Seasonal incidence and evolving an IPM strategy for erineum mite, *Aceria jasmini* Chann. on jasmine, *Jasminum auriculatum* Vahl.

M. VINOTH

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY
AGRICULTURAL COLLEGE AND RESEARCH INSTITUTE
TAMIL NADU AGRICULTURAL UNIVERSITY
MADURAI – 625 104

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M. VINOTH
I.D. No. 06-602-104

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DEPARTMENT OF AGRICULTURAL ENTOMOLOGY
AGRICULTURAL COLLEGE AND RESEARCH INSTITUTE
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CERTIFICATE

This is to certify that the thesis entitled **"Seasonal incidence and evolving an IPM strategy for erineum mite, *Aceria jasmini* Chann. on jasmine, *Jasminum auriculatum* Vahl."** submitted in part fulfillment of the requirements for the award of the degree of MASTER OF SCIENCE (AGRICULTURE) IN AGRICULTURAL ENTOMOLOGY to the Tamil Nadu Agricultural University, Coimbatore is a record of bonafide research work carried out by **Mr. M. VINOTH** under my supervision and guidance and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or other similar titles, prizes and that the work has not been published in part or full in any scientific or popular journal or magazine.

Dr. C. CHINNIAH
(Chairman)

Place : AC&RI, Madurai

Date :

Approved by

Chairman **(Dr. C. CHINNIAH)**

Members

(Dr. C. MUTHIAH)

(Dr. A. SADASAKTHI)

(Dr. N. GANAPATHY)

EXTERNAL EXAMINER

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ABSTRACT

Seasonal incidence and evolving an IPM strategy for Erineum mite, *Aceria jasmini* Chann. on jasmine, *Jasminum auriculatum* Vahl.

By

M. VINOTH

Degree : MASTER OF SCIENCE (AGRICULTURE) IN AGRICULTURAL ENTOMOLOGY

Chairman : Dr. C. CHINNIAH
Professor
Department of Agricultural Entomology
Agricultural College and Research Institute,
Madurai – 625 104.

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The present investigation was undertaken on seasonal incidence and the impact of abiotic factors / weather parameters on the population dynamics of erineum mite on jasmine, assessment of the efficacy of basal application of organic amendments in combination with foliar application of entomopathogenic fungi, bioefficacy of certain newer acaricides, insecticide molecules and medicinal herbal extracts to suppress the incidence of erineum mite of jasmine *A. jasmini*.

It was evident from the survey that the severity of incidence, egg and mite population of eriophyid mite was at the maximum in Dindigul, Madurai and Dharmapuri districts compared to those in Erode, Theni, Coimbatore, Ramanathapuram and Salem districts. Over 70% of the samples had severe to very severe infestation by *A. jasmini.* The assessment of damage potential of *Aceria jasmini* indicated that the intensity of eriophyid infestation had a significant impact on reduction of jasmine flower yield. An absolute yield reduction of 95.33 % was noticed when the bushes had 76-100 % erineum infestation.

The incidence of erineum mite of jasmine, *A. jasmini* was maximum during August 2007. Attempts made to establish the correlation between weather parameters and erineum mite population dynamics, revealed that maximum temperature, minimum temperature and rainfall had a negative correlation on population dynamics, whereas relative humidity had a

significant positive correlation on the population build up of mite. Other abiotic factors viz., sunshine hours and wind velocity did not have any significant impact on mite population dynamics. For every 1^0C increase in maximum temperature the mite population decreased by 0.71%, where as for every 1^0C increase in minimum temperature the mite population decreased by 0.02%, so also for every 1 mm increase in rainfall there was a reduction of 0.01% in mite population. Nevertheless for every one per cent increase in relative humidity, the mite population increased by 0.27%.

Basal application of neem cake @ 100 g/ plant + foliar application of (two rounds) *Hirsutella thompsonii* (1 $X10^8$ colonies per ml) was found to be the best and effective in reducing the mite population which also recorded 64.74% increased flower yield over untreated control with higher cost benefit ratio, next only to the standard i.e. carbofuran compared in this study. Hence, it can be construed that application of neem cake in combination with either foliar application of *Hirsutella thompsonii* (1 $X10^8$ colonies per ml) /*Beauveria bassiana* (1 $X10^8$ colonies per ml) may be a better alternative to the application of conventional synthetic acaricides, in the context of environmentally benign management tactics so also in order to mitigate the adverse effect on the total environment. This would not only trigger an idea of increased dependency on biologicals for better suppression of this notorious pest of jasmine in near future but also the slow and gradual elimination of the highly dangerous chemical molecules in the years to come. From the investigations, it is also evident that the application of profenophos @ 2ml / lit. or spiromesifen @ 0.7ml / lit. exerted an excellent suppression of jasmine erineum mite in field condition with increased flower yield and cost benefit ratio. These newer acaricidal molecules with novel mode of action should be popularized so that the existing older acaricides may be phased out eventually.

From the survey in jasmine ecosystem for the prevalence of possible alternate host plants, Jasmine species (*Jasminum auriculatum*) is the only one main host for the erineum mite, no other flora exhibited infestation by *A. jasmini*. Natural occurrence of predatory fauna like phytoseiid mites (several spp of *Amblyseius*); Stigmaeidae (*Agistemus* sp.) and an abundant population of coccinellid predators (*Micraspis discolor* Fab.) which would probably exert a natural check over the pest mite population and it will not lead to an out break situation in any circumstances.

CHAPTER -I

INTRODUCTION

Jasmine, *Jasminum auriculatum* Vahl. (Tamil-Mullai; Hindi-Juhi) is one of the major traditional flower crops of India. The genus *Jasminum* belongs to the family Oleaceae under the order Oleales. which is a climbing, trailing, erect, shrubby flowering, evergreen and deciduous plant. Jasmine buds are used for making garlands, bouquets, religious offerings and for the extraction of perfumed oils and attars. Jasmine is known in India as the "Queen of the Night" because of its perfume. The flowers and parts of this plant are also used for the preparation of several ayurvedic medicines (Ramadas *et al.*, 1985).

The commercial cultivation of jasmine is confined to certain traditional areas of Tamil Nadu viz., Madurai, Dindigul, Theni, Salem, Coimbatore, Erode, Dharmapuri and Ramnathapuram districts of Tamil Nadu; Bangaluru, Bellary, Mysore, and Kolar (Karnataka); Pune, Aurangabad and Ahmednagar (Maharashtra); Ahmedabad, Anand and Vadodara (Gujarat); Ambala, Gurgaon and Faridabad (Haryana); Kannauj, Jaunpur and Gazipur (Uttar Pradesh); Delhi; Ludhiana, Jalandhar, Patiala and Amritsar (Punjab);Ranaghat, Kolaghat, Panskura and 24-Parganas (West Bengal); Udaipur, Ajmer, Jaipur and Kota (Rajasthan); Hoja, Jorhat, Alnugarh (Assam) (Jayachandran, 2001). However, largest chunk of area under jasmine flower production is in Tamil Nadu and Karnataka (57.97%). The annual production of flowers is worth more than Rs. 120 million. Apart from domestic trade, the fresh flowers of jasmine are exported to Malaysia, Singapore and Sri Lanka for various uses, thus it earns considerable foreign exchange also.

A number of jasmine species are grown in India. Some of the commercially important species are *Jasminum sambac* Ait., *Jasminum auriculatum* Vahl., *Jasminum grandiflorum* Linn., *Jasminum multiflorum* (Burm. f.) Andrews. At present, about 29,288 ha of land is under cultivation of jasmine in India which is spread over the states like Tamil Nadu, Karnataka and Andhra Pradesh (Dadlani, 2007). Tamil Nadu accounts for about 9360 ha with an annual production of 77247 tonnes of fresh flower buds. Of late, there is an increasing demand for high-grade perfumes. There is also a tremendous scope for the development of essential oil industry with considerable foreign exchange by way of export of various jasmine based products.

Nevertheless, this popular commercial crop is ravaged by a number of insect pests and mite *viz.*, Erineum mite *Aceria jasmini* Chann., Bud worm *Hendecasis duplifascialis* Hmpsn., the gallery worm *Elasmopalpus jasminophagus* Hmpsn., the leaf web worm *Nausinoe geometralis* Guen., the blossom midge *Contarinia maculipennis* Felt., the red spider mite *Tetranychus cucurbitae* Rah., and root knot nematode *Meloidogyne incognita* Chitwood. apart from several diseases and deficiency symptoms.

The occurrence of the eriophyid mite, *Aceria jasmini* Chann. was first noticed in Tamil Nadu (David, 1958). on *Jasminum sambac* Ait. (Gundu malli) and *Jasminum flexile* Vahl. Later Channabasavanna (1966) reported its occurrence on *Jasminum pubescens* Wild. from Karnataka state. Colonisation by the mites results in the formation of felty outgrowths (erinea), resulting in malformation of vegetative and floral parts and consequent reduction in growth and yield. Sunder Raj *et al*. (1967) have reported that the infestation of this mite brought about severe damage to *Jasminum auriculatum* (J) in Coimbatore district. The long and pointed budded type is found be highly susceptible to the erineum mite.Parimullai which belongs to the species *Jasminum auriculatum* (J). (Medium round bud; with a flowering duration of nine months/year) is resistant to erineum mite.

Farmers depend mostly on chemical pesticides for managing these pests, because of the immediate and spectacular knockdown effects, often leading to indiscriminate use of broad spectrum pesticides culminating in reduction of biodiversity of natural enemies (Balasubramani and Swamiappan, 1993).Outbreak of secondary pests (David *et al.,* 1991), development of insect resistance to pesticides (Regupathy *et al.,* 1994), pest resurgence (Mitra *et al.,* 1999), dermal toxicity to the labours exposed in the field (Kuttalam and Regupathy, 1995), environmental pollution through accumulation of pesticides in soil, water and air and residues in agricultural products (Buttu *et al*., 1999). In order to mitigate these problems, concerted efforts in evolving an alternate strategy for pest management in recent years indicated a great potential for harnessing organic amendments, botanicals and biocontrol agents for the management of erineum mite of jasmine. Therefore, the present investigation was undertaken to evolve an IPM strategy for the management erineum mite on *Jasminum auriculatum* with the following objectives,

1. To conduct survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann.in the traditional jasmine growing tracts of Tamil Nadu.
2. To study the population dynamics/seasonal incidence of *Aceria jasmini* on jasmine to assess the influence of abiotic factors on temporal distribution.
3. To evolve an IPM strategy, incorporating the ecofriendly pest management methods against jasmine erineum mite.
4. To evaluate the bioefficacy of certain new acaricide / insecticide molecules and medicinal herbal extracts against *A. jasmini.*
5. To identify the alternate hosts and natural enemies of erineum mite of jasmine.

CHAPTER-II

REVIEW OF LITERATURE

Jasmine (mullai), *Jasminum auriculatum* Vahl. (Oleaceae) is one of the major traditional flower crops of India, Which is a climbing, trailing, erect, shrubby lowering, evergreen and deciduous plants. Jasmine buds are used for making garlands, bouquets, religious offerings and for the extraction of perfumed oils and attars. Jasmine is known in India as the "Queen of the Night" because of its perfume, released from the flowers. The flowers and parts of the plant also find a place in preparation of ayurvedic medicines (Ramadas *et al.,* 1985). Jasmine is attacked by several insect pests and mites (David, 1960, Sivagami and Janarthanan, 1963; Sivagami and Nagappan, 1967; Perumal *et al.,* 1971; Nair and Nair, 1974; David and Kumaraswami, 1975; Easwaramoorthy *et al.*, 1980; Tewari and Mohan, 1981; Vyas, 1998; Chandra Sekaran *et al.,* 2000; Saravanan and Umapathy, 2003).The Erineum mite, *Aceria jasmini* Chann. is one of the serious pests on mullai. It was also reported *as* a pest on other important species *viz*., *Jasminum sambac* Ait. *Jasminum flexile* Vahl. (David, 1958), *Jasminum pubescens* Wild. (Channabasavanna, 1966), *Jasminum multiflorum* (Burm.f.) Andrews (Umapathy and Mohanasundaram, 1998).

The review of work includes the literature pertinent to, distribution, symptom of damage, yield loss, biology, varietal screening for resistance, impact of organic and inorganic sources of nutrients and entomopathogenic fungi, botanical pesticides- bioefficacy of certain newer acaricide / insecticide molecules on Erineum mite, *Aceria jasmini*.

2.1. DISTRIBUTION

The occurrence of the eriophyid mite, *Aceria jasmini* Chann. on *Jasminum sambac* Ait. and *Jasminum flexile* Vahl. was first reported in Tamil Nadu (David, 1958). Later Channabasavanna (1966) reported the occurrence on *Jasminum pubescens* Wild. from Karnataka State. *A. jasmini* was recorded on *Jasminum auriculatum* (Sunder Raj *et al.,* 1967; Mohan and Udayagiri, 1985). New hosts and distribution of erineum mite *Aceria jasmini* were reported from South India (Umapathy and Mohanasundaram, 1998). New species of eriophyid mite *Calacarus jasmini* and *Phyllocoptus salmaliae* were reported from West Bengal on *Jasminum sambac* (Chakrabarti and Mondal, 1979). The incidence of *Aceria jasmini* was found to increase from March and reached its peak during July (Jose *et al.,* 1999).

2.2. SYMPTOMS OF DAMAGE

The white outgrowths of excessive hairs in small patches on leaves of *Jasminum auriculatum* are known as erinea with a characteristic swelling on both the surfaces of the leaves. The eruptions are produced singly in the beginning, which coalesce later. Shoots are also damaged by the mites with resultant erineum. When the leaves are completely covered by the blisters, their function is severely restricted and the vitality of the plant is greatly reduced, ultimately resulting in complete arrest of bud / flower formation (David, 1958). It has been also observed that the infestation by the eriophyid mite, results in severe malformation of vegetative and floral parts of the plant, leading to serious damage to the crop coupled with heavy yield loss (Sunder Raj *et al*., 1967). In case of severe infestation, the erineal lesions could be observed on the tender shoots, young emerging leaves also (Letchoumanane and Subramaniam, 1981).White velvetty outgrowths as small patches were recorded on leaves of *Jasminum auriculatum* (Mohan and Udayagiri, 1985; Jeppson *et al.*, 1994; Umapathy and Rajendran, 1999).

2.2.1. Eriophyid galls

The family Eriophyidae is extremely important, as much by virtue of its high number of cecidogenous species as by virtue of the diversity of cecidogenous effects. Of the approximately 500 gall- inducing species of Eriophyidae in the world (Mani, 1964), 350 are from Central and Northern Europe (Buhr 1964). Nalepa (1929), Roivainen (1953) and Keifer (1971) reported the occurrences of eriophyids in California. Jeppson, Keifer and Baker (1975) reported the works in California. Mathez (1965) mentioned the details of the monographs of *Eriophyes vitis* Pgst. on grapevine.

Noteworthy works on the morphology of acarocecidia was reported by Thomas (1877) and Schlechtendal (1916). A fairly complete catalogue was published from North America by Keifer, Baker, Kono, Delfinado and Styer (1982).The anatomy was studied by Fockeu (1896). Cytological studies were reported by Molliard (1897), Nemec (1924), Kendall (1930), Garrigues (1951) and Westphal (1977). Westphal (1977a) reported the morphogenesis and ultrastructural cytology of various types of acarocecidia. Westphal (1977b) reported the sequence of cecidogenetic processes occurring at early stages of induction of pouch galls on the leaf of *Prunus padus* L. by *Phytoptus padi* Nal.

2.2.2. Morphology and anatomy of eriophyid galls

Host reactions are mainly species- specific to the eriophyids. All the young aerial parts can be attacked, especially the vegetative and floral buds, as well as the leaves.

2.2.2. 1. Organoid galls

Morphogenetic action produced organoid galls. The role of eriophyids for inducing virescences was well demonstrated by Peyeritsch (1888). The virescences caused by *Eriophyes lycopersici* (Wolff). (= *E. cladophthirus* Nal.) and *E. peucedani* Can. was reported by Molliard (1905) and Westphal (1968). Westphal (1968) reported that, in addition to organoid action, eriophyids can stimulate the tissues and transform into well-differentiated nutritive tissues and *E. lycopersici* (Wolff) is not very specific in its host selection. Organoid effects also have been obtained experimentally by introducing individuals coming from *Solanum dulcamara* L. to other species, including *S. capsicastrum and S. luteum* Mill., and even different genera, like *Nicandra physaloides* and *Petunia hybrida*.

Arnold (1968) reported that, *Eriophyes loewi* Nal. causes witches' brooms on lilac. and apical transformations on *Nothofagus*, *Clianthus* and *Plagianthus.* Arnold (1970) reported that, cecidogenetic action can even lead to more or less total suppression of leaves.

2.2.2. 2.Histoid Galls

The attacked buds remain closed but greatly enlarged, as in the gall of *Cecidophyopsis psilaspis* Nal. on *Taxus baccata* L., the bud scales and young leaves are transformed and exhibit excrescences on their surface. Cecidogenetic action on leaves is extremely variable. Initially the "erinea" which occur in the form of mats of nutritive hairs. Erinea are extremely common in Europe on certain trees, particularly *Maples lindens*, beeches and alders. The nutritive hairs vary greatly, which are often species- specific with respect to the mite. Kuster (1952) reported that, in case of erineum on *Acer campestre*, the hairs arise after brief induction by feeding of the mite.

Nutritive hairs can sometimes arise in the larval cavities of pouch galls. But most in the galls of *Eriophyes similis* Nal. on *Prunus spinosa* L., (Kuster, 1930) as well as in leaf margin roll gall of *E. goniothorax* Nal. on *Crataegus oxyacantha* L. (Ross, 1932).

2.3. YIELD LOSS

Sunder Raj *et al.* (1967) recorded an yield loss of 59 to 74 per cent by weight owing to the infestation of erineum mite, *Aceria jasmini*. Saravanan and Umapathy (2003) also reported an yield loss of even 100 per cent in severe case of infestation.

The copra yield loss in Central and South America and the Caribbean and West Africa due to *A. guerreronis* Keifer. was recorded to be 30 per cent (Hernandez, 1977).

Mariau (1977) estimated an yield loss of copra as high as 25 per cent in the Caribbean Islands of Africa and America due to coconut perianth mite attack. Moore *et al*. (1999) had pointed out 31.50 per cent loss in potential nut yield of coconut. Kannaiyan (2000) reported an average loss of copra yield as 10 to 15 per cent in Tamil Nadu due to coconut mite attack. Ramaraju *et al*. (2002) found that the copra content was 1.6 kg copra per 10 healthy (uninfested) nuts, as against 1.16 kg in case of 10 infested nuts and the estimated loss of copra in Tamil Nadu was 27.5 per cent.

2.4. BIOLOGY

Channabasavanna (1966) recorded several biological observations on *Aceria jasmini*. Further, the structural and behavioral features of *Aceria jasmini* find a parallel in other eriophyids such as *Eriophyes ficus* (Baker, 1939), *Aceria sheldoni* (Boyce and Korsmeir, 1941), *Eriophyes vitis* (Kido and Stafford, 1955), *Aceria litchi* (Alam and Wadud, 1963). The life cycle of mite consists of egg, nymph, and adult stages. The eriophyid mite, *Aceria jasmini* is found to colonise several vegetative and floral organs of the jasmine plant. Egg laying is mostly inside the unopened leaf and leaf axils and there are three nymphal instars, with quiescent period occurring between the first and second instars. Eggs are laid singly, close to the base of hairs on the leaves. They are oval, transparent when fresh, turning to pearly white prior to hatching. The mean length and breadth being 45.9 and 38.8 microns respectively. Incubation period ranges between 2 and 5 days, averaging 3.6 days. In between I and II instar, a short quiescent period intervenes. The nymphs pass through three instars to reach the adult stage. The nymphal stage lasts for 8-11 days (Letchoumanane and Subramaniam, 1981).

The adult is vermiform, with its cylindrical body gradually tapering towards the caudal end. The mean length and width measures 190.1 microns and 51.9 microns respectively. The body is white with the gnathosoma being much reduced and set off from the rest of the body. The chelicerae are short and below these is the rostrum with a fine, slender and highly reduced stylet. Two pairs of six segmented legs are seen, being borne on the propodosoma. The tarsus is wedge shaped with its pointed, possessing a strong and thick three rayed feather claw. The total life cycle of the mite lasts for about 18.7 days ranging between 17 and 20 days (Letchoumanane and Subramaniam, 1981).

According to Saravanan and Umapathy (2003) the different life stages of Jasmine mite, *A. jasmini* indicated that the mean incubation period was 2.95 days, total nymphal period last for 6.7 days, where as the total longevity lasts for 14.40 days.

2.5. BIOSYSTEMATICS AND BIODIVERSITY

The earliest record of an eriophyid mite in this country was by Green (1890) who made certain observations on *Calacarus carinatus* (Green), the purple mite of tea. The pink mite of tea, *Acaphylla theae* (Watt, 1988) was also recorded towards the end of the last century (Watt and Mann, 1903). Later Das and Sengupta (1963) reported the occurrence of pink mite of tea in North East India and on the biology and management of the purple mite.

In the early decades of the nineteenth century, there were stray reports on the incidence and distribution of eriophyid mites (Misra, 1920; Massee, 1927; Cherian, 1931; Saksena, 1942; Muthukrishnan, 1956).

The first elaborate systemic account on Indian eriophyidae was published by Channabasavanna (1966) who recorded 61 species of mites under 18 genera. Later in the 1970's, the Indian eriophyid studies had a fillip due to contributions by Mohanasundaram (from 1979 to till date) who recorded hundreds of new taxa from South India. West Bengal and Andaman & Nicobar Islands eriophyid mite species have been reported by Chakrabarti, Ghosh, and Mondal (1981), also have reported several new taxa from Northern and North eastern states of our country.

