STUDIES ON COCONUT ERIOPHYID MITE *Aceria guerreronis* (Keifer) (ERIOPHYIDAE : ACARI)

By

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THESIS SUBMITTED TO THE
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CERTIFICATE

This is to certify that the thesis entitled **"Studies on Coconut Eriophyid mite *Aceria guerreronis* (Keifer) (Eriophyidae : Acari)"** submitted in partial fulfilment of the requirements for the degree of **'Master of Science in Agriculture'** of the Acharya N.G. Ranga Agricultural University, Hyderabad, is a record of the bonafide research work carried out by **Mr. B. Yuvaraja** under our guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part has been fully acknowledged. All assistance and help received during the course of the investigations have been duly acknowledged by the author of the thesis.

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This is to certify that **Mr. B. YUVARAJA,** has satisfactorily prosecuted the course of research and that the thesis entitled **"Studies on Coconut Eriophyid mite *Aceria guerreronis* (Keifer) (Eriophyidae : Acari)"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part there of has not been previously submitted by him for a degree of any University.

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Place :

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DECLARATION

I, **Mr. B. YUVARAJA,** here by declare that the thesis entitled "**Studies on Coconut Eriophyid mite *Aceria guerreronis* (Keifer) (Eriophyidae : Acari)"** submitted to Acharya N.G. Ranga Agricultural University, Hyderabad for the degree of **Master of Science in Agriculture** is the result of original research work done by me. I also declare that the materials contained in this thesis has not been published earlier.

Date : **(B. YUVARAJA)**

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LIST OF SYMBOLS AND ABBREVIATIONS

%	-	Percentage
@	-	At the rate of
cm	-	centimetre
DAS	-	Days after spraying
EC	-	emulsifiable concentrate
Fig.	-	Figure
g	-	gram
h	-	Hour
i.e.,	-	That is
kg	-	kilogram
kmph	-	kilometres per hour
l	-	litre
mg	-	Milli gram
µ	-	Micron
µg	-	Micro gram
ml	-	millilitre
no.	-	Number
ppm	-	parts per million
viz.	-	Namely
°C	-	degree celsius
wp	-	Wettable powder
SL	-	Soluble liquid
SD	-	Standard deviation
WG	-	Wettable granules

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ABSTRACT

Name of the student	:	**B. YUVARAJA**
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The studies on population dynamics (seasonal incidence), damage assessment, biology and chemical control of coconut eriophyid mite, *Aceria guerreronis* (Keifer) were carried out during August, 2003 to June, 2004 at S.V. Agricultural College, Tirupati.

Studies on population dynamics (seasonal incidence) were carried out on 4 months old nuts, during the period of August 2003 - May 2004. The peak mite activity was observed during March - April with the temperature range of 37.4°C to 40.3°C, RH of 48-55 per cent and with no rainfall. The mite activity coincided with summer period. The mites were more abundant on bunches which are facing in east and north with respect to the tree direction.

The survey on extent of damage revealed that, high damage percentage of 31.45 was recorded at Puttur in Chittoor district. Due to mite incidence, the

phosphorus, potassium and reducing sugars (glucose) levels, reduced to 16.13, 29.8 and 35.2% respectively in severely (scale-v) damaged nuts. The morphological and quantitative characteristics of the drupe like length, girth, perianth radius, nut weight, husk weight and copra weight get reduced in mite infested nuts.

Biology of eriophyid mite, *A. guerreronis* was studied on tender, succulent perianth discs. The results showed that the longevity of male and female was 8.3 and 15.93 days respectively. Pre-oviposition, oviposition and post-oviposition periods were 1.88, 8.1 and 1.91 days respectively. Fecundity of female was 12 eggs. Egg, protonymph and deutonymph periods were 2.5, 3.6 and 4.42 days respectively.

The field experiment on the efficacy of different pesticides in controlling eriophyid mite revealed that monocrotophos (0.05%) was the best chemical against the mite. The other chemicals in their efficacy were Lambda cyhalothrin (0.005%) with 63.69% population reduction, sulphur (0.3%) with 61.73%, phosalone (0.07%) with 61.45% and thiomethoxam (0.006%) with 61.15% population reduction stood next to them and are moderately effective. Dicofol (0.9%) and vertimec 0.0025% were found to be less effective as the population reduction in these treatments was recorded as 20.86 and 42.85% respectively.

CHAPTER - I

INTRODUCTION

Coconut, (*Cocos nucifera* L.) is eulogized as 'Kalpavriksha' or the 'Tree of heaven' provides not only food, but also shelter, medicine and employment to 10 millions of people (Koshy *et al.*, 1997). The crop has its origin in the oriental region and disseminated to Nearctic regions through trade and commerce (Child, 1974). It is one of the most valuable and commercial plantation crop of the wet tropics and is considered to be among the twenty most important crop plants in the world (Vietmeyer, 1986).

Globally, coconut is cultivated in about, 11,919 m ha. and in India it is cultivated in about 1.9 mha (15.15% of the world area), with a production of about 13.6 billion nuts per annum (Ramarethinam, 2001). It accounts to more than 90 per cent of the area and production of coconut is from the four southern states *viz.*, Kerala, Tamil Nadu, Karnataka and Andhra Pradesh.

The pest complex of coconut is widening in recent years. Lepesme (1947) listed 751 species of insects infesting palms, of which nearly 22 per cent are specific to the coconut palm. Nirula (1955) and Kurien *et al.* (1979) listed 106 and 547 insect and mite species respectively. Mohanasundaram and Kuppusamy (1989) presented a review on the coconut mites and listed twenty mite species including the occurrence of six new species from Tamil Nadu, South India (Sathiamma, 1995). Among them, coconut eriophyid mite (CEM) *Aceria guerreronis* (Keifer) is considered to be one of the very serious pest and found to cause serious damage resulting in heavy loss in production of nuts.

The mite measures 200-250 µm in length and 20-30 µm in width (Keifer, 1965). The life cycle of this mite spans 10-12 days (Ramarethinam and Loganathan, 2000). These mites inhabit the tender portion of the nut covered by the inner bracts of the perianth. The mite generally infests one to five months old nuts and disperse through wind (Sathiamma *et al.*, 1998). Due to feeding the perianth appear initially as whitish triangular patches, as the nuts grow in size, triangular yellow patches become visible, followed by large brownish patches with longitudinal fissures. In case of severe attack the buttons shed, resulting in poor nut setting. Whereas the intact nuts are deformed and undersized and poorly developed of kernel and husk. The farmers of West Bengal call this symptom as "Safeda Dag" (Apurba Bandyopadhyay and Khan, 2003).

The Eriophyid mite, *A. guerreronis* has become a serious problem in coconut plantations, causing heavy losses in coconut production. It was first recorded in 1965 in Guerrero state of Mexico (Keifer, 1965). The first report on occurrence of this exotic mite was made by Sathiamma *et al.* (1998) from Ernakulam district of Kerala and followed by parts of Tamil Nadu and Karnataka. The occurrence of this mite in Andhra Pradesh was first noticed in Chittoor district during September 1999 (Jagadiswari Rao *et al.,* 2001).

A few predatory mites which occur sporadically in small proportions inside the bract have no significant impact on bringing down eriophyid mite populations. Infection by the acarogenus fungi, *Hirsutella thompsonii* (F) on coconut eriophyid mite was first reported by Hall *et al.* (1980) and the field use of the fungus showed variable results.

Regular topical spraying of highly toxic insecticides and acaricides *viz.,* monocrotophos, triazophos, carbosulfan, cyhexatin etc. at monthly intervals resulted in variable results on the mite population and nut damage. Therefore, the management of this pest is of great importance to increase the yield potential of coconut in the state and the country as a whole.

Considering the severity and lack of sufficient information on these aspects in the region with reference to coconut eriophyid mite, *A. guerreronis* present investigations were carried out with focus on the following objectives.

i. Documentation of population dynamics of coconut eriophyid mite.

ii. Assessment of damage caused by the eriophyid mite.

iii. Biology of coconut eriophyid mite under laboratory conditions.

iv. Evaluation of the efficacy of synthetic chemicals against the coconut eriophyid mite at field level.

CHAPTER - II

REVIEW OF LITERATURE

Coconut is one of the important plantation crops in the tropical regions. Nearly 110 species of insects, nine species of eriophyid mites, four species of rodents and squirrels have been reported on coconut. Among these about 25 species are considered to cause economic damage to the crop and at present the eriophyid mite - *Aceria guerreronis* (Keifer), has become one of the major pests causing economic losses and threatening to the coconut widely. In recent times, it has become a main constraint in the production of coconut in India.

2.1 POPULATION DYNAMICS

2.1.1 Season and weather parameters

Mariau (1977 & 1986) reported that periods of water deficit result in greater yield losses due to coconut eriophyid mite, possibly because nut growth is slower in dry periods resulting in nuts remaining susceptible for the damage by the mite over a longer period.

Zuluaga and Sanchez (1971) and Griffith (1984) observed that although the pest is present in gardens throughout the year, the populations are more in relatively dry weather. However in some localities, there is no clear relationship between coconut mite population and wet (or) dry weather (Dorsete, 1968; Mariau, 1969 and 1977; Howard *et al.,* 1990). Howard *et al.* (1990) observed that though the coconut eriophyid mite was more predominant in tropical and sub-tropical regions, it was able to survive both short period of the frost and some prolonged periods of temperature just above zero.

Haq (1999) reported that the population of *A. guerreronis* in Trichur district of Kerala increased slightly from July to August and then declined upto October, a slow increase in population occurred from October - December, accelerated from December - March - April, then the mite population decreased during May - July. He concluded, the existence of a positive relationship between the dry climate during summer months and mite population and negative relationship between the rainfall during monsoon and mite population.

According to Vidyasagar (2001) the peak population of mite occurred during summer (or) dry periods in Kerala. Similar results have also been reported from Chittoor district of Andhra Pradesh (Reddy and Naik, 2000).

According to the Department of Agricultural Meteorology, TNAU (2000)

(i) Normal (or) excess rainfall during South west and North - east monsoon reduced the mite incidence.

(ii) Low relative humidity (< 45%) increased mite incidence during summer.

(iii) Summer rainfall (March to May) was critical for the control of mites in the subsequent months. If the rainfall was lower than the normal, the bunches produced in the subsequent months incidence is higher.

Varadarajan and David (2002) reported that the seasonal incidence of the mite is unpredictable; even though it was correlated with factors like temperature, rainfall and wind velocity.

2.1.2 Population sampling

Generally eriophyoids are not distributed evenly on all parts of their host plants (Muraleedharan *et al.*, 1998). Therefore various methods are employed to count the mite number in an unit area.

Youthers and Miller (1934) using a counting template of 0.05 inch square cut in a piece of paper to estimate the densities of citrus rust mite, *Phyllocoptruta oleivora*. An imprint of mites on an absorptive paper to get a semi-permanent record of all stages of the mite (Jeppson *et al.*, 1975) (or) to embed them on a cello - tape (Mathew *et al.*, 2000; Girija *et al.*, 2001) has been employed by various workers. A combination of alcohol and ultrasonic vibration was used by Ramarethinam *et al.* (2000b) to sample the populations of *A. guerreronis*. A glycerine drop trap (GDP) method was used to estimate the populations of *A. guerreronis* (David and Varadarajan, 2001). Populations of *A. guerreronis* also counted by using "nematological counting dish" (Ranjith 2001).

2.2 DAMAGE ASSESSMENT

To calculate the extent of damage by the mite *A. guerreronis* on coconut various scientists classified (or) graded the coconuts based on the visual observation and injury caused by this mite.

Mariau (1979) classified the nuts into 5 categories based on injury by mites, distortion and size of nuts.

(1) Nuts with no mite damage (0%)

(2) Nuts with superficial damage (1-10%)

(3) Nuts with significant mite damage but not much smaller (11-25%).

(4) Nuts with significant mite damage, smaller and with some distortion (26-50%).

(5) Nuts very heavily attacked, very much reduced in size and often greatly distorted (51-100%).

Moore *et al.* (1989) proposed damage scoring of the green nuts (about four months after fertilization of flower) into five categories.

Scale	Intensity of damage	Visible area damaged
1	None	0%
2	Low	1-10%
3	Medium	11-25%
4	Severe	26-50%
5	Very sever	51-100%

Muralidharan *et al.* (2001) graded the 7 months old nuts into 4 grades depending on the infestation i.e.,

(i) Free

(ii) Grade - 1 (less half the portion of the nuts exhibit the symptoms of mite damage)

(iii) Grade 2 (More than half the portion of the nut is damaged and may also be deformed).

(iv) Grade -3 (Deformed nuts which are apparently barren).

Varadarajan (2004) has developed a five - grade score that can be used to assess the damage to both the green and dry nuts.

Grade	**Injury level**
0	Nut surface plain and fresh without an inury.
1	Scarification on the drupe surface in random and / or triangular patches.
3	Contiguous (or) discontiguous on one-fourths of the drupe surface down the perianth.
5	Contiguous (or) discontiguous scarification on half of the drupe surface down the perianth.
7	Contiguous (or) discontiguous scarification, either on the three - fourths of the drupe surface with (or) without fissures and / or gummosis (or) on less than three fourths the surface with fissures and / or gummosis with (or) without deformation.

2.2.1 Influence of mite infestation on minerals

Satyavati Krishnakutty (1995) analysed that the matured coconut water contained 5.4% total solids, 3% soluble sugars, 0.5% minerals, 0.1% protein, 0.1% fat, 60 mg per cent acidity and pH 5.2. The corresponding value for tender coconut water (7 months old) 6.5%, 5.7% , 0.6%, 0.1%, 0.07%, 120 mg per cent and 4.5.

Geethalakshmi and Rabindra (2000) found that the amount of reducing sugars (glucose) in healthy nuts were more with less peroxidase.

According to Bopaiah *et al.* (1996) potassium plays a key role in the activation of enzymes and in plant growth and development and the husk of coconut is rich in potassium. The coconut plants requires large quantities of potassium.

Potassium increases the resistance of coconut from the attack of diseases and pests. Potassium contributed 25-39% increase in copra content. Potassium deficiency would result in poor quality of nut and kernel (Kamalakshmi *et al.*, 1999).

