

Arthropod pests of Coconut, *Cocos nucifera* L. and their management

Atanu Seni

Orissa University of Agriculture and Technology, AICRIP, RRTTS, Chiplima, Sambalpur-768025, Odisha, India

E-mail: atanupau@gmail.com

Abstract—Coconut, *Cocos nucifera* L. (Palmeaceae) is an important crop and widely cultivated in the tropical and subtropical regions of the world. Millions of people depend on this crop by employed in various coconut-based industries like coconut oil, dry coconut powder, tender coconut, coir, coconut cake, etc. But its production has been greatly affected by the infestation of several arthropod pests. Among them; *Rhynchophorus ferrugineus* Olivier, *Oryctes rhinoceros* L, *Opisina arenosella* Walker, *Aceria guerreronis* Keifer, *Latoia lepida* (Cramer) and *Aspidiotus destructor* Signoret are causing maximum damage in coconut which ultimately affect the true potential of the crop. Here, the present article provides recent information regarding different arthropod pests of coconut, their identification, life-history, nature of damage and their management in an effective way.

Keywords—Arthropod pests, Coconut, life-history, damage, management.

I. INTRODUCTION

Coconut, *Cocos nucifera* L., commonly known as “Kalpa Vriksha” and it provides livelihood to billions of people across the world. It is one of the most useful trees in the world because from top to root, every part of the plant is useful in households. It is grown in almost 93 countries mainly in India, Indonesia, Philippines and Sri Lanka together accounting for 78% of the total world production [9]. Fresh kernel is consumed all over the India and it forms an ingredient of many Indian food preparations [12]. But its production has been greatly affected by the infestation of several arthropod pests. Among them; *Rhynchophorus ferrugineus* Olivier, *Oryctes rhinoceros* L, *Opisina arenosella* Walker, *Aceria guerreronis* Keifer, *Latoia (Parasa) lepida* (Cramer) and *Aspidiotus destructor* Signoret are causing maximum damage in coconut. The tall height of coconut plant creates difficulties in the detection of the pest in correct time to manage the pest, hidden nature of the most coconut pests, and the availability of suitable foods throughout the year create serious pest threats to the coconut plant worldwide [9]. The infestation and intensity of damage caused by the pests varies from different crop growth stages, regions and seasons. So, it is very important to know the different arthropod pests of coconut, their identification, life-history, nature of damage and their management in an effective way for their sustainable productivity.

II. MAJOR ARTHROPOD PESTS ATTACKING COCONUT

1. Coconut black headed caterpillar

Opisina arenosella (Oecophoridae: Lepidoptera)

This insect pest is considered a serious defoliating pest of coconut.

Distribution: It is present in India, Sri Lanka, Bangladesh, Myanmar, Thailand and Indonesia. In India, it occurs more commonly along the west and east coast regions.

Host range: It infests on coconut, Palmyra (*Borassus*), *Corypha*, *Hyphaene*, *Phoenix*, *Roystonea* and banana [9].

Identification and life cycle: Adult is a greyish white moth measuring 10-15 mm long and 20-25 mm in wing span across outstretched wings. The female moth lays about 130 creamy white scale like eggs in batches along the underside of the leaflet generally near the old larval galleries. Eggs hatch in about 4-5 days. Caterpillar is light green with red brown stripes and black head, feed gregariously on the surface tissues of the leaflets scraped out from their lower surface. The leaflets are reduced to papery tissues. The larva constructs a gallery of silk and frass and lives and feeds under it. The attacked leaflets turn brown in colour and dry up. Larval period lasts for about 40 days. The larva pupates inside the gallery. Adult emerges after 12-14 days. Total life history occupies about 45-60 days. Some early larval and egg mortality has been observed in *O. arenosella* as a result

of cannibalism on the eggs and younger larvae by older larvae. The production of nuts gets adversely affected as photosynthetic activity of the palm is much reduced. The fronds become unsuitable for thatching and other purposes. The damage is more during summer months (March-May) and less during rainy season and the species has 4-5 generations annually.

