

PESTS OF ARECANUT*

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ABSTRACT

Damage to the arecanut palm due to pests results from feeding on seedlings, roots, stem, foliage, and inflorescence. About 90 insect and non-insect pests have been recorded including storage pests from India. The work done on them except the storage pests is reviewed here.

INTRODUCTION

The arecanut or betelnut palm *Areca catechu* L. is a tropical tree that grows in east Africa, Madagascar, Sri Lanka, India, Bangla Desh, Malaysia, Indonesia, China, Philippines, and southwards up to Fiji in the Pacific Ocean. This is used for its seeds which are used as a masticatory. In India, it is cultivated in over 1,74,300 ha. The palm is a single, straight, unbranched, cylindrical tree that grows to a height of 12 to 30 meters in about 40 years. The crown is compact with 7 to 9 pinnate leaves. Up to six spadices are produced in an year.

The areca palm is attacked by several insect and non-insect pests. They infest all parts of the palm, as roots, stem, foliage, inflorescence, and nuts. Stored arecanuts are also infested by different pests, but they are not included in this review.

The first record of a serious pest on areca palm was of the spindle bug (Khandige, 1955). Soon, mites, scale insects, root grubs, and thrips were recorded on areca palm. Nair and Menon (1963) and Rajamoni and

Nambiar (1970) have subsequently enumerated the pests of arecanut. Altogether about 90 insect and non-insect pests have been so far reported on areca including storage insects. In this review is presented the available information on different aspects of all the areca pests including the results of research carried out in this Institute during the last few years. Data on extent of losses due to different pests are lacking for this crop. However, they are discussed approximately in the order of their severity.

Spindle bug, *Carvalhoia arecae* Miller and China (Hemiptera: Miridae)

This bug was first reported from South Kanara, Karnataka (Khandige, 1955). More than 80% damage by this pest has been observed in certain plantations in southern Kerala (Nair, 1964 b). Miller and China (1957) described this genus and species from *A. catechu*.

The adult bugs and nymphs live inside the innermost leaf axil at the base of the spindle and suck sap from tender leaves and spindle. The infested portions develop necrotic pat-

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ches, turn brown, and dry up. Affected spindles show characteristic linear brown lesions and badly infested spindles do not open completely. The central portions of these patches often drop off, thus forming shot holes. When damage is severe, the spindle may break at the base. The attacked palms appear sickly and stunted.

Adult bugs are 6.0 mm long and 2.8 mm wide and are red and black. Nymphs are pale green to brown. Eggs are laid singly into the tissues of the unopened leaves. They hatch out in 9 days. The nymphal period with five instars is completed in 15-24 days (Nair and Das, 1962).

Only very little data are available on seasonal abundance of this pest. In Kerala State, the peak period of appearance is from June to October, with maximum numbers being found in August and September (Nair, 1964 b). Abraham *et al.* (1972) have subsequently seen that maximum population occurs in December and minimum in April.

This bug can also occur on *Chrysalidocarpus lutescens*, *Pinanga* sp., and *Areca triandra* (Nair, 1964 b).

The earlier recommendations for the control of this pest included spraying Endrin 0.125% or BHC 0.25% (Menon *et al.*, 1962; Nair and Das, 1962). As the population of the spindle bug is higher during monsoon period, spraying of insecticides against this pest will be ineffective. Use of granular insecticides is therefore advantageous. Phorate 10% or carbaryl 4% or thiodemeton 5% granules applied to the leaf axils around the central spindle at the rate of 10g/palm is therefore recommended (Abraham *et al.*, 1976). An applicator for facilitating leaf axil filling of areca palms with granular insecticides is also available (Abraham, 1975).

Mites. Mainly three species of mites infest areca palm. Phytophagous mites are serious in seedlings and young palms.

Cholam mite, *Oligonychus indicus* Hirst (Acarina: Tetranychidae)

This is the common spider mite which is serious on jowar and sugarcane in India (Rahman and Sapra, 1940). Puttarudriah and ChannaBasavanna (1956) first reported this mite on areca seedlings near Bangalore during 1954.

They infest the lower surface of areca leaves and yellow speckles develop as a result of feeding. These speckles later coalesce, become bronze coloured, and leaves wither away. In severe attack, the mites suck the sap from any green portion of plant including tender nuts.

