and other vertebrate pest management in coconut and cocoa. CPCRI Tech. Bull. No.26. Central Plantation Crops Research Institute, Kasaragod. pp. 1-13.

Biju, B., Sudhadevi, K., Danger, T.K., and Sathiamma, B. 1995. Biological suppression of *Oryctes rhinoceros* by re-release of *Baculovirus oryctes* in an infected contiguous area. *J. Plantn Crops* 23:62-63.

Caltagirone, L.E. 1981. Landmark examples in classical biological control. *Ann. Rev. Entomol.* 26 : 213-232.

Chandriya Mohan and Vidyasagar, P.S.P.V. 1993. Bioecology of coconut white grub *Leucopholis coneophora* Burmeister in Kerala. *J. Plant. Crops* 21(Suppl.): 167-172.

CPCRI, Annual Report 1991-92. Central Plantation Crops Research Institute, Kasaragod. p. 86.

CPCRI, Annual Report 1995-96. Central Plantation Crops Research Institute, Kasaragod. p. 101-102.

CPCRI, Annual Report 1996-97. Central Plantation Crops Research Institute, Kasaragod. p. 91.

Dangar, T.K.; Geetha, L.; Jayapal, S.P. and Pillai, G.B. 1991. Mass production of entomopathogen *Metarhizium anisopliae* in coconut water wasted from copra making industry. *J. Plantn. Crops* 19(1): 54-69.

Jacob T.K. 1990. control of rhinoceros beetle, *Oryctes rhinoceros* L. CARI Res. Bull. No.4.11 pp. Central Agricultural Research Institute, Port Blair, India.

Kurian, C.; Abraham, V.A. and Ponnamma, K.N. 1984. Attractants, an aid in red palm weevil management. pp.581-585. In: *PLACROSYM V*.

Kurian, C.; Sathiamma, B.; Pillai, G.B., and Ponnamma, K.N. 1979. Insects and mites associated with the coconut palm (*Cocos nucifera* L.) IN *Nematodes, fungi, insects and mites associated with the coconut palm*. CPCRI Tech. Bull. 2 : 93-236. Central Plantation Crops Research Institute, Kasaragod.

Mohan, K.S.; Jayapal, S.P. and Pillai, G.B. 1989. Biological suppression of coconut rhinoceros beetle (*Oryctes rhinoceros* L.) in Minicoy, Lakshadweep by *Oryctes baculovirus* - impact on pest population and damage. *J. Plantn. Crops*. 16 (Suppl.): 163 - 170.

Mohan, K.S. and Pillai, G.B. 1982. A method for laboratory scale mass cultivation of *Metarhizium anisopliae*. *Folia Microbiol.* 27: 281 - 283.

Nair, C.P.R.; Mariamma Daniel and Ponnamma K.N. 1997. Integrated Pest Management in Palms: Eds. Nambiar, K.K.N. and Nair, M.K. Coconut Development Board, Kochi, India. pp.30.

Oehlschlager, A.C.; Chinchilla, C.M.; Gonzales, L.M.; Jikon, L.F.; Mexzon, R. and MORGAN, B. 1993. Development of a pheromone-based trapping system for *Rhynchophorus palmarum* (Coleoptera : Curculionidae). *J. Econ. Entomol.* 86(5): 1381-1392.

Pillai, G.B. and Ramachandran Nair, K. 1989. Observations of *Xanthopimpla punctata* F. (Hymenoptera: Ichneumonidae), a pupal parasitoid of *Opisina arenosella*. *J. Plantn Crops* 16(Suppl.):173-177.

Pillai, G.B.; Sathiamma, B. and Danger, T.K. 1993. Integrated control of rhinoceros beetle. pp 455-463. In: *Advances in coconut research and development*. (Eds) Nair, M.K., Khan, H.H., Gopalsundaram, P. and Bhaskara Rao, E.V.V., Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.

Rochat, D.; Malosse, C.; Lettère, M.; Ramirez-Lucas, P.; Einhorn, J. and Zagatti, P. 1993. Identification of new pheromone - related compounds from volatiles produced by males of four *Rhynchophorinae* weevils (Coleoptera : Curculionidae) C.R Acad. Sc. Paris.

Sathiamma, B. 1993. a) *Opisina arenosella* Wlk. the leaf eating caterpillar of coconut palm. *Tech. Bull* No.27, p.11. Central Plantation Crops Research Institute, Kasaragod.

Sathiamma, B. 1993. b) Studies on transmission of baculovirus disease of *Oryctes rhinoceros* L. in nature and field evaluation of the pathogen. Final report on the ICAR AP Cess Fund Scheme. No. C1-88/10-ici-H20, September 1988 to September 1992. p. 35.

Sathiamma, B.; Pillai, G.B.; Jose Abraham; Bhat, S.K.; Jayapal, S.P. and Nair, K.R. 1987. Norms for release of larval, prepupal and pupal parasitoids of *Opisina arenosella* Wlk. the leaf eating caterpillar pest of coconut palm. *J. Plantn Crops*. 15(2):118-122.

Tamil Nadu Agricultural University 1985. *Crop production guide*. TNAU and Directorate of Agriculture, Horticulture and Oil seeds. pp. 306.