PESTS OF COCCINIA (*Coccinia grandis* (L.)Voigt.) AND THEIR MANAGEMENT

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DECLARATION

I hereby declare that this thesis entitled "**Pests of coccinia (*Coccinia grandis* (L.)Voigt.) and their management**" is a bonafide record of research work done by me during the course of research and that thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

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INTRODUCTION

1.INTRODUCTION

Coccinia (*Coccinia grandis* (L.) Voigt.) also known as ivy gourd, scarlet gourd, little gourd or Kowai fruit is a perennial herb, widely cultivated in South East Asian countries as a vegetable. The tender fruits are rich sources of proteins and vitamins. The nutritional value was assessed to be as high as that of goat's milk and meat. The roots, stems and leaves of the plant are also used as ingredients of medicines for treatment of skin diseases, bronchitis and diabetes (Veeraragavathatham *et al.*, 1998). The importance of the crop was known even from antiquity in India. The holy books and books of Ayurveda bear testimony to this.

In India, coccinia is extensively grown in West Bengal, Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. The crop is cultivated on a commercial scale in Kasaragod district and adjoining areas in Kerala. Hitherto, mainly confined to kitchen gardens only in Kerala, the gourd has now attained the status of a commercial crop. Due to ease in cultivation, prolific bearing, keeping quality, availability of fruits throughout the year, its yielding nature for three to four years (Seshadri, 1986) and scope for export, the vegetable is cultivated on a large scale throughout the state.

With extensive cultivation, large number of pests are now observed in coccinia in several parts of the country, quite often leading to destruction of the crop within one to one and a half years though there are no reports of pest incidence with the exception of reports on very low damage caused by fruit fly and gall fly from Kerala (KAU, 2002; Sibyvarghese, 2003 and Suresh, 2004). Coccinia being a vegetable generally cultivated along with other cucurbitaceous vegetables, there is every possibility of cross infestation of many of the pests of cucurbits to coccinia. Farmers usually use various contact insecticides especially synthetic pyrethroids in an unscientific and haphazard manner to control the pest. The unscientific management practices result in negative impact and great economic loss. Hence, there is an urgent need for protecting the valuable crop

from pests. For effective management of the pests, it is mandatory to identify the pests and assess their occurrence and distribution, nature and extent of damage and influence of weather parameters on the pests. Therefore, the present studies were taken up with the following objectives:

To identify the major and minor pests of coccinia and their natural enemies.

To find out the occurrence and distribution of various pests attacking coccinia throughout the year.

To assess the nature and extent of damage caused by each pest.

To correlate various weather parameters with the occurrence of the pests and with the extent of damage caused.

To identify suitable botanicals and chemical insecticides for the management of important pests of coccinia and determine their safety to spiders.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Pest incidence is a major constraint in the production of coccinia. Being an under exploited vegetable until recently, the literature related to the pests, their occurrence, nature of damage, symptom, natural enemies of the pests and management is scanty. For an indepth study, literature pertaining to these aspects on other crops is reviewed here under.

2.1 PESTS OF COCCINIA

Studies conducted at various places indicated very low occurrence of pests in coccinia (Premnath and Subramonian, 1971). Minor incidence of aphids and mites was reported by Sachan and Chundawat (1985). No serious pests were reported except mild attack of fruit flies and gall insects (KAU, 2002), minor attack of mealy bug and fruit borer (Sibyvarghese, 2003) and fruit fly (Suresh, 2004) in coccinia in Kerala.

2.1.1 *Saissetia* spp.

Several species of *Saissetia* were found to infest cucurbitaceous vegetables. The infestation of *Saissetia hemisphaerica* Targ. was observed in coccinia by Nayar *et al.* (2001) and David (2002). *Saissetia coffeae* Walker was found to infest *Coccinia indica* W. in India (Rao and Barwal, 1983).

S. coffeae was reported as a pest of pointed gourd (Valand *et al.*, 1989 ;Valand and Vyas, 1991). *S. hemisphaerica* also infested snakegourd and caused drying of vines (David, 2002).

According to Metcalf and Flint (1939), the scale insects sucked sap from phloem vessels by long suctorial threads. It injected toxic saliva into the plant. Feeding by the scale insects caused yellowing, defoliation, deformation of infested parts, reduction in fruit set, loss of vigour, presence of honey dew, sooty mould, reduction in photosynthesis, branch dieback and ultimately death of the plants (Beardsley and Gonsalez, 1925; Dekle, 1965 ; Valand *et al.*, 1989).

2.1.2 *Aphis* spp.

Coccinia was reported to be infested by *Aphis* sp. (Tindall, 1983) and *A. malvae* (Premchand, 1995; Nayar *et al.*, 2001 ; David, 2002)

Aphis gossypii Glover, a related species of *A. spiraecola* was found infesting other cucurbitaceous vegetables (Behura, 1963; Chinta *et al.*, 2002; Brown, 2003).

No literature was available on the occurrence of *Aphis spiraecola* Patch on coccinia, though it was reported to attack *Eupatorium conyzoides* (De Wijs, 1974), banana (Rao, 1980), lettuce (Nebreda *et al.*, 2004)and apple (Lowery *et al.*, 2005).

The nature of damage caused by *Aphis* spp. on cucurbitaceous crops was given by various workers. According to Van Embden *et al.* (1969) aphids colonized above ground levels in almost all plant parts *viz.*, leaf, stem, flower and immature fruits. Aphids could stunt plant growth, cause deformities and discoloration on leaves and fruits (Hamman, 1985). Nandihalli and Thontadharya (1986) reported that both nymphs and adults sucked cell sap and secreted honey dew on which black sooty mould developed and retarded plant growth. They also caused curling of leaves (Nair, 1999; David, 2002)

2.1.3 *Aleurodicus dispersus* Russell

A. dispersus was reported to be attacking on coccinia (Prathapan, 1996; Muralikrishna, 1999). According to Rani (2004) all the stages of *A. dispersus* infested coccinia.

Eight genera and twelve species of spiralling white fly were observed to attack cucurbits (Srinivasa, 2000). The incidence of the pest was reported in *Benincasa hispida*(Thum.) Cogn. , *Cucurbita maxima* Duch., *Lagenaria siceraria* (Molina) Stand. (Muralikrishna, 1999) and *Cucumis anguria* Rodsch, *Cucumis* sp. and *Momordica charatia* L. (Srinivasa, 2000).

The nymphs and adults of *A. dispersus* sucked plant sap from foliage and tender plant parts and heavy infestation combined with infection of sooty mould killed plants at its early stage (Rani, 2004).

2.1.4 Aspongous spp.

Various workers reported the incidence of *Aspongous obscurus* F. in coccinia (Senrayan and Annadurai, 1991; Premchand, 1995; Nayar *et al.*, 2001; David, 2002). According to Senrayan and Annadurai (1991) *Coridius brunneus* Thunberg was found infesting coccinia.

Aspongous janus F. infested cucurbits and different stages of the bug sucked sap from the plant parts (Nair, 1999). Regupathy *et al.* (2003) reported that the nymphs and adults of *A. janus* sucked sap from leaf and also retarded the growth of the plant.

2.1.5 *Ferrisia virgata* Targ.

The occurrence of *F. virgata* was found on coccinia (Nayar *et al.*, 2001; David, 2002). In 2003, Sibyvarghese reported a minor attack by the mealy bug on coccinia.

F. virgata was reported from chow-chow. Considering the damage caused by *F. virgata*, it resulted in yellowing and marginal drying of leaves and drying of the whole plant (Nayar *et al.*, 2001).

2.1.6 *Bactrocera* spp.

According to Tindall (1983) and Premchand (1995) coccinia was attacked by *Dacus* sp. Uchida *et al.* (1990) reported that coccinia was an excellent host of *Dacus cucurbitae* Coq. Coccinia was attacked by several species of fruit flies *viz.*, *Bactrocera diversa* Coq. (Kapoor, 1993) *Bactrocera cucurbitae* Coq. and *Dacus ciliatus* Loew. (Nayar *et al.*, 2001). The most preferred and damaged host of the fruit fly was coccinia among the cucurbits in Gujarat (Patel and Patel, 1998) whereas, very low infestation was noticed in Kerala (KAU, 2002; Suresh, 2004). Jiji *et al.* (2006) reported the incidence of *B. cucurbitae* in coccinia from Kerala and it was found to cause economic loss in the crop.

Choubey and Yadav (2000) screened twelve cucurbits and observed that coccinia had significantly lower fruit infestation by the fruit fly than all other cucurbits. Vidya (2005) also reported similar results when the infestation among five cucurbits were compared.

Narayanan (1953) observed that adult female fruit flies preferred tender fruits to lay eggs. The damage of fruit flies on cucurbits made the fruits unfit for human consumption (Sarode *et al.*, 1981). The adult fruit flies laid eggs in the fruit and sealed it with a gummy secretion from the ovipositor. The maggots on emergence feed on the internal content of the fruit which as a result rotted and dropped (Nair, 1999).

2.1.7 *Lasioptera cephalandrae* Mani

In 1973, Mani reported gall fly incidence in coccinia. Further reports on the attack of the gall fly *L. cephalandrae* in coccinia include that of Premchand (1995), Nayar *et al.* (2001) ; David (2002). *Lasioptera falcata* Mani was reported from other cucurbits (Rawat and Jakhmola, 1975 ;Regupathy *et al.*, 2003).

Mani (1973) reported the gall fly attack caused stem gall in coccinia developed, deformed shape of petiole or even tendril.

The occurrence of maggots of *D. cucurbitae* in the cecidomyiid galls in coccinia was reported by Dhamaraju and Edwin (1968). According to them, the female fruit fly laid eggs in fresh galls as they could not discriminate between fresh galls and young fruits. Bhatia and Mahto (1968) stated *Neolasioptera cephalandrae* M. was the most important pest of coccinia causing galls in the plant and that the fruit fly *D .cucurbitae* attacked these galls and not the fruits of coccinia.

2.1.8 *Epilachna* spp.

Epilachna implicata Mulsant was found feeding on coccinia (Tindall, 1983; Premchand, 1995; Nayar *et al.*, 2001; David, 2002).

Epilachna sp. was reported to feed other cucurbits *viz.*, bittergourd, snakegourd etc. (Basavanna, 1954; Kapoor, 1966; Tewari and Krishnamurthy,

1983; Abbas and Nakamura, 1985; Lily, 1995; Nair, 1999; Nandakumar, 1999;Chinta *et al.*, 2002).

In cucurbits, the damage was caused by the adults and grubs feeding on the leaf surface. Infested leaves presented a lace like appearance. They turned brown, dried up and fell off and completely defoliated the plant (Atwal, 1986 ;Nair, 1999).

2.1.9 *Aulacophora* spp.

Aulacophora sp. was recorded as a pest of coccinia (Tindall, 1983). The pest also attacked other cucurbitaceous crops (Bogawat and Pandey, 1967; Sharma, 1970; Thomas and Jacob, 1994; Rajak, 2001; Reetajohri and Johri, 2003; Brown, 2003). It was reported as a pest of cucurbits during all stages of development (Shinde and Purohit, 1978;Chinta *et al.*, 2002).

The beetles fed extensively on leaves, flowers and fruits. The roots as well as the stem and fruits that came in contact with the soil were damaged by the grubs of the beetles (Nair, 1999; David, 2002; KAU, 2002) in other cucurbits.

2.1.10 *Apomecyna* spp.

According to Premchand (1995) *Apomecyna* spp. was found attacking coccinia. Nayar *et al.* (2001) reported three species of vine borers of coccinia *viz.*, *Apomecyna histrio* Fb., *Apomecyna pertigera* Thoms. and *Apomecyna saltator* Fabricius.

The stem beetles *A. pertigera* and *A. histrio* was found as pests of coccinia and the grubs bored into the stem , caused galls and withering of vines (David, 2002).

2.1.11 *Diaphania indica* Saunder

D. indica was reported as a pest of coccinia (Premchand, 1995; Nayar *et al.*, 2001; David, 2002; Kargaonkar *et al.*, 2004). The pest infested other cucurbits also (Patel and Kulkarny, 1956; Shariff, 1969; Peter and David b, 1991; Nandakumar, 1999; Sivakumar, 2001; Kinjo and Arakaki, 2002; Brown, 2003).

D. indica fed the leaves, flowers and young developing fruits (Nair, 1999; Krishnamoorthy and Krishnakumar, 2001; Namvar and Alipanah, 2002). Damage done by the pest was conspicuous during vegetative and fruiting stage of the crop (Kargaonkar *et al.*, 2004).

2.2 Natural enemies

The occurrence of spiders *Tetragnatha* sp. and *Oxyopes* sp. from bittergourd was reported by Nandakumar and Saradamma (1996). According to Manu and Hebsybai (2006) in vegetables, there were about thirty species of spiders belonging to nine families and the major being *O. javanus*, *O. shweta* and *Thomsius* sp. and among them *O. javanus* appeared during vegetative stage and prevailed up to the end of cropping season but *O. shweta* appeared only during reproductive stage up to maturity stage.

There were reports of *Menochilus sexmaculatus* (Fb.) predating on aphids (Hagen, 1962; Rajamohan and Jayaraj, 1974; Haque and Islam, 1978; Anand, 1983; Agarwala and Ghosh, 1988). *A. gossypii* was preferred as food by third and fourth instar larvae and adults of *M. sexmaculatus* (Verma *et al.*, 1983). Gautam (1994) observed survival of *Coccinella septempunctata* Linn. on non aphid hosts.

Aphidophagous syrphids played an important role in the suppression of many aphid hosts of economic importance (Verma, 2003). *Paragus serratus* Fabr. was reported to feed on *A. gossypii* (Dahiya *et al.*, 1988 ; Mani and Krishnamoorthy, 1989).

Patel and Kulkarny (1956) reported *Apanteles* sp. on *D. indica* and the highest parasitism was reported on coccinia and bittergourd (Peter and David, 1991 b). The pest was parasitized by large number of parasitoids, among them important parasitoids were *A. taragamae* and *Goniozus sensorius* Gordh (Peter and David, 1991 a). They also observed that their combined action during January to March and October to December lowered the pest population

2.3 RELATIONSHIP BETWEEN WEATHER PARAMETERS AND OCCURRENCE OF THE PESTS

Prasad and Logisenan (1997) stated that build up of *A. gossypii* in brinjal was in positive correlation with maximum temperature and negative correlation with minimum temperature, wind velocity and rainfall.

The infestation of white fly started from November, reached peak in February and subsided at the end of April in tapioca (Palaniswami *et al.*, 1995). Sathe, 1999 reported that in guava, the white fly population reached its peak during January.

According to Nath (1966) fruit fly population was positively correlated with temperature and relative humidity. The key determinants of fruit fly abundance were host availability, temperature and relative humidity (Shukla and Prasad, 1985). Nandakumar (1999) reported highest damage by fruit fly in bittergourd was in March and April in Kerala.

N. falcata infested the bittergourd maximally during the second fortnight of December and no incidence occurred from August to November and low infestation from March to June (Nandakumar, 1999; Nandakumar and Gokulapalan, 2003).

The highest incidence of *D. indica* in coccinia was during April to September and lowest was in November to February (Peter and David, 1991a). The pest was found only during March and April and the pest and natural enemy incidence was positively correlated to maximum temperature and negatively correlated to minimum temperature, relative humidity, rainfall and number of rainy days in bittergourd (Nandakumar, 1999; Nandakumar and Gokulapalan, 2003).

The emergence of adults of *Aulacophora* spp. was highest in pre monsoon (80 per cent) followed by monsoon (74 per cent) and post monsoon (63 per cent). Peak infestation was in July and least in February (Reetajohri and Johri, 2003).

2.4 EFFECT OF BOTANICALS AND CHEMICAL INSECTICIDES ON THE PESTS

Even though coccinia is attacked severely by various insect pests, no work has been carried out on their management. The effect of botanicals and chemical insecticides, used for the present management studies on pests and spiders occurring on other crops is reviewed here.

2.4.1 Effect of botanicals on pests

2.4.1.1 Commercial formulations of Azadirachtin.

Cold extracts of neem seed kernel was toxic to *A. gossypii* (Cherian and Menon, 1944). Phadke *et al.* (1988) reported neem leaf extract and neem seed kernel extract against *A. gossypii.* According to Saradamma (1989) benzene extracts of neem 2 per cent reduced *A. gossypii* population on brinjal and similar observations were made by Srinath (1990). Wood (1993) tested a neem based product Azatin and suggested that it was broadly effective at the rate of 50 g a.i.ha^{-1} against aphids. Neem Azal was highly effective against *A. gossypii* in okra (Chandrasekaran, 2001). According to Regupathy *et al.* (2003) neem based formulations 2 ml l^{-1} was effective against aphids.