2.2.2 Nut components

Sujatha and Chalapathi Rao (2004) reported that due to mite infestation, the economic value of product, copra, was reduced by 49.1% with a decrease in oil weight by 36.9% . Mite infestation resulted in 49.2% reduction in dehusked nut weight with a corresponding decrease in nut size (46.83%), while nut weight (27.93%) and husk weight (6.73%). The circumference of nut, meat weight, meat thickness and shell thickness were reduced by 31.78, 48.59, 2.5 and 16.66% respectively.

Ambily Paul and Thomas Biju Mathew (2004) reported that the damaged nuts coming under category 5 took maximum time for dehusking 100 nuts (75 minutes) followed by nuts in 4^{th} and 3^{rd} categories (58.3 and 50 min. respectively). Additional time taken for dehusking the damaged nuts coming under category 5, 4 & 3 over uninfested nuts was 41.75, 25.05 and 16.75 min. respectively.

Varadarajan and David (2004) reported that the morphological qualities of the just harvested drupes such as length, girth and weight or drupes, husk (mesocarp) weight and nut (endocarp + endosperm) weight decreased by 11, 23, 27, 29 and 29 per cent respectively, due to mite infestation.

2.3 BIOLOGY

The coconut mite is minute, measures 205-255 µm in length and 20-30 µm in width; the body is elongate, worm like, with two pairs of legs (Keifer, 1965). Ramarethinam and Marimuthu (1998) reported that the mite passes through two nymphal and an adult stage, which are completed in about seven days. The mite takes 7-10 days to complete its development from egg to adult (Mariau, 1977; Haq, 1999 and Vidyasagar, 2000).

Ramarethinam and Loganathan (2000) studied the life cycle of *A. guerreronis* under the laboratory condition. An average of 10.50 days was required for complete development from egg to adult stage. The mean developmental period of various life stages was : Eggs - 2.60 ± 0.49 days, protonymphs - 3.50 ± 0.67 days Deutonymphs, 4.40 ± 0.42 days ; the adult longevity was : 8.20 ± 1.40 days and 15.30 ± 2.70 days for male and female respectively. The female deposited 1.56 eggs per day with total of 18.50 eggs in her life time of 15-17 days.

A. guerreronis was elongated and worm like in appearance, body is finely ringed and beset with bristles. The adult measured about 250 µ in length and had two pairs of legs towards the anterior end of the body. The life cycle is completed in 7-10 days and adult female laid about 200 eggs (Chandrika Mohan and Nair, 2000).

Haq (2001) studied the life history of coconut eriophyid mite at 28 ± 1°C and 70-75% RH. The eggs are small, round glittering and laid singly one after another. The incubation period ranged for 3-3.5 days. The first instar nymph lasted for 1.5-2 days and at the end the body became swollen, spindle shaped and inactive. The inactive (or) quiescent period lasted for 1-1.5 days. The second nymph was pale white, elongated vermiform and lasted for 2.0 - 2.5 days. There was also one more quiescent (inactive) stage observed between the second nymph and the adult emergence. The post embryonic periods lasted for 8.0 - 10.5 days.

2.3.1 Rearing techniques

For rearing of the *A. guerreronis*, tender and succulent discs of coconut (1 cm diameter) free from insect and mite damage were cut and used successfully under laboratory condition. The discs were placed to keep the upper surfaces in contact with tender coconut water in small plastic cups (12 cm diameter). The tender coconut water was changed daily to keep the discs fresh which help to rear the mite for longer period. Mites were moved to fresh, tender and succulent perianth discs, whenever it was found necessary (Ramarethinam and Loganatham, 2000).

Haq (2001) reared the *A. guerreronis* by using culture rings. These culture vessels are made up of Borosil (or) Perspex glass. Commercially available Borosil glass rods of 5 cm diameter were bored and cut as rings with diameter of 2.5, 3.0, 3.5 and 4.0 cm with a height of 1.5-2.5 cm and thickness of 0.5-1 cm. Cover glasses of 1mm thickness were suitably cut and used as lids for the culture vessels. The culture rings were fixed at the meristematic zone of nut with the help of plasticine (or) paraffin wax. After introducing the mites, a drop of water is placed at the mouth of culture rings to secure the cover glass in position. This arrangement considerably helps in observing the behaviour of individual stages of mite through the cover glass.

2.4 MANAGEMENT

2.4.1 Host plant resistance

Mariau (1977 and1986, Moore, 1986; Howard and Rodriquez, 1971) reported that the infestation of *A. guerreronis* is less in tightly adpressed tepals with rounded nuts than elongated ones. Hybrids (Dwarf x Tall) were more tolerant to *A. guerreronis* (Taffin *et al.*, 1991). According to Moore and Alexander (1990), the trees with dark green inflorescence generally had less damage than other trees. But David *et al.,* (2000) found that dark green nuts were most susceptible.

The post fertilization third - bunch mite population was much lower on the nuts when the perianth cleft angle (PCA) was wider (> 135°) than that on the nuts when the perianth cleft angle was narrower (<135°) (David *et al.,* 2000; Varadarajan, 2000).

Muthiah and Bhaskaran (1999) reported that various genotypes such as Lakshadeep ordinary, Cochin China, Andaman ordinary, British Solomon island, Ayiramkachi, Spicata and Gangabondam were found to be tolerant to coconut eriophyid mite attack. But the genotypes, seyshelles and St. Vincent were found to be highly susceptible to mite damage. Paul *et al.*

(2002) reported that high mite incidence (or) damage observed in varieties like Komadam followed by west coat tall (WCT), Laccadive ordinary and T x YD, but less damage was observed DO (Dwarf orange). Yellow types were highly susceptible than green types. The palms which are present at the middle of the garden recorded the highest infestation followed by northern side. The minimum incidence was recorded in the trees found in southern side (Chezhiyan and Ramar, 2000).

2.4.2 Cultural practices:

Long periods of water deficit resulted in yield losses due to coconut mite, under certain conditions (Mariau, 1986 and 1997), because fruit growth is slower during dry periods. Well maintained trees, with appropriate fertilizer application were found to suffer less mite attack. Moore *et al.* (1991) reported that *A. guerreronis* damage in general increased with increasing levels of nitrogen and decreased with increase in potassium levels.

Kannaiyan *et al.* (2002) reported that crown cleaning and water spray method was found to reduce with infestation as compared to uncleaned trees.

2.4.3 Biological control

The coconut eriophyid mites *A. guerreronis* are not prone to number of natural enemies (Predators and pathogens) like other arthropod pests because it lives in very concealed part of nut i..e beneath the perianth of nuts there by limits number of natural enemies.

2.4.3.1 Predators

Moore and Alexander (1987) observed that predators could attack *A. guerreronis* during dispersal, which occurs regularly. Hall *et al.* (1980) and Howard *et al.*(1990) observed predaceous mites on infested coconuts occasionally and was very small populations, but found no evidence that they make significant impact on coconut mite populations.

Effective natural enemies observed on the coconut mite, include two unidentified phytoseiids, a tarsonemid (Julia and Mariau, 1979) and *Bdella distincta* Baker and Balock; *Amblyseius lagoensis* Muma; *Neoseiulus mumai* Denmark and *Neoseiulus paspalivorus* Deleon (Howard *et al.*, 1999).

Hall *et al.,* (1980) recorded two species of *Lupotarsonemus* feeding on all stages of *A. guerreronis*, but these appeared to have only very minor effect on populations of the mite.

The association of other arthropods within the ecological limit of *A. guerreronis* was reported from chalcidoidea (Morgan and Hedlin,1960; Mezei,1965), Ceccidomyiidae Diptera, Coleopteran staphylinid (Perring and Mc Murthy,1996; Ocete and Skuthrava, 1996) and these organisms had no significant impact on reduction of coconut eriophyid mite population (Hall and Espinosa, 1981).

2.4.3.2 Pathogens

The acaro-pathogens are self perpetuating, due to their versatility and convenience to formulate into products, these are best agents for mite biological control. The pathogen *Hirsutella nodulosa* Petch, has been reported from cuba acts as a potential bio-agent. Sporulation is an important factor for achieving high kill of the mites under field conditions (Moore *et al.,* 1989). Hall *et al.* (1980) reported that under natural conditions, *H. thompsonii* could assume epizootic status among the mites present below the bracts of coconuts. All the strains of *H. thompsonii* have been pathogenic to *A. guerreronis* (Hall *et al.,* 1980; Ramarethinam *et al.,* 2000 a, b, c ; Ramarethinam and Marimuthu, 1998; Moraces, 2000).

The combination of treatment involving nimbicidine and the biocontrol agents *H. thompsonii, Verticillium lecanii* and *Paecilomyces* sp in the laboratory condition were found encouraging in the control of *A. guerreronis* (Ramarethinam *et al.,* 2000).

The fungus *Sporothrix fungorum* caused epizootic development of *A. guerreronis* in Karnataka (Sreeramakumar *et al.,* 2001).

Flourescent pseudomonas acts as potential biocontrol agent against *A. guerreronis*. Talc based formulation of isolates (10^{10} cells / g) was sprayed at 5% and 1% concentration on "first size" excised nutlets (90-110 days after opening of spadix) already colonized by the mites. (Sivaprasad *et al.,* 2002).

The combined treatments involving combinations of culture filterates of *Streptomyces avermitilis*, culture filterates of other entomopathogens like *Beauveria basiana, Verticillium lecanii* and *Paecilomyces fumosoroseus,* the spot crown application with *H. thompsonii* formulation in conjunction with neem oil formulation. Nimbicidine was effective against *A. guerreronis* (Ramarethinam *et al.,* 2003).

2.4.4 Chemicals

Spraying of mancozeb had slow effect on *A. guerreronis* (Julia and Mariau, 1979). Stem injection of vamidothion gave mixed results (Childers *et al.,* 1996). Monocrotophos was used to control several eriophyid species (Childers *et al.,* 1996), including *A. guerreronis* on coconut (Mariau, 1977; Hernandez, 1977; Childers *et al.,* 1996; Fernando *et al.,* 2000; Ramaraju *et al.,* 2000).

Two to three sprayings with neemoil - garlic emulsion 2% (20 ml neem oil + 20 g crushed garlic + 5 g soap in one litre of water) or dicofol 0.1% 1-2 litre / palm covering all bunches and inflorescence were recommended (Mathur Kutty, 1998). Administration of triazophos, monocrotophos (or) dicofol concentration @ 5ml/l through root after the harvest of mature nuts was also recommended (Ramarethinam and Marimuthu, 1998).

Muthiah and Bhaskaran (1999) reported that spraying methyl demeton at 4ml (or) triazophos at 5 ml per litre of water at 7 to 10 days interval reduced mite infestation.

Vidyasagar (2000) observed that root feeding with monocrotophos at 10ml per palm with equal quantity of water at monthly intervals, provided adequate control of mite infestation. However, spraying either dicofol at 6 ml per litre of water (or) 2 per cent neem oil + garlic mixture at monthly interval, gave a reasonable control of the coconut mite (Vidyasagar, 2000; Reddy and Naik, 2000).

Ramaraju *et al.* (2000) reported that root feeding with 15 ml of monocrotophos + 15 ml of water once in 45 days interval significantly reduced the mite population. Dey *et al.,* (2001) reported that fenazaquin as root feeding @ 10 ml per palm and for spraying 200-250 ml / 100 litres of water were found to be effective for controlling the mite population and safer to predatory mite, *Amblyseius* sp.

Recently Dey and Somachodhary (2001) reported that the root feeding of fenpyroximate 5 EC @ 10ml / palm and spraying of 0.75-1 ml /l of water was more effective in checking the eriophyid mite populations.

The root feeding of monocrotophos (20 ml + 20 ml water) was the most effective treatment with 89% decrease in mite population followed by fenazaquin (1 ml + 10 ml water) and fipronil (20 ml + 20 ml water) with 78 and 71% decrease, respectively (Sujatha *et al.,* 2004).

Sujatha and Chalapathi Rao (2004) reported that spraying of chemicals like sulphur 80% WP @ 6 g/l, profenophos 50% EC @ 5 ml/l and triazophos 40% EC @ 5 ml/l were observed to be effective over 95.74, 78.94 and 78.45% reduction in mite count respectively 6^{th} day after treatment. Spraying of neem formulations Achook - 1500 ppm (5 ml /l) and NSKE - 50 ml/l recorded 28% and 27.36% decrease of mite population.

CHAPTER - III

MATERIALS AND METHODS

The studies on Coconut Eriophyid mite (CEM) *Aceria guerreronis* (Keifer) were carried out in the coconut gardens, around Tirupati from August 2003 to January 2004. The nut samples were removed from coconut palms and placed in individual polythene bags and brought to the Department of Entomology, S.V.Agricultural College, Tirupati. In the laboratory, observations were made on mite numbers and various stages of mite viz, egg, nymphal and adult stages and bioagents under a stereo-binocular microscope.

The materials used and methodologies adopted in the present study are summarized here under.

3.1 POPULATION DYNAMICS

3.1.1 Seasonal abundance

Studies on the population dynamics of the eriophyid mite were carried out at the coconut field - Pudipatla, Tirupati. The palms selected belonged to "East coast tall" variety of 12 years old.

A preliminary survey was made in the garden for fixing the trees suitable for the population studies. The incidence and severity of the mite on all the trees were recorded. Five palms were selected for the study; palms bearing maximum number of damaged nuts on the three to four months old bunches were selected and marked. One infested nut was selected from fourth bunch of each of these palms.

In the laboratory, tepals (bracts) were removed from the nut. The mites present in the inner three tepals were recorded as inner whorl mites and the mites present in the outer three tepals (bracts) were recorded as outer whorl mites. The mites were recorded in one square centrimeter area of randomly selected tepals under stereo binocular microscope. The observations on predatory mites of coconut mite were also recorded during each sampling.

The weather parameters were obtained from the College meteorological observatory.

Distribution pattern of *A. guerreronis*

To study the distribution pattern of *A. guerreronis* in the field three palms of 6-8 meters height were selected randomly in each direction with the bunch (3 months old) facing the direction of North, West, South and east of the plantation. There are three observations were made from each tree. Five nuts (3 months old) were collected from each tree in each observation.

3.2 DAMAGE ASSESSMENT

To study the extent of damage, a survey was conducted during September 2003 to May 2004. Damage assessment were made in four geographical regions (or) mandals viz., Chandragiri, Puttur, Chittoor and Palamaner of Chittoor district of Andhra Pradesh.

