

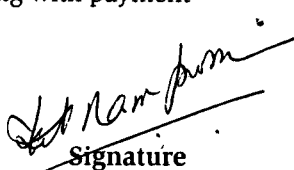
# PLACROSYM-XV

Plantation Crops Symposium

MYSORE, KARNATAKA

DECEMBER 10-13, 2002

## FINAL REGISTRATION FORM

Name : DR. K. U. K. NAMPOOTHIRI  
Address : Former Director (CPCRI), THRAIKOT  
KODUNGANNOOR (P.O) 695 013  
TRIVANDRUM, KERALA STATE  
Presenting any paper : Yes/No   
If yes, title of the paper : Coconut eriophyid mite (Aceria  
guerreronis) - an update.  
Name of the Technical Session : IV - Enhancing input efficiency -  
For Protection,  
Details of payment : Amount To be paid by ISPC.  
DD/Cheque No. and Date  
Bank name  
Whether needs any hotel reservation: Yes/No  Guest House  
preferred  
If yes, the enclosed form may be filled up and sent along with payment  
① Oral presentation by  
Dr. C. P. R. Nair, CPCRI  
  
Signature

-----  
Please send this form to :

Dr. Jayarama  
General Convener, PLACROSYM-XV  
Central Coffee Research Institute,  
Coffee Research Station 577 117  
Chikmagalur District, Karnataka.

## COCONUT ERIOPHYID MITE( *ACERIA GUERRERONIS* KEIFER) – AN UPDATE

K.U.K.Nampoothiri, C.P.R. Nair, S.Kannaiyan, Sabitha Doraisamy,  
K.Saradamma, S. Naseema Beevi and P.Sreerama Kumar

### ABSTRACT

*Coconut eriophyid mite was spotted in India in 1998. The pest later established in various locations of Kerala, Karnataka and Tamil Nadu. The mite infests buttons and colonising inside the perianth sucks sap from the tender tissues resulting in button shedding, reduction of both nut size and kernel content as well as loss of husk. The life cycle is completed in 7-10 days. The pest can be managed by periodic spray of insecticides like monocrotophos, dicofol and wettable sulfur. Botanicals such as neem oil, garlic, fish oil, rosin soap etc are preferred, though less effective, due to their ecofriendliness. Proper management of the palms helps to contain the pest and reduce economic loss. Hirsutella thompsonii is regarded as a potential biological agent. No cultivar is resistant to the pest, but certain features like round shape of nut, tight petals etc. offer some tolerance. An upto date review on the pest in India is presented along with suggestions on future course of action.*

### INTRODUCTION

Among various species of eriophyid mites reported from coconut, *Aceria guerreronis* Keifer has been considered to be a pest with the maximum destructive potential. In India the pest has a history of recent incidence. Sathiamma *et al.* (1998) reported this pest from India for the first time from coconut gardens near Cochin. Subsequent surveys revealed the fast spread of the pest within a short period to nearby districts of Kerala state. During the same period report on the occurrence of the pest from the adjoining states of Karnataka and Tamil Nadu also came out.

## GEOGRAPHIC DISTRIBUTION

*A. guerreronis* was described first from Mexico (Keifer, 1965). Subsequently the mite was reported from many coconut growing countries in Americas and Africa (Hall and Espinosa, 1981). *Aceria guerreronis* was reported to cause extensive damage on coconut in Sri Lanka (Fernando *et al.*, 2000). According to Howard *et al.* (1990) it was possible that the mite was present in low population in many locations but in recent years it would have increased due to certain unknown ecological factors. The widespread occurrence of the pest at present in India and Sri Lanka is a serious concern to the coconut industry in these two countries. There is also a chance of the mite spreading to other countries in Asia and Oceania where coconut has a great role in the economy of millions.

## BIOLOGY AND DESCRIPTION

During the early phase following pollination enough space is available allowing easy entry of the mite into the developing nut. Thousands of mites form an active colony and colonise the tender region covered by perianth. The life cycle of the mite is completed in 7 to 10 days (Mariau, 1977). Female mites lay more than 200 eggs and under favourable conditions the mite multiplies enormously within a short period. Development from egg to adult takes about 7 to 10 days. This mite is elongated and wormlike in appearance. Body is ringed and beset with elongate micro tubercles. Colour of the body is light yellowish white. It bears two pairs of legs towards the anterior part of the body. Mouthparts are very well developed and suitable for sucking plant sap. It measures 205 to 255 microns in length and 36-52 microns in width.