Damage Symptoms: When the caterpillar lives on the lower surface of leaflets it produces galleries made of excreta and silken web and feeds on the chlorophyll containing parenchymatous tissues. Later, dried up patches appeared on the upper epidermis of the leaves. In severe infestation, the whole plantation presents a burnt like appearance due to the drying of leaves/leaflets or in cases of old infestation leaves remain with midrib of the leaflet only. When palms are severely damaged, the attacked leaves droop, bunches buckle and the immature nuts shed heavily [4, 12].

Management:

- Clipping and destroying the infested portions.
- Bacteria like *Serratia marcescens* and *Bacillus thuringiensis* cause disease in larvae.
- Encourage the population of Predatory carabid beetle, *Parena laticincta*
- Root feeding of bio pesticide Azadiractin F5% @ 10 ml + 10 ml water and inundative release of larval parasitoids *Bracon brevicornis* @ 30 no./ tree and *Goniozus nephantidis* @ 20 no./ tree at 21 days interval for each treatment in two phases significantly reduced Coconut Blackheaded caterpillar.
- Root feeding with Monocrotophos 36 SL 10 ml mixed with 10 ml water.

Root feeding technique: A dark brown coloured root is selected for root administration of pesticide to the trees. The root is given a slant cut. The cut end of the root is kept in polythene bag containing pesticide mixed in water for plants having 15 feet height. Allow the root to absorb the chemical for 24-48 hours. If the root does not absorb the chemical then, change the root.

Note: Before administering the chemical the mature nuts should be harvested. After root administration there should be a gap of at least 45 days for harvest of nuts.

2. Rhinoceros beetle

Oryctes rhinoceros (Dynastidae: Coleoptera)

It is one of the most damaging insects to coconut palm and African oil palm in South and Southeast Asia and the western Pacific Islands. In India, the infestation in oil palm was more prevalent in mature plantations (10-15 year old) compared to immature or younger plantings.

Distribution: It has a wide distribution in Asia, Australia and Pacific Islands and is reported from all regions where coconut is grown.

Host range: It attacks coconut, oil palm, date palm, sugarcane, banana, sisal, pineapple, papaya etc.

Identification and life Cycle: Adult is a stout beetle measuring 35-50 mm in length, shiny and black above and reddish brown and hairy ventrally. On the face, beetle has a pointed horn and hence the name, rhinoceros beetle. The cephalic horn is longer in males than in females. Full grown grub is 9-10 cm long, stout, fleshy, dirty white, curved (C-shaped) with brownish head. Tail end dark, body segments wrinkled. Female lays 50- 140 oval creamy white eggs in manure pits or decaying logs or stumps or decaying vegetable matter at a depth of 5 to 15 cm. Egg period 8-18 days, Stout, sluggish, white grub present at a depth of 5 to 30 cm. Grubs feed on the decaying matter and grub stage lasts for 99 to 182 days. Grub pupates in earthen cells at a depth of 0.3 to 1 m and emerges as adults in 10-25 days. The beetles are active at night and hide in feeding or breeding sites during the day. Most mating takes place at the breeding sites. Egg laying starts 10-60 days after emergence. Total life cycle takes about 6-12 months. Adult lives for more than 200 days under favourable conditions.

Damage Symptoms: Coconut rhinoceros beetle adults damage the palms by boring into the center of the crown, where they injure the young, growing tissues and feed on the exuded sap. As they bore into the crown, they cut through the developing leaves. When the leaves grow out and unfold, the damage appears as V-shaped cuts in the fronds or holes through the midrib. In severe infestation, death of the central growing primordium occurred in both young and old plants. Damaged palms become susceptible and often infected by fungal rots [4,12].

Management:

- Periodical examination of the breeding places and destruction of eggs, grubs and pupae by raking and turning up of the manure pits.
- Treating breeding places with carbaryl 50 WP 3g/l at least once in three months i.e. January, April, July, August.