Neem extract was effective as an excellent alternative to synthetic insecticides and azadirachtin had some effect on the fecundity and post embryonic development of melon fly (Sivendrasingh, 2003).

According to Jayarajan and SundaraBabu (1990) azadirachtin rich neem fraction was a good antifeedant against adults and fourth instar grubs of epilachna beetle in brinjal. Venkatarami Reddy *et al.* (1990) reported azadirachtin offered cent per cent protection of leaves and 33.5 per cent mortality of grubs.

Gujar and Mehrotra (1988) found that neem had toxic effect in controlling *Aulacophora* sp.

2.4.1.2 Neem oil-garlic emulsion

According to Schmutterer (1990) neem oil-garlic emulsion had some growth inhibitory effect to the aphids. Sivakumar (2001) observed neem oil-garlic emulsion 2.5 per cent was very effective in controlling aphids in snakegourd compared to chemicals.

The persistent effect of neem oil-garlic emulsion was due to its antifeedant effect (Kulkarni, 1999). Sivakumar (2001) reported neem oil-garlic emulsion 2.5 per cent was effective against *Aulacophora* sp.

2.4.1.3 Neem oil

Neem oil was effective against *A. gossypii* (Cherian and Menon, 1944;Phadke *et al.*, 1988). According to Sarode *et al.* (1995) neem oil was effective against *A. gossypii* in okra. Neem seed oil emulsion at 5 per cent concentration provided good control of *A. gossypii* in bitter gourd (Reghunath and Gokulapalan, 1999) and chillies (Santhoshkumar, 1999).

Neem oil 1.2 per cent was effective in fruit fly, according to Ranganath *et al.* (1997). Jhansirani (2001) reported that neem oil 2 per cent was effective in preventing feeding of leaf beetles.

2.4.1.4 Illipe oil

Illipe oil (1 per cent and 2 per cent) was superior against rose aphid *Microsiphum rosae* L. according to Reddy *et al.* (2002).

2.4.2 Effect of chemical pesticides on pests and spiders of coccinia.

2.4.2.1 Imidacloprid

Imidacloprid was a new systemic insecticide very effective against sucking insects (Mote *et al.*, 1994; Chao *et al.*, 1997). Different concentrations of imidacloprid were equally effective against scale insects even at thirty days after application (Irulandi *et al.*, 2000). According to Rebek and Saief (2003) imidacloprid was used to control scale insect.

Imidacloprid was very effective against aphids (Chiranjeevi *et al.*, 2002; MichaelRaj and Punnaiah 2003; Regupathy *et al.*, 2003; Biradar and Shaila, 2004). Imidacloprid 0.004 per cent gave higher per cent reduction in aphid population on bhindi (Chandrasekaran, 2001). Patil *et al.* (2002) reported imidacloprid @ 125 and 150 ml ha^{-1} was highly effective against *A. gossypii* on chilli. Imidacloprid @ 25 g a.i. ha^{-1} was superior in controlling aphid in okra (Misra, 2002). An overall efficacy of 98.92 per cent reduction in aphid population was recorded by spraying imidacloprid (MichaelRaj and Punnaiah, 2003).

2.4.2.2 Quinalphos

Scale insect was effectively controlled by quinalphos 25 EC at the rate of 120 ml ha^{-1} in coffee and quinalphos @ 0.025-0.05 per cent in pineapple (KAU, 2002).

Mandal et al. (2000) reported quinalphos 0.05 per cent spray was most effective at all stages of plant against *A. gossypii*. Quinalphos 0.03 per cent gave protection against aphid in cucurbits (KAU, 2002).

Bhatnagar and Yadav (1992) reported that quinalphos 0.2 per cent gave better control of fruit fly in cucurbits *viz.*, bottlegourd, spongegourd and ridgegourd.

Quinalphos 25 EC was effective against *Epilachna* spp. for twenty days (Rajgopal and Trivedi, 1989). Shanmugapriyan and Kingsly (2001) reported that quinalphos gave 95 per cent larval mortality of *Epilachna* spp.

Quinalphos 0.05 per cent was effective in controlling *Aulacophora* spp., according to Krishnamoorthy and Krishnakumar (2001).

2.4.2.3 Malathion

According to Copland and Ibrahim (1983) malathion 0.1 per cent proved to be effective in controlling scale insects. Lowest percentage of scale insect infestation (30.53) was recorded in malathion treatment (Jhansi and Babu, 2001).

Chauhan *et al.* (1988) revealed that application of malathion 0.05 per cent at weekly intervals was effective against aphids in chick pea. Malathion 0.05 per cent was recommended against aphids in other cucurbits (KAU, 2002).

Malathion 0.1 per cent at fortnightly intervals was effective against fruit fly (Kosaraju, 1982; David, 2002). Bhatnagar and Yadava (1992) found malathion 0.5 per cent effective against fruit fly in bottlegourd, spongegourd and ridgegourd.

For the control of *Epilachna* spp., malathion 0.1 per cent played a significant role (Sengupta and Panda, 1958; Annice Bernice, 2000). Jayakumari and Nair (1969) reported that malathion was toxic to *Epilachna* spp. Malathion 0.1 per cent protected foliage from beetle damage (Jhansirani, 2001).

Malathion 0.1 per cent proved effective in controlling *Aulacophora* spp. (Butani and Verma, 1977; Kosaraju, 1982). Regupathy *et al.*, 2003 recommended malathion 50 EC 1 ml^{-1} for controlling the leaf beetles.

2.4.2.4 Dimethoate

According to Premkumar and Devasahayam (1988) scale insect in pepper was controlled by spraying dimethoate 0.05 per cent and repeated application might be given after fifteen days if infestation persisted. In dimethoate sprayed plots of sugarcane lower percentage of scale insect infestation was noticed (Jhansi and Babu, 2001).

Dimethoate 0.05 per cent was very effective in controlling aphids of cucurbits (Champ, 1966; Hemagirish *et al.*, 2001; Regupathy *et al.*, 2003 ;Biradar and Shaila, 2004). According to Masoodkhan *et al.* (2001) and Chinnaiah (2001) dimethoate 0.065 per cent proved effective in controlling aphid in bhendi. Dimethoate 1 ml l^{-1} was very effective for potato aphid (KAU, 2002). Misra (2002) reported that dimethoate @ 300 g a.i. ha^{-1} proved effective in controlling aphid in okra.

Nagappan *et al.* (1971) observed that dimethoate 0.1 per cent was effective in reducing fruit fly damage from 41.39 to 15.95 per cent. Kerser *et al.* (1973)

reported dimethoate as the most toxic insecticide to fruit fly. Dimethoate 0.1 per cent and 0.05 per cent controlled fruit fly infestation (Mann *et al.*, 1976)

Hameed and Adlakho (1973) reported that dimethoate gave good control of grubs and pupae of *Epilachna* sp. within ten days. Dimethoate 0.05 per cent was effective in controlling *Aulacophora* sp. (Champ, 1966; Regupathy *et al.*, 2003).

2.4.3 Effect of botanicals and chemical insecticides on spiders

The population of spiders was not reduced in plants treated with neem seed kernel extract 48 days after treatment (Kareem *et al.*, 1988). Neem products did not affect the population of *O. javanus* (TNAU, 1992). Neem products were safe to *Tetragnatha* sp. and *Oxyopes* sp. (Nandakumar and Saradamma, 1996). Manu (2005) reported neem products were less toxic.

The studies on the effect of neem oil 2 per cent and illipe oil 2 per cent on spiders indicated that they caused less than 50 per cent mortality when applied topically (Manu, 2005).

Abundance of spiders was unaffected by imidacloprid (Kunel *et al.*, 1999). Imidacloprid 0.02 per cent proved less toxic to spiders (Manu, 2005).

The application of malathion 0.1 per cent did not produce any toxic effect on predatory spiders in the vegetable patola (*Luffa cylindrica* L. Roem.) according to Oben *et al.* (1986). According to Mishra and Mishra (2002) spider population of okra was unaffected by malathion application whereas, the reports of Manu (2005) showed that malathion 0.1 per cent was toxic to spiders. Studies on the effect of dimethoate on natural enemies showed that it was toxic to spiders (Manu, 2005).

MATERIALS AND METHODS

3. MATERIALS AND METHODS

A survey was undertaken to record the pests of coccinia (*Coccinia grandis* (L.) Voigt.) and their natural enemies and to assess their seasonal occurrence in Kalliyoor panchayat of Thiruvananthapuram district during July 2005 to June 2006. A field trial was conducted to identify suitable botanicals and chemical insecticides for the management of the pests and to evaluate their safety to natural enemies. The materials and methods used for the study are given below.

3.1 PESTS OF COCCINIA

Ten plots with four month old plants were selected in Kalliyoor panchayat for recording the pests infesting the crop. Four of the selected plots were in the Instructional Farm, Vellayani, where the crop was raised without applying insecticides. Six plots were located in the farmers' field in Kalliyoor and Palapoor wards of the panchayat. Since insecticides were frequently applied by the farmers, an area comprising of hundred plants was demarcated in each location and maintained without adopting any plant protection measures for recording the incidence of the pests. The nature of feeding and the symptoms observed were also noted. Besides, ten plants were selected at random at each location and the population of the pests and extent of damage caused were also recorded as detailed below.

***Saissetia hemisphaerica* (Targ.)**

The population of *S. hemisphaerica* was recorded from 10 cm length of the mature vine. Two months after completion of observation, the number of plants completely destroyed by *S. hemisphaerica* was recorded to determine the intensity of attack of the pest

***Aphis spiraecola* Patch**

The population of *A. spiraecola* was recorded from randomly selected vines from 10 cm length of the growing point.

***Leptoglossus australis* Fabricius**

The total number of nymphs and adults feeding on a plant were recorded.

***Aspongopus obscurus* F**

The nymphs and adults present in a single plant were counted

***Aleurodicus dispersus* Russell**

The number of infested leaves was counted from the total number of thirty leaves sampled from each plant and the percentage of leaves infested was worked out.

***Henosepilachna vigintioctopunctata* F.**

The grubs and adults of *H. vigintioctopunctata* present in each plant were recorded. The number of infested leaves was counted out of total number of thirty leaves sampled from each plant and the percentage of infested leaves was worked out.

***Aulacophora* spp.**

The number of adults was counted from a single plant. Similarly, the number of leaves damaged by *Aulacophora* spp. was recorded out of thirty leaves sampled from each plant and the percentage of infestation was worked out.

***Apomecyna saltator* Fabr.**

The total number of plants in each location and the number of plants completely damaged by the pest was counted.

***Diaphania indica* Saunder**

The population of the pest was recorded by counting the number of caterpillars in a plant.

***Bactrocera cucurbitae* Coq.**

The percentage of fruits infested was calculated from the thirty fruits sampled from each plant.

***Lasioptera cephalandrae* Mani**

The number of infested vines was counted from randomly selected thirty tender vines. The percentage of vines infested was worked out from the data obtained. Further, the total number of galls and the number of galls of *L. cephalandrae* harboring *B. cucurbitae* present in each plant was counted and the percentage of infested galls was worked out. The number of adult *B. cucurbitae* emerged from a single gall/fruit was also recorded.

***Tetranychus* sp.**

Thirty leaves were sampled from each plant and the number of leaves infested was counted and the percentage of infested leaves was worked out.

3.2 NATURAL ENEMIES OF PESTS OF COCCINIA

The predators found feeding on the pests were collected from the field and the predators and their respective hosts were confined in petri dish for confirmation of their predatory nature. The population of spiders was recorded and counts were taken from randomly selected ten plants from each location.

The parasitized larvae of *D. indica* were collected from the field. They were placed in a perforated polythene bag, sealed, labelled and kept for the emergence of parasitoids. The emerged parasitoids were identified and recorded.

3.3 CORRELATION BETWEEN WEATHER PARAMETERS AND POPULATION OF PESTS AND THE EXTENT OF DAMAGE IN COCCINIA

The weather parameters *viz.*, maximum and minimum temperature, relative humidity, rainfall and number of rainy days were recorded from the Department of Meteorology, College of Agriculture, Vellayani. The average of the monthly data was worked out and used for the study (Appendix – I). The monthly weather parameters were correlated with the population of pests and extent of damage caused by the pests during the month of observation and the succeeding month.

3.4 FIELD EVALUATON OF BOTANICALS AND CHEMICAL INSECTICIDES FOR THE MANAGEMENT OF PESTS OF COCCINIA

A field experiment was conducted to evaluate the effect of different botanicals *viz.*, azadirachtin, neem oil-garlic, neem oil, illipe oil and chemical insecticides *viz.*, imidacloprid, quinalphos, malathion and dimethoate against the pests attacking coccinia and their natural enemies.

3.4.1 Preparation of the Experimental Plot

3.4.1.1 Raising Crop

Local variety of coccinia obtained from Instructional farm, College of Agriculture,Vellayani was raised and maintained during the period from March 2005 to September 2006. It was raised in an area of 1000 m^2 with a spacing of 5 × 4 m. The crop husbandry practices were done as envisaged in the Package of Practices Recommendations of the Kerala Agricultural University (KAU, 2002) except the spacing adopted for planting.

3.4.1.2 Pandal and Vine Separation

Pandals made of wooden poles and coir was erected and vines of individual plants were grown separately. Inter twining of vines was prevented by separating out the vines at weekly intervals.

3.4.2 Details of the Experiment

The experiment was laid out in Randomized Block Design with eight treatments and an untreated control, each replicated thrice. Each treatment comprised a single plant.

The treatments were

T_1- Azadirachtin 0.004 per cent

T_2- Neem oil-garlic 2 per cent

T_3- Neem oil 2 per cent

T_4- Illipe oil 2 per cent

T_5- Imidacloprid 200 SL 0. 005 per cent

T_6- Quinalphos 25EC 0.05 per cent

T_7- Malathion 50 EC 0.1 per cent

T_8- Dimethoate 30 EC 0.05 per cent

T_9-Control

The treatments were applied twice during October-November 2005 and January-February 2006. Observations on the population of the pests were taken one day prior to application of insecticides and one, three, five, seven, fifteen, thirty, forty five and sixty days after each application. The extent of damage caused by different pests was recorded fifteen days after spraying.

3.4.3 Preparation of Spray Solution

3.4.3.1 Azadirachtin

The botanical insecticide, NeemAzal containing azadirachtin one per cent was used for the experiment. Azadirachtin 0.004 per cent was obtained by mixing 20 ml of NeemAzal in five litres of water.

3.4.3.2 Neem oil-garlic emulsion

Twenty five g of sliced ordinary washing soap was dissolved in 500 ml lukewarm water and it was mixed thoroughly with 100 ml neem oil and made up to an emulsion. One hundred g of garlic was ground in 400 ml water and sieved through muslin cloth and mixed with neem oil emulsion to get one litre of stock solution. This was made up to five litres and mixed thoroughly to get two per cent spray solution.

3.4.3.3 Neem Oil Emulsion

Soap (25 g) was cut in to small pieces and mixed with 900 ml of lukewarm water to get soap solution. Neem oil (100 ml) was added to the soap solution with continuous stirring to prepare one litre stock solution. Two per cent neem oil emulsion was prepared by mixing four litres of water to the stock solution.

3.4.3.4 Illipe Oil Emulsion

Twenty five g of soap was cut in to small pieces and mixed with 900 ml of luke warm water. Illipe oil (100 ml) was added to the soap solution with continuous stirring to get one litre stock solution. The illipe oil two per cent emulsion was prepared by mixing four litres of water to the stock solution.

3.4.3.5 Imidacloprid

A commercial pesticide, Confidor 200 SL was used for the experiment. Imidacloprid 0.005 per cent was prepared by mixing 1.40 ml in five litres of water.

3.4.3.6 Quinalphos

Quinalphos 0.05 per cent was prepared by mixing 10 ml of Ekalux 25 EC formulation in five litres of water.

3.4.3.7 Malathion

Malathion 0.1 per cent was prepared by mixing 10 ml of Malathion 50 EC formulation in five litres of water.

3.4.3.8 Dimethoate

A commercial pesticide, Rogor 30 EC was used for the experiment. Dimethoate 0.05 per cent was prepared by mixing 8.3 ml of Rogor 30 EC formulation in five litres of water.

3.4.4 Assessment of Population of Pests after Application of Insecticides

S. hemisphaerica

S. hemisphaerica was recorded from 10 cm length of the top, middle and bottom portions of the mature vine of three labelled plants in each treatment.

