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Chapter 3

Arecanut

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1. Introduction

Arecanut is perennial plantation crop attacked by more than 90 species of insect and non-insect pests round the year. The pests infest all parts of the palm *viz.*, stem, leaves, inflorescence, fruits and roots. Pest attacking on fruits and inflorescence causes direct crop losses, and those attacking on vegetative parts like leaves, stem and roots causes indirect crop loss. Insect pests, such as root grubs (*Leucopholis lepidophora* Blanch. and *L. burmeisteri* Brens.) (Melolonthinae: Scarabaeidae: Coleoptera), spindle bug (*Carvalhoia arecae*), inflorescence caterpillars (*Tirathaba mundella*) and mites were found more prominent on arecanut. Among minor pests the coccids (scales and mealybugs), occupy an important place with possibilities of attaining the status of major pests in future due to climate change. As many pests and diseases are lethal to areca palm, a systematic monitoring and timely adoption of integrated pest management approaches are very critical for up keeping the health status of the palm.

2. Root Grubs/White Grubs *Leucopholis lepidophora* Blanchard *Leucopholis burmeisteri* Brenske and *Leucopholis coneophora* Burmeister (Scarabaeidae: Coleoptera)

Root grubs/white grubs are larval stage of scarabaeid beetles which feed on subterranean parts of arecanut and intercrops. White grub complex associated with arecanut based cropping system in India comprised of closely related three species of genus *Leucopholis viz., Leucopholis burmeisteri* Brenske, *Leucopholis lepidophora* Blanchard and *Leucopholis coneophora* Burmeister (Veeresh *et al.*, 1982). *L.*

lepidophora was first reported to feed on arecanut in Karnataka by Puttarudraiah and Channabasavanna (1957) and later by Nair and Daniel, (1982). It is the predominant species present in arecanut cultivated in hill tracts along Western Ghats areas of Karnataka (Subaharan *et al.*, 2001), Shivamogga and Chikkamagaluru district Sringeri, Thirthahalli (Prathibha 2015; Kalleswaraswamy *et al.*, 2015), parts of Northern western ghats of Maharashtra (Therurkar *et al.*, 2012) and North Eastern states of India (Thakur *et al.*, 2012). Adults are medium sized beetle with greenish black elytra. Raster of third instar *L. lepidophora* larva bears two rows of pali, arranged in ladder like fashion. Each row is separated by half the length of the pali, leading to overlap of the roundish pali along the mid line of the raster (Veeresh *et al.*, 1982; Kumar, 1997).

L. burmeisteri is one of the principal pests of areca palm (Daniel and Kumar, 1976). The larvae cause severe damage to roots of areca palms (Kumar, 1974; Kumar and Daniel, 1981). It is distributed in Dakshina Kannada district of Karnataka in areas having altitude > 200 m above MSL where arecanut is cultivated (Kumar, 1997). It is present in Sullia and Belthangadi taluks of Dakishna Kannada district of Karnataka (Prathibha, 2015). Adults of this species are yellowish brown in colour covered by yellow scales all over the body and dorsal surface is strongly convex. The raster of third instar grubs bears relatively strongly sclerotized, flat and dagger like pali which are regularly arranged in a barrel shape. It was found feeding on subterranean parts of cocoa, banana and rubber in the field (Veeresh *et al.*, 1982). *L. burmeisteri* and *L. lepidophora* are known as arecanut white grubs and have biennial life cycle.

Leucopholis coneophora Burmeister was recorded as a pest on coconut by Nirula *et al.* (1952) and followed by Shekhar (1958), Abraham and Kurian (1970), Kurian *et al.* (1974), Abraham and Mohandas (1988a; 1988b) and Abraham (1993). It is distributed in coastal areas and plains and at an altitude < 200 m above MSL (Kumar, 1997). Eventhough, *L. coneophora* is known as coconut white grub, it feeds on roots of arecanut grown in plains and coastal areas. Veeresh (1981) furnished a key for the identification of the South Indian genera of root grubs and these included three species of genus *Leucopholis*. The description provided by Patil and Veeresh (1981) and Veeresh *et al.* (1982) clearly differentiated the larvae of three species of *Leucopholis viz., L. coneophora, L. lepidophora* and *L. burmeisteri.* Adults differed in respect of shape, size, clypeal notch, and density of scales, shape of the scale and punctuations on the body and with respect to relative orientation of the parameres of male genetalia. All the three species exhibited sexual dimorphism with respect to antennae and meta tibial characters. In females antennal club was short and tibial spur was narrow. Kumar (1997) suggested population representing species *L. burmeisteri* in Dakshina Kannada district was morphologically similar to *L. coneophora*. Differentiating characters identified by Veeresh *et al.* (1982) were not strong enough to warrant delineation of populations into specific status. He described them as *L. coneophora* – coastal strain which occur at altitude of < 200 m above MSL and *L. coneophora* – hill strain for those occurring at altitudes of over 200 m above MSL to represent two geographical conditions. Suggesting further studies involving karyology and DNA finger printing might confirm these suppositions and also their specific status. Nagesha *et al.* (2011) partially amplified mitochondrial

cytochrome oxidase sub unit I (*COI*) gene of *L. burmeisteri sulyareca* isolate and deposited sequence (accession number AEM 24341) in gene bank data base of NCBI. Study of phylogenic relation by partial amplification of 16s rRNA and *COI* gene of *L. burmeisteri, L. coneophora* and *L. lepidophora* (collected from Dharmasthala, Kasaragod and Sringeri, respectively) revealed 98, 83 and 89 per cent similarity, respectively with *L. burmeisteri sulyareca* isolate (Prathibha *et al.*, 2013a).

In addition to *Leucopholis*, a close relative of this genus, *Lepidiota* was also reported to feed on arecanut in Karnataka. *Lepidiota* sp. damaged arecanut seedling by feeding on roots and inflicted sort of similar symptoms *viz.*, drooping and drying of leaves as in case of *Leucopholis* infestation (Rao *et al.*, 1961).

2.1. Damage Symptoms

It induced seedling mortality due to damage of root system (Rajamani and Nambiar, 1970; Kumar, 1974; Daniel and Kumar, 1976; Kumar and Daniel, 1981; Padmanabhan and Daniel, 2003). Grub infestation on arecanut seedlings led to damage to the root system and the seedling could be pulled out easily (Anonymous, 1967). Second and third instar grubs were voracious feeder which fed about 2.3 g arecanut root tissue/grub/day (Padmanabhan and Daniel, 2003). The grubs preferred younger roots as compared to older roots (Rajamani and Nambiar, 1970). Prolonged damage to root induces gradual yellowing of leaves, immature nut fall there by reduction in nut yield, delayed flowering and lack of production of inflorescence. Grub feeding on apical tender region of roots affect the nutrient absorption and restrict the nutrient flow which in turn led to stem tapering and reduction in crown size (Figure 3.1). Root grub infested palms can be easily pulled out with a small jerk as the entire root system in eaten away by the grubs. In addition, it caused poor production of inflorescence in areca palms which eventually led to yield loss (Rajamani and Nambiar, 1970). Nair and Daniel (1982) observed that the young palms attacked by *L. burmeisteri* died fast while older palms continued to survive and the palms damaged by root grubs are susceptible to secondary infection (Veeresh *et al.*, 1982).

