

PESTS OF CASHEW AND THEIR CONTROL IN INDIA— A REVIEW OF CURRENT STATUS

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ABSTRACT

The major pests affecting cashew in India are the stem and root borers, tea mosquito, leaf miner, and leaf and blossom webber. Among the less serious pests, the defoliating caterpillars, shoot tip and inflorescence caterpillars, leaf thrips, flower thrips, leaf beetles and weevils, apple and nut borers and nut crinkler, at times appear in severe proportion in some pockets and cause considerable damage. Nature and extent of damage, biology, seasonal abundance, and control measures of these pests are discussed in detail. The natural enemies of different pests are also listed.

INTRODUCTION

Cashew is attacked by a number of insect pests during different stages of its growth and development. More than fifty species of insects are known to be infesting cashew in India in different degrees of intensity. However, when the extent of damage is taken into account only four are considered to be major pests. They are the stem and root borers, the tea mosquito, the leaf miner, and the leaf and blossom webber. Among the less serious ones are a few, which at times appear in sporadic proportions in certain localised tracts and cause untold havoc to the crop. The present review is an attempt to update the available information on different pests of cashew. For this we have drawn liberally from the results of studies carried out at Kasaragod under the All India Co-ordinated Spices and Cashewnut Improvement Project.

The most important records of observations on the insects affecting cashew are those of Ayyar (1932, 1940, 1941, and 1942). Insects like tea mosquito, *Helopeltis antonii*

Sign., the cerambycid beetle, *Plocaederus ferrugineus* L., the red banded leaf thrips, *Selenothrips rubrocinctus* Giard, the flower thrips, *Rhynchothrips raoensis* G., the leaf caterpillar, *Cricula trifenestrata* W., the leaf miner, *Acrocercops syngamma* M., the weevil, *Apion amplum* F., and the scales, *Ceroplastes floridensis* Comst., and *Lecanium latiopeculum* G. have been reported by him as pests of cashew. Davis (1949) referred to a pentatomid bug, *Catacanthus* sp. occurring in the West Coast particularly of the erstwhile Travancore state. According to Madhava Rao (1955), the cerambycid borer is the most important pest of cashew. Abraham (1958) described as many as 40 insect pests, including a few stored product pests of cashew in an extensive survey of the erstwhile Madras state, estimating the nature and extent of damage caused by each and suggesting control measures. Basu Choudhuri (1962) made a preliminary survey of cashew pests in the forest areas in Kerala. Khan (1963) gave a review on different cashew pests and suggested control measures

against them. Basheer and Jayaraj (1964) listed 43 insect and non-insect pests infesting cashew and the processed kernels under storage. The nature and extent of damage caused by different pests, their life histories and control measures were discussed. Nair and Remamony (1964) described a coreid bug, *Paradasynus (rostratus* Dist. ?) attacking tender cashewnuts causing their shrivelling and drying up. Remamony (1965) reported that the caterpillars of the gelechiid moth, *Anarsia epotias* Meyr cause considerable damage to the tender shoots of cashew. Basu Choudhuri and Misra (1973) reported the pyralid caterpillars, *Hyalospila leuconeurella* Ragonet and *A. epotias* Meyr, to be pests of cashew apples and nuts in south India. Misra and Basu Choudhuri (1974) recorded the lymantriid *Lymantria obfuscata* Walker as a pest of cashew in s. India and gave a short account on its distribution, habit, and habitats. Sreeramulu *et al.* (1975) reported *Popillia complanata* Newm. (Coleoptera: Rutelidae), *Pingasa ruginaria* Gn. (Lepidoptera: Geometridae), and *Estigmene lactinea* C. (Lepidoptera: Arctiidae) as three new pests of cashew and gave short accounts of their nature of damage. The spotted locust *Aularches miliaris* Linn. and an unidentified species of bagworm (Lepidoptera: Psychidae) have been observed to feed on the foliage of cashew (Pillai *et al.*, 1976).

Beccari and Gerini (1968) reported more than 50 species of pests from throughout the world and considered ten of them as major pests. The major pests of cashew reported by Northwood and Kayumbo (1970) from Tanzania include the sucking bugs *H. schoutedeni* Reut. and *H. anacardii* Miller, the Theraptus bug *Pseudotheraptus wayi* Brown, the thrips *S. rubrocinctus* Giard, the bark borer *Mecocorynus loripes* Chevr, and the defoliating caterpillar *Nudaurelia bellina*. Rodrigues (1967) reported that the mites *Oligonychus coffeae* Nietm, *Eotetranychus falcatus* Meyer and Rodrigues, and *Brevipal-*

pus californicus (Banks.) infest cashew trees in Mozambique.

Brief descriptions of the nature and extent of damage to the crop, the life history of the pest, and possible control measures are discussed in the following paragraphs.

Stem and root borer, *Plocaederus ferrugineus* L. (Coleoptera: Cerambycidae)

This is a dreaded enemy of cashew which is capable of killing the tree outright. The symptoms of damage include the presence of small holes in the collar region, gummosis, extrusion of frass through the holes, yellowing and shedding of leaves, and drying of twigs. After hatching, the grubs bore into the fresh tissues of the bark and feed on the subsequent subepidermal and sapwood tissues and make tunnels in irregular directions. As a result of the injury to the cells, a resinous material oozes out which on exposure gets hardened. The larval tunnels made by *P. ferrugineus* in the sapwood are broad and irregular, deepest in the middle and shallow at the sides, and fully packed with fibrous tissues and frass. When the vascular tissues are damaged the ascent of plant sap is arrested and the leaves become yellow and are shed. During final stages of infestation the twigs dry up and the tree dies. For pupation the grub descends to the root through the tunnels in the sapwood and bores into the heartwood, and forms a chamber tightly packed with fibrous tissues and frass providing protection for the calcareous cocoon.

The intensity of infestation is often very severe in certain pockets, particularly in forest plantations. Infestations ranging from 1.6–4.0% were noticed in a few tracts of Kerala, Karnataka, Tamil Nadu, and Maharashtra in a casual survey; but in certain neglected plantations, where dead trees were not removed, higher intensities of up to 10% were observed.