2.6. VARIETAL SCREENING FOR RESISTANCE AGAINST JASMINE ERINEUM MITE

The study by Sunder Raj *et al.* (1967) revealed that the long and pointed budded variety was highly susceptible (94%) to the erineum mite while the medium and pointed budded selections recorded a negligible infestation (3.5%). Rajagopal (1968) proved that out of 15 species and 36 varieties of jasmine evaluated for the degree of mite injury, based on the assessment of erineum, *Jasminum auriculatum blood* were infested severely. Rajagopal *et al.* (1970) reported that the physiological mechanisms of resistance in jasmine was due to the feeding injury of mite on the plant surface, the epidermal cells became meristematic, producing multicellular uniseriate rows of hairs which later formed erineum. The resistant varieties were found to have a larger number of vascular bundles with highly ramifying veins in the mesophyll, whereas the susceptible varieties had comparatively fewer vascular bundles with lesser ramification of the veins in the mesophyll.

2.7. INFLUENCE OF ABIOTIC FACTORS ON THE INCIDENCE OF ERINEUM MITE

2.7.1. Effect of temperature, relative humidity, and rainfall on mite infestation

Letchoumanane and Subramaniam (1981) studied the seasonal fluctuations of the erineum mite, *A. jasmini* at various temperature- humidity combinations. The incidence was above 75 per cent (77.7% to 96.7%) during April to October and this part of the year experienced relatively lower humidity (84 to 90% RH) coupled with a higher maximum temperature (29 to 36 ºC). There was a gradual reduction in infestation during November and February. The period between October and December also experienced considerable precipitation, and the minimum temperature was lower (15-20 ºC) during this period of decline. The highest mite incidence (97.1%) observed in July and lower humidity levels (84% RH). Further, the two peaks in maximum temperature, one in May (37 ºC) and the other in September (32 ºC), were apparently marked by corresponding peaks in mite infestation.

Coconut mites were found rarely and in small numbers in matured nuts (Moore and Alexander, 1987).They occurred in both tropical and subtropical climates, more severe in relatively, dry climates (Zuluaga and Sanchey, 1971; Griffith, 1984; Howard *et al*., 1990).However, no clear relationship existed between mite population and wet and dry weather, or if such relationship existed, it was obscured by other factors (Doreste, 1968; Mariau, 1977; Howard *et al.*, 1990; Ramaraju *et al*., 2002). Mohammed *et al.* (1999) observed that the prolonged lower maximum temperature and minimum temperature, high humidity and absence of rainfall coincided with peak activity. They also found that the maximum and minimum temperatures had a significant negative influence of the population buildup of the yellow mite, *Polyphagotarsonemus latus* (B.) on chilli. Ramaraju *et al*. (2002) recorded maximum population of mite during May and fairly high mite populations even during the rainy months. Though the coconut mite is found throughout the year, the maximum population was recorded during summer with a fairly high mite populations during the rainy months (Kannaiyan, 2000).

Boudreaux (1958), who studied the role of humidity on the biology of spider mites, postulated that low humidity favoured reproduction and development. Alam and Wadud (1963) found that hot and dry weather periods favoured the multiplication of the mite, *A. litchi*, while damp weather and considerable rains deterred the population build up. Huang (1967) found that *A. litchi,* the influence of rainfall rather than temperature had an overwhelming impact on the seasonal population of the mite. Sharma *et al*. (1986) found temperature and humidity influenced the population of *Aceria litchi.* Detrimental influence of rainy weather on mite population has also been reported among several tetranychid species (Huffaker and Mc Murtry, 1969).

Rice and strong (1962) reported that the tomato russet mite, *Aculops lycopersici* (Massee), had its shortest life cycle at 27.6 C and at a relative humidity of 30 percent. Davis

(1964) reported that a magnolia leaf vagrant, *Rhynacus breitlowi* (Davis), which tested in the higher atmospheric humidities of Georgia, required about 30 C temperature and a 4 mm saturation deficit for optimum growth.

2.8. EFFECT OF ORGANIC AND INORGANIC SOURCES OF NUTRIENTS ON JASMINE MITE

2.8.1. Effect of organic sources of nutrients

Organic manuring was found to have slow release effects on nutrients providing a balanced growth, thus making the plants less prone to pests and diseases. In India, neem (*Azadirachta indica* A. Juss.) and pungam (*Pongamia glabra* L.) are commonly available and they have been exploited as botanical pesticides. The oil cakes are invariably used as soil amendments and further play a multirole as organic fertilizer, antifeedant and insecticide. In addition to deterrent action, neem seed cake (NSK) residue contained a greater concentration of nitrogen, phosphorus, potassium, calcium and magnesium than farmyard manure and might economize the use of fertilizers (Basu, 1989). Neem cake has been recognized as potent organic fertilizer as it combines the properties of fertilizer as well as pesticide (Sidhu *et al.*, 2002).

Rani and Mohan (1994) reported that, soil application of neem cake @100g / plant and foliar application of neem oil 2% significantly suppressed the damage by *Aceria jasmini* on *Jasminum auriculatum*. Chinniah and Mohanasundaram (1995) reported that, the superiority of neem formulation viz., NSKE 10% and neem oil 3% caused 90.0 and 87.7 per cent mortality respectively of *A. cajani* on pigeon pea. Ramarethinam and Marimuthu (1998) recommended Neem oil formulation at 25 to 30 ml per liter of water for the control of the coconut mite, *A. guerreronis* K. Muthiah and Baskaran (2000) recorded 63 per cent population reduction of mite using Neem oil 2 per cent + Garlic extract (2 per cent).

Soil application of neem cake @ 250kg/ha combined with foliar application of NSKE 10% was found be effective in controlling erineum mites (Umapathy and Rajendran, 1999). Muthiah and Bhaskaran (2000) reported that, the coconut perianth mite mean damage grade index in the chemical fertilizer treatment was the highest (50%).While the least damage (29%) was observed in the treatment of neem cake @2 kg + bone meal 0.5 kg + mill ash 4 kg (per tree/Year).

The studies conducted by Chakrabarti (2004) revealed that the application of neem cake @ 3 kg \ m^2 effectively controlled yellow mite population on chilli. The investigations on the influence of organic based sources of nutrients and biofertilizer against red spider mite, *T. urticae* (Koch) on okra revealed that application of farm yard manure @ 12.5 t/ha and biofertilizer (Azophos @ 2 kg/ha) with any of the oil cakes *viz*., neem cake @ 600 kg/ha or pungam cake @ 800 kg/ha as basal was found to be effective in reducing the mite population significantly (Balaji and Chinniah, 2006). The various organic sources of nutrients evaluated as basal application of farm yard manure @ 6.25 t/ha + neem cake @ 300 kg/ha + Azophos @ 1kg/ha was found to be significantly effective in reducing the chilli yellow mite,*P. latus,* egg and mite population (Ambika and Chinniah, 2007).

Soil application of neem cake effectively checked the infestation of mango mealy bug, *Drosicha mangiferae* (Green) (Tandon and Lal, 1980). The development of BPH nymphs was significantly reduced on TN 1 rice seedlings when 2 per cent neem cake was mixed with water soaked seeds for 48 hours (Abdul Kareem *et al*., 1987). Mallik and Lal (1989) reported that, deoiled neem cake application @ 5 kg per plot reduced the incidence of the fruit borer in okra. Rajendran (1993) observed that neem cake @ 250 kg/ha along with 20 kg N was found to be superior than pungam, illuppai and castor cakes against sucking pests of okra. The populations build up of *Nilaparvata lugens* (Stal.) was found to be low in rice, applied with 3: 10 neem cake – urea mixture than in control plots (Saxena *et al*., 1984). Velusamy *et al*. (1987) stated that neem cake blended urea @ 75 kg N / ha recorded less population of green leaf hopper compared to control. Neem cake + carbofuran mixture (1:1 w/w) effectively checked the population of rice GLH, *Nephotettix virescens* (Distant.) and in turn rice tungro virus infection (Abdul Kareem *et al*., 1989). Geetha and Gopalan (2001) reported the reduction of BPH population in neem cake treated plots.

Dayakar *et al*. (1995) recorded the least incidence of pod borer on pigeon pea treated with Farm Yard Manure @ 6000 kg/acre. Application of FYM @ 30t/ha reduced the population of aphids, jassid and fruit borers compared to NPK as straight fertilizers @ 100:50:50 kg/ha on bhendi (Surekha and Rao, 2000). Godase and Patel (2001) advocated application of FYM @ 20 t/ha to control the incidence of sucking pest on brinjal. Appreciable reduction of nematode gall index of *Meloidogyne incognita* (Kofoid & White) on brinjal was observed in FYM treated plots (@ 25t/ha) (Karthikeyan *et al*., 2001). Rao *et al*. (2001) observed the least incidence of groundnut leaf miner, *Aproaerema modicella* (Dev.) in FYM treated plots. Apart from this, the FYM recorded the least incidence of groundnut sucking pests namely jassid, *Empoasca kerri* (Pruthi) and aphid, *Aphis craccivora* (Koch) when compared to straight fertilizers (Rao, 2002).

2.8.2. **Effect of plant products**

Rani and Mohan (1994) reported that, foliar application of 4% aqueous extract of pongamia kernel significantly suppressed the damage by *Aceria jasmini* on *Jasminum auriculatum*. Five per cent aqueous leaf extracts of *Lippia nodiflora* (Nees.), *Cissus* *quadrangularis* (L.), *Aloe* sp (Mill.) and *Vitex negundo* (L.) were found to significant reduce the yellow mite population on chilli. Aqueous leaf extract of neem (5 per cent) also reduced the chilli yellow mite population (Palaniswamy and Ragini, 2000; Ramaraju, 2002). Basal application of neem cake @ 600 kg/ha + *Ocimum sanctum* (20% aqueous leaf extract as foliar spray) recorded maximum per cent reduction of chilli yellow mite (93.04**)** and egg (90.78) population, followed by basal application of farm yard manure 12.5 t/ha + *O. sanctum* (20% aqueous leaf extract as foliar spray) which ranked second in terms of reduction of chilli yellow mite population (Ambika and Chinniah, 2007).

Foliar application of powdered neem cake or neem seed @ 3 per plant after crop emergence significantly reduced the foliar damage of *Chilo partellus* on maize (Saxena, 1998). Rosaiah (2001) reported that, NSKE five and ten per cent, neemazal 0.5 per cent were effective in reducing jassid population on okra. Bhanukiran and Panwar (2005) found that the incidence of maize stalk borer, *C. partellus* was the lowest in the plots treated with azadirachtin based formulations i.e. Neem Azal – F 5 EC and Neem Azal – T/S 1 EC.

Singh *et al*., (2004) reported that plant extracts of *Melia azadirachta* (L.), *Jatropha gossypifolia* (L.), *Ageratum conyzoides* (L.), *Lantana camara* (L.), *Acorus calamus* (L.) and *Artemesia nilagirica* (L.) sprayed at five per cent concentration were found very effective in reducing aphid population significantly on cabbage. Aqueous plant extracts from *Wedelia calendulacea* (L.) and *Acorus calamus* (L.) @ five per cent was found to be effective in controlling the activity of *S. litura* (Fab.) (Raja *et al.,* 2003). Neemazal one per cent significantly reduced the incidence of *S. litura* (Fab.), *Aproaerema modicella* (Dev.) and *Aphis craccivora* (Koch) on groundnut (Jayakumar *et al.,* 2004). Neem in combination with *A. calamus* (L.) and *Pongamia glabra* (L.) @ 0.3 per cent inhibits the growth of *E. vittella* (Hub.) on bhendi (Srinivasa Rao *et al*., 2002).

2.8.3. **Fungal biocontrol agents of mites**

Fungal pathogens are most virulent against Acari and insects. The fungal pathogens against Acari (‘acaropathogenic’ fungi) probably form a functional sub group within the entomopathogenic fungi occurring in the same phylogenetic assemblages as the latter, but being less diverse (Poinar and Poinar, 1998). *Hirsutella thompsonii,* when applied as a foliar spray to orange trees infested with high populations of citrus rust mite *Phyllocoptruta oleivora* (Ashmead) suppressed the mite population significantly. Mite populations remained at low levels for 10 – 14 weeks (Mc Coy *et al*., 1971). Smitley *et al.* (1986) reported that *Neogygites floridana* (Weiser and Muma) was a key natural enemy of *T. urticae* and the Banks grass mite, *Oligonychus pratensi* (Banks) in the mid western and south eastern USA which caused epizootics in populations of these mite pests on maize, soybean, peanut and sorghum.

The natural incidence of *H. thompsonii* on coconut eriophyid mite, *Aceria guerreronis* (Keifer) in certain districts of Karnataka and Tamil Nadu was reported by Kumar *et al.* (2000). Xian Hong *et al*. (2001) reported that *Lecanicillium lecanii* V-816 strain was isolated from the body of *Anoplophora chinensis* (Forster) adults; a formulation of the V-816 strain containing 1% Tween – 80 and 4 x 10^7 spores / liter was sprayed against *T. urticae*. Its pathogenicity was significantly higher. Neem cake in combination with *B. bassiana* / *Paecilomyces fumosoroseus* recorded maximum reduction of mite population (Balaji and Chinniah, 2006). Neem cake in combination with *Hirsutella thompsonii* \ B. *bassiana* recorded maximum reduction of chilli yellow mite population (Ambika and Chinniah, 2007).The sensitivity of green house whitefly and two spotted spider mite, to two local isolates of entomopathogenic fungi *P. fumosoroseus* was determined. Their biological efficacy against whitefly on 8^{th} day after treatment was 83.1 and 37.6 – 85.2%, respectively. On the 14^{th} day, 100 and 95.2 – 100% against two spotted spider mite, on 6^{th} day 93.1 and 54.3% and on 9^{th} day 96.4 and 32.3% (Yankovskaya, 1999).

B. bassiana was proved to be a potential biocontrol agent against the rice hispa, *Dicladispa armigera* (Oliv.). The mortality of adult reached up to 80% at a spray concentration of 10^6 spores/ml of water (Puzari *et al*., 1997). Saxena and Ahmad (1997) also reported a similar trend i.e. application of *B. bassiana* against gram pod borer, *H. armigera* (Hub.) and coupled with a minimum pod damage. *B. bassiana* and *M. anisopliae* have been proved to be pathogenic to the adults of *Delia radicum (*L.) and *D. antiqua* (Meigen). The fungal isolates caused less mortality to *D. antiqua* (L.) larvae than adults. *Metarhizium anisopliae* was found to cause more than 50% mortality of *D. antiqua* (L.) larvae (Davidson and Chandler, 2005). *Agrilus planipennis* (Fairmaire) adults were susceptible to *B. bassiana* (Liu and Bauer, 2006).

2.9. EFFECT OF ORGANIC AND INORGANIC SOURCES OF NUTRIENTS ON SOIL MICROFLORA

Microbes continuously added to soils as biofertilizers increased soil organic carbon, microbial polysaccharides and in turn improved soil properties. The repeated application of microbes through biofertilizers increased the availability of N, P, K and other micronutrients to the crops (Dubey, 2001). Although microbial biomass accounts for only about 1 to 3 per cent of the soil organic matter, it exhibits a rapid turnover and can be considered as a driving force of major nutrient cycles.

2.9.1. Farm yard manure

Vemana *et al*. (1999) observed maximum increase in the fungal and bacterial population in farm yard manure treatment. Higher bacterial population, available nitrogen and organic carbon content were observed in FYM treated plots (Sriramachandrasekaran, 2002). Farm Yard Manure @ 12.5 t/ha in combination with neem cake @ 600 kg/ha, pungam cake @ 800 kg/ha and Azophos @ 2 kg/ha, registered more fungal and bacterial population (Balaji and Chinniah, 2006). Combination with biofertilizer, basal application of farm yard manure @ 6.25 t/ha + neem cake @ 300 kg/ha + Azophos @ 1kg/ha was found to have maximum bacterial colonies 126.50 x 10^6 and fungal colonies 20.75 x 10^3 in soil (Ambika and Chinniah, 2007).

2.9.2. Neem cake

Goswamy and Bhattacharya (1989) reported greater frequency of fungi in neem cake amended soils. Maximum soil fungal colonies and maximum plant growth were recorded in plots amended with neem cake (Pandey and Singh, 1990). There was a marked predominance of *Aspergillus spp*. in neem amended soil. Increased fungal population during the decomposition of oil cakes could be due to the release of acids and other chemicals from decomposing oil cakes which changed the soil environment in favour of dormant fungal bodies present in soil originally. These dormant bodies on getting suitable environment and organic carbon as food from decomposing oil cakes multiply fast and increase quantitatively as well as qualitatively. Neem cake @ 600 kg/ha + *B. bassiana* (1x10^8 colonies per gram) registered more fungal and bacterial population (Balaji and Chinniah, 2006). Application of neem cake @ 600 kg/ha + *Ocimum sanctum* (20% aqueous leaf extract as foliar spray) recorded the maximum number of bacterial (128.63 x 10^6) and fungal colonies (28.25 x 10^3) in the rhizosphere soil (Ambika and Chinniah, 2007).

2.9. 3. Pungam cake

Pungam contained more nitrogenous matter and favoured the production of urease by soil microorganisms (Balasubramanian *et al*., 1972). The positive effect of neem and pungam cakes on the rhizosphere microflora of groundnut was proved and found to have no detrimental effect on beneficial microbial biomass (Abdullah *et al.*, 1999). Further it was proved to be superior in improving the rhizosphere mycoflora.

2.10. EFFECT OF HOST PLANT RESISTANCE ON MITE INFESTATION

Rajagopal *et al*. (1970) reported that the high yielding Mullai selection, medium long and pointed budded variety (*Jasminum auriculatum* Vahl.), is highly resistant to the erineum mite, *Aceria jasmini* Chann. Mariau (1986) reported that cultivars varied in their susceptibility to coconut mite infestations and trees of cultivars from Cambodia suffered no attack. This may be due to the fact that tepals were more tightly adpressed to the fruits in rounded nuts than in elongated ones (Moore, 1986; Howard and Rodriguez, 1991). Upto 90 per cent of the trees were attacked in varieties Atlantic tall as against lower infestation in Malayan Yellow Dwarf in Costa Rica (Schliesske, 1988).

2.11. EFFECT OF CULTURAL PRACTICES ON MITE INFESTATION

Pruning of jasmine shoots reduced the infestation of *Aceria jasmini* Chann., so as the population of *A. litchi* Keifer. was significantly reduced on litchi when the affected shoots were pruned (Kumar, 1992). Long periods of drought resulted in greater yield losse due to the coconut perianth mite (Mariau, 1977 and 1986), because the fruit development was very slow during dry periods. Well maintained trees, with appropriate fertilizer application, were found to suffer less from coconut perianth mite attack.

2.12. EFFECT OF INSECTICIDES FOR THE MANAGEMENT OF ERIOPHYID MITES

Management of eriophyid mites has become challenging on account of its potent damage to some important crops. Evaluation of soil application of four insecticides at four doses (0.5, 1.0, 1.5, and 2.0 kg a.i / ha) indicated that aldicarb at the highest dose could provide the best control of Jasmine mite, *Aceria jasmini* followed by carbofuran and phorate, while disulfotan was the least effective chemical (Letchoumanane and Subramaniam, 1981). Fortnightly application of monocrotophos @ (0.5 kg a.i per ha), Phosalone (0.7 kg a.i per ha) or Wettable sulphur (1 kg a.i per ha) was found to be effective in controlling *Aceria jasmini* (Mohan and Udhayagiri, 1984). Mallikarjunappa *et al.,* (1991) reported that a mixture of ethion 0.05 % and dimethoate 0.03 % effectively reduced the incidence of Jasmine mite in Karnataka. Spraying of Wettable sulphur 0.3% or triazophos 0.06% with the onset of monsoon at 14 days interval, when repeated 2-3 times, provided effective control of *A. jasmini* (Shivaramu and Jhansi Rani, 1996). Application of carbofuran at a higher dose (2 kg/ ha) resulted in substantial reduction of *Aceria jasmini* population on jasmine (Umapathy and Rajendran, 1997). Jose *et al*. (1999) reported that diafenthiuron (0.1 %) was the most effective chemical followed by bromoprophylate (0.1 %), dicofol (0.1 %) and monocrotophos (0.1 %) in controlling *Aceria jasmini* Chann. Untreated crops were severely infested during July to August where more than 90% of branches exhibited damage symptom. However, Saravanan and Umapathy (2003) reported that field evaluation of triazophos was more effective in controlling *Aceria jasmini* Chann.

Acaricides *viz*., Bromoprophylate, endosulfan, binapacryl, chlorobenzilate, triazophos, omethoate were reported as effective treatments against cocoa bud mite, *Eriophyes reyesi* (Jesus *et al*., 1991). Management of litchi mite, *Aceria litchi* by pruning the infested twigs combined with foliar application of dicofol or monocrotophos at 0.05% recorded effective control (Kumar, 1992). The apple rust mite, *Aculus schlechtendali* Nalepa was effectively managed by timely application of tricyclohexyl tin hydroxide, fenpyroximate and pyridaben (Funayama and Takahashi, 1993). Mancozeb was effective chemical in controlling *Phyllocoptes oleivora* (Iskander, 1993). Gyorffyne (1994) reported the efficacy of the new acaricide, magister 200 @ 0.5 l/ ha against *Calepitrimerus vitis* Nalepa on grapes. Dicofol and Wettable sulphur were found to be effective as preventive acaricides against *Aceria pongamia* Keifer. which is responsible for formation of profused leaf and flower galls (Umapathy and Mohanasundaram, 1995).

The effect of certain acaricide on yellow mite of chilli, *Polyphagotarsonemus latus* was reported by Thangaraju *et al*. (1995), on sorghum mite, *Oligonychus indicus* (Manjunatha *et al.*, 1995) and Red spider mite, *Tetranychus telarius* on brinjal (Veeravel *et al*., 1995). The rust mite, *Calepitrimerus russoi* Di Stefano could be controlled by the application of two rounds of amitraz (Haungens, 1996).The use of several conventional and newer acaricides against *A. jasmini* was reported by Umapathy and Rajendran (1997). In an interesting study, it was found that the leaf mite of mango, *Cisaberoptes kenyae* Keifer remained unaffected by dicofol @ 1.5mi, Wettable sulphur @ 2g, endosulfan @ 1.5ml, neem oil @ 3% and neem seed kernel extract (NSKE) @ 10% due to the presence of silvery layer on the upper leaf surface which acted as a protective coating (Umapathy, 1997). In an experiment to evaluate certain acaricides against the bud mite of mango, *Aceria mangiferae* Sayed, it was observed that the performance of dicofol was superior followed by monocrotophos with 84.0% and 79.0% reduction on pest population respectively (Umapathy and Rajendran, 1997).