2.2. Bionomics

Adults of white grubs are known as cockchafer beetles which emerge with the setting of South West monsoon in Southern part of peninsular India. The emergence of *L. burmeisteri* occurs during the month of June after the receipt of 3 - 4 good rains in June in Dakshina Kannada district. *L. lepidophora* emerges in last week of July or in the first week of August in hilly tracts of Chikkamagaluru district of Karnataka. *L. lepidophora* is active flier when compared to *L. burmeisteri*. Adult emergence of L. *coneophora* commence with the summer shower in March/April after a pause in May it resumes with the setting of south west monsoon (Abraham, 1993; Prathibha *et al.*, 2013b; Prathibha, 2015). Adults remain active noticed in the evening hours between 6.30 - 7.30 PM in case of both the species during this time they feed and copulate then go back to soil (Figure 3.2). Eggs are laid singly in interspaces during June. Incubation period varies from 12-15 days and hatch into tiny grubs with a brown head and white body. Larval stage prolongs for 226 to 346 days and has

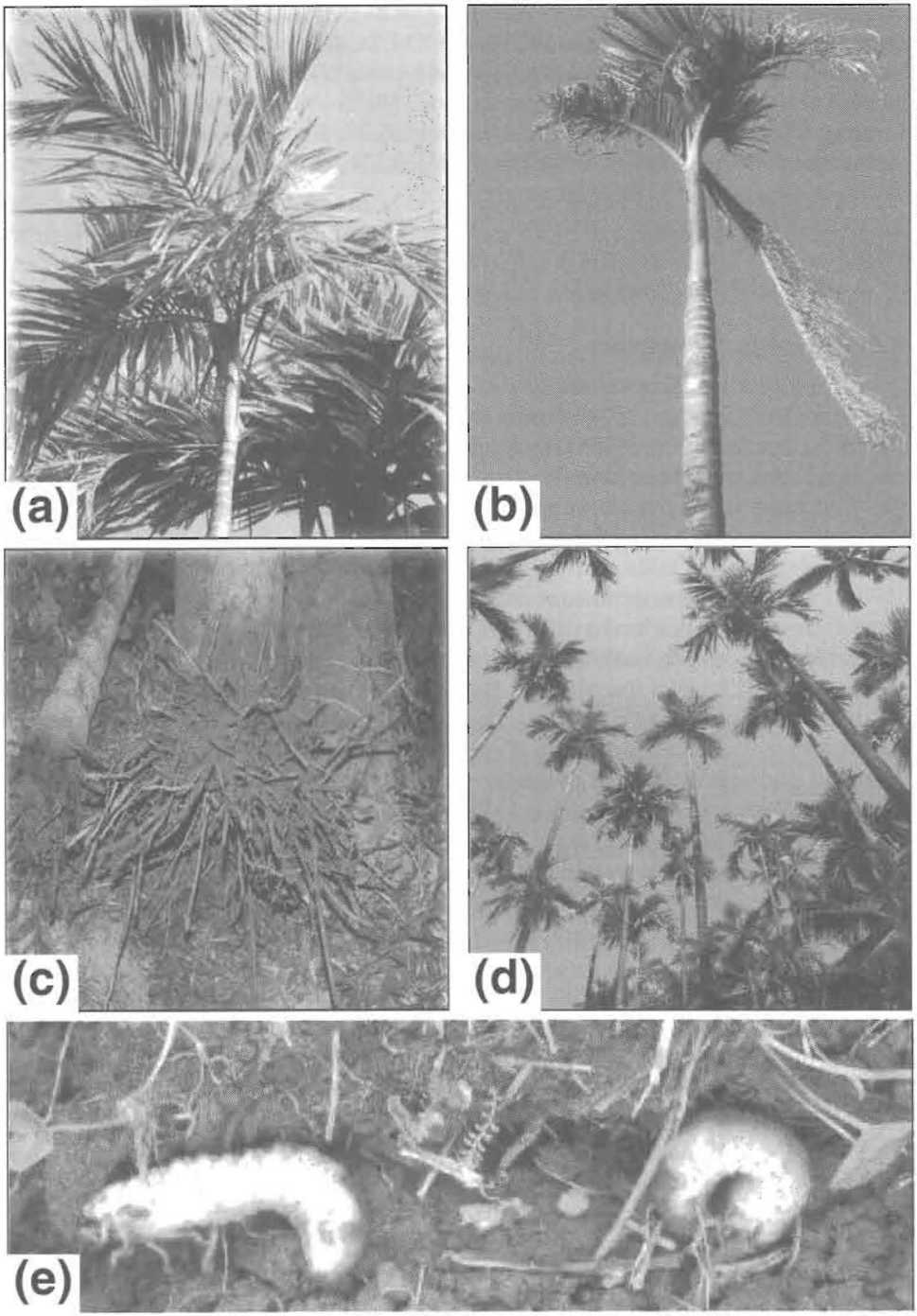

Figure 3.1: Root Grub.

(a) Yellowing of fronds, (b) Stem tapering, (c) Root damage, (d) Reduction in crown size, (e) Root grub, *L. burmeisteri.*