One hundred nuts were randomly selected irrespective of the nut age i.e., from 4-7 months. The selected nuts were classified at the market based on the classification scale of Moore *et al.* (1989).

Scale	Intensity of damage	Visible area damaged
1	None	0%
2	Low	1-10%
3	Medium	11-25%
4	Severe	26-50%
5	Very severe	51-100%

3.2.1 Analysis of quality parameters in tender coconut water

Minerals like phosphorus, potassium and reducing sugars in the tender coconut water were analysed to determine the influence of mites on the nuts.

Determination of Phosphorus

Determination of phosphorus in coconut water was done by ascorbic acid method by Murphy and Riley (1962).

Reagents

Solution A :

One gm of ammonium molybdate weighed and 0.02 gm of potassium antimony tartarate was added in 1000 ml measuring flask. 16 ml of conc. H_2SO_4 added slowly by touching outlet point of measuring cylinder to the inner neck of the flask. Distilled water added slowly dissolved the contents of shaking and made upto the mark.

Solution B

0.88 gm of ascorbic acid weighed and dissolved in one litre of solution A.

Standard phosphate solution :

0.2195 g of anhydrous KH_2PO_4 dissolved in water and diluted to one litre.

Procedure

10 ml of coconut water sample and standard phosphorus solution were pipetted out in 50 ml conical flask. 10 ml of reagent B was added, volume made upto 50 ml with distilled water and kept for 30minutes. Absorbance of the colour measured at 660 nm wave length. Graph was drawn for the standard phosphorus solutions and plotted the straight line relationships. Read the phosphorus concentration of unknown water samples from this graph in µg/ml.

Calculations,

$$P, mg/l = \frac{\text{mg in P}}{\text{ml sample}} \times 1000$$

Determination of Potassium

The potassium content of coconut water was determined by flame photometry method (Systronic model-121) (Jackson 1967).

Preparation of standard graph

191 mg of KCl weighed and dissolved in distilled water. The volume made upto one litre. This serves as potassium stock solution. For preparing working standard solutions of 0, 2, 4, 6, 8 and 10 ppm, pipetted out the same volume in each case into 100 ml measuring flask and made upto 100ml mark. Readings were taken at galvanometer and prepared the standard graph.

Determination of reducing sugars (glucose)

The amount of reducing sugars present in the coconut water was determined by Dinitrosalicylic acid method (Miller, 1972).

Procedure

100 ml of coconut water was taken and the sugars are extracted with hot 80% ethanol. The supernatants were collected and evaporated it by keeping it on a water bath at 80°C. 10ml of water was added and dissolved

the sugars. Aliquot were pipetted out (0.2, 0.4, 0.6, 0.8 and 1 ml) and volume made up to 2 ml with distilled water. 2 ml of distilled water pipetted out in a separate tube (blank) one ml of alkaline copper tartarate reagent was added and placed the tubes in boiling water for 10minutes and 1ml of arsenomolybdic acid reagent was added and volume made upto 10ml in each tube with water. Read the absorbance of blue colour at 620 nm after 10 min. Standard graph was drawn and amount of reducing sugar was calculated.

The tender coconut water standardized to different concentrations i.e. from 10% - 100% by using distilled water. The 50% concentrated solution was taken for all the analysis.

3.2.2 Nut component analysis

Variation in morphological parameters like length, girth, perianth radius were analysed (or) measured by using twine then that was measured by using scale and components like total nut weight, husk weight, husked nut weight, shell weight, copra weight and water weight also recorded by weighing balance and analysed between the mite infested nuts and healthy nuts. The nuts of 7 month old were collected from the field and were graded into four based on the severity of infestation.

i.e.
(i) Free
(ii) Grade - I (< half the portion of nut exhibit damage symptom)
(iii) Grade - II (> half the portion of nut damaged and also may be deformed)
(iv) Grade - III (deformed nuts which are apparently barren).

In each grade mean of 10 nuts were taken.

Biology

To study the biology, three to five months old nuts were collected from the coconut garden, Pudipatla. The nuts were brought to the laboratory and the tepals were removed from the nuts. The fresh and very succulent perianths were selected and cut into bits of 2.0 cm diameter. The upper surface of bits were placed in the petridish (10 cm diameter) (Plate 1) containing tender coconut water. The well developed and swollen abdomen females were selected and transferred individually onto the discs with the help of eye brow hair brush. The eye brow hair has very sharp end, helps to pick the desired, single female by inserting the eye-brow hair on the stick

(0.2 cm diameter and 10-15 cm length) having molten wax. Twenty five replications were kept. 40 adult females were released on the discs. After releasing the female, observations were recorded at periodical intervals to study the egg laying of female, egg hatching and development of nymphal stages to adult. Tender coconut water changed daily to keep the discs fresh.

The adult longevity, fecundity and the morphometrics like length, width of the developmental stages of mite were also recorded. Biology and morphometrics were studied in laboratory at 28 ± 2°C temperature and 60 ± 5% humidity during March 2004.

Efficacy of chemicals against *A. guerreronis*

The efficacy of different groups of chemicals was evaluated against the eriophyid mite in the field conditions at Gollapallae village, near Chittoor. The garden had more than 500 palms with different age group ranging from 10-15 years with east coast tall variety.

Table 1 : Details of pesticides used in the experiment

S. No.	Common name	Formu-lation	Trade name	Concen-tration (%)	Dosage
1.	Vertimec	1.9% EC	Abamectin	0.005	2.6 ml/l
2.	Vertimec	1.9% EC	Abamectin	0.0025	1.3 ml/l
3.	Lambda cyhalothrin	50% EC	Karate	0.005	1 ml/l
4.	Monocrotophos	36% SL	Monophos	0.05	1.4 ml/l
5.	Profenophos	50% EC	Curacron	0.05	1 ml/l
6.	Thiomethoxam	25% WG	Actara	0.06	0.24 g/l
7.	Micronised wettable sulphur	80% WW	Thiovit	0.3	3.7 g/l
8.	Phasalone	35 EC	Zolone	0.077	2 ml/l
9.	Dicofol	18.5 EC	Hexakel	0.09	0.4 ml/l
10.	Profenophos-40 EC + Cypermthrin - 4 EC	C44	Polytrin	0.04	1 ml/l
11.	Water spray (control)				

To spray the chemicals, the trees having 4months old bunches were selected. The chemicals (Table 1) were sprayed as per dosages with the help of hand sprayer on the bunches (Plate 2). Before spraying, pre sampling was made by plucking the nut from each bunch under each treatment and the number of mites present in a cm^2 area are taken as pre - counting and 2, 5 and 7 days after spraying as post - counting. The reduction in number of mites (or) mite population per unit (cm^2) area taken as the criteria to evaluate the efficacy of chemicals.

Statistical analysis :

Efficacy of the treatments was assessed by the mean per cent reduction of the population of mites, (both nymphs and adults) with reference to untreated control was calculated by using the following formula.

Per cent population reduction

$$= \frac{\text{Population in untreated check - Population in treatment}}{\text{Population in untreated check}} \times 100$$

The data were analysed through simple randomized block design. The critical difference was worked out for significant treatment and was utilized for comparing the treatment.

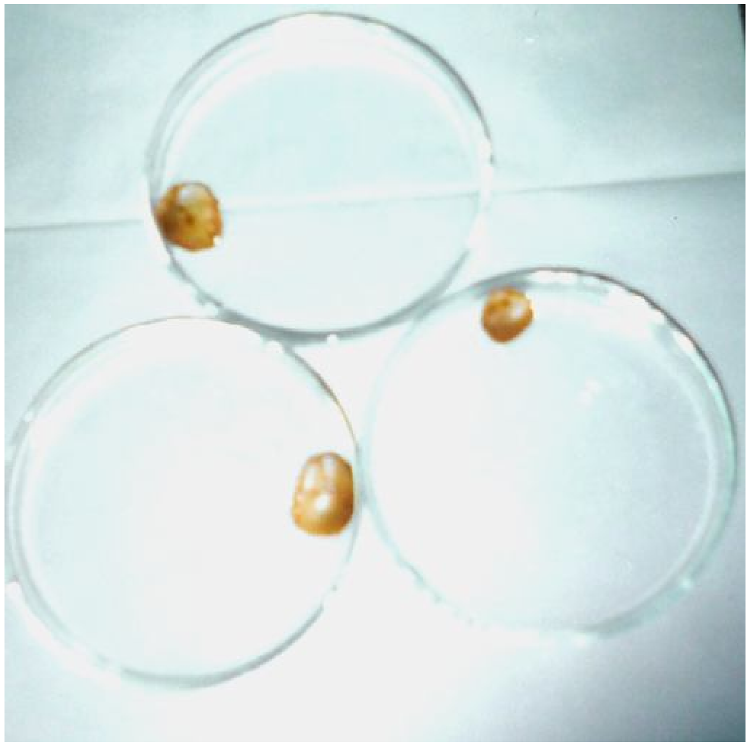


Plate 1 : Rearing technique of *Aceria guerreronis*


Plate 2 : Spraying of chemicals on the tree bunch

CHAPTER - IV

RESULTS

The results obtained from various field experiments and laboratory studies on population dynamics, damage assessment, biology and efficacy of chemicals against *A. guerreronis* are presented here under.

4.1 POPULATION DYNAMICS (Seasonal abundance)

Observations on the incidence of mite population were recorded at fortnight interval from August 2003 to May 2004 at Pudipatla, Tirupati.

During this period, the information regarding nymphs, adults and total population of coconut eriophyid mite and bioagents (predatory mites) (Plate 3) were recorded. The abundance of eriophyid mite with respect to bioagents (predatory mites) and weather parameters like maximum temperature, minimum temperature, relative humidity, rainfall, sunshine and wind velocity were analysed.

The mite population was high during second fortnight of March 2004 (52 / cm^2) to first fortnight of April (55 / cm^2) in the inner whorl of perianth. The total population in the outer whorl perianth was high during second fortnight of March - 2004 (43 / cm^2) to first fortnight of April - 2004 (45 / cm^2). The lower level of mite population in the inner whorl perianth during first fortnight of December - 2003 (18 / cm^2) and in the outer whorl perianth (12 / cm^2). A slow and steady increase of mite population from end of December - 2003 to first fortnight of April 2004 in both the whorls and a slow decline was observed between end of April-2004 to May-2004. Thus, the fluctuations on inner and outer whorl perianth showed similar trend (Table 2).

4.1.1 Inner whorl of perianth

4.1.1.1 Nymphs

The correlation between the abundance of nymphs and predatory mites wasfound to negative (r = -0.386). A highly positive significant and significant positive relationship between the nymphs and maximum temperature (r = 0.844) and minimum temperature (0.472). There was highly significant negative correlation between nymphs and rainfall (r = -0.189). Whereas correlation between the nymphs and sunshine hours highly significant positive (Table 3, Fig. 1).

The regression equation results predicted that an increase in maximum temperature by 1°C would increase the abundance nymphs by 0.9 mite/ cm^2 and an increase of sunshine by one hour would lead to increase in nymphs abundance by 1.88 / cm^2 (Table 4).

4.1.1.2 Adults :

There was highly significant positive correlation between the adults and maximum temperature (r = 0.944), minimum temperature (r = 0.607) and sunshine (r = 0.506). The correlation between the adults and rainfall (r = 0.224) and wind velocity (r = 0.280) was positive and negative relation with the predatory mites (r = -0.187) and significant negative relationship with the relative humidity (r = -0.427) (Table 3, Fig. 2)

The regression equation results predicted that an increase in maximum temperature by 1°C would increase the adult abundance by 1.523 / cm^2 and increase in minimum temperature by 1°C would increase the adult abundance by 0.109 / cm^2 (Table 4).

4.1.1.3 Total population

Highly positive and significant correlation between the total population and maximum temperature (r = 0.926), minimum temperature (r =0.591) sunshine (r = 0.644). Positive relationship with rainfall and wind velocity. Whereas, highly significant negative relationship with predatory mites (r= -0.271) and highly significant negative relationship with relative humidity (r = -0.497) were observed (Table 3, Fig. 3).

The results predicted through regression equation reveals that an increase in maximum temperature by 1°C would increase the total mite population by 2.310 / cm^2 and increase in sunshine hour, would increase the total mite population by 2.85 / cm^2 and 1°C increase in minimum temperature, would increase the total mite population by 0.26 / cm^2 (Table 4).

4.1.2 Outer whorl of perianth

4.1.2.1 Nymphs

Nymphs present in the outer whorl of perianth are highly significant positive correlation with maximum temperature (r = 0.951) and minimum temperature (r =0.68). Positive relationship with rainfall (r = 0.122) sunshine (r = 0.416) and wind velocity (r = 0.1150) where as with predatory mites (r = -0.207) was negative and significant negative relationship with relative humidity (r = -0.463) (Table 3, Fig. 4).

The regression equation results predicted that an increase in temperature by 1°C would increase the nymphs abundance by 1.431 / cm^2 and minimum temperature by 0.3 nymphs / cm^2 (Table 4).

4.1.2.2 Adults

The adults of outer whorl perianth showed highly significant positive correlation with maximum temperature (r = 0.930) and minimum temperature (r = 0.680). Positive relationship with rainfall (r = 0.098), sunshine (r = 0.294) and wind velocity (r = 0.164). Where as negative relationship with predatory mites (r = -0.352) and relative humidity (r = - 0.358) (Table 3, Fig. 5).

The regression equation results predicted that an increase in maximum temperature by 1°C, would increase the abundance of adults by 0.075 / cm^2 (Table 4)

4.1.2.3 Total population

There was highly positive significant relationship between the total population and maximum temperature (r = 0.952) and minimum temperature (r = 0.543). Positive relationship with rainfall (r = 0.122), sunshine (r = 0.459) and wind velocity (r = 0.207), whereas, for predatory mites (r = -0.356) was negative and for relative humidity (r = -0.536) was significant negative (Table 3, Fig. 6).

The regression equation results predicted that, an increase in the maximum temperature by 1°C would increase the total mite population by 2.59 / cm^2, increase in rainfall increase mite population by 0.278 / cm^2, and increase in wind velocity one kilometer per hour would increase the total mite population by 0.0475 / cm^2 (Table 4).