The adult is a 25–40 mm long, reddish brown, longicorn beetle, the head and thorax

of which are dark brown or almost black. The eggs are deposited into the live tissues in the crevices of loose bark in the trunk or roots exposed above the soil. The eggs are ovoid (4.5 mm × 2 mm) and dirty white. The incubation period ranges from 4 to 6 days at a temperature of 26-35°C and relative humidity 47-100%. The grub stage lasts for 6 to 7 months. In laboratory cages the pupal period ranges from 20 days, when cocoon is not formed, to 60 days when pupation is inside calcareous cocoons.

Besides cashew, *P. ferrugineus* L. also infests *Bombax malabaricum*, *Boswellia serrata*, *Buchanania latifolia*, *Diospyros melanoxylon*, *Hardwickia binata*, and *Lannea grandis* (Beeson, 1941).

Other stem and root borer pests include the cerambycid beetles *Prionoma atratum* G. and *Plocaederus consocius* P., reported by Abraham (1958), and *P. obesus* Gahan (Cerambycinae) and *Batocera rufomaculata* De G. (Lamiinae), observed by Pillai *et al.* (1976). *P. obesus* Gahan is a chestnut brown longicorn beetle with black pubescence. The adult is 40 mm long whereas the fully grown grub measures 75 mm. Its excavations are wider than those of *P. ferrugineus*.

B. rufomaculata De. G. is a dark brown beetle with fine greyish vestiture, pronotum with two kidney-shaped orange yellow spots, white scutellum, and elytra with numerous black tubercles and yellowish spots which vary in number and shape. The adult beetles are 35-50 mm long. The female beetle lays eggs in incisions made on the bark. The newly hatched larva is 10 mm long. It feeds first on the meristem and then penetrates deeper. The fully grown grub is 100 mm long. The larval excavations in the early stages are extensive, irregular and deep, and packed with coarse fibres and scraps of wood and bark. The pupae are bigger than those of *P. ferrugineus* and *P. obesus*.

Besides the longicorn beetles, grubs of bark and sapwood borers like *Xylothrips*

flavipes Ill. (Bostrychidae) *Lampetis fastuosa* F. and *Belionota prasina* Thumb. (Buprestidae), *Xystrocera globosa* Oll. (Cerambycinae), and *Coptops aedificator* F. (Lamiinae) were also collected from cashew trees infested by longicorn beetles (Pillai *et al.*, 1976). *X. flavipes* is a widespread species occurring on a variety of host plants. The buprestid *B. prasina* is a general wood borer known also from *Buchanania latifolia*, *Mangifera indica*, and *Spondias mangifera*. Adult is a dark bluish green smooth beetle. The grub is 60 mm long. The larval tunnels of *X. globosa* run in the inner bark and sometimes in the sapwood. *C. aedificator* F. is a bark borer of dead trees rather than a sap wood borer. The beetle is brown in colour with black speckles and grey as well as black markings on the elytra. The larval galleries and the pupal chamber are mostly in the bark. This species has a wide host range.

The bark borer *Indarbela tetraonis* Mo. (Lepidoptera: Arbelidae) is reported to be a minor pest in some plantations in Kerala and Tamil Nadu. The caterpillars make small holes and tunnel through the superficial tissues of the bark on which they feed. The caterpillars are seen inside galleries made of silken threads reinforced with scraps of tissue and frass.

No indigenous parasite or predator affecting the stem and root borer pests has been reported so far (Basu Choudhuri, 1969). The dead grubs of *P. ferrugineus* collected from the field yielded an isolate of *Aspergillus* sp. which in further tests proved to be non-pathogenic (Pillai, unpublished). Basu Choudhuri (1973) reported that the entomogenous fungus *Metarrhizium anisopliae* Metch. (Sorokin) causes the green muscardine disease in *P. ferrugineus* grubs, and gave the details of its host range, epidemiology, symptomatology, and pathogenicity. However, tests carried out at Kasaragod with *M. anisopliae* isolate from *Oryctes rhinoceros* grubs showed that this is not very effective

particularly when the inoculum is applied in a mixture with feed material. Similar trials with entomogenous bacteria, *Bacillus thuringiensis* Berl. and *B. popilliae* Dutky also did not give any encouraging results in preliminary tests when the inoculum was mixed with the feed. However, the nematode *cum* bacterium culture DD-136 (*Neoplectana carpocapsae* W. and *Achromobacter nematophilus*), at an inoculum dose of 100 nemas per gram body weight of the host grubs, effected 50-60% mortality within 24 days, when the inoculum was mixed with cashew bark.

Field trials on the curative control of stem and root borer using BHC, carbaryl, pyrethrins, piperonyl butoxide, dimethoate, trichlorphon, fenitrothion, dichlorvos (applied as injection and drenching the base), phorate granules, and aluminium phosphide tablets (applied into tunnels on the stem) reveal that the success of the curative treatment depends much on the intensity of infestation. Even though most of the above insecticides are quite effective in controlling the grubs, the trees in the medium and advanced stages of infestation can not be saved. If the infestation is detected in the early stages even swabbing with BHC 0.1% suspension after removal of the affected tissues which harbour immature stages of the pest is quite effective (Pillai *et al.*, 1976). The dead trees and those which are beyond recovery should be removed from the plantation lest they serve as a reservoir for multiplication of stem borers and other species of bark and sapwood borers.

The mosquito, *Helopeltis antonii* Sign. (Heteroptera: Miridae)

The tea mosquito causes more economic loss to the crop than the other pests. Both the adults and immature stages of this mirid (capsid) bug suck sap from the tender shoots, leaves, floral branches, developing nuts, and apples. The injury made by the suctorial mouth parts of the insect causes the tender shoots to exude a resinous gummy substance which on exposure to air gets hardened.