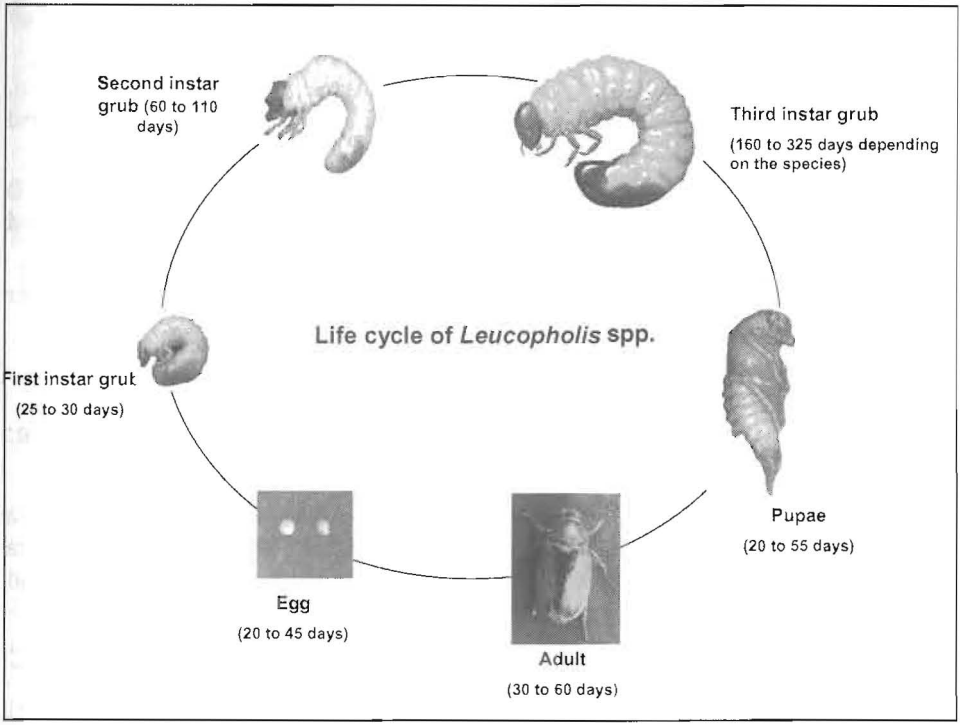

Figure 3.2: Life Cycle of White Grub.

three instars, with first instar larvae feed on organic matter present in the soil later it starts feed on roots of grasses and weeds present in the interspaces. Late second and third instar larvae feed on roots of arecanut and other intercrops. More number of third instar larvae can be noticed in root zone area during September to February. In some area overlapping generations are noticed where third instar larvae can be seen round the year. During summer months the grubs move deeper and deeper layers of soil as moisture in top layer deplete. From initial infestation, the spread of root grub infestation takes 4 - 6 years (Padmanabhan and Daniel, 2003). Therefore it is easy to manage the white grub infestation by means of integrated approach. Several natural enemies have been found infecting on the white grubs.

2.3. Management

- ☆ Hand picking of adults during peak emergence period of two weeks commencing from first day of South west monsoon daily in the evening 6.30–7.30 pm. It commence during May last to June first week in planes and during August in hilly tracts
- ☆ Application of neem cake @ 2 kg/palm/year during June to July in the basin which help in the rejuvenation of roots
- ☆ Patch application of chlorpyriphos or bifenthrin @ 2kg ai/ha covering interspaces and root zone area where grub infestation is noticed (*ie.*, chlorpyriphos 20 EC @ 10 litre/ha, bifenthrin 10 EC @ 20 litre/ha)

coinciding with early instar stage in the field in planes. In hilly areas, first round application may be carried out during first week of September

- ☆ Application of Entomopathogenic nematode liquid suspension, *Steinernema carpocpasae* during September - October in plains and November - December in hills
- ☆ Second round need based root zone application of chlorpyriphos 20 EC @ 7 ml/palm or bifenthrin 10 EC @ 14ml/palm after 45 days of first round insecticide application
- ☆ Repeated ploughing (3- 4 ploughings) of gardens from October- December to expose the grubs to predators
- ☆ Provide good drainage in field

3. Spindle Bug, *Mircarvalhoia arecae* Miller and China (Miridae: Hemiptera)

Spindle bug/capsid bug, *Carvalhoia arecae* Miller and China (F. Miridae) is a major pest of areca palms which was first reported from DK district of Karnataka by Khandige in 1955. Miller and China (1957) recorded this as a new genus and species from *Areca catechu*. These are brightly coloured red and black bugs which are active during morning hours and nymphs are brownish red in colour. Kerzhner and Schuh (1998) proposed *Mircarvalhoia* as a replacement name for *"Carvalhoia"*, as latter has preoccupied as a junior homonym of *Carvalhoia* Kormaed, 1951 (Hemiptera : Colobathristidae). *Mircarvalhoia arecae* is considered as an endemic species of southern India, and are of a chronic problem in areca plantations of Kerala, Karnataka and parts of Tamil Nadu (Nair, 1964). At shimogga in Karnataka, it has assumed a serious pest status and spread extensively in areca gardens and causing economic loss to the farmers (Kantharaju *et al.*, 2009). As per survey conducted in Kerala during 1990, it is distributed in all states except middle zone *ie.*, Wadakkanchery and Palakkad districts (Stanley, 1990). Its limited occurrence outside the centre of origin of the areca palm was explained in terms of the origin and evolution of the insect on the native rattan palm *Calamus travancoricus* Bedd. ex Becc. and Hook. f. and subsequent host shift and adaptation to introduced palms such as *Areca catechu* L., *Areca concinna* Thwaites, *Areca lutescens* Bory, *Areca triandra* Roxb. ex Buch.-Ham., *Chrysalidocarpus madagascariensis* Becc., *Elaeis guineensis* Jacq., *Loxococcus* sp. and *Pinanga* sp. (Shameem and Prathapan, 2014). It is reported on areca palms of North eastern states of India (Thakur *et al.*, 2012). Most recently, it is reported from Sipighat and Mitha Khari in the South Andaman district and Diglipur in North Andaman and Nicobar islands for the first time on arecanut (Yaswant and Prathapan, 2014).

3.1. Damage Symptoms

Both nymphs and adults hiding in leaf axils and suck the sap from the emerging spindle, tender leaflets and leaf axil. While feeding, the bug injects toxic saliva, as a result fresh feeding marks appear as watery streaks on the infested leaflets and spindle. These linear lesions turn brown and become necrotic which appears

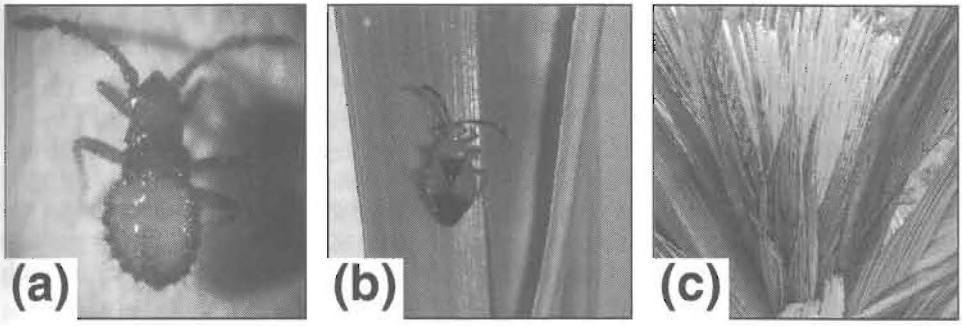

Figure 3.3:
(a) Spindle bug Nymph, (b) Adult,
(c) Necrotic linear lesions on arecanut leaf caused by spindle bug.

as elongated patch on the fronds while unfurling (Figure 3.3). Severely infested spindle leaf fails to unfurl. Such feeding damage results in stunted growth and reduction in yield. Infestation on seedlings leads to complete decay and drying of seedlings. Observation on gardens in Southern Kerala and parts of DK district revealed that feeding by these bugs caused 80 per cent damage to the spindle (Nair, 1964; Abraham *et al.*, 1976).