Danitol 10E was observed to be an ideal acaricides and safer to predatory mites (Mallikarjunappa *et al.*, 1999). Kannaiyan (2000) recommended spot application of any one of the chemicals like triazophos 40 EC (5ml /l), monocrotophos 36 SP (1.5 ml/l) or carbosulfan 25 EC (2 ml/l) in alternation with Neemazal T/S 1% (5 ml/l) and root feeding of monocrotophos, triazophos, carbosulfan at the rate of 15 ml + 15 ml water in alternation with a 45 days of waiting period for harvest after treatment. Muthiah and Baskaran (2000) observed two sprayings of triazophos @ 5 ml/l (or) 2 ml/l to give significant reduction of the mite population. The coconut mite, *Aceria guerreronis* K. was also managed by crown spraying of triazophos 5 ml/l, methyldemeton 4ml/l or monocrotophos 1.5ml/l and in taller trees root feeding of monocrotophos 15ml chemical + 15ml of water per tree was recommended (Ramaraju *et al*., 2002).

2.13. ACARICIDE RESIDUES

Kale and Dethe (1996) reported that the initial residue of dicofol in green chilli harvested was 3.12 to 4.55 ppm when applied @ 250 to 500 g a.i/ha. The residue level was below the permissible limit (5 ppm). Residue half-life was 3.08 to 3.29 days. Residue levels of lindane on the day of spraying was 1.42 to 2.10 ppm when applied @ 150 to 300g a.i/ha which was less than the MRL (3 ppm) prescribed for lindane (Dethe *et al*., 1997). The waiting period of triazophos was 5 to 9 days in bhendi and it was found as 26.5 days in curry leaf (Vijayalakshmi *et al*, 2000; Vijayalakshmi and Kuttalam, 2000). Suganya Kanna *et al*. (2006) reported that the residues of Spiromesifen 240 SC dissipated to below detectable limit (BDL) of 0.16 ppm when sprayed @ 400 ml/ha and 0.66 ppm @ 800 ml/ha on tea. The residues of quinalphos and triazophos were found to be below the maximum residual limit (MRL) of 0.01 and 0.05 mg/kg @ 2.0 kg a.i/ha and 0.250 kg a.i/ha on paddy (Chahal and Singh, 2006). Chechani and Gupta (2006) reported that when ethion was sprayed @ 1000 and 2000g a.i/ha, the residue was 3.76 – 3.85 ppm. The half life values and waiting periods were 2.48 – 2.71 days and 4.31 – 4.37 days. Raj *et al*. (1990) reported that the residue of endosulfan on cotton was 0.5 and 0.2 mg/kg when applied @ 700 and 1400 g a.i /ha. Chinniah *et al*. (1999) reported the residue of lindane was 0.015 and 0.017 mg/kg when applied @ 500 and 1000g a.i/ha which was below the tolerance limit on cotton. The residue of carbaryl when sprayed @ 1250 g a.i/ha was found below the MRL of 1.0 mg/kg (Gupta *et al*., 1990).

CHAPTER -III

MATERIALS AND METHODS

Survey was conducted in jasmine growing tracts of Tamil Nadu to assess the incidence and population of Jasmine Eriophyid mite and its damage potential. Field experiments were carried out at Horticultural College & Research Institute, Periyakulam, to assess the seasonal incidence and population dynamics of erineum mite, *Aceria jasmini* Chann. on *Jasminum auriculatum* Vahl. (Mullai) and to evaluate the influence of organic amendments, botanicals, biopesticides and bioefficacy of certain new acaricide / insecticide molecules for the management of Jasmine erineum mite. The details of the materials used and methodology adapted are furnished below.

3.1. Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann. in the major jasmine growing tracts of Tamil Nadu

Surveys were conducted to assess the incidence, population and the damage potential of Eriophyid mite on *Jasminum spp*. in different, traditional floriculture tracts of Tamil Nadu.

The traditional jasmine growing tracts of Tamil Nadu *viz*., Madurai, Periyakulam, Dindigul, Theni, Erode, Coimbatore, Mettupalyam, Ramnathapuram, Salem and Dharmapuri were surveyed for the occurrence and severity of erineum mite. A total of 50 localities were surveyed during the course. The damage intensity was assessed by grading method (1-4 scale) as suggested by Saravanan and Umapathy (2003). The mite population and egg count was observed per $2mm^2$ of affected leaves. The mite population was assessed from the damaged sample, collected at random from the affected plants. Before observing the population, the leaf samples were spread on a flat surface under table lamp in the evening hours to slowly desiccate the leaf material so that the mites come out of the erineal patches. The parameters like number of mites and number of eggs were recorded after 24 hours in $2mm^2$ area by viewing through a stereozoom microscope. Besides, information on pesticide use in jasmine against mite was also collected from growers.

3.1.1. Damage potential of *Aceria jasmini*

The severity of damage (Plate no: 10) was assessed in field conditions by adapting the grading method suggested by Saravanan and Umapathy (2003).

Grade	Scoring
1	0 – 25 % of foliage with erineum symptom
2	26 – 50 % of foliage with erineum patches
3	51 – 75 % foliage, stem and floral parts with erineum
4	76 – 100 % foliage, stem and floral parts with erineum

Two years old jasmine (Jasminum *auriculatum*) bushes with uniform infestation were selected and tagged for observation. The flower yields from ten consecutive pickings were recorded and the mean yield was worked out. The data were statistically analysed.

3.2. Seasonal incidence and population dynamics of Erineum mite, *Aceria jasmini*

A study was conducted to assess the population dynamics of Erineum mite through the period (August 2007 to February 2008) in field condition at Horticultural College and Research Institute (HC & RI), Periyakulam, TNAU. The variety CO 1 was selected for this study and the field (Fd. no. 4) located at western block was choosen. The observations were recorded consecutively at fortnightly intervals, on ten randomly selected bushes of Jasminum *auriculatum* which were two years old. In each location, 10 shoots were tagged at random and the numbers of infested and healthy leaves were counted on all the shoots, based on characteristics deformities accompanying mite colonization on leaves and shoots. The mean population was worked out for statistical analysis after square root transformation as suggested by Goulden (1972). The population of jasmine Erineum mite was correlated with weather parameters, *viz*., maximum and minimum temperatures, relative humidity, rainfall and wind velocity, collected from the meteorological observatory installed at HC & RI Periyakulam.

3.3. Field Trial I (August 2007 - November 2007)

A field trial was conducted in western block (field No.4) at Horticultural College and Research Institute (HC & RI), Periyakulam, Theni District, which is one of the traditional floricultural tracts in Tamil Nadu, during August 2007 - November 2007 (Plate no:7).

3.3.1. Experiment I – Evaluation of organic sources of nutrients / amendments in combination with foliar application of acarogenic fungi on the incidence of jasmine Erineum mite, *A. jasmini* on jasmine, *J*asminum *auriculatum*.

The field experiment was conducted to evaluate the effect or influence of organic sources of nutrients / amendments in combination with foliar application of acarogenic fungi on the incidence of jasmine erineum mite, *A. jasmini* with the following technical programme.

Location : Horticultural College and Research Institute, Periyakulam, TNAU.

Variety : CO 1

Season : August 2007 to November 2007

Design : RBD

Soil type : Sandy loam

pH : 7.0

Replication : Three

Altitude : 300 m MSL

Latitude : $10^0 12^{'}$ N

Longitude : $77^0 55^{'}$ E

Annual rainfall : 594.5 mm

Treatments :

T_0 : Untreated control

T_1 : Soil application of FYM @ (2kg/plant)

T_2 : Pungam cake @ 200g / plant

T_3 : Neem cake @100g / plant

T_4 : T_1 + *Beauveria bassiana* (foliar application @ 1 x 10^8 spores/ ml)

T_5 : T_1 + *Hirsutella thompsonii* (foliar application @ 1 x 10^8 spores/ ml)

T_6 : T_1 + *Lecanicillium lecanii* (foliar application @ 1 x 10^8 spores/ ml)

T_7 : T_1 + *Paecilomyces fumosoroseus* (foliar application @ 1 x 10^8 spores/ ml)

T_8 : T_2 + *Beauveria bassiana* (foliar application @ 1 x 10^8 spores/ ml)

T_9 : T_2 + *Hirsutella thompsonii* (foliar application @ 1 x 10^8 spores/ ml)

T_{10} : T_2 + *Lecanicillium lecanii* (foliar application @ 1 x 10^8 spores/ ml)

T_{11} : T_2 + *Paecilomyces fumosoroseus* (foliar application @ 1 x 10^8 spores/ ml)

T_{12} : T_3 + *Beauveria bassiana* (foliar application @ 1 x 10^8 spores/ ml)

T_{13} : T_3 + *Hirsutella thompsonii* (foliar application @ 1 x 10^8 spores/ ml)

T_{14} : T_3 + *Lecanicillium lecanii* (foliar application @ 1 x 10^8 spores/ ml)

T_{15} : T_3 + *Paecilomyces fumosoroseus* (foliar application @ 1 x 10^8 spores/ ml)

T_{16} : Soil application of Carbofuran 3G @ 50g / plant

❖ Two rounds of foliar application were given as and when the mite population shot up.

3.4. Field Trial II (November 2007 - February 2008)

This trial was also conducted in western block (field No.4) at Horticultural College and Research Institute (HC & RI), Periyakulam, Theni District, during November 2007 - February 2008 (Plate no:8).

3.4.1. Experiment II -Field efficacy of certain newer acaricides / insecticides and medicinal herbal extracts against erineum mite, *A. jasmini* on jasmine, Jasminum *auriculatum* Vahl.

The field experiment was conducted to evaluate the field efficacy of certain newer acaricide and insecticide molecules and medicinal herbal extracts as foliar application for the management of erineum mite of jasmine, *Jasminum auriculatum* with the following technical programme.

Location : Horticultural College and Research Institute, Periyakulam, TNAU.

Variety : CO 1

Season : November 2007 to February 2008

Design : RBD

Soil type : Sandy loam

pH : 7.0

Replication : Three

Altitude : 300 m MSL

Latitude : 10^0 12' N

Longitude : 77^0 55' E

Annual rainfall : 594.5 mm

Treatments :

T_0 : Untreated control

T_1 : Profenophos 50 EC @ 2ml / lit

T_2 : Spiromesifen 240 SC @ 0.7ml / lit

T_3 : Propargite 57 EC @ 2 ml / lit

T_4 : Fenpropathrin 10 EC @ 2ml / lit

T_5 : Abamectin 1.8 EC @ 0.5 ml/ lit

T_6 : Wettable Sulphur 80 WG @ 3 g / lit

T_7 : Dicofol 18.5 EC @ 4ml/lit

T_8 : Triazophos 40 EC @ 2ml/lit

T_9 : NSKE 5%

T_{10} : *Ocimum sanctum* extract 10% (Aqueous leaf extract)

T_{11} : *Vitex negundo* extract 10% (Aqueous leaf extract)

T_{12} : *Lippia nodiflora* extract 10% (Aqueous leaf extract)

3.4.1. Preparation of leaf extracts

The medicinal herbs like *V.negundo*, *L. nodiflora*, *O. sanctum* (Plate no: 1) were collected from the herbal garden maintained at AC & RI, Madurai. Five hundred grams of leaves was macerated well with minimum quantity of distilled water. Then it was transferred to a 500 ml beaker. After an hour, the mother extract was filtered, and the volume was made up to 500 ml. This mother extract was used to prepare further required test concentrations as prescribed in the treatment, by serial dilution. The 10 per cent leaf extract was prepared by adding 10 ml of mother extract with 100 ml of distilled water and applied as foliar spray using high volume sprayer. Two rounds of sprays were given during investigation.

3.5. Observations recorded in Field Experiments

1. Damage index, by grading the erineum development
2. Number of mites / Erineum patch ($2mm^2$) @ 5 leaves/ plant; 3 plants/ plot, selected at random thrice at 15 days intervals
3. Number of eggs / $2mm^2$ @ 5 leaves/ plant; 3 plants/ plot, selected at random thrice at 15 days intervals
4. Natural enemy fauna prevalent in the experimental plots
5. Soil microflora (fungi, bacteria and actinomycetes)
6. Flower Yield / plant (kg/ha)
7. Cost-benefit ratio

3.5.1. Assessment of mite population

The jasmine Erineum mite population which occurred in each treatment was assessed by adapting the following methodology. Three plants were selected at random from each replication. Five leaves were selected from each plant (two each from top, and middle, one from bottom) which were examined for the presence of mite. On each selected leaf, the population was counted on the lower and upper surface. Assessment of the mite population in the sample was made at various stages of the infested leaves. Field collected samples were stored in refrigerator for a brief period when the number of samples was more. Before counting the population, the samples were kept under a table lamp for gradual and gentle heating of leaves, so that the mites emerge out of the erineal hairs. The number of eggs and mites (Adults& nymphs) were counted in an area of $2mm^2$. A stereozoom binocular microscope was used for counting of eggs, and mites (Plate no:9). The mean population was worked out, before subjecting the data for transformation to worked out the percent mortality as suggested by Regupathy and Dhamu (2001).The data were square root transformed to work out means, to find out the most effective treatment by DMRT as suggested by Gomez and Gomez (1984).

$$\frac{\text{Number of mite in control} - \text{Number of mite in treatment}}{\text{Number of mite in control}} \times 100$$

3.5.2. Egg count

The methodology followed in 3.5.1 was followed for counting of eggs, as done for mite population and the means were compared by DMRT to identify the effective treatment.

3.5.3. Natural enemy fauna

A survey was conducted in jasmine fields in all flower growing tracts of Tamil Nadu to observe the occurrence of natural enemies on jasmine erineum mite. The occurrence of natural enemies *viz.*, predators (Plate no: 13), parasitoids and pathogens was observed in and around the experimental fields and during the course of survey in different pockets.

3.5.4. Intensity of erineum development

Three plants were selected at random from each replication to assess the intensity of erineum development (Plate no:11 and 11a). The per cent damage was calculated by adopting the formula suggested by Desai *et al*. (2006).

$$\text{\% Damage as erineal patches} = \frac{\text{Number of damaged leaves/ plant}}{\text{Total number of leaves/ plant}} \times 100$$

This value was compared with the score chart to fix the intensity of damage

3.5.5. Assessment of Soil Microflora

The microbial load and diversity in the soil was assessed by (serial dilution plate technique) adapting the procedure suggested by Martin (1950). Bacteria, actinomycete and fungi populations were assessed in soil samples from various treatments (Plate no: 12).

The soil samples were drawn from rhizosphere region of the treated plants with organic sources of nutrients, in a test tube containing 10 ml. of sterile water blank. The test tubes containing the soil sample were shaken for two minutes vigorously to obtain a uniform suspension of microorganisms. Then the contents were allowed to settle for a brief period. One ml of the supernatant was then transferred asceptically from hundred fold dilution to a 9 ml sterile water blank and it was mixed well. This dilution procedure was continued to obtain a dilution of 10^{-6}. One ml portion from the dilutions 10^{-3}, 10^{-4} and 10^{-6} were transferred to sterile petridishes for plating out the fungi, actinomycetes and bacteria. Approximately 15 – 20 ml of molten cooled agar medium (Martin rose Bengal agar medium; Kenknight agar medium; nutrient agar medium) were added to dilutions 10^{-3}, 10^{-4} and 10^{-6} respectively.

The medium was dispersed on the plates uniformly by rotating clockwise and anticlockwise gently. The plates were then allowed to solidify by placing them in an inverted position. Plates were incubated at room temperature of 28 ±1 ^{0}C. The bacterial colonies in nutrient agar plates were observed 24 – 48 h after incubation, while the fungal colonies from Rose Bengal agar plates were observed after 3 to 5 days.Actinomycetes colonies in Kenknight agar medium plates were observed after 7 days.

The number of colonies from each plate was counted. The individual colonies of fungi, actinomycetes and bacteria were then examined under a high power microscope. The populations of fungi, actinomycetes and bacteria in the samples were enumerated and expressed as number per gram of dry soil.

Soil microflora was assessed using the following formula suggested by Rangaswami (1996).

$$\text{Number of colony forming units (CFU) per gram of oven dry soil} = \frac{\text{Mean number of CFU X Dilution factor}}{\text{Weight of oven dry soil (g)}}$$

3.6. Organic amendments

Organic amendments viz., well decomposed farm yard manure, neem cake, and pungam cake were applied in the field trial at recommended doses, at the time of field preparation.

3.6.1. Acarogenic Pathogens

3.6.1.1. Mass multiplication and field application of *Beauveria bassiana*

M/S Cenicafe, Columbia has developed a simple technique for production of beneficial fungus in the farms (Antia *et al*., 1992). This method was followed to mass multiply the fungus for the present study. According to this method 50 g of rice and 50 ml of water were taken in a 375 ml bottle and plugged with cotton wool. Then water was taken to about 5 cm depth in a large aluminium vessel, a perforated plate was placed above the water level and the bottles were placed over it. The vessel was closed with a lid and the bottles were allowed to cool and inoculated with one teaspoon full of mother culture in rice. Inoculation was done over two spirit lamps in a clean room and the culture was made ready for use within three weeks. Each bottle could provide around 4×10^{11} spores.

The spores from the bottle were extracted using water, containing 0.2% oil emulsion (the oil emulsion was prepared by mixing equal quantities of a vegetable oil and agricultural wetting agent @ 2 ml of emulsion to one litre of water and mixed well). Two or three washings could remove most of the spores from the bottle. Once the spores were extracted from the bottles, the suspension was then strained / filtered through a muslin cloth to remove the rice particles. The suspension was made up to 1×10^{8} colonies per gram by serial dilution and sprayed using high volume sprayer (knapsack sprayer) and observations were recorded at regular intervals as per protocol (Plate no:3 and 6c).

3.6.1.2. *Lecanicillium lecanii* Z. (= *Verticillium lecanii*)

The commercial formulation of *L. lecanii Z.* (=*V. lecanii*) (Vertifyte®), manufactured by M/S Eco – Tech Agro, Pune was marketed by M/S Krushitek, Adal.M.I.D.C, Satara. M.S. (India). A talc based *L. lecanii* Z. containing 1×10^{8} colonies per gram was chosen for this study. The talc based *L. lecanii* (500 gms) was mixed with 100 litres of water along with 100 ml of wetting agent. This suspension was then mixed well and uniformly sprayed using knapsack sprayer (Plate no: 4 and 6d).

3.6.1.3. *Paecilomyces fumosoroseus*

The commercial formulation of *P. fumosoroseus* (Pilicide®) manufactured and marketed by M/S Rom Vijay Biotech, Pondicherry was used for this study. A talc based *Paecilomyces fumosoroseus* containing 1 X10^8 colonies per gram was chosen for this study. The talc based *Paecilomyces fumosoroseus (*500 gms) was mixed with 100 litres of water along with 100 ml of wetting agent. This suspension was mixed well and uniformly sprayed using knapsack sprayer (Plate no: 5 and 6a).

3.6.1.4. *Hirsutella thompsonii*

The commercial formulation of *H. thompsonii* (Mycohit®) (Plate 2 and 6b), marketed by Hindustan Antibiotics Ltd, Pimpri, Pune. A talc based *Hirsutella thompsonii* containing 1 X10^8 colonies per gram was chosen for this study. The talc based *Hirsutella thompsonii (*500 gms) was mixed with 100 litres of water along with 100 ml of wetting agent. This suspension was then mixed well and uniformly sprayed using knapsack sprayer.

The post treatment observations were recorded on 15th, 30th and 45th days after spraying, besides a pretreatment count on the population of eggs and mite on infested leaves collected at random. The first spray was given when sufficient erineum development was observed in the test plots.

3.6.1.5. Carbofuran 3G

Carbofuran 3G (Furadon®) marked by M/S Ralis India Ltd., was used for this study, as standard check for comparison. This granule was treated as soil application @ 50g/ plant. The post treatment counts on mites and eggs were recorded on 15th, 30th and 45th days after spraying, besides a pretreatment count.

3.6.1.6. Fenpropathrin 10 EC

Fenpropathrin 10 EC (Danitol®) which is an acaricide was applied as foliar spray using knapsack sprayer. Fenpropathrin is stomach and contact synthetic pyrethroid. This chemical is manufactured by M/S Sumitomo Chemical Company, Ltd., Japan.

3.6.1.7. Profenophos 50 EC

Profenophos 50 EC (Hilfos®) is a broad spectrum organo phosphorus group, foliar insecticide and acaricide with contact and stomach action. It is non systemic but has an excellent translaminar action. This chemical is manufactured by M/S Hindustan Insecticides Limited.

3.6.1.8. Spiromesifen 240 SC

Spiromesifen 240 SC (Oberon®) is a novel insecticide/ acaricide belonging to the new chemical class of spirocyclic phenyl- substituted tetronic acids. It has translaminar action. Spiromesifen is manufactured by M/S Bayer India Ltd.,

3.6.1.9. Triazophos 40 EC

Triazophos 40 EC (Hostathion®) is a broad spectrum organo phosphorus insecticide and acaricide with nematicidal properties having contact and stomach action (It is an organo phosphorus compound). Triazophos is manufactured by M/S Bayer India Ltd.,

3.6.1.9. Propargite 57 EC

Propargite 57 EC (Simbaa®) is an acaricide with residual toxicity. It acts primarily by direct contact, residual contact and vapour action. It belongs to a new group of sulfite esters. Propargite is manufactured by M/S Pi Industries Ltd., Gujarat.

3.6.1.10. Abamectin 1.8 EC

Abamectin 1.8 EC (Vertimec®) is a mixture of avermectins containing more than 80% avermectin B1a and less than 20% avermectin B1b. These two components, B1a and B1b have very similar biological and toxicological properties. The avermectins are insecticidal or anti helminthic derived from the soil bacterium *Streptomyces avermitilis*. Abamectin is a natural fermentation product of this bacterium. It has contact and stomach action. This chemical is commercially marketed by M/S Willowood Agro-Chem Ltd., Hong Kong.

3.6.1.10. Dicofol 18.5 EC

Dicofol 18.5 EC (Kelthane®) is an organochlorine acaricide. It is a contact poison, manufactured by M/S Hindustan Insecticides Limited.