A. spiraecola

The population of *A. spiraecola* was taken after treatment from 10 cm length of the growing point from nine vines of three labelled plants in each treatment and the mean population was worked out.

3.4.5 Assessment of Extent of Damage Caused by Various Pests

B. cucurbitae

The number of infested fruits out of total number of thirty fruits collected at random from three labelled plants for each treatment was recorded and the percentage of fruits infested was worked out.

H. vigintioctopunctata

The number of leaves infested by *H. vigintioctopunctata* out of thirty leaves from three labelled plants for each treatment was recorded and the percentage of leaves infested was worked out.

Aulacophora spp.

The number of leaves infested by *Aulacophora* spp. out of thirty leaves from three labelled plants for each treatment was recorded and the percentage of leaves infested was worked out.

3.4.6 Assessment of Population of Spiders after Application of Insecticides

The counts of spiders were recorded one day prior to spraying and one, three, five, seven and fifteen days after spraying from three labelled plants.

3.5 STATISTICAL ANALYSIS

Data on the population of pests, natural enemies and extent of damage by various pests in coccinia was subjected to ANOVA (Panse and Suhatme, 1985).

RESULTS

4. RESULTS

Identification and seasonal occurrence of various pests attacking coccinia, their nature and extent of damage, natural enemies of pests of coccinia, relationship between the weather parameters and incidence of the pests and the results obtained from the field experiment to find out the impact of various botanicals and chemical insecticides on the population of the pests and their extent of damage and on spiders are presented in this chapter.

4.1 PESTS ASSOCIATED WITH COCCINIA

Different pests observed in coccinia at various locations are depicted in Table 1.

4.1.1 Description of pests, their nature of damage and symptoms

***Saissetia hemisphaerica* (Targ.)**

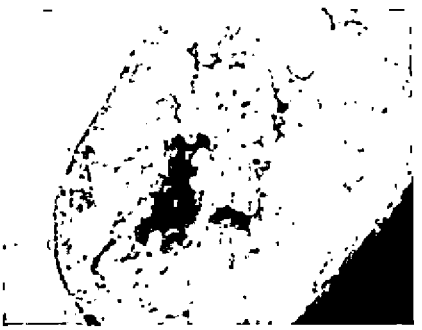
The adult scale insect was convex with a smooth, reddish brown helmet shaped carapace (Plate1). Eggs were laid beneath the carapace of the female which remained attached to the plant even after the eggs hatched. The neonate crawlers were flat, oval and brown with six short legs. After moving about for a short while, the crawlers settled on the plant parts and began to feed. Passing through three instars, the crawlers moulted to adult. The pest congregated in large numbers on the stem, leaves, petiole and even fruits of coccinia and suck the sap. The infested leaves were distorted, with shortened and thick petioles. The fruits were deformed. Ultimately, the infested vines became weak, withered and dried up (Plate 1).

***Aphis spiraecola* Patch**

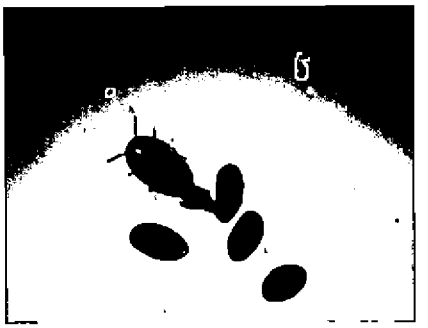
The winged and wingless forms of *A. spiraecola* were seen on various parts of coccinia. The greenish aphid sucked sap from the underside of the leaves, petioles, tender twigs, flowers and fruits. The leaves crinkled and the petioles and internodes were shortened (Plate 2). The growth of the plant was retarded. The infested fruits were crinkled and small in size.

Table 1. Pests of coccinia recorded from Kalliyoor panchayat of Thiruvananthapuram district

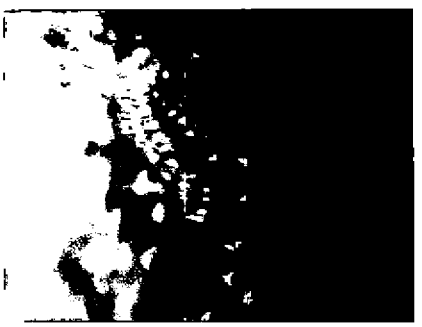
Order	Family	Common name	Scientific name
Hemiptera	Coccidae	Scale insect	*Saissetia hemisphaerica* (Targ.)
	Aphididae	Aphid	*Aphis spiraecola Patch*
	Aleurodidae	Spiralling whitefly	*Aleurodicus dispersus* Russell
	Coriedae	Leaf footed bug	*Leptoglossus australis* F.
	Pentatomidae	Pentatomid bug	*Aspongopus obscurus* F.
		Green stink bug	*Nezara viridula* Linn.
	Pseudococcidae	Mealy bug	*Ferrisia virgata* (Ckll.)
Diptera	Tephritidae	Fruit fly	*Bactrocera cucurbitae* Coq.
	Cecidomyiidae	Gall midge	*Lasioptera cephalandrae* Mani
Coleoptera	Coccinellidae	Epilachna beetle	*Henosepilachna vigintioctopunctata* F.
	Chrysomelidae	Pumpkin beetle	*Aulacophora foveicollis* (Lucas)
			Aulacophora impressa Fabricius
			Aulacophora bicolor Weber
	Cerambycidae	Vine borer	*Apomecyna saltator* Fabricius
Lepidoptera	Pyraustidae	Leaf folder	*Diaphania indica* Saunders
	Arctiidae	Woolly bear	*Pericallia ricini* Fb.
Acariformes	Tetranychidae	Red spider mite	*Tetranychus* sp.



Eggs



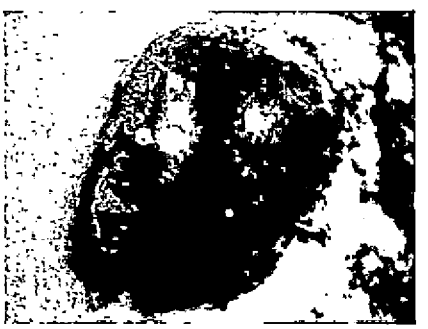
Crawler emerging from egg



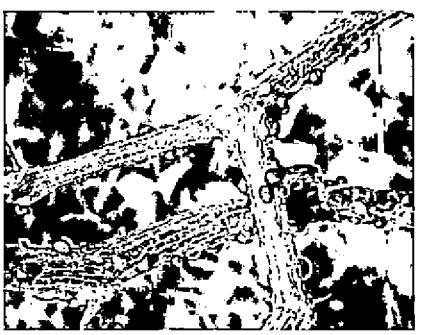
Second instar nymph

Third instar nymph

Fourth instar nymph



Adult of *S. hemisphaerica*



Medium infestation

Severe infestation

Plate 1. Life stages of *S. hemisphaerica* and their damage

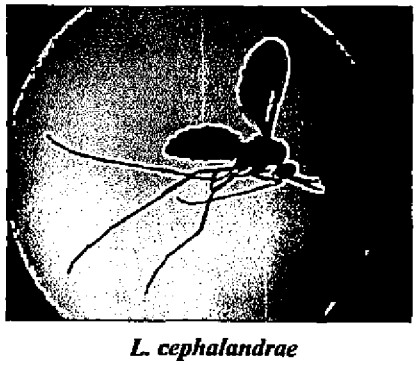
A. spiraecola

Shoot infested by *A. spiraecola*

B. cucurbitae

Fruit infested by *B. cucurbitae*

Vine galls with larvae and pupae of *B. cucurbitae*



L. cephalandrae

Shoot infested by *L. cephalandrae*

Plate 2. Major pests of coccinia and their symptoms

A. dispersus

The adult fly resembled a tiny moth, wings of which were covered with white powdery material (Plate 3). The nymphs and adults infested the underside of leaves and caused yellowish discolouration.

L. australis

The leaf footed bug was dull black in colour (Plate 3) with several yellow spots on the underside of the body. The tibia of the hindlegs swollen and flat. The adults and nymphs sucked sap from the vines and the fruits. The vines withered. Thickened spots developed at the points of sucking on the fruits.

A. obscurus

A. obscurus was a red and black bug (Plate 3).The ventral side, legs and head were dull black. The different stages of the bug sucked sap from the vines as a result of which the plant became weak.

N. viridula

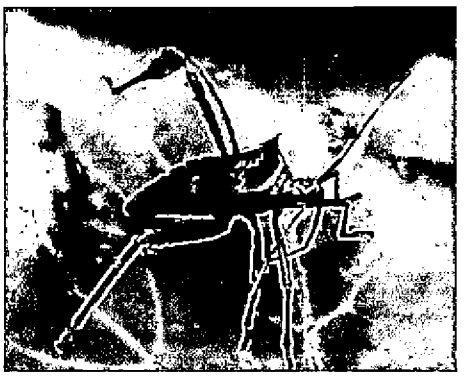
The adult bug was a large green shield bug with pale ventral side (Plate 5). The nymphs and adults sucked sap from the tender portions of the vines and the fruits. The feeding resulted in discoloration and weakening of the plant.

F. virgata

The white mealy bug was two tailed (Plate 5). The nymphs and adults of the bug were seen on the underside of the leaves. Due to sap sucking, the leaves turned yellow and the vigour of the plant was reduced.

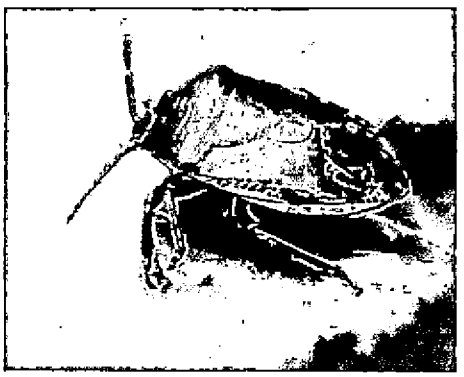
B. cucurbitae

The reddish brown fruit fly had lemon-yellow curved vertical markings on the thorax and shadings on the outer wing margins (Plate 2). The maggots were legless and dirty white in colour. The adult females oviposited in the fruits. The maggots on hatching bored into the fruits and fed on the internal contents. The fruits rotted and dropped prematurely.

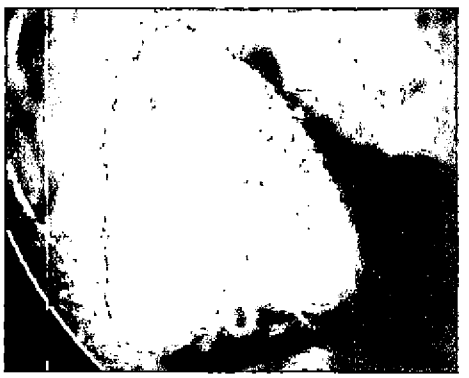


L. australis

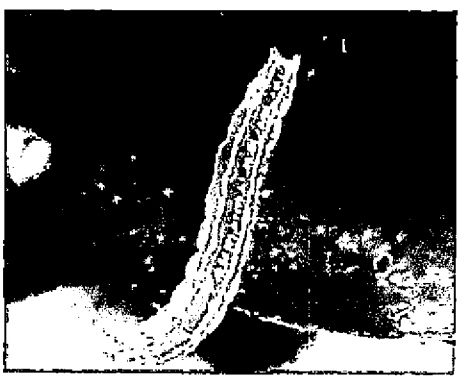
Fruit infested by *L. australis*



A. obscurus



A. dispersus



Larvae of *D. indica*

Combined infestation of leaf and fruit by *D. indica*

Plate 3. Minor pests of coccinia and their damage

L. cephalandrae

The adult was a slender dark brown mosquito like fly. Eggs were laid inside the vine. The maggots on emergence fed within the vine. The feeding activity resulted in gall like swellings on the vines. (Plate 2). The soft and succulent galls also served as oviposition and breeding sites for the fruit fly *B. cucurbitae*.

H. vigintioctopunctata

The beetle was hemispherical, reddish brown in colour with 12 black spots on the elytra. Cigar shaped and yellowish eggs were laid on the lower surface of leaves. Grubs were yellow, plump and covered with black spines. The adults and the grubs scraped the green leaf tissue, skeletonising the leaves. The attacked leaves and the whole plant showed a sickly appearance (Plate 3).

***Aulacophora* spp.**

A. foveicollis was uniformly red in colour. *A. impressa* was red coloured with black markings on the top of the wing and *A. bicolor*, the beetle with black coloured patch on red coloured elytra. Damage was caused by the adult beetles feeding extensively on the leaves, flowers and fruits. As a result of feeding, irregular holes appeared on the leaves and flowers and fruits (Plate 4).

A. saltator

A. saltator was a greyish brown cerambycid beetle with white patches on the dorsal surface of the elytra (Plate 5). The grubs bored in to the vine and fed on the central core resulting in drying up of the vines. Ultimately the whole plant dried up.

D. indica

The moth had hyaline wings with broad and black margin. A tuft of orange coloured hairs were seen at the anal end of the abdomen of female. The caterpillar was green coloured with a pair of thin longitudinal lines on the dorsal surface (Plate 3). The pupa was seen within the leaf foldings and was brown in

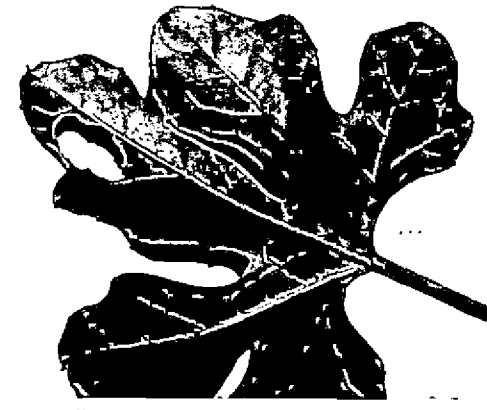
H. vigintioctopunctata

Leaf damaged by *H. vigintioctopunctata*

A. foveicollis

A. impressa

A. bicolor



Leaf damaged by *Aulacophora* sp.

Plate 4. Minor pests of coccinia and their damage

colour. The caterpillars webbed together the leaves and fed on it by remaining within the webbed leaves and completely defoliated the plant. They also fed on the flowers and young developing fruits and bore holes were seen on the fruits.

P. ricini

The moth was stout and the forewings were fuscous brown with black spots. The hind wings were crimson with four bands. The abdomen was crimson coloured with black bands. The caterpillar was hairy and black in colour. The caterpillars fed on the leaf lamina completely, leaving only the skeleton(Plate 5).

***Tetranychus* sp.**

The red spider mite, *Tetranychus* sp. (Plate 5) colonized on the underside of the leaves. They sucked sap from the leaves and produced chlorotic spots on the upper surface of the leaves. These spots coalesced into wider patches and the leaves withered ultimately.

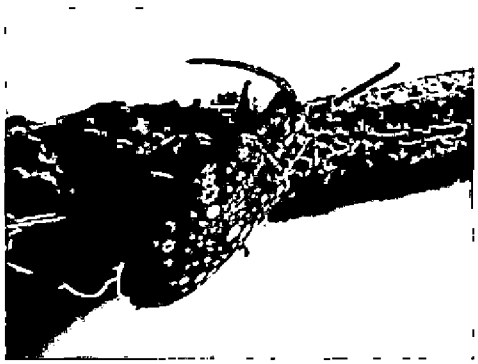
4.1.2 SEASONAL OCCURRENCE OF PESTS AND THEIR EXTENT OF DAMAGE IN COCCINIA

4.1.2.1 Occurrence of pests

The results presented in Tables 2 to 8 showed the distribution of the pests during various periods and different locations. The population of *S. hemisphaerica* and *A. spiraecola* was recorded from 10 cm length of the plant and the total number of insects present per plant was observed for the other pests.

