Journal of Plantation Crops 14 (1): 1–10 June, 1986

Review Article

THE TEA MOSQUITO BUG *HELOPELTIS ANTONII* SIGNORET ON CASHEW IN INDIA*

S. DEVASAHAYAM** and C. P. RADHAKRISHNAN NAIR***
Central Plantation Crops Research Institute, Regional Station, Vittal, 574 243, Karnataka, India.

ABSTRACT

The tea mosquito bug *Helopeltis antonii* Signoret is the most serious pest of cashew in India. The information available on its distribution, nature and extent of damage, biology, seasonal abundance, natural enemies, alternate host plants and control measures with particular reference to India are discussed in this review.

INTRODUCTION

Cashew *(Anacardium occidentale* L*)*, a native of Brazil, was introduced into the West Coast of India by the Portuguese during the sixteenth century. The crop soon established in India and has now gained considerable economic importance earning more than 1200 million rupees annually in foreign exchange. Though cashew is grown in about 4.5 lakh ha mainly in Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Goa, Maharashtra and Orissa, the productivity of the crop is generally low, the national average being around 2 kg nuts/tree. Infestation by insect pests has been identified as a major factor responsible for low productivity. More than fifty species of insect pests have been recorded on the crop in India. The nature of damage, life history and control measures of these pests have been reviewed (Pillai, Dubey and Singh, 1976; Butani, 1981; Hari Babu, Rath and Rajput, 1983). Among the major pests, the tea mosquito bug *Helopeltis antonii* Signoret (Heteroptera : Miridae) is the most serious one. Both adults and nymphs of the pest suck the sap of tender shoots, inflorescences and immature fruits resulting in shoot and inflorescence blight, immature fruit drop and shrivelling of nuts. In view of the considerable importance of the pest, the information available on *H. antonii* with particular reference to cashew in India has been consolidated in this review.

---

* *Contribution No. 509 of Central Plantation Crops Research Institute, Kasaragod 670 124, Kerala.*
Present address : ** *CPCRI Regional Station, Marikunnu P. O., Calicut 673 012, Kerala.*
*** *CPCRI Regional Station, Krishnapuram P. O., Kayangulam 690 533, Kerala.*

In India apart from *H. antonii*, *H. theivora* and an undetermined species of *Helopeltis* have also been recorded to feed and breed on tender shoots of cashew at Vellanikkara in Kerala (Ambika and Abraham, 1983).

Distribution

Precise data on the distribution and extent of damage caused by *H. antonii* to cashew are not available; however, its incidence is reported to be severe in most of the cashew growing tracts of Kerala, Karnataka, Goa and Maharashtra on the West Coast and also in Cuddalore, Vriddhachalam and Pudukottai areas of Tamil Nadu in the East Coast (Pillai et al, 1976). In Goa, the infestation is reported to be severe in certain pockets of Canacona, Kepam and Salcete talukas (Anonymous, 1984a). Rao and Srinivasan (1984) have reported the occurrence of the pest in Andhra Pradesh at Tirupati (Chittoor district); they have also observed the typical damage symptoms on cashew at Satyaredu (Chittoor district) and Kavali (Nellore district) areas. Recently the pest has been recorded on cashew plantations at Orissa (Jena, Patnaik and Satpathy, 1985).

At Adanakottai (Tiruchirapalli district, Tamil Nadu) up to 15 per cent of tender shoots were found to be infested by the pest during April 1956 (Abraham, 1958). At Vittal, during 1975-76 an average of 14.0 per cent of shoots, 48.5 per cent of panicles and 32.0 per cent of fruits were damaged by the pest (Sathiamma, 1977).

At Ullal, yield losses of up to 30 per cent have been reported due to the incidence of inflorescence blight (Anonymous, 1966). At Goa, severe infestations have been found to cause a loss of production to the extent of 30-40 per cent (Desai, Kulkarni and Rodrigues, 1977).