3.6.1.10. Wettable Sulphur 80 WG

Wettable Sulphur 80 WG (Cosavet®) is a contact acaricide and fungicide, manufactured by M/S Sulphur Mills Ltd., Maharashtra, India.

3.7. Alternate hosts of Jasmine erineum mite

During the course of survey the fields were observed for the alternate hosts for erineum mite. The weed floras inside the field and on the bunds were also observed, which may harbour these mites or natural enemies of erineum mite. During the survey, the flora *viz*., Gundumalli, *Jasminum sambac*; Pitchi, *Jasminum grandiflorum*; amman pacharisi, *Euphorbia hirta*; saranai, *Trianthema portulacastrum*; kelanelli, *Phyllanthus niruri*; melanelli, *Phyllanthus maderaspatensis*; korai, *Cyperus rotundus*; arugampul, *Cynodon dactylon*; mookuthipoondu, *Vernonia cinerea*; boomisakrapoondu, *Convolvulus arvensis* were collected and observed for the occurrence of *A. jasmini,* in the laboratory and development of gall symptom.

3.8. Assessment of yield

The yield of jasmine flowers was recorded from each plot, replication wise and treatment wise, and the same was weighed and recorded for statistical scrutiny. The yield was computed in terms of kg/ha and the increase in yield in treated plots over the untreated control was worked out adapting the formula suggested by Regupathy and Dhamu (2001).

$$\text{Increase over untreated control (\%)} = \frac{\text{Treatment} - \text{control}}{\text{Treatment}} \times 100$$

3.9. Cost – Benefit Ratio

The cost-benefit ratio (CBR) was worked out adapting the formula suggested by Saraswathy (2002) to assess the economic viability of the management strategies tested.

$$\text{CBR} = \frac{\text{Net Return}}{\text{Cost of Cultivation}}$$

3.9.1. Statistical Analysis

The method suggested by Goulden (1972) was adapted for statistical scrutiny of the data obtained from field experiments. Prior to analysis, the data on egg and mite count were subjected to square root transformation. The mean values of treatments were then compared using Duncan’s multiple range test (DMRT) (Gomez and Gomez, 1984) to identify the most effective treatments.

Corrélation and Regression

This analysis was applied to find out the relationship between the occurrence of all stages of mite population and the possible influence of weather parameters (abiotic factors) on the population dynamics. The fortnightly observation of mite and weekly mean of weather data such as rainfall, maximum and minimum temperature, relative humidity, sun shine hours and wind velocity were related for correlation coefficient adapting the formula suggested by Regupathy and Dhamu (2001).

Correlation Co – efficient

$$r = \frac{\sum xy - \frac{\sum x \sum y}{n}}{\sqrt{\sum x^2 - \frac{(\sum x)^2}{n}} \sqrt{\sum y^2 - \frac{(\sum y)^2}{n}}}$$

Linear Regression

$$y = a \pm bx$$

CHAPTER - IV

EXPERIMENTAL RESULTS

The results of various field experiments conducted on seasonal incidence of erineum mite on jasmine, evaluation for the efficacy of organic amendments in combination with entomopathogenic fungi for the management of jasmine erineum mite, bioefficacy of certain newer acaricide / insecticide molecules and medicinal herbal extracts as foliar spray for the management of erineum mite, *Aceria jasmini* Chann. on jasmine, identification of alternate hosts and natural enemies of jasmine erineum mite, are presented in this chapter.

4.1. Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann. in the major jasmine growing tracts of Tamil Nadu

The survey was conducted in the traditional floriculture tracts, spreading over eight districts of Tamil Nadu (to assess the occurrence and damage potential of the erineum mite of the jasmine). Apart from this, the information on acaricides sprayed by the farmers for the control of mites were also collected. The study revealed (Table 1) the following findings.

Out of the fifty sampling locations which represented all major flower growing areas in each district, almost all the fields observed, had the erineum mite infestation. Farmers complained that mite was the major recurring problem and difficult to control. The farmers had raised more than one flower crops in their adjoining fields. Mullai, *Jasminum auriculatum* was seldom grown as a sole crop and the area under mullai was also less than 1 ac mostly 40-50 cents. According to growers, in order to mitigate the threat posed by erineum mite to *J. auriculatum* and to compensate the total monetary loss, the farmers diversified the flower crops in the same field and season. The infestation could not be observed on *J. grandiflorum* (pitchi) and *J. sambac* (gundu malli). The farmers have been already using the conventional acaricides like wettable sulphur and dicofol as recommended by Dept. of Horticulture and the pesticide dealers. From state wide survey it is crystal clear that Jasmine erineum mite has been the numerous in posing danger to Jasmine cultivation and will continue to be a serious problem in future too.

The fields in certain areas like Dindigul, Madurai and Dharmapuri districts had severe to very severe infestation, where the intensity falls under grade 4 (> 75% damage) coupled with heavy yield loss. The entire bush becomes unproductive in extreme cases of infestation mostly in ill maintained gardens with out proper irrigation and pruning. Out of 50 sampling locations in 9 locations (18%) the intensity of damage fall under the category of grade 1, where the mite population ranged from 4 to 5.07 per $2mm^2$ area of erineum and egg population ranged from 6.45 to 7.59 per $2mm^2$. Eighteen (36%) samples fall under the category of grade 2, where the mite population ranged from 5.57 to 6.66 per 2mm^2 area and egg population ranged from 7.24 to 8.66 per 2mm^2. Another 18 (36%) samples fall under the category of grade 3, with the mite population ranged from 7.66 to 8.94 per 2mm^2 and egg population ranged from 8.81 to 10.66 per 2mm^2. However 5 samples (10%) fall under the category of grade 4, where the mite population ranged from 9.00-10.11 per 2mm^2 and egg population ranged between 10.18 and 11.86 per 2mm^2. Thus, the survey showed a significant variation with reference to the damage intensity and population level of erineum mite at various locations surveyed. It also revealed a higher incidence of mite in Dindigul, Madurai and Dharmapuri districts compared to other locations surveyed (Table 2).

4.1.1. Assessment of damage potential of *Aceria jasmini* on jasmine

The field experiment on assessment of damage potential indicated that the damage level was directly correlated to the flower yield of jasmine. The bushes which had 0-25 per cent damage, suffered the reduction of flower yield by 19.08 per cent, compared to the healthy plants. The yield loss was 48.31 per cent when the bushes had the damage level of 26 to 50 per cent. While on yield loss of 69.66 per cent was recorded on the bushes with the damage level of 51-75 per cent. The yield loss was as high as (95.33 per cent) on bushes which suffered 76-100 per cent damage (Table 3).

4.2. Influence of weather parameters on the population dynamics of erineum mite, *A. jasmini* on jasmine

4.2.1. Seasonal incidence of erineum mite, *A. jasmini*

Simple correlation analysis was carried out to assess the influence of weather parameters on the incidence of erineum mite, *A. jasmini* on jasmine in field condition during the period from August 2007 – November 2007 and November 2007 - February 2008 at Horticultural College and Research Institute, Periyakulam (Table 4). The population fluctuation of erineum mite was recorded at fortnightly intervals in fixed plots. The possible influence of abiotic factors on the population dynamics of mite exhibited the following trend.

4.2.1.1. Season I (August 2007 – November 2007)

In the first season (Aug 2007-Nov 2007), the population of erineum mite, *A. jasmini*. was higher due to the prevalence of low temperature and higher humidity. However, from Aug 24-Sep 7 the mite population started declining owing to high relative humidity. Simple correlation analysis revealed (Table 5) that the maximum temperature (r = -0.712), minimum temperature (r = -0.019) and rainfall (r = -0.017) had a significant negative correlation with mite population whereas the relative humidity (r = +0.076) had a significant positive correlation with mite population

From the linear regression equation, it could be inferred that an increase in maximum temperature by 1^0C there was a decrease in mite population by 0.71 per cent; increase in minimum temperature by 1^0C there was a decrease in mite population by 0.02 per cent so also an increase in rainfall by 1mm decreased the mite population by 0.01 per cent. Nevertheless when there is an increase in relative humidity by 1 %, there was an increase in erineum mite population by 0.27 per cent. The other weather parameter *viz*., wind velocity, sun shine hours seldom had any impact on the population dynamics of Jasmine mite.

4.2.1.2. Season II (November 2007 – February 2008)

With reference to the second season (Nov 2007-Feb 2008), the incidence of erineum mite, *A. jasmini* was initially higher during the first fortnight of Nov 7-Nov 21. However, from Nov 22- Dec 6 the mite population started declining owing to high relative humidity. The simple correlation coefficient worked out between weather parameters and the population of jasmine eriophyid mite during the second season (November 2007 and February 2008) revealed that the maximum temperature (r = -0.814), minimum temperature (r = -0.003) and rainfall (r = -0.388) had a significant negative correlation with mite population whereas the relative humidity (r = +0.309) had a significant positive correlation with mite population (Table 6).

The linear regression equation, showed that an increase in maximum temperature by 1^0C there was a decrease in mite population by 0.79 per cent; increase in minimum temperature by 1^0C decreased the mite population by 0.004 per cent; while an increase in rainfall by 1mm decreased the mite population by 0.32 per cent, However an increase in relative humidity by 1 %, increased mite population by 1.07 per cent. Other two factors namely wind velocity and sun shine hours had no remarkable impact on the population dynamics of erineum mite of jasmine.

4.3. Field trials

4.3.1. Field trial I (August 2007- November 2007) Location- HC& RI, Periyakulam

4.3.1.1. Evaluation of organic sources of nutrients in combination with foliar application of entomopathogenic fungi for the management of erineum mite, *A. jasmini*

First spray

A field experiment was conducted to evaluate the efficacy of different organic amendments *viz*., farm yard manure, pungam cake and neem cake in combination with foliar application of entomopathogenic fungal formulations *viz*., *Beauveria bassiana*, *Hirsutella thompsonii*, *Lecanicillium lecanii* and *Paecilomyces fumosoroseus*. The common insecticide/ acaricide carbofuran was used as standard check for comparison. The results of this experiment are presented in Tables (7 to 9). The pretreatment count on eggs and mite population ranged between 9.14 and 10.93 eggs per leaves ($2mm^2$), 8.66 and 9.33 mites per leaves ($2mm^2$). The post treatment counts were recorded on 15^{th}, 30^{th} and 45^{th} days after each spray. The data revealed that, among the various treatments tested soil application of neem cake @ 100 g/ plant + *Hirsutella thompsonii* (1 $X10^8$ colonies per ml on foliar application) recorded the highest mean per cent reduction of eggs (47.80) and mites (64.74) over untreated control coupled with least number of mean egg count (10.94) and mean mite population (10.07) which was followed by neem cake @ 100 g/ plant + *Beauveria bassiana* (1 $X10^8$ colonies per ml) which record a mean per cent reduction of eggs (46.61) and mites (61.46), neem cake @ 100 g/ plant + *Lecanicillium lecanii* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (45.97) and mites (54.22), neem cake @ 100 g/ plant + *Paecilomyces fumosoroseus* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (43.41) and mites (50.44) respectively.

The other treatments worth mentioning are pungam cake @ 200 g/ plant + *Hirsutella thompsonii* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (41.77) and mites (50.14), pungam cake @ 200 g/ plant + *Beauveria bassiana* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (41.49) and mites (48.75), pungam cake @ 200 g/ plant + *Lecanicillium lecanii* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (39.94) and mites (47.56), pungam cake @ 200 g/ plant + *Paecilomyces fumosoroseus* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (38.93) and mites (45.48), Soil application of Farm yard manure @ 2 kg/ plant + *Hirsutella thompsonii* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (38.11) and mites (43.19), soil application of Farm yard manure @ 2 kg/ plant + *Beauveria bassiana* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (37.84) and mites (40.91), Soil application of Farm yard manure @ 2 kg/ plant + *Lecanicillium lecanii* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (36.28) and mites (40.21),), Soil application of Farm yard manure @ 2 kg/ plant + *Paecilomyces fumosoroseus* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (35.83) and mites (38.72), neem cake alone with a per cent reduction of eggs (34.00) and mites (34.16), pungam cake alone with a per cent reduction of eggs (33.63) and mites (33.36) and soil application of farm yard manure alone with a per cent reduction of eggs (32.35) and mites (30.78). Carbofuran 3G (Standard check) @ 50 g/ plant was significantly superior to all other treatments which recorded the highest per cent reduction of eggs (49.45) and mites (69.91).

Second spray

Similarly after second spray also the same trend could be noticed. (Table 10-12) Among the organic amendments and entomopathogenic fungi combinations tested, neem cake @ 100 g/ plant + *Hirsutella thompsonii* (1 $X10^8$ colonies per ml) recorded the highest per cent reduction of eggs (65.00) and mites (82.30) over untreated control which was followed by neem cake @ 100 g/ plant + *Beauveria bassiana* (1 $X10^8$ colonies per ml) which recorded a mean per cent reduction of eggs (64.58) and mites (79.93), neem cake @ 100 g/ plant + *Lecanicillium lecanii* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (63.44) and mites (76.15), neem cake @ 100 g/ plant + *Paecilomyces fumosoroseus* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (62.61) and mites (74.00) respectively.

The other treatments which recorded same significant effect are pungam cake @ 200 g/ plant + *Hirsutella thompsonii* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (61.05) and mites (71.73), pungam cake @ 200 g/ plant + *Beauveria bassiana* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (60.64) and mites (70.55), pungam cake @ 200 g/ plant + *Lecanicillium lecanii* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (58.25) and mites (69.79), pungam cake @ 200 g/ plant + *Paecilomyces fumosoroseus* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (57.32) and mites (68.82), soil application of Farm yard manure @ 2 kg/ plant + *Hirsutella thompsonii* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (55.65) and mites (66.77), Farm yard manure @ 2 kg/ plant + *Beauveria bassiana* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (53.58) and mites (64.50), Farm yard manure @ 2 kg/ plant + *Lecanicillium lecanii* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (53.27) and mites (64.29),), Farm yard manure @ 2 kg/ plant + *Paecilomyces fumosoroseus* (1 $X10^8$ colonies per ml) with a per cent reduction of eggs (52.64) and mites (62.99). However basal application of either of there soil amendments *viz*., Neem cake, pungam cake and farm yard manure without foliar application of fungal formulation had comparatively less effect on mites population with a per cent reduction of 55-58 %.

Carbofuran 3G (Standard check) @ 50 g/ plant was significantly superior than all other treatments and recorded the highest per cent reduction of eggs (65.62) and mites (85.22). All the organic amendments + entomopathogenic fungal combinations were effective in checking the incidence of mite, which is obvious from the data on per cent reduction of the egg and mite population. A decreased trend of pathogenicity by entomopathogenic fungi was noticed after fourth week of application.

4.3.1.1.1. Impact of organic sources of nutrients in combination with entomopathogenic fungi on the flower yield of jasmine

The highest flower yield of 9352.14 kg/ha was recorded (Table 13) in the plots treated with neem cake @ 100 g/ plant + *Hirsutella thompsonii* (1 X10^8 colonies per ml). There was an increase of 36.32 per cent flower yield over untreated control. Where as application of neem cake @ 100 g/ plant + *Beauveria bassiana* (1 X10^8 colonies per ml) treatment recorded 9314.03 kg/ha coupled with percent increase of 36.05 over untreated control. The yield recorded in untreated control was only 5955.44 kg/ha. The standard check carbofuran 3G @ 50g/plant recorded the highest flower yield of 9386.72 kg/ha which amounts to 36.55 per cent increase of jasmine flowers over untreated control.

The other treatments which recorded significant per cent increase of flower yield were neem cake + *L. lecanii* (1 X10^8 colonies per ml) (32.92), neem cake + *P. fumosoroseus* (1 X10^8 colonies per ml) (32.43), pungam cake + *H. thompsonii* (1 X10^8 colonies per ml) (32.21), pungam cake + *B. bassiana* (1 X10^8 colonies per ml) (31.98), pungam cake + *L. lecanii* (1 X10^8 colonies per ml) (31.65), pungam cake + *P. fumosoroseus* (1 X10^8 colonies per ml) (31.59), Soil application of Farm yard manure + *H. thompsonii* (1 X10^8 colonies per ml) (21.96), Soil application of Farm yard manure + *B. bassiana* (1 X10^8 colonies per ml) (21.35), Soil application of Farm yard manure + *L. lecanii* (1 X10^8 colonies per ml) (20.94), Soil application of Farm yard manure + *P. fumosoroseus* (1 X10^8 colonies per ml) (20.23), neem cake alone (18.12), pungam cake alone (11.04), soil application of farm yard manure alone (10.72).

The standard check carbofuran recorded the highest cost benefit ratio of 1:5.85 closely followed by application of neem cake @ 100 g/ plant + *Hirsutella thompsonii* (1 X10^8 colonies per ml) (1:5.80), neem cake @ 100 g/ plant + *Beauveria bassiana* (1 X10^8 colonies per ml) (1:5.78). The other treatments which recorded a reasonably higher cost benefit ratio are as follows neem cake + *L. lecanii* (1 X10^8 colonies per ml) (1:4.63), neem cake + *P. fumosoroseus* (1 X10^8 colonies per ml) (1:4.25), pungam cake + *H. thompsonii* (1 X10^8 colonies per ml) (1:4.13), pungam cake + *B. bassiana* (1 X10^8 colonies per ml) (1:4.09), pungam cake + *L. lecanii* (1 X10^8 colonies per ml) (1:4.05), pungam cake + *P. fumosoroseus* (1 X10^8 colonies per ml) (1:4.02), Soil application of Farm yard manure + *H. thompsonii* (1 X10^8 colonies per ml) (1:3.69), Soil application of Farm yard manure + *B. bassiana* (1 X10^8 colonies per ml) (1:3.57), Soil application of Farm yard manure + *L. lecanii* (1 X10^8 colonies per ml) (1:3.34), Soil application of Farm yard manure + *P.*

fumosoroseus (1 X10^8 colonies per ml) (1:3.08), neem cake alone (1:2.86), pungam cake alone (1:2.63), soil application of farm yard manure alone (1:2.57). Cost benefit ratio was found to be the least in untreated control (1:2.51).

4.3.1.1.2. Influence of organic sources of nutrients in combination with entomopathogenic fungi on soil microflora

Total fungi

The maximum number of fungal colonies (26.34 X 10^3) was recorded in neem cake + *Hirsutella thompsonii* treated plots followed by application of neem cake + *Beauveria bassiana* 23.85 X 10^3as against 10.02 X 10^3 in untreated control (Table 14). Further the treatment, neem cake + *L. lecanii* recorded higher fungal colonies during the period of observation (23.26 X 10^3 mean fungal colonies). The number of fungal colonies in other treatments in the decreasing order are 22.50 X 10^3 in neem cake + *P. fumosoroseus,* which was closely followed by pungam cake + *H. thompsonii* (21.75 X 10^3), pungam cake + *B. bassiana* (20.85 X 10^3), pungam cake + *L. lecanii* (20.25 X 10^3), pungam cake + *P. fumosoroseus* (19.62 X 10^3), soil application of farm yard manure + *H. thompsonii* (18.75 X 10^3), soil application of farm yard manure + *B. bassiana* (16.58 X 10^3), soil application of farm yard manure + *L. lecanii* (15.36 X 10^3), soil application of farm yard manure + *P. fumosoroseus* (15.25 X 10^3), neem cake alone (10.86 X 10^3), pungam cake alone (10.32 X 10^3), soil application of farm yard manure alone (10.18 X 10^3).

Total actinomycetes

With reference to actinomycetes colonies also, the application of neem cake + *Hirsutella thompsonii* recorded the highest actinomycetes colonies (18.8 X 10^4) in the soil. It was closely followed by application of neem cake + *Beauveria bassiana* (17.7 X 10^4) as against 6.7 X 10^4 in untreated control (Table 14). The other treatments worth mentioning are application of neem cake + *L. lecanii* recorded higher actinomycetes colonies (16.7 X 10^4). The number of actinomycetes colonies in other treatments was 15.8 X 10^4 in neem cake + *P. fumosoroseus,* followed by pungam cake + *H. thompsonii* (15.6 X 10^4), pungam cake + *B. bassiana* (13.4 X 10^4), pungam cake + *L. lecanii* (12.4 X 10^4), pungam cake + *P. fumosoroseus* (11.4 X 10^4), soil application of Farm yard manure + *H. thompsonii* (10.6 X 10^4), soil application of Farm yard manure + *B. bassiana* (10.2 X 10^4), soil application of Farm yard manure + *L. lecanii* (10.1 X 10^4), soil application of Farm yard manure + *P. fumosoroseus* (9.4 X 10^4), neem cake alone (9.3 X 10^4), pungam cake alone (8.4 X 10^4), soil application of farm yard manure alone(7.8 X 10^4).

Total bacteria

With reference to bacterial colonies also, the application of neem cake + *Hirsutella thompsonii* recorded the highest bacterial colonies 116.85 X 10^6 in soil. It was followed by application of neem cake + *Beauveria bassiana* (115.35 X 10^6) as against 56.95 X 10^6 in untreated control (Table 14). The other treatment namely application of neem cake + *L. lecanii* recorded the bacterial colonies of (109.54 X 10^6) during the period under observation. The number of bacterial colonies recorded in the other treatments were 107.75 X 10^6 in neem cake + *P. fumosoroseus*, followed by pungam cake + *H. thompsonii* (104 X 10^6), pungam cake + *B. bassiana* (103.25 X 10^6), pungam cake + *L. lecanii* (99.75 X 10^6), pungam cake + *P. fumosoroseus* (98.55 X 10^6), soil application of farm yard manure + *H. thompsonii* (96.54 X 10^6), soil application of farm yard manure + *B. bassiana* (96.25 X 10^6), soil application of farm yard manure + *L. lecanii* (95.75 X 10^6), soil application of farm yard manure + *P. fumosoroseus* (93.28 X 10^6), neem cake alone (91.25 X 10^6), pungam cake alone (88.65 X 10^6), soil application of farm yard manure alone (57.78 X 10^6).