S. hemisphaerica

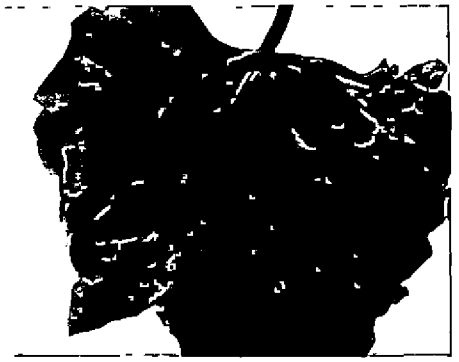
The mean population of *S. hemisphaerica* during various months ranged from 2.66 to 29.49 (Table 2). A very low population of the pest was recorded during July 2005 (2.66), August 2005 (5.90) and September 2005 (5.90). A significant increase in the population of hemispherical scale was observed from October 2005(15.08). The population recorded during November 2005, December 2005 and January 2006 was 18.63, 21.33 and 16.13 respectively. The population increased still further during February 2006 (25.45) and reached its



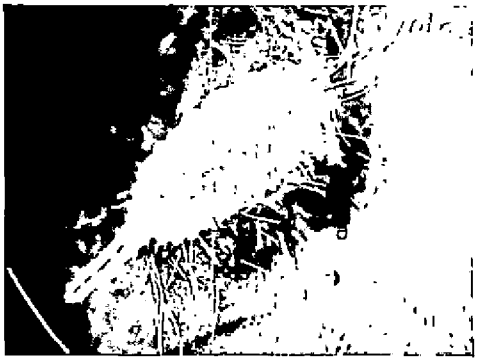
A. saltator

Vine infested by *A. saltator*

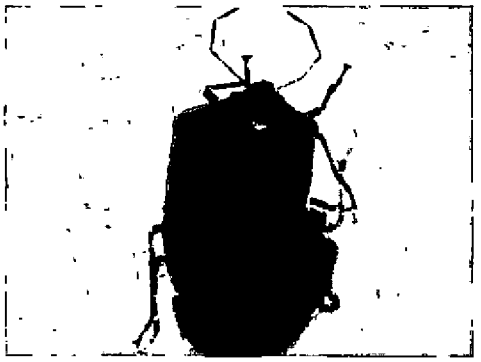
Tetranychus sp.



Leaf infested by *Tetranychus* sp.



F. virgata



N. viridula

Leaf damaged by *P. ricini* larva

Plate 5. Minor pests of coccinia and their damage

Table 2. Seasonal occurrence of *S. hemisphaerica* in coccinia at Kalliyoor panchayat in Thiruvananthapuram district .

Month	Mean number of scale insects per 10 cm length of vine at different locations*								Mean
	Instructional farm				Farmers' field				
	1	2	3	4	7	8	9	10	
July-2005	2.30	2.00	2.40	3.70	1.90	2.40	3.30	3.30	2.66
August-2005	3.90	7.60	9.80	6.40	3.90	2.20	5.20	8.20	5.90
September-2005	3.90	7.60	9.80	6.40	3.90	2.20	5.20	8.20	5.90
October-2005	36.40	14.50	20.70	25.50	6.50	3.50	5.00	8.50	15.08
November-2005	31.40	23.00	40.20	25.60	6.30	6.20	7.20	9.10	18.63
December-2005	37.50	36.20	34.90	32.80	6.30	9.10	5.10	8.70	21.33
January-2006	21.30	24.60	24.30	23.00	5.80	11.50	7.70	10.80	16.13
February-2006	39.70	29.60	49.40	31.40	14.70	11.00	11.30	16.50	25.45
March-2006	41.30	46.00	51.80	35.20	9.80	8.90	14.10	12.60	27.46
April-2006	39.80	44.40	41.80	37.20	12.10	10.00	10.40	13.90	26.20
May-2006	47.00	51.50	59.00	28.70	14.40	8.80	12.10	14.40	29.49
June-2006	21.40	14.60	27.30	15.30	7.80	8.80	6.10	9.90	13.90
Mean	27.16	25.13	30.95	22.60	7.78	7.05	7.73	10.34	

CD (0.05)

Month : 5.977
Location : 4.880
M × L : 16.906

* Locations 5 and 6 - Pest not observed

maximum (29.49) in the month of May 2006. There was no significant difference in population of the pest during February 2006, March 2006 (27.46), April 2006 (26.20) and May 2006. A significant decline was observed in the population of the pest during June 2006 (13.90).

Among the ten locations observed, *S. hemisphaerica* was present only in eight locations. The incidence of the pest was significantly higher in all the four plots located in the Instructional Farm and the population ranged from 22.60 to 30.95, as compared to other four locations in the farmers' field. No significant difference in the mean population of *S. hemisphaerica* was observed in all the four locations observed in the farmers' field and the population ranged from 7.05 to 10.34 only.

There was significant difference in the population of the pest in different locations during various months. In all the locations, the population of *S. hemisphaerica* was lowest during July 2005 and the population ranged from 1.90 to 3.70. There was no significant difference in the population of the pest during August 2005 (2.20 to 9.80) and September 2005 (2.20 to 9.80) when compared to that of July 2005 in the eight locations.

In the first location, there was no significant difference in the population of the pest from October 2005 to June 2006 and the population ranged from 21.30 to 47.00.

In the second location, the population of *S. hemisphaerica* during October 2005 (14.50) was statistically similar to that of July 2005 (2.00), August 2005 (7.60) September 2005 (7.60) and June 2006 (14.60). The population of the pest from November 2005 (23.00) to January 2006 (24.60) was on par. The population during February 2006, March 2006 and April 2006 were statistically similar with that of May 2006 (51.50) and the population ranged from 29.60 to 46.00.

Higher population was observed during February 2006 (49.40), March 2006 (51.80) and May 2006 (59.00) when compared to other months in the third location. Highest population was recorded in the fourth location during April 2006

(37.20) and was on par with the population noted from October 2005 to March 2006 and May 2006, the population ranged from 23.00 to 35.20. The population of *S. hemisphaerica* observed from July 2005 to June 2006 in the fifth to eighth locations from farmers' field (1.90 to 16.50) did not show any significant difference.

A. spiraecola

The incidence of the aphid was observed in all the ten plots throughout the period of observation from July 2005 to June 2006 (Table 3).

The mean population of *A. spiraecola* ranged from 18.32 to 81.59. The lowest population was recorded in July 2005 and was 18.32. There was significant increase in the population of the aphid in August 2005 (33.23) and it was on par with the population recorded during September 2005, October 2005, November 2005 and June 2005, the population being 39.31, 43.77, 43.60 and 34.59 respectively. Still higher population was seen during March 2006 (78.79), April 2006 (74.47) and May 2006 (81.59). Statistically the same population was recorded during March 2006 and April 2006. The population observed during December 2005 to February 2006 ranged from 52.09 to 64.28 and was significantly lower than that of March to May 2006 and higher than that of July and August 2005 and June 2006.

A comparison of the mean population in different locations showed significant difference. The highest incidence of aphid was observed in the first location (73.51) in the Instructional Farm, Vellayani and it was significantly higher than the population recorded in all other locations. The incidence of the pest in the second location (60.71) also showed the same trend as that of the first location. The mean population recorded in the third location(53.45) was on par with sixth(48.53) and seventh (50.81) locations, whereas the population observed in the fourth location (56.26) was significantly higher than the population recorded in the fifth (42.34), eighth (44.67), ninth (44.43) and tenth (42.37) locations.

Table 3 . Seasonal occurrence of *A. spiraecola* in coccinia at Kalliyoor panchayat in Thiruvananthapuram district

Month	Mean number of aphids per 10 cm length of vine at different locations										Mean
	Instructional farm				Farmers' field						
	1	2	3	4	5	6	7	8	9	10	
July-2005	19.70	24.60	28.20	19.60	12.10	17.30	15.60	13.90	16.40	15.80	18.32
August-2005	56.40	39.20	35.10	31.00	37.90	28.00	30.60	24.80	25.20	24.10	33.23
September-2005	60.20	43.10	46.00	34.30	39.20	31.60	43.70	32.10	22.10	40.80	39.31
October-2005	57.30	47.30	45.80	39.90	36.90	41.80	48.00	42.10	39.10	39.50	43.77
November-2005	65.30	53.40	42.90	48.00	42.80	49.80	39.00	34.40	35.20	25.20	43.60
December-2005	76.60	46.00	46.30	67.90	37.80	53.30	42.70	52.70	56.90	40.70	52.09
January-2006	71.70	48.00	63.90	60.60	52.70	56.90	48.20	56.50	47.60	51.70	55.78
February-2006	77.30	45.60	75.70	82.50	48.70	61.50	54.00	77.30	71.20	49.00	64.28
March-2006	132.90	105.20	68.10	84.90	55.70	71.70	89.00	71.50	53.70	55.20	78.79
April-2006	89.20	104.20	88.30	83.50	54.30	58.60	92.20	53.80	61.80	58.80	74.47
May-2006	130.70	100.30	72.30	78.70	59.30	71.30	83.90	55.70	77.30	86.40	81.59
June-2006	44.80	65.10	28.80	44.20	30.70	40.50	22.80	21.20	26.60	21.20	34.59
Mean	73.51	60.17	53.45	56.26	42.34	48.53	50.81	44.67	44.43	42.37	

CD (0.05)
Month : 13.101
Location : 11.960
M × L : N.S

The population recorded from the ten locations during different months did not show any significant difference.

L. australis

The population of *L. australis* was observed in four locations throughout the period of observation (Table 4). There was no significant difference in the population of *L. australis* recorded during various months, different locations and also when the interaction between various months and locations were considered.

A. obscurus

The pest was observed in the field in five locations throughout the period of observation (Table 5). Significant difference was not observed in the population of *A. obscurus* in the various locations during different months.

H. vigintioctopunctata

The mean population of *H. vigintioctopunctata* recorded from the ten locations and different months showed significant difference, whereas the population observed in each location during various periods did not show significant variation (Table 6).

The population of *H. vigintioctopunctata* was observed throughout the year and ranged from 0.14 to 2.23. The population increased significantly during August 2005 (1.51) after recording a low population in July 2005 (1.01) and was on par with the population from September to November 2005, February 2006, March 2006 and June 2006, the population ranging from 1.58 to 1.95. The population recorded during December 2005 (2.23) and January 2006 (2.12) was statistically similar with the population of November 2005 (1.90). The lowest population of *H. vigintioctopunctata* (0.14) was observed during April and May, 2006.

H. vigintioctopunctata showed significant difference in their mean population in all the ten different locations. The population was higher in all the four locations in the Instructional Farm and the population was 1.79, 1.73, 1.58 and 1.70, respectively. The lowest population was recorded in the fifth location

Table 4. Seasonal occurrence of *L. australis* in coccinia at Kalliyoor panchayat in Thiruvananthapuram district.

Month	Mean number of adults per plant at different locations				Mean
	Instructional farm				
	1	2	3	4	
July-2005	0.60	1.40	1.50	1.80	1.33
August-2005	1.00	1.60	1.20	1.30	1.28
September-2005	1.10	1.50	1.40	2.00	1.50
October-2005	1.40	1.20	1.10	1.80	1.38
November-2005	1.20	1.80	1.10	2.00	1.53
December-2005	1.90	2.10	1.50	2.50	2.00
January-2006	1.10	1.50	1.70	1.80	1.53
February-2006	1.70	1.90	1.70	2.30	1.90
March-2006	2.40	2.70	1.80	2.20	2.28
April-2006	1.50	2.20	1.90	1.50	1.78
May-2006	1.80	1.80	2.10	2.30	2.00
June-2006	2.10	2.80	3.10	1.40	2.35
Mean	1.48	1.88	1.68	1.91	

CD (0.05)

Month : N.S
Location : N.S
M×L : N.S

Table 5. Seasonal occurrence of *A. obscurus* in coccinia at Kalliyoor panchayat in Thiruvananthapuram district.

Month	Mean number of nymphs and adults per plant at different locations					Mean
	Instructional Farm				Farmers' field	
	1	2	3	4	5	
July-2005	2.10	2.30	3.30	1.20	2.40	2.26
August-2005	3.00	3.50	2.90	1.40	2.30	2.62
September-2005	3.00	3.80	3.20	2.90	3.60	3.30
October-2005	2.80	1.50	2.10	1.20	3.60	2.24
November-2005	2.70	3.20	3.00	3.00	3.80	3.14
December-2005	2.70	3.60	4.20	3.50	2.90	3.38
January-2006	2.80	2.80	4.30	3.40	3.40	3.34
February-2006	3.80	2.20	2.90	3.10	3.30	3.06
March-2006	2.40	2.80	3.70	3.40	2.70	3.00
April-2006	2.20	3.30	4.40	4.30	3.90	3.62
May-2006	5.40	2.90	4.20	3.90	3.20	3.92
June-2006	3.00	3.00	2.40	4.10	2.50	3.00
Mean	2.99	2	3.38	2.95	3.13	

CD (0.05)

Month : N.S
Location : N.S
M × L : N.S

Table 6 .Seasonal occurrence of *H.vigintioctopunctata* in coccinia at Kalliyoor panchayat in Thiruvananthapuram district

Month	Mean number of grubs and adults per plant observed at different locations										Mean
	Instructional farm				Farmers' field						
	1	2	3	4	5	6	7	8	9	10	
July-2005	1.00	1.40	0.90	1.20	1.00	1.20	0.70	0.70	1.00	1.00	1.01
August-2005	1.60	2.00	1.30	2.20	1.00	0.90	1.10	1.80	1.60	1.60	1.51
September-2005	2.10	1.70	1.80	1.70	1.50	1.30	1.10	1.80	1.30	1.50	1.58
October-2005	3.10	2.20	1.80	2.30	1.20	1.70	2.20	1.60	1.70	1.70	1.95
November-2005	2.40	1.50	2.20	1.70	1.50	1.70	2.30	2.30	1.80	1.60	1.90
December-2005	3.60	3.00	2.60	1.80	1.50	1.90	2.50	1.90	2.00	1.50	2.23
January-2006	3.20	2.60	2.30	3.10	1.40	1.50	2.00	1.60	1.70	1.80	2.12
February-2006	2.50	2.20	2.10	2.10	0.90	0.90	2.00	1.40	1.10	1.60	1.68
March-2006	2.00	1.50	2.30	1.80	1.10	1.60	1.30	1.90	2.00	1.30	1.68
April-2006	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.20	0.30	0.30	0.14
May-2006	0.00	0.00	0.00	0.00	0.20	0.10	0.20	0.20	0.30	0.40	0.14
June-2006	0.00	2.70	1.60	2.50	1.40	1.780	1.40	1.40	1.70	1.40	1.58
Mean	1.79	1.73	1.58	1.70	1.07	1.23	1.43	1.40	1.38	1.31	

CD (0.05)

Month : 0.481
Location : 0.439
M × L : N.S

(1.07) in the farmers' field and this was statistically similar with the mean population of *H. vigintioctopunctata* in all other locations in the farmers' field and the population ranged from 1.23 to 1.43.

There was no significant difference when the population of *H. vigintioctopunctata* and the interaction between the various months and different locations were considered.

***Aulacophora* spp.**

The population of *Aulacophora* spp. was recorded from all the ten locations during all the months (Table 7).

The mean population of the beetle recorded during the period ranged from 0.44 to 2.26. In the initial observation taken during July 2005, the population was 1.07 and there was no significant difference in the population during August 2005 (1.35), November 2005 (1.44) and June 2006 (1.47). The population observed during September 2005 was 1.58 and statistically same as that of October 2005 (1.65). There was a significant increase in the population during December 2005 (1.76) and it was on par with that of the population from January 2006 to March 2006, the population ranging from 1.87 to 2.26. Thereafter, there was a significant reduction in the population during April 2006 and the population remained constant during May 2006 (0.44).

Significant difference was noticed in the mean population of the pest in various locations. The mean population recorded in all the locations in the Instructional Farm and the sixth (1.57) location in the farmers' field was significantly high and ranged from 1.52 to 1.90. In all other farmers' fields, there was significantly lower population of *Aulacophora* spp. The population of *Aulacophora* spp. was lowest in the eighth location (1.03) and there was no significant variation with fifth, seventh, ninth and tenth locations and the mean population ranged from 1.27 to 1.44.

The population of *Aulacophora* spp. had no significant difference when the population at various locations during different months was considered.