3.2. Bionomics

The bug completes life cycle in 24- 33 days (Nair and Das, 1962). Adults thrust eggs singly into the tender tissues as a result, oviposition site becomes dark in colour. Freshly laid eggs are white in colour, oval in shape and measures 1.36 mm x 0.34 mm. The anterior end is distinctly demarcated into a short neck, bearing at its tip thick and rigid convex oval operculum (Figure 3.3). The chorion is smooth and leathery. Two curved bristle which are unequal in length arise from the operculum. During the course of development egg turns to pink and then red and hatches out in a period of 10 days. Kantharaju *et al.* (2011a) reported five nymphal instars in the biology. The total nymphal duration ranged from 22-28 days. The preoviposition and oviposition period prolonged 2.45 ± 0.43 and 2.00 ± 0.40 days, respectively. The bug had the fecundity rate of 10 - 18 eggs. The adult male and female lived for 12 - 28 days and 14 - 35 days with a mean of 18.77± 6.39 and 25.66 ± 7.85 days, respectively. The adult bugs are black in colour and measures 6.0 mm long and 2.8 mm broad. The head is triangular with a pair of four segmented antennae. Three segmented rostrum reached up to hind coxa. The thoracic segments are equal in size. The six segmented legs bear a two segmented tarsus. The abdomen is oval with nine visible segments. The antennae, legs and rostrum are deep violet brown; thorax and boarder of abdomen are light violet brown, remaining part of abdomen is greenish yellow. The head is light yellow with scarlet red eyes. The fifth instar nymphs are 4.43 mm long and 2.15 mm broad. Wing pads are well developed reaching up to the third abdominal segment in the fifth instar nymph.

Though, the pest incidence occurs throughout the year, the peak incidence of the pest in Kerala is from June to October with maximum population in August and September (Nair, 1964). A peak in population density was noticed during

December, January and July (Anonymous, 1972). According to Koya *et al.* (1979) the pest population was high during the monsoon and post monsoon periods and low during summer months. There was a positive correlation between the rainfall and population of *C. arecae* and peak period of abundance varied at different places (Sathiamma *et al.*, 1980; 1985). Kantharaju *et al.* (2011b) reported the highest incidence during I fortnight of August, while the lowest incidence during II fortnight of March, 2007 and II fortnight of December, in arecanut growing areas of Shivamogga, Karnataka. Incidence of spindle bug had the significant negative correlation with maximum temperature and significant positive correlation with rainfall and relative humidity.

3.3. Management

Studies conducted for the past five decades revealed that majority of the insecticides were found to be effective in controlling spindle bug population. But most of the insecticides used are banned now. Menon *et al.* (1962) suggested spraying either of the chlorinated hydrocarbons/OP compound *viz.*, DDT, endrin, ethyl parathion or wettable BHC are effective in managing spindle bug population. Palms treated with BHC 0.2 per cent and endrin 0.025 per cent were completely free from damage (Nair and Das, 1962). Filling the innermost two leaf axils around the spindle with granular systemic insecticides like phorate 10 G or carabaryl 4G or methyl o demeton at the rate of 10 g/palm at an interval of three months was recommended (Abraham *et al.*, 1976). For this, a granular leaf axil filling applicator was also devised (Abraham, 1975). General recommendations included keeping sachets with granular insecticides into the innermost two or three leaf axils of arecanut palm (Sathiamma *et al.*, 1985; Jacob, 1990). Malathion 5 per cent dust, phorate 10 per cent granules, monocrotophos 0.15 per cent spray, lamda cyhalothrin 0.10 per cent spray showed cent per cent mortality in bug population on seventh day after application. Chlorpyriphos 0.20 per cent spray and profenophos spray exhibited highest efficacy in controlling the bug population (Kantharaju *et al.*, 2009). Spraying of Fish Oil Rosin Soap (FORS) (1 kg in 80 litres of water) or quinalphos @ 1 ml/litre or endrin 1 kg in 900 litres of water could control the pest or drenching with lindane (1.3 D) at 2.5 g/lt of water on the spindles or placing 2g of phorate at 10g/palm in perforated poly bags on the top most leaf axils is also recommended (Jayaraj and Balakrishnan, 2007).

- ☆ Regulation of shade in the garden
- ☆ Placement of thiamethoxam 25 WG of (2 g) in perforated poly-sachets in the inner most two leaf axils of areca palms during April- May
- ☆ Spraying with thiamethoxam 25 WG (0.25 g per litre water) in and around the spindle and inner whorl of leaves

4. Pentatomid Bug *Halyomorpha marmorea* Fab. (Pentatomidae : Hemiptera)

Pentatomid bug assumed status of serious pest and spreads extensively now a days, earlier it was a low density insect which is conspicuous only by the damage that it causes. It was first reported by Vidyasagar and Bhat (1986) that its

infestation caused dropping of tender nuts. In parts of Karnataka and Kerala tender nut drop due to infestation of pentatomid bug was reported during April to July (Chandramohanan and Shantaram, 1986). *H. marmorea* are not easily found on the palm host, but can be seen on other host plants for most part of the year. The incidence could be recognized by the shed immature fruits, which is concentrated on palm basins. Cowpea, *Vigna sinensis* is reported as collateral host of *H. marmorea*. But so far, *H. marmrea* has not been reported as a pest on any crop in India except arecanut. According to Daniel (2010), intensity of attack varied widely and ranged from 8 – 78 per cent and it was is a low density pest. Even within a plantation, the activity of the bug was confined to a few palms. Wherever the intensity of attack was severe in a plot it was surrounded by secondary jungles of different trees, shrubs *etc.* Such locations were found in the south and southeast parts of Dakishna Kannada district of Karnataka bordering Kerala (Daniel, 2010).

4.1. Damage Symptoms

The bug pierces tender nuts with long proboscis and feeding continues for several hours. Due to continuous feeding the developing kernel was depleted of the most vital sap, leading to the nut shedding (Figure 3.4). Adult bug could feed on the sap of a single nut in a day, which causes drop in two days (Anonymous, 1985; 1990; Vidyasagar and Shama Bhat, 1986). Feeding activity is very intense during morning and evening hours in comparison to hot hours of the noon. It infests on fertilized flowers and immature fruits and do not feed on fruits once the endosperm is hardened. It is noticed that point of proboscis insertion on the fruit surface may be at the periath's attachment to rachillae, or at the end of perianth on the fruit body, or at the middle of the fruit body, or at the lower end of the fruit body. As a result microscopic pin prick black dot could be observed on the fruit. Later, tissues surrounding the puncture discolored later to light brown to black and this is more conspicuous on the inner surface of the husk when cut open. At the point of proboscis insertion on endosperm, the surface appears as thickened and rough. Presence of shriveled and sunken endosperm is the typical symptom of pentatomid bug attack. Developing kernel would be discoloured and blackened. In some cases, rotting of the kernel is also reported. Gummosis can be seen in some of the attacked fruits due to hyper sensitive reaction by the plant.

