

Integrated Pest Management in coconut based cropping systems

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Being evergreen with a unique morphology, the coconut palm provides shelter and food for a wide array of arthropod borer pests and their natural enemies. Many biotic and abiotic factors limit the palm productivity worldwide, causing loss to the tune of 30%. Rhinoceros beetle (*Oryctes rhinoceros* Linn.), red palm weevil (*Rhynchophorus ferrugineus* Oliv.), black headed caterpillar (*Opisina arenosella* Wlk.) nut infesting eriophyid mite (*Aceria guerreronis* Keifer) and white grub (*Leucopholis coneophora* Burm.) are the major pests of coconut having wider distribution in all coconut growing tracts of India. Rodents also cause heavy crop loss in certain areas like Island ecosystem and lands locked with water bodies. Minor pests include coreid bug, slug caterpillars, scale insects, mealybugs, termites and whiteflies. Their nature and severity of the problems however vary with the type of cultivars, height, location, weather and cultural practices.

Rhinoceros beetle: *Oryctes rhinoceros* Linn. (Scarabaeidae : Coleoptera)

Oryctes rhinoceros commonly known as rhinoceros beetle or black beetle is a major pest of coconut in all the coconut growing regions of the world. Besides coconut, the pest also infests oil palm, date palm, palmyrah, areca, sago palm, pandanus, pine apple, colocasia, banana, sugar cane etc.

Damage symptoms: The adult beetles cause damage to palms of all age groups by boring into the unopened spear leaves and spathes and chew off



the soft internal tissues. Once these injured spindles open up, the green leaves present a geometric 'V' shaped cut pattern. Attack in young seedlings results in stunted growth and delayed flowering. Black beetle infestation has to be considered serious as the damage done by this pest provides egg laying sites for another lethal pest viz., red palm weevil and for entry of fungal pathogens.

Pest Management: Integrated Pest Management adopted on a community basis is very much essential to bring an effective control of Rhinoceros beetle population. The components of IPM package are as follows.



Field sanitation: Remove dead and decaying organic debris from coconut plantations as they serve as breeding sites for the beetles. Dead planting material must be removed.

Mechanical control: This method involves periodical examination of the palm, crown and extracting the adult beetles by menace of a beetle hook during the peak period of pest infestation (June – September). The wounds may be treated with Bordeaux mixture (1%) and plug the holes with mixture mud/cement to avoid further entry of pathogens or insect pests. Covering the crown or cabbage portion with nylon nets also found to be effective



Prophylactic leaf axil filing with either of the following material should be practiced before and after monsoon season

- Application of neem or marotti (*Hydnocarpus wightiana*) cake in powder form and fine sand (1:1

ratio) @ 500g. in to the top most three leaf axils around the base of the spindle leaf during May, September and December

- Application of naphthalene balls in the leaf axils at the base of the spindle @ 12g. per palm covered with sand at 45 day intervals also provide good protection against the pest especially in young palms.
- Mixture of chlorantraniliprole 0.4 % WG (50 g) + 2 kg Sand
- Placement of two perforated sachets (3g) containing chlorantraniliprole (0.4 % WG) or fipronil (0.3 % ai) per palm. Pour 100 ml of water to the sachets for subsequent release of insecticides.

Biological control: Two microbial pathogens viz., *Oryctes rhinoceros nudivirus* (OrNV) and *Metarhizium anisopliae* are widely employed for the black beetle management.

All the three larva instars and adult stages are susceptible to OrNV infection. This virus gains entry in to the host orally through contaminated food only.

Field dissemination: The best practical method of dissemination of this virus is by releasing the infected adults in the field @ 10-15 number/hectare.

Release the beetles in the field preferably at dusk .The beetles disseminate the virus in to the surroundings through their excreta.

Observe the field for rhinoceros beetle control once in six months. This technology is highly successful in island where infiltration of natural population is less.

Metarhizium anisopliae: This is also known as the “green muscardine fungus” and is pathogenic to all life stages of the *Oryctes rhinoceros*. Infected grubs die within 10 – 15 days and turn into green colour due to production of powdery spores. Treating the breeding sites spore suspension @ 5×10^{11} spores/m³ is effective when high humidity and ambient temperature prevails. Once the fungus establishes itself, it will survive in the site for more than two years.

Botanical control: Incorporation of the weed plant *Clerodentron infortunatum* Linn. in the compost pit is suggested as cheap and effective method for managing *Oryctes rhinoceros* in the breeding sites



as the chemical substances contained in the plant arrests the development of different stage of the pest.