Nature of damage

The nature of damage caused by *H. antonii* has been described by various authors (Abraham, 1958; Pillai and Abraham, 1975; Sathiamma, 1977; Ambika and Abraham, 1979). Both adults and nymphs suck the sap from tender shoots, panicles and immature fruits. The typical feeding damage is the formation of a necrotic area called 'lesion' around the point of entry of the stylets of the mouth parts of the bug. The lesions appear as water soaked areas soon after feeding and become prominent turning brownish-black later due to the death of the plant cells. The lesions are elongate on tender shoots, its size varying with the maturity of the affected tissues. When the shoots are tender, the adjacent lesions coalesce and the entire shoot dries up; when they are relatively mature, the lesions remain as separate streaks. On tender leaves, the pest infestation results in the crinkling and malformation of leaves; the feeding marks are generally seen all over the leaf lamina in the form of brownish-black lesions. In severe cases of infestation especially during the emergence of new flushes the infested trees present a scorched appearance. When successive new shoots are infested the growth of the plant is adversely affected resulting in either stunting or even the death of the tree.

The damage on the panicles may either be partial (secondary rachii alone

infested) or complete (main rachis or main rachis and secondary rachii infested). The injury on the inflorescences is more concentrated around the nodal region. When the panicles are tender the lesions coalesce and the entire panicle dries up. Very often the affected shoots and panicles are subsequently colonised by fungi resulting in shoot / inflorescence blight. Studies conducted earlier indicated that the malady was caused by *H. antonii* in association with the fungi *Gloeosporium mangiferae* and *Phomopsis anacardii* (Anonymous, 1965). Later Nambiar, Sarma and Pillai (1973) found that *H. antonii* alone was the primary causal agent of the inflorescence blight and the fungi were only secondary saprophytic colonizers. Recently *Colletotrichum*, *Fusarium* and *Botryodiplodia* have been isolated from affected dry twigs. However, they did not have any direct role in the incidence of the malady (Anonymous, 1983a).

The damage on the fruits occurs on immature nuts and apples. The lesions on the fruits appear as brownish-black circular scabby spots. When immature nuts are infested they shrivel and dry up; older nuts and apples develop a characteristic scabby appearance. When the infestation occurs during the early stages of fruit set, it results in immature fruit drop. Infestation by the tea mosquito bug, flower thrips and fruit borers were reported to cause 12.3 per cent fruit drop during mustard stage, 16.4 per cent during pea nut stage and 1.1 per cent during later stages (Pillai and Pillai, 1975).

The feeding activity of the pest is higher during the morning hours before 9 a. m. and in the evening hours after 4 p. m. (Abraham and Nair, 1981). Final instar nymphs can be more damaging than the adults. A final instar nymph was found to cause 114 lesions (range 78-235), a female 97 lesions (range 16-238) and a male 25 lesions (range 11-59) during a 24 h period.

Morphology

The morphometrics of adults and immature stages of *H. antonii* have been presented by Ambika and Abraham (1979). Adult females measure about 8 mm in length and 0.76 mm across thorax; the adult male is slightly smaller measuring 6 × 0.74 mm. A knobbed process arises from the dorsal aspect of the thorax of both sexes which is erect, tapering and the apex being swollen and funnel shaped. Sathiamma (1981) reported the occurrence of colour variants which were morphologically similar except for the colour of the thorax which was either reddish-brown, black, red or blackish-red. Individual forms mated with each other and the mated females laid viable eggs.

Biology

The biology of *H. antonii* has been studied (Anonymous, 1974; 1976; 1977; 1981; 1982 and 1983b; Ambika and Abraham, 1979; Sathiamma, 1984). The eggs are generally laid inserted into tender shoots and inflorescence stalks and sometime on the leaf mid-rib and petioles either singly or in groups of 2-6. The site of oviposition can be recognised by the presence of a pair of silvery white thread like chorionic processes of unequel size

that projects outside the plant tissue. There are five nymphal instars. Under Kasaragod conditions at a temperature range of 24–32° C and relative humidity of 47 - 100 per cent, the incubation period lasted for 6–7 days and the nymphal period 10 days. The variations in the fecundity of females and duration of oviposition, egg and nymphal periods and longevity of adults reported by various authors may be due to the different temperature and relative humidity conditions under which the studies have been conducted.

Recent studies on the seasonal biology of the pest indicated that duration of oviposition and fecundity of females were maximum during the period January - March. The incubation period of eggs was maximum during the period July–September; nymphal period was maximum during the period October–December (Devasahayam, 1985).

Ambika and Abraham (1979) reported that among the three constant temperature ranges tried, 25±0.5°C was the most suitable for fertilisation and oviposition and 28±0.5°C ideal for embryonic development and progeny production.

