MANAGEMENT OF TEA MOSQUITO BUG FOR ENHANCING THE PRODUCTIVITY OF COCOA

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Introduction

Mirids/ plant bugs are serious pests of cocoa worldwide. It is a polyphagous sap sucking insect pest. Both nymphs and adults suck the sap from all parts of the cocoa plant except the roots by inserting its mouthparts into the plant at the same time, salivary secretions are injected into the plant tissues which results in plasmolysis of the cells. This cellular lysis results in necrosis, followed by the appearance of depressed oily spots known as lesions on the cocoa pods and chupons (Mariau, 1999). On young shoots, the mechanical damage and the effect of the toxic saliva are sufficient to cause death of shoots called die back. However, subsequent invasion of the wounds by a pathogenic fungus, *Albonectria rigidiuscula* (Crowdy, 1947) and *Calonectrica rigidicula* (Wood and Lass, 1989) have been reported. These infections result in cankering or bark roughening, destruction of the flower cushions and a severe dieback of twigs and branches. On fully grown pods, the feeding sites are marked by black spots of dead tissue, but maturation may continue. However, on young pods or cherelles, a high number of feeding punctures may cause distortion during growth or even death of the pod.

Yield loss could be as high as 75% in cocoa farms attacked by the mirids and which are left unattended for a period of three years and above. Estimates of crop loss attributed to damage by *Helopeltis* are variable and depend on factors such as agricultural practices, control methods, locality, climate and the varieties and insect species involved. The control of this obnoxious insect pest has been dominated by the use of synthetic insecticides alone. However, concerns over insecticides resistance, resurgence of sucking pests and insecticide residues in the cocoa bean coupled with ecological hazards, dictate the Integrated Pest Management which is safe and eco-friendly.

Hosts

Plant bugs of the genus *Helopeltis* are serious pests of various cultivated plants in the Old World tropics. Since the late 1800's over 100 species of plants have been reported as hosts for *Helopeltis* spp. From an economic perspective the primary plants attacked are cashew, cinchona, cocoa and tea. Other economically important plants damaged by *Helopeltis* spp. include all spice (*Pimenta dioica*) and black pepper (Devasahayam *et al.,* 1986), apple (*Malus* sp.) and grapes (*Vitis* sp.) (Puttarudriah and Appana, 1955) and guava (*Psidium guajava*) (Chong, 1987; Gopalan and Perumal, 1973).

Biology

The eggs of *Helopeltis* spp. are white, ovo-elongate (slightly narrower apically) and laterally compressed apically, 1.0-1.2 mm long (Ambika and Abraham, 1979; Miller, 1941; Tan, 1974a and b). Two unequal respiratory horns (filaments) arise from the anterior end of the egg, this usually 0.4-0.5 mm long. The eggs are embedded in plant tissue singly or in groups, usually with the operculum and respiratory horns exposed. The majority of species preferred oviposition sites depending on the host plant. On cocoa, *H. theivora* prefers the pods, but will occasionally oviposit on young shoots (Miller, 1941; Tan, 1974a and b), while on tea this species prefers new shoots and rarely the petioles and midribs of leaves (Das, 1984; Mann, 1902). Incubation periods vary depending on locality and season, but are generally in the range of 6-11 days.

About 60% of the eggs normally hatch out as nymphs. Young nymphs feed on tender leaves which later become necrotic. The nymphs are wingless and smaller, but otherwise resemble the adults. *Helopeltis* spp. has five nymphal instars that vary in size, colour and the development of certain body parts (e.g. antennae, wings). The young nymphs are orange coloured and ant-like. The first instar is completed in 1.9 days, second instar in 2.2 days, third in 2.8 days, fourth instar in 2.8 days and fifth instar in 3.2 days and thus nymphal period completes within 13-15 days. Nearly 60 per cent nymphs survive and moult as adults. The female bug lives for about 7 days, while the longevity of male is 9-10 days. The life-cycle is completed in 25-32 days. The bugs resembles mosquito in sitting position and hence this pest is known as 'mosquito bug'. The rate of nymphal development is affected by climatic factors and/or rearing conditions such as temperature and relative humidity (Betrem, 1950), as well as the quality of the food source (Awang *et al.,* 1988).