4.2 INFLUENCE OF HEIGHT OF THE PLANT AND LOCATION OF THE PLANT IN THE DISTRIBUTION PATTERN OF *A.guerreronis* IN THE FIELD

The distribution pattern of *A. guerreronis* in the field indicated that the mite population per unit area varies with respect to the height of tree and direction (Table 5, Fig. 7). The maximum number of mite population per unit area observed in the palms which were in the Eastern part of the field i.e., ranging from 16-58 with an average of 40.3 / cm^2, followed by the palms which were in North direction. The average number of mites 35.6 / cm^2 ranging from 13-50. The minimum number of mites recorded in the palms which were in west direction. The number of mites ranging from 1 to 7. With an average of 2.3 mites /cm^2 and the height of the tree also influences the abundance of mite population. It was observed that the maximum number of mite observed in the tree which are 7.7 m height but declined towards decrease in height of tree and slightly decreased towards the increase in height of tree.

4.3 DAMAGE ASSESSMENT

Survey conducted at coconut market, of different mandals of Chittoor revealed that the severe damage percentage was more during summer season (IV and V scale) of the year (March - May, 2004) in all the mandals of Chittoor district (Plate 4-8). The damage percentage ranging from 57.2 to 75.7. The highest percentage of damage were recorded at Puttur 75.76.

During winter (November, December, January) the highest percentage of damage were recorded at Palamaner (75.4%) and lowest percentage at Chandragiri (56.0%) and at Chittoor (57.7%), Puttur (58.5%). In total, the highest per cent of damage was observed (summer + winter) at Puttur (67.1%) with severe damage (scale IV & V) 32.15%, followed by Chittoor recorded the highest percentage of damage (65.12%) with severe damage of 31.45%. The lowest percentage of damage recorded at Chandragiri (56.6%) with the severe damage of 20.11%. The corresponding recorded value for Palamaner was 62.11% and 21.26%.

4.3.1 Influence of mite infestation on the minerals (P & K) and reducing sugars in tender coconut water

The analysis of minerals (Potassium and Phosphorus) and reducing sugars in tender coconut water with respect to different damage categories indicated that there was negative relationship between the abundance of minerals and sugars towards the severity of damage (Table 7). There was relatively high abundance of phosphorus, potassium and reducing sugars (glucose) in the normal nuts i.e., damage % - 0 (None) A gradual reduction of these parameters from zero per cent damage to more than 50% damage. In the very severely damaged nuts i.e, damage percentage 51-100 the phosphorus, potassium and reducing sugars was 50.60 ppm, 49.60 ppm and 130.30 (mg/100 ml) respectively. The corresponding values for normal nuts (zero percentage damage) was 66.73 ppm, 70.66 ppm and 201.30 (mg / 100 ml). Thus, the reduction of phosphorus from 66.73 ppm to 50.60 ppm (24%), potassium from 70.66 ppm to 49.60 ppm (29.8%) and reducing sugars from 201.30 (mg/100 ml) to 130.30 (mg/100 ml) (35.2% with) respect to scale-1 (zero per cent damage) to scale - 5 (> 50% damage).

4.3.2 Nut component analysis

The analysis of matured nuts (more than 7 months old) reported that the morphological factors of the drupe like length, girth and perianth diameter declined in case of infested nuts (Grade - I to Grade - III) with respect to healthy nuts. The per cent reduction ranges from 15-46, 17-47.5, 25-60 respectively in length, girth and perianth diameter and the reduction percentage in weight of nut, weight of husk, weight of husked nut, weight of shell, weight of copra and coconut water with ranging from 18-43, 30-61.5, 26-56, 17-29, 18.75-35.37, 15-55 respectively in the Grade - I to Grade - III nuts (Table 8, Fig. 8).

4.4 BIOLOGY OF COCONUT ERIOPHYID MITE - *A. guerreronis*

Biological studies of *A. guerreronis* were carried out on tender and succulent perianth disc of coconut. The data regarding the measurements and developments viz., egg, protonymph, deutonymph, adult longevity (both male and female) and pre-oviposition, oviposition, fecundity and post-oviposition periods of female were recorded and presented in the Tables (9, 10, 11).

4.4.1 Egg :

The eggs are minute, globular, shiny and laid singly one after another (Plate 9). Fresh eggs are transparent, before hatching, it turns into milky white colour. The egg measured 58 µ (55-60) in length and 29 µ width (Table 11). The average egg period was 2.5 ± 0.5 (2-3) days, under laboratory conditions (Table 9).

4.4.2 Protonymph

Very small, sluggish and transparent (Plate 10). It measures on average of 57.5 µ (55-60 µ) in length and 28.14 µ (26.3-30.67 µ) in width (Table 11). The protonymph stage lasted for an average period of 3.6 days (Table 9).

4.4.3 Deutonymph

Deutonymph are pale white in colour, elongated and vermiform (Plate 11). It actively feeds on the cell - sap which measures about 47.5 µ (44-54 µ) in length and 23.8 µ (21-26.5 µ) in width (Table 11). The Deutonymph lasted for an average period of 4.42 days (Table 9).

4.4.4 Adult

The adult stage of the mite was vermiform and pale in colour (Plate 9). Male mite was smaller than female. The adult mites were creamy like appearance and bear two pairs of legs towards the anterior end of body. Adult male measures on an average of 138 µ (131-145 µ) in length and 26.5 µ (25-28 µ) in width. The females laid the eggs singly, with an average of 12 (9-15). The female adults measures an average of 200-205 µ length and 30-35.3 µ width (Table 11).

4.4.5 Quiscent stages

During the biological studies of *A. guerreronis* there was two quiescent stages recorded. The first stage between proto and deutonymph. The second stage between the deutonymph and adult emergence. During the quiescent stages the body become swollen and inactive.

4.4.6 Post developmental periods and fecundity of *A. guerreronis*

After moulting into an adult, there was no egg laying was observed for a period of 1.5 - 3.0 days as pre-ovipositional period. Female laid an average of 12 ± 3 eggs during its ovipositional period of 7.5 - 9.5 days. The post - developmental period lasted for an average of 1.9 ± 0.83 (0.75-3.0) days (Table 10).

Table 7 : Influence of mite infestation on the minerals (P & K) and reducing sugars (glucose) in tender coconut water

S.No	Damage category	"P" content (ppm)	"K" content (ppm)	Reducing sugars (mg/ 100 ml)
1	None (0%)	66.37	70.66	201.30
2.	Low (1-10%)	59.00	62.63	194.00
3.	Medium (11-25%)	57.53	57.50	174.66
4.	Severe (26-50%)	53.70	56.16	142.00
5.	Very severe (50-100%)	50.60	49.60	130.30

Table 9 : Biology *A. guerreronis* (keifer) at 28 ± 2°C and RH 60 ± 5%

S.No.	Stages of mite	Range (days)	Mean ± SD
1.	Egg	2.0-3.0	2.5 ± 0.50
2.	Protonymph	2.7-4.2	3.6 ± 0.42
3.	Deutonymph	3.9-4.93	4.42 ± 0.47
4.	Adult male	7.5-9.5	8.3 ± 1.31
5.	Adult female	14.30 -16.80	15.93 ± 0.94

Table 10 : Post development periods and fecundity, of *A. guerreronis* female

S.No.	Description	Range (days)	Mean ± SD
1.	Pre-oviposition (days)	1.5-3.0	1.88 ± 0.61
2.	Ovi-position (days)	7.5-9.5	8.10 ± 0.77
3.	Post-oviposition (days)	0.75-3.0	1.91 ± 0.83
4.	Fecundity (eggs per female)	9-15	12 ± 1.98

Table 11 : Morphometrics of different stages of *A. guerreronis* (Keifer)

Stage of mite	Length (μ)		Width (μ)	
	Range	Mean ± SD	Range	Mean ± SD
Egg	55-60	58.0 ± 2.50	26.3-30.67	28.9 ± 1.62
Protonymph	44-51	47.5 ± 3.5	21-26.5	23.8 ± 2.7
Deutonymh	131-145	138 ± 7.0	25-28	26.5 ± 1.50
Adult male	183-189	186 ± 3.00	30-35	32.5 ± 2.5
Adult female	200-205	202.5 ± 2.5	30-35.3	32.6 ± 2.5

Table 3 : Relationship between abundance of mite population and biotic and abiotic (weather) factors

Stages of mite	Biotic and abiotic factors						
	Predatory mites (no.)	Maximum temperature (°C)	Minimum temperature (°C)	RH (%)	RF (mm)	Sunshine hours	Wind velocity (kmph)
Nymphs on inner whorl	-0.386	0.844**	0.472*	-0.568**	0.189	0.749**	0.420
Adults on inner whorl	-0.187	0.944**	0.607**	-0.427**	0.224	0.506**	0.280
Total population on inner whorl (eggs, nymphs, adults)	-0.271	0.926**	0.591**	-0.497**	0.272	0.644**	0.295
Nymphs and outer whorl	-0.207	0.951**	0.680**	-0.463*	0.122	0.416	0.115
Adults on outer whorl	-0.352	0.930**	0.548**	-0.358	0.098	0.294	0.164
Total population (eggs, nymphs, adults) on outer whorl	-0.350	0.952**	0.543*	-0.537*	0.122	0.459*	0.207

Table 4 : Multiple linear regression between stages of mite on different parts of the nut and biotic and (weather) factors

Part of the nut	Stages of mite	Regression equation	R^2 value
Inner whorl perianth	Nymphs	$Y = 27.703 + 0.299 X_1 + 0.90 X_2 + 0.127 X_3 - 0.08 X_4 -0.0326 X_5 + 1.880 X_6 -0.263 X_7$	0.936
	Adults	$Y = 31.552 - 0.055 X_1 + 1.523 X_2 + 0.109 X_3 - 0.018 X_4 -0.581 X_5 -0.087 X_6 -0.263 X_7$	0.952
	Total population	$Y = -3.472 + 0.374 X_1 + 2.305 X_2 + 0.257 X_3 - 0.091 X_4 -0.575 X_5 + 2.845 X_6 -0.917 X_7$	0.961
Outer whorl perianth	Nymphs	$Y = 31.520 + 0.21 X_1 + 1.431 X_2 + 0.324 X_3 - 0.124 X_4 +0.1367 X_5 -0.05 X_6 -0.0547 X_7$	0.939
	Adults	$Y = 33.132 -0.0414 X_1 + 1.580 X_2 -0.323 X_3 + 0.075 X_4 -0.226 X_5 -0.191 X_6 -0.0120 X_7$	0.914
	Total population	$Y = -43.237 + 0.0358 X_1 + 2.594 X_2 -0.075 X_3 -0.158 X_4 +0.278 X_5 -0.225 X_6 + 0.047 X_7$	0.934

Independent variables

X_1 = Predatory mites (nos.)
X_2 = Maximum temp (°C)
X_3 = Minimum temp (°C)
X_4 = Relative Humidity (%)
X_5 = Rainfall (mm)
X_6 = Sunshine (hours)
X_7 = Wind velocity (kmph)

Table 6 : Damage scale recorded from different mandals of Chittoor
(Total number of nuts observed →100 nuts / mandal)

Season	Chittoor					Chandragiri					Puttur					Palamaner				
	Scale					Scale					Scale					Scale				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Winter (Sept. Oct. Nov. Dec. & Jan.)	42.3	23.11	11.9	12.56	10.13	44	21.89	16.21	11.6	6.3	41.5	16.9	14.0	16.4	1.2	38.6	24.6	17.82	11.08	7.9
Summer (Mar, April & May)	27.46	17.20	15.14	21.6	18.6	42.8	20.3	14.58	12.5	9.82	24.3	19.4	19.6	20.6	16.1	37.18	21.3	17.98	12.82	10.27
(summer + winter)	34.88	20.155	13.52	17.08	14.365	43.4	21.09	15.04	12.05	8.06	32.9	18.15	16.18	18.5	13.65	37.89	22.95	17.9	11.95	9.31

Scale :

1 = 0%
2 = 1-10%
3 = 11-25%
4 = 26-50%
5 = 50-100%

Table 12 : Efficacy of synthetic chemicals against *A. guerreronis*

Sl. No	Treatments	Concen-tration	Before treatment No. of mites /cm^2	Per cent reduction over control			
				2 DAS	5 DAS	7 DAS	Mean
1.	Vertimec	0.005%	38.67	35.0 (36.27)	72.32 (58.24)	63.53 (52.83)	56.95 (48.97)
2.	Vertimec	0.0025%	35.67	19.78 (26.42)	53.57 (47.06)	55.21 (47.98)	42.85 (40.86)
3.	Lambdacyhalothrin	0.005%	32.30	42.86 (40.92)	73.21 (58.82)	75.00 (60.00)	63.69 (52.95)
4.	Monocrotophos	0.05%	22.60	68.1 (55.61)	83.91 (66.34)	83.34 (65.88)	78.45 (62.31)
5.	Profenophos	0.05%	30.00	30.76 (33.71)	65.17 (53.79)	63.53 (52.83)	53.15 (46.78)
6.	Thiomethoxam	0.006%	42.00	37.35 (37.640	73.21 (58.820	72.9 (58.63)	61.15 (51.41)
7.	Micronised wettable sulphur	0.3%	35.00	36.26 (36.99)	68.73 (55.98)	80.2 (63.58)	61.73 (51.71)
8.	Phosalone	0.07%	29.67	37.35 (36.64)	74.09 (59.41)	72.9 (58.63)	61.45 (51.19)
9.	Dicofol	0.09%	46.33	15.39 (23.11)	38.08 (38.12)	39.59 (39.00)	20.86 (27.20)
10.	Profenophos + Cypermethrin	0.04%	41.33	37.35 (37.64)	66.05 (54.33)	67.71 (55.37)	57.03 (49.20)
11.	Control (water spray)		24.66	-	-	-	-
	CD		-	10.54	8.15	6.68	

Table 8 : Nut component analysis

S. No.	Components of the nut	Healthy nut	Infested nuts			% reduction
			Grade - I	Grade - II	Grade - III	
1.	Length (cm)	26 (18-30)	22 (16.1-27)	18 (10-21.1)	14 (6.4-172.)	15-46
2.	Girth (cm)	40 (20-46.1)	33 (16-36.7)	27 (11-38.30	21 (10.3-30.3)	17-47.5
3.	Perianth diameter (cm)	20 (13.6-26.9)	15 (12-20)	12 (10-16.3)	8 (5-9.3)	25-60
4.	Total weight of the nut (kg)	1.6 (0.9-2.2)	1.3 (0.76-2.0)	1.12 (0.60-1.8)	0.9 (0.6-1.4)	18-43
5.	Weight of the husk (kg)	1.30 (0.6-2.0)	0.9 (0.49-1.6)	0.7 (0.36-1.00)	0.50 (0.25-0.8)	30-61.5
6.	Weight of husked nut (kg)	0.9 (0.40-1.26)	0.66 (0.40-1.10)	0.48 (0.3-1.06)	0.39 (0.25-0.80)	26-56
7.	Weight of the shell (g)	140.3 (110-210)	116.2 (83-200)	111-3 (53-170)	99.7 (42-160)	17-29
8.	Weight of copra (g)	155.2 (80-220)	126.1 (60-200)	116.7 (50-170)	100.3 (40-130.1)	18.75-35.37
9.	Coconut water (g/ nut)	100 (80-120)	85 (70-100)	65 (50-80)	45 (43-70)	15-55
10.	No. of samples	10	10	10	10	

Table 5 : Influence of height of the tree and location of the tree in the distribution pattern of *A. guerreronis* in the field

Height from ground (m)	No. of mites / cm^2 on 4 months old bunch					Mean
	North	East	West	South	Total	
6.5	13	16	1	4	34	8.50
7.7	50	58	2	9	119	29.75
10.0	44	47	4	20	115	28.75
Total	**107**	**121**	**7**	**33**	**268**	
Mean	**35.6**	**40.3**	**2.3**	**11**		

4.5 CHEMICAL CONTROL OF *A. guerreronis*

A field experiment was carried out in the coconut garden, Gollapalle village near Chittoor during June 2004 to test the efficacy of certain insecticides / acaricides against *A. guerreronis*. The chemicals of different origin were vertimec (0.005%), vertimec (0.0025%), Lambda cyhalothrin (0.005%), Monocrotophos (0.05%), Profenophos (0.05%), Thiomethoxam (0.006%), Wettable sulphur (0.3%), Phasalone (0.07%), Dicofol (0.09%) and Profenophos + Cypermethrin - 0.04%.