4.2. Bionomics

H. marmorea (Figure 3.4) completes the life cycle in a month. Biology was studies by Vidyasagar (1991) and reported five nymphal instars with an average duration of 3.7, 6.1, 5.1, 6.5 and 9.3 days respectively. The nature and extent of damage to arecanut and host range of this bug also described by Vidyasagar (1991). It is a seasonal pest occurs from February – March and continues up to July – August with a peak infestation in June depending on the availability of green nuts. The first incidence of the pentatomid bug on arecanut occurs in March. The percentage of shed nuts showing *H. marmorea* infestation was maximum during June (29.15) followed by July, Aug. and October (Anonymous, 1988). The incidence of the bug is found to become very serious during some years making it a major pest causing considerable loss to arecanut production.

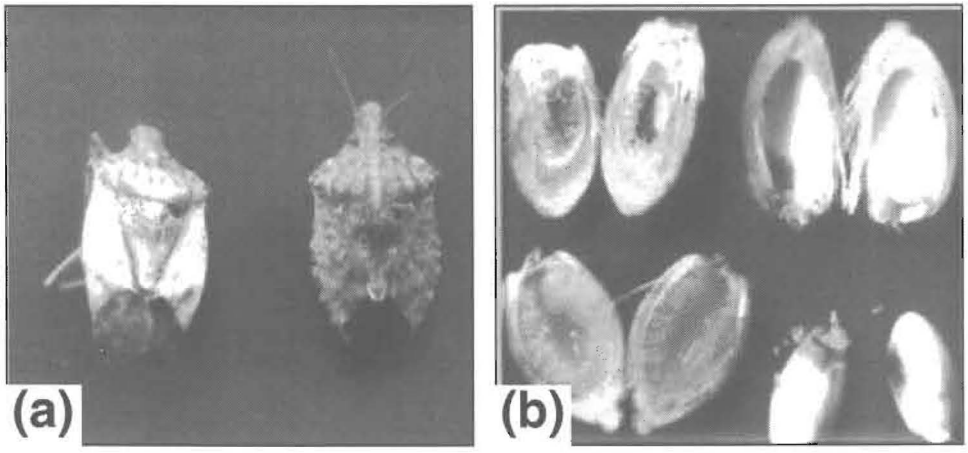

Figure 3.4
(a) *Halyomorpha marmorea*, (b) Damaged caused by pentatomid bug.

4.3. Management

Earlier, spraying with fenvalerate, monocrotophos, dimethoate, endosulfan and methyl parathion was followed, among which endosulfan 0.05 per cent and fenvalerate 0.02 per cent spraying were found to be cost effective (Anonymous, 1990). The bugs were collected and destroyed from alternate host plants such as chillies, ladies finger and bitter gourd. In case of severe infestation it was observed that spraying two rounds of endosulfan 0.05 per cent during April - May and the second round after an interval of 45 days was effective

- ☆ Adopt clean cultivation practices: Collection and destruction of the various stages of this insect seen on alternate hosts like cowpea, bhendi, bitter gourd, chillies *etc*, before these bugs shift to areca palms,
- ☆ Application of neem oil emulsion (0.5 per cent) two - times in fortnightly intervals only to the infested palms and surrounding palm. Care may be taken to avoid spraying of oil emulsion in freshly opened inflorescence as it affect the fruit set
- ☆ Spraying of 0.008 per cent imidacloprid (17.8 per cent ai) @ 0.5 ml/litre

5. Foliar Mites

Mites are widely distributed in all areca growing tracts of India and are polyphagous in nature. There are two species of foliar mites reported on arecenut *viz.*, false spider mite/palm mite/scarlet mite/red mite, which is scientifically known as *Raoiella indica* Hirst. Another one is a spider mite/jowar mite/white mite, *Oligonychus indicus* Hirst.

5.1. *Oligonychus indicus* Hirst. (F. Tetranychidae)

It was first reported in 1956 on arecanut seedlings in Bangalore. Both adults and nymphs colonise under webs on lower surface of leaves (Figure 3.5). The incubation period varies from 72 to 95 h. Total duration of immature stages (larval proto nymph, deuteron nymph) stage ranges form 6.5 – 9 days. Females mites lays on an average of 3 - 4 eggs per day and ovipostion period prolongs for 10 days.

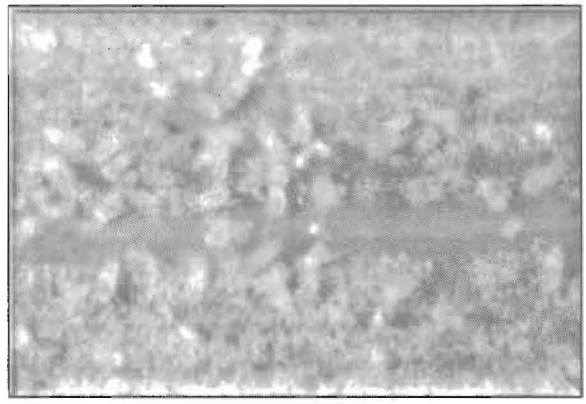

Figure 3.5: White Mite, *Oligonychus indicus.*

5.2. *Raoiella indica* (Tenuipalpidae)

Among false spider mites genus (*Brevipalpuls, Raoiella* and *Tenuipalpus*), the genus *Raoiella* gained economic importance in the recent years and the species, *Raoiella indica*

R. indica was first described in the district of Coimbatore (India) by Hirst in 1924 on coconut leaflets [*Cocos nucifera*, whereas, on arecanut the first report was made in 1956 in Bangalore, Karnataka. The Red Mite/scarlet mite, *Raoiella indica* heavily infests palms of nursery stage and young palms and induces damage by sucking sap from the leaves of young palms during hot dry weather. The mite attained economic significance when it was first reported as an invasive species in the Caribbeans in 2004 (Flechtmann and Etienne, 2004), which was reported as important pest of coconut, and banana. (Nagesha and Channabasavanna, 1984; Welbourn, 2006). This polyphagous species of false spider mite rapidly spreads through the Neotropical region where the mite damages economically and ecologically important plants. Both the nymphs and adults are seen in large number on the ventral surface of arecanut leaves. In severe case of infestation they were seen on the upper surface and on the spindle too. It completes life cycle in 11.2 to 12.9 days. Other than arecanut it is infesting coconut, date palms and other ornamental palms also.