Table 7. Seasonal occurrence of *Aulacophora* spp. in coccinia in Kalliyoor panchayat in Thiruvananthapuram district

Month	Mean number of adults per plant at different locations										Mean
	Instructional farm				Farmers' field						
	1	2	3	4	5	6	7	8	9	10	
July-2005	1.40	0.90	1.10	1.10	1.30	1.00	1.40	0.80	0.80	0.90	1.07
August-2005	1.40	1.40	1.80	1.90	1.00	1.30	1.10	0.90	1.20	1.50	1.35
September-2005	2.30	1.80	2.10	1.40	1.20	1.50	1.30	0.90	1.80	1.50	1.58
October-2005	2.10	1.60	1.70	2.10	1.80	1.70	1.50	1.20	1.00	1.80	1.65
November-2005	1.20	1.50	2.30	1.20	1.10	1.70	1.60	1.00	1.20	1.60	1.44
December-2005	2.60	1.90	2.00	1.70	1.70	1.70	1.40	1.10	1.80	1.70	1.76
January-2006	1.60	2.10	2.40	2.40	1.30	2.10	1.70	1.50	1.80	1.80	1.87
February-2006	1.90	3.00	3.70	2.40	1.70	2.20	1.80	1.60	2.10	2.20	2.26
March-2006	2.00	2.20	2.00	1.50	1.80	2.90	1.50	1.70	1.80	2.30	1.97
April-2006	0.00	0.20	0.90	0.70	0.30	0.40	0.40	0.60	0.50	0.40	0.44
May-2006	0.50	0.80	1.10	0.30	0.20	0.50	0.20	0.30	0.20	0.30	0.44
June-2006	1.60	1.20	1.70	1.50	2.30	1.80	1.30	0.80	1.20	1.30	1.47
Mean	1.55	1.55	1.90	1.52	1.31	1.57	1.27	1.03	1.28	1.44	

CD (0.05)

Month : 0.469
Location : 0.428
M × L : N.S

D. indica

The population of larvae of *D. indica* was seen during one year of observation in all the ten locations (Table 8).

The mean population of the pest during various periods ranged from 1.18 to 2.30. The lowest population was recorded during July 2005 (1.18) which was statistically similar with that of August 2005 (1.66) and September 2005 (1.52). A significant increase in the population was seen during October 2005 (1.78). The population increased and reached its maximum in the month of June 2006 (2.30) and there was no significant difference in the population observed from November 2005 to May 2006 which ranged from 1.81 to 2.20 when compared with the population recorded in June 2006.

The mean population of *D. indica* observed in all the locations showed significantly higher larval population in the four plots located in the Instructional Farm (locations 1 to 4) and the population ranged from 2.12 to 2.64 when compared with the mean population from six locations in farmers' fields. The lowest population was recorded in the ninth location (1.38) and had no significant variation with the mean population recorded in the fifth (1.58), sixth (1.59), seventh (1.43), eighth (1.43) and tenth (1.72) locations.

There was no significant variation in the population of the larvae of *D. indica* recorded when the interaction with the locations and different periods under study was considered.

4.1.2.2 Extent of damage caused by the pests

S. hemisphaerica

Coccinia plants completely damaged by the pests at different locations is depicted in Fig. 1.

Complete destruction of the plants by *S. hemisphaerica* was recorded from eight locations. Destruction was comparatively higher in all the locations observed in the Instructional Farm which varied from 30 to 100 per cent. Only 4

Table 8. Seasonal occurrence of *D. indica* in coccinia at Kalliyoor panchayat in Thiruvananthapuram district

Month	Mean number of larvae per plant at different locations										Mean
	Instructional farm				Farmers' field						
	1	2	3	4	5	6	7	8	9	10	
July-2005	2.30	1.50	1.50	1.80	0.60	1.20	0.80	0.60	0.80	0.70	1.18
August-2005	2.40	4.00	2.20	2.10	1.20	1.00	0.60	1.00	0.90	1.2	1.66
September-2005	2.00	2.20	1.80	2.20	1.20	1.20	1.10	1.10	0.80	1.60	1.52
October-2005	1.90	2.40	2.40	2.70	1.00	1.70	0.90	1.70	1.30	1.80	1.78
November-2005	2.10	2.10	2.70	2.50	2.10	1.10	1.70	1.20	1.20	2.00	1.87
December-2005	2.10	3.00	2.70	3.40	2.70	0.60	1.00	1.40	1.50	2.10	2.05
January-2006	2.00	3.90	2.30	1.90	1.50	2.60	2.10	1.20	1.50	2.00	2.10
February-2006	2.30	3.40	2.00	2.30	1.30	1.70	1.90	1.70	1.80	1.30	1.97
March-2006	1.60	2.90	3.10	3.30	1.60	1.80	2.30	2.00	1.90	1.70	2.20
April-2006	2.70	1.80	2.40	2.50	1.90	2.10	1.30	1.30	1.90	1.30	1.92
May-2006	2.00	1.80	2.40	3.30	1.70	2.10	1.80	1.90	1.50	2.10	2.06
June-2006	2.00	2.70	3.00	3.30	2.10	2.00	1.70	2.00	1.40	2.80	2.30
Mean	2.12	2.64	2.38	2.61	1.58	1.59	1.43	1.43	1.38	1.72	

CD (0.05)

Month : 0.482
Location : 0.440
M × L : N.S

to 15 per cent plants in the farmers' field were completely destroyed due to the infestation of the scale insect.

B. cucurbitae

Infestation of the fruit fly *B. cucurbitae* was seen in all the months and in all the ten locations. The percentage of fruit damage caused by the pest in coccinia during July 2005 to June 2006 is depicted in the Table 9.

The damage caused by *B. cucurbitae* to the fruits of coccinia during different months ranged from 1.96 to 21.66 per cent. The lowest damage was recorded during the month of July 2005 (1.96). A significant increase in the damage was noticed from August 2005 (8.00) onwards and it was statistically similar with the damage observed in September 2005 (12.40) and November 2005 (12.54). The fruits damaged during October 2005 (16.14), December 2005 (15.00), January 2005 (17.75), February 2005 (17.06) and June 2006 (14.05) were statistically similar with November 2005 (12.54). . Maximum damage was recorded during May 2006 (21.66) and it was on par with the damage recorded during April 2006 (19.70) and March 2006 (19.07).

The damage to fruits caused by *B. cucurbitae* was significantly higher in three locations in Instructional Farm, Vellayani. The maximum damage to fruits was occurred in the third location (29.14) and it was statistically similar with the damage in the first (23.60) and second (28.92) locations. Significantly lower damage of fruits was recorded in the fourth location (10.09) and was statistically similar to the damage in the fifth (10.76) and sixth (10.09) locations. The damage of fruits in the seventh location (16.98) showed significant variation. The damage of fruits in the eighth, ninth and tenth locations in the farmers' fields were significantly lower and ranged from 6.24 to 8.30.

The damage by fruit flies during various months at different locations showed no significant difference.

Table 9. Extent of fruits damaged by *B. cucurbitae* in coccinia at Kalliyoor panchayat in Thiruvananthapuram district (%).

Month	Locations										Mean
	Instructional farm				Farmers' field						
	1	2	3	4	5	6	7	8	9	10	
July-2005	2.62(1.90)	3.61(2.15)	4.32(2.31)	1.44(1.56)	1.30(1.52)	1.47(1.57)	2.04(1.74)	1.30(1.52)	1.36(1.54)	0.98(1.41)	1.96(1.72)
August-2005	10.89(3.45)	19.39(4.52)	23.38(4.94)	5.42(2.53)	6.77(2.79)	8.02(3.00)	8.67(3.11)	2.55(1.88)	3.81(2.19)	1.76(1.66)	8.00(3.01)
September-2005	17.23(4.27)	24.64(5.06)	30.77(5.64	6.23(2.69)	8.57(3.09)	9.47(3.24)	24.68(5.07)	3.64(2.15)	4.52(2.35)	8.02(3.01)	12.40(3.66)
October-2005	38.64(6.30)	43.04(6.64	76.94(8.83)	3.03(2.01)	4.69(2.39)	10.25(3.35	21.09(4.70	5.75(2.60)	4.67(2.38)	3.82(2.20)	16.14(4.14)
November-2005	18.76(4.45)	34.56(5.96)	26.46(5.24)	9.15(3.19)	8.62(3.10)	7.18(2.86)	19.73(4.55)	4.03(2.24)	6.38(2.72)	5.10(2.47)	12.54(3.68)
December-2005	19.97(4.58)	24.61(5.06)	29.57(5.53)	12.92(3.73)	14.94(3.99)	13.84(3.85)	18.39(4.40)	4.95(2.44)	4.47(2.34)	15.31(4.04)	15(4.00)
January-2006	43.65(6.68)	44.18(6.72)	34.18(5.93)	14.39(3.92)	16.45(4.18)	8.63(3.10)	12.18(3.63)	7.00(2.83)	7.06(2.84)	10.84(3.44)	17.75(4.33)
February-2006	24.96(5.09)	30.65(5.63)	38.52(6.29)	15.93(4.11)	16.76(4.21)	10.83(3.44))	16.24(4.15)	7.79(2.96)	8.03(3.00)	11.63(3.55)	17.06(4.25)
March-2006	37.12(6.17)	39.17(6.34)	35.87(6.07)	11.61(3.55)	17.65(4.32)	15.16(4.02)	21.45(4.74)	9.64(3.26)	5.12(2.47)	14.15(3.89)	19.07(4.48)
April-2006	33.92(5.91)	35.12(6.01)	34.73(5.98))	15.91(4.11)	12.75(3.71)	14.56(3.95)	24.59(5.06)	12.07(3.62)	7.31(2.88)	17.49(4.30)	19.70(4.55)
May-2006	34.27(5.94)	35.66(6.05)	23.84(4.98)	14.76(3.97)	20.36(4.62)	13.62(3.82)	33.63(5.88)	17.02(4.25)	15.71(4.09)	15.04(4.00)	21.66(4.76)
June-2006	21.77(4.77)	29.87(5.56)	15.85(4.11)	20.01(4.58)	9.83(3.29)	13.29(3.78)	13.82(3.85)	6.66(2.77)	10.91(3.45)	6.02(2.65)	14.05(3.88)
Mean	23.60(4.96)	28.92(5.47)	29.14(5.49)	10.09(3.33)	10.76(3.43)	10.09(3.33)	16.98(4.24)	6.34(2.71)	6.24(2.69)	8.30(3.05)	

CD (0.05)

Month : 0.699
Location : 0.638
M × L : N.S

Figures in parentheses are $\sqrt{x+1}$ transformed values

L. cephalandrae

The extent of damage caused by *L. cephalandrae* to the shoots of coccinia is presented in the Table 10. The attack of the gallfly was observed only in six locations.

The damage of the gall fly during various months ranged from 0.00 to 9.43 per cent. No damage was caused during July and August 2005. During September, October and November 2005 the damage caused by *L. cephalandrae* did not show any significant variation and the values ranged from 0.56 to1.86. There was a significant increase in the damage during December 2005 (3.08). The highest damage was noticed during February 2006 (9.43) and it was statistically similar with that of January 2006 (8.80), March 2006 (5.97), April 2006 (5.92) and May 2006 (6.18). Subsequently, a significant decrease in the extent of damage was recorded during June 2006 (4.71).

No significant difference was observed in the incidence of the pest in the six locations. Similarly, there was no significant difference in the gall fly damage during various months at different locations.

A comparison of the intensity of infestation by *B. cucurbitae* in the galls made by *L. cephalandrae* and fruits of coccinia was made and the results are presented in Fig. 2.

The extent of infestation in the fruits was higher (80 per cent) compared to the infestation in the galls (30 per cent).

Significant difference was not observed in the number of *B. cucurbitae* emerging from the fruits and galls. The mean number of *B. cucurbitae* emerged from a single fruit was 8.33 and that from one gall was 8.00 (Fig. 3).

Table 10. Extent of shoots damaged by *L. cephalandrae* in coccinia at Kalliyoor panchayat in Thiruvananthapuram district (%)

Month	Locations*						Mean
	Instructional farm			Farmers' field			
	1	2	3	7	8	9	
July-2005	0(1.00)	0(1.00)	0(1.00)	0(1.00)	0(1.00)	0(1.00)	0(1.00)
August-2005	0(1.00)	0(1.00)	0(1.00)	0(1.00)	0(1.00)	0(1.00)	0(1.00)
September-2005	1.15(1.47)	0.65(1.29)	0.39(1.18)	2.07(1.75)	1.14(1.46)	1.41(1.55)	1.10(1.45)
October-2005	0.23(1.11)	0.23(1.11)	0.39(1.18)	1.37(1.54)	0.84(1.36)	0.39(1.18)	0.56(1.25)
November-2005	1.82(1.68)	0.52(1.23)	2.29(1.81)	5.38(2.52)	0.84(1.36)	1.35(1.53)	1.86(1.69)
December-2005	2.66(1.91)	2.66(1.91)	7.41(2.90)	1.95(1.72)	1.86(1.69)	3.00(2.00)	3.08(2.02)
January-2006	7.54(2.92)	19.93(4.58)	14.92(3.99)	9.86(3.30)	3.59(2.14)	2.40(1.84)	8.80(3.13)
February-2006	23.07(4.91)	6.12(2.67)	11.97(3.60)	7.31(2.88)	6.53(2.74)	5.72(2.59)	9.43(3.23)
March-2006	5.14(2.48)	7.75(2.96)	7.26(2.87)	9.17(3.19)	4.29(2.30)	3.18(2.04)	5.97(2.64)
April-2006	5.94(2.63)	6.66(2.77)	5.94(2.63)	4.39(2.32)	6.88(2.81)	5.74(2.60)	5.92(2.63)
May-2006	13.61(3.82)	6.08(2.66)	9.89(3.30)	5.57(2.56)	2.25(1.80)	2.77(1.94)	6.18(2.68)
June-2006	5.94(2.63)	3.83(2.20)	3.82(2.20)	5.58(2.57)	5.32(2.51)	4.10(2.26)	4.71(2.39)
Mean	4.29(2.30)	3.45(2.11)	4.34(2.31)	3.84(2.20)	2.42(1.85)	2.24(1.80)	

CD (0.05)

Month : 0.612
Location : N.S
M × L : N.S

Figures in parentheses are $\sqrt{x+1}$ transformed values

* Locations 4, 5, 6 and 10 - Pest not observed

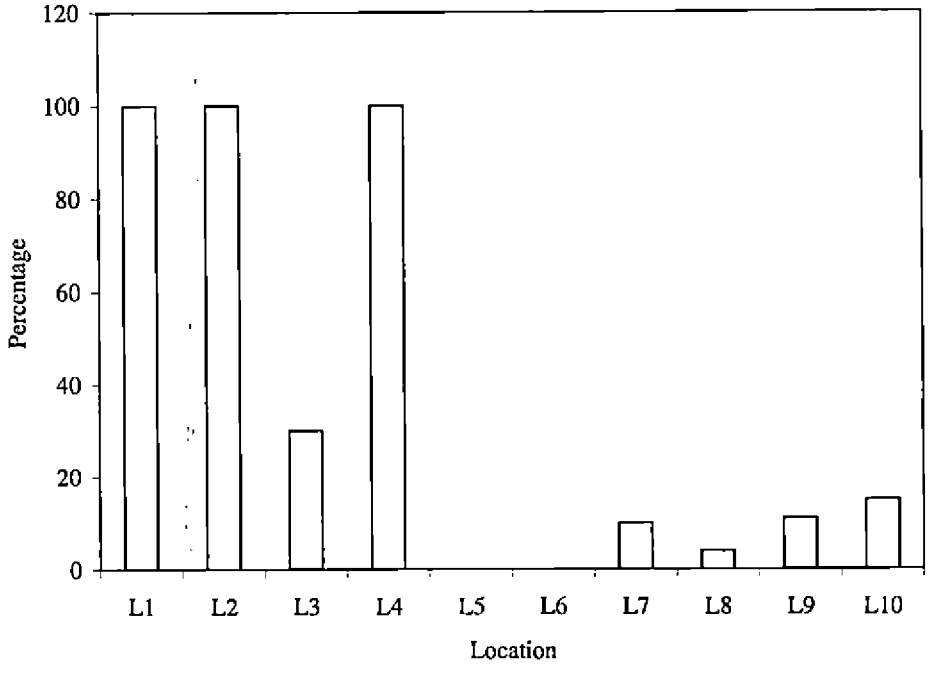


Fig. 1. Coccinia plants completely damaged by *S. hemisphaerica* at different locations