## SYMPTOMS OF INFESTATION

*A. guerreronis* infests buttons either immediately after the pollination or during their development in the early months. The mites colonizing inside the perianth suck sap from the tender tissues. Draining of the sap results in the formation of whitish longitudinal patches extending below the perianth. This is the first visual symptom of mite infestation. When the population inside the perianth is at low density, whitish streaks appear at the perianth level. The longitudinal white patches further develop into triangular yellow patches. Feeding injury

causes the affected tissues to dry up and this results in brownish patches observed at the perianth region (Plates 1&2).

As the nut grows, these brownish patches become more prominent and appear as warts. Longitudinal fissures appear on the surface of the nuts. Severe damage by the mites results in the drying and shedding of buttons/young nuts. Draining of sap from young buttons results in poor development of nuts leading to reduction in nut size and kernel content. The nuts become malformed, kernel development is seriously impaired and at times they are only partially developed. The husk also is poorly developed and becomes corky.

#### DISPERSAL

Dispersal of the mite is quick and is mainly through wind. Some dispersal may also take place by phoresy (Moore and Howard, 1996). The dispersal and spread within the palm have been observed to be almost certain. A palm which once gets infested shows symptoms of mite attack on new bunches in subsequent months.

#### POPULATION DYNAMICS

Drought situation is believed to aggravate the pest infestation. In India the pest is present in the field throughout the year with the population reaching its peak during summer months. New infestations are observed even during rainy season. Observations on population dynamics have revealed that a period of high temperature with intermittent rains providing high relative humidity is very congenial for the mite (Nair *et al.*, 2000).

#### CROP LOSS

Infestation by the mite results in button shedding and formation of malformed or undersized nuts. The mite incidence affects both copra and coir industry. During 1998 when the pest outbreak occurred almost 85-90% of nuts in the affected gardens became malformed and showed reduction in size. During subsequent years there was reduction in incidence and the highest incidence in 1999 was reported as 77% (Anon., 2000). Study conducted by CPCRI in Alappuzha District, Kerala on the crop loss indicated an average loss of 30.94% in

terms of copra and 41.74% in total husk production. (Muralidharan *et al.*, 2001) Hardening of coconut husk and reduction in fibres result in severe loss to coir industry. Recent observations indicate that the incidence of the pest has come down to around 20% in areas of original occurrence, thus reducing the extent of loss.

#### CHEMICALS AND BOTANICALS IN MITE MANAGEMENT

Studies on eriophyid control was taken up at Kerala Agricultural University (KAU), Tamil Nadu Agricultural University (TNAU), University of Agricultural Sciences, Bangalore (UAS), Project Directorate of Biological Control (PDBC) and Central Plantation Crops Research Institute (CPCRI). The spectrum of insecticides tried includes monocrotophos, dimethoate, dicofol, carbosulfan, wettable sulphur, methyl demeton, phosalone, ethion, triazophos, fenpropathrin, profenophos, imidacloprid, fenazquin, Tannic acid, azadirachtin, garlic, *Vinca rosea*, *Adathoda*, Karinjotti, Pongamia, rubber seed oil, soap and fish oil. Various formulations of these were tried individually, in various combinations and concentrations. Spraying and root feeding at various intervals were the main methods adopted. The effectiveness was assessed by number of palms affected, number of nuts infected and wherever possible population of mite as well as percentage loss of copra. It is difficult to compare the results from various locations since no uniformity was maintained in the yardsticks adopted for the assessment of efficacy.

As it is not possible to give the data of individual trials, involving as many as 29 treatments, only the most effective ones are discussed here. Almost all the control measures were effective to varying extent in controlling the pest. The trials in KAU indicated that monocrotophos (0.01%), dicofol (0.1%), triazophos (0.2%), fenpropathrin (0.02%) and carbosulfan (0.05%) were promising in controlling the mite. Among the newer chemicals screened in the laboratory, profenophos (Curacron 50EC), imidacloprid (Confidor 20SL) and fenazaquin (Magister 100 EC) were found promising. Monocrotophos was not recommended due to its high toxicity and probable chances of persistence in tender coconut. Dicofol spray was recommended as an interim measure. However

this met with strong public opposition. Wet table sulphur (0.4%) application was then recommended since it was almost equally effective in controlling the pest (Saradamma *et al.*, 2000).

Tamil Nadu Agricultural University conducted multilocation trials in six locations in the state. Spraying of methyl demeton 25 EC (4ml/l) and monocrotophos 36 SL (1.5ml/l) were found to significantly reduce the mite population. Two rounds of spraying triazophos @ 5ml/l and carbosulfan 2ml/l at 45 days interval reduced the population of mite by 70 and 68 % respectively (Ramaraju *et al.*, 1999, Palaniswamy *et al.*, 2000, Muthiah and Bhaskaran, 2000).