- Crownless trees and dead trees should be cut and dried to avoid breeding of the pest.
- Extraction of the beetle with a barbed iron hook or wire and filling up the holes with filling the hole with neem cake 100 g + 150 g sand to prevent further attack.
- Place 3 Naphthalene balls /palm weighing 3.5g each at the base of the inter space and cover it with fine sand.
- Castor cake at 1 kg is soaked in water in small mud pots and when kept in coconut gardens attract the beetle. The slurry should be changed once a month [4].
- Keeping the pheromone [male-produced aggregation pheromone, ethyl 4-methyloctanoate (E4-MO)] in a small, heat-sealed, polymer membrane bag and placed between interlocking metal vanes mounted on a plastic bucket attracted the beetles and trapped inside the bucket. It is very useful as a monitoring tool, and as an economical control method particularly in young oil palm replant areas when placed at one trap per 2 ha [2].
- The histrid beetle, *Santalus parallelus* is predaceous on the eggs and first instar grub.
- The green muscardine fungus *Metarrhizium anisopliae* infects all stages except eggs.
- Nematode, DD 136 or *Neoaplectana carpocapsae* and the associated bacterium *Achromobacter nematophilus* parasitize the grub.
- Release of Baculovirus infected adults @ 15/ha.

3. Red palm weevil

Rhynchophorus ferrugineus (Curculionidae: Coleoptera)

The weevil multiplies enormously in young coconut plantations, especially in those close to the forest areas and the damage is to the extent of 5-10 % in young plantations of 5-20 years age.

Distribution: It is distributed in Pakistan, India, Sri Lanka, South East Asia to China, Taiwan and the Solomon islands. In India it occurs in all coconut growing tracts.

Host range: It also infests oil palm, date, sago and other species of Palmae

Identification and life Cycle: Adult is a brown weevil about 35 mm long. It has six dark spots on thorax and in the males the long snout has a tuft of hairs. The full grown grub is stout, fleshy and apodous. The female weevil commences oviposition 1-7 days after pairing and continues it for 25-63

days. Fecundity is 276 eggs. Eggs are laid in small holes scooped out by the weevil on the soft regions of young palms of up to 7 years age, in the grown up trees the eggs are laid only in the cuts or wounds which may be present on the stem or leaf stalk. The plant sap oozing out of the wounds and cuts attract the weevil for oviposition. It prefers to oviposit in the exposed plant tissues. The infestation by rhinoceros beetle or crown rot or leaf rot diseases also attracts the weevil for egg laying and for crown infestation. The creamy white egg hatches in 2-5 days. Grub tunnels inside and lives in any part of young palms but prefers to concentrate at or near the growing points in trees older than 5 years. A trunk may harbour 40-45 grubs. Larval period ranges from 36-78 days. Larva constructs an oval cocoon with the fibres of the internal tissues and pupates within it for a period of 12-33 days. The adult female lives for 76 days and the male for 133 days.

Damage Symptoms: The grubs hatched from the eggs laid in crown enter in to the growing point of the crown and causes yellowing and wilting leaves of inner and middle whorls. The grub also causes damage by producing the tunnels when feeding large numbers within the stem tissues. In advance stages, circular holes on the stem are observed and brownish black viscous fluid oozing out from there. Their presence also identified by the occurrence of longitudinal splitting of leaf bases and presence of cocoons or chewed up fibres in leaf axis or at the base of the palm. The sound of feeding by the grub can be heard by keeping the ear on the trunk of the tree [4, 12].

Management:

- Disposal of felled trunks, tree stumps, dying and dead palms, dead plants due to lightning or bud rot
- Avoiding wounds, mechanical injuries and stripping of leaves
- Avoid damage to roots and stem during cultural operation.
- Removal of rhinoceros beetle from the hole using an arrow headed rod and filling the hole with neem cake 100 g + 150 g sand to prevent weevil attack on young plants.
- Set up attractant traps using mud pots with molasses / toddy 2.5 lit + acetic acid 5 ml + yeast 5 g + split tender coconut stems / petioles @ 65/ha.
- Placement of aggregation synthetic pheromone traps viz., Rhino lure (without feeding stimulant)

@ one / ha; Ferro lure @ one / ha with feeding attractant (Sugarcane molasses 2.5kg + 5 ml acetic acid +5gm yeast) at 1-1.5 m height on tree trunk to attract and capture more numbers of beetles and red weevils of both sexes.