The mating process involves a brief courtship, mounting and copulation in an 'end to end' position. Copulation lasts for a mean period of 51 minutes (range : 27–81 min). Studies on the sequence of eggs laying in relation to oviposition period indicated that maximum number of eggs was laid on the first day of the oviposition period (Devasahayam, unpublished).

Seasonal abundance

Studies on the seasonal fluctuation in population of *H. antonii* carried out at Kasaragod indicated that the build up of the pest population commences during October–November synchronising with the emergence of new flushes after the cessation of monsoon showers and reaches its peak in January when the trees are in full bloom. The pest is active in the field till May and absent during the monsoon period June–September. The population build up was negatively correlated with minimum temperature, minimum relative humidity and rainfall and positively with sunshine. The most favourable period for rapid multiplication and population build up of the pest was during December–February when the host plant provided an abundant supply of succulent plant parts. During the monsoon period June–September when the succulent plant parts are not generally available on grown up trees the population of the pest was completely absent (Pillai et al, 1984).

At Ullal, *H. antonii* was active in the field during November – April with a high incidence during January and February (Rai, 1981). At Vittal, the pest was observed almost throughout the year with a high incidence during February and March (Sathiamma, 1978). The pest is known to damage younger trees throughout the year as they produce flushes almost continuously. At Goa, the build up of pest population and its damage commenced from October–November onwards. Peak pest population occurred during February; no damage was

observed during June – September (Sundararaju, 1984a).

Trees established from seedlings and those above 25 years are reported to be relatively less prone to the pest infestation. Trees established by vegetative propagation are particularly vulnerable for up to 10 years after planting mainly due to the protracted flowering habits which favours uninterrupted pest multiplication (Abraham and Nair, 1981).

Natural enemies

At Goa, a spider *Hyllus* sp. (Salticidae) has been recorded as a predator of *H. antonii* (Sundararaju, 1984a); At Vittal, three types of spiders (*Oxyopes schireta, Phidippus patch* and *Matidia* sp.) have been observed to predate on the earlier instars of the nymphs of the pest in the field (Radhakrishnan Nair and Devasahayam, unpublished).

Crematogaster wroughtonii Forel (Formicidae) has been recorded to feed on the first and second instar nymphs of the pest in the field. A single ant was capable of devouring about 10 nymphs per day (Ambika and Abraham, 1979).

The reduvid bug *Endochus inornatus* Stal. was observed to feed on the adults and nymphs of the pest at Vittal and Kasaragod areas. An adult bug was reported to feed on 10–15 adults and 18–20 nymphs of the pest per day (Anonymous, 1982). At Goa, *Sycanus collaris* (Fab.), *Sphedanolestes signatus* Dist., *S. minusculus* Berger, *Irantha armipes* Stal., *Endochus inornatus, E. cingalensis* Stal., *Occamus typicus* Dist. and *Alcmena* sp. have been recorded to feed on *H. antonii* in the field. The reduvids had a capacity of feeding on 1–5 adults/nymphs per day; however, they were not specific to *H. antonii* in the field. Preliminary attempts to colonise *S. collaris* under field conditions were not successful (Anonymous, 1983b; Anonymous 1984a; Sundararaju, 1984a).

Recently, a hymenopteran parasite *Erythmelus helopeltidis* Gahan (Mymaridae) has been recorded to parasitize the eggs of the pest in the field at Shantigodu (Devasahayam, unpublished).

Alternate hosts

Fletcher (1914) reported the occurrence of *H. antonii* on tea, mahogany, neem, cocoa, cinchona and annatto *(Bixa orellana)*. The pest has been recorded on red gum in South Kerala (Rau, 1937) and on guava in South India (Cherian, 1937). All the eleven varieties of guava in an orchard in Tamil Nadu were found susceptible to the pest (Gopalan and Perumal, 1973). The biology of the pest has been studied on guava at Bangalore (Sudhakar, 1975).

H. antonii has been recorded on apple and grape vines in Mysore. On apple, the feeding activity of the bugs caused the flowers to dry up and young fruits to develop a scabby appearance. On grape vines, tender leaves and developing fruits were attacked resulting in the drying up of the affected tissues (Puttarudriah and Appanna, 1955).