In another trial, spot application of wettable sulphur and root feeding of monocrotophos gave significant control up to 45 days after treatment while spot application of carbosulfan effectively checked the mite up to 60 days. A reduction of mite population to the extent of 42 % could be obtained by using different formulations of wettable sulphur (0.4%). Root feeding of monocrotophos 15ml + 15ml water per palm and stem injection @ 15ml/palm were equally effective (Philip Sridhar *et al.*, 2000).

In the field experiments carried out by CPCRI in 98-99, root feeding of monocrotophos and triazophos @ 10 + 10 ml water two times at an interval of one month significantly reduced the mite infestation in younger bunches and the treatment was effective for 60 days. Spraying of dicofol @ 0.1%, monocrotophos @ 0.5% and endosulfan @0.1% also showed significant reduction in infestation. Another concurrent trial showed that wettable sulphur @0.4%, triazophos @ 0.1% and carbosulfan @ 0.05% when applied on younger buttons twice at monthly intervals could significantly reduce the incidence of the infestation till 75 days after treatment ((Nair *et al.* 2000).

Another field trial laid out in 2000-2001, indicated that 3 rounds of pesticidal application in peak summer (April- May), post monsoon (October) and early summer (i.e. December-January) reduced the mite infestation significantly. Pesticides like profenophos @ 0.05%, and methyl demeton 0.1% proved to be effective in this trial.

UAS evaluated five chemicals against the mite. Monocrotophos and carbosulfan were tested by injecting into the stem; dicofol, and ethion by spraying and triazophos by both the methods. Triazophos (0.16%) proved to be the most effective when sprayed (83% mortality) or injected into the stem (69%). Ethion 0.05% spray resulted in 73% mortality followed by dicofol 0.05% which gave 40% mortality. As stem injection, monocrotophos was the best causing 76% mortality.

In the tractor mounted coconut tree sprayer developed by TNAU the spray gun can be taken up to a height of 15m and the chemical can be sprayed in the form of mist to the entire canopy (Manian *et.al*, 2000).

While chemicals are effective in controlling the mite, many other factors are to be considered before recommending their use. Since flowering is continuous in coconut, frequent application of insecticides is required to check the pest. High toxicity, destruction of beneficial predators leading to outbreak of other pests, possible environmental pollution and resulting health hazards as well as residual problems are factors to be reckoned with. The disastrous consequences of over dependence on synthetic insecticides prompted trials using botanicals.

Considering the unique cropping pattern and habitation in Kerala and Lakshadweep, three rounds of spraying annually with the ecofriendly bio pesticide neem oil + garlic emulsion (2%) was recommended against the mite. Cleaning the crown before spraying and restricting the spray to the susceptible bunches only were also recommended. A massive spraying programme based on this recommendation was taken up in Kerala. In the field trials conducted by KAU, effectiveness of azadirachtin 0.003% (Neemazal T/S @ 3ml/l) was found to be on par with the recommended chemicals. Seed oils and their combinations, when evaluated in the laboratory gave a mortality up to 60%. Among 24 treatments tried, more than 50% mortality was observed in neem oil + castor oil (2:1 and 4:1) sesamum oil (2%), illupai oil (2%), karinjotti oil (1%), pongamia oil (3%) and New FOIS (G)-formulation of fish oil rosin soap.

Based on field trials CPCRI recommended spraying of Neemazal T/S containing 1% azadirachtin at the rate of 4ml per litre of water. In recent trials, azadirachtin 50,000 ppm @ 0.004% and Fish-oil-Rosin - Soap @ 5% proved to be

effective in reducing the percentage of infestation and mite population in susceptible stages of the nuts. Studies on the effectiveness of root feeding of azadirachtin are now being carried out in farmer's field. Azadirachtin (5%) @ 7.5 ml + 7.5ml water has been indicated as promising.

At TNAU, it was found that spraying Azadirachtin 0.005%(Neemazal (5ml/l)), FORS (40g/l) per palm and root feeding of NSKE 25% (100ml/palm) significantly checked the pest up to 45 days after treatment. TNAU neem oil 60 EC (3%) and garlic extract (25g) + Neem oil (20ml) per palm effectively reduced the mite population upto 60 days after treatment.