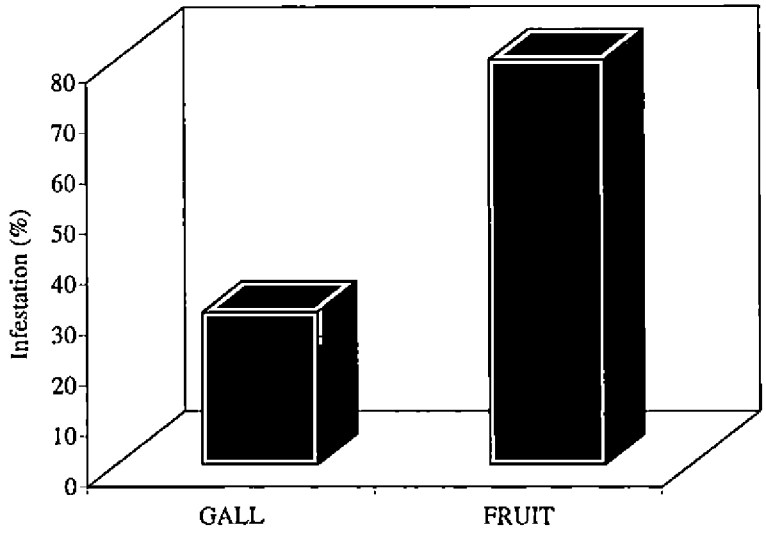


Fig. 2. Extent of infestation by *B. cucurbitae* in galls and fruits in coccinia

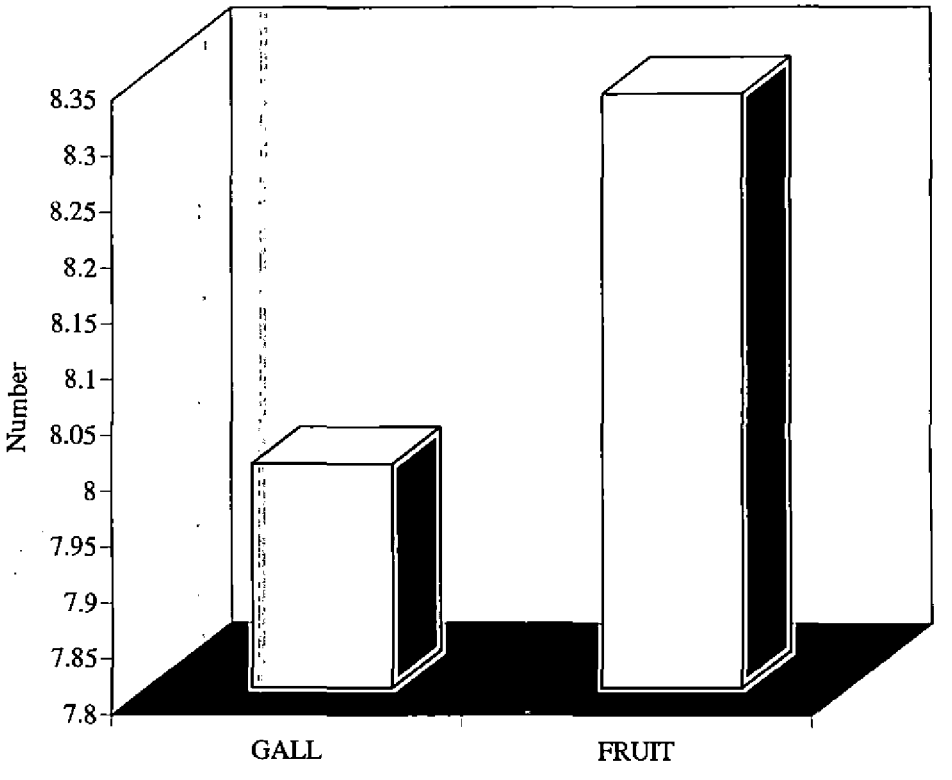


Fig. 3. Population of adult *B. cucurbitae* emerged from a single gall and fruit of coccinia

H. vigintioctopunctata

The infestation by *H. vigintioctopunctata* was recorded throughout the period of observation from all the ten locations and the related data is presented in the Table 11.

The mean damage to the leaves by the pest during different months ranged from 0.28 to 6.40. The infestation was the lowest during the month of May 2006 (0.28) and the leaf damage was statistically on par with that of April 2006 (0.30). The highest damage by *H. vigintioctopunctata* was during January and February, 2006 (6.40) and the damage was statistically on par with the damage caused during October 2005 to December 2005, March 2006 and June 2006 and the damage ranged from 4.95 to 6.24. There was no significant variation in the extent of damage during the months of July, August, and September 2005, the percentage of damage being 2.28, 3.93 and 3.88, respectively.

The damage caused by the pest differed significantly in various locations. The damage in the first location (8.99) was significantly higher than other locations. The damage in the seventh location (3.80) had no significant variation with the damage in the second (4.20), third (3.84), fourth (4.62) and eighth (3.93) locations. The lowest damage was in the fifth location (2.35) and was on par with sixth, ninth and tenth locations and ranged from 2.92 to 3.49.

No significant difference was observed in the damage caused by the pest when the interaction between the population of different months and locations was considered.

***Aulacophora* spp.**

The attack by *Aulacophora* spp. was recorded during all the months from all the ten locations under observation and the data is depicted in the Table 12.

The infestation by *Aulacophora* spp. during the various months ranged from 0.44 to 5.71 per cent. The damage by *Aulacophora* spp. during July 2005 was 3.46 which were statistically on par with August 2005 (3.84). The highest infestation by the pest was observed during the month of March 2006 (5.71)

Table 11. Extent of leaves damaged by *H. vigintioctopunctata* in coccinia at Kalliyoor panchayat in Thiruvananthapuram district (%).

Month	Locations										Mean
	Instructional farm				Farmers' field						
	1	2	3	4	5	6	7	8	9	10	
July-2005	1.69(1.64)	5.00(2.45)	1.64(1.62)	2.25(1.80)	3.28(2.08)	2.22(1.80)	1.51(1.59)	1.44(1.56)	2.22(1.80)	2.22(1.80)	2.28(1.81)
August-2005	7.32(2.88)	4.36(2.32)	3.33(2.08)	6.18(2.68)	2.45(1.86)	2.62(1.90)	3.19(2.05)	4.76(2.40)	4.04(2.25)	2.22(1.80)	3.93(2.22)
September-2005	9.85(3.29)	2.45(1.86)	2.62(1.90)	6.21(2.69)	2.45(1.86)	2.62(1.90)	3.19(2.05)	4.26(2.29)	3.41(2.10)	3.86(2.20)	3.88(2.21)
October-2005	13.13(3.76)	4.49(2.34)	3.80(2.19)	4.78(2.40)	3.05(2.01)	4.26(2.29)	5.67(2.58)	4.54(2.35)	3.86(2.20)	4.26(2.29)	4.95(2.44)
November-2005	13.94(3.87)	5.29(2.51)	5.18(2.49)	4.50(2.35)	3.06(2.01)	4.26(2.29)	5.47(2.54)	5.93(2.63)	4.51(2.35)	3.64(2.15)	5.35(2.52)
December-2005	12.93(3.73)	7.61(2.93)	7.72(2.95)	7.31(2.88)	2.89(1.97)	5.10(2.47)	6.32(2.71)	6.32(2.71)	5.51(2.55)	2.78(1.94)	6.24(2.69)
January-2006	20.70(4.66)	5.95(2.64)	5.49(2.55)	8.47(3.08)	3.94(2.22)	3.48(2.12)	4.76(2.40)	5.89(2.63)	4.79(2.41)	5.29(2.51)	6.40(2.72)
February-2006	17.34(4.28)	7.61(2.93)	10.09(3.33)	7.21(2.86)	2.11(1.76)	2.50(1.87)	5.67(2.58)	7.31(2.88)	4.45(2.33)	4.70(2.39)	6.40(2.72)
March-2006	14.98(4.00)	4.59(2.37)	6.10(2.66)	6.13(2.67)	2.22(1.79)	4.22(2.28)	8.25(3.04)	5.40(2.53)	5.49(2.55)	3.22(2.05)	5.76(2.60)
April-2006	0(1.00)	0(1.00)	0(1.00)	0(1.00)	0.23(1.11)	0.65(1.29)	0.65(1.29)	0.48(1.22)	0.48(1.22)	0.65(1.29)	0.30(1.14)
May-2006	0(1.00)	0(1.00)	0(1. 00)	0(1.00)	0.39(1.18)	0.23(1.11)	0.48(1.22)	0.39(1.18)	0.65(1.29)	0.83(1.35)	0.28(1.13)
June-2006	13.20(3.77)	7.99(3.00)	5.54(2.56)	8.00(3.00)	3.40(2.10)	5.12(2.47)	3.79(2.19)	4.32(2.31)	4.56(2.36)	5.58(2.57)	5.92(2.63)
Mean	8.99(3.16)	4.20(2.28	3.84(2.20)	4.62(2.37)	2.35(1.83)	2.92(1.98)	3.80(2.19)	3.93(2.22)	3.49(2.12)	3.12(2.03)	

CD (0.05)

Month : 0.354

Location : 0.323

M × L : N.S

Figures in parentheses are $\sqrt{x+1}$ transformed values

Table 12. Extent of leaves damaged by *Aulacophora* spp. in coccinia at Kalliyoor panchayat in Thiruvananthapuram district (%).

Month	Locations										Mean
	Instructional farm				Farmers' field						
	1	2	3	4	5	6	7	8	9	10	
July-2005	3.25(2.06)	3.27(2.07)	2.62(1.90)	2.86(1.97)	2.13(1.77)	3.19(2.05)	1.62(1.62)	1.76(1.66)	1.69(1.64)	2.37(1.84)	3.46(1.86)
August-2005	3.39(2.10)	4.47(2.34)	6.87(2.81)	4.83(2.41)	3.11(2.03)	3.55(2.13)	3.13(2.03)	2.06(1.75)	3.13(2.03)	4.46(2.34)	3.84(2.20)
September-2005	5.25(2.50)	5.87(2.62)	8.70(3.11)	6.03(2.65)	2.89(1.97)	3.59(2.14)	3.33(2.08)	3.13(2.03)	4.83(2.41)	5.37(2.52)	4.81(2.41)
October-2005	9.11(3.18)	4.76(2.40)	5.47(2.54)	6.81(2.79)	6.81(2.79)	4.83(2.41)	4.93(2.44)	3.00(2.00)	2.84(1.96)	6.84(2.80)	5.40(2.53)
November-2005	5.97(2.64)	7.78(2.96)	8.49(3.08)	6.61(2.76)	5.23(2.50)	4.11(2.26)	4.29(2.30)	4.29(2.30)	2.57(1.89)	6.28(2.70)	5.45(2.54)
December-2005	9.04(3.17)	4.89(2.43)	7.13(2.85)	5.10(2.47)	4.01(2.24)	5.23(2.50)	4.54(2.35)	3.59(2.14)	4.23(2.29)	5.12(2.47)	5.20(2.49)
January-2006	6.33(2.71)	6.58(2.75)	8.16(3.03)	7.94(2.99)	4.76(2.40)	4.45(2.33)	4.13(2.27)	4.04(2.25)	4.63(2.37)	6.24(2.70)	5.66(2.58)
February-2006	5.71(2.59)	7.28(2.88)	10.16(3.34)	6.46(2.73)	5.67(2.58)	4.45(2.33)	5.61(2.57)	3.74(2.18)	4.68(2.38)	3.94(2.22)	5.66(2.58)
March-2006	6.21(2.68)	6.87(2.81)	5.82(2.61)	5.39(2.53)	4.76(2.40)	9.85(3.29)	3.33(2.08)	4.29(2.30)	5.58(2.57)	5.84(2.62)	5.71(2.59)
April-2006	0(1.00)	0.39(1.18)	2.37(1.84)	1.47(1.57)	0.65(1.29)	0.94(1.39)	0.79(1.34)	1.10(1.44)	0.65(1.28)	1.10(1.45)	0.90(1.38)
May-2006	0.98(1.41)	1.69(1.64)	0(1.00)	0(1.00)	0.23(1.11)	0.23(1.11)	0.23(1.11)	0.23(1.11)	0.23(1.11	0.94(1.39)	0.44(1.20)
June-2006	5.51(2.55)	2.62(1.90)	5.87(2.62)	5.80(2.61)	4.48(2.34)	4.38(2.32)	3.56(2.14)	1.87(1.69)	3.06(2.01)	2.97(1.99)	3.93(2.22)
Mean	4.66(2.38)	5.43(2.33)	6.55(2.56)	5.62(2.37)	3.49(2.12)	4.80(2.19)	3.12(2.03)	2.65(1.91)	3.00(2.00)	4.06(2.25)	

CD (0.05)

Month : 0.318
Location : 0.290
M × L : N.S

Figures in parentheses are $\sqrt{x+1}$ transformed values

which was statistically similar with the damage during the months of September 2005 to February 2006 which ranged from 4.81 to 5.66. The lowest damage to the leaves occurred during May 2006 (0.44) which was on par with that of April 2006 (0.90). In the next month June 2006, the damage showed a significant increase and was 3.93.

The damage caused by *Aulacophora* spp. showed significant difference between the various locations. The damage was highest in the third location (6.55) and it was statistically similar to that of tenth location and other locations in the Instructional Farm which ranged from 4.06 to 5.62. The lowest percentage of damage was in the eighth location (2.65) and was statistically similar to the fifth, sixth, seventh, eighth and ninth location, the population being 3.48, 4.80, 3.12, 2.65 and 3.00, respectively.

When the interaction between months and locations was considered, there was no significant difference in the percentage of damage by *Aulacophora* spp.

A. saltator

The sizeable number of *A. saltator* was not observed in the field. The damage caused by the pest in various locations during February 2006 was recorded and is given in Fig. 4

The complete destruction of coccinia plants by *A. saltator* was recorded from the three locations in the Instructional Farm out of the ten locations observed. The percentage of plants completely destroyed in the second, third and fourth locations varied from 4 to 12 per cent.

A. dispersus

The damage by *A. dispersus* was observed in the field only from February 2006 to June 2006 and it ranged from 2.39 to 14.76 and the related data is presented in the Table 13.

The infestation by *A. dispersus* showed significant difference during different months of observation. The lowest damage was observed in June 2006 (2.39). The highest infestation was observed in May 2006 (14.76) and it was

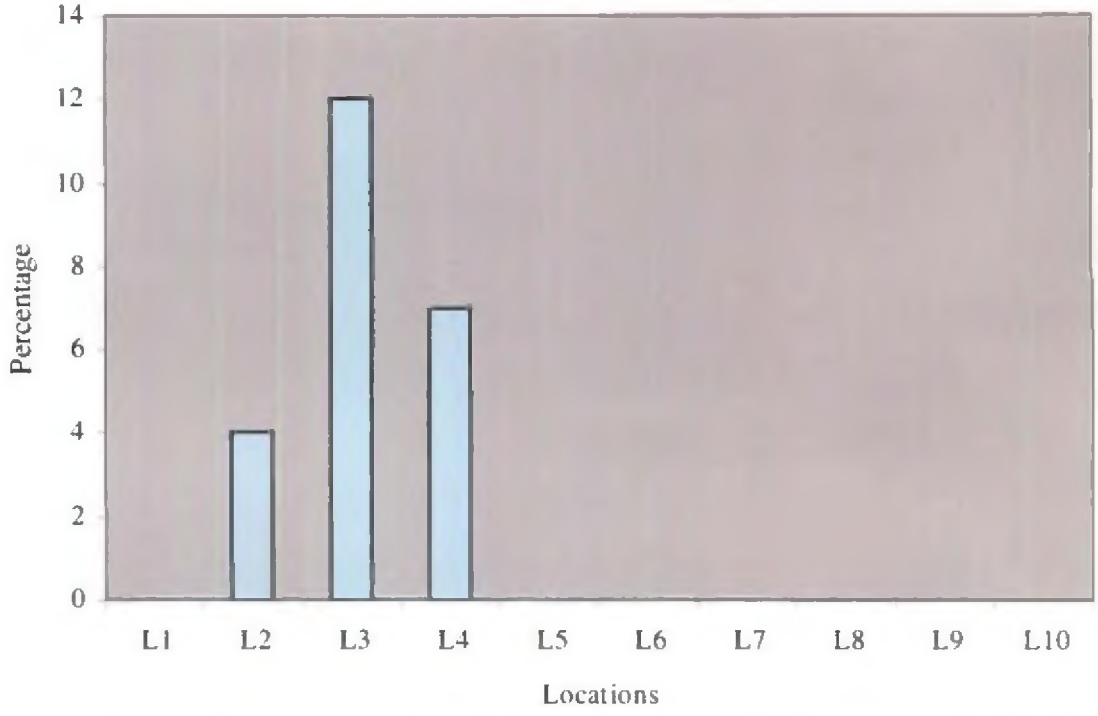


Fig. 4 Coccinia plants completely damaged by *A. saltator* at different locations

Table 13 .Extent of leaves damaged by *A. dispersus* in coccinia at Kalliyoor panchayat in Thiruvananthapuram district (%).