4.3.2. Field trial II- (November 2007 – February 2008) Location- HC&RI, Periyakulam

4.3.2.1. Efficacy of certain newer acaricide / insecticide molecules and medicinal herbal extracts on the incidence of *Aceria jasmini*

First spray

The field experiment was conducted to evaluate the bioefficacy of certain newer insecticide/ acaricide molecules such as profenophos, spiromesifen, propargite, fenpropathrin, abamectin, triazophos, NSKE5% and medicinal herbal extracts viz., *Ocimum sanctum, Vitex negundo, and Lippia nodiflora.* The common acaricides wettable sulphur and dicofol were used as standard checks for comparison. The outcomes of these experiments are presented in Tables (15 to 17). The pretreatment count of eggs and mites population ranged between 9.33 and 10.94 eggs per infested leaves ($2mm^2$), 8.66 and 9.33 mites per infested leaves ($2mm^2$) which were not statistically significant. The post treatment counts were recorded on 15^{th}, 30^{th} and 45^{th} days after each spray. The data indicated that, among the various treatments profenophos @ 2ml / lit recorded the highest mean per cent reduction of eggs (71.57) and mites (74.83) over untreated control which was closely followed by spiromesifen @ 0.7ml / lit which recorded a mean per cent reduction of eggs (71.38) and mite population (74.65) respectively, which were statistically on par in their bioefficacy.

The other treatments worth mentioning are triazophos @2ml/lit with a per cent reduction of eggs (68.19) and mites (71.40), fenpropathrin @ 2ml / lit with a per cent reduction of eggs (61.51) and mites (64.43), NSKE 5% with a per cent reduction of eggs (51.91) and mites (51.99), abamectin @ 0.5 ml/ lit with a per cent reduction of eggs (49.63) and mites (50.88), *Ocimum sanctum* extract (10% aqueous leaf extract) with a per cent reduction of eggs (48.53) and mites (48.83), propargite @ 2 ml / lit with a per cent reduction of eggs (46.61) and mites (46.70), *Vitex negundo* extract (10% aqueous leaf extract) with a per cent reduction of eggs (44.97) and mites (45.03) and *Lippia nodiflora* extract (10% aqueous leaf extract) with a per cent reduction of eggs (44.05) and mites (44.10).

Wettable Sulphur @ 3 g / lit and dicofol @ 4ml/lit (Standard checks) were significantly superior to all other treatments and recorded the highest per cent reduction of eggs (79.70), (79.52) and mites (80.87), (80.59) respectively and they were statistically on par in their bioefficacy.

Second spray

The same trend could be observed in second spraying (Tables 18-20) also. Among the newer acaricides, profenophos @ 2ml / lit recorded the highest mean per cent reduction of eggs (83.47) and mites (86.21) over untreated control closely followed by spiromesifen @ 0.7ml / lit which recorded a mean per cent reduction of eggs (83.38) and mites (86.11) respectively, which were statistically on par in their bioefficacy.

The other treatments worth mentioning are triazophos @2ml/lit with a mean per cent reduction of eggs (79.17) and mites (81.34), fenpropathrin @ 2ml / lit with a mean per cent reduction of eggs (78.88) and mites (81.05), NSKE 5% with a mean per cent reduction of eggs (73.90) and mites (77.18), abamectin @ 0.5 ml/ lit with a mean per cent reduction of eggs (69.69) and mites (70.83), *Ocimum sanctum* extract (10% aquous leaf extract) with a mean per cent reduction of eggs (67.54) and mites (69.14), propargite @ 2 ml / lit with a mean per cent reduction of eggs (66.27) and mites (67.16), *Vitex negundo* extract (10% aquous leaf extract) with a mean per cent reduction of eggs (57.77) and mites (60.11) and *Lippia nodiflora* extract (10% aquous leaf extract) with a mean per cent reduction of eggs (55.81) and mites (58.92).

The standard checks namely wettable sulphur @ 3 g / lit and dicofol @ 4ml/lit (Standard check) was significantly superior to all other treatments and recorded the highest mean per cent reduction of eggs (93.15), (93.05) and mites (97.91), (97.81) respectively and they were statistically on par in their bioefficacy.

4.3.2.2. Impact of certain newer acaricide molecules and medicinal herbal extracts on the flower yield of jasmine

The highest flower yield of 8987.39 kg/ha was recorded in the plots treated with profenophos @ 2ml / lit. There was an increase of 33.57 per cent flower yield over untreated control. Where as the plots treated with spiromesifen @ 0.7ml / lit. recorded 8981.14 kg/ha with 33.52 per cent increase of flower yield over untreated control. The yield recorded in untreated control was only 5970.23 kg/ha (Table 21). The standard check wettable sulphur @ 3 g / lit and dicofol @ 4ml/lit recorded the highest flower yield of 9524.76 kg/ha and 9520.66 kg/ha which amounts to 37.31 and 37.29 per cent increase over untreated control.

The other treatments which recorded significant yield increase are triazophos @ 2ml/lit (26.06), fenpropathrin @ 2ml / lit (25.49), NSKE 5 %(21.68), abamectin @ 0.5 ml/ lit (17.96), *Ocimum sanctum* extract (10% aqueous leaf extract) (16.68), propargite @ 2 ml / lit (14.86), *Vitex negundo* extract (10% aqueous leaf extract) (8.84), *Lippia nodiflora* extract (10% aqueous leaf extract) (6.53).

The standard check wettable sulphur and dicofol recorded the highest cost benefit ratio of 1:5.98 and 1:5.93 which are closely followed by profenophos @ 2ml / lit (1:4.99) and spiromesifen @ 0.7ml / lit (1:4.87). The other treatments which recorded a high cost benefit ratio are triazophos @ 2ml/lit (1:3.91), fenpropathrin @ 2ml / lit (1:3.86), NSKE 5 %(1:3.52), abamectin @ 0.5 ml/ lit (1:3.39), *Ocimum sanctum* extract (10% aqueous leaf extract) (1:3.24), propargite @ 2 ml / lit (1:3.06), *Vitex negundo* extract (10% aqueous leaf extract) (1:2.87), *Lippia nodiflora* extract (10% aqueous leaf extract) (1:2.79).Cost benefit ratio was the least in untreated control (1:2.58).

4.4. Alternate host and natural enemies of erineum mite

During the course of survey for the mite incidence, observations were made for the occurrence of natural enemies like parasite, predators and pathogens on the mites, on jasmine plants in the fields. The mite infested leaf samples were brought to the laboratory and observed under microscope for the presence of any natural enemies. So also the occurrence of natural infestation of *A. jasmini* on other species of Jasmine i.e. *J. grandiflorum* and *J. sambac* and weed flora available in and around the fields were also observed. In all the areas surveyed, the mite incidence was noticed only on *J. auriculatum* and not on other related species. However, a few predatory mites of the family Phytoseiidae (*Amblyseius* spp.); Stigmaeidae (*Agistemus* sp.) and predatory coccinellids (*Micraspis discolor* Fab.) could be recorded on the host plants. Otherwise no epizootic could be observed in the fields surveyed.

CHAPTER-V

DISCUSSION

Jasmine is one of the most important flower crops grown across the globe, which is ravaged by several insect and non - insect pests. The erineum mite, *Aceria jasmini*. is one of the serious pests damaging the crop rendering it unproductive. The injudicious application of synthetic pesticides has resulted in development of resistance by mites and insects besides resurgence, secondary outbreak and deposition of toxic residues in the environment and in the consumable produces. The increasing concern for environmental safety and global demand for pesticide free products has evoked keen interest in pest control through ecofriendly pest management approaches. In recent years, pest management, using organic amendments is gaining momentum besides usage of entomopathogenic fungi and certain newer acaricide molecules of novel mode of action and medicinal herbal extracts are in vogue, since they have been proved as promising alternative tools in the management of mite and insect pests.

The results and salient findings obtained from the field studies on the survey for the incidence of erineum mite in the traditional floriculture areas, evaluation of the efficacy of organic sources of nutrients combined with foliar application of entomopathogenic fungal formulations, evaluation of bioefficacy of certain newer acaricidal / insecticidal molecules for the management of erineum mite of jasmine, influence of weather factor on the population dynamics of erineum mite of jasmine in different cropping season, are discussed in this chapter.

5.1. Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini*. in the major jasmine growing tracts of Tamil Nadu

The survey conducted in eight districts of Tamil Nadu revealed the occurrence of mites in various locations. More severe mite incidence were noticed in Dindigul, Madurai and Dharmapuri districts compared to Erode, Theni, Coimbatore, Ramnathapuram and Salem districts (Figure 1). The mean grade index, mean No. of egg/2mm^2 and mean No. of mite/2mm^2 was also higher in Dindigul, Madurai and Dharmapuri districts. This higher intensity of mite attack may be attributed to the continuers availability of main host crop, as the farmers grow flower crops year after year, besides prevalence of a congenial climatic condition which in turn aggravate the infestation. Almost all the samples had moderate to severe infestation. About 36% of the sample falls under the category 2 (26-50% damage) and another 36% fall under the category 3 (Figure 2) (51-75% damage). Thus over 70% of the samples had severe infestation by erineum mite in field condition, even with the adaption of proper management practices. This highlights the fact that erineum mite is a regular pest and a major pest causing havoc to jasmine cultivation.

5.1.1. Assessment of damage potential of *A. jasmini*

The results on damage potential of *A. jasmini* corroborated that (Figure 3) the intensity and severity of eriophyid mite infestation had a direct impact on the yield reduction. In a 1-5 grading system adapted, an absolute reduction in yield (95.3% reduction) was observed on bushes with 76-100% damage to plants. When the damage level was 1-25% there was an yield reduction of 19% compared to healthy plants. However when the damage level was 26-50% the yield reduction happened to be 48.3%, while the reduction in flower yield was 69.6%. When the damage ranged between 51 and 75%. Thus the mite incidence has a direct and greater impact on the yield of jasmine flower in field condition. In extreme cases of infestation the entire plant is often rendered unproductive with 100% yield loss. This study envisages a close and continuous monitoring for the onset of this pest. Similar trend has been also reported by Saravanan and Umapathy (2003). In case of coconut perianth mite attack on coconut where 1-5 grading was adapted to assess, the damage potential of *A. guerreronis*, similar yield loss was noticed (Julia and Mariau, 1979; Moore *et al*., 1999; Varadarajan, 2001).

5.2. Influence of weather parameters on the seasonal incidence and population dynamics of erineum mite, *A. jasmini* on jasmine

In the first season (Aug 2007-Nov 2007), (Figure 4) the population of erineum mite, *A. jasmini*. was higher due to the prevalence of low temperature and higher humidity. The mite population was 9.33 per 2mm^2 during second fortnight of August 2007. Letchoumanane and Subramaniam (1981) also reported similar trend. According to their study the mite population reached the peak due to prevalence of low humidity and high temperature (April-September).This finding is in conformity with the findings of Chinniah *et al*. (2007) who also observed the peak population density of *T. urticae* on okra during kharif season at Madurai district. However, from the Aug 24-Sep 7 the mite population started declining owing to high relative humidity.

From the linear regression equation, it could be inferred that an increase in maximum temperature by 1^{0}C the mite population decreased by 0.71 per cent while an increase in minimum temperature by 1^{0}C there was a decrease in mite population by 0.02 per cent so also an increase in rainfall by 1mm, decreased the mite population by 0.01 per cent. Nevertheless when there is an increase in relative humidity by 1 %, there was an increase in erineum mite population by 0.27 per cent. The other weather parameter *viz*., wind velocity, sun shine hours seldom had any impact on the population dynamics of Jasmine mite. Thus maximum temperature, relative humidity and rainfall are the major abiotic factors that adversely influence the mite population buildup/dynamics in field condition.

With reference to the second season (Nov 2007-Feb 2008), (Figure 5) the incidence of erineum mite, *A. jasmini* was initially higher during the first fortnight of Nov 7-Nov 21 (9.06 mites per $2mm^2$). Letchoumanane and Subramaniam (1981) also reported the similar trend.

The linear regression equation fit, showed that an increase in maximum temperature by 1^0C there was a decrease in mite population by 0.79 per cent while an increase in minimum temperature by 1^0C decreased the mite population by 0.004 per cent; However an increase in rainfall by 1mm decreased the mite population by 0.32 per cent, neverthless an increase in relative humidity by 1 %, increased mite population by 1.07 per cent. Other two factors namely wind velocity and sun shine hours had no remarkable impact on the population dynamics of erineum mite of jasmine.

5.5. Evaluation of organic sources of nutrients in combination with foliar application of entomopathogenic fungi on the incidence of erineum mite, *A. jasmini* on jasmine - Field Trial I

5.5.1. Field trial I

Among the various organic amendments evaluated in combination with entomopathogenic fungi, (Figure 6 and 7) the basal application of neem cake @ 100 g/ plant + two rounds of foliar application of *Hirsutella thompsonii* (1 X10^8 spores/ml) recorded the maximum per cent reduction of eggs (47.80 and 65.00) and mites (64.74 and 82.30) population after first and second sprays respectively. It was closely followed by neem cake @ 100 g/ plant + *Beauveria bassiana* (1 X10^8 spores/ml) which recorded a mean per cent reduction of eggs (46.61 and 64.58) and mites (61.46 and 79.93) population after first and second sprays respectively.

H. thompsonii, a fungal pathogen was reported to be very effective in controlling citrus rust mite *Phyllocoptruta oleivora* (Ashmead) as foliar spray (Mc Coy *et al*., 1971). Natural incidence of *H. thompsonii* on coconut eriophyid mite, *Aceria guerreronis* (Keifer) in certain districts of Karnataka and Tamil Nadu was reported by Kumar *et al.* (2001). Basal application of neem cake in combination with *B. bassiana* (1 X10^8 spores/ml) recorded the maximum reduction of red spider mite, *Tetranychus urticae* population on okra (Balaji *et al*., 2007). Higher infections of B. bassiana on Tetranychid mite were recorded on beans (12.94%) in Karnataka, as reported by Basavaraj Kalmath *et al*. (2007). Foliar application of *B. bassiana* recorded the highest per cent mycosis on coffee berry borer *H. hampei* (Irulandi, 2006), thus it is proved effective not only against sucking pests but also against coleopteran borers. Basal application of neem cake in combination with foliar application of *Ocimum sanctum* (20% aqueous extract) recorded the highest reduction in yellow mite and egg population on chilli (Ambika and Chinniah, 2007).

Carbofuran 3G (Standard check) @ 50 g/ plant recorded the highest per cent reduction of eggs (49.45 and 65.62) and mites (69.91 and 85.22) population. It was found to be superior than all other treatments. In the present investigation the egg and mite population was the highest in untreated control. Hence as an alternative to the chemical pesticides, these naturally available cheaper botanicals and entomopathogenic fungal formulation which are ecofriendly can be harnessed in future for the management of jasmine mite.

5.6. Evaluation of the combination of organic sources of nutrients in combination with foliar application of entomopathogenic fungi on the flower yield of jasmine -Field Trial I

5.6.1. Field trial I

The results obtained from field trials corroborated that (Figure 8) the combination of neem cake @ 100 g/ plant + *Hirsutella thompsonii* (1 X10^8 spores/ml) recorded the highest flower yield of 9352.14 kg/ha with 36.32 per cent increase over untreated control with a maximum cost benefit ratio of 1:5.80 followed by neem cake @ 100 g/ plant + *Beauveria bassiana* (1 X10^8 spores/ml) which recorded the flower yield 9314.03 kg/ha with 36.05 per cent increase over control with a cost benefit ratio of 1:5.78. The other treatments worth mentioning are neem cake + *L. lecanii* (1 X10^8 spores/ml) with the flower yield 8878.93 kg/ha with 32.92 per cent increase over control with a cost benefit ratio of 1:4.63; neem cake + *P. fumosoroseus* (1 X10^8 spores/ml) with the flower yield 8814.25 kg/ha with 32.43 per cent increase over untreated control with a cost benefit ratio of 1:4.25.

The standard check carbofuran 3G @ 50g/plant recorded the highest flower yield of 9386.72 kg/ha which amounts to 36.55 per cent increase of jasmine flowers over untreated control.

5.7. Influence of organic sources of nutrients on soil micro flora

As far as the impact of organics amendments on soil microflora is concerned the treatments viz., basal application of neem cake + *Hirsutella thompsonii* (1 X10^8 spores/ml) recorded the highest population of (26.34 x 10^3, 18.8 x 10^4, 116.85 x 10^6 fungi, actinomycets and bacteria respectively, where as the application neem cake + *Beauveria bassiana* combination (1 X10^8 spores/ml) recoded 23.85 x 10^3, 17.7 x 10^4, 115.35 x 10^6 fungi, actinomycets and bacteria respectively. This is in conformity with the reports of Vemana *et al*. (1999) who recorded the occurrence of more number of fungal and bacterial colonies in farm yard manure treated plots. Further, a high bacterial population was recorded in FYM treated plots by several workers Sriramachandrasekaran (2002). Farm Yard Manure @ 12.5 t/ha in combination with neem cake @ 600 kg/ha, pungam cake @ 800 kg/ha and azophos @ 2 kg/ha, registered more fungal and bacterial population in bhendi ecosystem (Balaji and

Chinniah, 2006). Basal application of farm yard manure @ 6.25 t/ha in combination with biofertilizer + neem cake @ 300 kg/ha + Azophos @ 1kg/ha recorded maximum bacterial colonies 126.50 x 10^6 and fungal colonies 20.75 x 10^3 in soil in chilli ecosystem (Ambika and Chinniah, 2007). The untreated control and carbofuran applied plots had the lowest soil micro flora.

5.5. Efficacy of certain newer acaricide/insecticide molecules, medicinal herbal extracts on the incidence of *Aceria jasmini* on jasmine

5.6.1. Field trial II

Among the various acaricide / insecticides evaluated for their efficacy (Figure 9 and 10) for the management of *A. jasmini*, foliar application of profenophos @ 2ml / lit recorded the higher per cent reduction of eggs (71.57and 83.47) and mites (74.83 and 86.21) after first and second sprays respectively, closely followed by spiromesifen @ 0.7ml / lit which recorded the per cent reduction of eggs (71.57and 83.47) and mites (74.83 and 86.21) after first and second sprays respectively. These two chemicals are latest molecules introduced for the control of sucking pests and mites, found to be very promising against *A. jasmini*. As for as herbal extracts are concerned *Ocimum sanctum* extract (10% aqueous leaf extract) recorded the % reduction of eggs (67.54) and mites (69.14) after first and second spray respectively, which was followed by *Vitex negundo* extract (10% aqueous leaf extract) and *Lippia nodiflora* extract (10% aqueous leaf extract).

Reports indicate that application of profenophos registered 33 per cent suppression of coconut eriophyid mite *A. guerreronis* in field condition (Thirumalai Thevan, 2001). Earlier studies also proved that application of profenophos is highly effective against the spider mite, *Tetranychus spp.* on okra (Allen, 1998). Spiromesifen which is a recent acaricide cum insecticide molecule reduced jasmine erineum mite population up to 80% (Saravanan and Umapathy, 2003). Apart from these two chemicals the jasmine eriophyid mite was effectively controlled by application of diafenthiuron (0.1%) and bromoprophylate (0.1%) to an extent of 85% and 70% respectively (Jose *et al*., 1999).

Wettable Sulphur @ 3 g / lit and Dicofol @ 4ml/lit (Standard checks) recorded the highest per cent reduction of eggs (79.70 and 93.15; 79.52 and 93.05) and mites (80.87 and 97.91; 80.59 and 97.81) population after first and second sprays respectively. It was found to be superior than all other treatments, evaluated in this study. In the present investigation the egg and mite population was the highest in untreated control. However owing to the reason that these two standard checks (wettable sulphur and dicofol) are fairly older and has been in vogue for a longer time, it is high time to find some newer and alternate chemicals with different mode of action, in order to avoid development of resistance/ cross resistance by mites.

5.6.2. Efficacy of certain newer acaricide/insecticide molecules and medicinal herbal extracts on the flower yield of jasmine -Field Trial II

The results obtained from the field experiments corroborated that (Figure 11) application of profenophos @ 2ml / lit recorded the highest flower yield of

8987.39 kg/ha (33.57 per cent increase over untreated control) with a maximum cost benefit ratio of 1:4.99, closely followed by spiromesifen @ 0.7ml / lit with the flower yield of 8981.14 kg/ha (33.52 per cent increase over untreated control) with a cost benefit ratio of 1:4.87. The standard checks viz., wettable sulphur @ 3 g / lit and dicofol @ 4ml/lit recorded the highest flower yield of 9524.76 kg/ha and 9520.66 kg/ha which amounts to 37.31 and 37.29 per cent increase over untreated control, coupled with the maximum cost benefit ratio.

Ocimum sanctum extract (10% aqueous leaf extract) recorded the flower yield 7065.91 kg/ha (16.68 per cent increase over untreated control) with a cost benefit ratio of 1:3.24, which was followed by *Vitex negundo* extract (10% aqueous leaf extract) and *Lippia nodiflora* extract (10% aqueous leaf extract). These medicinal herbal extracts should be further exploited to isolate /identify the alkaloids responsible for pesticidal action for large scale commercial usage in the years to come.

5.8. Alternate hosts and natural enemies of jasmine erineum mite *A. jasmini*

The present investigation revealed that *Jasminum auriculatum* (Mullai) was the only host plant attacked by *A. jasmini*. Despite the availability of reports for the occurrence of *A. jasmini* on other species of *Jasminum,* the infestation could never be recorded on *Jasminum sambac* Ait. and *Jasminum flexile* Vahl. and *Jasminum grandiflorum* in Tamil Nadu. Later Channabasavanna (1966) reported the occurrence on *A. jasmini* on *Jasminum pubescens* Wild. from Karnataka State. New hosts and distribution of erineum mite *Aceria jasmini* were reported from South India (Umapathy and Mohanasundaram, 1998). Even none of the weed flora was found to be infested by *A. jasmini*. Predatory mites belonging to the family Phytoseiidae (*Amblyseius* spp.) Stigmaeidae (*Agistemus* sp.) and Coccinellid beetle (*Micraspis discolor* Fab.) were found associated with *A. jasmini*. Manjunatha *et al*. (2001) observed the natural association of phytoseiid mite *Amblyseius ovalis* evens with chilli mite which could reduce the mite population appreciably. Zhang (2001) also recorded the occurrence of *Amblyseius perlongisetus* in chilli ecosystem, in association with chilli mite. These biological agents should be conserved in their natural habitat for the natural suppression of phytophagous mites by a concerted biodiversity conservation measures in future.