TNAU-Agro-Biocide containing plant extracts, plant based oils and fungal culture filtrate was tried in 156 demonstration plots. The formulation when applied as root feeding @ 30 ml/palm recorded a reduction in mite population of 65.1-75%, 89.6, 94.9% and 64.7-100% over untreated control on 15th, 30th and 45th day after treatment respectively (Kannaiyan,2000). At UAS it was found that root feeding of 10 ml Econeem and stem injection of 1.6 g soluneem caused considerable reduction in mite infestation.

#### RESIDUAL TOXICITY

One of the main causes of worry in undertaking chemical application is the possible residual toxicity of the pesticides. A series of studies were taken up by KAU and TNAU on this aspect. At KAU it was established that the residues of dicofol in soil ranged from non-detectable to 0.173 ppm. Tender coconut water was found to be safe for consumption as none of the samples analysed 15 and 30 days after treatment had any residues. Studies on translocation of carbosulfan when root fed indicated that tender coconut water was free from residues even in the first week after treatment. However traces of carbosulfan could be detected in tender pulp only up to seven days after treatment. Residues of triazophos were also not found to persist in tender nut as well as mature coconut water and kernel.

Studies at TNAU indicated the presence of measurable amounts of monocrotophos residues (0.02-0.05  $\mu$ g/g) in coconut water 15 and 30 days after application at Aliyarnagar. But no detectable residues were found at Cheripalayam. Residues of triazophos were found in coconut water and kernel on

30 and 45 days after the first application and 15<sup>th</sup> and 30<sup>th</sup> day after second application. The level observed at 45 days was below the tolerance limit of 0.1  $\mu\text{g/g}$ . Residues of profenofos were in detectable amount in coconut water (0.015-0.021  $\mu\text{g/g}$ ) from third day onwards at Bhavanisagar and Cheripalayam and water and kernel from seventh day onwards. The residues detected on 45<sup>th</sup> day after application was below the MRL of 0.05  $\mu\text{g/g}$  in kernel. Similarly, residues of carbosulfan in coconut water and kernel were below detectable limit. Based on these studies it is recommended as safe to consume coconut water and kernel 45 days after treatment (Kuttalam et. al., 2000).

#### MICROBIAL AGENTS IN ERIOPHYID MITE MANAGEMENT

Predators as well as pathogens are known to attack *A. guerreronis*. The predatory fauna associated with the mite in India has been investigated by the three Agricultural Universities, PDBC and CPCRI. The dominant species recorded are *Amblyseius* spp., and *Podella* spp. Besides these coccinellid beetles, one species of cecidomyid and another species of thrips are also occasionally seen in the infested buttons. The predatory mites are seen mostly in nuts above five months maturity. The limiting factor is the inability of the predators to crawl into the younger nuts due to the tight perianth. Conservation of the available predatory fauna and detailed studies on them are important.

Logistically the use of pathogens is likely to be more effective than that of predators especially because of their versatility (Moore,2000). The only pathogen that has been commercialised for mite control is the Acari-specific fungus, *Hirsutella thompsonii* (McCoy, 1981).

No bacterial, viral or protozoan pathogens have been recorded from eriophyid mites (Lipa, 1971; McCoy, 1996). But a large number of fungi have been recorded as pathogens of many eriophyids the world over in several different ecosystems. *H. thompsonii* and *H. nodulosa* are the two major fungal pathogens reported to be associated with the coconut mite in countries where the mite had been a pest.

## *HIRSUTELLA THOMPSONII*

*H. thompsonii* strains from the local populations of the coconut mite are slow growing, whose colonies on potato dextrose agar (PDA) after about 15 days are grey, raised, cottony, with greyish brown substratum.

Host infection by *H. thompsonii* is initiated by a hydrophilic conidium and host mortality appears to be caused by the proliferation of chains of hyphal bodies in the haemocoel (McCoy, 1981). Hyphae can emerge from cadavers through the oral and anal openings, appendages, and genital opening and at times laterally through the body wall (Baker and Neunzig, 1968). Interestingly, all these phenomena have been observed in the infection of both the nymphal and adult stages of the coconut mite by the fungus. The mycelia emerging from the dead mites, spread on the nut surface or the inner surface of the bracts, forming the phialides and conidia. Infection spreads very fast in the population and groups of dead mites entwined in the mycelium can often be noticed.

### Natural regulation of the coconut mite in India

Sustained surveys since early 1999 for natural enemies, especially pathogens, of the coconut mite in the southern States had indicated the natural regulatory role played by many entomopathogens. Among them, only *H. thompsonii* was found to have a greater effect as a natural regulator of the pest. It was found to be widespread throughout Karnataka and Tamil Nadu (T. N.). The incidence of the pathogen was the highest in Coimbatore district of T. N., where 17.19 per cent of samples yielded the fungus. In contrast, the presence of the pathogen was the lowest in Bangalore rural district, where only 1.37 per cent of the samples showed the occurrence of the fungus. The average incidence of *H. thompsonii* in mite-infested coconuts was 6.85%, which is quite significant. Overall, 7.03% of the population of mites was found to be infected with *H. thompsonii*. The nymphal stages were more susceptible (9.34%) than the adults (4.72%).