During dry periods the pest assumes serious proportions (Patel and Rao, 1958). Poorly irrigated gardens and nurseries, particularly those in exposed situations, are very prone to attack. The mite population declines with the onset of monsoon.

The life cycle is of short duration. The incubation period varies from 72 to 95 hr. The larval, protonymphal, and deutonymphal periods last 26.6, 30.8, and 44.0 hr, respectively. The total duration of the immature stages varies from 6.5 to 9.0 days with an average of 7.5 days. The female mite lays an average of 3-4 eggs per day and the average oviposition period is 10.1 days (Misra and Seshadri, 1970).

To check the spread of this pest, the heavily infested and dried leaves may be pruned and burned. Work on control aspects using insecticides has been reported by various workers (Patel and Rao, 1958; Khandige, *et al.*, 1957; Annual Report, CARS, 1960, 1963), but these chemicals are not used now.

Palm mite, *Raoiella indica* Hirst (Acarina: Tenuipalpidae)

This is also an important pest of areca palms during summer months. It has been observed also on coconut, date palm, and the ornamental palm *Livistona chinensis*.

Puttarudriah and ChannaBasavanna (1956) first observed it on areca seedlings at Hebbal, Bangalore.

R. indica and *O. indicus* often coexist together on the same leaves. Both infest leaves in a like manner. Puttarudriah and ChannaBasavanna (1957) and Kantha *et al.* (1963) evaluated the effectiveness of some insecticides and acaricides on *R. indica*.

O. indicus and *R. indica* can be controlled by spraying with dicofol (Kelthane) (186 ml in 100 litres of water), carbophenothion (Trithion) (126 ml in 100 litres of water) or chlorobenzilate (Akar 338) (100 ml in 100 litres of water) (Annual Report, CRARS, 1967). Maximum ovicidal effect on *O. indicus* was shown by Kelthane (1.86 ml per litre of water) (Annual Report, CRARS, 1969).

A number of indigenous predators have been recorded on these mites. These are *Aspectes indicus* (Dermestidae), *Cybocephalus semipictis* (Nitidulidae), *Stethorus parcepunctatus* Kapur (Coccinellidae), *S. tetranychii*, *Juarvia soror* (Coccinellidae), and *Spilocaria bissetata* (Coccinellidae) (Puttarudriah and ChannaBasavanna, 1956). *S. keralicus* Kapur on *R. indica* was recorded by Kapur (1961). This ladybird beetle is one of the major predators of this mite. The beetle requires 12-14 days to complete its life cycle from egg to adult. An adult beetle consumes 2.41-6.46 host mites/hour during a period of 24 hr (Daniel, 1976). A number of indigenous predators have been reported on both these mites (Daniel and Kumar, 1975).

Biological control of *O. indicus* and *R. indica* using an introduced predaceous mite *Phytoseiulus persimilis* A-H. was taken up at our Station during 1969-1973. This predator was found to be unable to acclimatize itself to the local conditions, possibly because it is indigenous to the temperate zone (Daniel and Kumar, 1974; Daniel and Seshadri, 1976).

Calyx mite, *Dolichotetranychus* sp. (Acarina: Tenuipalpidae)

This mite harbours in the calyx region of tender arecanuts and cause immature nut fall. It is severe in the areca plantations of Trichur District, Kerala. It may be controlled by spraying the bunches with dimethoate 0.1% or formothion 0.2% (Sadanandan and Antony, 1973).

Inflorescence caterpillar, *Tirathaba munda* Walk. (Lepidoptera: Pyralidae)

The caterpillars feed on the inflorescence and cause damage. It is serious in pockets of South Kanara, Karnataka and Trichur, Kerala (Anonymous, 1962b; Nair and Rawther, 1969).

The female moth enters the inflorescence through punctures made by slugs and earwigs and lays eggs. The caterpillars are dull white in colour with a brown head. They tunnel into the anterior portion of the inflorescence and feed on tender flowers and rachillae. The whole inflorescence is made into a wet mass of frass with silken threads formed by the pest and they take shelter in them. As a result of this webbing, the inflorescence is unable to exert the natural pressure on the spathe necessary for its opening and thus the opening of the spathe is delayed. The late instar caterpillars can damage also newly opened inflorescences. In severe cases, the pest may bore into the tender buttons as well.