Within a short time the surrounding tissues become necrotised and brown or black scabs are formed, presumably due to the action of phytotoxin present in the saliva. Adjacent lesions coalesce and finally the affected shoot dries up. In certain endemic areas, the entire flush dries up and the trees present a scorched appearance. Abraham (1958) estimated the average damage to be 25% in tender shoots and 15% in tender nuts. The infestation of inflorescence quite often results in blossom blight and causes yield losses exceeding 30%. The immature nuts infested by this pest develop characteristic eruptive spots and finally shrivel and fall off.

The tea mosquito has a wide host range including tea, guava, cacao, mahogany, cinchona, red gum, apple, grapes, and neem (Rao, 1915; Puttarudriah and Appanna, 1955). Even though data on the extent of losses are lacking, a recent study reveals that the pest incidence is very severe in most of the cashew growing tracts of Kerala, Karnataka, Goa, and Maharashtra on the West Coast. Contrary to earlier belief that it is not a major pest on the East Coast, recent observations revealed its incidence in severe proportions in the cashew growing tracts of Tamil Nadu, particularly in Cuddalore, Vriddhachalam, and Pudukkottai areas.

The adult bug is reddish brown with a black head, red thorax, and black and white abdomen. A knobbed process arises from the dorsal aspect of the thorax. The bug lays eggs singly deep inside the tender shoots and soft tissues of inflorescence branches. A pair of fine thread-like chorionic processes projecting outside indicates the presence of egg inside the tissues. Eggs are reniform and creamy white. The incubation period lasts about 6-7 days at a temperature range of 24-32°C and relative humidity of 47-100%, and the nymphal period comprising five instars is completed in ten days. Female bugs reared in the laboratory live for an average period of seven days (range 4-14 days) and

lay 25 eggs (range 10-41). The longevity of male bugs is 9.5 days (Pillai and Abraham, 1974; Pillai *et al.*, 1976). Amruth Sudhakar (1975) did not find any significant difference in the duration of life cycle of the insect on cashew and guava, and Sathiamma (1976) could not observe any significant difference on cashew and mango seedlings and cacao pods. The total life cycle of the bug at Bangalore as reported by Amruth Sudhakar (1975) was 22-35 days whereas under Kasaragod conditions it was only 16-17 days (Pillai and Abraham, 1974).

Data on the fluctuations in population density of the pest, collected from sample trees at weekly intervals from June 1972 onwards, showed that its build up commences from October onwards synchronising with the emergence of new flushes after the cessation of rains. The pest population reaches its peak during the blossom period in January. It was totally absent on the trees during the monsoon period. Highly significant negative correlations were observed between meteorological factors like rainfall, relative humidity, and minimum temperature and the population abundance of the pest, and positive correlations between pest population (adults and immature stages) and percentage of infested shoots and panicles (Pillai and Abraham, 1975).

Swaine (1959) also observed the absence of *H. anacardii* Miller during the rainy season and its abundance during the flushing season (July-November) after the monsoon in Tanganyika territory. He reported that the insects were scarce on older trees from December until June but they were readily found on young trees in December-April as these were putting on a considerable amount of new and succulent growth during this period in addition to the main growth after June. *H. bergrothi* Reut. and *H. schoutedeni* Reut. are the other species of mirids recorded as pests of cashew from Tanzania and other African countries.

'Inflorescence blight' of cashew is one of the major problems as it results in drying of panicles and causes heavy losses. Incidence of upto 30% has been reported from Cashew Research Station, Ullal (Anon., 1966). Studies carried out at Ullal have shown that inflorescence blight is caused by *H. antonii* S. in association with *Gloeosporium mangiferae* P. Henn., and *Phomopsis anacardii* (Anon., 1965). As such, recommendations for its control included spraying of Cuman 0.1% in combination with Dimecron 0.03% (Anon., 1966; 1969). Damodaran and Balakrishnan Nair (1969) assessed the relative efficacy of eleven insecticides in controlling *H. antonii* and concluded that two sprayings with DDT 0.2% (first as soon as the symptom of pest attack was noticed and the second 15 days thence) gave the best results followed by Sevin (0.1%), endrin (0.03%), and dieldrin (0.05%). The systemic insecticides, trichlorfon, phosphamidon, thiometon, and dimethoate were not as effective as the contact insecticides in controlling the pest. Nambiar *et al.* (1973), after conducting experiments on the role of tea mosquito and fungi in the incidence of blossom blight under controlled conditions in the field, concluded that infestation of tea mosquito alone was primarily responsible for the malady and that the fungi associated with blighted inflorescences were only secondary saprophytic colonisers. As such, sprays with suitable insecticides alone at the appropriate time will help in controlling the malady and no fungicides need be incorporated in the spray fluid. Chemical control trials conducted at Kasaragod revealed that endosulfan (0.05%) applied as high volume spray, or 0.1% as low volume spray, at the time of emergence of new shoots, panicles, and fruitset was effective in controlling tea mosquito population and reducing the resultant crop losses. The treated plots recorded 10.7% infestation (partial and full) of inflorescence as against 32.5% in the untreated control. The average yield of nuts

per tree in the endosulfan-treated plot was 2.5 kg as against 1.3 kg in the untreated control (Pillai and Abraham, 1975). Three rounds of sprayings are recommended taking into consideration the trends in population fluctuations of the pest. Moreover, the third round of spraying given at the time of fruit set will take care of not only tea mosquito but also other pests which are responsible for immature fruit drop in cashew. Infestation by tea mosquito, flower thrips, and fruit borers accounts for 12.3% fruit drop during the mustard stage, 16.4% during the peanut stage, and 1.1% during later stages (Pillai and Abraham, 1974).

The time of spraying is very important for effective control of a pest like tea mosquito. The plant protection spray against this pest has to be done well in advance before the insect has inflicted injury to the crop.

No effective parasite or predator exerting natural control of the pest has hitherto been observed.