Similarly in Chittoor and East Godavari (E. G.) districts of Andhra Pradesh (A. P.) surveys were undertaken during May-November 2000. Whereas 50% of the localities showed the presence of *H. thompsonii* in Chittoor, 80% of the localities

showed the occurrence of the pathogen in E. G. The presence of *H. thompsonii* was observed in 5.35% and 16.80% of the coconut samples collected from Chittoor and E. G. respectively with an average incidence of 11.08 per cent.

The situation is the same in the case of Kerala as well. *H. thompsonii* has been found to be doing a very important regulatory role in the state. Although both synnematosus and mononematosus strains of the fungus were found to be causing infection in the mite, the former were predominant.

The consistent association of the fungus with the mite in the southern states surveyed indicates that augmentation of the pathogen in the form of a mycoacaricide would result in artificial epizootics and help spread the fungus in areas where there is no natural presence.

#### *H. thompsonii* as a biocontrol agent

*H. thompsonii* has been tried in several countries for its potential as a bio control agent for the coconut mite. For the first time in India, a mycoacaricide (Mycohit) has been developed based exclusively on *H. thompsonii* at PDBC (Kumar and Singh, 2001). The product is based on the strain MF(Ag)5 (ITTC 4962; IMI 385470- ex Pollachi). The product has a potency of  $2.5 \times 10^8$  CFU/g, so that a final concentration of at least a million fungal propagules can be assured to be present in the spray solution. The moisture content of the formulation is kept more than 12% for immediate field application and less than 12% for delayed use. 'Mycohit' is generally recommended for use as a spray when the weather is dry. However, in certain situations such as after a heavy rain, just dusting of the product on the bunches is enough because of the wet microclimate within the crown. The product is advised to be stored in a cool and dry place away from direct sunlight and heat.

'Mycohit' is used at a 1% concentration to get a minimum of  $2.5 \times 10^6$  CFUs/ml of the spray solution. About 2 litres of the spray solution is needed per palm and the volume may be changed depending on the number of bunches. At least two rounds of spray are recommended for bringing down the mite population. Application of the formulated product has never created a problem during the field trials.

Field trials have been conducted in more than 10 different places for evaluating the performance of 'Mycohit'. About 20-70 per cent mortality of the mite could be realized with a single spray of 'Mycohit'. To get a more consistent kill (60-80%) of the mite, at least two sprays are required to be given (Kumar and Singh, 2000). Studies have indicated that the fungus could be made to establish itself and to survive longer in a particular coconut plantation with three successive sprays of the mycoacaricide.

#### Biosafety

The fungus as well as the formulated product is being tested for biosafety separately as required for registration. Invertebrate predators and parasites have never been found to be adversely affected in artificial applications of *H. thompsonii* (McCoy, 1981). Investigations on the safety of *H. thompsonii* to natural enemies indicated that the commonly employed bio control agents in the coconut ecosystem are not susceptible to the pathogen. Similarly, other parasitoids and predators were also found to be unaffected. Studies have indicated the innocuity of *H. thompsonii* to adult honeybees.

#### Benefits of using *Hirsutella thompsonii*

Use of *H. thompsonii* is advocated on more scores than one. Some of its advantages over other methods of coconut mite management are that the fungus is specific to the target organism, it is safe to vertebrates and other non-targets, no toxic residues are left in the environment, development of resistance and resurgence are ruled out, no secondary pest outbreak because of its application, its compatibility with many chemical pesticides, parasitoids, predators, and other pathogens, long term control of the pest, easiness in application and perfection in the mass production of the fungus in several countries. Moreover its amenability for genetic modification paves way for production of more virulent and effective strains.

The positive results of work in India against *A. guerreronis* warrant more intensive work towards making available a mycoacaricide based on the fungus. Additionally, pathogens belonging to the genera *Verticillium*, *Beauveria*,

*Metarhizium*, *Paecilomyces* and *Sporothrix* may offer more opportunities in their use against the mite either as individual agents or as cocktails.