- The affected plant puts scraped off and swabbed with coal tar or Japan black.
- Release of sterile males to compete with the normal males to reduce the progeny.
- Conserve the population of earwig, *Cheliosoches moris* which feeds on eggs and grubs
- Insert 1-2 aluminium phosphide tablets inside the tunnel and plug all the holes with clay + copper oxychloride.
- Root feeding with monocrotophos 10 ml mixed with 10 ml of water. (Do not harvest thenuts for the next 45 days).

4. Coconut eriophyid mite

Aceria guerreronis (Eriophyidae: Acarina)

It is one of the most serious arthropod pests of coconut. It was first described in 1965 from specimens from Guerrero State, Mexico [8]. In India it was first reported in Ernakulam district of Kerala in 1998 at Ambalour panchayat [14]. Presently it is present all the coastal states of India mainly Kerala, Tamilnadu, Andhra pradesh, Odisha, West Bengal and Maharashtra. It may reduce 7.5-60% yield losses of coconut [7].

Distribution: It is present in the Americas, Africa and in South-East Asia.

Host range: Although coconut palm appears to be the only host of coconut mite, but it also attacks *Lytocaryum weddellianum*, *Borassus flabellifer* and *Syagrus romanzoffiana*.

Identification and life Cycle: The adult female mite is vermiform, white and translucent, 36-52 μ m wide and 205-255 μ m long with two pairs of legs and a finely ringed body with several long setae. A female laid 18-20 ovoid, glossy, translucent white eggs singly on the meristematic tissue of young buttons and on the inner surface of the perianth. The mean incubation period is 2.8 days. The duration of egg, protonymph, deutonymph and adult are 2-3, 3-4, 3-4 and 3-5 days respectively [13]. A coconut mite develops from egg to adult in 10 days, so populations can build up rapidly, often producing thousands of mites in several aggregations on the same fruit. They probably disperse from one plant to another on air currents or by phoresy (e.g., carried on

insects or birds that visit palm flowers). Where coconut palms are dense, they can crawl from plant to plant.

Damage Symptoms: The mites infest the abaxial (lower) surfaces of the perianth and the part of the fruit surface covered by the perianth. They penetrate between the tepals of the perianth and fruit surface a month after the fruit begins development. The mites feed by piercing the superficial plant tissue and sucking the juices. Early infested fruits when expands from beneath the perianth and becomes exposed to air, it develops a triangular pale or yellow patch close to perianth and later turn into brown patches with longitudinal deep fissures. If mite feeding is concentrated on one side of the fruit meristem, growth of the fruit may be uneven. Severe damage results in Shedding of butons, oozing of the gummy exudation from the affected surface and stunting of fruits [11].

Management:

- Application of urea 1.3 kg., super phosphate 2.0 kg and murate of potash 3.5 kg./palm / year.
- Application of neem cake 5 kg and organic manure 50 kg / palm / year.
- Grow intercrops, banana, cacao, turmeric, vegetables in rich soils and shelter belt with causuarina all around the coconut garden to minimize the pest.
- Application of Borax 50 g + gypsum 1.0kg + Manganese sulphate 0.5 kg/palm/ year
- Root feeding of Azadirachtin 10,000 ppm @ 10 ml + 10 ml water/ tree (3 times in a year April-May, September –October and February -March) is helpful.
- Root feeding with Fenpyroximate 5 EC 10 ml + 10 ml water/tree is effective against mite infestation.
- Spraying twice at weekly interval on buttons and developing nuts on bunches with wettable sulphur 6g/l or Fenpyroximate 5 EC @ 1ml/lit of water.

5. Coconut scale

Aspidiotus destructor (Diaspididae: Hemiptera)

Coconut scale is considered as one of the major threats to coconut palms throughout the world. It infests at high densities on the undersurface of coconut leaves, as well as on the frond stalks, flower clusters and young fruit. As the coconut scale is classified as an armored scale, unlike other scales, it does not produce honeydew [1].