Adult longevity and fecundity also vary depending on rearing conditions. Tan (1974a) recorded a mean adult longevity of 30 days for *H. theivora* raised on cocoa pods in West Malaysia. The same species was reported by Awang *et al.* (1988) to have a mean longevity of 20 days when reared on cocoa pods, but only six days when raised on the shoots. Devasahayam (1985) showed that the fecundity of *H. antonii* reared on cashew plants at Vittal, Karnataka, India, was seasonally variable (13-82 eggs per female), with the highest mean value in the period from January to March (46.1 eggs per female). Awang *et al.* (1988) noted that *H. theivora* did not produce viable eggs when reared on shoots of the cocoa plant, but had a mean fecundity of 44 eggs per female when raised on the pods.

Integrated Pest Management

Population Dynamics

Understanding the recent trends of seasonal abundance of tea mosquito bug is prerequisite to develop an integrated management system for the pest. The knowledge of population dynamics can help to predict where and when infestations will occur, how big they will become, and how long they will last. Implications of population dynamics of tea mosquito bug to pest management decision making will also be considered. In peninsular India, the build-up of populations of *H. antonii* on cashew in October-November is synchronized with the emergence of new foliage following the cessation of the monsoon rains. Peak abundance is reached in January-February when cashew trees are in full bloom, the insects remain active on the plants until the onset of the monsoon rains in June (Devasahayam, 1985; Rajapakse and Jeevaratnam, 1983; Sundararaju, 1984). There is also evidence indicating that *Helopeltis* populations fluctuate in response to more localized and less regular climatic events, tending not to do well under conditions of heavy rain, high winds or low relative humidity (Betrem, 1950; Lever, 1949; Miller, 1941; Pillai *et al.,* 1976).

Biocontrtol

Parasitoids

In India, the occurrence of *Erythmelus helopeltis* Gaha (Hymenoptera: Mymaridae) was first reported by Devasahayam (1989). Subsequently four species of Hymenopteran egg parasitoid *viz., Telenomus* sp., *laricis* group (Scelionidae), *Chactostricha* sp. and *Ufens* spp. (Trichogrammatidae) and *Gonatocerus* sp. Nr *bialbifuniculatus* (Mymaridae) were documented (Sundararaju, 1993, 1996). All these were solidary parasitoids. Parasitism by *Telenomus* sp is always negligible in the eggs of *H. antonii* laid on neem and is totally absent in east coast of Tamil Nadu, whereas dominant species in cashew ecosystem of West Coast of India and Kanyakumari dt of Tamil Nadu is *Ufens sp*. Thelytolous type is the dominant species in the neem ecosystem of Tamil Nadu. Solidary nymphal endo parasitoids *Leiophron spp* (Braconidae) appears to be most promising in Indonesia and Africa (CIBC, 1983). But the activities of their hyper parasitoids limit their potentiality in biological control. In India *Leophron* like parasitoids has been reported from *H. theivora* on tea (Rau, 1948). First time the single grub of endoparasitoid was encountered from one adult female of *H. antonii* at coastal Karnataka region from cashew ecosystem

(NRCC, 1997). *Telenomus* sp has been reported to parasitize upto 36% of the fertile eggs of *H. cinchonae* on tea (Lever, 1949) and 11-47% of the eggs of *H. theivora* on cocoa (Ibrahim, 1989). Parasitism levels of 6-66% have been recorded for *Leiophron sahlbergellae* (Wilkinson) on *Sahlbergella singularis* Haglund (Heteroptera: Miridae) in West Africa (CIBC, 1983).

Predators

Crematogaster wroughtonii Forel (Formicidae) has been recorded as a predator on nymphs of *H. antonii* on cashew (Ambika and Abraham, 1979). Several Species of Spiders *Hyllus* sp, *Oxyopes* sp, *O. sehireta, Phidippus patch, Matidia* sp have been reported on *H. antonii*. (Sundararaju, 1984 and 1996; Devasahayam and Nair, 1986). Five species of reduvid bugs, *Sycanus collaris, Sphedanolestes signatus, Endochus inornarus*, *Irantha armipes* and *Occamus typycus* have been recorded as the predator on *H. antonii* (Sundararaju, 1984 and 1996). The reduviid, *Endochus inornatus* Stdl was reported taking as many as 20 individuals of *H. antonii* per day on cashew plantations in India. The role of ants in deterring *Helopeltis* spp. on cocoa by way of their close association with mealy bugs has been investigated by various workers, but opinions are mixed regarding the influence these insects have on *Helopeltis* populations (Chong, 1987; CIBC, 1983).