Pheromone traps: Specially designed PVC tube trap employing synthetic pheromone ethyl 4-methyl-octonate (Rhinolure) @ 1 trap / hectare is found feasible for trapping black beetles. This can be employed as one of the components in IPM in community based pest management approach with close monitoring. Avoid installation of traps in gardens with juvenile palms.



as ploughing, cutting of steps for climbing the palms, the injured palm becomes more susceptible to weevil infestation. Timely treatment of wounds or injuries is unavoidable to ward off pest infestation. Palms showing early stage of infestation may be subjected to curative treatment of stem injection with spinosad 2.5 % SL @ 4 ml / litre or imidacloprid 17.8 % SL @ 0.6 – 1 ml/ litre and plug the hole with cement or mud. If the damage is noticed in the crown, damaged portion may be cleaned and insecticide suspension may be poured in. A waiting period of 45 days is to be strictly followed to avoid the residue problem. With the synthesis and availability of ferrugineol based pheromone lure for RPW, the IPM programme was modified to incorporate pheromone traps and it was successfully utilized to combat the pest in coconut and date palm which have proved that trapping of red palm weevil using pheromone lures (4-methyl 5-nonanone (Ferrugineone) and 4-methyl 5-nonanol (Ferrugineol) in food baited bucket traps can be one of the effective IPM tools when adopted in community level to manage red palm weevil.

Red palm weevil: *Rhynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae)

Red palm weevil (RPW), the fatal enemy of coconut palm is reported to attack 17 palm species worldwide. Young and dwarf palms are more susceptible to the pest infestation. Incidence of red palm weevil is relatively high in those areas having high incidence of rhinoceros beetle, bud rot disease and leaf rot disease. This pest is now continuously spreading in all the areas of palm cultivation throughout the world.

Damage symptoms: Being an internal tissue feeder with all the life stages inside the palm tissues, it is very difficult to detect the pest attack during the early stages. The characteristic symptoms of this pest attack includes yellowing and wilting of inner and outer whorls of leaves, presence of circular holes and tunnels on the palm, fermented odouration, gnawing sound of grubs while feeding, oozing out of a brownish viscous fluid from the holes/ tunnels, presence of fibrous cocoon and/or chewed up fibers at the leaf axil or palm base. Severe infestation results in toppling of the crown.

Pest Management: IPM for managing red palm weevil comprises the following important components viz., phytosanitation, prophylactic treatments, curative chemical treatments and pheromone trapping. Dead palms retained in the field or coconut gardens serve as ideal source of inoculum for further build up of the pest in the field and clean cultivation should be practiced. Prophylactic leaf axil filling suggested for the management of rhinoceros beetles are to be followed. Due to mechanical farm operations such

Black headed caterpillar: *Opisina arenosella* Walker (Oecophoridae: Lepidoptera)

The black headed caterpillar, *Opisina arenosella* Walker (Lepidoptera: Oecophoridae) is a dominant caterpillar pest of coconut in India and Sri Lanka. The larvae of this insect feeds on the under surface of leaflets resulting in considerable reduction on the photosynthetic area of the palm. Severe infestation by this pest reduces the yield of the palm and in addition renders the leaves unsuitable for thatching and other purposes. Generally, it is a sporadic pest and outbreak occurs during summer months (Feb - May) which lead to severe damage to coconut plantations.

Damage symptoms: First noticeable symptom of infestation is the drying of leaflets in patches. The caterpillars are voracious feeders and feed on the chlorophyll containing leaf tissues leaving the thin upper epidermis. Close examination of leaflets shows presence of larval galleries on the lower side with live or dead stages of the pest. Severe pest damage

results in complete drying of middle to inner whorl of leaves also. In case of severe infestation, the whole plantations exhibit a scorched appearance.

Pest Management: Biological method of pest suppression has been accepted as a long term strategy to curb the pest problem in this perennial crop on account of increasing ill effects by the use of chemical methods for pest management. Parasitoids and predators play an important role in the natural biological suppression of *O. arenosella*. Cut and burn severely infested lower whorl of leaves. Field release of parasitoids may be done as follows: *Goniozus nephantidis* @ 20 parasitoids / palm, *Bracon brevicornis* @ 30 parasitoids / palm, the pre-pupal parasitoid, *Elasmus nephantidis* @ 50 /100 prepupae, and the pupal parasitoid *Brachymeria nosatoi* @ 32 / 100 pupae at the appropriate time. Nutritional management of the palm with balanced dose of recommended fertilizers and proper irrigation to rejuvenate the pest affected palms are



essentially required to regain the yield potential of pest infested palms.