Nair and Rawther (1969) studied the biology of this pest. The egg period is 5 days. Mature larvae are brownish black in colour and the larval period is about 12 days. They pupate in silken cocoons in the wet mass of frass inside the spathe. Pupation lasts for 9-12 days.

For the control of this pest, spadices which show external symptoms of damage by slugs or traces of frass outside may be force-opened, and if the female flowers have been

damaged, then the inflorescence should be removed and burnt. If the damage is only partial, the affected portions may be removed and sprayed with malathion 0.125% (Rajamoni and Misra, 1971). Since it is the injury by slugs that predisposes the unopened inflorescences to the attack of inflorescence caterpillar, the slugs should be controlled by either handpicking or placing poison baits containing a mixture of bran and cement in the ratio 13:2 with a part of metaldehyde (Rajamoni, 1971).

Lever (1937) noted the occurrence of *T. rufivena* on areca palm in the British Solomon Islands.

Appanna (1959) mentioned about a lepidopterous borer of tender nuts of areca palm near Koppa, Chikmagalore District, Karnataka. The caterpillar is dark slate in colour and the attacked nuts show lots of webbed brownish excreta and smaller circular holes on the surface.

Root grubs *Leucopholis burmeisteri* Brenske (Coleoptera: Melolonthidae)

The white grubs or root grubs feed on roots of arecanut palms, coconut palms, and also the intercrops raised in these gardens. They are polyphagous pests and their incidence appears to be increasing of late.

Leucopholis lepidophora Blanchard was found to damage the roots of areca palms in Siddapur, Sagar, and Thirthahalli areas of Karnataka State (Puttarudriah and Channa Basavanna, 1957b). *Lepidiota* sp. was recorded in South Kanara, Karnataka State (Rao, et al., 1961). *Leucopholis burmeisteri* is the most common species feeding on the roots of areca palms in South Kanara, Karnataka (Annual Report, CRARS, 1967).

The white grubs occur typically in low lying and clayey soils where the water table is high. The infested palms show a sickly appearance, with yellowing of leaves, taper-

ing of stem, and reduction in yield. The grubs feed on the growing roots. In severe cases of infestation, the bole of the palm is also eaten by them.

The grubs are usually seen in the moist layers of soil, usually at 7.5-10.0 cm soil depth. During the dry weather, they move down further to 30-45 cm. As many as 40 grubs have been observed at the base of a single palm (Patel and Rao, 1958).

The pest has a long life cycle. The grubs have a soft U-shaped body. The adult beetles are chestnut brown in colour. Eggs are laid in soil. They are smooth, round, and creamy white. The incubation period lasts for more than one month. Pupation takes 35-40 days. Adults emerge *en masse* during the premonsoon period in May-June. Biology of this pest has not been fully studied.

Soil insecticides control this pest effectively (Annual Report, CARS, 1960). The insecticides are applied twice a year, once just before the onset of monsoon and the second in October at the close of the monsoon. Seshadri (1972) recommended chlordane EC 0.05% or phorate granules 8g/palm. The treatment has to be continued for two or three years to get satisfactory control of the pest. The garden should be provided with drainage channels.

More recently, granular systemic insecticides have been used for the control of this pest. Kumar (1975) observed that dimethoate (Rogor) 5% granules 30 kg/ha gave good control.

The nematode *cum* bacterium culture DD-136 (*Neoalectana carpocapsae* Weiser and *Achromobacter nematophilus* Poinar and Thomas) has been tested for the biological control of this pest. A nematode suspension of 60-100 nemas killed the early instar grubs in 5 days. Soil treatment with 600-800 nemas killed the grubs in 23 days (Kumar and Daniel, 1974).

Besides *L. burmeisteri*, the grubs of *Phyllophaga fissa* (Seshadri, 1969), *Xylotrupes gideon* (Annual Report, CRARS, 1969) and *Anomelochela* sp. (Murthy, *et al.*, 1965) have also been reported to feed on areca roots. *Anomala varians* Ol. (Rutelinae) has also been reported from arecanut (Nair, 1975).

Grapevine thrips, *Rhipiphorothrips cruentatus* Hood (Thysanoptera: Thripidae)

It is widely distributed in India on a variety of host plants including grapevines, mango, pomegranate, crotons, rose, and cashew.