Pillai, Saradamma and Nair (1979) observed the pest on *Moringa oleifera* in Trivandrum and Quilon districts of Kerala. The pest was observed to complete its life cycle on the tree and its infestation resulted in withering and

die back of terminal shoots, drying up of inflorescences and incomplete development of fruits.

At Vittal, the pest was recorded on tender shoots of mango, neem, *Syzygium* sp. and on cocoa (Anonymous, 1983 b). The pest infestation on mango and neem resulted in the drying up of the entire shoot; on *Syzygium* sp. necrotic spots were seen on the tender leaf lamina. On cocoa the damage was seen on the pods in the form of scabby spots; when cherelles were infested they dried up completely. The pest infestation on tender cocoa shoots resulted in the formation of necrotic lesions and drying up of the same.

Recently the pest has been observed to damage tender shoots and leaves of black pepper, allspice and *Eugenia jambos* in some tracts of Calicut district in Kerala (Devasahayam, Abdulla Koya and Premkumar, unpublished). Sundara raju (1984a) has recorded the pest damaging *Lawsonia alba* in Goa.

The pest thus has a wide host range occurring on 17 plant species representing 13 families. As the damage on these plants is not as pronounced as on cashew, the presence of the pest on them is often not noticed.

Relative susceptibility of cashew types

Field observations indicate the wide variability available in the natural populations of cashew trees with reference to the reaction of the trees to the infestation of *H. antonii*.

At Vittal, all the 74 accessions in the germplasm collection of cashew at the Central Plantation Crops Research Institute were found to be susceptible. However, significant differences were observed between accessions with regard to the degree of susceptibility. Based on the shoot and panicle damage and pest population, the accession VTH–153 (H–3–17 Anakayam) was the least susceptible (Sathiamma, 1979).

Screening of 11 promising accessions at the Cashew Research Station, Vellanikkara indicated that all of them were susceptible to varying degrees. Accession No. 665 (F_1 hybrid of BLA–139 and E-2-1) was the least susceptible based on shoot and panicle damage (Ambika, Abraham and Vidyadharan, 1979).

Control

Effective control of *H. antonii* has been suggested as one of the short term strategies for increasing cashew yields (Nambiar, 1976). Earlier recommendations for the control of the pest included spraying of cuman 0.1% in combination with dimecron 0.03% in view of the reported involvement of both the insect and fungus in the causation of inflorescence blight (Anonymous, 1966 and 1969).

Damodaran and Nair (1969) evaluated 11 insecticides and concluded that two sprayings of DDT 0.2% (the first as soon as the first symptom of infestation was noticed and the second 15 days later) gave the best result followed by carbaryl 0.1%, endrin 0.03% and dieldrin 0.05%; the systemic insecticides trichlorphon, phosphamidon, thiometon and dimethoate were not as effective as the contact ones.

Based on the conclusion that infestation by *H. antonii* was primarily responsible for inflorescence blight, Nambiar et al. (1973) recommended spraying of endosulfan 0.05% alone during emergence of panicles and fruit set for controlling the malady. In trials involving endosulfan, fenitrothion, malathion+fenitrothion and phosphamidon applied at 0.1% as low volume spray during emergence of flushes, panicles and fruit set, endosulfan was found to be the most effective (Anonymous, 1975). Singh and Pillai (1984) evaluated the efficacy of four insecticides (0.05% each) and found that endosulfan was the most effective followed by quinalphos and formothion; diazinon was the least effective. Sundararaju (1984b) evaluated the efficacy of six insecticides and found that endosulfan 0.05% was the best in reducing shoot and panicle damage; monocrotophos, quinalphos and phosalone (0.05% each) were also found to be promising.

The comparative efficacy of application of endosulfan through aerial means and rocker sprayer has been evaluated. The pest infestation was significantly less in plots subjected to aerial spraying; it was significantly less in both the treatments when compared to control (George, Singh and Peter, 1984).

Trials conducted at Vriddhachalam and Neyveli against major pests of cashew indicated that two sprays of quinalphos 0.05% during panicle initiation and nut formation was the most effective against *H. antonii* followed by endosulfan 0.05% and quinalphos 0.035% (Muthu and Baskaran, 1979). Nair and Abraham (1982) reported that among the insecticides evaluated in field trials, endosulfan (0.05%), carbaryl (0.15%) phosphamidon (0.03%) and quinalphos (0.05%) were relatively more effective in reducing shoot and flower infestation.