Nematodes and entomopathogens

The occurrence of *Agamermis paracaudatu* Steiner on *H. theivora* infesting tea was reported by Rau (1948). Two fungal pathogens *viz.*, *Aspergillus flavus* and *A. tamari* can cause infection in *H. antonii* (Sathiamma and Saraswathy, 1990; Karthikeyan, 1992).

Cultural methods

Cultural practices including pruning, weeding and shading also were employed early to assist in the control of *Helopeltis* spp. (Das, 1984; Fernando and Manickavasagar, 1956). Weeds offer excellent hiding places and serve as alternate hosts for *Helopeltis*. Growth of weeds and wild host plants in and around cocoa fields may be controlled which will help to reduce the incidence of this pest. Therefore, it is advised to maintain the length of pruning cycles to 4 years in mid elevation areas.

Pheromones

Earlier reports have indicated the presence of sex pheromones in the female *Helopeltis clavifer*. A congeneric species of *H. antonii.*, the olfactometer studies conducted in the laboratory indicated the presence of female sex pheromone in the adult female of *H. antonii* (Sundarajaju *et al.,* 1994). If virgin female is caged on neem tree when it is 3 to 4 days old it attracts males throughout the day. The attraction of males was continued upto the death of female. Attraction has been observed upto a maximum distance of 63 m from the infested tree situated in the leeward side. Presence of sex pheromone in female has also been reported in the eight other species of mirids.

The woks related to behavioral and electroantennographic responses of the tea mosquito bug, *Helopeltis theivora*, to female sex pheromones is going on at Division of Entomology, UPASI Tea Research Foundation, Tea Research Institute, Valparai, Coimbatore Dist, Tamil Nadu. Responses of the tea mosquito bug, *H. theivora,* a major pest of tea, to female sex pheromone compounds were measured using wind tunnel and electroantennogram (EAG) bioassays. In the wind tunnel, male tea mosquitoes were found to be most attracted to a dichloromethane extract of the female thorax. Gas chromatography-mass spectrometry (GC-MS) analysis of female thoracic extracts and dynamic head space samples of virgin females showed the presence of five compounds: (Z)-3 hexenyl acetate, (Z)-3 hexenyl butanoate, (E)-2 hexenyl pentanoate, 2,4 dimethyl pentanal, and (E)-2-hexenol. Male tea mosquitoes were attracted to blends of (Z)-3 hexenyl acetate and (E)-2-hexenol in the wind tunnel with a 1:5 ratio eliciting the greatest response. EAG recordings of male antenna confirmed the ability of this blend to evoke antennal responses in male insects. Similarly active EAG responses were recorded toward female thoracic extract and a blend of (Z)-3 hexenyl acetate and (E)-2-hexenol. Behavioural responses of adult males are mediated by a blend of volatile female sex pheromone compounds, (Z)-3 hexenyl acetate and (E)-2-hexenol, at a ratio of 1:5. This female sex pheromone blend may be useful for tea mosquito control and management programmes.

Host plant resistance

The use of resistant varieties as an option for the control of economically important insect pest species will be cheap, affordable to the poor resource farmers as well as being ecologically sound. The Federal Government of Nigeria through the National Cocoa Development Committee in conjunction with other stakeholders such as Cocoa Research Institute of Nigeria (CRIN) is establishing Cocoa seed gardens in the cocoa growing communities in Nigeria. This will facilitate accessibility and easy adoption of resistant and improved cocoa cultivars by the farmers. There are three mechanisms of resistance *viz.,* antixenosis, antibiosis and tolerance were tested on selected cocoa genotypes for resistance to tea mosquito bug. The development and use of mirid resistant cocoa varieties is one of the alternatives to chemical control. Mirid resistance studies in cocoa have been carried out by several workers, including Nguyen-Ban (1993), Sounigo *et al*. (1993), N' Guessan (1998), N' Guessan *et al.* (2004) and Anikwe *et al.* (2009). However, these studies have mostly concentrated on assessment of field damage and progress has so far been limited. No work has elucidated the mechanisms of mirid resistance in cocoa.