### MANAGEMENT PRACTICES

If cultural methods can reduce the intensity of mite infestation, it would be a great help in management of the pest especially as it avoids any risk of toxic effects in the coconut water and kernel. Long periods of water stress results in greater yield loss due to mite attack possibly because fruit growth is slower and the fruits remain susceptible over a longer period. So irrigation can circumvent this problem. Better managed palms with appropriate fertiliser application may suffer less due to mite attack (Mariau, 1977). Preliminary trial conducted by CPCRI on drenching of Azadirachtin coupled with soil applications of Neem oil cake has shown promising results. The experiments conducted by TNAU revealed that higher dose of K and neem cake reduced the eriophyid mite attack. Further Ca, Mg, and B are known to induce some amount of resistance to mite. Therefore application of 1.5 kg muriate of potash, 5kg neem cake, 50g borax, 1.0kg gypsum and 0.5 kg magnesium sulphate per palm per year along with the recommended fertilisers is recommended. The mean damage grade index was maximum (50%) when the chemical fertiliser alone was applied. The damage was least (29%) when 2kg neem cake + 0.5kg bone meal + 4kg mill ash per palm /year were applied implicating the beneficial effects of organic manure.

When a single intercrop (bhendi or sun hemp) was raised along with coconut, the mite damage was reduced to 73% compared to 76% in the monocrop. The mite damage was 70% with banana as an intercrop. When high density multiple species cropping was adopted for a few years, the damage was reduced to 58-64% (Muthiah and Bhaskaran, 2000).

Induction of resistance was attempted by root feeding with a nutrient -growth regulator mixture containing 10g urea, 10 g muriate of potash, 5g zinc sulphate, 2g ferrous sulphate, 2 g magnesium sulphate, 1g copper sulphate, 2g borax, 2g manganese sulphate, 10 mg sodium molybdate, 1ml planofix, 10mg citric acid and 20 mg salicylic acid in one litre of water. This resulted in higher amounts of K (1.69%), as well as primary and secondary metabolites like total

phenols(65 mg/g), ascorbic acid(207 mg/g), and total carbohydrates(8.17 mg/g) imparting likely resistance to the coconut palms. Kamala Thirumalaiswamy *et al* (2000) reported that the above treatment with NAA helped to increase the retention of buttons (43%) compared to control (16.3%). Crown cleaning and water spray was found to reduce the mite infestation ( Chezhiyan and Ramar,2000).

Some of the farmer's practices to control the eriophyid mite include keeping repellents like neem cake, garlic paste and naphthalene balls in polythene covers on the palms, smoking garlic, sulphur, camphor etc in the garden, hanging cupboards pasted with gum, spraying salt or starch solution on the bunches and nurturing ants on the crown.

#### VARIETAL RESISTANCE

Very little work has been done on this aspect. Mite damage was reported to be less where the petals are tightly pressed as in round fruits, compared to the elongated nuts where more gap is seen (Moore, 1986 and Moore & Alexander, 1990). This is found to be true in the case of Indian cultivars also. Mariau (1986) has reported similar situations in West African Tall. In Cuba, cultivar Indio and in Tanzania Polynesian tall, Malayan Red Dwarf, Rennel Tall, Cameroon Red Dwarf, and Equitorial Green Dwarf and in Costa Rica, Malayan Yellow Dwarf showed more tolerance to mite attack ( Moore and Howard,1996, Seguni,2000). In Tamil Nadu, Kenthali recorded the lowest mite population (16.33/8 sq.mm) followed by SCT x COD (19) and British Solomon Islands(27) whereas Tiptur Tall showed the highest population(140.33). Field surveys in Kerala showed that West Coast tall and Chowghat Green Dwarf showed relatively high incidence. The chowghat Orange Dwarf palms with tight petals and round shaped nuts showed very low incidence. Hence there is ample scope for breeding for resistance to combat *A. guerreronis*

#### CONCLUSION

Four years after the first occurrence of the eriophyid mite in India, the population seems to have stabilised and the incidence now remains below 20% in areas of its first occurrence in Kerala and Tamil Nadu. However it is very necessary to keep a vigil on the pest to detect any possible outbreak and take

timely appropriate steps. Farmers should be well educated so that they can be watchful. Many of them still confuse other pest manifestations, like that of coreid bug, with eriophyid infestation. Chemical application, especially on a large scale should be adopted only when there is an outbreak. Botanicals are preferred thereafter coupled with ecofriendly cultural and nutrient management practices to keep the palms healthy and minimise the economic loss. Considering the specific situation in which coconut is grown in India, utilisation of natural enemies is the best solution. In all areas where the pest occurs, presence of a few natural enemies has been recorded. While this is a welcome sign, success in mass multiplication and field level establishment have not been satisfactory. This is an area where research has to be strengthened particularly involving *Hirsutella thompsonii*. While breeding for resistance is difficult and time consuming relentless efforts on this aspect will be rewarding. It is hoped that the steering committee which periodically reviews the research programmes will keep these aspects in view.