Puttarudriah and ChannaBasavanna (1956) reported it as a pest of areca palms in Tharikere and Bangalore, Karnataka State. Pillai and Kurian (1959a) observed them in Ochira, Kerala State.

The dark brown adults and pinkish nymphs occur in colonies on the lower surface of areca leaves and suck the sap. Feeding marks are seen as silvery blotches. These blotches turn yellow and dry away. This pest may assume serious proportions during summer months in certain localised tracts. Areca palms of all ages are attacked.

Biology of the pest was studied by Pillai and Kurian (1959a). The duration of the immature stages varies from 11-24 days. This pest is attacked by an endoparasite *Thripoctenus maculatus* (Hymenoptera: Eulophidae).

The pests of minor importance are reviewed below. These may at times assume severe proportions in isolated tracts and cause damage to the crop. These are arranged mostly according to their feeding habits.

Stem-infesting.

Shot-hole borer, *Xyleborus perforans* Wolaston (Coleoptera: Scolytidae). It is a polyphagous beetle, which attacks old dead stems of arecanut, coconut, *etc.* Seshadri (1968) recorded them on areca and coconut

palms at Puttur, Sullia, and Belthangadi in Karnataka State.

The pest enters the palms through the basal portion of the stem and bores upwards gradually. Numerous circular holes with frass extruding from them are seen on the stem. When the damage is severe, the leaves become yellow and finally the palm dries up. Maximum damage is seen in October and November.

The pest completes its life cycle within the stem. Painting infested stems with contact insecticides like BHC or dieldrin could check the incidence of the beetle. *X. habercorni* was reported by Murthy *et al.* (1965).

Stem weevil, *Diocalandra stigmaticollis* Gyll. (Coleoptera: Curculionidae). The weevil attacks the tender portions of the stem even when it is covered by leaf sheath. Damage is seen on or above the nodes and invariably on the same side. The grubs feed on the stem tissues. Young palms are more susceptible. If damage is severe, the leaves fail to emerge, the stem gets weakened, and breaks off easily.

The adult is brown and cylindrical. The adults bore through the tender leaf sheaths and lay eggs on the stem surface. Sun-scorched stem appears to be a better breeding site. This weevil has been reported from Kerala and Mettupalayam, Tamil Nadu (Pillai and Kurian, 1959b; Naidu and Kumar, 1963). Contact insecticides like DDT or BHC spray or dust keep the weevil in control (Murthy and Hanumanthappa, 1965).

A nitidulid, *Carpophilus* sp. has been reported from rotten stem parts (Murthy *et al.*, 1965).

Red palm weevil, *Rhynchophorus ferrugineus* F. (Coleoptera: Curculionidae). The grubs bore into the stem as in the coconut. No special control measures have been worked out for arecanut, but those for

coconut may be equally effective (Pillai and Kurian, 1959b).

Leaf infesting.

Spider mite, *Tetranychus fijiensis* Hirst (Acarina: Tetranychidae). Daniel (1977) reported this species on arecanut. It occurs during all seasons of the year.

The caterpillars of the lymantriid, *Hemerocampa* sp. and *Porthesia* sp. infest both young and adult palms (Nair and Menon, 1963). The lymantriid *Euproctis semisignata* Walk. has also been reported (Nair, 1975) as a pest.

The grasshopper, *Morismus carinatus* Walk. and the spotted locust, *Aularches miliaris* L. (Orthoptera: Acrididae) attack young palms. (Kumar and Naidu, 1965; Nair and Menon, 1963). The slug caterpillar, *Contheyla rotunda* H. (Lepidoptera: Eucleidae) attacks palms of all ages (Sathiamma and Bhat, 1972). The black-headed caterpillar, *Nephanthis serinopa* Meyr. (Lepidoptera: Cryptophasidae) has been reported from some tracts of West Bengal and South Kanara, Karnataka State (Valsala, 1958). Caterpillars of *Spatulifimbria gresia* Herring has also been reported as a pest (Annual Report, CRARS, 1969).

Case worms (Lepidoptera: Psychidae). Venugopal and Venugopal (1961) observed an unidentified caseworm in Mettupalayam, Tamil Nadu. The caterpillars make holes in the fronds and also scrape away the entire green matter leaving only midribs and side veins. *Acanthopsyche plagiophelps* Hampson has been reported from Hirehalli, Karnataka State (Seshadri, 1969).