4.5.1 Effect of pesticides in the control of coconut Eriophyid mite

The data regarding the mean of mite population (both nymphs and adults) per cm^2 area on inner and outer whorl perianth was observed one day before spraying and 2, 5, 7 days after spraying. Mean per cent reduction over control was calculated and the results are presented in the table 12.

4.5.2 Two days after spraying

The per cent reduction of mite population in different treatments over control indicated that Monocrotophos (0.05%) was most effective with a maximum population reduction of 68.1% followed by Lambda cyhalothrin

(0.005%) with a population reduction of 42.86%, Thiomethoxam (0.006%, Phasalone (0.07%) and Profenophos + Cypermethrin (0.04%) stood next to above two chemicals with 37.35% population reduction over control and were on par with each other. Next came the sulphur (0.03%) and vertimec (0.005%) with a population reduction of 36.26% and 35% respectively and were on par with each other. These chemicals were followed by Profenophos (0.05%) with population reduction of 30.76% and finally the vertimec (0.025%) with the population of 19.78%.

The efficacy observed through the first post count can be depicted in the following

$$T_4 > T_3 > T_6 = T_8 = T_{10} > T_7 > T_1 > T_5 > T_2 > T_9$$

4.5.3 Five days after spraying

Monocrotophos (0.05%) were recorded the maximum population reduction over control of 83.91% followed by phasalone (0.07%) with the population reduction of 74.09%. The lambda cyhalothrin (0.005%) and Thiomethoxam (0.006%) stood next to them with 73.21% reduction and were on par each other. Next came vertimec (.005%), sulphur (0.3%), profenophos + cypermethrin (0.04%) and profenophos (0.05%) with a population reduction of 72.32%, 68.73%, 66.05% and 65.17%, respectively and were on par with each other. These were followed by Vertimec (0.025%) and Dicofol (0.09%) with a population reduction of 53.57% and 38.08% respectively.

The efficacy was as follows :

$$T_4 > T_8 > T_3 = T_6 = T_1 > T_7 > T_{10} > T_5 > T_2 > T_9$$

4.5.4 Seven days after spraying

Seven days after spraying Monocrotophos (.05%) sulphur (0.3%) were recorded 83.34% and 80.2% population reduction over control and were on par with each other. These were followed by Lambda Cyhalothrin (0.005%), Thiomethoxam (0.006%), and Phasalone (0.07%), with 75%, 72% and 72% reduction. Next came the vertimec (0.005%), profenophos (0.05%), vertimec (0.025%) and dicofol (0.09%) with the population reduction of 63.53%, 63.53%, 55.21% and 39.59% respectively.

The efficacy was as follows ;

$$T_4 > T_7 > T_3 > T_8 > T_{10} > T_5 > T_1 = T_5 > T_2 > T_9$$

4.5.5 Over all efficacy of treatments in reducing *A. guerreronis*.

The overall efficacy of the treatment in the control of coconut eriophyid mite presented in the Table 12, Fig. 9. The treatment monocrotophos were significantly superior over all the treatments with 78.45% population reduction. The next most effective treatment was Lambda cyhalothrin with 63.69% reduction. This was followed by sulphur, phasalone, thiomethoxam and profenophos + cypermethrin with 61.73%, 61.45%, 61.15% and 57.03% population reduction respectively. Next came vertimec (0.005%) profenophos, vertimec (0.0025%) and dicofol with the population reduction of 56.95%, 53.15%, 42.85% and 20.86% respectively. The over all efficacy of the treatments was in the following order.

$$T_4 > T_3 > T_7 > T_8 > T_6 > T_{10} > T_1 > T_5 > T_2 > T_9$$

There was highly significant difference between different intervals after spraying with regard to the per cent reduction of mite population. Five days after spraying recorded the highest population reduction T_1, T_4, T_5, T_6, & T_8 whereas T_7, T_3, T_2, T_9 & T_{10} showed at seven days after spraying.

Plate 3 : Predatory mite (Amblyseius species)

Plate 4 : Typical brownish triangular spot on the nut due to *Aceria guerreronis*

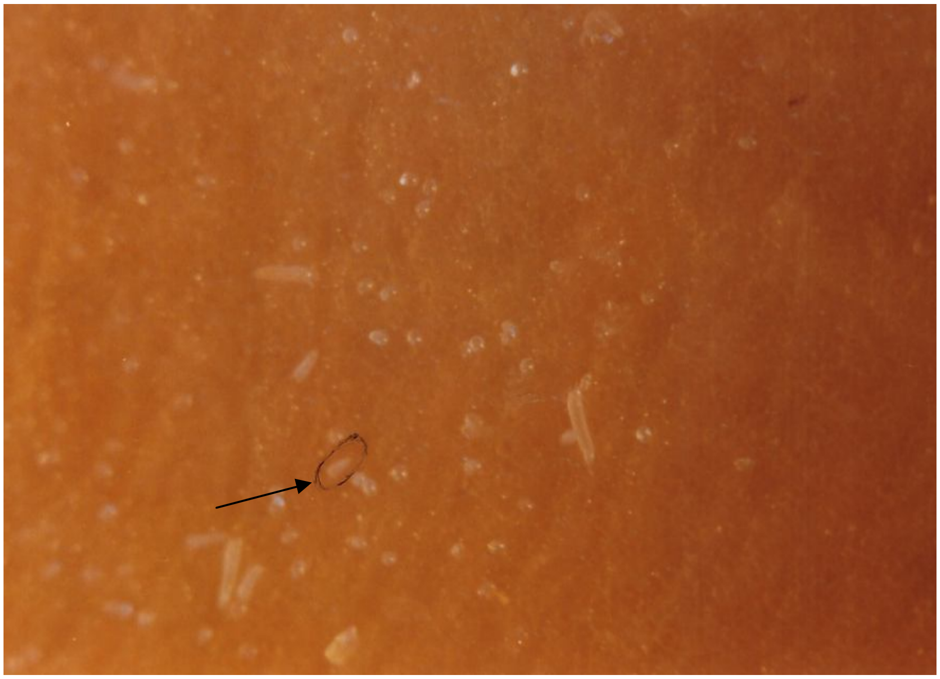


Plate 10 : Protonymph of *A. guerreronis*

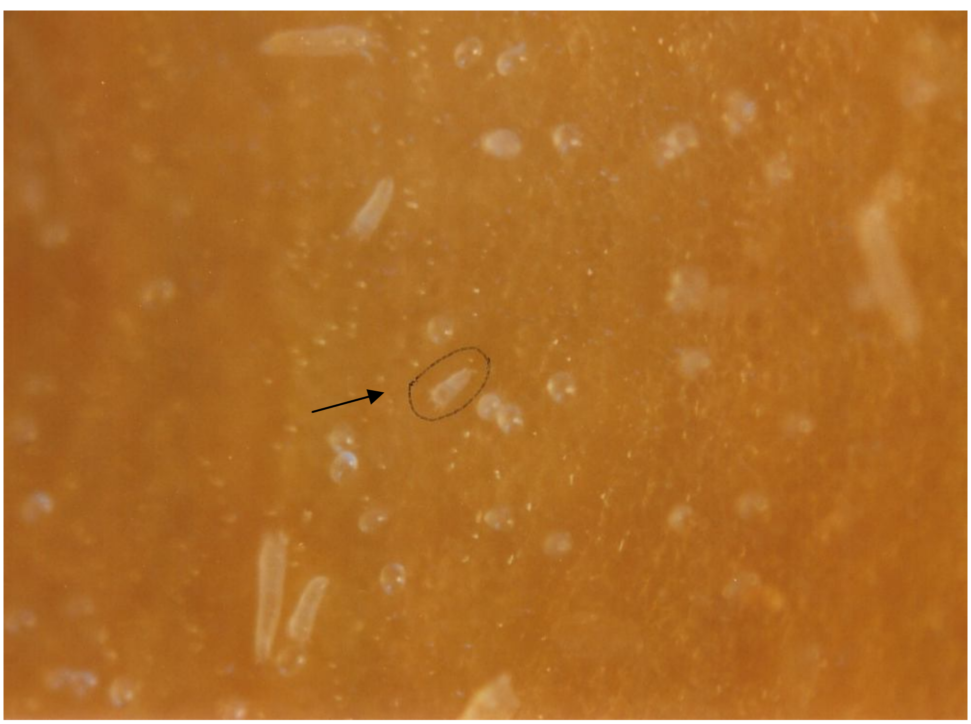


Plate 11 : Deutonymph of *A. guerreronis*

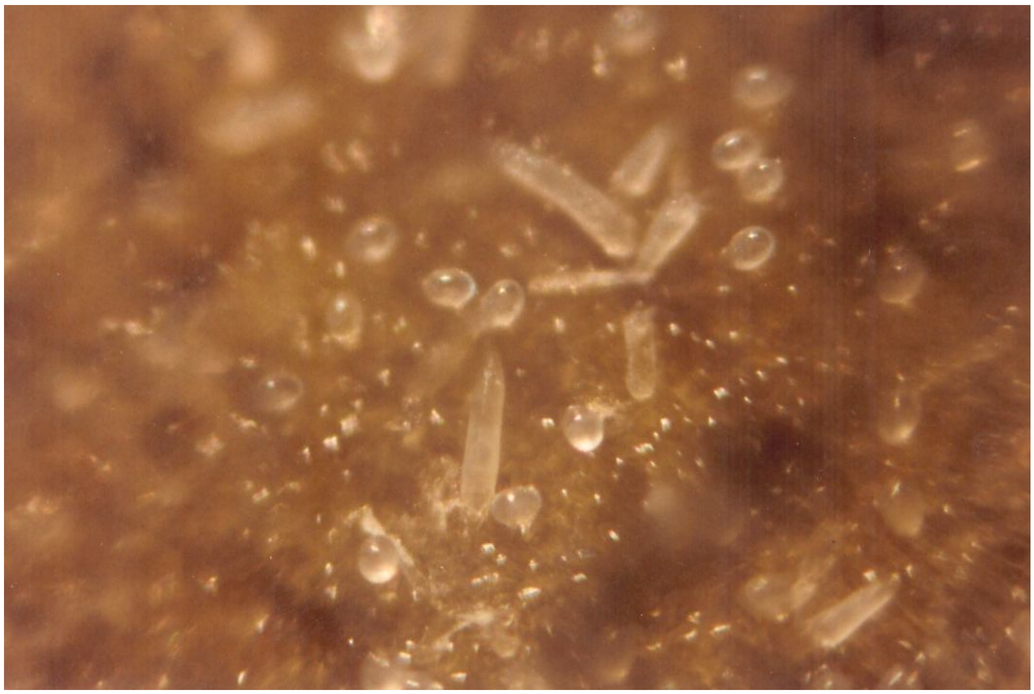


Plate 9 : Eggs and adults of *A. guerreronis*

Plate 5 : Longitudinal scarifications on the nut due to *Aceria guerreronis*

Plate 6 : Gummy exudation with severe infestation on the nut due to *Aceria guerreronis*

Plate 7 : Extent of damage (gummy exudation) of *Aceria guerreronis* to matured coconut