Insecticides

- For efficient management of mosquito bug, it is essential to check the build up of the pest population on cocoa as well as on the alternate hosts such as cashew, guava, neem, drum stick, mahogany and black pepper in the vicinity of cocoa plantations. Remove the volunteer (self-sown) neem plants in and around cocoa plantations.
- Among the various insecticides tested, monocrotophos 36 WSC 0.05% (@ 1.5 ml/lit) one spray at flushing season (Sep-Oct) and carbaryl 50 WP 0.1% (@ 2g/lit) one spray at fruiting season (Jan-Feb) were found to be superior in checking the pest. If the chemical is sprayed with motorized knapsack sprayer, the concentration of the chemical has to be doubled.
- Spray well in advance before the insect inflicts damage to the crop. Thorough foliar coverage is a must. The same insecticide should not be repeated in the second round. Avoid indiscriminate use of synthetic pyrethroids as it causes flare-up of sucking pests. Insecticides should be sprayed in evening hours to avoid toxicity to the insect pollinators.
- If no new growth is seen from the dried up shoots or branches in spite of spraying insecticides in the severely infested cocoa trees, such shoots or branches should be split open for confirmation of "die back" disease which is caused by fungal pathogen (*Botrydiplodia theobromae*). If the discolouration of sap wood is seen, it indicates the manifestation of die back disease.
- For controlling this disease, pruning of dried shoots or branches, swabbing the cut surfaces with Bordeaux mixture paste (10%) and spraying the tree with Bordeaux mixture (1%) are required in addition to insecticidal sprays.
- Lamdacyhalothrin and carbaryl are having higher ovicidal action. The combination product profenofos + Cypermethrin also exhibited highest residual action against tea mosquito bug. Chloropyriphos 20 EC (2.5ml/l), triazophos 40 EC (0.5ml/l), profenophos 50 EC (1ml/l), lamdacyhalathrin 25 EC (0.6ml/l), imidacloprid 17.8 SL (0.25ml/l), carbaryl 0.1%, fibronil (1ml/l), indoxacarb 0.05% are some of the effective insecticides against tea mosquito bug.

Precautions of insecticide spray

- Control should not be based on single insecticide class; in other words the insecticides should be altered in such a way that their modes of actions are different.

- ➢ Apply insecticides for killing the rising tea mosquito bug population as per requirement, not as a routine spray.
- ➢ Recommended dose of chemicals should be followed and avoid sub and supra-lethal doses. Sub-lethal doses would not only be ineffective but may help in the development of resistant strains, while overdose of pesticide would invariably increase the cost, pollute the environment and lead to the undesirable residue problem.
- ➢ Detection and marking of the initial pest-build up sites can help contending and managing the pest through spot spraying. Such operation would reduce the pesticide load that results from routine and blanket applications.
- ➢ Time of spraying should coincide with surfacing of the pest at the bush table.
- ➢ Nymphs and adults of tea mosquito bug generally feed in the morning and late afternoon hours. Hence, spraying operation against this pest should be carried out early in the morning or late in the afternoon. Spraying during the hot midday hours should be avoided as strong sunshine may cause decay of the insecticide.
- ➢ Toxicity persistence of different insecticides at recommended dose falls between 7-16 days. Hence, interval between two subsequent rounds must be 7-15 days.

Future thrusts

Clearly, much work need to be done on the potentials of biological control by parasitoids, predators and fungal and bacterial pathogens on tea mosquito bug. High levels of parasitism provided by some egg and nymphal parasitoids certainly need further investigation. Potential of biological control agents to be explored. Varietal resistance studies need to be done. Resistance breeding for development of resistant/ tolerant cocoa genotypes for tea mosquito bug resistance, pheromone technology and role of biorational insecticides to be investigated in details.

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