Population builds up immediately post monsoon. With the onset of hot weather from April–May, and becomes more active and virulent form. Study on population dynamics of *R. indica* in northern Kerala indicated that occurrence of the pest during March–September, with a peak incidence on March–April and more number located

on bottom fronds (Prabheena and Ramani, 2014). Gardens under water stress and nurseries are more prone to mite infestation. The population declines with the onset of monsoon.

5.2.1. Damage Symptoms

Scarlet mite and Jower mite colonies are coexisting on the same leaf. They suck the sap from the green portion of the plant. Feeding by the mites leads to development of yellow speckles on the lamina (Figure 3.6). These speckles coalesce, become bronze coloured and the leaves wither away. In older palms, the infestation starts from the lower whorls. Severe infestation affects the photosynthetic capacity of the leaf. In case of infested seedling, yellowing and subsequent mortality occurs.

5.3. Perianth Mite: *Dolichotetranychus* sp. (Tenuipalpidae)

Mite infestation results in severe tender nut fall in affected palms. The infestation is noticed extensively in or around central Kerala. The mites are slender, orange coloured and seen colonized inside the perianth of tender nuts. As a result of feeding activity, the nuts shriveled and later on fall off resulting up to 10 per cent crop loss. The period of infestation is during November – May.

5.4. Management

- ☆ Cut and burn heavily infested and dried leaves to check the lateral spread of mites.
- ☆ Regulate shade in the field and provide adequate irrigation for seedlings
- ☆ Conserve indigenous natural enemies (predatory mites, coccinellid beetles (*Stethorus keralicus*) Neuropteran (*Chrysopa* sp.), predatory mites (*Amblyseius channabasavanni*) as they exert good check on the mite population
- ☆ Application of neem oil emulsion (0.5 per cent) two times at fortnightly intervals

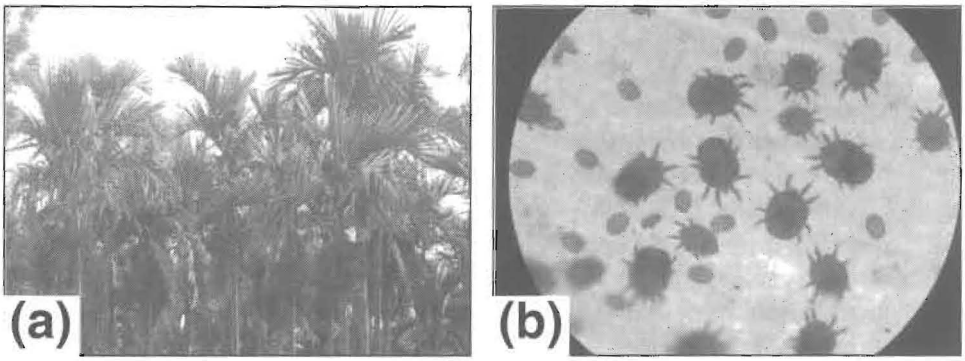

Figure 3.6

(a) Mite–induced damage symptom on areca palms, (b) Scarlet mite *Raoiella indica.*

6. Scales and Mealybugs

6.1. Damage

Many species of mealybugs are found to colonize almost all parts of areca palm *viz.*, spadices, inflorescence, developing fruit bunches, leaves and leaf sheaths. They colonise on the lower surface and in severe cases even the tender nuts also are affected. In the early stage of the crop, scales and mealybugs suck sap from leaves, which results in development of yellowish patch on leaf blade there by inhibit the growth (Figure 3.7). In the later stage they interfere with pollination and photosynthesis thereby severely affecting the yield of arecanut. Severe feeding leads to withering and shedding of buttons/fruits. Damage is very high during drought conditions. As of now, infestation by most of the mealybugs do not cause an economic yield loss to plantations. But there are chances for these sucking pests for major pest status due to huge shift in climate. The following mealybugs are associated with the leaves and leaf sheath.

Pseudococcus cryptus Hempel. Polyphagous in nature and are found to infest leaves inflorescence and developing fruit bunches.

Icerya seychellarum Westwood which is polyphagous in nature. In addition to outer surface of the leaf sheath they infest developing bunches and spadices.

Aonidiella orientalis Newstead is highly polyphagous hard diaspidid scale that feeds on inflorescence as well as on immature fruits

6.2. Management

- ☆ Collection and destruction of the various stages of this insect seen on alternate hosts like cowpea, bhendi, bitter gourd, chillies *etc*, before it shift to areca palms, must be done.
- ☆ Conserve and augmentation of lady bird beetle *Chilocorus nigrita*. These can be mass multiplied and released in affected areca garden to control the scale insects.

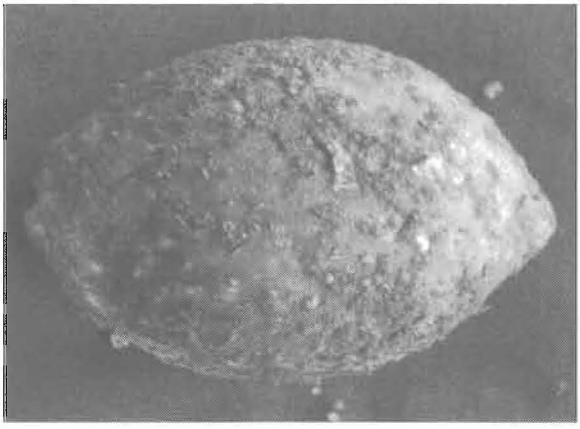

Figure 3.7. Scale Infested Arecanut.

- ☆ Regulation of shade in the garden
- ☆ Application of neem oil emulsion (0.5 per cent) two times in fortnightly intervals

7. Whitefly *Aleurocanthus* sp. (Aleyrodidae : Hemiptera)

It infests leaflets of areca palm from under surface. Population is high on young areca plantation in Dakishna Kannada district of Karnataka. It causes severe blotching and drying of leaves. The honey dew secreted by the insect promotes the colonization of sooty mould which interferes with photosysnthesis of palm.

8. Palm Aphid *Cerataphis brasiliensis* (Aphididae : Hemiptera)

This is commonly known as palm aphid and they colonized the leaves, spindle leaves and inflorescence. Natural enemies like *Paragnus yebuiensis* and *Pseudasphidimerus* sp. were recorded.

Sprayinng of 0.6 per cent neem oil emulsion or commercial neem formulation would check the whitefly and aphid population

9. Inflorescence Caterpillar

9.1. *Thirathaba mundella* (Pyralidae: Lepidoptera)

The pest causes damage to areca inflorescence, by boring on tender button, female flowers and spathe and feed on tender rachille and male flowers from the tip. It webs on the terminal portion of the inflorescence with silken thread, which delays the spadix opening. Mechanical injury on the palm pre-disposes the infestation (Figure 3.8). It is distributed in parts of Dakshina Kannada districts of Karnataka, Kerala, Andhra Pradesh, Bihar, Gujarat, Tamil Nadu, Madhya Pradesh and Orissa. Female moth deposits eggs into the spadix through punctures made on the spathe by slugs or snails. Incubation period is for 5 days. The fully grown larvae are greyish brown with a reddish brown head and measure 23- 25 mm in length. The larval period lasts for about 26 days covering five instars. Pupation is in silken cocoons with a wet mass of frass inside the spathe. Pupal period lasts for 9- 11 days.