Plate 8 : Severely damaged nuts at the market

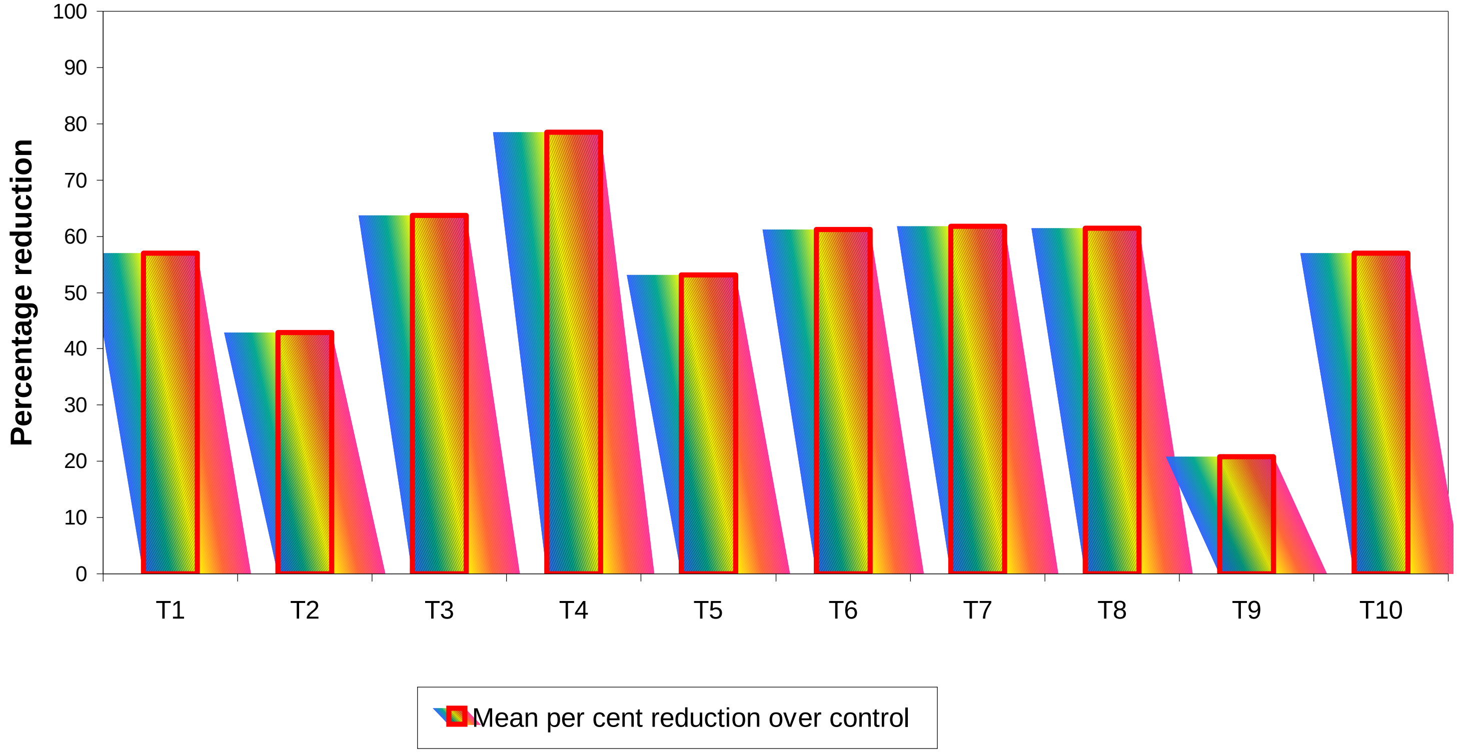


Fig. 9 : Efficacy of synthetic chemicals against *Aceria guerreronis*

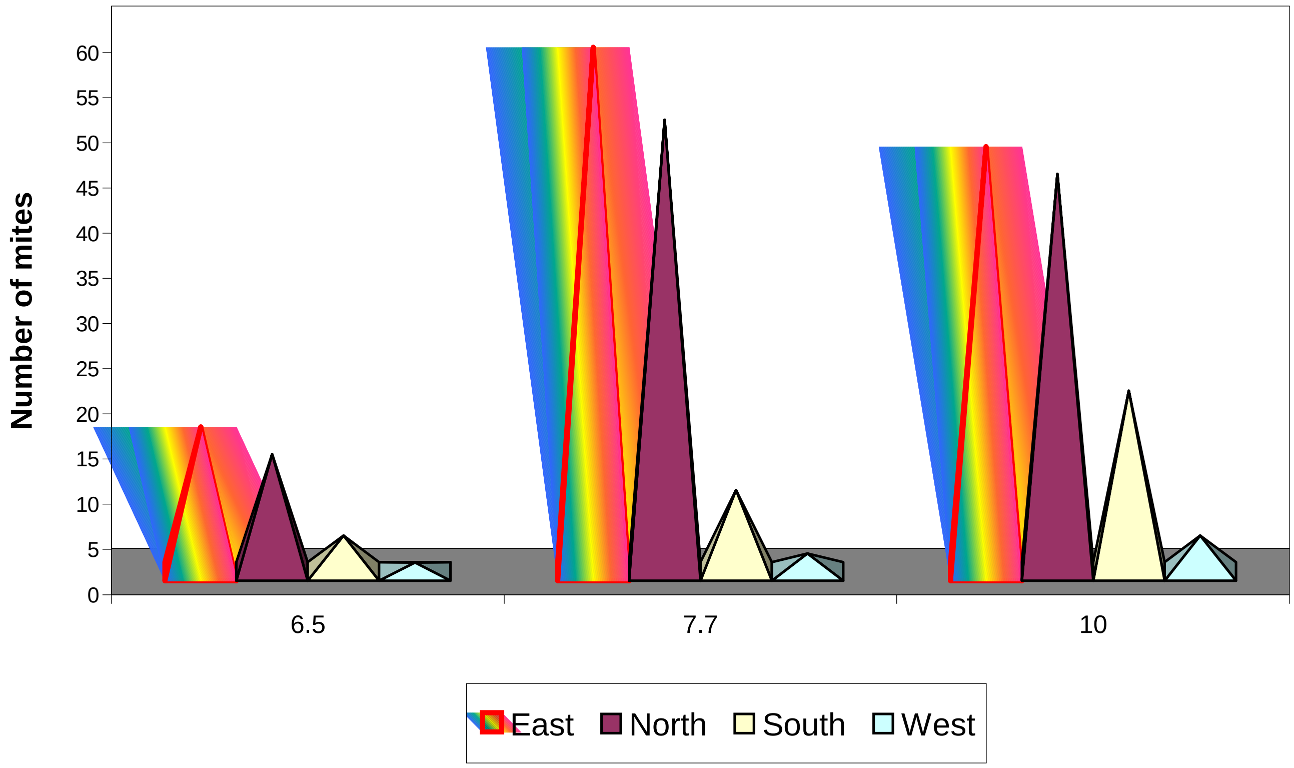


Fig. 7 : Distribution pattern of *Aceria guerreronis* in relation to tree direction and height

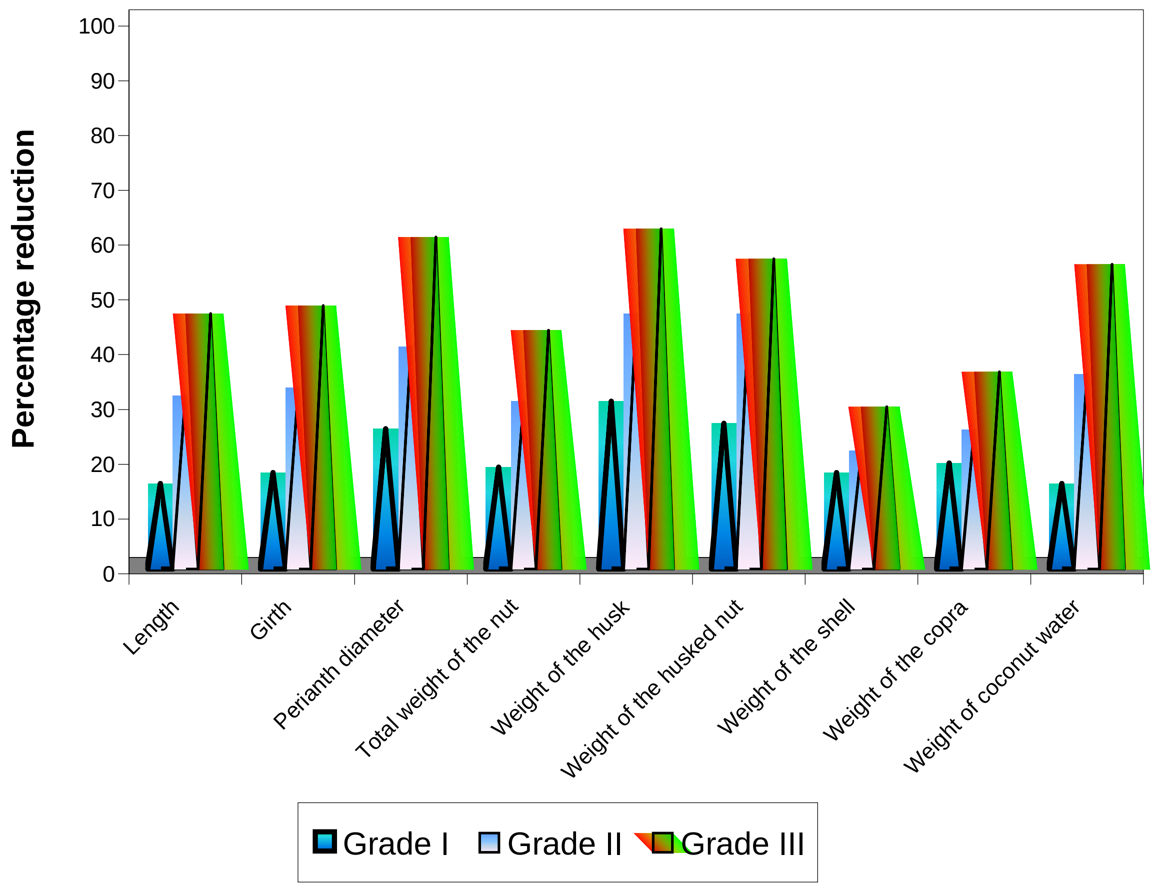


Fig. 8 : Percentage reduction in nut components due to *Aceria guerreronis*

Fig. 6 : Seasonal occurrence of total population of *Aceria guerreronis* on outer whorl perianth with reference to biotic and abiotic factors

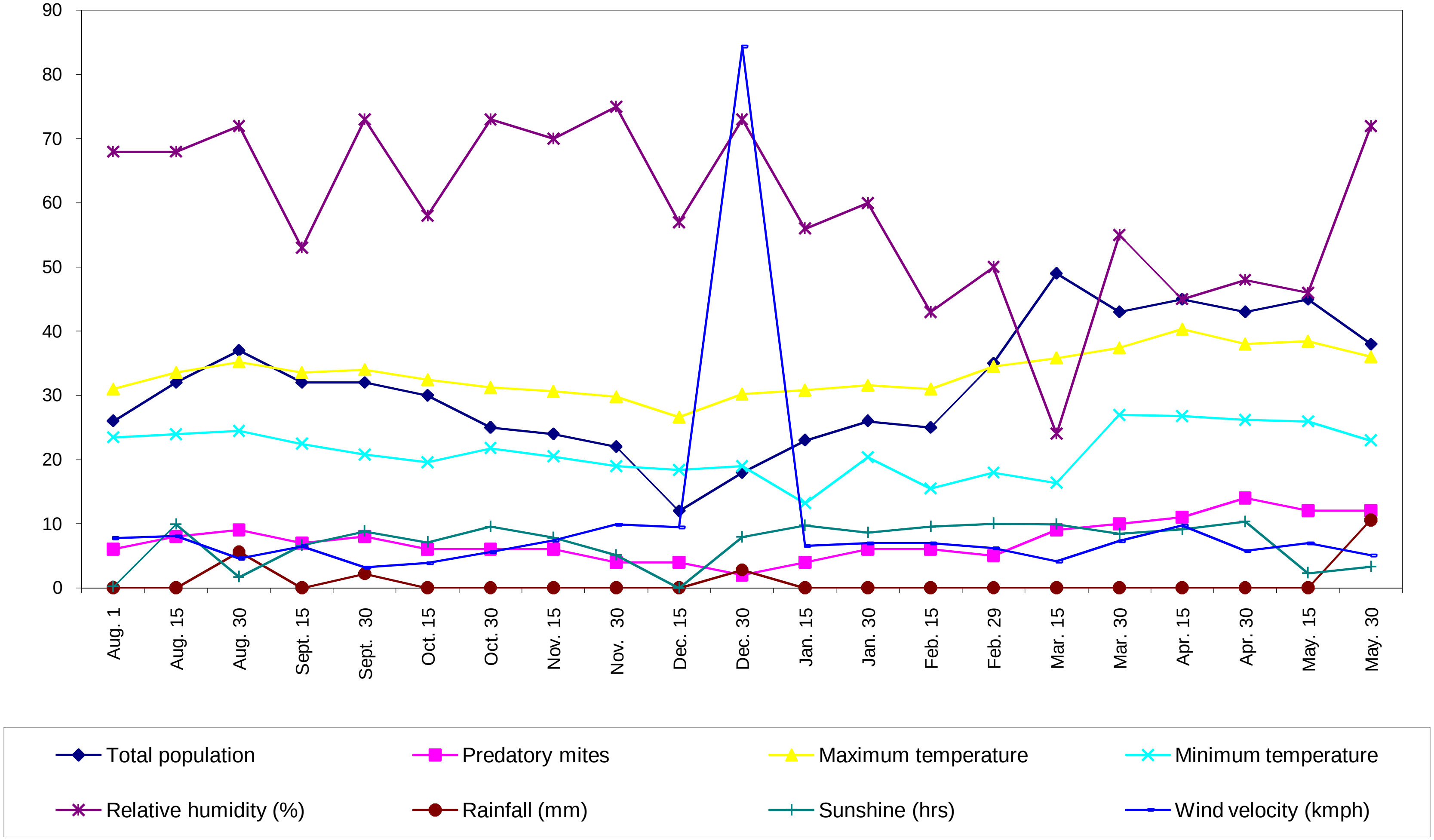


Fig. 5 : Seasonal occurrence of adult of *Aceria guerreronis* on outer whorl perianth with reference to biotic and abiotic factors