The rhinoceros beetle, *Oryctes rhinoceros* L. (Coleoptera: Scarabaeidae), which is an important pest of coconut has been found damaging the fronds of areca palms in Midnapur, West Bengal (Nambiar, 1949). Their grubs have been observed to damage the roots of seedlings (Naidu, 1963). The adult beetles damage the stem. The beetles

bore into the stem 60-90cm below the crown exposing the inner fibrous tissues (Kumar, et al., 1967).

The scale insects (Hemiptera: Diaspididae) *Aonidiella orientalis* Newstead. (Puttarudriah and ChannaBasavanna, 1956), *Aspidiotus ficus* Ashmead (Ayyar, 1963), and *A. destructor* Sign. (Nair, 1975) have been reported as pests.

Soft brown scale, *Coccus hesperidum* L. (Hemiptera: Coccidae). Puttarudriah and ChannaBasavanna (1956) recorded this scale insect in Karnataka State. It occurs also on coconut, citrus, and red gram. *C. acutissimus* Green has also been reported from areca (Nair and Menon, 1963).

The other scale insects infesting areca are *Pinnaspis aspidistrae* Sign. (Pillai and Kurian, 1959b), *P. buxi* Bouche, *P. strachani* Cooley (Nair, 1975), *Parlatoria mytilaspiformis* Gr. (Puttarudriah and ChannaBasavanna, 1956), *Chionaspis dilatata* Gr., *Phenacaspis cockerelli* Cooley, *Lepidosaphes* sp., *Qudraspidotus* sp., and *Saissetia* sp. (Nair, 1975). The mealy bugs *Pseudococcus citriculus* Gr. and *Rostrococcus iceryoides* Gr. also infest the areca palm (Nair, 1975).

Inflorescence infesting.

The caterpillars of the moths *Batrachedra* sp. (Lepidoptera: Tineidae) and *Pyroderces* sp. (Lepidoptera: Cosmopterygidae) were first reported as pests by Nair and Menon (1963). The adults lay eggs on the outer surface of unopened spathes or newly opened inflorescences. The caterpillars feed on the flowers. The attacked inflorescences finally assume a burnt or charred appearance.

The caterpillars of the lymantriid *E. semisignata* have also been reported to damage the inflorescence (Nair, 1975).

The aphid, *Cerataphis lataniae* Boisd. (Hemiptera: Aphididae) has been observed to damage the inflorescence and nuts in Karnataka State. Flowers and tender nuts drop off from affected bunches. Secondary infestation

of sooty mold is usually seen (Nair and Menon, 1963). *C. variabilis* H.R.L. has also been reported.

***Icerya aegyptiaca* Douglas (Hemiptera: Margarodidae).** The other host plants of this "mealy bug" are jack and crotons. Ripe arecanuts are infested by this insect at Karwar in Karnataka State (Puttarudriah and Channa-Basavanna, 1957b). Natural enemies like the adults and grubs of the coccinellid *Rodolia* sp. and the pteromalid parasite *Pachycrepoides coorgensis* keep the pest under control.

P. strachani*, *Gossyparia* sp., and *R. iceryoides infest also inflorescence and cause nut fall (Nair, 1975).

***Rhynchophorus* sp., *Acionemis praembulans* Fst. (Curculionidae), *Bruchus* sp., *Dioryctus* sp., *Aulachophora* sp. (Chrysomelidae), and *Leucohimatum* sp. (Cryptophagidae)** have been recorded as infesting inflorescence (Murthy *et al.*, 1965).

The ants, ***Oecophylla smaragdina* F. and *Monomorium gracillimum* S. (Hymenoptera: Formicidae)** dwell on the foliage and inflorescence. They infest the newly opened inflorescence and web together the rachillae. Sometimes pollination is prevented causing severe shedding of buttons. *M. gracillimum* has been found feeding on young inflorescence caterpillars (Anonymous, 1962 a).

Seedling Pests.

The butterfly pest ***Elymnias caudata* Butl. (Lepidoptera: Nymphalidae)** is found in seedlings from September to December. The caterpillars feed on the leaves. Fully mature larvae are green in colour with two parallel yellow lines on the dorsal surface of the body. The adult butterfly is brown with splashes of white, yellow, and violet colouration (Nair, 1964).