Distribution: It has been recorded worldwide in tropical and subtropical areas, including China, Southeast Asia,

India, Pakistan, Russia, Brazil, Central America and Caribbean, the Pacific Islands, Africa and North America.

Host range: It is a polyphagous species and recorded from hosts belonging to more than 60 plant families. Common hosts are banana, coconut, guava, mango, palm, papaya, breadfruit, ginger, bird of paradise, sugarcane, ficus, apple, plumeria, avocado, citrus and grape.

Identification and life Cycle: Adult female have a circular or broadly oval cover that is 1.5-2.0 mm in diameter. The cover is flat and translucent with a subcentral pale exuviae. Adult male are small, two-winged, reddish, gnat-like insects with eyes, antennae, three pairs of legs and long appendages. Adult males do not feed and are short lived. Adult females lay 28-65 smooth, elongate and whitish eggs in concentric circles under the scale cover over a period of 11-13 days, and may produce 3 or 4 consecutive batches in their lifetime. Newly hatched nymphs (also called crawlers) move over the leaf surface for 2-48 hours to find a feeding site. Females have two nymphal stages, while males have two feeding nymphal stages, followed by non-feeding pre-pupal and pupal stages (four immature stages altogether) [15]. After settling, females remain sessile throughout their development; adult males undergo a pseudo-pupation, develop a pair of wings and can disperse by flying to find mates [5]. They reproduce sexually. Males locate unmated females by following pheromones released by them [10]. The life cycle of *A. destructor* typically lasts for 32-34 days for females and 27 days for males. Crawlers are the primary dispersal stage of coconut scale within and between host trees.

Damage Symptoms: On leaves, it causes yellow spots to develop beneath the insects, due to the toxicity of saliva injected in to plant tissues while feeding. Later, entire leaves may turn yellow to brown, wither and dry up, and fruits may be discoloured, stunted or fall prematurely. In severe cases, entire fronds drop off, the crown dies and the entire crop lost. Neglected coconut plantations are particularly susceptible to damage by this insect.

Management:

- Pruning of trees and proper disposal of infested leaves, branches and twigs will help control scale insects on nursery plants and trees.
- Do not use excessive dose of plant fertilizers which may responsible for pest outbreaks.
- Encourage and conserve the population of *Aphytis melinus* and *Aphytis lingnanensis* (Hymenoptera: Aphelinidae) parasitoid species and black

coccinellid beetle, *Chilocorus nigrius* (predator) for controlling the coconut scale populations [4, 16].

- Spraying of Carbaryl 50 WP @ 3g/l or Dimethoate 30 EC @ 2ml/litr of water is effective.

6. Slug caterpillars

Contheyla rotunda

Macroplectra nararia

Latoia (Parasa) lepida

(Limacodidae: Lepidoptera)

Distribution: It is a sporadic pest. *C. rotunda* is common in west coast, while *M. nararia* is common in Godavari district in India. *Latoia lepida* mainly found in South East Asian region including India, Sri Lanka, Vietnam, Malaysia, Indonesia and Japan. Although slug caterpillars are minor pest but sometimes, in congenial weather they become major pest.

Host range: Beside coconut, these infest mango, castor, cashew and pomegranate.

Identification and life Cycle: In the male insects (*Latoia lepida*) head is greenish, with red brown at the sides and the thorax is green with a brown stripe on the vertex. Hindwing is yellowish at base and reddish brown towards margin. In the female, the reddish-brown stripe on the thorax is much wider and nearly the whole of the hindwing is reddish brown. Larva has greenish body with white lines and four rows of spiny scoli tipped red or black, which cause irritation and pain and slug like, hence also called "nettle grub". Adult female lays flat shiny eggs on the under surface of leaves in batches of 20-30, egg period is 6-7 days. Larval period is about 42 days. It pupates in a compact elliptical chocolate brown shell like cocoon, which is convex above and flat below. Cocoons are covered with irritating spines and hairs; pupal period is 21 days. *C. rotunda* larva is dorsally and dorso-laterally black or grey in colour. Adult is a small greyish brown moth. Forewings are slight dark in colour with series of black points; hind wings slightly darker.