Nair and Abraham (1983) evaluated five dust formulations and found that carbaryl 10% and phosalone 4% were the most effective in reducing the pest damage on the shoots. However, none of the chemicals were effective in reducing the damage to panicles and floral branches.

Nair and Abraham (1984) have also evaluated the efficacy of endosulfan (0.05%), phosphamidon (0.05%), monocrotophos (0.05%), carbaryl (0.15%) and HCH (0.15%) and their joint formulations with carbaryl and found that all the insecticides and their joint formulations were effective in reducing the pest infestation; plots treated with phosphamidon (0.015%) + carbaryl (0.075%) had minimum infestation. The conjuctive use of insecticides did not show superior performance as compared to their individual applications except in the case of HCH (0.075%) + carbaryl (0.075%) where the combined application was found superior to HCH; but this mixture was not superior to carbaryl applied alone.

Attempts to control *H. antonii* through stem injection of systemic insecticides *viz.*, monocrotophos, fenitrothion, fenthion, dimethoate and thiometon were not successful (Abraham and Nair, 1981; Anonymous, 1984b).

Ambika and Abraham (1979) studied the effect of topical application of juvenile hormone analogues on early 5th instar nymphs. Farnesyl Methyl Ether (FME) was relatively more effective and the nymphs treated with 0.5μ each did not moult but were transformed into 6th instar super-numerary nymphs which had juvenile characters. At doses above 0.5μg FME was lethal to the nymphs. Nymphs treated with graded doses of ZR 512 and MV 678 moulted into adultoids which were similar to the late fifth instar nymphs except for the presence of wings.

Conclusions

Detailed information on certain aspects of *H. antonii* infestation on cashew in India is lacking. A comprehensive survey has to be carried out in all the cashew growing tracts to assess the relative infestation and the crop losses caused by the pest. Though data on the seasonal abundance of the pest are available for regions in the West Coast, no such studies have been conducted in the East Coast. Studies on the inter-relationships between the predators/parasite with that of the pest have to be carried out. The morphological, anatomical and biochemical parameters that are responsible for the relative tolerance of some of the cashew accessions to the pest have to be investigated. Though evaluation of insecticides for the pest had received serious attention from many workers, additional insecticides could be screened for the effective control of the pest. As suggested by Abraham and Nair (1981) the management strategy of the pest should consist of utilisation of resistant/tolerant types for cultivation, reducing the carry over potential through alternate hosts, conservation of predatory and beneficial insects and scheduled application of appropriate insecticides.

ACKNOWLEDGEMENTS

We are thankful to Sri G. B. Pillai, Head of the Division of Entomology, CPCRI Regional Station, Kayangulam for going through the manuscript critically and also to our colleagues at Vittal for their suggestions while preparing the same.

REFERENCES

ABRAHAM, E. V. 1958. Pests of cashew *(Anacardium occidentale)* in South India. *Indian J. Agric. Sci.* **28:** 531–544.

ABRAHAM, C. C. and NAIR, G. M. 1981. Effective management of the tea mosquito bugs for breaking the yield barriers in cashew. *Cashew Causerie.* 3 (1): 6–7.

AMBIKA, B. and ABRAHAM, C. C. 1979. Bio-ecology of *Helopeltis antonii* Sign. (Miridae: Hemiptera) infesting cashew trees. *Entomon.* 4: 335–342.

AMBIKA, B. and ABRAHAM, C. C. 1984. Effect of topical application of JH analogues on the development and survival of the cashew mirid bug *Helopeltis antonii* Sign. (Miridae : Heteroptera). pp. 111–115. In *Cashew Research and Development.* eds. Rao, E. V. V. B. and Khan, H. H. Indian Society for Plantation Crops, CPCRI, Kasaragod, India.

AMBIKA, B., ABRAHAM, C. C. and VIDYADHARAN, K. K. 1979. Relative susceptibility of cashew types to infestation by *Helopeltis antonii* Sign. (Hemiptera : Miridae). *Proc. PLACROSYM II.* pp. 513–516.

*ANONYMOUS, 1965. *Annual Progress Report 1964–1965*. Central Cashew Research Station, Ullal.

*ANONYMOUS, 1966. *Annual Progress Report 1965–1966*. Central Cashew Research Station, Ullal.