The feaf miner, *Acrocercops syngamma* M. (Lepidoptera: Gracillariidae)

Infestation by this pest is common in the post-harvest and the post-monsoon flushes; young plantations are found to be more prone to the attack of the pest. The injury by the caterpillars which mine through tender leaves becomes visible as tortuous markings. In the mined areas the thin epidermal peel swells up as blistered patches. As the infested leaves mature the damage is manifested as big holes. The adult is a silver-grey moth which lays eggs in tender leaves. Freshly hatched caterpillars are pale white. Fully grown caterpillars are reddish brown and are about 6 mm long. They make their way out of the mined area and fall to the soil where they pupate. Abraham (1958) reported that the larval stage lasts for two weeks. Under laboratory conditions, when no soil is supplied, the caterpillars were observed to pupate on the leaf surface itself, mainly at

the midrib region making a thin membranous protective covering over it. The pupal stage lasts for 7-9 days.

As many as eight caterpillars have been observed on a single leaf. Abraham (1958) estimated the damage to be 26% in severely infested tracts, whereas Basu Choudhuri (1962) observed that nearly 75-80% of 500 leaves sampled from standing trees were damaged during September-October season in Kerala.

Khan (1963) suggested spraying 0.025% parathion or 0.05% BHC synchronising with the time of emergence of new flushes to control the pest. In trials at Kasaragod, Pillai (1975) observed that phosphamidon (0.05%) spray or fenitrothion (0.05%) spray also gave effective control of the pest. In areas where tea mosquito is also present the first round of spray with endosulfan (0.05%) recommended for its control at the time of emergence of new flushes in October-November will take care of the leaf miner also.

Leaf and blossom webber, *Macalla moncusalis* Walker (Lepidoptera: Pyralide)

Of the two species of leaf and shoot webbing caterpillars, *Macalla moncusalis* Walker and *Orthaga exvinacea* Hamps. considered to be minor pests, the former has attained the status of a major pest in recent years in the east coast tracts, particularly in the coastal districts of Andhra Pradesh. The pest incidence is also becoming severe in the cashew plantations of Tamil Nadu and Orissa. The symptoms of infestations are the presence of web on the terminal portions of new shoots and blossom and the drying of the webbed shoots. The galleries of silken webs reinforced with scraps of plant parts and castings indicate the presence of caterpillars in the webbed leaves.

M. moncusalis male is dark fuscous and female paler and more olive green. Ganeswara Rao *et al.* (1973) studied the

comparative biology of this pest on cashew and mango and concluded that the pest prefers cashew even though much difference was not observed in the life span of this pest on the two hosts. The eggs are laid singly or in groups of six on the leaves, more usually on the ventral surface, and occasionally on the tender shoots, firmly glued on to the surface. Freshly laid eggs are yellowish green in colour but three broad pink bands appear across the surface a day later. The incubation period lasts for 4-7 days. There are five larval instars and the total larval period ranges from 16-22 days in cashew and 18-25 days in mango. Pupation takes place in cocoons in the leaf webs or in the soil. The prepupal period lasts for one to four days and the pupal period 9-14 days in cashew and 9-15 days in mango. The life cycle is completed in 37 days on cashew and 41 days on mango. Two species of *Apanteles* and an unidentified species of Braconid have been recorded as parasites of this pest.

Spraying 0.2% BHC or 0.05% fenitrothion or endosulfan at the time of emergence of new flushes immediately after the monsoon is effective in controlling the pest. Plant protection sprays against the tea mosquito are also effective against this pest.

Among the less serious enemies of cashew, the most important ones are the defoliating caterpillars, shoot tip caterpillars, leaf thrips, leaf beetles and weevils, flower thrips, apple and nut borers, and nut crinkler.

Defoliating caterpillars

***Cricula trifenestrata* H. (Lepidoptera: Saturniidae).** This is a sporadic pest which causes extensive damage by defoliation of isolated trees in certain localities. The body of the caterpillar is beset with urticating hairs and spines. The full-grown larva is stout, dark brown, and about 50-65 mm long. Pupation takes place inside dark silken cocoon spun amongst the leaves, often in masses. The adult is a medium sized reddish

brown moth with three clear concentric spots on wings.

***Metanastria hyrtaca* Cram. (Lepidoptera: Lasiocampidae).** This is another sporadic pest which attacks isolated trees. Nair *et al.* (1974) studied the biology of the pest. The moth lays eggs in clusters on the lower surface of the leaves. The eggs are spherical and ash grey to black in colour. The eggs hatch in nine days. The larval period lasts for 33 days for males and 35 days for females. There are five larval instars for males and six for females. The duration of different instars also varies for males and females. The pupal period lasts for 12 days for both the males and females.

The early instar caterpillars are gregarious feeders of tender foliage, whereas the full grown caterpillars feed voraciously on mature leaves as well, but are active during night only. During day time they congregate on the trunk or branches and often escape notice. The caterpillars often completely defoliate young trees. *Perilampus microgastri* Ferr. (Perilampidae) was reared from a parasitised larva collected from the field (Pillai *et al.*, 1976).

***Lymantria obfuscata* Walker (Lepidoptera: Lymantriidae).** Misra and Basu Choudhuri (1974) recorded this defoliator as a new pest of cashew from south India. The caterpillars feed voraciously on foliage during night but are inactive during day time. They congregate in large numbers on the ground under dry leaves, near the base of the tree in crevices of bark, or on lower parts of well shaded main branches. After dusk they crawl up the trunk and feed till dawn. The feeding commences from the margin of leaves. When tender leaves are not available, the caterpillars feed on older leaves. During April-May the life cycle lasts for 45-51 days. Field and laboratory observations reveal that the pest completes five generations and starts a sixth in

a year under south Indian conditions. As the reproductive potential of the insect is very high it can cause considerable damage in cashew plantations. Misra and Basu Choudhuri (1974) reported some Tachinids as parasites of this pest.