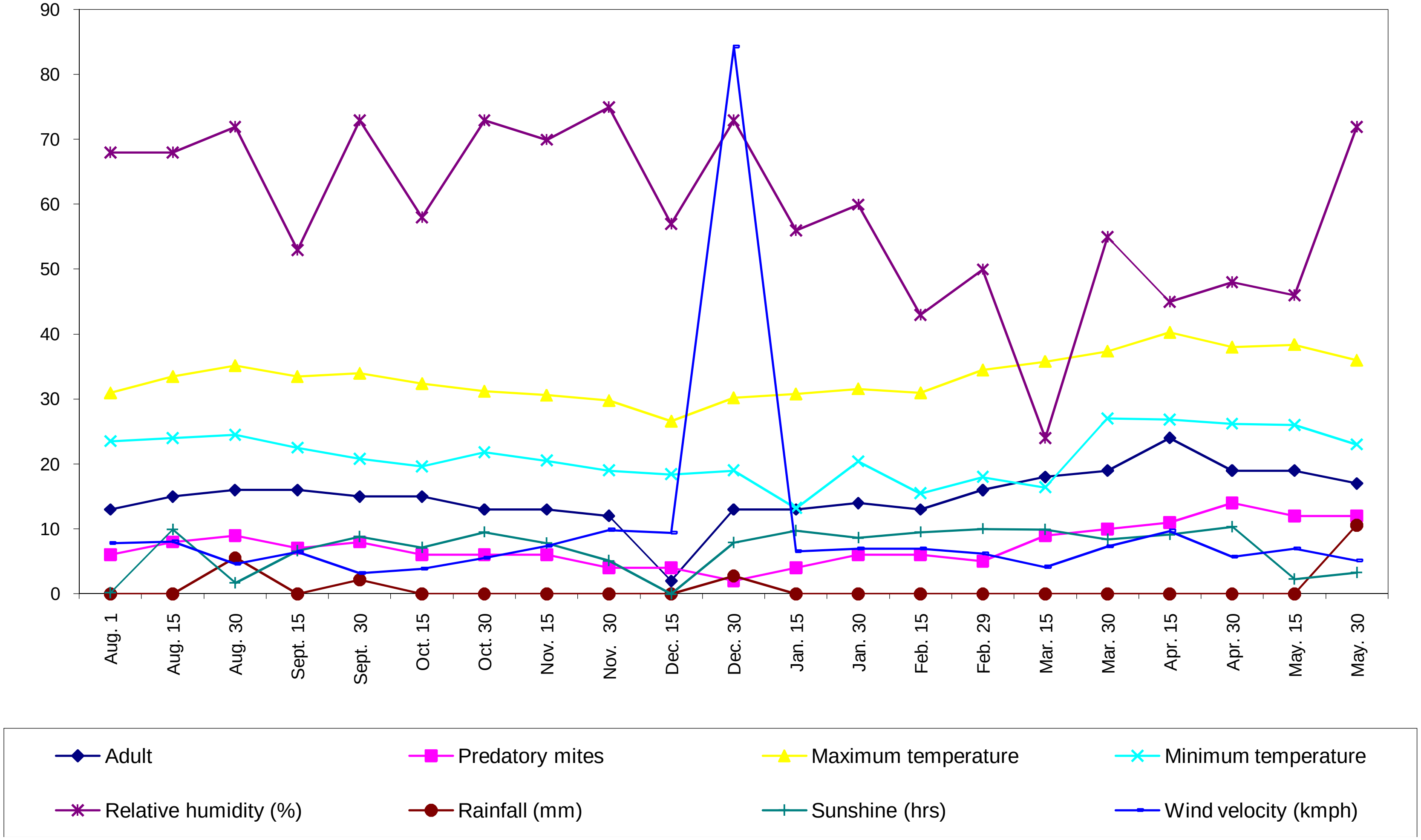


Fig. 3 : Seasonal occurrence of total population of *Aceria guerreronis* on inner whorl perianth with reference to biotic and abiotic factors

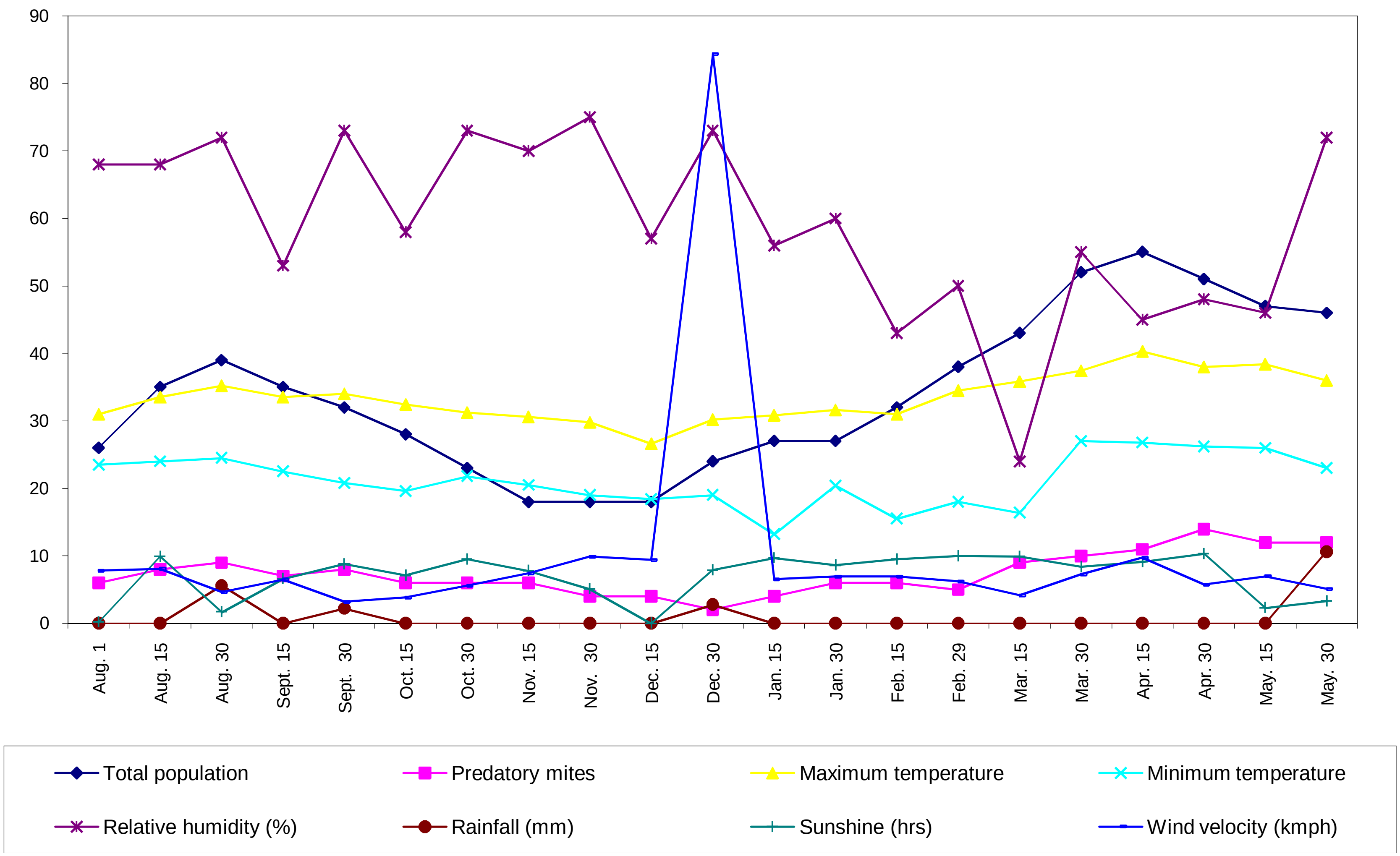


Fig. 2 : Seasonal occurrence of adults of *Aceria guerreronis* on inner whorl perianth with reference to biotic and abiotic factors

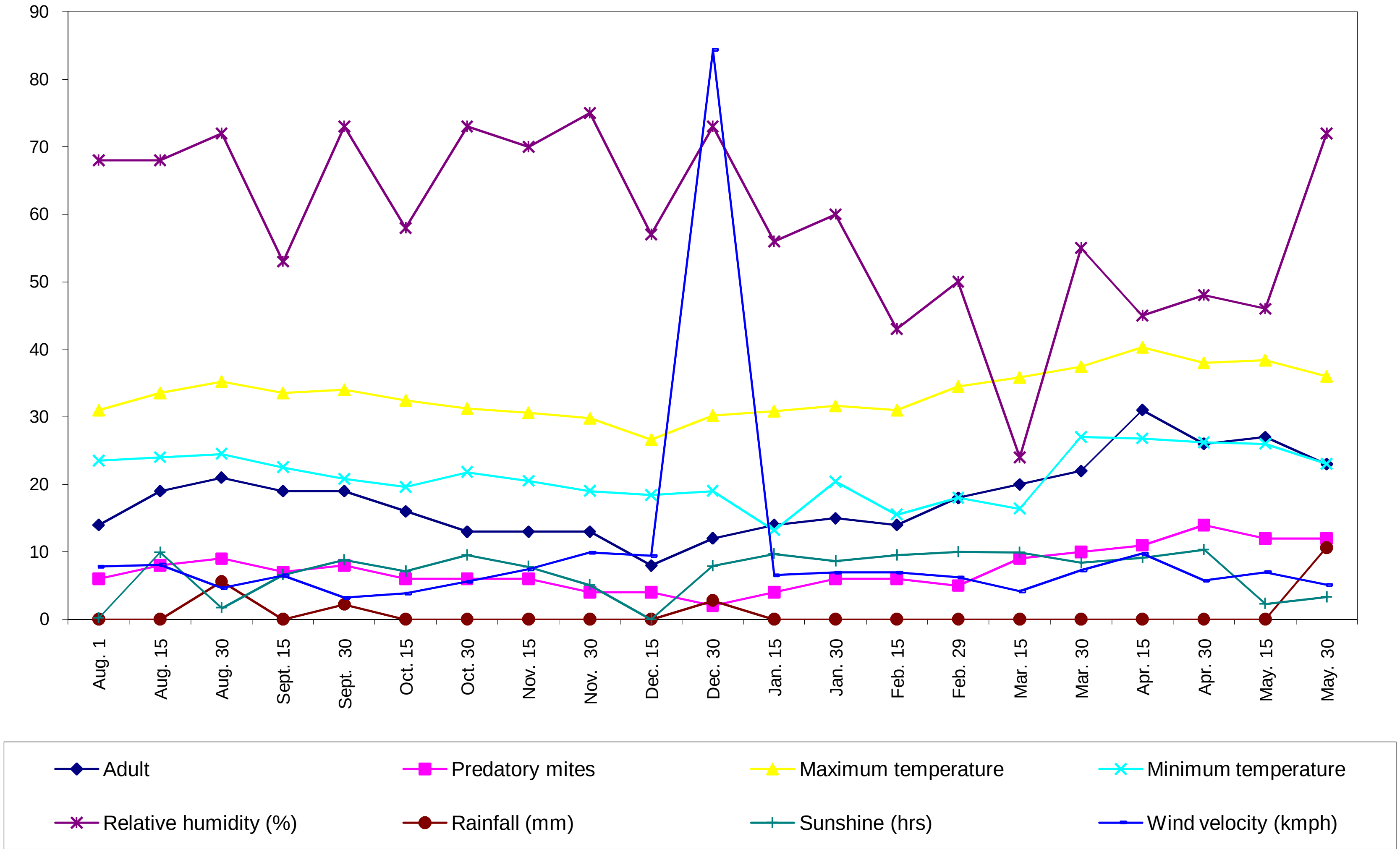
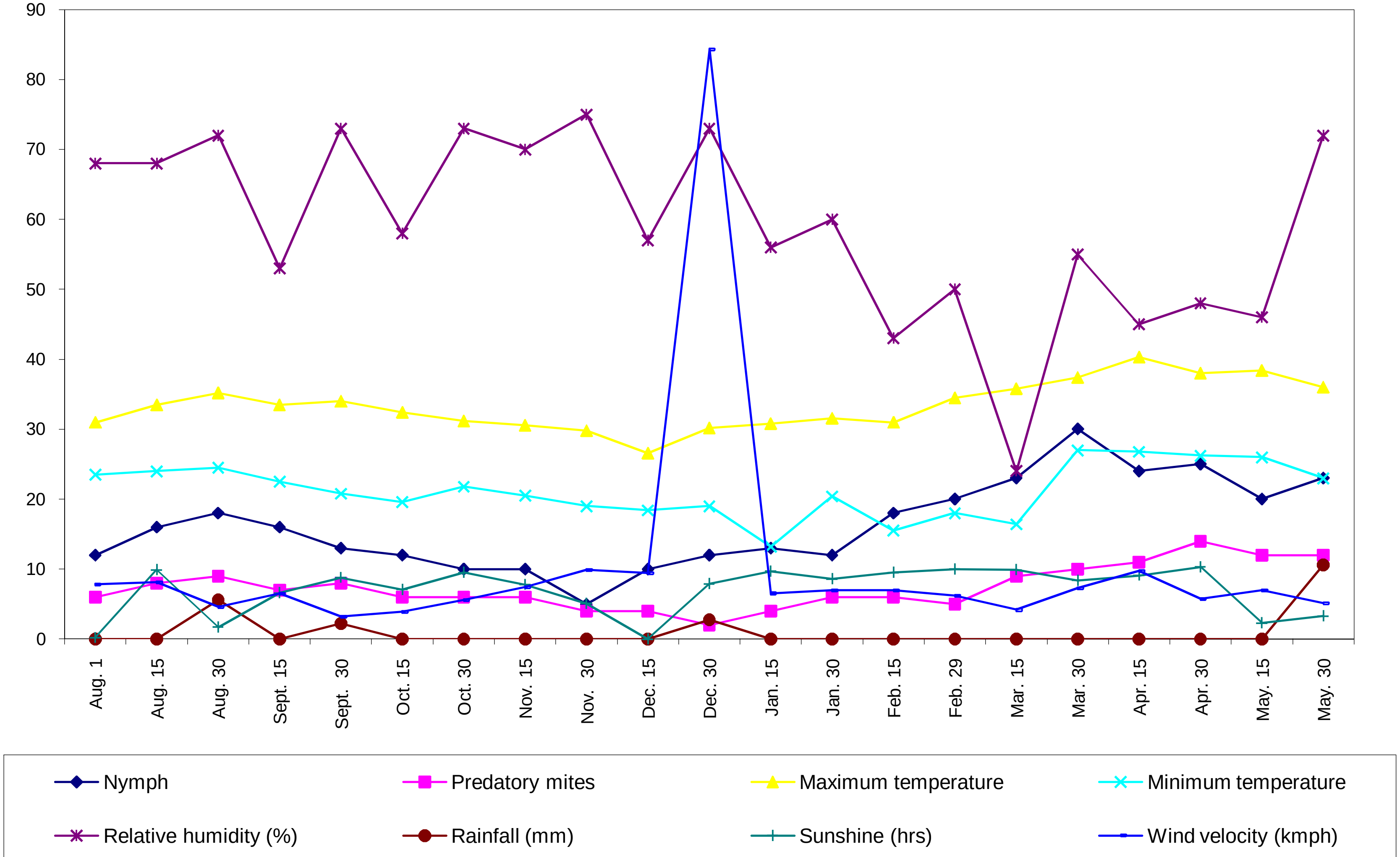


Fig. 1 : Seasonal occurrence of nymphs of *Aceria guerreronis* on inner whorl perianth with reference to biotic and abiotic factors



CHAPTER - V

DISCUSSION

Investigations were carried out on the population dynamics, damage assessment, biology and efficacy of new insecticides / acaricides on coconut eriophyid mite *A. guerreronis* (Keifer) and the results obtained from the field and laboratory studies are discussed here under.