*ANONYMOUS, 1969. *Annual Progress Report 1968–1969*. Central Cashew Research Station, Ullal.

ANONYMOUS, 1974. *Annual Report for 1973*. Central Plantation Crops Research Institute, Kasaragod, India. p. 138.

ANONYMOUS, 1975. *Annual Report for 1974*. Central Plantation Crops Research Institute, Kasaragod, India. p. 133.

ANONYMOUS, 1976. *Annual Report for 1975*. Central Plantation Crops Research Institute, Kasaragod, India. pp. 131.

ANONYMOUS, 1977. *Annual Report for 1976*. Central Plantation Crops Research Institute, Kasaragod, India. pp. 150–151.

ANONYMOUS, 1981. *Annual Report for 1978*. Central Plantation Crops Research Institute, Kasaragod, India. p. 120.

ANONYMOUS, 1982. *Annual Report for 1979*. Central Plantation Crops Research Institute, Kasaragod, India. pp. 132–134.

ANONYMOUS, 1983 a. *Annual Report for 1981*. Central Plantation Crops Research Institute, Kasaragod, India. pp. 140–141.

ANONYMOUS, 1983 b. *Annual Report for 1981*. Central Plantation Crops Research Institute, Kasaragod, India. pp. 144–146.

ANONYMOUS, 1984 a. *Annual Report for 1980*. Central Plantation Crops Research Institute, Kasaragod, India. pp. 103–104.

ANONYMOUS, 1984 b. *Annual Report for 1980*. Central Plantation Crops Research Institute, Kasaragod, India. p. 104.

BUTANI, D. K. 1981. Insect pests of cashewnuts and their control. *Pestology*. 4 (4): 9–17.

*CHERIAN, M. C. 1937. Administration report of the Government Entomologists, Coimbatore for 1936–1937. *Rep. Dep. Agric. Madras*. pp. 126–133.

DAMODARAN, V. K. and NAIR, M. P. B. 1969. Studies on the insecticidal control of *Helopeltis antonii* Signoret on cashew. *Agric. Res. J. Kerala*. **7** (1): 28-30.

*DESAI, M. A., KULKARNI, S. V. and RODRIGUES, A. 1977. *Report on the marketing survey on cashew in Goa*. Government of Goa, Daman and Diu. pp. 11–17.

DEVASAHAYAM, S. 1985. Seasonal biology of tea mosquito bug *Helopeltis antonii* Signoret (Heteroptera : Miridae) – a pest of cashew. *J. Plant. Crops*. **13** : 145–147.

FLETCHER, T. B. 1914. *Some South Indian Insects*. Government Press, Madras. pp. 488–489.

GEORGE, M. V., SINGH, V. and PETER, T. 1984. Aerial spraying in cashew for the control of tea mosquito. pp. 120–125. In *Cashew Research and Development*. eds. Rao, E. V. V. B. and Khan, H. H. Indian Society for Plantation Crops, CPCRI, Kasaragod, India.

GOPALAN, M. and PERUMAL, R. S. 1973. Studies on the incidence of tea mosquito bug *(Helopeltis antonii* S.) on some varieties of guava. *Madras Agric. J.* **60** : 81–83.

HARIBABU, R. S., RATH, S. and RAJPUT, C. B. S. 1983. Insect pests of cashew in India and their control. *Pesticides*. **17** (4) : 8–16.

JENA, B. C., PATNAIK, N. C. and SATPATHY, C. R. 1985. Insect fauna of cashewnut in Orissa. *Science and Culture*. **51** : 385–386.

MUTHU, M. and BASKARAN, P. 1979. Performance of quinalphos against the insect pests of cashew *(Anacardium occidentale* L.). *Proc. I'LACROSYM II*. pp. 474–483.

NAIR, G. M. and ABRAHAM, C. C. 1982. Relative efficiency of some foliar insecticidal treatments for the control of *Helopeltis antonii* Signoret infesting cashew trees. *Agric. Res. J. Kerala*. **20** (2) : 41–48.

NAIR, G. M. and ABRAHAM, C. C. 1983. Control of *Helopeltis antonii* Signoret infesting cashew using dusting powder formulations of some common insecticides. *Agric. Res. J. Kerala.* **21** (1) : 21–26.