Caseworms (Lepidoptera: Psychidae). Pillai and Kurian (1959 b) reported *Manatha albipes* Moore as doing damage to areca

seedlings. Nair and Menon (1963) have recorded *Cryptothelia* sp. and *Thyridopteryx* sp. from Kerala.

The mealy bug, ***Dysmicoccus brevipes* Ckll. (Hemiptera: Pseudococcidae)** infests the collar region of seedlings and cause their destruction (Rao and Bavappa, 1961).

***Odontotermes obesus* Ramb. (Isoptera: Termitidae)** infests seed nuts and seedlings during the dry weather (Pillai and Kurian, 1959 b; Rao *et al.*, 1961). They attack the collar region of the seedling and the central shoot wilts. Termites attack the bark and bole portions of adult palms sometimes. Covering the nursery bed with a layer of river sand and dusting soil insecticides like chlordane or aldrin are the control measures.

Mammalian Pests.

Rats and squirrels can damage both tender and mature nuts. They feed on the nuts when they are 3-5 months old. Spraying arecanut bunches with 5% zinc phosphide has been reported to control squirrels (Naidu, 1962) but this appears improbable.

The frugivorous bat can occasionally cause loss by removing ripe nuts. Monkeys may also damage areca bunches as in the hilly tracts of Karnataka and Midnapur, W. Bengal (Nair and Menon, 1963; Nambiar, 1949).

CONCLUSION

Taken as a whole, pests of arecanut are not a serious economic problem except that a few species may cause considerable losses frequently in localized regions. Chemical control is effective in such cases, as for instance, in spindle bug, inflorescence caterpillar, and root grubs. However, these chemicals should be used with caution to prevent or at least minimize their harmful effects on pollinators, parasites, and predators. Prophylactic control measures are effective in the case of spindle bug since it is a capsid.

Breeding for resistance to the insect pests is a long cry and may be unnecessary also for the present. However, a better understanding of the life history and ecological factors conditioning their reproductive strategy are called for for working out safer, more effective, and economic ways of controlling them.

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REFERENCE

- 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., SATHIAMMA, B., AND ABRAHAM, K. J. 1972. in Annual Report for 1971, Central Plantation Crops Research Institute Kasaragod. p. 185.
- ABRAHAM, V.A., SATHIAMMA, B., ABRAHAM, K. J., AND KURIAN, C. 1976. Control of arecanut spindle bug (*Carvalhoia arecae* Miller and China) using granular insecticides. *J. Plant. Crops* 4: 24-25.
- ANNUAL REPORT for 1959-'60. Central Arecanut Research Station, Vittal. pp. 73-75, 1960.
- ANNUAL REPORT for 1962-'63. Central Arecanut Research Station, Vittal. pp. 57-58. 1963.
- ANNUAL REPORT for 1964-'65. Central and Regional Arecanut Research Stations, pp. 64-65. 1967.
- ANNUAL REPORT for 1967. Central and Regional Arecanut Research Stations, pp. 52-54. 1969.
- ANNUAL REPORT for 1961-'62. Regional Arecanut Research Station, Mohitnagar. p. 19. 1962.
- ANONYMOUS CONTRIBUTION, 1962a. A lepidopterous pest of arecanut. *Arecanut J.* 13: 34.
- ANONYMOUS CONTRIBUTION, 1962b. A note on the new pest of arecanut crop. *Arecanut J.* 13: 241-243.
- APPANNA, M. 1959. Some new insects and mites on areca palm in Mysore IV. Preliminary observations on a lepidopterous borer damaging areca fruits. *Arecanut J.* 10: 93-96.
- AYYAR, T.V.R. 1963. Handbook of Economic Entomology for South India. Rev. Ed. 516 pp. Government of Madras, Madras.
- DANIEL, M. 1976. Biology and predatory habits of the ladybird beetle *Stethorus keralicus* Kapur (Coleoptera: Coccinellidae) predatory on the palm mite. *J. Plant. Crops* 4: 7-9.
- DANIEL, M. 1977. The spider mite *Tetranychus fijiensis* Hirst on the betelnut palm. *Acarologia* 19 (in press).
- DANIEL, M. AND KUMAR, T. P. 1974. in Annual Report for 1973, Central Plantation Crops Research Institute, Kasaragod, p. 122.
- DANIEL, M. AND KUMAR, T. P. 1975. in Annual Report, Central Plantation Crops Research Institute Kasaragod, pp. 111-112.
- DANIEL, M. AND SESHADRI, S. N. 1976. Observations on *Phytoseiulus persimilis* A-H (Acarina: Phytoseiidae) for control of the phytophagous mites of areca palm. *Acarology News Letter* No. 3: (in press).
- KANTHA, S., RAI B. K. AND LAL, R. 1963. Laboratory evaluation of the toxicity of pesticides to palm mite *Raoiella indica* Hirst (Tenuipalpidae = Phytoptipalpidae = Acarina). *Indian Coconut J.* 16: 63-66.
- KAPUR, A. P. 1961. A new species of *Stethorus* Weise. (Coleoptera: Coccinellidae) feeding on arecanut palm mite in Kerala, Southern India. *Entomophaga* 6: 35-38.
- KHANDIGE, S. B. 1955. A capsid bug on areca. *Arecanut Bull.* 6: 120-121.
- KHANDIGE, S. B., PATEL, G. I. AND BAVAPPA, K. V. A. 1957. Preliminary observations on the yellow leaf disease of arecanut palm. *Arecanut J.* 8: 61-62.
- KUMAR, S.N.S. AND NAIDU, G.V.B. 1965. *Morismus carinatus* Walk. as a new pest of arecanut *Arecanut J.* 16: 9-11.
- KUMAR, S.N.S., SANNAMARAPPA, M., AND KHAN, T. A. 1967. Occurrence of rhinoceros beetle (*Oryctes rhinoceros*) in arecanut crop. *Sci. & Cult.* 33: 542.
- KUMAR, T. P. 1975. Chemical control of the arecanut white grub *Leucopholis burmeisteri* Brenske. *Arecanut & Spices Bull.* 6: 35.
- KUMAR T. P. AND DANIEL, M. 1974. in Annual Report for 1973. Central Plantation Crops Research Institute, Kasaragod. pp. 122-123.
- LEVER, R.J.A.W. 1937. Economic insects and biological control in the British Solomon Islands. *Bull. ent. Res.* 28: 325-331.