5.1 POPULATION DYNAMICS

Studies on the population dynamics (seasonal incidence) of *Aceria guerreronis* on coconut indicate that all developmental stages of the mite are present on the host plant through out the year.

The population density of *Aceria guerrerronis* was high during second fortnight of March to second fortnight of April 2004. This was accompanied by increase in temperature, wind velocity, sunshine hours and decrease in relative humidity.

There was slow increase of population from August 2003 to October 2003, but sudden decline of population recorded during first fortnight of

November to first fortnight of December 2003. This was characterized by increase in number of predatory mites, decline of temperature, sunshine hours and increase of relative humidity percentage.

There was gradual increase of population from January 2004 to April 2004 which are accompanied by increase of temperature and sunshine hours and decline in relative humidity. The mite population also fluctuated with the abundance of predatory mites. Due to continuous drought for the past three years, the rainfall not at all influenced the population of coconut eriophyid mite during the study period.

When the population data were analysed, a positive correlation between the population density and dry climate, where as a negative relationship with relative humidity was observed. This indicates that mite cannot tolerate the increase of relative humidity and decrease of temperature. The vice versa presence of high temperature and low relative humidity of dry weather was highly favourable.

The present findings are correlation with findings of Zuluaga and Sanchez (1971) and Griffith (1984) who observed the presence of mites in gardens throughout the year, with severe infestation during relatively dry climates. Similarly, Haq (1999) observed a positive correlation between mite population and dry climate during summer months and a negative correlation with rainfall during monsoon.

5.2 DISTRIBUTION PATTERN OF *A. guerreronis*

The present experimental findings indicates that mite population was more in palms which are located in east direction followed by north direction. It might be due to that the mite population was more active during early morning hours ie. 6-9 AM than any other time of the day. The present findings on population dynamics indicated that the temperature and sunshine are positively correlated with mite population. With this it was assumed that the trees which are in the east and north direction received more temperature and sunshine than the palms which are in west direction. The trees which are in west direction are over shaded by the palms of eastern side, hence the less mite population. This might be due to the influence of weather factors like temperature, sunshine.

During this period of observation the wind was blowing from north east and south east directions. This indicates that the wind aided dispersal of mite within the garden.

The present findings are in agreement with that of Moore and Alexander (1987) and Schliesskel (1990) who reported that the principle made by which the coconut mite spreads and colonizes new palms, particularly over long distance, is probably through wind. The air currents carry the mites to racemes (or) to the more vertical leaves in the crown from where they may drop onto inflorescences. Coconut mites can walk between touching inflorescence and being negatively geotactic, tend to move from older to younger inflorescence. Reddy and Naik (2000) also reported that wind plays major role in the dispersal of *A. guerreronis* over large area.

Chezhiyan and Ramar (2000) reported that the palms which are present at the middle of the garden recorded the highest infestation followed by northern side. The minimum incidence was recorded in the trees found in southern side.

5.3 DAMAGE ASSESSMENT

The present findings indicates that the severity of damage was more during summer season (March to May) in all mandals of Chittoor district. During the period of survey (September 2003 to May 2004) the highest percentage of damage recorded in Puttur mandal and the lowest percentage of damage in Chandragiri mandal. This might be due to their geographical locations. Because Chittoor district located in between the states like Tamil Nadu and Karnataka. These two states are already the largest area of coconut, in Southern India as well as these two states are severely attacked by this coconut mite. The mechanical transfer of mites during the transport of nuts might be one of the reason for the damage of coconut. During the survey by Department of Agricultural Economics, TNAU reported that Vellore, Namakal districts of Tamil Nadu recorded more than 40% of nuts exhibited more than 60% of damage. Puttur mandal being the border of Tamil Nadu and high damage percentage at Vellore might have influenced the severity of incidence in Puttur mandal.

5.3.1 Influence of mite infestation in minerals (P & K) and reducing sugars (Glucose) in tender coconut water

The analysis results on minerals and reducing sugars of tender coconut water indicated that the phosphorus, potassium and reducing sugars declined from 66.75 to 50.60 ppm, 70.66 to 49.60 ppm and 201.30 to 130.80 (mg/100 ml) with respect to damage percentage from scale 1 to 5.

According to Bopaiah *et al.* (1996) potassium plays a key role in the activation of enzymes and in plant growth and development and the husk of coconut is rich in potassium. During dry and rainfed conditions the mites prone to attack the nuts and the nuts which possess less amount of potassium are severely affected. They reported that the coconut plants requires large quantities of potassium. The loss of potassium due to mite incidence was 29.8%.

Non-availability of this element in required quantity with prolonged dry spell experienced during the last few years might have shared their role collectively in contributing the current outbreak and havoc, created by the mite pest. Similar results were also observed by Haq, 1999.

The loss of reducing sugars from 201.30 (0% damage) to 130.30 (>50% damage) due to *A. guerreronis* in terms of 35%. The similar results were obtained by Geethalakshmi and Rabindra (2000).

5.3.2 Nut components

The mite renders the fruit inferior in quality which declines as the level of damage increases. This has been quantified grade - wise which is very easy to follow and more realistic than other methods (Mariau and Julia 1979; Moore *et al.*, 1989) that are rather ambiguous in grading the symptoms. Reduction in nut size and kernel content coupled with poor quality of husk are the features associated with mite attack (Ramarethinam and Marimuthu, 1998; Sathiamma *et al.,* 1998; Mohanasundaram *et al.*, 1999). Greatest reduction was observed in weight of husk ranging from 30-61.5% in Grade - I to Grade - III from the normal nuts followed by perianth diameter form 25-60%, copra weights and total weight of the nuts dropped in 18.75-35.37% and 18.43% respectively. Reduction in length and girth ranging form 15-46% and 14-47.5% respectively. Thus *A. guerreronis* makes the fruit inferior in quality in terms of both size and weight, the vital factors at marketing. It also makes the dehusking labour - intensive as the affected husks are difficult to remove because of the compaction of the fibrous mesocarp (Moore and Howard, 1996). The results also supported by Sujatha and Chalapathi rao (2004), Varadarajan and David (2004).

5.4 BIOLOGY

Eggs are minute, globular, shiny and laid singly in the tepal surface of coconut. Before hatching the eggs turns into milky white colour. It measures an average of 58 µ length and 28.9 µ width. The egg period ranges from 2-3 days. Similarly the results of Mohanasundaram *et al.* (1999) revealed that the eggs are glassy and transparent.

The present findings inconformity with the findings of Ramarethinam and Loganathan (2000) and Haq (2001) who reported that the eggs are ovoid, translucent, before hatch they turn into pearly white and the incubation period was 2.60 ± 0.49 days

There were two nymphal stages observed. The first nymphal stage, protonymph very small sluggish and transparent. It measures on average of 57.5 µ in length and 28.14 µ in width. Similar results were also made by Ramarethinam and Loganathan (2000) who stated that the newly hatched protonymphs are in white colour and lasted 3.50 ± 0.67 days. According to Haq (2001) the first nymph is small, sluggish and transparent which lasted for 1.5-2.0 days. Mohanasundaram *et al.* (1999) reported that the protonymph lasted 2 days feeds on the tissue sap and moults after two days to become deutonymph.

The deutonymphs are pale white elongated and vermiform 47.5 µ in length and 23.8 µ in width. Similar results were also obtained by

Mohanasundaram *et al.*, (1999); Ramarethinam and Loganathan, (2000) and Haq (2001) reported that the deutonymphs are pale white, longer more active than protonymph and lasted 2-2.5 days.

The adult stage of mite is vermiform and pale in colour. The male adult measures on an average of 138 µ in length and 26.5 µ in width. The adult female laid on an average of 12 eggs throughout the life span and the length was 200-205 µ and width was 30-35.3 µ. The adult mites are creamy white and had two pairs of legs towards the anterior of the body. It also supported by Ramarethinam and Loganathan (2000), Haq, (2001) and Chandrika Mohan and Nair, (2002).

There were two quiescent stages during the life cycle of *A. guerreronis* one was between the first and second nymphal stages and another was between second nymphal stage and adult emergence and these two stages were inactive and swollen. Ramarethinam and Loganathan (2000) revealed that the Protonymph and Deutonymph passed through quiescent stage before moulting into next stage. According to Haq (2001), the first nymphal inactive period lasts for 1-1.5 days and during this inactive period mites are motionless.

The life cycle of *A. guerreronis* completed in 10-12 days. Ramarethinam and Loganathan (2000) also stated that the life cycle of *A. guerreronis* from egg to adult completed within 10.50 ± 1.27 days. Haq (2001) also confirmed that the post - embryonic development of the mite is completed within a period of 8-10.5 days.

The pre ovi-position period, oviposition, post oviposition period with 1.88 ± 0.61, 8.1 ± 0.77 and 1.91 ± 0.83 days respectively. Ramarethinam and Loganathan (2000) also stated that the adult females lived longer (15.31 ± 2.7 days) than males (8.2 ± 1.40 days).

5.5 CHEMICAL CONTROL OF COCONUT ERIOPHYID MITE *A. guerreronis* (K.)

The results of the chemical control experiment showed that all the pesticides used against *A. guerreronis* were significantly superior to the untreated check in reducing the population. In all the treatments population reduction gradually increased and the chemicals viz., sulphur, Lambda cyhalothrin, vertimec (0.025%) and profenophos + cypermethrin and dicofol showed maximum population reduction at seven days after spraying whereas vertimec (0.05%), monocrotophos, profenophos, thiomethoxam, phasalone showed maximum population reduction at five days after spraying.

Over all efficacy of the selective insecticide and acaricides indicated that monocrotophos was the most effective one because of its systemic action, with 78.45% population reduction. The other pesticides in the descending order of their efficacy were as follows : Lambda cyhalothrin (63.69%), sulphur (61.73%), phosalone (61.45%), thiomethoxam (61.15%), profenophos + cypermethrin (57.03%), vertimec (0.05%) ➔ (56.95%), profenophos (53.15%), vertimec (0.0025%) ➔ (42.85%) and dicofol (20.86%).

The superiority of monocrotophos in controlling *A. guerreronis* in the present study is in agreement with Mariau, 1977; Hernandez, 1977; Childers *et al.*, 1996; Muthiah and Bhaskaran, 1999; Palanisamy *et al.*, 2000; Reddy and Naik, 2000; Fernando *et al.*, 2000; Ramaraju *et al.*, 2000; Sujatha *et al.*, 2004; Sujatha and Chalapathi Rao, 2004).

The next best treatment was Lambda cyhalothrin. Wettable sulphur also moderately effective against *A. guerrernois*. The present findings are in agreement with Sujatha and Chalapathi Rao, 2004.

Phasalone, Profenophos also moderately effective against *A. guerreronis*. This was also supported by Mohanasundaram *et al.* (1999).

In the present study Vertimec (0.0025%) and Dicofol were found to less effective in controlling *A. guerreronis*.

CHAPTER - VI

SUMMARY

The studies on population dynamics, damage assessment, biology and chemical control of eriophyid mite, *Aceria guerreronis* (Keifer) were carried out during August 2003 to June 2004 at S.V.Agricultural College, Tirupati.

Studies on the population dynamics (seasonal incidence) were carried out on four months old nuts of coconut, the variety "East coast tall". The mite population reached its peak level during March - April at maximum temperature, minimum temperature, RH, RF, sunshine and wind velocity of 37°C, 27°C, 55%, 0 mm, 8.4 hour and 7.28 kmph respectively.

The minimum level of mite population was observed during first fortnight of December at maximum temperature, minimum temperature, RH, RF, sunshine and wind velocity were 26.6°C, 18.4°C, 57%, 0 mm, 0 hour and 9.42 kmph respectively.

The correlation of eriophyid mite with biotic factor i.e., bioagents was negative. The development of eriophyid mite had positive relationship with maximum temperature, minimum temperature, sunshine and wind velocity. Regarding distribution of *A. guerreronis*, it was maximum in bunches facing east and north with respect to the tree direction.

Regarding random sampling survey on damage assessment, the severe damaged per cent of nuts were highest (32.15%) at Puttur mandal and lowest (20.11%) at Chandragiri. The minerals like Phosphorus, Potassium and reducing sugars were reduced in severely affected nuts (damage scale - V) at 24.17%,. 29.8% and 35.2% respectively. The reduction percentage in morphological parameters like length, girth, perianth radius, and quantitative parameters like weight of nut, weight of husk, weight of husked nut, weight of shell, copra weight and coconut water in Grade - I to Grade - III were varied from 15-46, 17-47.5, 25-60, 18-43, 30-61.5, 26-56, 17-29, 18.75-35.37 and 15-55% respectively.

Observations pertaining to biology were carried out on tender succulent perianth discs with tender coconut water and the result showed that on an average the longevity of male and female was 8.3, 15.93 days respectively.

Pre-oviposition, oviposition and post oviposition periods were on an average of 1.88, 8.1, 1.91 days respectively. The average fecundity was found to be 12 eggs and these eggs hatched in 2.5 days. During the period of development two nymphal stages viz., protonymph and deutonymph were observed. The duration of protonymph and deutonymph lasted 2.7-4.2 and 3.9-4.9 days, respectively.

A field experiment was conducted to evaluate the efficacy of chemicals in controlling eriophyid mite. The overall efficacy of pesticides revealed that monocrotophos (0.05%) was the most effective among the other tested pesticides with 78.45% population reduction over control.

This was followed by Lambda cyhalothrin (0.005%) with 63.69% population reduction. Sulphur (0.3%) with 61.73%, phosalone (0.07%) with 61.45% and thiomethoxam (0.006%) with 61.15% population redcuiton stood next to them and are moderately effective. Dicofol (0.9%) with 20.86% and vertimec (0.0025%) with 42.85% population reduction were the less effective, comparatively.

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