#### ACKNOWLEDGEMENT

The authors are grateful to Central Plantation Crops Research Institute, Tamil Nadu Agricultural University, Kerala Agricultural University, University of Agricultural Sciences, Project Directorate of Biological Control and Coconut Development Board for readily providing the large quantum of data, which has been separately compiled under the aegis of the Ministry of Agriculture from which this review has been prepared. The encouragement received from the Horticulture Commissioner, Government of India is gratefully acknowledged. We thank Dr. K. Subaharan, CPCRI for his help in editing the information.

#### REFERENCES

- Anonymous 2000 Central Plantation Crops Research Institute, Annual Report for 1999, Kasaragod, India p.88.
- Baker, J.R. and Neunzig, H.H. 1968. *Hirsutella thompsonii* as a fungus parasite of the blueberry bud mite. *J.Econ.Entomol.*, **61**: 1117-1118.

- Chezhiyan, N. and Ramar, A. 2000 Eriophyid mite incidence on different varieties of coconut. Paper presented in group meeting. 15<sup>th</sup> May, 2000 at Tamil Nadu Agricultural University, Coimbatore.
- Fernando, L.C.P., Wickramananda, I.R. and Aratchige, N.S. 2000. Status of coconut mite *Aceria guerreronis* in Sri Lanka. Paper presented in the "International workshop on Coconut mite *Aceria guerreronis*." 6-8 January 2000. Coconut Research Institute, Sri Lanka.
- Hall, R.A. and Espinosa, B.A. 1981. The coconut mite *Eriophyes guerreronis* with special reference to the problem in Mexico. *Proc. 1981 British Crop Protection Conf. Pest and Diseases*, British Crop Protection Council. Farnham, UK, pp. 113-120.
- Howard, F.W., Abreu-Rodriguez, E. and Denmark, H. A. 1990. Geographical and seasonal distribution of the coconut mite *Aceria guerreronis* (Acari: Eriophyidae) in Puerto Rico and Florida, USA. *J.Agric. Univ. Puerto Rico* 74: 237-251.
- Kamala Thirumalaiswamy, Senthil, S., Rajkumar, M., Thangaraj, M. and Srinivsan. 2000. Root feeding of nutrients and growth regulators for inducing resistance and rejuvenation of coconut palms infested by eriophyid mite. Paper presented in group meeting on coconut eriophyid mite. 15<sup>th</sup> May at Tamil Nadu Agricultural University, Coimbatore.
- Keifer, H. H. 1965. Eriophyid studies B-14. *Calif. Dept. of Agric. Bureau of Entomol.* p. 20
- Kumar, P. S. and Singh, S. P. 2000. *Hirsutella thompsonii*: The best biological control option for the management of the coconut mite in India. *Indian Coconut J.*, 31(5): 11-17.
- Kumar, P.S. and Singh, S.P. 2001 Development of 'Mycohit', the first mycoacaricide based exclusively on *Hirsutella thompsonii*, for suppressing the coconut mite in India. National symposium on "Bioinoculants for sustainable agriculture and forestry", Kaktiya University, Warangal, India, 16-18, February, 2001.

- Kannaiyan, S. 2000 Integrated packages for the management of coconut eriophyid mite. Interactive workshop on coconut eriophyid mite, Tamil Nadu Agricultural University, Coimbatore, 19,May,2000.
- Kuttalam,S., Manoharan,T., Chandrasekharan,S., Jayakumar,R., Chinnaiiah,C., Vijayalakshmi,,K., Santharam,G. and Rabindra,R.J. 2000 Residues of insecticides used for eriophyid mite management in coconut. Paper presented in group meeting on coconut eriophyid mite.Tamil Nadu Agricultural University, Coimbatore, 15,May,2000.
- Lipa, J. J. 1971. Microbial control of mites and ticks, pp. 357-373. In: Burges, H. D. and Hussey, N. W. (Eds.). *Microbial Control of Insects and Mites*. Academic Press, London, UK.
- Manian, R., Kathirvel,K. and Senthil Kumar,T. 2000 Development of spraying devices for spot application of pesticides on coconut bunches. Paper presented in group meeting on coconut eriophyid mite, Tamil Nadu Agricultural University, Coimbatore, 15,May,2000.
- Mariau, D. 1977. *Aceria (Eriophyes) guerreronis*: un important ravageur des cocoteraies africainnes et americaines. *Oleagineux* **32**: 101-111.
- Mariau, D. 1986. Behaviour of *Eriophyes guerreronis* Keifer with respect to different varieties of coconut. . *Oleagineux* ,**41**(11): 499-505.
- McCoy, C. W. 1981. Pest control by the fungus *Hirsutella thompsonii*, pp. 499-512. In: Burges, H. D. (Ed.). *Microbial Control of Pests and Plant Diseases 1970-1980*. Academic Press, London, UK.
- McCoy, C. W. 1996. Pathogens of eriophyid mites, pp. 481-490. In: *Eriophyid Mites- Their Biology, Natural Enemies and Control* (Eds, E. E. Lindquist, M. W. Sabelis and J. Bruin), Elsevier Science B. V., Amsterdam, The Netherlands.
- Moore, D. 1986. Bract arrangement in the coconutfruit in relation to attack by the coconut mite *Eriophyes guerreronis* Keifer. *Trop. Agric. (Trinidad)*, **63**: 285-288.
- Moore, D. 2000. Non-chemical control of *Aceria guerreronis* on coconuts. *Biocontrol News Inform.*, **21** (3): 83N-88N.