Figure 3.8: Inflorescene Caterpillar and Infested Areca Inflorescence.

9.2. Inflorescence Caterpillar *Batrachedra arenosella* (Batrachedridae: Lepidoptera)

A new pest reported in the recent past causing significant economic loss was noticed in Southern plains of Karnataka during 1999. It is found to infest on coconut inflorescence also. Caterpillars feed on inflorescence and bore on female flower. Removal and burning of affected inflorescence. Spraying of chlorpyriphos (0.04 per cent) or lambda cyhalothrin (0.005 per cent) would keep the pest under check.

References

Abraham, V. A. (1975). An applicator for filling granular insecticides into the leaf axils of arecanut palms. *Pesticides.* 9(2): 26- 28.

Abraham, V. A. (1993). Behaviour of adult beetles of the coconut white grub, *Leucopholis coneophora* Burm. *Indian Coconut J.*, 24: 2-4.

Abraham, V. A and Kurian, C. (1970). Save your coconut palms from the ravages of white grubs. *Coconut Bull.*, 1: 3-4.

Abraham, V.A., Sathiamma, B., Abraham, K.J. and Kurian, C. (1976). Control of arecanut spindle bug, *Carvolhoia arecae* Miller and China using granular insecticides. *J. Plantn. Crops* 4: 24-2.

Anonymous (1967). Annual report Central and Regional Arecanut Researcch Station. Vittal, ICAR. p. 92.

Anonymous (1972). Annual report for 1971. Central plantation crops research Institute, Kasaragod India.

Anonymous (1985). *Annual Report for 1985.* Central Plantation Crops Research Institute, Kasaragod. pp 120.

Anonymous (1988). *Annual Report for 1988.* Central Plantation Crops Research Institute, Kasaragod. Pp 8.

Anonymous (1990). *Annual Report for 1989.* Central Plantation Crops Research Institute, Kasaragod. pp 262.

Chandramohanan, R. and Shantaram, M. (1986). *Indian Cocoa Arecanut and Spices J.*, 2: 27-28.

Daniel, M. (2010). Bionomics of the marmorated bug, *Halyomorpha marmorea* Fab. (Hemiptera: Pentatomidae) in arecanut plantation ecosystem. *J. Plantation Crops* 38(1): 78-81.

Daniel, M. and Kumar, T. P. (1976). Pests of arecanut. *J. Plantation Crops*, 4: 68-77.

Flechtmann, C.H.W. and Etienne, J. (2004). The red palm mite, Raoiella indica Hirst, a threat to palms in the Americas (Acari: Prostigmata: Tenuipalpidae). *Systematic and Applied Acarology* 9, 109.

Gupta, K.M. (1973). Neem leaves attract white grub beetles. *Indian J. Entomology*, 35(3): 276.

Jacob, S.A. (1990). Distribution of the spindle bug of arecanut, *Carvalhoia arecae* Miller and China in Kerala, its bio-ecology, suspected role as a vector of yellow leaf disease and control. Central Plantation Crops Research Institute, Palode, Trivendrum. Series/Report No: RNT VIII (131).

Jayaraj, J and Balakrishnan, S. (2007). Spindle bug menace in arecanut. Daily *The Hindu* dated 20th December 2007.

Kalleshwara Swamy, C.M., Adarsha,S.K., Naveena, N.L and Sharanabasappa. (2015). Incidence of arecanut white grubs (*Leucopholis* spp.) in hilly and coastal regions of Karnataka, India. *Current Biotica* 8(4): 423-424.

Kantharaju, N., Thippeswamy, C and Venkatesh Hosamani, (2009). Efficacy of Certain Insecticides Against Arecanut Spindle Bug, *Carvalhoia arecae* Miller and China (Heteroptera : Miridae) Under Field Conditions. *International Journal of Plant Protection* 2: 237-239.

Kantharaju, N., Thippeswamy, C., Siddalingappa, H. V. and Shivasharanappa, Y (2011). Incidence of arecanut spindle bug, *Carvalhoia arecae* Miller and China (Heteroptera : Miridae). *Environment and Ecology*, 29: 143-147.

Kantharaju, N.C., Thippeswamy, Venkatesh, H., Shivasharanappa, Y. and Siddalingappa (2011). Biology of arecanut spindle bug, *Carvalhoia arecae* Miller and China (Heteroptera: Miridae MKK Publication, Kolkata, India. *Environment and Ecology* 29: 148-151.

Kerzhner, I.M. and R.T. Schuh. (1998A). Replacement names for junior homonyms in the family Miridae (Heteroptera). *Zoosystematica Rossica* 7: 171-172.

Khandige, S.B. (1955). A Capsid bug on areca. *Arecanut Bull.*, 6: 120-121.

Koya, K.M. Rawther, T.S.S., Sathiamma, B. and Kurian, C. (1979). Evaluation of six granular insecticides for the control of arecanut spindle bug *Carvalhoia arecae* Miller and China in field. *Pesticides*. 13(8): 50- 51.

Kumar, A.R.V. (1997). Bio-ecology and management of arecanut white grubs. *Leucopholis* spp. (Coleoptera : Scarabaeidae) in Karnataka. Ph.D. thesis, UAS, Bangalore, p. 230.

Kumar, T.P. (1974). Chemical control of areccanut white grubs *Leucopholis burmeisteri* Bren. *Arecanut and Spices Bull.*, 6: 35.

Kumar, T.P. and Daniel, M. (1981), Studies on the control of soil grubs of arecanut palm. *Pesticides*, 15(9): 29-30.

Menon, R., Nair, R.B. and Abraham, K.J. (1962). A note on pests and diseases of arecanut seedlings. *Arecanut J.* 13: 26-29.

Miller, N.C.E. and China, W.E. (1957). A genus and species of Miridae from *Areca catechu* in South India (Hemiptera : Heteroptera).*Bull. Ent. Res.*, 47: 429-431.

Nagesh, M., Shylesha, A. N., Thippeswamy, R. and Ramesh, B. D. (2011). Cytochrome oxidase subunit I, partial (mitochondrion) *Leucopholis burmeisteri* Sulyaarecae isolate. NCBI data base, gene bank accession no: AEM24341.1

Nagesha, C.B.K. and Channabasavanna, G.P. (1984). Development and ecology of *Raoiella indica* Hirst (Acari : Tenuipalpidae) on coconut. In: D.A. Griffiths and C.E. Bowman [eds.], *Acarology* VI, 2(8) pp. 785–798.