Slug caterpillar, *Parasa lepida* Cram. (Lepidoptera: Eucleidae). Abraham (1958) observed this pest assuming severity on isolated trees around Coimbatore, Tamil Nadu. The adult moth lays eggs in groups on the under surface of leaves. The caterpillars in early stages feed gregariously on the interveinal leaf tissues. They scatter themselves on the tree as they grow. The caterpillars are bright green in colour and beset with urticating hairs and spines. They pupate on the stem. Pupal cases also are covered with stinging hairs. The life cycle lasts for about ten weeks (Ananthanaryanan and Abraham, 1955). Spraying with 0.2% BHC or 0.1% carbaryl effectively controls the pest.

The looper, *Oenospila flavifuscata* W. (Lepidoptera: Geometridae). Caterpillars of this medium sized moth with greenish wings have been observed to feed on the tender foliage of cashew. The moth lays whitish round eggs singly on leaf edges. The eggs hatch in about five days and the newly emerged caterpillars feed along the leaf margins. The larval period lasts for 15 days and the full grown caterpillars are 25 mm long. On attaining full growth, its colour becomes greenish. Pupation takes place inside leaf folds. The pupa is pale red in colour and is seen attached to the leaf surface by means of silken thread. The pupal stage lasts for about 10 days. The total life cycle takes about 30 days. Although the insect affects young leaves it is generally a minor pest on cashew (Abraham, 1958).

Stray cases of incidence of the leaf roller *Sylepta aurantiscollis* F., a eucosmid caterpillar, *Argyroproctea tonsonia* M., and the Tassar

silk moth *Antherea paphia* B. have also been noticed on cashew by Abraham (1958).

Shoot tip caterpillars

***Chelaria haligramma* M. (Lepidoptera: Gelechiidae).**

The tiny yellowish or greenish brown briskly moving caterpillars of this moth damage the shoot tips at the time of emergence of new flushes. Full grown caterpillar is 12 mm long. Pupation takes place inside the unopened leaves or in bore holes on the apical shoot. The pupa is yellowish red. Pupal period lasts for 7-8 days. Adult is a tiny dark moth which infests mango also. The pest damages tender leaves mostly at the bud stage and 3-4 caterpillars have been observed on a single shoot tip. The emerging leaves are folded and the caterpillar remains inside and feeds on them. It occasionally bores through into tender shoot tip to a depth of about 20-25 mm and the growing shoot tip becomes stunted and dries up. Upto 26% damage has been recorded in severe cases of infestation (Abraham, 1959). Heavy incidence of this pest has been observed in some tracts of Kerala in 1975.

***Anarsia epotias* Meyr. (Lepidoptera: Gelechiidae).**

Remamony (1965) recorded the caterpillars of this pest to be causing considerable damage to tender shoots. The newly emerged caterpillar remains in the leaf axil for some time and then slowly moves into the folds of tender unopened leaves. It then starts webbing the leaf margins together by silken threads and commences feeding by scraping the tissues. As the caterpillar reaches the third or fourth instar, it bores into the terminal shoot tip and tunnels backwards feeding on the internal tissues and filling the tunnels with frass. Usually it bores to a depth of 20-30 mm. Gummosis will also be seen in such shoots. The attacked shoots gradually dry up. The life cycle lasts for 24-29 days.

Two unidentified species of Hymenoptera were recorded as natural enemies of the pest (Remamony 1965).

As the infestation of shoot tip caterpillars coincides with the emergence of new flushes, sprays against tea mosquito will effectively control these pests.

Leaf thrips: *Selenothrips rubrocinctus* Giard, *Rhipiphorothrips cruentatus* Hood, *Retithrips syriacus* M. (Thysanoptera: Thripidae)

Of the three species of thrips recorded as foliage pests of cashew, *S. rubrocinctus* and *R. cruentatus* cause very severe damage to young plantations, particularly during the summer months. The adults and immature stages of thrips colonise the lower surface of leaves. As a result of their rasping and sucking activity the leaves become pale brown and slightly crinkled with roughening of the upper surface. In severe cases there will be shedding of leaves and stunting of growth of trees. The nymphs of the red banded thrips, *S. rubrocinctus* can be distinguished by their greenish yellow colour and red bands across the first and the last abdominal segments. Infestation by foliage thrips in severe proportion had been noticed during the summer months of 1974 and 1975 in different cashew growing tracts of Tamil Nadu. Spraying 0.05% endosulfan or fenitrothion or quinalphos so as to give a thorough coverage to the lower surface of leaves will control the pest (Pillai, 1975).

Boboye (1968) reported a severe outbreak of *S. rubrocinctus* on cashew at Okigwi in E. Nigeria, in February 1965, which caused premature leaf fall and deterioration of the crop. He observed that the peak period of pest abundance was during the summer months. Control trials revealed that dieldrin 0.11%, DDT 0.12% or dimethoate 0.14% were more effective in controlling thrips populations than BHC 0.14% and malathion 0.16%.

S. rubrocinctus and *R. cruentatus* have been observed as pests of cacao, arecanut, and a variety of other host plants also.

Leaf beetles and weevils

***Monolepta longitarsus* Jac. (Coleoptera: Chrysomelidae)**

These red beetles appear in large numbers on the West Coast during the South West monsoon (June-August) period and cause damage to tender leaves as well as portions of the stem. The incidence is found to be more on young trees. When disturbed, the beetles fly away producing a characteristic sound by knocking against the leaves.

The authors have recently recorded *Hyperaxis albostriata* Mots., *Arodepus marginatus* Pasc. (Chrysomelidae), and *Oxyctonia versicolor* (Cetoniidae) as infesting cashew trees.

The leaf twisting weevil (*Apoderus tranquebaricus* F. (Coleoptera: Curculionidae), which is a pest on mango, was observed on cashew also at the time of emergence of new flushes (Abraham, 1958). The weevil folds the leaves along the midrib, deposits its oval orange coloured eggs on leaf tips and twists the leaf into a compact roll. The grubs feed on the rolled up leaf tissues. Three other species of weevils observed feeding on tender foliage of cashew are *Myloccerus discolor* B. M. *viridanus* F., and *Amblyrhinus poricollis* B. Of these, *M. discolor* was observed to cause heavy damage to tender leaves particularly in nursery seedlings and young plantations during rainy season.