- MENON, R., NAIR, R. B., AND ABRAHAM, K.J. 1962. A note on pests and diseases of areca seedlings. *Arecanut J.* 13: 26-29.
- MILLER, N.C.E. AND CHINA, W. E. 1957. A new genus and species of Miridae from *Areca catechu* in South India (Hemiptera: Heteroptera). *Bull. ent. Res.* 47: 429-431.
- MISRA, B. C., RAJAMONI, S., AND KUMAR S.N.S. 1971. in Annual Report for 1969. Central and Regional Arecanut Research Stations. p. 67.
- MISRA, B. C. AND SESHADRI, S. N. 1970. in Annual Report for 1968. Central and Regional Arecanut Research Stations. pp. 54-57.
- MURTHY, K. N. AND HANUMANTHAPPA, S. 1965. *Diocalandra stigmaticollis* Gyll. (Curculionidae: Coleoptera) as a major pest on arecanut (*Areca catechu*) in Mysore. *Sci. & Cult.* 31: 645-646.
- MURTHY, K. N., KRISHNAPPA, K. T., HANUMANTHAPPA, S., CHANNAMARAPPA, M. AND NAGARAJAN, B. 1965. Some insects and mites of areca palm in Mysore. V. *Arecanut J.* 16: 5-7.
- NAIDU, G.V.B. 1962. Squirrel damage to the arecanut crop and its control. *Arecanut J.* 13: 91-94.
- NAIDU, G.V.B. 1963. A note on the grub of rhinoceros beetle as a pest of arecanut crop. *Arecanut J.* 14: 13-14.
- NAIDU, G.V.B. AND KUMAR, S.N.S. 1963. *Diocalandra stigmaticollis* Gyll. as a new borer pest of arecanut crop. *Curr. Sci.* 32: 425-426.
- NAIR, M.R.G.K. 1975. Insects and Mites of Crops in India. 404 pp. ICAR, New Delhi.
- NAIR, M.R.G.K. AND DAS, N. M. 1962. On the biology and control of *Carvalhoia arecae* Miller and China as a pest of arecanut palm in Kerala. *Indian J. Ent.* 24: 86-93.
- NAIR, R. B. 1964a. The butterfly pest of arecanut seedlings. *Arecanut J.* 15: 179-181.
- NAIR, R. B. 1964b. *Carvalhoia arecae* Miller and China. A major pest of *Areca catechu*. *Arecanut J.* 15: 57-61.
- NAIR, R. B. AND MENON, R. 1963. Major and minor pests of arecanut Crop. *Arecanut J.* 14: 139-147.
- NAIR, R. B. AND RAO, K.S.N. 1964. Occurrence of two new genera of mites on arecanut. *Arecanut J.* 15: 182.
- NAIR, R. B. AND RAWTHER T.S.S. 1969. On the biology of *Tirathaba mundella* as a pest of areca palms. *Agr. Res. J. Kerala.* 7: 47-50.
- NAMBIAR, K. K. 1949. A Survey of Arecanut Crop in Indian Union. 76 pp. Indian Central Arecanut Committee, Calicut.
- PATEL, G. I. AND RAO, K.S.N. 1958. Important diseases and pests of arecanut and their control. *Arecanut J.* 9: 89-96.