NAIR, G. M. and ABRAHAM, C. C. 1984. Relative efficacy of some of the common insecticides and their joint formulations with carbaryl against the tea mosquito bug *(Helopeltis antonii* Signoret) infesting cashew trees. *Agric. Res. J. Kerala.* **22** : 118–123.

NAMBIAR, M. C. 1976. Technology for increasing cashew production and productivity. pp. 21–24. In *Increasing production and productivity of cashew in India.* eds. Bavappa, K. V. A. and Haridasan, M. Central Plantation Crops Research Institute, Kasaragod, India.

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.

PILLAI, G. B. and ABRAHAM, V. A. 1975. Tea mosquito – a serious menace to cashew. *Indian Cashew J.* **10** (1) : 5–7.

PILLAI, G. B., DUBEY, O. P. and SINGH, V. 1976. Pests of cashew and their control in India–a review of current status. *J. Plant. Crops.* **4**: 37–50.

PILLAI, G. B., SINGH, V., DUBEY, O. P. and ABRAHAM, V. A. 1984. Seasonal abundance of tea mosquito, *Helopeltis antonii* on cashew in relation to meteorological factors. pp. 103–110. In *Cashew Research and Development.* eds. Rao, E. V. V. B. and Khan, H. H. Indian Society for Plantation Crops, CPCRI, Kasaragod, India.

PILLAI, K. S., SARADAMMA, K. and NAIR, M. R. G. K. 1979. *Helopeltis antonii* Sign. as a pest of *Moringa oleifera. Curr. Sci.* **49**: 288–289.

PILLAI, P. K. T. and PILLAI, G. B. 1975. Note on the shedding of immature fruits in cashew. *Indian J. Agric. Sci.* **45**: 233–234.

PUTTARUDRIAH, M. and APPANNA, G. B. 1955. Two new hosts of *Helopeltis antonii* Signoret in Mysore. *Indian J. Ent.* **17**: 391–392.

RAI, P. S. 1981. Seasonal distribution of cashew pests in coastal Karnataka. *Indian Cashew J.* **13** (4): 17, 19.

RAO, D. V. S. and SRINIVASAN, S. 1984. Tea mosquito *(Helopeltis antonii* Sign.)–a new pest of cashew in Andhra Pradesh. *Cashew Bull.* **21** (9): 10–12.

*RAU, S. A. 1937. Report of the Entomologist. *Rep. Tea Dep. UPASI 1936-1937.* pp. 14–24.

SATHIAMMA, B. 1977. Nature and extent of damage by *Helopeltis antonii* S., the tea mosquito on cashew. *J. Plant. Crops.* **5** : 58–62.

SATHIAMMA, B. 1978. Occurrence of insect pests on cashew. *Cashew Bull.* **15** (4) : 9–10.

SATHIAMMA, B. 1979. Varietal reaction of cashew to tea mosquito, *Helopeltis antonii* S. (Hemiptera : Miridae), a major pest of cashew. *Proc. PLACROSYM II.* pp. 530–534.

SATHIAMMA, B. 1981. Occurrence of colour variants in *Helopeltis antonii* S. (Hemiptera : Miridae) on cashew. *Cashew Bull.* **18** (6) : 5.

SATHIAMMA, B. 1984. Biology of tea mosquito *Helopeltis antonii* Signoret reared on mango seedlings in the laboratory. *Cashew Bull.* **21** (1) : 6–8.

SINGH, V. and PILLAI G. B. 1984. Field evaluation of the efficacy of four insecticides in the control of tea mosquito *(Helopeltis antonii* Sign.) infestation on cashew. p. 301. In *Cashew Research and Development.* eds. Rao, E. V. V. B. and Khan, H. H. Indian Society for Plantation Crops, CPCRI, Kasaragod, India.

SUDHAKAR, A. M. 1975. Role of *Helopeltis antonii* Signoret (Hemiptera : Miridae) in causing scab on guava fruits, its biology and control. Abstract of M. Sc. (Ag.) thesis. *Mysore J. Agric. Sci.* **11** : 205–206.

SUNDARARAJU, D. 1984a. Studies on cashew pests and their natural enemies in Goa. *J. Plant. Crops.* **12** : 38–46.

SUNDARARAJU, D. 1984b. Chemical control of tea mosquito bug *(Helopeltis antonii* Sign.) in cashew at Goa. *Cashew Causerie.* **6** (3) : 10.

* *Original not seen.*