CHAPTER-VI

SUMMARY

The findings of various experiments conducted *viz*., survey on the incidence of jasmine mite, seasonal incidence of erineum mite on jasmines, assessment of the efficacy of organic amendments in combination with entomopathogenic fungi for the management of jasmine erineum mite, Bioefficacy of certain newer acaricide/insecticide molecules and medicinal herbal extracts as foliar spray against erineum mite, *Aceria jasmini*, identification of alternate hosts and natural enemies of jasmine erineum mite are summarized here.

- It is evident from the survey that the incidence of eriophyid egg and mite population was the maximum in Dindigul, Madurai and Dharmapuri districts. Which the had higher level of mean egg (10.27) and mite (8.99) population in the erineal patches Over 70% of the samples had severe to very severe infestation by *Aceria jasmini* collected from various districts. Erode, Theni, Coimbatore, Ramanathapuram and Salem districts recorded a lesser incidence comparatively.
- The assessment of damage potential of *Aceria jasmini* indicated that the intensity of eriophyid infestation had a direct impact on the reduction of jasmine flower yield. An absolute yield reduction of 95.33 % was noticed on jasmine bushes which had 76-100 % leaf damage.
- The incidence of erineum mite of jasmine, *A. jasmini* started during the second week of August and the mite population attained its peak during August but started declining from the first week of February due to unfavourable weather conditions such as low temperature and high humidity.
- Correlation studies between *A. jasmini* population and weather parameters, (during August 2007 – November 2007 and November 2007 – February 2008) revealed that an increase in maximum temperature by 1^0C reduced the mite and egg population by 0.71 % and 0.79 % respectively. For every 1^0C increase in minimum temperature there was a reduction of mite and egg population by 0.02 and 0.004 % respectively. For every 1 mm increase in precipitation the reduction in mite and egg population was 0.01 and 0.32 % respectively. However an increase in maximum temperature, minimum temperature and rainfall had an adverse effect on the mite population, where as an increase in relative humidity had a positive correlation on the population build up of mite which is evident from the fact that for every 1% increase in relative humidity there was a corresponding increase in mite and egg population by 0.27 and 1.07 % respectively. Sunshine hours and wind velocity had no significant impact on the population dynamics of jasmine erineum mite.

* The treatment combinations comprising of basal application organic amendments and foliar application of entomopathogenic fungi were evaluated under field condition for their efficacy. Among them neem cake @ 100 g/ plant + *Hirsutella thompsonii* (1 X10^8 colonies per ml) recorded the maximum per cent reduction of eggs (65.00) and mites (82.30) population after second spray coupled with an enhanced flower yield of 9352.14 kg/ha coupled with higher CBR ratio 1: 5.80 which also recorded the maximum number of bacteria (26.34 x 10^6), actinomycets (18.8 x 10^4) and fungal colonies (28.25 x 10^3) in the rhizosphere soil. This was closely followed by neem cake @ 100 g/ plant + *Beauveria bassiana* (1 X10^8 colonies per ml) which ranked next in terms of reduction of egg (64.58) and mite population (79.93), higher yield, Cost Benefit ratio and increase in the number of rhizosphere microbial colonies.

* Carbofuran 3G (Standard check) @ 50 g/ plant recorded the highest per cent reduction of eggs (65.62) and mites (85.22) population, which recorded the maximum flower yield of 9386.72 kg/ha with the highest cost benefit ratio (1:5.80). This treatment was statistically superior than all other treatments evaluated for their bioefficacy.

* Some of the other effective treatments in the decreasing order of bioefficacy are neem cake @ 100 g/ plant + *Lecanicillium lacanii* (1 X10^8 colonies per ml); neem cake @ 100 g/ plant + *Paecilomyces fumosoroseus* (1 X10^8 colonies per ml); pungam cake @ 200 g/ plant + *Hirsutella thompsonii* (1 X10^8 colonies per ml); pungam cake @ 200 g/ plant + *Beauveria bassiana* (1 X10^8 colonies per ml); pungam cake @ 200 g/ plant + *Lecanicillium lacanii* (1 X10^8 colonies per ml); pungam cake @ 200 g/ plant + *Paecilomyces fumosoroseus* (1 X10^8 colonies per ml); Soil application of Farm yard manure @ 2 kg/ plant + *Hirsutella thompsonii* (1 X10^8 colonies per ml); Soil application of Farm yard manure @ 2 kg/ plant + *Beauveria bassiana* (1 X10^8 colonies per ml);

* Soil application of Farm yard manure @ 2 kg/ plant + *Lecanicillium lacanii* (1 X10^8 colonies per ml); Soil application of Farm yard manure @ 2 kg/ plant + *Paecilomyces fumosoroseus* (1 X10^8 colonies per ml); neem cake alone; pungam cake; soil application of farm yard manure alone were found to be less effective in terms of various parameters recorded. Hence basal application of either neem cake 100 g/ plant combined with two rounds of foliar application of *Hirsutella thompsonii* (1 X10^8 colonies per ml) or *Beauveria bassiana* (1 X10^8 colonies per ml) can be a better alternative to the chemical acaricides to suppress the mite population in an ecofriendly manner, which well suits in the IPM package.

* Among the various newer acaricide/insecticide molecules evaluated for the management of *A. jasmini*, profenophos @ 2ml / lit recorded the maximum per cent reduction of eggs (71.57) and mites (74.83) population after second spray coupled with an enhanced flower yield of 8987.39 kg/ha and higher Cost Benefit ratio . This was closely followed

by spiromesifen @ 0.7ml / lit which ranked next in terms of reduction in egg and mite population increase in yield and Cost Benefit ratio. Hence these two insecticides can be recommended for effective management of *A. jasmini*

* Wettable Sulphur @ 3 g / lit and Dicofol @ 4ml/lit (Standard check) recorded the highest per cent reduction of eggs (93.15 and 93.05) and mites (97.91 and 97.81) population and recorded the maximum flower yield of 9524.76 kg/ha and 9520.66 kg/ha with the highest cost benefit ratio (1:5.98) and (1:5.93). These two treatments were statistically superior than all other treatments. However they has been in vogue for more than 3 decades, newer molecules may be included in their place.

* Jasmine species (*Jasminum auriculatum*) is the only one host for the erineum mite *A. jasmini* and as such no alternate crops/weed flora could be recorded.

* The natural enemies such as *Amblyseius* spp (Phytoseiidae); *Agistemus* sp. (Stigmaeidae) and *Micraspis discolor* (Fab.) (Coccinellidae) were the predators found, often associated with jasmine mite population in jasmine ecosystem. If the predators could be conserved and augmented properly they may serve as a potential biotic factor to suppress the mites in field condition.

APPENDIX – II

Meteorological data for Season I and Season II

(SEASON I – HC&RI,PERIYAKULAM) August 2007 – November 2007							(SEASON II - HC&RI,PERIYAKULAM) November 2007 – February 2008						
Month	**Max. temp. (^{0}C)**	**Min. temp. (^{0}C)**	**R.H (%)**	**Rainfall (mm)**	**Sunshine hours**	**Wind Velocity (Kms/hr)**	**Month**	**Max. temp. (^{0}C)**	**Min. temp. (^{0}C)**	**R.H (%)**	**Rainfall (mm)**	**Sunshine hours**	**Wind Velocity (Kms/hr)**
Aug 9-Aug 23	32.3	19.8	70	10.9	9	5.55	Nov 7-Nov 21	32.7	20.36	70.3	11.87	8.23	5.82
Aug 24-Sep 7	32.6	21.5	76.5	13.93	7.6	5.8	Nov 22-Dec 6	32.1	21.68	71.5	12.12	7.5	5.78
Sep 8-Sep 22	30.3	23.3	75.8	11.7	8.09	6.5	Dec 7-Dec 21	30.82	23.52	72.4	9.87	8.12	6.23
Sep 23-Oct 7	29.3	23.7	82.8	13.5	3.89	4.7	Dec 22-Jan 6	29.56	24.21	80.3	9.45	7.26	4.28
Oct 8-Oct 22	29.7	21.3	71.6	12.2	5.62	5.5	Jan 7-Jan 21	29.84	21.56	72.1	10.99	5.64	5.42
Oct 23-Nov 6	30.8	19.1	80.5	10.78	7.2	7.53	Jan 22-Feb 6	30.24	19.3	80.1	10.28	7.84	7.32

APPENDIX – I

Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann. in the major jasmine growing tracts of Tamil Nadu

Loca tions No	Villages surveyed	Species cultivated	Area culti vate d (Ac)	Stage of the crop	Pesticide sprayed and Dose	No. of mit es / 2m m²	No. of egg s/ 2m m²	Dam age inten sity (1-4 scale)
L1	**Coimbato re districts** Annur	*Jasminum auriculatum* *Jasminum sambac*	1.0 acre 0.80	Flowe ring Flowe ring	Wettable Sulphur (3g/l) -	5.0 0 -	7.0 2 -	1 grade -
L2	aghutham Palayam	*Jasminum auriculatum*	0.40	Prunin g	Wettable Sulphur (3g/l)	6.6 6	8.3 4	2 grade
L3	Puduvada valli	*Jasminum auriculatum* *Jasminum grandiflorum*	0.60 0.65	Prunin g Flowe ring	Dicofol (4ml/l) -	5.6 6 -	8.0 7 -	2 grade -
L4	Pujankanu r	*Jasminum auriculatum*	0.20	Prunin g	Dicofol (4ml/l)	5.7 3	8.1 2	2 grade
L5	rumugai	*Jasminum auriculatum*	0.30	Flowe ring	Wettable Sulphur (3g/l)	5.0 2	7.5 6	1 grade
L6	Theranpal ayam	*Jasminum auriculatum*	0.40	Prunin g	Wettable Sulphur (3g/l)	5.0 6	7.5 9	1 grade
L7	**2) Dharma puri districts** A.Pappar patty	Jasminum auriculatum Jasminum sambac	1.0 acre 0.45	Flowe ring Flowe ring	Dicofol (4ml/l) -	8.0 2 -	9.3 4 -	3 grade -
L8	Kanapatt y	Jasminum auriculatum Jasminum sambac	0.80 1.0 acre	Prunin g Prunin g	Wettable Sulphur (3g/l) -	5.6 7 -	8.1 0 -	2 grade -

Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann. in the major jasmine growing tracts of Tamil Nadu

Contd……..

Locations No	**Villages surveyed**	**Species cultivated**	**Area cultivated (Ac)**	**Stage of the crop**	**Pesticide sprayed and Dose**	**No. of mites / 2m m^2**	**No. of eggs / 2m m^2**	**Damage intensity (1-4 scale)**
L9	Mathahalli	Jasminum auriculatum Jasminum sambac	1.0 acre 1.0 acre	Pruning Flowering	Wettable Sulphur (3g/l) -	5.66 -	8.07 -	2 grade -
L10	O.G.halli	Jasminum auriculatum	1.0 acre	Flowering	Wettable Sulphur (3g/l)	5.69	8.10	2 grade
L11	Vallur	Jasminum auriculatum Jasminum sambac	40 cents 80 cents	Pruning Flowering	Dicofol (4ml/l) -	8.06 -	9.37 -	3 grade
L12	**3) Dindigul district** Kallathukottam	*Jasminum auriculatum* *Jasminum sambac*	1.0 acre 1.0 acre	Flowering Flowering	Wettable Sulphur (3g/l) -	8.87 -	10.06 -	3 grade -
L13	Kamatchipuram	*Jasminum auriculatum* *Jasminum sambac*	0.60 0.40	Flowering Flowering	Dicofol (4ml/l) -	10.07 -	11.64 -	4 grade -
L14	Kavariyapuram	*Jasminum auriculatum* *Jasminum grandiflorum*	0.60 0.45	Flowering Flowering	Wettable Sulphur(3g/l) -	8.66 -	9.31 -	3 grade -
L15	Kongupatty	*Jasminum auriculatum* *Jasminum sambac*	0.45 1.0 acre	pruning Flowering	Wettable Sulphur (3g/l) -	8.86 -	10.01 -	3 grade -

Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann. in the major jasmine growing tracts of Tamil Nadu

Contd……..

Locations No	Villages surveyed	Species cultivated	Area cultivated (Ac)	Stage of the crop	Pesticide sprayed and Dose	No. of mites / $2mm^2$	No. of eggs/$2mm^2$	Damage intensity (1-4 scale)
L16	Kovilpatty	*Jasminum auriculatum* *Jasminum sambac* *Jasminum grandiflorum*	0.30 0.50 0.35	Pruning Flowering Flowering	Wettable Sulphur (3g/l) - -	8.94 - -	10.09 - -	3 grade - -
L17	Mulakapatty	*Jasminum auriculatum* *Jasminum sambac*	0.40 0.40	Flowering Flowering	Dicofol (4ml/l) -	9.00 -	10.18 -	4 grade -
L18	Nariyuthu	*Jasminum auriculatum* *Jasminum sambac* *Jasminum grandiflorum*	0.45 0.60 0.60	Flowering Flowering Flowering	Wettable Sulphur (3g/l) - -	9.33 - -	11.13 - -	4 grade - -
L19	Palayasilukuvarpatty	*Jasminum auriculatum*	0.50	Pruning	Wettable Sulphur (3g/l)	7.66	8.81	3 grade
L20	Pallapatty	*Jasminum auriculatum*	0.40	Pruning	Wettable Sulphur (3g/l)	8.73	10.00	3 grade
L21	Sillampatty	*Jasminum auriculatum* *Jasminum sambac*	0.60 0.50	Flowering Flowering	Wettable Sulphur (3g/l) -	10.11 -	11.86 -	4 grade -
L22	Silukkuvarpatty	*Jasminum auriculatum* *Jasminum sambac*	0.50 0.80	Flowering Flowering	Wettable Sulphur (3g/l) -	9.02 -	10.86 -	4 grade -

Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann. in the major jasmine growing tracts of Tamil Nadu

Contd……..

Locations No	**Villages surveyed**	**Species cultivated**	**Area cultivated (Ac)**	**Stage of the crop**	**Pesticide sprayed and Dose**	**No. of mites / 2mm^2**	**No. of eggs/2 mm^2**	**Damage intensity (1-4 scale)**
L23	Singampatty	*Jasminum auriculatum*	0.40	Pruning	Wettable Sulphur (3g/l)	8.68	9.35	3 grade
L24	**4) Erode district** Bhavanisagar	*Jasminum auriculatum*	0.70	Pruning	Wettable Sulphur (3g/l)	5.68	7.27	2 grade
L25	Kothamangalam	*Jasminum auriculatum*	0.60	Pruning	Dicofol (4ml/l)	5.07	7.12	1 grade
L26	Puliampatty	*Jasminum auriculatum* *Jasminum sambac* *Jasminumgrandiflorum*	0.40 1.0 acre 0.30	Pruning Flowering Flowering	Dicofol (4ml/l) - -	6.66 - -	8.53 - -	2 grade - -
L27	Rajannagar	*Jasminum auriculatum*	0.20	Pruning	Wettable Sulphur (3g/l)	5.66	7.24	2 grade
L28	Samraj Nagar	*Jasminum auriculatum* *Jasminum sambac*	1.0 acre 1.0 acre	Flowering Flowering	Wettable Sulphur (3g/l) -	5.00 -	7.04 -	1 grade -
L29	Sathyamangalam	*Jasminum auriculatum* *Jasminum sambac*	1.0 acre 1.0 acre	Flowering Flowering	Wettable Sulphur (3g/l) -	8.68 -	10.66 -	3 grade -

Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann. in the major jasmine growing tracts of Tamil Nadu

Contd……..

Locations No	**Villages surveyed**	**Species cultivated**	**Area cultivated (Ac)**	**Stage of the crop**	**Pesticide sprayed and Dose**	**No. of mites / 2mm^2**	**No. of eggs/2 mm^2**	**Damage intensity (1-4 scale)**
L30	Uppupallam	*Jasminum auriculatum* *Jasminum sambac*	1.0 acre 0.40	Flowering Flowering	Wettable Sulphur (3g/l) -	8.66 -	10.63 -	3 grade -
L31	**5) Madurai district** Kappalur	*Jasminum auriculatum* *Jasminum sambac*	0.60 1.0 acre	Pruning Flowering	Wettable Sulphur (3g/l) -	8.03 -	9.03 -	3 grade -
L32	Mavuthu	*Jasminum auriculatum* *Jasminum sambac*	1.0 acre 1.0 acre	Flowering Flowering	Wettable Sulphur (3g/l) -	8.08 -	9.09 -	3 grade -
L33	Meenakshipuram	Jasminum auriculatum Jasminum sambac	0.50 1.0 acre	Pruning Flowering	Wettable Sulphur (3g/l) -	8.57 -	9.23 -	3 grade -
L34	Peraiyur	*Jasminum auriculatum* *Jasminum sambac* *Jasminum grandiflorum*	0.75 1.0 acre 0.35	Pruning Flowering Flowering	Wettable Sulphur (3g/l) - -	8.69 - -	9.26 - -	3 grade - -
L35	Solankuruni	*Jasminum auriculatum*	1.0 acre 1.0	Pruning Prunin	Wettable Sulphur	8.10 -	9.11 -	3 grade -

		Jasminum sambac	acre	g	(3g/l) -			
L36	T. Kallupatty	*Jasminum auriculatum* *Jasminum sambac*	0.40 0.40	Flowering Flowering	Dicofol (4ml/l) -	8.48 -	9.16 -	3 grade -

Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann. in the major jasmine growing tracts of Tamil Nadu

Contd……..

Locations No	**Villages surveyed**	**Species cultivated**	**Area cultivated (Ac)**	**Stage of the crop**	**Pesticide sprayed and Dose**	**No. of mites / 2mm^2**	**No. of eggs/2 mm^2**	**Damage intensity (1-4 scale)**
L37	Vadipatty	Jasminum auriculatum Jasminum sambac	0.40 1.0 acre	Flowering Flowering	Wettable Sulphur (3g/l) -	6.58 -	8.26 -	2 grade -
L38	**6) Ramnad district** Ayyanar kulam	*Jasminum auriculatum*	0.25	Pruning	Wettable Sulphur (3g/l)	5.66	8.12	2 grade
L39	Kavadipatty	*Jasminum auriculatum* *Jasminum grandiflorum*	0.50 0.65	Pruning Flowering	Dicofol (4ml/l) -	6.00 -	8.18 -	2 grade -
L40	Koraipalayam	*Jasminum auriculatum* *Jasminum*	0.45 0.80	Flowering Flowering	Wettable Sulphur (3g/l)	6.06 -	8.37 -	2 grade -

		sambac			-			
L41	N.Nallasubhira Maniapuram	*Jasminum auriculatum*	0.45	Pruning	Wettable Sulphur (3g/l)	6.66	8.66	2 grade
L42	Ramasamy patty	*Jasminum auriculatum*	0.40	Pruning	Dicofol (4ml/l)	5.00	7.22	1 grade
L43	**7) Salem district** Maramangalathu patty	*Jasminum auriculatum*	1.0 acre	Pruning	Dicofol (4ml/l)	4.96	6.89	1 grade

Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann. in the major jasmine growing tracts of Tamil Nadu

Contd……..