Damage Symptoms: Initially, caterpillar feeds the undersurface of coconut leaflets by scrapping the surface tissues which gives a glistening appearance on the feeding area. Leaf spot-like black halo marking develops on the feeding areas which later coalesce and form bigger lesions. During severe infestation caterpillars feed on the entire leaflet sparing only the midrib. They also feed on buds, flower shoots and developing fruits [6].

Management:

- Clipping the affected leaves along with the larvae.
- Installation of 200 W light traps installed at 1 ½ feet above ground with water pan@ 3 light traps /ha.
- Encourage the population of braconid parasitoid *Apanteles parasae* and the tachinid parasitoid *Chaetexorista javana*, both of which attacked the older larvae[3].
- Spray application of Carbaryl 50 WP@ 3 g/l or Deltamethrin 2.8 EC @ 1ml/l or Fenvalerate 20 EC @ 0.5 ml/l or root feeding with Monocrotophos 36SL is effective[3].

7. Termite

Odontotermes obesus(Termitidae: Isoptera)

It is a widespread termite species in South Asia causing significant losses to major agricultural crops and forest plantation trees. They generally damage the coconut seedlings in the nursery and transplanted seedlings preferring the husk of seed nuts. Invasion is either through the base of the seednut or at the collar region. Later, wilting of central shoot is a common symptom of the attack. Up to 20% of the seedlings are destroyed by the termites in the laterite soils. Base of the plant trunk, is seen plastered with runways made of soil and fibre.

River sand is taken as rooting media, locating termite mounds in or near the coconut nursery or garden, the digging out the termitarium and destroying the queen, drenching the soil with Chlorpyrifos 20 EC @ 10 ml/l of water are effective measures.

However, another coleopteran insect, coconut beetle, *Brontispa longissima* Gestro (Coleoptera: Chrysomelidae) is a serious pest of coconut in Southeast Asia. But, it does not occur in India and Sri Lanka. This is probably due to the trade of coconut and planting materials takes in a sea route connecting the Maldives, Malaysia, Indonesia, Vietnam, and other East Asian countries [9].

Beside the above mentioned major insect pests there are many minor insect pests causing damage to coconut palm at different region and growth stages of the crop.

White grub: *Leucopholis coneophora* Burmeister (Melolonthidae: Coleoptera) grub causes leaves to turn yellow, immature nuts shed, flowering delay. They are predominantly noticed in sandy as well as sandy clay soils in coastal districts, feeding on the roots of coconut seedlings. Female lays eggs in the soil at a depth of 7 to 15

cm. Egg period 20 days, grub period 10-11 months, prepupal period 9-12 days. pupal period 25 days. Pupation occurs in soil. Adult beetle emerges after monsoon showers. For management point of view, summer ploughing is helpful which exposes the immature stages; treat the seeds with chlorpyrifos 20 EC @ 12 ml/kg of kernel; Application of Phorate 10G 10 kg or Carbofuran 3G 30 kg per ha in the soil at or before sowing is helpful.

Mealy bug: *Pseudococcus longispinus* (Targioni Tozzetti) (Pseudococcidae: Hemiptera) causes damage by sucking sap from the spindle leaves, spathes and bunches; root mealybug, *Nipaecoccus nipae* (Maskell) feeds on the roots of coconut seedlings. Lacewing bug: *Stephanitis typicus* Distant (Tingidae: Hemiptera) sucking the sap from the under surface of leaflets causing white spots on the upper surface; it is reported as one of the vectors of coconut root (wilt) disease [6]. Coconut skippers, *Gangara thyrasis* Fab. and *Saustus gremius* Fab. (Hesperiidae: Lepidoptera) causes damage by cutting the one half of the leaflets and rolled into a case and later the rolled leaflets are dried. Coconut skippers occur throughout the year but maximum population found in June to September months. Spiralling whitefly, *Aleurodicus dispersus* Russel causes damage coconut palm by sucking sap from the foliage. Conservation and release of parasitoid; *Encarsia guadeloupaecan* suppress the whitefly population [6].