Nut infesting eriophyid mite: *Aceria guerreronis* Keifer (Eriophyidae: Prostigmata)

The nut infesting eriophyid mite, *A. guerreronis* is one of the most serious pests of coconut causing significant reduction in yield. Mite activity has been observed throughout the year with the population peak during the summer months. Coconut mite is a microscopic creamy white, vermiform organism and completes its life cycle in 7-10 days.

Damage symptoms: The mite infests buttons during early stages of growth soon after pollination. Developing nuts harbour a large population of mites under the perianth. Symptoms appear approximately one month after initial colonization in side pollinated button. Appearance of white longitudinal patches just below the perianth and their development to



triangular yellow patches are the early symptoms of pest infestation. As the nut grows these patches turn brown and longitudinal fissures and wartings appear on the nut surface. Drying and shedding of buttons and young nuts are also seen.

Pest Management: Owing to the concern over environment contamination by repeated chemical pesticides application, currently botanical pesticides viz., neem based biopesticides are recommended for management of the pest in the field. Spraying of neem oil-garlic soap mixture at 2% or commercial botanical pesticides containing azadirachtin 10,000 ppm @ 0.004% or root feeding with neem formulations containing azadirachtin 50,000 ppm (7.5 ml) or azadirachtin 10,000 ppm (10 ml) mixed with equal volume of water is recommended for mite management. The nutritional status of the palm plays a significant role in the management of the pests. The nutrient management package consists of balanced application of NPK fertilizers at recommended doses in two splits (Urea 1.0 kg, rock phosphate 1.5 kg, muriate of potash 2.0 kg), recycling of organic biomass in coconut ecosystem using in situ vermi composting or growing of green manure crops like cow pea or sunnhemp and its incorporation in coconut basin and conservation of soil moisture by appropriate mulching methods.

White grubs: *Leucopholis coneophora* Burm., *L. burmeisteri* Brenk., *L. lepidophora* Blanch (Scarabaeidae: Coleoptera)

White grubs are major pests of coconut palm mostly found in sandy loam soil tracts of Kerala and Karnataka. Grubs are polyphagous and feed on roots of coconut palm as well as other intercrops like tubers, rhizomes, vegetables etc.

Damage: In nursery seedlings the grubs feed on tender roots and also tunnel into the bole and collar regions resulting in the drying of the spindle leaves followed by gradual death of the seedlings. In older

coconut plantations continuous infestations by the grub's results in yellowing of leaves, premature nut fall, delayed flowering, retardation of growth and reduction in yield. Peak grub population is seen in the coconut basin during September-October.

Pest Management

- Hand picking and destruction of adult beetles during emergence period (May/ June)
- Soil application of bifenthrin @ 2 kg ai / ha (bifenthrin 10 EC @ 20 litres ha-1 in 500 l of water) when first instar stage of grubs dominate in the field (July-August).
- Root zone application of chlorpyrifos 20 EC @ 2kg ai / ha (i.e @ 7 ml / palm after 45 days of first round insecticide application.
- Drenching aqua suspension of EPNs Steinernema carpocapsae in the interspaces 5-10 cm depth with 40 - 50 Lakh ijs / 5 litre of water. Need based repeated application of EPN.
- Regular ploughing to expose the grubs to predators

Coreid bug: *Paradasynus rostratus* Dist. (Coreidae : Hemiptera)

The widespread occurrence of the coreid bug, *Paradasynus rostratus* Dist. (Heteroptera: Coreidae) was reported as a serious emerging pest on coconut from Southern districts of Kerala. The bug causes heavy crop loss by shedding of developing buttons and immature nuts. Guava, cashew, cocoa, tamarind, anona and neem are alternate hosts of *P. rostratus*.

Damage: Nymphs as well as adults feed on female flowers and tender nuts. While feeding, the saliva is injected into the feeding site through the proboscis and the toxin present in the saliva damaged the tissues around the feeding site. These feeding punctures develop into necrotic lesions and these eye-like depressions can be clearly seen if the perianth of the shed button is removed. Most of the infested buttons and tender nuts shed down. The retained nuts on the bunches develop furrows and crinkles on their husks and are malformed.

Pest Management: Crown cleaning to destroy eggs and immature stages of the pest is recommended for coreid bug management. Application of neem seed oil plus garlic emulsion 2% was found effective in



the suppression of the pest. Spraying of azadirachtin 300 ppm @ 0.0004% (13 ml / L) reduced the pest incidence at the highest level.