Spotted locust and bag worms

The spotted locusts, *Aularches miliaris* Linn. (Orthoptera: Acrididae) have been observed to cause severe damage by feeding on the foliage of cashew trees (Pillai *et al.*, 1976). This is a polyphagous insect infesting teak, coconut, arecanut, coffee, and *Erythrina*. Its incidence on an epidemic scale in June 1975 in the Malappuram district of Kerala caused

severe damage to cashew, coconut, arecanut, and other crops.

An unidentified species of bag worm (Lepidoptera: Psychidae) was observed feeding on cashew foliage in the Forest department plantations at Goa by Pillai *et al.* (1976).

Flower thrips

Rhynchothrips raoensis G. and another unidentified species of thrips have been reported by Abraham (1958) as attacking cashew inflorescences and leaves. The latter was more common in all the cashew growing tracts of the erstwhile Madras state during flowering season. The rasping and feeding injury made by thrips results in scabs on floral branches, apples and nuts. The infestation on developing nuts results in the formation of corky layers on the affected parts, malformation of nuts and even immature fruit drop. The third round of spray against tea mosquito at the time of fruit set will control flower thrips also.

Hairy caterpillar, *Euproctis scintillans* W. (Lepidoptera: Lymantriidae).

The caterpillars of this moth occasionally feed in groups on the inflorescence and tender nuts. They scrape the green tissues of the floral branches and even the tissues of tender nuts. Occasionally tender leaves also are scraped. The adult moth has yellowish wings. It lays eggs covered with hairs in batches on the leaf surface. The caterpillars in early stages show gregarious habits and they disperse as they grow. Pupation takes place in silken cocoons in leaf folds. The braconid parasite *Apanteles euproctisiphagus* Muzaffer Ahmed was found to parasitise this pest under field conditions.

The black hairy caterpillar, *Estigmene lactinea* C. (Lepidoptera: Arctiidae) has also been reported to be feeding on foliage. (Sreeramulu *et al.*, 1976). Pillai *et al.* (unpublished) have recorded *Diacrisia obliqua* Wlkr. (Arctiidae) and *Stathmopoda* sp. nr.

praealbata Meyr (Stathmopodidae) also as infesting cashew foliage.

Pseudococcids, coccids, aphids, and flatids

Incidence of mealy bug *Planococcus lilacinus* (Ckll.) and wax scale *Ceroplastes floridensis* C. on tender shoots, mild incidence of the scale *Diaspis* sp. on leaves and stray incidence of the giant scale *Monophlebus* sp. on tender shoots were reported by Abraham (1958) and Basheer and Jayaraj (1964).

The mealy bug *Ferrisia virgata* (Ckll.) infests cashew inflorescences. In severe cases of infestation the flowers are shed and the inflorescences dry up. The soft scale *Coccus* sp. also infests tender nuts. The aphid *Toxoptera odinae* Vdg. occurs on the inflorescence branches and even on tender shoots. Heavy infestation results in shedding of flowers.

Recently, two species of Flatidae, viz., *Flata* sp. and *Ketumala* sp. have been recorded as infesting cashew inflorescences. They are of minor importance only.

Chafer beetle and inflorescence caterpillar

Sreeramulu *et al.* (1976) recorded two new pests—*Popillia complanata* Newm. (Coleoptera: Rutelidae) feeding on unopened and opened cashew flowers and *Pingasa ruginaria* Gn. (Lepidoptera: Geometridae) feeding on foliage and inflorescences.

Apple and nut borers

***Thylecoptila panrosema* M.** (Lepidoptera: Pyralidae). Khan (1963) described this pest as a pinkish dark, actively moving caterpillar which bores into tender apples and nuts. In years of severe incidence nearly 10% of the apples and nuts are affected. The adult is a medium sized moth with dark forewings and pale dark hind wings. (Basheer and Jayaraj, 1964). Spraying phosphamidon at 0.05% will control the pest. The third round of spraying at the time of fruit set against tea mosquito will control this pest also.

The apple borer *Nephopteryx* sp. (Pyralidae) also is responsible for heavy crop losses. Abraham (1958) had reported the occurrence of this pest in Tiruchirappalli, Tamil Nadu. Dharmaraju *et al.* (1976) reported that damage by this pest amounts to 20 to 60% in certain cashew plantations in Bapatla and Chirala taluks of Andhra Pradesh. The caterpillars attack the fruits at all stages and cause the shrivelling and premature fall of nuts. Only a single caterpillar is generally seen either in the apple or the nut, but there are reports of upto five larvae occurring in apples and three in nuts. There are five larval instars lasting 15-33 days. The full grown larvae drop to the ground and pupate in earthen cocoons. The pupal period lasts for 8-10 days. Spraying DDVP (dichlorvos) 100% at 1 ml in 2 litres of water has been recommended for the control of the pest.

Basu Choudhuri and Misra (1973) reported *Hyalospila leuconeurella* Ragonot (Lepidoptera: Pyralidae) and *Anarsia epotias* Meyr (already reported by Remamony, 1965, as a pest affecting tender shoots) as two pests of cashew apples and nuts in s. India. *H. leuconeurella* lays eggs in the groove near the junction of nut and apple. Incubation period lasts for 4-5 days. The caterpillars bore through the apple from one end to the other. Up to six caterpillars of different stages have been observed in a single apple. The larval period lasts for 12-17 days and pupal period 9-12 days. *A. epotias* completes the life cycle in 27-29 days. The caterpillars feed on the nuts and apples. Basu Choudhuri and Misra (1973) observed that the caterpillars of earlier generations feed on tender shoots as reported by Remamony (1965), and those of the later generations feed on apples and nuts. They also reported one chalcid parasite *Brachymeria* sp. from *A. epotias* and an ichneumonid *Cremastus* sp. from *H. leuconeurella*.