III. CONCLUSION

Due to the tall height of coconut palm, it is difficult to detect as well as manage the pests during early infestation. So, importance should be given to conserve and release of indigenous bio control agents and other easily available management practices mainly cultural, mechanical and physical means for suppressing the major arthropods pests in coconut.

REFERENCES

- [1] Beardsley, J. W. 1970. *Aspidiotus destructor* Signoret, an Armored Scale Pest New to the Hawaiian Islands. *Proceedings of the Hawaiian Entomological Society*, 20: 505-508.
- [2] Bedford, G. 2014. Advances in the control of rhinoceros beetle, *Oryctes rhinoceros* in oil palm. *Journal of oil palm research*, 26(3): 183-194
- [3] Chenon, R. D. 1982. *Latoia (Parasa) lepida* (Cramer) Lepidoptera Limacodidae, a coconut pest in Indonesia. *Oleagineux*, 37 (4): 177-183.
- [4] David, B. V. 2001. Elements of economic entomology. Popular book depot, Chennai. pp 589.

- [5] Ghauri, M. 1962. The morphology and taxonomy of male scale insects (Hemiptera: Coccoidea). British Museum (Natural History). Adlard and Son, Dorking, UK. 221 pp.
- [6] Josephraj Kumar, A., Mohan, C., Rajan, P., Thomas R, J., Chandramohan, R., Jacob P.M. 2012. Pest Management in Coconut Nursery. Technical Bulletin No. 73. Central Plantation Crops Research Institute Kasaragod, Kerala, 16p.
- [7] Julia, J. F. Mariau, D. 1979. New research on the coconut mite, *Eriophyes guerreronis* K., in the Ivory Coast. *Oleagineux*, 34(4): 181-189.
- [8] Keifer, H. H. 1965. Eriophyid studies B-14. California Department of Agriculture, Bureau of Entomology.
- [9] Kumara, D. N. T., Chandrashekharaiah, M., Kandakoor, S. B. and Chakravarthy, A. K. 2015. Status and Management of Three Major Insect Pests of Coconut in the Tropics and Subtropics. In: A. K. Chakravarthy (ed.), *New Horizons in Insect Science: Towards Sustainable Pest Management*. Springer India. Pp 359-381.
- [10] Moreno, D. S. 1972. Location of the site of production of the sex pheromone in the yellow scale and the California red scale. *Annals of the Entomological Society of America*, 65: 1283-1286.
- [11] Nair, C.P. R., Rajan, P., Mohan, C. 2005. Coconut eriophyid mite *Aceria guerreronis* Keifer- an overview. *Indian Journal of Plant Protection*, 33(1): 1-10.
- [12] Panwar, V. P. S. 1995. Agricultural insect pests of crops and their control. Kalyani publishers, Ludhiana. pp 286.
- [13] Paul, A., Mathew, T. B. and Mohan, P. 2004. Biology and population of coconut eriophyid mite, *Aceria guerreronis* Keifer. *Pest management in horticultural ecosystems*, 10 (1): 83-86.
- [14] Sathiamma, B., Nair, C. P. R., Koshy, P. K. 1998. Outbreak of nut infesting eriophyid mite *Eriophyes guerreronis* (K) in coconut plantation in India. *Indian Coconut Journal*, 29(8):1-3.
- [15] Tabibullah, M., Gabriel, B. F. 1973. Biological study of *Aspidiotus destructor* Signoret in different coconut varieties and other host plants. *Philippine Entomologist*, 2(6): 409-426.
- [16] Watson, G. W., Adalla, C. B., Shepard, B. M., Carner, G. R. 2015. *Aspidiotus rigidus* Reyn (Hemiptera: Diaspididae): a devastating pest of coconut in the Philippines. *Agricultural and Forest Entomology*, 17: 1-8.