Month	Locations				Mean
	Instructional farm				
	1	2	3	4	
February-2006	6.12(2.67)	9.31(3.21)	9.24(3.20)	5.82(2.61)	7.53(2.92)
March-2006	6.65(2.77)	9.26(3.20)	14.38(3.92)	8.46(3.08)	9.50(3.24)
April-2006	9.28(3.21)	12.84(3.72)	10.61(3.41)	13.76(3.84)	11.53(3.54)
May-2006	13.77(3.84)	15.13(4.02)	14.51(3.94)	15.64(4.08)	14.76(3.97)
June-2006	4.16(2.27)	1.45(1.57)	1.21(1.49)	3.21(2.05)	2.39(1.84)
Mean	7.70(2.95)	8.86(3.14)	9.18(3.19)	8.80(3.13)	

CD (0.05)

Month : 1.227
Location : N.S
M × L : N.S

Figures in parentheses are $\sqrt{x+1}$ transformed values

statistically similar to the infestation caused by the pest in February 2006 (7.53), March 2006 (9.50) and April 2006 (11.53).

The infestation was seen only in four locations in Instructional Farm and there was no significant difference between the percentage of infestation in the four locations and also when the interaction between months and locations was considered.

***Tetranychus* sp.**

The mean percentage of infestation by *Tetranychus* sp. during different months showed significant difference and the data is presented in the Table 14.

The infestation by *Tetranychus* sp. was observed only in five months. During the period of observation and the infestation ranged from 4.06 to 27.62. The lowest infestation was recorded during June 2006 (5.50) and no significant variation was observed in the infestation during February 2006 (7.01). The highest infestation was recorded during May 2006 (27.62) and it was on par with the infestation of March 2006 (20.81) and April 2006 (26.56).

No significant difference was observed in the infestation caused by *Tetranychus* sp. when the ten locations and the interaction between various months and locations were considered.

4.2 NATURAL ENEMIES OF PESTS OF COCCINIA

The natural enemies recorded during the study included five predators (Table 15) and one parasitoid. The predators comprised spiders, coccinellid and syrphid(Plate 6).

The spiders observed were *O. shweta, Thomisius* sp. and *Tetragnatha* sp. and they were found predating on the larvae of *D. indica,* nymphs and adults of *A. spiraecola* and adults of *H. vigintioctopunctata.* The coccinellid *M. sexmaculatus* and the syrphid *P. serratus* were seen feeding on nymphs and adults of *A. spiraecola.*

A larval parasitoid of *D. indica* was recorded and identified as *Apanteles* sp.

Table 14 .Exent of leaves damaged by *Tetranychus* sp. in coccinia at Kalliyoor panchayat in Thiruvananthapuram district (%).

Month	Locations										Mean
	Instructional farm				Farmers' field						
	1	2	3	4	5	6	7	8	9	10	
February-2006	8.89(3.15)	3.75(2.18)	5.17(2.48)	10.30(3.36)	3.85(2.20)	3.65(2.16)	5.81(2.61)	7.33(2.89)	10.15(3.34)	14.59(3.95)	7.01(2.83)
March-2006	17.34(4.28)	14.11(3.89)	31.08(5.66)	21.27(4.72)	21.51(4.72)	23.04(4.90)	17.45(4.29)	15.66(4.08)	23.70(4.97)	25.45(5.14)	20.81(4.67)
April-2006	25.09(5.11)	22.28(4.82)	38.76(6.30)	25.36(5.13)	31.93(5.74)	19.41(4.52)	22.00(4.80)	31.67(5.72)	22.81(4.88)	28.51(5.43)	26.56(5.25)
May-2006	25.26(5.12)	37.05(6.17)	26.23(5.22)	38.30(6.27)	22.47(4.84)	18.46(4.41)	23.27(4.93)	40.51(6.44)	31.49(5.70)	17.93(4.35)	27.62(5.35)
June-2006	1.21(1.49)	3.65(2.16)	4.16(2.27)	7.35(2.89)	11.82(3.58)	7.05(2.84)	8.47(3.08)	8.45(3.07)	2.99(2.00)	3.44(2.11)	5.50(2.55)
Mean	13.67(3.83)	13.75(3.84)	18.27(4.39)	19.07(4.48)	16.81(4.22)	13.21(3.77)	14.52(3.94)	18.71(4.44)	16.47(4.18)	16.64(4.20)	

CD (0.05)
Month : 0.928
Location : N.S
M × L : N.S
Figures in parentheses are $\sqrt{x+1}$ transformed values

Table 15. Natural enemies of pests of coccinia recorded from Kalliyoor panchayat of Thiruvananthapuram district

Order	Family	Scientific name	Host
PREDATORS			
Araneae	Oxyopidae	*Oxyopes shweta Tikader*	*A. spiraecola* *D. indica*
	Thomisidae	*Thomisius* sp.	
	Tetragnathidae	*Tetragnatha* sp.	
Coleoptera	Coccinellidae	*Menochilus sexmaculatus* (Fb.)	*A. spiraecola*
Diptera	Syrphidae	*Paragus serratus* Fabr.	*A. spiraecola*
PARASITOID			
Hymenoptera	Braconidae	*Apanteles* sp.	*D. indica*

O. shweta

Thomisius sp.

Tetragnatha sp.

M. sexmaculatus

Maggot of *P. serratus*

Pupal case of *Apanteles* sp.

Adult of *Apanteles* sp.

Plate 6. Natural enemies of pests of coccinia

The data on the population of spiders present in the field during the entire period of study is presented in the Table 16.

The lowest mean population was recorded during June 2006 (1.58) and it was statistically similar with that of July 2005 (1.68). The mean population recorded during April 2006 (2.39) had no significant difference with the mean population during August 2005, September 2005, October 2005, November 2005, December 2005, January 2006, February 2006, March 2006 and May 2006 and the population was 2.26, 2.09, 2.18, 2.27, 2.15, 2.22, 2.00, 2.17 and 2.17, respectively.

There was no significant difference in the mean population of spiders when the various locations and the interaction between different months and locations were considered.

4.3 RELATIONSHIP BETWEEN WEATHER PARAMETERS AND OCCURRENCE OF THE PESTS

4.3.1 Correlation between weather parameters and population of the pests

Correlation coefficients between weather parameters and incidence of pests during the month and succeeding month of observation are presented in Table 17.

During the month of observation, the population of *S. hemisphaerica* had significant positive correlation with maximum temperature (r value = 0.7992) and significant negative correlation with evening relative humidity (r value = 0.5943) and rainfall (r value = 0.5961). The minimum temperature, morning relative humidity and the number of rainy days did not influence the population of *S. hemisphaerica* significantly.

The maximum temperature was positively correlated with the population of *S. hemisphaerica* of the succeeding month and had significant negative correlation with evening relative humidity (r value = 0.7394) and rainfall (r value = 0.7636). Though the relationships were not significant, minimum temperature and morning relative humidity was positively correlated and number

Table 16. Seasonal occurrence of spiders in coccinia at Kalliyoor panchayat in Thiruvananthapuram district

Month	Mean number of spiders per plant at different locations										Mean
	Instructional farm				Farmers' field						
	1	2	3	4	5	6	7	8	9	10	
July-2005	1.60	2.10	1.90	1.80	1.40	1.50	1.90	1.50	1.60	1.50	1.68
August-2005	2.40	3.50	2.90	1.70	2.10	2.70	2.50	1.60	1.60	1.60	2.26
September-2005	2.60	2.30	1.90	1.50	2.20	2.40	2.20	2.10	1.70	2.00	2.09
October-2005	1.80	2.10	3.30	2.30	2.00	2.70	2.00	2.00	2.00	1.60	2.18
November-2005	2.30	2.40	2.60	2.00	2.80	2.10	2.00	2.20	2.10	2.20	2.27
December-2005	1.90	2.40	2.20	2.80	2.10	2.20	2.10	2.20	2.10	1.50	2.15
January-2006	2.30	2.50	1.90	2.40	2.30	1.90	2.30	1.90	2.60	2.10	2.22
February-2006	2.80	1.40	2.20	1.50	1.80	2.50	2.10	2.10	2.10	1.50	2.00
March-2006	2.80	2.00	1.90	2.30	2.40	1.70	1.90	2.40	2.00	2.30	2.17
April-2006	2.50	2.10	3.10	3.10	2.60	2.80	2.00	1.90	1.80	2.00	2.39
May-2006	2.30	2.60	1.90	3.10	2.50	1.70	2.10	1.80	1.90	1.80	2.17
June-2006	1.80	1.30	1.90	1.50	1.80	1.60	1.60	1.70	1.40	1.20	1.58
Mean	2.26	2.23	2.31	2.17	2.17	2.15	2.06	1.95	1.91	1.78	

CD (0.05)
Month : 0.486
Location : N.S
M × L : N.S

Table 17. Correlation coefficient between weather parameters and the population of various pests of coccinia during the month and succeeding month

Parameters	*S. hemisphaerica*		*A. spiraecola*		*L. australis*		*A. obscurus*		*H. vigintioctopunctata*		*D. indica*	
	A	B	A	B	B	A	A	B	A	B	A	B
Maxm temp.	0.7992**	0.7657**	0.8081**	0.8204**	0.7110**	0.6645*	0.4761	0.6596*	-0.3603	-0.5986*	0.6602*	0.6394*
Minm temp.	-0.0175	0.0728	0.0753	0.0633	0.3797	0.0549	0.3751	-0.0024	-0.4965	-0.2379	0.0957	0.2017
RH Morning	-0.0463	0.1930	-0.0676	0.1841	0.0522	-0.1615	-0.0979	0.0247	-0.6032*	0.2478	-0.0398	0.1547
RH Evening	-0.5943*	-0.7394**	-0.5998*	-0.8575**	-0.2681	-0.4507	-0.1249	-0.6826*	-0.1953	0.3710	-0.4565	-0.4209
RF	-0.5961*	-0.7636**	-0.6178*	-0.8498**	-0.4261	-0.5699	-0.3941	-0.6648*	-0.1790	0.2897	-0.7081**	-0.4966
No. of rainydays	-0.5082	-0.5503	-0.5512	-0.7132**	-0.5714	-0.5126	-0.4674	-0.4575	0.0339	0.3864	-0.6407*	-0.4142

A - During the month
B - Succeeding month
** - Significant at 0.01
* - Significant at 0.05

of rainy days was negatively correlated with the population of *S. hemisphaerica* of the succeeding month.

The population of *A. spiraecola* showed significant positive correlation with maximum temperature (r value = 0.8081) and significant negative correlation with evening relative humidity (r value =¯ 0.5998) and rainfall (r value =¯ 0.6178) of the corresponding month of observation. The minimum temperature was positively correlated and the morning relative humidity and the number of rainy days were negatively correlated with the population of *A. spiraecola* during the month, but the relationships were not significant.

The maximum temperature (r value = 0.8204) had significant positive correlation whereas evening relative humidity (r value = 0.8575), rainfall (r value =0.7132) and the number of rainy days had significant negative correlation with the population of *A. spiraecola* in the succeeding month. The population was also positively correlated with minimum temperature and relative humidity though the relationships were not significant.

The maximum temperature had significant positive correlation with the population of *L. australis* during the month of observation. The minimum temperature and morning relative humidity had positive correlation while evening relative humidity, rainfall and number of rainy days had negative correlation with the population of *L. australis*, though the relationships were not significant.

The maximum temperature had significant positive correlation with the population of *L. australis* of the succeeding month also. The population of the pest was positively correlated with minimum temperature and negatively correlated with morning and evening relative humidity , rainfall and number of rainy days , though the relationships were not significant.

There were no significant correlations between the population of *A. obscurus* and the weather parameters. A positive correlation was recorded with the maximum and minimum temperature and negative correlation with other

parameters when the population of the pest was correlated with the weather parameters of the current month of observation.

The population of *A. obscurus* of succeeding month of observation showed significant positive correlation with the maximum temperature (r value =0.6596) and significant negative correlation with evening relative humidity(r value =⁻ 0.6826) and rainfall (r value =⁻ 0.6648). Though the relationships were not significant, the population of the pest had positive correlation with morning relative humidity and negative correlation with minimum temperature and number of rainy days.

The population of *H. vigintioctopunctata* had significant negative correlation with morning relative humidity (r value =⁻ 0.6032) during the month. There was positive correlation with number of rainy days and negative correlation with other weather parameters though the relationship was not significant.

The population of *H. vigintioctopunctata* of the succeeding month of observation had significant negative correlation with maximum temperature (r value =⁻ 0.5986). The population of *H. vigintioctopunctata* had negative correlation with minimum temperature and positive correlation with other weather parameters though the relationship was not significant.

During the month of observation, the population of *D. indica* had significant positive correlation with maximum temperature (r value=0.6602) and negative correlation with rainfall(r value=⁻ 0.7081) and number of rainy days (r value=⁻ 0.6407). The population of *D. indica* was positively correlated with minimum temperature and negatively correlated with morning and evening relative humidity even though the relationships were not significant.

The population of *D. indica* of succeeding month of observation had significant positive correlation with maximum temperature (r value = 0.6394). There was positive correlation with minimum temperature and morning relative humidity and negative correlation with evening relative humidity, rainfall and number of rainy days even though the relationships were not significant.

4.3.2 Correlation between weather parameters and the extent of damage

The relationship between weather parameters and the extent of damage caused by the pests during the month of observation and succeeding month are presented in the Table 18.

During the month of observation, the extent of damage caused by *B. cucurbitae* was positively correlated with maximum temperature (r value = 0.6562) and negatively correlated with rainfall (r value =⁻ 0.5936) and the relationships were significant. The damage was positively correlated with minimum temperature and negatively correlated with morning relative humidity, evening relative humidity and number of rainy days, even though the relationships were not significant.

In the succeeding month of observation, the damage by *B. cucurbitae* had significant positive correlation with maximum temperature (r value = 0.6386) and significant negative correlation with rainfall (r value =⁻ 0.6643). The infestation in the succeeding month was positively correlated with the morning relative humidity and had negative correlation with minimum temperature, evening relative humidity and number of rainy days though the relationship were not significant.

The damage caused by *L. cephalandrae* during the month had significant positive correlation with maximum temperature (r value = 0.7731) and negative correlation with rainfall (r value =⁻ 0.7325) and number of rainy days (r value =⁻ 0. 8039). Though the relationship were not significant, the damage by gall fly was negatively correlated with minimum temperature, morning and evening relative humidity.

There was significant positive correlation with maximum temperature (r value = 0. 6773) and negative correlation with evening relative humidity (r value =⁻ 0. 6508), rainfall (r value =⁻ 0.7816) and number of rainy days (r value =⁻ 0.7718) when the damage by *L. cephalandrae* during the succeeding month was correlated. A positive correlation with morning relative humidity and

Table 18. Correlation coefficient between weather parameters and the extent of damage caused by various pests of coccinia during the month and succeeding month

Parameters	*B. cucurbitae*		*Lasioptera* sp.		*H. vigintioctopunctata*		*Aulacophora* spp		*A. dispersus*		*Tetranychus* sp.	
	A	B	A	B	A	B	A	B	A	B	A	B
Maximum temperature	0.6562*	0.6386*	0.7731**	0.6773*	-0.1251	-0.3884	-0.2281	-0.4901	0.7934**	0.8962**	0.5563	0.7949**
Minimum temperature	0.0705	0.4322	-0.1164	-0.1653	-0.4615	-0.2783	-0.4850	-0.3362	0.3152	0.1034	0.3108	-0.0946
Relative humidity (Morning)	-0.1520	0.1411	-0.1775	0.3166	0.5436	0.2272	0.5957*	0.2015	-0.3622	-0.1035	-0.1750	-0.3496
Relative humidity (Evening)	-0.5323	-0.5676	-0.5524	-0.6508*	-0.3114	0.2449	-0.3315	0.2058	-0.3261	-0.7353**	-0.1214	-0.6029*
Rain fall	-0.5936*	-0.6643*	-0.7325**	-0.7816**	-0.3465	0.1099	-0.2641	0.1072	-0.3330	-0.7375**	-0.1535	-0.6065*
Number of rainy days	-0.3682	-0.5315	-0.8039**	-0.7718**	-0.1842	0.1595	-0.1260	0.1890	-0.4373	-0.7390**	-0.2904	-0.6341*

A - During the month
B - Succeeding month
** - Significant at 0.01
* - Significant at 0.05

negative correlation with minimum temperature, rainfall and number of rainy days were recorded when correlated with the damage caused by *L. cephalandrae,* but the relationships were not significant.

The damage caused by *Aulacophora* spp. during the month had significant positive correlation with morning relative humidity(r value = 0.5957). The damage by *Aulacophora* spp. had no significant negative correlation with other weather parameters. There was no significant correlation in the damage by *Aulacophora* spp. during the succeeding month with any of the weather parameters. The maximum and minimum temperature had negative correlation and morning and evening relative humidity and rainfall and number of rainy days had positive correlation with the damage by *Aulacophora* spp.