- PILLAI, G. B. AND KURIAN, C. 1959a. Some observations on areca thrips, *Rhipiphorothrips cruentatus* Hood (Thripidae: Terebrantia: Thysanoptera). *Arecanut J.* 9: 123-125.
- PILLAI, G. B. AND KURIAN, C. 1959b. New light on areca's pest enemies. *Indian Fmg.* 9(8): 5-7.
- PRASAD, V. A Catalogue of Mites of India. 320 pp. Indira Acarology Publishing House, Ludhiana, India.
- PUTTARUDRIAH, M. AND CHANNA-BASAVANNA, G. P. 1956. Some new insects and mites on areca palm in Mysore II. *Arecanut J.* 7: 9-10.
- PUTTARUDRIAH, M. AND CHANNA-BASAVANNA, G. P. 1957a. Preliminary acaricidal test against the areca mite *Raoiella indica* Hirst. *Arecanut J.* 8: 87-88.
- PUTTARUDRIAH, M. AND CHANNA-BASAVANNA, G. P. 1957b. Some new insects and mites on areca palm in Mysore III. *Arecanut J.* 8: 10-11.
- RAHMAN, K. A. AND SAPRA, A. N. 1940. Biology of the mite *Paratetranychus indicus* Hirst, a pest of sugarcane in Punjab. *Indian J. Ent.* 2: 201-212.
- RAJAMONI, S. 1971. in Annual Report for 1969-70. Central Plantation Crops Research Institute, Kasaragod. pp. 176-177.
- RAJAMONI, S. AND MISRA, B. C. 1971. in Annual Report for 1969. Central and Regional Arecanut Research Stations. pp. 64-66.
- RAJAMONI, S. AND NAMBIAR, K.K.N. 1970. Pests of arecanut palm. *Indian Fmg.* 20(8): 23.
- RAO, K.S.N. AND BAVAPPA, K.V.A. 1961. Nursery diseases and pests of arecanut and their control. *Arecanut J.* 12: 136.
- RAO K.S.N., NAIDU, G.V.B. AND BAVAPPA, K.V.A. 1961. White grub pest of arecanut. *Arecanut J.* 12: 22-25.
- SADANANDAN, A. K. AND ANTONY, K. J. 1973. Control of a new calyx mite of arecanut in Kerala. *Arecanut & Spices Bull.* 4: 17-18.
- SATHIAMMA, B. AND SHAMA BHAT, K. 1972. Record of new alternate host plants for the slug

- caterpillar, *Contheyla rotunda* Hampson. *Curr. Sci.* **41**: 721.
- SESHADRI, S. N. 1968. Occurrence of *Xyleborus perforans* Woll: (Scolytidae: Coleoptera) as a pest of arecanut and coconut crops. *Sci. & Cult.* **34**: 132.
- SESHADRI, S. N. 1969. in Annual Report for 1965-'66. Central and Regional Arecanut Research Stations. pp. 51-53.
- SESHADRI, S.N. 1972. in Annual Report for 1971. Central Plantation Crops Research Institute, Kasaragod. p. 184.
- VALSALA, P. G. 1958. Pests of arecanut and their control. *Coconut Bull.* **12**: 13-16.
- VENUGOPAL, S. V. AND VENUGOPAL, V. 1961. A new occurrence of caseworm on arecanut in Coimbatore District. *Madras agric. J.* **48**: 309-310.