Locations No	**Villages surveyed**	**Species cultivated**	**Area cultivated (Ac)**	**Stage of the crop**	**Pesticide sprayed and Dose**	**No. of mites / 2mm^2**	**No. of eggs/2 mm^2**	**Damage intensity (1-4 scale)**
L44	Panamarathupatty	*Jasminum auriculatum* *Jasminum sambac*	1.0 acre 0.80	Pruning Flowering	Dicofol (4ml/l) -	5.58 -	8.02 -	2 grade -
L45	Santhiyur	*Jasminum auriculatum*	0.60	Pruning	Dicofol (4ml/l)	5.57	8.00	2 grade
L46	Veerapandi	*Jasminum auriculatum*	1.0 acre	Pruning	Wettable Sulphur (3g/l)	5.58	8.01	2 grade
L47	**8) Theni district** HC&RI, Periyakulam	*Jasminum auriculatum* *Jasminum sambac* *Jasminum grandiflorum*	0.40 0.60 0.60	Flowering Flowering Flowering	Triazophos (1.5ml/l) - -	8.66 - -	9.14 - -	3 grade - -
L48	Kanavillaku	*Jasminum auriculatum* *Jasminum sambac*	0.40 1.0 acre	Flowering Flowering	Wettable Sulphur (3/l) -	5.00 -	7.56 -	1 grade -
L49	Muthanampatty	*Jasminum auriculatum* *Jasminu*	0.20 1.0 acre	Pruning Flowering	Wettable Sulphur (3g/l) -	5.66 -	8.21 -	2 grade -

		m sambac						
L50	Subhulapuram	*Jasminum auriculatum* *Jasminum sambac*	0.30 0.80	Flowering Flowering	Wettable Sulphur (3g/l) -	4.00 -	6.45 -	1 grade -

Table 1. Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann. in the major jasmine growing tracts of Tamil Nadu

Grade	Damage level	No. of locations	Per cent of locations	Mite population/2mm^2 (Range)	Egg population/2mm^2 (Range)
1	0-25%	9	18%	4-5.07	6.45-7.59
2	26-50%	18	36%	5.57-6.66	7.24-8.66
3	51-75%	18	36%	7.66-8.94	8.81-10.66
4	76-100%	5	10%	9.00-10.11	10.18-11.86

Table 2. Survey on the occurrence and abundance of jasmine erineum mite, *Aceria jasmini* Chann. in the major jasmine growing tracts of Tamil Nadu (district wise details)

District	No. of locations surveyed	Mean grade index (1-4 scale)	Mean mite population/2mm^2	Mean egg population/2mm^2
Coimbatore	6	1.5	5.52	7.78
Dharmapuri	5	2.4	6.62	8.59
Dindigul	12	3.16	8.99	10.27
Erode	7	2.00	6.48	8.35
Madurai	7	2.85	8.07	9.02
Ramnad	5	1.8	5.87	8.11
Salem	4	1.75	5.42	7.73
Theni	4	1.75	5.83	7.84

Table 3. Assessment of damage potential of *Aceria jasmini* on jasmine in field condition

Grade	Damage level	* flower yield in g/ bush on daily basis ** overall mean	% reduction in yield compared to healthy plant
1	(healthy bush)	30.03	-
2	1-25%	24.30	19.08
3	26-50%	15.52	48.31
4	51-75%	9.11	69.66
5	76-100%	1.40	95.33

* Mean of 3 replications

** Mean of 10 consecutive harvest (daily) flower yield g/plant

SED = 0.098

Table 4. Seasonal incidence of jasmine erineum mite, *A. jasmini* on jasmine during August 2007 – November 2007 and November 2007 – February 2008

(SEASON I – HC&RI,PERIYAKULAM) August 2007 – November 2007		(SEASON II - HC&RI,PERIYAKULAM) November 2007 – February 2008	
Fortnight	**Mite population / $2mm^2$ of erineum (fortnightly count)**	**Fortnight**	**Mite population / $2mm^2$ of erineum (fortnightly count)**
Aug 9-Aug 23	9.33	Nov 7-Nov 21	9.06
Aug 24-Sep 7	9.00	Nov 22-Dec 6	9.01
Sep 8-Sep 22	8.66	Dec 7-Dec 21	8.25
Sep 23-Oct 7	7.66	Dec 22-Jan 6	7.54
Oct 8-Oct 22	5.66	Jan 7-Jan 21	5.60
Oct 23-Nov 6	7.33	Jan 22-Feb 6	7.27

Table 5. Correlation between weather parameters and the population dynamics of jasmine erineum mite, *A. jasmini* during Aug'07-Nov'07

Pest	Correlation	Temperature (^0C)		Relative humidity (%)	Rainfall (mm)	Sunshine hours	Wind velocity (Km/hr)
		Maximum	Minimum				
Jasmine erineum mite	R	0.712	0.019	-0.076	0.017	0.644	0.014
	r^2 (R)	0.506	0.0003	0.005	0.0001	0.414	0.0001
	Y = a + bx	25.18-0.71x	21.24-0.02x	78.41+0.27x	12.03-0.01x	-0.069-0.87x	5.84-0.01x
	Significance						
	P = 0.05*	*	*	*	*	-	-
	Non Significance	-	-	-	-	NS	NS

Table 6. Correlation between weather parameters and the population dynamics of jasmine erineum mite, *A. jasmini* during Nov'07-Feb' 08

Pest	Correlation	Temperature (^{0}C)		Relative humidity (%)	Rainfall (mm)	Sunshine hours	Wind velocity (Km/hr)
		Maximum	Minimum				
Jasmine erineum mite	r	0.814	0.003	-0.309	0.388	0.836	0.096
	r^2 (R)	0.662	0.00000009	0.095	0.150	0.698	0.009
	Y = a + bx	24.68-0.79x	21.73-0.004x	82.81+1.07x	8.24-0.32x	2.66-0.61x	5.23-0.07x
	Significance						
	P = 0.05*	*	*	*	*	-	-
	Non Significance	-	-	-	-	NS	NS

Table 7. Evaluation of organic sources of nutrients and foliar application of entomopathogenic fungi on the incidence of *Aceria jasmini* on jasmine – Field Trial I – Spray I (Season: Aug '07- Nov '07)

Treatments	*Pre treatment count	Number of eggs on leaves (2mm^2)			
		15 DAS	30 DAS	45 DAS	Mean
T_0 : Untreated control	10.10	10.25 (3.19)^e	10.93 (3.29)^i	11.64 (3.40)^f	10.94 (3.29)^j
T_1 : Soil application of FYM (2kg/plant)	10.86	9.14 (3.01)^d	7.38 (2.71)^h	5.69 (2.38)^e	7.40 (2.70)^{hi}
T_2 : Pungam cake @ 200g / plant	9.31	8.96 (2.98)^{cd}	7.28 (2.69)^{gh}	5.55 (2.35)^e	7.26 (2.67)^{ghi}
T_3 : Neem cake @100g / plant	9.14	8.87 (2.97)^{cd}	7.27 (2.69)^{gh}	5.53 (2.34)^e	7.22 (2.66)^{ghi}
T_4: T_1 + Beauveria *bassiana* (foliar application @ 1 X 10^8 spores/ ml)	10.00	8.64 (2.93)^{cd}	6.83 (2.60)^{efgh}	4.94 (2.20)^d	6.80 (2.57)^{hi}
T_5: T_1 + *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spores/ ml)	10.14	8.61 (2.92)^{cd}	6.79 (2.60)^{defgh}	4.93 (2.21)^d	6.77 (2.57)^{efgh}
T_6: T_1 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spores/ ml)	9.47	8.76 (2.95)^{cd}	7.16 (2.67)^{gh}	5.00 (2.23)^d	6.97 (2.61)^{fgh}
T_7: T_1 + *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spores/ ml)	9.77	8.81 (2.96)^{cd}	7.25 (2.69)^{gh}	5.00 (2.23)^d	7.02 (2.62)^{fghi}
T_8: T_2 + *Beauveria bassiana* (foliar application @ 1 X 10^8 spores/ ml)	10.67	8.36 (2.88)^{bcd}	6.45 (2.53)^{cdef}	4.39 (2.09)^c	6.40 (2.50)^{cdef}
T_9: T_2 + *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spores/ ml)	10.93	8.35 (2.88)^{bcd}	6.41 (2.52)^{bcde}	4.36 (2.09)^c	6.37 (2.49)^{bcdef}
T_{10}: T_2 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spores/ ml)	10.86	8.49 (2.90)^{bcd}	6.58 (2.55)^{defg}	4.65 (2.15)^{cd}	6.57 (2.53)^{defg}
T_{11}: T_2 + *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spores/ ml)	10.69	8.52 (2.90)^{bcd}	6.66 (2.57)^{efgh}	4.87 (2.20)^d	6.68 (2.55)^{efgh}
T_{12}: T_3 + *Beauveria bassiana* (foliar application @ 1 X 10^8 spores/ ml)	10.57	7.72 (2.77)^{abc}	5.94 (2.43)^{abc}	3.87 (1.96)^{ab}	5.84 (2.38)^{abc}
T_{13}: T_3 + *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spores/ ml)	10.72	7.56 (2.74)^{ab}	5.74 (2.39)^{ab}	3.83 (1.95)^a	5.71 (2.36)^{ab}
T_{14}: T_3 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spores/ ml)	10.54	8.22 (2.86)^{abcd}	5.73 (2.39)^{ab}	3.80 (1.94)^{ab}	5.91 (2.39)^{abcd}
T_{15}: T_3 + *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spores/ ml)	10.18	8.22 (2.86)^{abcd}	6.12 (2.46)^{abcd}	4.23 (2.05)^{bc}	6.19 (2.45)^{abcde}
T_{16}: Soil application of Carbofuran 3G @ 50g / plant	10.64	7.21 (2.69)^a	5.64 (2.37)^a	3.74 (1.93)^a	5.53 (2.33)^a

*NS

*DAS – Days after spray

*Each value is the mean of three replications.

*Figures in parentheses are square root transformed values

*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 8. Evaluation of organic sources of nutrients and foliar application of entomopathogenic fungi on the incidence of *Aceria jasmini* on jasmine – Field Trial I – Spray I (Season: Aug '07- Nov '07)

Treatments	*Pre treatment count	Number of mites on leaves (2mm^2)			
		15 DAS	30 DAS	45 DAS	Mean
T_0 : Untreated control	9.33	9.77 (3.12)^{e}	10.11 (3.17)^{h}	10.33 (3.20)^{h}	10.07 (3.16)^{h}
T_1 : Soil application of FYM (2kg/plant)	9.33	8.66 (2.93)^{de}	6.93 (2.62)^{g}	5.33 (2.30)^{g}	6.97 (2.61)^{g}
T_2 : Pungam cake @ 200g / plant	9.00	8.06 (2.83)^{de}	6.93 (2.63)^{g}	5.16 (2.27)^{efg}	6.71 (2.57)^{fg}
T_3 : Neem cake @100g / plant	9.00	8.26 (2.87)^{de}	6.40 (2.52)^{fg}	5.23 (2.28)^{fg}	6.63 (2.55)^{fg}
T_4: T_1 + *Beauveria bassiana* (foliar application @ 1 X 10^8 spores/ ml)	8.66	7.53 (2.72)^{cde}	5.66 (2.35)^{efg}	4.66 (2.15)^{defg}	5.95 (2.40)^{defg}
T_5: T_1 + *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spores/ ml)	8.66	7.33 (2.69)^{cde}	5.40 (2.30)^{defg}	4.43 (2.09)^{defg}	5.72 (2.36)^{defg}
T_6: T_1+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spores/ ml)	9.00	7.66 (2.72)^{cde}	5.70 (2.37)^{efg}	4.70 (2.15)^{defg}	6.02 (2.41)^{defg}
T_7: T_1+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spores/ ml)	9.33	7.90 (2.80)^{de}	5.83 (2.40)^{efg}	4.80 (2.18)^{defg}	6.17 (2.46)^{efg}
T_8: T_2+ *Beauveria bassiana* (foliar application @ 1 X 10^8 spores/ ml)	8.66	6.73 (2.58)^{bcd}	4.96 (2.22)^{cdef}	3.80 (1.93)^{cde}	5.16 (2.24)^{cde}
T_9: T_2+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spores/ ml)	9.01	6.66 (2.56)^{bcd}	4.76 (2.17)^{bcde}	3.66 (1.89)^{bcd}	5.02 (2.20)^{cd}
T_{10}: T_2 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spores/ ml)	9.19	6.93 (2.62)^{cde}	5.00 (2.22)^{cdef}	3.93 (1.97)^{def}	5.28 (2.27)^{cde}
T_{11}: T_2+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spores/ ml)	9.00	7.33 (2.67)^{cde}	5.16 (2.26)^{def}	4.00 (1.98)^{defg}	5.49 (2.30)^{cde}
T_{12}: T_3 + *Beauveria bassiana* (foliar application @ 1 X 10^8 spores/ ml)	9.33	5.33 (2.27)^{abc}	3.66 (1.89)^{abc}	2.66 (1.62)^{abc}	3.88 (1.92)^{ab}
T_{13}: T_3+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spores/ ml)	9.00	4.83 (2.13)^{ab}	3.33 (1.82)^{ab}	2.50 (1.57)^{ab}	3.55 (1.84)^{a}
T_{14}: T_3 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spores/ ml)	9.19	6.33 (2.50)^{bcd}	4.00 (1.92)^{bcd}	3.50 (1.86)^{abcd}	4.61 (2.09)^{bc}
T_{15}: T_3+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spores/ ml)	9.33	6.33 (2.56)^{bcd}	4.73 (2.17)^{bcde}	3.63 (1.89)^{bcd}	4.99 (2.20)^{cd}
T_{16}: Soil application of Carbofuran 3G @ 50g / plant	9.01	4.00 (1.98)^{a}	2.66 (1.62)^{a}	2.43 (1.55)^{a}	3.03 (1.71)^{a}

*NS

*DAS – Days after spray

*Each value is the mean of three replications.

*Figures in parentheses are square root transformed values

*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 9. Evaluation of organic sources of nutrients and foliar application of entomopathogenic fungi on the incidence of *Aceria jasmini* on jasmine – Field Trial I – Spray I (Season: Aug '07- Nov '07)

Treatments	Mean egg count on leaves ($2mm^2$)	% reduction over control	Mean mite count on leaves ($2mm^2$)	% reduction over control
T_0 : Untreated control	10.94 $(3.29)^{j}$	-	10.07 $(3.16)^{h}$	-
T_1 : Soil application of FYM (2kg/plant)	7.40 $(2.70)^{hi}$	32.35	6.97 $(2.61)^{g}$	30.78
T_2 : Pungam cake @ 200g / plant	7.26 $(2.67)^{ghi}$	33.63	6.71 $(2.57)^{fg}$	33.36
T_3 : Neem cake @100g / plant	7.22 $(2.66)^{ghi}$	34.00	6.63 $(2.55)^{fg}$	34.16
T_4: T_1+ *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	6.80 $(2.57)^{hi}$	37.84	5.95 $(2.40)^{defg}$	40.91
T_5: T_1 + *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	6.77 $(2.57)^{efgh}$	38.11	5.72 $(2.36)^{defg}$	43.19
T_6: T_1 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	6.97 $(2.61)^{fgh}$	36.28	6.02 $(2.41)^{defg}$	40.21
T_7: T_1 + *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	7.02 $(2.62)^{fghi}$	35.83	6.17 $(2.46)^{efg}$	38.72
T_8: T_2+ *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	6.40 $(2.50)^{cdef}$	41.49	5.16 $(2.24)^{cde}$	48.75
T_9: T_2+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	6.37 $(2.49)^{bcdef}$	41.77	5.02 $(2.20)^{cd}$	50.14
T_{10}: T_2+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	6.57 $(2.53)^{defg}$	39.94	5.28 $(2.27)^{cde}$	47.56
T_{11}: T_2+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	6.68	38.93	5.49	45.48

	(2.55)^{efgh}		(2.30)^{cde}	
T_{12}: T_3 + *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	5.84 (2.38)^{abc}	46.61	3.88 (1.92)^{ab}	61.46
T_{13}: T_3+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	5.71 (2.36)^{ab}	47.80	3.55 (1.84)^{a}	64.74
T_{14}: T_3 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	5.91 (2.39)^{abcd}	45.97	4.61 (2.09)^{bc}	54.22
T_{15}: T_3+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	6.19 (2.45)^{abcde}	43.41	4.99 (2.20)^{cd}	50.44
T_{16}: Soil application of Carbofuran 3G @ 50g / plant	5.53 (2.33)^{a}	49.45	3.03 (1.71)^{a}	69.91

*Each value is the mean of three observations at fortnightly interval.

*Figures in parentheses are square root transformed values

*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 10. Evaluation of organic sources of nutrients and foliar application of entomopathogenic fungi on the incidence of *Aceria jasmini* on jasmine – Field Trial I – Spray II (Season: Aug '07- Nov '07)

Treatments	*Pre treatment count	Number of eggs on leaves (2mm^2)			
		15 DAS	30 DAS	45 DAS	Mean
T_0 : Untreated control	9.10	9.14 (3.02)^{p}	9.77 (3.12)^{m}	10.00 (3.16)^{p}	9.63 (3.09)^{q}
T_1 : Soil application of FYM (2kg/plant)	8.74	7.36 (2.71)^{o}	5.29 (2.29)^{l}	3.49 (1.86)^{o}	5.38 (2.31)^{p}
T_2 : Pungam cake @ 200g / plant	8.87	7.10 (2.66)^{n}	5.14 (2.26)^{k}	3.14 (1.76)^{n}	5.12 (2.25)^{o}
T_3 : Neem cake @100g / plant	8.96	7.00 (2.64)^{m}	5.13 (2.38)^{k}	3.01 (1.73)^{m}	5.04 (2.24)^{n}
T_4: T_1 + *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	8.76	6.73 (2.59)^{j}	4.49 (2.27)^{i}	2.19 (1.47)^{j}	4.47 (2.11)^{k}
T_5: T_1 + *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	8.81	6.39 (2.52)^{i}	4.42 (2.24)^{h}	2.02 (1.41)^{i}	4.27 (2.06)^{j}
T_6: T_1+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	8.22	6.76	4.52	2.22	4.50

		(2.60)^{k}	(2.27)^{j}	(1.48)^{k}	(2.11)^{l}
T_7: T_1+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	8.22	6.80 (2.60)^{l}	4.54 (2.28)^{j}	2.34 (1.52)^{l}	4.56 (2.13)^{m}
T_8: T_2 + *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	8.96	6.05 (2.45)^{f}	3.97 (2.14)^{e}	1.37 (1.16)^{f}	3.79 (1.94)^{g}
T_9: T_2+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	8.74	6.01 (2.45)^{e}	3.91 (2.12)^{d}	1.33 (1.15)^{e}	3.75 (1.93)^{f}
T_{10}: T_2+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	8.36	6.16 (2.48)^{g}	4.15 (2.97)^{f}	1.75 (1.31)^{g}	4.02 (2.00)^{h}
T_{11}: T_2+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	8.49	6.18 (2.48)^{h}	4.33 (2.19)^{g}	1.93 (1.38)^{h}	4.11 (2.02)^{i}
T_{12}: T_3 + *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	8.52	5.24 (2.28)^{b}	3.80 (2.05)^{b}	1.20 (1.09)^{c}	3.41 (1.84)^{c}
T_{13}: T_3+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	8.74	5.23 (2.28)^{b}	3.79 (2.05)^{b}	1.09 (1.04)^{b}	3.37 (1.83)^{b}
T_{14}: T_3+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	8.22	5.53 (2.35)^{c}	3.83 (2.08)^{c}	1.21 (1.09)^{c}	3.52 (1.87)^{d}
T_{15}: T_3+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	8.49	5.73 (2.39)^{d}	3.84 (2.09)^{c}	1.24 (1.11)^{d}	3.60 (1.89)^{e}
T_{16}: Soil application of Carbofuran 3G @ 50g / plant	8.96	5.21 (2.28)^{a}	3.77 (2.05)^{a}	0.97 (0.98)^{a}	3.31 (1.81)^{a}

*NS

*DAS – Days after spray

*Each value is the mean of three replications.

*Figures in parentheses are square root transformed values

*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 11. Evaluation of organic sources of nutrients and foliar application of entomopathogenic fungi on the incidence of *Aceria jasmini* on jasmine – Field Trial I – Spray II (Season: Aug '07- Nov '07)

Treatments	*Pre treatment count	Number of mites on leaves (2mm²)			
		15 DAS	30 DAS	45 DAS	Mean
T_0 : Untreated control	9.17	9.19 (3.03)^{o}	9.31 (3.05)^{q}	9.33 (3.05)^{p}	9.27 (3.04)^{n}
T_1 : Soil application of FYM (2kg/plant)	8.87	6.53 (2.55)^{n}	3.53 (1.87)^{p}	2.43 (1.55)^{o}	4.16 (2.03)^{m}
T_2 : Pungam cake @ 200g / plant	8.96	6.50 (2.54)^{n}	3.36 (1.83)^{o}	2.26 (1.49)^{n}	4.04 (2.00)^{lm}
T_3 : Neem cake @100g / plant	8.64	6.00 (2.44)^{m}	3.33 (1.82)^{n}	2.13 (1.45)^{m}	3.82 (1.95)^{l}
T_4: T_1 +*Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	8.66	5.26 (2.29)^{k}	2.86 (1.68)^{k}	1.76 (1.32)^{k}	3.29 (1.81)^{lm}
T_5: T_1 + *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	8.26	5.00 (2.23)^{j}	2.53 (1.58)^{j}	1.71 (1.30)^{j}	3.08 (1.75)^{ij}
T_6: T_1+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	8.06	5.27 (2.29)^{k}	2.90 (1.72)^{l}	1.77 (1.32)^{k}	3.31 (1.81)^{jk}
T_7: T_1+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	8.81	5.41 (2.32)^{l}	3.00 (1.72)^{m}	1.90 (1.37)^{l}	3.43 (1.85)^{k}
T_8: T_2+ *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	8.26	4.50 (2.12)^{g}	2.10 (1.44)^{g}	1.60 (1.26)^{g}	2.73 (1.64)^{fg}
T_9: T_2+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	8.64	4.28 (2.06)^{f}	2.00 (1.41)^{f}	1.58 (1.25)^{f}	2.62 (1.61)^{ef}
T_{10}: T_2 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	8.66	4.55 (2.13)^{h}	2.23 (1.48)^{h}	1.63 (1.27)^{h}	2.80 (1.66)^{gh}
T_{11}: T_2+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	8.66	4.73 (2.17)^{i}	2.30 (1.51)^{i}	1.65 (1.28)^{i}	2.89 (1.69)^{hi}
T_{12}: T_3+ *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	8.61	3.19 (1.78)^{c}	1.26 (1.12)^{c}	1.15 (1.07)^{c}	1.86 (1.35)^{bc}
T_{13}: T_3+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	8.96	2.84 (1.68)^{b}	1.10 (1.04)^{b}	0.99 (0.99)^{b}	1.64 (1.27)^{ab}
T_{14}: T_3 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	8.96	3.51 (1.87)^{d}	1.73 (1.31)^{d}	1.40 (1.18)^{d}	2.21 (1.48)^{cd}
T_{15}: T_3+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	8.06	3.95 (1.98)^{e}	1.76 (1.32)^{e}	1.52 (1.23)^{e}	2.41 (1.54)^{de}
T_{16}: Soil application of Carbofuran 3G @ 50g / plant	8.02	2.18 (1.47)^{a}	1.03 (1.01)^{a}	0.92 (0.95)^{a}	1.37 (1.16)^{a}

*NS

*Each value is the mean of three replications.

*Figures in parentheses are square root transformed values

*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 12. Evaluation of organic sources of nutrients and foliar application of entomopathogenic fungi on the incidence of *Aceria jasmini* on jasmine – Field Trial I – Spray II (Season: Aug '07- Nov '07)

Treatments	Mean egg count on leaves ($2mm^2$)	% reduction over control	Mean mite count on leaves ($2mm^2$)	% reduction over control
T_0 : Untreated control	9.63 (3.09)^{q}	–	9.27 (3.04)^{n}	–
T_1 : Soil application of FYM (2kg/plant)	5.38 (2.31)^{p}	44.13	4.16 (2.03)^{m}	55.12
T_2 : Pungam cake @ 200g / plant	5.12 (2.25)^{o}	46.83	4.04 (2.00)^{lm}	56.41
T_3 : Neem cake @100g / plant	5.04 (2.24)^{n}	47.66	3.82 (1.95)^{l}	58.79
T_4: T_1 +*Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	4.47 (2.11)^{k}	53.58	3.29 (1.81)^{lm}	64.50
T_5: T_1+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	4.27 (2.06)^{j}	55.65	3.08 (1.75)^{ij}	66.77
T_6: T_1+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	4.50 (2.11)^{l}	53.27	3.31 (1.81)^{jk}	64.29
T_7: T_1 + *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	4.56 (2.13)^{m}	52.64	3.43 (1.85)^{k}	62.99
T_8: T_2+ *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	3.79 (1.94)^{g}	60.64	2.73 (1.64)^{fg}	70.55
T_9: T_2+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	3.75 (1.93)^{f}	61.05	2.62 (1.61)^{ef}	71.73
T_{10}: T_2+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	4.02 (2.00)^{h}	58.25	2.80 (1.66)^{gh}	69.79
T_{11}: T_2+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	4.11	57.32	2.89	68.82

	(2.02)[i]		(1.69)[hi]	
T_{12}: T_3 + *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	3.41 (1.84)[c]	64.58	1.86 (1.35)[bc]	79.93
T_{13}: T_3+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	3.37 (1.83)[b]	65.00	1.64 (1.27)[ab]	82.30
T_{14}: T_3 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	3.52 (1.87)[d]	63.44	2.21 (1.48)[cd]	76.15
T_{15}: T_3+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	3.60 (1.89)[e]	62.61	2.41 (1.54)[de]	74.00
T_{16}: Soil application of Carbofuran 3G @ 50g / plant	3.31 (1.81)[a]	65.62	1.37 (1.16)[a]	85.22

*Each value is the mean of three observations at fortnightly interval.