Scale insects and mealy bugs

In coconut, four species of armoured scales viz., *Aonidiella orientalis*, *Aspidiotus destructor*, *Lepidosaphes megregori*, *Chionaspis* sp. were recorded from Kerala and Minicoy. Three species of soft scales viz., *Ceroplastes floridensis*, *Coccus hesperidum*, *Vinsonia stellifera* were also observed on coconut from these regions.

Five species of mealybugs are associated with coconut in India. They are *Palmiculter palmarum*, *Pseudococcus longispinus*, *Pseudococcus cocotis*, *Dysmicoccus* sp. and *Rhizoecus* sp.

Pest Management: Destruction of highly infested plant parts at the initial stages of infestation and removal of alternate weed hosts in the immediate vicinity is practiced for pest management. As the pest is naturally suppressed by predators especially coccinellid beetles, conservation of them in the ecosystem is recommended. Scale insects are spread by transport of infested plants or plant parts. Surveillance should be strict on the movement of planting material to avoid spread of scale insects across the transcontinental borders. In case of out breaks, three sprays of 2.5% fish oil rosin soap were found to be effective in reducing the population of *A. destructor*.

Whiteflies

Rugose spiralling whitefly (RSW): *Aleurodicus rugioperculatus* Martin

Bondar's nesting whitefly, *Paraleyrodes bondari* Peracchi

Nesting whitefly, *Paraleyrodes minei* Iaccarino

Palm infesting whitefly, *Aleurotrachelus atratus* Hampel

Since 2016, plantation cropping system especially coconut and arecanut crops in our country witnessed the incursion of four exotic whiteflies. Both the nymphs and adults of whiteflies directly suck the phloem sap of the leaf and excrete honey dew thereby forming the sooty mould on leaf surface eventually reducing the photosynthesis in the affected palms. The affected leaves are characterised by the presence of conspicuous sooty mould fungus on the upper side and the presence of



whitefly colonies in the lower surface of the infested leaflets.

The integrated pest management strategies to be adopted are as follows:

- Application of 1% starch on the sooty mould affected leaves to flake out the mould,
- Fixing of yellow sticky trap of one meter width painted with white grease or castor oil on the trunk of infested palms to trap the adult whiteflies.
- Conserve /encourage natural buildup of *Encarsia guadeloupae* through providing reservoir plants/ banker plants.
- Pesticides holiday may be declared for the pest. Therefore, application of unwarranted insecticides may be avoided to enhance the natural parasitism.
- Under severe outbreak situation and absence of natural parasitism, neem oil 1% may be applied.

Rodents: *Rattus rattus wroughtoni* Hinton

Damage: Typical rat damage to tender coconut consists of a small hole about 5 cm diameter near the stalk region. The rat after gnawing the husk consumes the inner contents including the soft shell of the nut and such damaged nuts usually remain on the bunch for a further period of 2-6 days. The fallen nuts are seen around the basin of the palm. Three to six months old tender nuts are mostly preferred by this mammalian pest.

Pest Management: Planting coconut seedlings in correct spacing as well as destruction of fallen fronds and other farm wastes at regular intervals would ward off the rat activity from coconut gardens. Wrapping the trunk of coconut trees using aluminium or polythene sheets was found to reduce the damage

by rats in Minicoy. In coconut plantations, the black rats generally live on the crowns of the coconut palm by constructing nests. Hence, removal of dried leaves, spathes and matrix regularly from the crowns expose the nesting place of these rats to predators. A habitat alteration discourages rats from population build up on the crown. The more effective and economic way of managing this pest is by the use of single dose anticoagulant rodenticide, Bromadiolone (0.005%) in wax cake formulation. In coconut, application of 10 g Bromadiolone (0.005%) blocks two times at an interval of 12 days on the crown of one tree out of every five trees is recommended for effective control of black rat. This method is highly cost-effective. If the damage is restricted to certain palms, only such palms require baiting.

Conclusion

Careful understanding of pests and its diagnostic symptoms are very crucial for successful implementation of pest management strategies in plantation crops. A holistic approach in the execution of IPM with greater emphasis on pest-defender relationship and crop-habitat diversification strategies are the need of the hour. Adequate and timely nutrition of crops with need-based irrigation are very essential components in the field level suppression of pests. Farmers field school and farmer participatory approaches in pest management have emerged as effective tools in pest management. Impact of climate change and transformation of minor pests as key pests need to be closely scrutinized. Crop production and protection systems should therefore work in synergy for realizing highest returns from plantation crops farming. ■