Nair, C. P. R. and Daniel, M. (1982). Pests of areca nut. In: K.V.A. Bavappa, M. K. Nair and T. Premkumar (Eds). The Arecanut Palm (*Areca catechu* Linn.) CPCRI, Kasargod (India). pp: 162-184.

Nair, M.R.G.K and Das, N.M. (1962). On the biology and control of *Carvalhoia arecae* Miller and China. A pest of areca palms in Kerala. *India J. Ent.*, 24: 86-93.

Nair, R.B. (1964). *Carvalhoia arecae* Miller and China, a major pest of *Areca Catechu*. *Arecanut J.*, 15 : 57-61.

Nirula, K.K., Antony, J. and K.P.V. Menon (1952). A new pest of coconut palm in India. *Indian coconut J.* 12(1): 10-34

Patil, S.P. and Veeresh, G.K. (1981), Description of larvae *Leucopholis burmeisteri* and *L. lepidophora* (Scarabaeidae: Coleoptera) In: *Progress in Soil Biology and Ecology in India* (Ed. G.K. Veeresh), 1979, UAS Tech. Ser. No. 37, pp. 172-178.

Prabheena, P. and Ramani, N. (2014). Seasonal incidence and injurious status of *Raoiella indica* (Hirst) (Acari: Tenuipalpidae) on arecanut palms of Kozhikode district of Kerala. *International J. Plant, Animal and Environmental Sciences.*

Prathibha, P.S. (2015). Behavioural studies of palm white grubs, *Leucopholis* spp. (Coleoptera: Scarabaeidae) and evaluation of new insecticides for their management. Ph.D. Thesis submitted to University of Agricultural Science Bangalore. P. 119.

Prathibha, P.S., Kumar, A.R.V. and Subaharan, K. (2013b). Ethology of coconut root grub chafer, *Leucopholis coneophora* Burmeister (Melolonthinae: Scarabaeidae). *International J. Agric. Food Sci. Technology*, 4(2): 24-28.

Prathibha, P.S., Rachana, K.E., Shafeeq, R., Sabana, A. A., Subaharan, K. and Rajesh, M.K. (2013a). Molecular characterization of arecanut white grubs, *Leucopholis* spp. (Scarabaeidae: Coleoptera). P. 13 Abstract of paper: National Seminar on Application of Bioinformatics Tools in Agriculture Nov. 11th to 12th.

Puttarudraiah, M. and Channabasavanna, G.P. (1957). Some new insect and mite pests of areca palm in Mysore. III. *Arecanut*, 8(1): 10-11.

Rajamani, S. and Nambiar, K.K.N. (1970). Pests of arecanut palm. *Indian Fmg.*, 20(8): 23.

Rao, K.S., Naidu, G.V. and Bavappa, K.V.A. (1961). The white grub pest of arecaut. *Arecanut J.*, 12: 22-25.

Sathiamma, B., Abraham, V.A., Koya, K.M.A. and Abraham, K.J. (1980). Bionomics and control of spindle bug, *Carvalhoia arecae* Miller and China. *Final Report*, CPCRI, Kasaragod, pp. 27.

Sathiamma, B., Koya, K.M.A., Abraham, V.A., Rawther, T.S.S. and Kurian, C. (1985). Control of arecanut spindle bug, *Carvalhoia arecae* M and C using granular

insecticides in the field. In : Arecanut Research and Development. (Eds. Shama Bhat, K. and Nair, C.P.R). Proc. SIJAR 1982. CPCRI, Kasaragoda. pp. 137-139.

Shameem, K. M. and Prathapan, K. D. (2014). Rattan cane *Calamus travancoricus* - a new host plant record for spindle bug of arecanut palm, *Mircarvalhoia arecae* (Miller and China). *Indian J. Ent.*, 76(3): 252-253.

Shekhar, P.S., 1958. Studies on the cock chafer *Leucopholis coneophora* Burm. A pest of coconut palm and other inter-cultivated crops. *Indian Coconut J.*, 11: 67-80.

Stanley, A. J. (1990). Distribution of spindle bug of arecanut *Carvalhoia arecae* Millar and China, its bioecology, suspected role as the vector of YLD and control. Ph. D. Thesis. Kerala Agricultural University.

Subaharan K., Vidyasagar P. S. P. V. and Mohammed Basheer B. M. (2001). Bioefficacy of Insecticides Against White Grub, *Leucopholis lepidophora* Blanch Infesting Arecanut alm. *Indian J. Plant Protection 29(1 and 2)*: 25-29.

Thakur, N.S.A., Firake, D.M., Behere, G.T., Firake, P.D. and Saikia, K. (2012). Biodiversity of Agriculturally Important Insects in North Eastern Himalaya: An Overview. *Indian Journal of Hill Farming* 25,37-40.

Theurkar S. V., Patil S. B., Ghadage M. K., Zaware Y. B. and Madan S. S. (2012). Distribution and abundance of white grubs (Coleoptera: Scarabaeidae) in Khed Taluka, part of Northern Western Ghats. *International Research Journal of Biological Sciences* 1: 1- 6.

Veeresh, G. K., Vijayendra M., Reddy, N. V. M. and Rajanna, C. (1982). Bio-ecology and management of areca nut white grubs (*Leucopholis* spp) (Coleoptera; Scarabaeidae: Melolonthinae). *J. Soil Biol. and Ecol.*, 2, 78-86.

Veeresh, G.K., 1981. Larval taxonomy of white grubs with special reference to Melolonthinae beetles. Final project report, ICAR Ad hoc Project on larval taxonomy of Melolonthinae beetles, 1977- 80, Dept. of Entomology, UAS, Bangalore.

Vidyasagar, P.S.P.V. 1991. Studies on *Halyomorpha marmorea* E. (Pentatomidae: Heteroptera), associated with tender nut drop in arecanut. *J. Plantn Crops* 18 (Suppl.): 305-311.

Vidyasagar, P.S.P.V. and Shyama Bhat, K. 1986. A pentatomid bug causes tender nut drop in arecanut. *Curr. Sci.*, 55: 1096-1097.

Welbourn, C. (2006). Red palm mite Raoiella indica (Acari:Tenuipalpidae). Pest Alert. DPI- FDACS. Available from http://www.doacs.state.fl.us/pi/enpp/ento/r.indica.html. (Accessed October 10, 2008).

Yeshwanth, H.M and Prathapan, K.D (2014). First report of the occurrence of the arecanut spindle bug, *Mircarvalhoia arecae* (Miller and China) in the Andaman and Nicobar Islands. *Journal of Tropical Agriculture* 52(2): 82-84.