The control measures suggested include

identification of trees which bear apples and nuts during off-season (July-October) and control of the pest by destroying or spraying infested inflorescences, apples and nuts, lest these would serve as reservoir for these pests. Total removal and destruction of dead and dried inflorescences during the pre-flowering season is an effective cultural method for controlling pest population. Foliar application of endrin 0.03% or parathion 0.02% during July-October will arrest the population build up.

Nut crinkler, *Paradasynus* sp. (*rostratus* Dist.?) (Heteroptera: Coreidae)

Nair and Remamony (1964) observed this coreid bug to be infesting tender nuts, causing them to shrivel and dry up. This was the first record of its occurrence as a pest of cashew. The bug thrusts its long stylets into the tender nuts to suck sap. The infested nuts shrivel, turn black and dry up. The adult bug lays eggs on leaf surface in groups of upto 52, equally spaced and arranged in regular rows of five or six. The incubation period is 8-11 days and the nymph emerges by pushing open the operculum. There are five nymphal instars and the nymphal period ranges from 21-36 days with an average of 27 days. The eggs are parasitised in the field by *Hadrophanurus* (Scelionidae) and *Anastatus* sp. (Eupelmidae). This pest has also been recorded as a new nut crinkler pest of coconut in Kerala.

Northwood and Kayumbo (1970) reported the Theraptus bug *Pseudotheraptus wayi* Brown (Heteroptera: Coreidae) from Tanzania, as feeding on developing nuts and producing black sunken spots on the kernels. Usually there will not be any sign of damage on the shells. The percentage of affected kernels in some consignments may be as much as 8-10.

DISCUSSION AND CONCLUSION

Though more than 50 species of insects have been recorded as pests of cashew in

India, only four of them are now considered to be major pests, when the extent of damage is taken into account. However, among the less serious ones, defoliating caterpillars, leaf thrips, flower thrips, apple and nut borers and nut crinkler have been reported to cause severe damage in certain tracts in recent years.

In view of the heavy economic losses caused by the pests it is imperative to have concerted efforts at the national level to popularise plant protection measures in cashew. Chemical control of various pests with different insecticides has been reported to be successful, but it would be impracticable to adopt control measures against individual pests, except in cases of isolated outbreaks. Adoption of suitable plant protection schedules to cover different pests infesting cashew at a particular time would be desirable and more economical. For example, in areas where tea mosquito infestation is rampant, three rounds of spraying done at the time of emergence of new shoots, panicles and fruit-set will be effective against other pests also which infest tender shoots, panicles and developing nuts. Similarly the treatment schedules recommended against leaf and blossom webber, which is very severe in some tracts of Andhra Pradesh and Orissa, will take care of other foliage and inflorescence pests. The endemic areas should receive adequate pest management practices well in time. There should be strict surveillance on the potential pests as well.

Selection of suitable chemicals for plant protection treatments in cashew is an important aspect. As the flowering in cashew is protracted, the insecticide that is used for spraying the inflorescences should be one which does not harm the pollinating insects, particularly honey bees. Insecticides which will not have harmful residues on the apple and nuts should be preferred.

A thorough knowledge of the ecological factors that govern the seasonal abundance

of pests in different cashew growing tracts and the factors that are responsible for the sporadic outbreaks of certain pests in some localised tracts, is an essential prerequisite for evolving suitable integrated control schedules against them. Research on these lines is to be intensified. Conservation of natural enemies of pests should be encouraged and biological control should form one of the major areas of thrust in the future research programme on cashew pests.

REFERENCES

- ABRAHAM, E. V. 1958. Pests of cashew (*Anacardium occidentale*) in south India. *Indian J. agric. Sci.* **28**: 531-544.
- ABRAHAM, E. V. 1959. Killer insects of cashew. *Indian Fmg.* **9**(3):14-15.
- AMRUTH SUDHAKAR, M. 1975. Role of *Hemiptis antonii* Signoret (Hemiptera: Miridae) in causing scab on guava fruits, its biology and control. Abstract of MSc (Ag) thesis. *Mysore J. agric. Sci.* **11**: 205-206.
- ANANTHANARAYANAN, K. P. AND ABRAHAM, E. V. 1955. The castor slug caterpillar, *Parasa lepida* Cram. and its control. *J. Bombay nat. Hist. Soc.* **53**: 205-209.
- ANONYMOUS, 1965. *Ann. Prog. Report Cent. Cashew Res. Station, Ullal, 1964-1965.*
- ANONYMOUS, 1966. *Ann. Prog. Report Cent. Cashew Res. Station, Ullal, 1965-1966.*
- ANONYMOUS, 1969. *Ann. Prog. Report Cent. Cashew Res. Station, Ullal, 1968-1969.*
- AYYAR, T.V.R. 1932. Annotated list of the insects affecting the important cultivated plants in South India. *Agric. Dept. Madras Bull.* No. 27.
- AYYAR, T.V.R. 1940. *Hand Book of Economic Entomology for South India.* pp. 528. Govt. Press, Madras.
- AYYAR, T.V.R. 1941. Insects associated with cashew plants in South India. *Proc. 28th Indian Science Cong.* **III**: 208.
- AYYAR, T.V.R. 1942. Insect enemies of the cashew-nut plant (*Anacardium occidentale*) in south India. *Madras agric. J.* **30**: 223-226.
- BASHEER, M. AND JAYARAJ, S. 1964. Cashew-nut Pests, pp. 261-266. In *Entomology in India*, Silver Jubilee Number. *Indian J. Ent. Entomological Society of India*, New Delhi.