- Moore, D and Alexander, L. 1990. Resistance of coconuts in St. Lucia to attack by the coconut mite *Eriophyes guerreronis* Keifer *Trop. Agric. (Trinidad)*, **67(1)**: 33-36.
- Moore, D. and Howard, F. W. 1996 In: *Eriophyid mites, their biology, natural enemies and control* E. E. Lindquist *et al.* (Editors) Elsevier Science. 561-570.
- Muralidharan, K., Jacob Mathew, Thamban, C., Amarnath, C. H., Anitha Kumari, P., Chandrika Mohan, Vijayakumar, K., Sairam, C. V., Nair, C.P.R. and Arulraj, S. 2001. Pilot sample survey on the incidence and yield loss due to Eriophyid mite on coconut in Alappuzha District. *Ind. Cocon J.* **32(1)**: 28-32.
- Muthiah, C. and Bhaskaran, R. 2000. Survey, bioefficacy and management of eriophyid mite on coconut. Paper presented in group meeting on coconut eriophyid mite. Tamil Nadu Agricultural University, Coimbatore, 15,May,2000.
- Nair, C. P. R., Rajan, P. and Chandrika Mohan. 2000. Distribution, Ecology and management of the Eriophyid mite *Aceria guerreronis* Keifer affecting coconut palm. Paper presented in the International Entomology Symposium Entomocongress, 2000, 5-8 Nov. 2000, Thiruvananthapuram. Abstract of papers p.180.
- Palanisamy,S., Karuppuchamy, P., Ramaraju,K., Philip Sridhar, R., Kempraj,T., Bharathi,M. and Rabindra,R.J. 2000. Evaluation of ecofriendly agents and insecticides against coconut eriophyid mite. Paper presented in group meeting on coconut eriophyid mite. Tamil Nadu Agricultural University, Coimbatore, 15,May,2000.
- Philip Sridhar,R., Ramaraju,K., Karuppuchamy,K., Palanisamy,S., Kempraj,T., Bharathy,M. and Rabindra,R.J. 2000 Evaluation of insecticides against coconut eriophyid mite by root feeding and crown placement. Paper presented in group meeting on coconut eriophyid mite. Tamil Nadu Agricultural University, Coimbatore, 15, May,2000.

- Ramaraju,K., Natarajan,K. Sundara babu, P.C. and Murali Ragni, G.T. 1999. Management of coconut eriophyid mite, *Aceria guerreronis* K. Tamil Nadu J. Acarol. **14**: 82-83.
- Saradamma,K., Beevi,S.N., Mathew,T.B., Sreeekumar,V, Jacob, A.V. and Visalakshi,A 2000. Management of coconut eriophyid mite in Kerala. Paper presented at Entomocongress 2000 –Perspective plan for the new millennium, 5-8 November, 2000, Association for advancement of entomology,Thiruvananthapuram.
- Sathiamma, B., Nair, C. P. R. and Koshy, P. K. 1998. Out break of a nut infesting eriophyid mite *Eriophyes guerreronis* (K.) in coconut plantations in India. *Ind. Cocon J.* **29**: (2) 1-3.
- Seguni,Z. 2000. Incidence, distribution and economic importance of the coconut eriophyid mite, , *Aceria guerreronis*, K. in Tanzanian coconut based cropping systems. Paper presented in the International workshop on coconut eriophyid mite , 6-8 January,2000, Coconut Research Institute, Sri Lanka.