*Figures in parentheses are square root transformed values

*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 13. Evaluation of organic sources of nutrients and foliar application of entomopathogenic fungi on the flower yield of jasmine (Kg/ha) – Field Trial I (Season: Aug '07- Nov '07)

Treatments	Flower yield	% increase over untreated control	Cost Benefit Ratio
T_0 : Untreated control	5955.44	-	1:2.51
T_1 : Soil application of FYM (2kg/plant)	6670.95	10.72	1:2.57
T_2 : Pungam cake @ 200g / plant	6694.94	11.04	1:2.63
T_3 : Neem cake @100g / plant	7273.63	18.12	1:2.86
T_4: T_1+*Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	7572.48	21.35	1:3.57
T_5: T_1 + *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	7631.64	21.96	1:3.69
T_6: T_1+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	7533.13	20.94	1:3.34
T_7: T_1+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	7466.17	20.23	1:3.08
T_8: T_2 + *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	8756.33	31.98	1:4.09
T_9: T_2+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	8785.26	32.21	1:4.13
T_{10}: T_2+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	8713.66	31.65	1:4.05
T_{11}: T_2+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	8706.11	31.59	1:4.02
T_{12}: T_3+ *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	9314.03	36.05	1:5.78
T_{13}: T_3+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	9352.14	36.32	1:5.80
T_{14}: T_3 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	8878.93	32.92	1:4.63
T_{15}: T_3+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	8814.25	32.43	1:4.25
T_{16}: Soil application of Carbofuran 3G @ 50g / plant	9386.72	36.55	1:5.85

Table 14. Impact of organic sources of nutrients on density of soil micro flora in jasmine ecosystem - Field Trial I- (Season: Aug '07- Nov '07)

Treatments	Total fungi (Cfc x10^3/g of soil)	Total actinomycetes (Cfcx10^4/g of soil)	Total bacteria (Cfcx10^6/g of soil)
T_0 : Untreated control	10.02	6.7	56.95
T_1 : Soil application of FYM (2kg/plant)	10.18	7.8	57.78
T_2 : Pungam cake @ 200g / plant	10.32	8.4	88.65
T_3 : Neem cake @100g / plant	10.86	9.3	91.25
T_4: T_1+*Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	16.58	10.2	96.25
T_5: T_1 + *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	18.75	10.6	96.54
T_6: T_1+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	15.36	10.1	95.75
T_7: T_1+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	15.25	9.4	93.28
T_8: T_2 + *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	20.85	13.4	103.25
T_9: T_2+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	21.75	15.6	104.75
T_{10}: T_2+ *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	20.25	12.4	99.75
T_{11}: T_2+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	19.62	11.4	98.55
T_{12}: T_3+ *Beauveria bassiana* (foliar application @ 1 X 10^8 spore conc.)	23.85	17.7	115.35
T_{13}: T_3+ *Hirsutella thompsonii* (foliar application @ 1 X 10^8 spore conc.)	26.34	18.8	116.85
T_{14}: T_3 + *Lecanicillium lecanii* (foliar application @ 1 X 10^8 spore conc.)	23.26	16.7	109.54
T_{15}: T_3+ *Paecilomyces fumosoroseus* (foliar application @ 1 X 10^8 spore conc.)	22.50	15.8	107.75
T_{16}: Soil application of Carbofuran 3G @ 50g / plant	9.13	4.6	56.13

*** Each value is the mean of three replications**

Table 15. Efficacy of certain newer acaricide /insecticide molecules and medicinal herbal extracts on the incidence of *Aceria jasmini* on jasmine – Field Trial II – Spray I (Season: Nov '07- Feb '08)

Treatments	*Pre treatment count	Number of eggs on leaves (2mm^2)			
		15 DAS	30 DAS	45 DAS	Mean
T_0 : Untreated control	10.25	10.65 (3.26)^k	10..97 (3.31)^k	11.22 (3.34)^j	10.94 (3.30)^k
T_1 : Profenophos @ 2 ml / lit	9.36	4.85 (2.20)^b	2.50 (1.58)^b	1.98 (1.40)^b	3.11 (1.76)^b
T_2 : Spiromesifen @ 0.7 ml / lit	9.42	4.86 (2.20)^b	2.53 (1.59)^c	2.00 (1.41)^b	3.13 (1.76)^b
T_3 : Propargite @ 2 ml / lit	10.02	7.50 (2.73)^g	5.49 (2.34)^i	4.54 (2.13)^h	5.84 (2.41)^h
T_4: Fenpropathrin @ 2 ml / lit	9.33	6.38 (2.52)^d	3.76 (1.93)^e	2.51 (1.58)^d	4.21 (2.05)^d
T_5: Abamectin @ 0.5 ml / lit	10.52	7.33 (2.70)^f	5.36 (2.31)^h	3.98 (1.99)^f	5.51 (2.35)^f
T_6: Wettable Sulphur @ 3 g / lit	10.12	3.23 (1.79)^a	1.77 (1.33)^a	1.66 (1.28)^a	2.22 (1.48)^a
T_7: Dicofol @ 4 ml / lit	9.79	3.25 (1.80)^a	1.79 (1.33)^a	1.68 (1.29)^a	2.24 (1.49)^a
T_8: Triazophos @ 2 ml / lit	10.66	5.40 (2.32)^c	2.93 (1.71)^d	2.12 (1.45)^c	3.48 (1.86)^c
T_9: NSKE 5%	10.24	6.86 (2.61)^e	5.02 (2.24)^f	3.91 (1.97)^e	5.26 (2.29)^e
T_{10}: *Ocimum sanctum* extract 10% (Aqueous leaf extract)	10.93	7.65 (2.76)^h	5.22 (2.28)^g	4.02 (2.00)^g	5.63 (2.37)^g
T_{11}: *Vitex negundo* extract 10% (Aqueous leaf extract)	10.25	7.77 (2.78)^i	5.75 (2.39)^j	4.54 (2.13)^h	6.02 (2.45)^i
T_{12} : *Lippia nodiflora* extract 10% (Aqueous leaf extract)	10.94	7.82 (2.79)^j	5.76 (2.40)^j	4.79 (2.18)^i	6.12 (2.47)^j

*NS

*DAS – Days after spray

*Each value is the mean of three replications.

*Figures in parentheses are square root transformed values

*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 16. Efficacy of certain newer acaricide/insecticide molecules and medicinal herbal extracts on the incidence of *Aceria jasmini* on jasmine – Field Trial II –Spray I (Season: Nov '07- Feb '08)

Treatments	*Pre treatment count	Number of mites on leaves ($2mm^2$)			
		15 DAS	30 DAS	45 DAS	Mean
T_0 : Untreated control	9.20	10.25 (3.20)[k]	10.93 (3.30)[j]	11.14 (3.33)[j]	10.77 (3.28)[k]
T_1 : Profenophos @ 2 ml / lit	9.13	4.47 (2.11)[b]	2.10 (1.44)[c]	1.58 (1.25)[b]	2.71 (1.64)[b]
T_2 : Spiromesifen @ 0.7 ml / lit	9.33	4.50 (2.12)[c]	2.10 (1.44)[c]	1.60 (1.26)[b]	2.73 (1.65)[b]
T_3 : Propargite @ 2 ml / lit	9.13	7.33 (2.70)[h]	5.42 (2.32)[h]	4.43 (2.10)[h]	5.74 (2.39)[h]
T_4: Fenpropathrin @ 2 ml / lit	9.33	6.00 (2.44)[e]	3.34 (1.82)[e]	2.13 (1.45)[d]	3.83 (1.95)[d]
T_5: Abamectin @ 0.5 ml / lit	9.19	6.93 (2.63)[g]	5.00 (2.23)[f]	3.94 (1.98)[f]	5.29 (2.30)[f]
T_6: Wettable Sulphur @ 3 g / lit	9.20	3.19 (1.78)[a]	1.64 (1.28)[a]	1.37 (1.17)[a]	2.06 (1.43)[a]
T_7: Dicofol @ 4 ml / lit	8.86	3.21 (1.79)[a]	1.67 (1.29)[b]	1.39 (1.17)[a]	2.09 (1.44)[a]
T_8: Triazophos @ 2 ml / lit	9.06	5.00 (2.23)[d]	2.53 (1.59)[d]	1.72 (1.31)[c]	3.08 (1.75)[c]
T_9: NSKE 5%	8.86	6.71 (2.59)[f]	4.98 (2.23)[f]	3.82 (1.95)[e]	5.17 (2.27)[e]
T_{10}: *Ocimum sanctum* extract 10% (Aqueous leaf extract)	9.33	7.34 (2.70)[h]	5.17 (2.27)[g]	4.00 (2.00)[g]	5.51 (2.34)[g]
T_{11}: *Vitex negundo* extract 10% (Aqueous leaf extract)	9.20	7.50 (2.73)[i]	5.66 (2.37)[i]	4.66 (2.15)[i]	5.92 (2.43)[i]

T_{12} : *Lippia nodiflora* extract 10% (Aqueous leaf extract)	9.00	7.66 (2.76)^{j}	5.70 (2.38)^{i}	4.70 (2.16)^{i}	6.02 (2.45)^{j}

*NS

*DAS – Days after spray

*Each value is the mean of three replications.

*Figures in parentheses are square root transformed values

*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 17. Efficacy of certain newer acaricide/insecticide molecules and medicinal herbal extracts on the incidence of *Aceria jasmini* on jasmine – Field Trial II – Spray I (Season: Nov '07- Feb '08)

Treatments	Mean egg count on leaves ($2mm^2$)	% reduction over control	Mean mite count on leaves ($2mm^2$)	% reduction over control
T_0 : Untreated control	10.94 (3.30)^{k}	-	10.77 (3.28)^{k}	-
T_1 : Profenophos @ 2 ml / lit	3.11 (1.76)^{b}	71.57	2.71 (1.64)^{b}	74.83
T_2 : Spiromesifen @ 0.7 ml / lit	3.13 (1.76)^{b}	71.38	2.73 (1.65)^{b}	74.65
T_3 : Propargite @ 2 ml / lit	5.84 (2.41)^{h}	46.61	5.74 (2.39)^{h}	46.70
T_4: Fenpropathrin @ 2 ml / lit	4.21 (2.05)^{d}	61.51	3.83 (1.95)^{d}	64.43
T_5: Abamectin @ 0.5 ml / lit	5.51 (2.35)^{f}	49.63	5.29 (2.30)^{f}	50.88
T_6: Wettable Sulphur @ 3 g / lit	2.22 (1.48)^{a}	79.70	2.06 (1.43)^{a}	80.87
T_7: Dicofol @ 4 ml / lit	2.24 (1.49)^{a}	79.52	2.09 (1.44)^{a}	80.59
T_8: Triazophos @ 2 ml / lit	3.48 (1.86)^{c}	68.19	3.08 (1.75)^{c}	71.40
T_9: NSKE 5%	5.26	51.91	5.17	51.99

	(2.29)[e]		(2.27)[e]	
T_{10}: *Ocimum sanctum* extract 10% (Aqueous leaf extract)	5.63 (2.37)[g]	48.53	5.51 (2.34)[g]	48.83
T_{11}: *Vitex negundo* extract 10% (Aqueous leaf extract)	6.02 (2.45)[i]	44.97	5.92 (2.43)[i]	45.03
T_{12} : *Lippia nodiflora* extract 10% (Aqueous leaf extract)	6.12 (2.47)[j]	44.05	6.02 (2.45)[j]	44.10

*Each value is the mean of three observations at fortnightly interval.

*Figures in parentheses are square root transformed values

*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 18. Efficacy of certain newer acaricide/insecticide molecules and medicinal herbal extracts on the incidence of *Aceria jasmini* on jasmine – Field Trial II –Spray II (Season: Nov '07- Feb '08)

Treatments	*Pre treatment count	Number of eggs on leaves (2mm^2)			
		15 DAS	30 DAS	45 DAS	Mean
T_0 : Untreated control	9.16	10.02 (3.16)^{j}	10.26 (3.20)^{l}	10.42 (3.22)^{k}	10.23 (3.19)^{j}
T_1 : Profenophos @ 2 ml / lit	8.80	2.38 (1.54)^{b}	1.44 (1.20)^{c}	1.26 (1.12)^{b}	1.69 (1.30)^{b}
T_2 : Spiromesifen @ 0.7 ml / lit	8.76	2.39 (1.54)^{b}	1.46 (1.20)^{c}	1.27 (1.12)^{b}	1.70 (1.30)^{b}
T_3 : Propargite @ 2 ml / lit	8.26	5.46 (2.33)^{g}	2.97 (1.72)^{i}	1.94 (1.39)^{h}	3.45 (1.85)^{g}
T_4: Fenpropathrin @ 2 ml / lit	8.99	3.53 (1.87)^{c}	1.57 (1.25)^{e}	1.39 (1.17)^{d}	2.16 (1.46)^{c}
T_5: Abamectin @ 0.5 ml / lit	8.78	4.93 (2.22)^{e}	2.56 (1.60)^{g}	1.82 (1.34)^{f}	3.10 (1.76)^{e}
T_6: Wettable Sulphur @ 3 g / lit	8.91	0.75 (0.86)^{a}	0.72 (0.84)^{a}	0.64 (0.80)^{a}	0.70 (0.83)^{a}
T_7: Dicofol @ 4 ml / lit	8.75	0.74 (0.86)^{a}	0.74 (0.86)^{b}	0.65 (0.80)^{a}	0.71 (0.84)^{a}
T_8: Triazophos @ 2 ml / lit	8.74	3.53 (1.87)^{c}	1.52 (1.23)^{d}	1.34 (1.15)^{c}	2.13 (1.45)^{c}
T_9: NSKE 5%	8.60	3.92 (1.97)^{d}	2.33 (1.52)^{f}	1.78 (1.33)^{e}	2.67 (1.63)^{d}
T_{10}: *Ocimum sanctum* extract 10% (Aqueous leaf extract)	8.29	5.32 (2.30)^{f}	2.73 (1.65)^{h}	1.91 (1.38)^{g}	3.32 (1.82)^{f}
T_{11}: *Vitex negundo* extract 10% (Aqueous leaf extract)	8.68	6.73 (2.59)^{h}	3.68 (1.91)^{j}	2.56 (1.60)^{i}	4.32 (2.07)^{h}
T_{12} : *Lippia nodiflora* extract 10% (Aqueous leaf extract)	8.10	6.97 (2.64)^{i}	3.73 (1.93)^{k}	2.86 (1.69)^{j}	4.52 (2.12)^{i}

*NS

*DAS – Days after spray

*Each value is the mean of three replications.

*Figures in parentheses are square root transformed values

*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 19. Efficacy of certain newer acaricide/insecticide molecules and medicinal herbal extracts on the incidence of *Aceria jasmini* on jasmine – Field Trial II –Spray II (Season: Nov '07- Feb '08)

Treatments	*Pre treatment count	Number of mites on leaves (2mm^2)			
		15 DAS	**30 DAS**	**45 DAS**	**Mean**
T_0 : Untreated control	9.14	9.78 (3.12)[j]	10.12 (3.18)[k]	10.34 (3.21)[j]	10.08 (3.17)[j]
T_1 : Profenophos @ 2 ml / lit	8.76	2.20 (1.48)[b]	1.04 (1.01)[c]	0.93 (0.96)[b]	1.39 (1.17)[b]
T_2 : Spiromesifen @ 0.7 ml / lit	8.72	2.22 (1.48)[b]	1.06 (1.02)[c]	0.94 (0.96)[b]	1.40 (1.18)[b]
T_3 : Propargite @ 2 ml / lit	8.24	5.27 (2.29)[h]	2.89 (1.70)[h]	1.79 (1.33)[g]	3.31 (1.81)[g]
T_4: Fenpropathrin @ 2 ml / lit	8.24	3.26 (1.80)[d]	1.29 (1.13)[d]	1.18 (1.08)[c]	1.91 (1.38)[c]
T_5: Abamectin @ 0.5 ml / lit	8.98	4.84 (2.20)[f]	2.33 (1.52)[f]	1.66 (1.28)[e]	2.94 (1.71)[e]
T_6: Wettable Sulphur @ 3 g / lit	8.76	0.24 (0.48)[a]	0.21 (0.45)[a]	0.19 (0.43)[a]	0.21 (0.45)[a]
T_7: Dicofol @ 4 ml / lit	8.83	0.25 (0.50)[a]	0.23 (0.47)[b]	0.20 (0.44)[a]	0.22 (0.46)[a]
T_8: Triazophos @ 2 ml / lit	8.74	3.21 (1.79)[c]	1.27 (1.12)[d]	1.16 (1.07)[c]	1.88 (1.37)[c]
T_9: NSKE 5%	8.56	3.53 (1.87)[e]	1.95 (1.39)[e]	1.43 (1.19)[d]	2.30 (1.51)[d]
T_{10}: *Ocimum sanctum* extract 10% (Aqueous leaf extract)	8.25	5.01 (2.23)[g]	2.58 (1.60)[g]	1.74 (1.31)[f]	3.11 (1.76)[f]
T_{11}: *Vitex negundo* extract 10% (Aqueous leaf extract)	8.66	6.49 (2.54)[i]	3.34 (1.82)[i]	2.23 (1.49)[h]	4.02 (2.00)[h]
T_{12} : *Lippia nodiflora* extract 10% (Aqueous leaf extract)	8.06	6.51 (2.55)[i]	3.49 (1.86)[j]	2.42 (1.55)[i]	4.14 (2.03)[i]

*NS
*DAS – Days after spray
*Each value is the mean of three replications.
*Figures in parentheses are square root transformed values
*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 20. Efficacy of certain newer acaricide /insecticide molecules and medicinal herbal extracts on the incidence of *Aceria jasmini* on jasmine – Field Trial II – Spray II (Season: Nov '07- Feb '08)

Treatments	Mean egg count on leaves (2mm^2)	% reduction over control	Mean mite count on leaves (2mm^2)	% reduction over control
T_0 : Untreated control	10.23 (3.19)^j	-	10.08 (3.17)^j	-
T_1 : Profenophos @ 2 ml / lit	1.69 (1.30)^b	83.47	1.39 (1.17)^b	86.21
T_2 : Spiromesifen @ 0.7 ml / lit	1.70 (1.30)^b	83.38	1.40 (1.18)^b	86.11
T_3 : Propargite @ 2 ml / lit	3.45 (1.85)^g	66.27	3.31 (1.81)^g	67.16
T_4: Fenpropathrin @ 2 ml / lit	2.16 (1.46)^c	78.88	1.91 (1.38)^c	81.05
T_5: Abamectin @ 0.5 ml / lit	3.10 (1.76)^e	69.69	2.94 (1.71)^e	70.83
T_6: Wettable Sulphur @ 3 g / lit	0.70 (0.83)^a	93.15	0.21 (0.45)^a	97.91
T_7: Dicofol @ 4 ml / lit	0.71 (0.84)^a	93.05	0.22 (0.46)^a	97.81
T_8: Triazophos @ 2 ml / lit	2.13 (1.45)^c	79.17	1.88 (1.37)^c	81.34
T_9: NSKE 5%	2.67 (1.63)^d	73.90	2.30 (1.51)^d	77.18
T_{10}: *Ocimum sanctum* extract 10% (Aqueous leaf extract)	3.32 (1.82)^f	67.54	3.11 (1.76)^f	69.14
T_{11}: *Vitex negundo* extract 10% (Aqueous leaf extract)	4.32 (2.07)^h	57.77	4.02 (2.00)^h	60.11
T_{12} : *Lippia nodiflora* extract 10% (Aqueous leaf extract)	4.52 (2.12)^i	55.81	4.14 (2.03)^i	58.92

*Each value is the mean of three observations at fortnightly interval.

*Figures in parentheses are square root transformed values

*In a column, means followed by common letter(s) are not significantly different at P = 0.05% by DMRT

Table 21. Efficacy of certain newer acaricide/insecticide molecules and medicinal herbal extracts on the flower yield of jasmine (Kg/ha) – Field trial II

Treatments	Flower yield	% increase over untreated control	Cost Benefit Ratio
T_0 : Untreated control	5970.23	-	2.58
T_1 : Profenophos @ 2 ml / lit	8987.39	33.57	1:4.99
T_2 : Spiromesifen @ 0.7 ml / lit	8981.14	33.52	1:4.87
T_3 : Propargite @ 2 ml / lit	7012.32	14.86	1:3.06
T_4: Fenpropathrin @ 2 ml / lit	8013.27	25.49	1:3.86
T_5: Abamectin @ 0.5 ml / lit	7277.31	17.96	1:3.39
T_6: Wettable Sulphur @ 3 g / lit	9524.76	37.31	1:5.98
T_7: Dicofol @ 4 ml / lit	9520.66	37.29	1:5.93
T_8: Triazophos @ 2 ml / lit	8075.33	26.06	1:3.91
T_9: NSKE 5%	7623.54	21.68	1:3.52
T_{10}: *Ocimum sanctum* extract 10% (Aqueous leaf extract)	7065.91	16.68	1:3.24
T_{11}: *Vitex negundo* extract 10% (Aqueous leaf extract)	6549.82	8.84	1:2.87
T_{12} : *Lippia nodiflora* extract 10% (Aqueous leaf extract)	6387.53	6.53	1:2.79

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*** Originals not seen**