- BASU CHOUDHURI, J. C. 1962. Preliminary investigations on the insect pests of cashew plantations in Kerala. *Indian Forester* 88: 516-522.
- BASU CHOUDHURI, J. C. 1969. The cashew stem borer. *The Southern Forest Rangers' College Magazine* 51-59.
- BASU CHOUDHURI, J. C. 1973. Mycosis of stem and root borers of cashewnut, *Plocaederus ferrugineus* L. (Coleoptera: Cerambycidae). *J. Plant. Crops* (Supplement): 1: 164-167.
- BASU CHOUDHURI, J. C. AND MISRA, M. P. 1973. *Hyalospila leuconeurella* Ragonot (Lepidoptera: Pyralidae) and *Anarsia epotias* Meyrick (Lepidoptera: Gelechiidae), two pests of cashew apples and nuts in S. India with notes on their control. *J. Plant. Crops* (Supplement) 1: 168-170.
- BECCARI, F. AND GERIIN, V. 1968. Contributo alla conoscenza dell' 'Entomofauna dell' *Anacardium occidentale* L. in Tanzania e nel Mondo. *Rivista di Agricoltura Subtropicale e Tropicale* 62 (4/6): 129-134. (vide Johnson, DV. 1972. *The cashew of north-east Brazil: A geographical study of a tropical tree crop*. A dissertation for PhD in Geography, Univ. California, Los Angeles.)
- BEESEON, C.F.C. 1941. *The Ecology and Control of the Forest Insects of India and the Neighbouring Countries*. 767. pp. Govt. of India Press, New Delhi.
- BOBOYE, S. O. 1968. Studies on the biology and chemical control of red banded cacao thrips *Sele-nothrips rubrocinctus* Giard (Thysanoptera: Thripidae) infesting cashew at Okgwi, Eastern Nigeria. *Niger. Ent. Mag.* 1(15): 77-81.
- DAMODARAN, V. K. AND BALAKRISHNAN NAIR, M. P. 1969. Studies on the insecticidal control of *Helopeltis antonii* Signoret on cashew. *Agric. Res. J. Kerala* 9: 28-30.
- DAVIS, T. A. 1949. An unrecorded insect pest of the cashew tree (*Anacardium occidentale* L.) in South India. *Curr. Sci.* 18: 133.
- DHARMARAJU, E. AYYANNA, T., AND SREERAMULU, G. 1976. *Nephopteryx* sp. (Lepidoptera: Pyralidae) a serious pest of cashew. *Indian Cashew J.* 10(3): 9-11.
- GANESWARA RAO, A, KRISHNA, J. G., AND AYYANNA, T. 1973. Studies on the comparative biology of *Macalla moncusalis* Walker on cashew (*Anacardium occidentale* L.) and mango (*Mangifera indica* L.) *Andhra agric. J.* 20: 120-127.
- KHAN, K. F. 1963. Common pests of the cashew trees and their control (unpublished). *Indian Central Spices & Cashewnut Committee, Ernakulam*.
- MADHAVA RAO, V. N. 1955. Cashewnut cultivation in South India. *ICAR Farm Bull.* No. 9. 18 pp.
- MISRA, M. P. AND BASU CHOUDHURI, J. C. 1974. New pest and distributional records of *Lymantria obfuscata* Walker (Lepidoptera: Lymantriidae) on cashew from South India. *Indian Forester* 100: 391-393.
- NAIR, C. P. RADHAKRISHNAN, ABRAHAM, V. A., AND PILLAI, G. B. 1974. Biology of *Metanastria hyrtaca* Cram., a defoliator of cashew. *J. Plant. Crops* 2(2): 32-33.
- NAIR, M.R.G.K. AND REMAMONY K. S. 1964. *Paradasynus* sp. (Hemiptera: Coreidae) as a pest of cashewnut in Kerala. *Indian J. Ent.* 26: 461-462.
- NAMBIAR, K.K.N., SARMA, Y. R., AND PILLAI, G. B. 1973. Inflorescence blight of cashew (*Anacardium occidentale* L.) *J. Plant. Crops* 1: 44-46.
- NORTHWOOD, P. J. AND KAYUMBO, H. Y. 1970. Cashew production in Tanzania. *World Crops* 22(2): 89-91.
- PILLAI, G. B. 1975. Pests of cashewnut and how to combat them. *Cashew News Teller* (Oct.-Dec.): 31-33.
- PILLAI, G. B. AND ABRAHAM, V. A. 1974. In *CPCRI Annual Report* for 1973. pp. 138-139. Kasaragod, India.
- PILLAI, G. B. AND ABRAHAM, V. A. 1975. Tea mosquito—a major menace to cashew. *Indian Cashew J.* 10(1): 5-7.
- PILLAI, G. B. AND ABRAHAM, V. A. 1975. In *CPCRI Annual Report* for 1974. pp. 132-133, Kasaragod, India.
- PILLAI, G. B. DUBEY, O. P., AND VIJAY SINGH 1976. In *CPCRI Annual Report* for 1975: 131. Kasaragod, India.
- PILLAI, G. B., VIJAY SINGH, AND PREM-KUMAR, T. 1976. In *CPCRI Annual Report* for 1975. pp. 134. Kasaragod, India.
- PUTTARUDRIAH, M. AND APPANNA, M. 1955. Two new hosts of *Helopeltis antonii* Signoret in Mysore. *Indian J. Ent.* 17: 391-392.
- RAO, Y. RAMACHANDRA 1915. *Helopeltis antonii* as a pest of neem trees. *Agric. J. India* 10: 412-416.

- REMAMONY, K. S. 1965. Biology of *Anarsia epottias* Meyr. (Lepidoptera: Gelechiidae). *Agric. Res. J. Kerala* 3: 46-47.
- RODRIGUES, M. da. C. 1967. The mites of cashew in Mozambique. Part I. *Agronomia Mosamb.*, 1(1): 21-26.
- SATHIAMMA, B. 1976. In *CPCRI Annual Report for 1975*. pp. 132-133. Kasaragod, India.
- SREERAMULU, C., PREMKUMAR, T., MARIAMMA DANIEL, AND SATHIAMMA, B. 1975. Record of three new pests of cashew: *Popillia complanata* Newm., *Pingasa ruginaria* Gn. and *Estigmene lactinea* C. J. *Plant. Crops*: 3(1): 38.
- SWAINE, G. 1959. A preliminary note on *Helopeltis* spp. damaging cashew in Tanganyika Territory. *Bull. ent. Res.* 50: 171-181.