The damage caused by *A. dispersus* during the month had significant positive correlation with maximum temperature (r value = 0.7934). There was positive correlation with minimum temperature and negative correlation with other weather parameters, though the relationship was nonsignificant.

The damage caused by *A. dispersus* had significant positive correlation with maximum temperature (r value = 0.8962) and had significant negative correlation with evening relative humidity(r value =¯ 0.7353), rainfall (r value =¯ 0.7375) and number of rainy days (r value =¯ 0.7390) of the succeeding month. Though the relationships were not significant, the damage had positive correlation with the minimum temperature and negative correlation with morning relative humidity.

There was positive correlation between the damage due to *Tetranychus* sp. and maximum and minimum temperature and negative correlation with morning and evening relative humidity, rainfall and number of rainy days even though the relationships were not significant when the weather parameters of the same month was considered.

The damage due to *Tetranychus* sp. had significant positive correlation with maximum temperature (r value = 0.7949) negative correlation with evening

relative humidity(r value =¯ 0.6029), rainfall(r value =¯ 0.6065) and number of rainy days (r value =¯ 0.6341) during the succeeding month. The damage was negatively correlated with minimum temperature and morning relative humidity, though the relationships were not significant.

4.4 EFFECT OF BOTANICALS AND CHEMICAL INSECTICIDES ON THE PESTS OF COCCINIA.

4.4.1 Effect of botanicals and chemical insecticides on population of pests

4.4.1.1 S. hemisphaerica

The population of *S. hemisphaerica* at different intervals after application of treatments expressed as number per 10 cm length of vine is depicted in Table 19.

After first spraying.

One day after spraying, neem oil-2 per cent (21.07), illipe oil 2 per cent (19.41), imidacloprid 0.005 per cent (16. 89), malathion 0.1 per cent (13.41) and dimethoate 0.05 per cent (15.37) reduced the population of *S. hemisphaerica* significantly when compared to the control (29.41). Treatment of the plants with azadirachtin 0.004 per cent (24.56), neem oil-garlic 2 per cent (22.66), quinalphos 0.05 per cent (23.56) did not reduce the population of the pest significantly.

Imidacloprid 0.005 per cent (13.93), malathion 0.1 per cent (8.63) and dimethoate 0.05 per cent (11.30) were significantly superior to control (27.56) in reducing the population of *S. hemisphaerica* on the third day after spraying. Azadirachtin 0.004 per cent, neem oil-garlic 2 per cent, neem oil 2 per cent, illipe oil 2 per cent, quinalphos 0.005 per cent did not record any significant reduction in the population of *S. hemisphaerica* the population ranging from 18.44 to 22.96 per cent.

On the fifth day, all the treatments reduced the population of the scale insect significantly when compared to control (30.45). The population of *S. hemisphaerica* recorded in plants sprayed with azadirachtin 0.004 per cent, neem oil-garlic 2 per cent, neem oil 2 per cent, illipe oil 2 per cent and quinalphos

Table 19. Effect of botanical and chemical insecticides on *S. hemisphaerica* in coccinia after spraying .

Treatment	Mean number of scale insects per 10 cm length of vine at different intervals									
	Days after first spray					Days after second spray				
	1	3	5	7	15	1	3	5	7	15
Azadirachtin 0.004 %	24.56	22.96	20.48	20.50	22.14	22.06	20.70	18.96	21.00	22.81
Neem oil + garlic 2 %	22.66	22.11	20.82	20.19	20.45	22.40	21.53	20.73	19.17	22.07
Neem oil 2%	21.07	20.70	21.70	19.96	20.15	22.90	21.54	20.70	19.87	21.03
Illipe oil 2 %	19.41	18.44	19.30	18.19	17.48	24.60	20.15	20.39	20.04	22.35
Imidacloprid 0.005 %	16.89	13.93	10.70	5.33	3.81	17.45	13.95	10.37	4.85	3.12
Quinalphos 0.05 %	23.56	18.63	17.55	11.52	9.26	14.15	11.19	10.56	12.02	14.24
Malathion 0.1 %	13.41	8.63	7.11	9.18	11.89	15.30	13.33	8.85	10.22	13.11
Dimethoate 0.05 %	15.37	11.30	9.30	11.04	13.74	18.59	15.38	15.70	17.17	19.98
Control	29.41	27.56	30.45	32.59	34.11	21.11	21.37	22.81	23.89	27.00
CD(0.05)	7.728	9.229	3.909	10.464	9.192	-	7.177	6.830	5.326	5.567

0.05 per cent was 20.48, 20.82, 21.70, 19.30 and 17.55,respectively and were on par. The lowest population of *S. hemisphaerica* was recorded in malathion 0.1 per cent (7.11) treated plants, followed by dimethoate 0.05 per cent (9.30) and imidacloprid 0.005 per cent (10.70).

On the seventh day after spraying, all the treatments were significantly superior to the control (32.59) in reducing the population of the pest. The least population of *S. hemisphaerica* was seen on imidacloprid treated plants (5.33) which was on par with malathion 0.1 per cent (9.18), dimethoate 0.05 per cent (11.04) and quinalphos 0.05 per cent (11.52). The treatments with chemical insecticides recorded significantly lower population than the treatments with botanicals. The population observed in azadirachtin 0.004 per cent, neem oil-garlic 2 per cent, neem oil 2 per cent and illipe oil 2 per cent was 20.50, 20.19, 19.96 and 18.19,respectively.

The population reduction observed at fifteen days after spraying showed the same trend as that of fifth and seventh day when compared to control. Imidacloprid 0.005 per cent which recorded the lowest population (3.81) showed statistically the same effect in the population reduction of *S. hemisphaerica* as that of quinalphos 0.05 per cent (9.26) and malathion 0.1 per cent (11.89). Compared to other chemical insecticides, significantly higher population (13.74) was recorded in dimethoate 0.05 per cent sprayed plants and was on par with azadirachtin 0.004 per cent (22.14), neem oil – garlic 2 per cent (20.45), neem oil 2 per cent (20.15) and illipe oil 2 per cent (17.48).

After second spraying

One day after second spraying, there was no significant difference in the population of *S. hemisphaerica* in the treated and untreated plants. On the third day after spraying, quinalphos 0.05 per cent (11.19), malathion 0.1 per cent (13.33) and imidacloprid 0.005 per cent (13.95) suppressed the population of *S. hemisphaerica* significantly. No significant difference was observed in the population of *S. hemisphaerica* when treated with the plant products *viz.*, azadirachtin 0.004 per cent (20.70), neem oil-garlic 2 per cent (21.53), neem oil 2

per cent (21.54) and illipe oil 2 per cent (20.15) and dimethoate 0.05 per cent (15.38) when compared to the control.

The population observed from treatment with botanicals ranged from 18.96 to 20.73 on the fifth day after spraying. Malathion 0.1 per cent (8.85), imidacloprid 0.005 per cent (10.37), quinalphos 0.05 per cent (10.56) and dimethoate 0.05 per cent (15.70) reduced the population of *S. hemisphaerica* significantly when compared with botanicals and control (22.81).

On the seventh day after spraying, malathion 0.1 per cent, quinalphos 0.05 per cent and dimethoate 0.05 per cent recorded significantly lower population than the control (23.89), the population being 10.22, 12.02 and 17.17, respectively. The botanicals *viz.*, neem oil-garlic 2 per cent, neem oil 2 per cent, illipe oil 2 per cent and azadirachtin 0.004 per cent recorded similar population as that of control and the population ranged from 19.17 to 21.00. Imidacloprid 0.005 per cent recorded the lowest population of *S. hemisphaerica* (4.85) among the treatments and was the superior among all other treatments.

Superiority of imidacloprid in reducing the population of *S. hemisphaerica* continued even on the fifteenth day, the population observed was 3.12. Malathion 0.1 per cent (13.11), quinalphos 0.05 per cent (14.24), dimethoate 0.05 per cent (19.98) and neem oil 2 per cent (21.03) recorded significantly lower population compared to the control (27.00). Neem oil-garlic 2 per cent (22.07), illipe oil 2 per cent (22.35) and azadirachtin 0.004 per cent (22.81) had the same effect.

4.6.1.2 A. spiraecola

The population of *A. spiraecola* estimated as number of aphids per 10 cm length of vine at different intervals after treatment is given in the Table 20.

Table 20. Effect of botanicals and chemical insecticides on *A. spiraecola* in coccinia after spraying

Treatment	Mean number of aphids per 10 cm length of vine at different intervals									
	Days after first spray					Days after second spray				
	1	3	5	7	15	1	3	5	7	15
Azadirachtin 0.004 %	34.40	15.03	8.83	6.77	10.93	30.81	14.86	6.74	4.28	6.48
Neem oil + garlic 2 %	57.07	29.77	14.03	9.57	10.30	45.59	30.76	17.56	12.93	15.07
Neem oil 2%	54.00	34.20	22.47	14.54	15.55	46.34	35.12	13.43	11.91	15.26
Illipe oil 2 %	53.20	24.33	15.03	7.44	11.66	68.47	36.74	20.01	12.93	18.57
Imidacloprid 0.005 %	28.17	6.47	0.43	0.97	2.41	53.44	22.59	2.63	3.07	8.85
Quinalphos 0.05 %	36.13	20.23	9.30	8.06	8.43	35.26	16.74	6.08	5.52	6.52
Malathion 0.1 %	81.67	34.47	9.50	7.64	8.00	67.67	7.67	6.63	7.41	8.94
Dimethoate 0.05 %	76.73	25.4	18.80	12.63	13.49	67.69	38.66	22.80	20.48	21.56
Control	50.90	50.03	66.40	62.77	74.34	62.42	66.32	74.70	72.47	61.28
CD(0.05)	-	19.100	11.768	7.441	6.366	-	21.258	15.039	12.486	20.963

After first spraying

There was no significant reduction in the population of *A. spiraecola* in the various treatments on the first day after spraying. Three days after spraying, all the treatments were superior to control in reducing the population of *A. spiraecola,* excepting neem oil 2 per cent (34.20) and malathion 0.1 per cent (34.47). The population of *A. spiraecola* in the treatments *viz.,* azadirachtin 0.004 per cent (15.03), quinalphos 0.05 per cent (20.23),illipe oil 2 per cent (24.33) and dimethoate 0.05 per cent (25.40) gave statistically the same effect as that of imidacloprid 0.005 per cent (6.47) .

On the fifth day after spraying, all the treatments significantly reduced the population of *A. spiraecola* when compared to control (66.40). Among the treatments, imidacloprid showed significantly lower population (0.43) which was on par with population recorded in azadirachtin 0.004 per cent (8.83), quinalphos 0.05 per cent (9.34) and malathion 0.1 per cent (9.50). Treatments with neem oil – garlic 2 per cent, illipe oil 2 per cent, dimethoate 0.05 per cent and neem oil 2 per cent were comparatively less effective to the aphid and the population recorded in the treatments being 14.03, 15.03, 18.8 and 22.47, respectively.

Seven days after spraying, imidacloprid 0.005 per cent, azadirachtin 0.004 per cent, illipe oil 2 per cent, malathion 0.1 per cent, quinalphos 0.05 per cent, neem oil – garlic 2 per cent, dimethoate 0.05 per cent and neem oil 2 per cent reduced *A. spiraecola* population significantly when compared to control (62.77), the population being 0.97, 6.77, 7.44, 7.64, 8.06, 9.57 and 14.54, respectively.

Imidacloprid 0.005 per cent, malathion 0.1 per cent, quinalphos 0.05 per cent, neem oil – garlic 2 per cent, azadirachtin 0.004 per cent, illipe oil 2 per cent, dimethoate 0.05 per cent and neem oil 2 per cent significantly suppressed the *A. spiraecola* count as against control, the population range being 2.41 to 15.55 at fifteen days after spraying. Imidacloprid, malathion and quinalphos were on par whereas neem oil- garlic, azadirachtin, illipe oil, dimethoate and neem oil showed significantly higher population and produced similar effect.

After second spraying

None of the treatments recorded significant reduction in the population of *A. spiraecola* when compared to control one day after spraying. On the third day after spraying, all the treatments were superior to control (66.32) in suppressing the population of *A. spiraecola.* Malathion 0.1 per cent showed the lowest population (7.67) followed by azadirachtin 0.004 per cent (14.86), quinalphos 0.05 per cent (16.74), imidacloprid 0.005 per cent (22.59), neem oil – garlic 2 per cent (30.76), neem oil 2 per cent (35.12), illipe oil 2 per cent (36.74) and dimethoate 0.05 per cent (38.66). Malathion, azadirachtin, quinalphos and imidacloprid were found to be similar in producing the toxic effect.

On the fifth day after spraying, imidacloprid 0.005 per cent (2.63), quinalphos 0.05 per cent (6.08), malathion 0.1 per cent (6.63), azadirachtin 0.004 per cent (6.74), neem oil 2 per cent (13.43), neem oil-garlic 2 per cent (17.56), illipe oil 2 per cent (20.01) and dimethoate 0.05 per cent (22.8) reduced the pest population when compared to control (74.70). Statistically the same effect was exhibited by imidacloprid, quinalphos, malathion, azadirachtin, neem oil, neem oil- garlic, illipe oil and dimethoate.

On the seventh day after treatment, all the treatments were found to be superior to control (72.47). All the treatments except dimethoate 0.05 per cent (20.48) were on par, the population ranging from 3.07 to 12.93.

On the fifteenth day after spraying, all the treatments significantly reduced the population of pests compared to control (61.28) and the treatments were found to be statistically similar in producing toxic effect, the population ranged from 6.52 to 21.56.

4.4.3 Effect of botanicals and chemical insecticides on the extent of damage caused by pests of coccinia

4.4.3.1 B. cucurbitae

The effect of botanicals and chemical insecticides on the damage caused by *B. cucurbitae* on the fruits is presented in Table 21.

Table 21. Effect of botanicals and chemical insecticides on the extent of damage caused by various pests in coccinia after spraying (%).

Treatment	Fifteen days after first and second application					
	Fruits damaged by *B. cucurbitae*		Leaves damaged by			
			H. vigintioctopunctata		*Aulacophora* spp.	
	1	2	1	2	1	2
Azadirachtin 0.004 %	60.00	55.56	57.78	63.34	45.56	52.22
Neem oil + garlic2 %	58.89	57.78	51.11	47.78	50.00	48.89
Neem oil 2%	64.45	65.56	52.22	50.00	46.67	54.45
Illipe oil 2 %	58.89	60.00	47.78	48.89	43.33	48.89
Imidacloprid 0.005 %	24.45	35.56	25.56	25.56	33.33	28.89
Quinalphos 0.05 %	46.67	38.89	31.11	35.56	52.22	44.44
Malathion 0.1 %	57.78	47.78	37.78	34.44	47.78	57.78
Dimethoate 0.05 %	53.33	53.33	42.22	42.22	36.67	40.00
Control	75.56	80.00	76.67	84.44	70.00	78.89
CD (0.05)	14.313	16.790	14.578	17.819	16.144	10.747

1 – After first spray

2 – After second spray

After first spraying

All the treatments except neem oil 2 per cent (64.45) significantly suppressed the damage caused by the pest on fifteenth day after spraying when compared to control (75.56). Imidacloprid 0.005 per cent (24.45) was the most effective among the treatments. Quinalphos 0.05 per cent, dimethoate 0.05, malathion 0.1 per cent, illipe oil 2 per cent, neem oil-garlic 2 per cent and azadirachtin 0.004 per cent showed no significant difference in their effect on the reduction in the damage and the percentage of damage were 46.67, 53.33, 57.78, 58.89, 58.89 and 60, respectively.

After second spraying.

Fifteen days after the second spraying, imidacloprid 0.005 per cent, quinalphos 0.05 per cent, malathion 0.1 per cent, dimethoate 0.05 per cent, neem oil 2 per cent, neem oil-garlic 2 per cent and illipe oil 2 per cent were found to be effective when compared to control (80.00) and the percentage of damage ranged from 35.56 to 60. Imidacloprid 0.005 per cent, quinalphos 0.05 per cent and malathion 0.1 per cent showed significant reduction in the damage caused by *B. cucurbitae*. There was no significant reduction in the percentage of damage by *B. cucurbitae* when azadirachtin 0.004 per cent (65.56) was sprayed.

4.4.2.2 H. vigintioctopunctata

The data regarding the percentage of damage caused by *H. vigintioctopunctata* on the leaves is depicted in Table 21.

After first spraying

When compared with control (76.67), imidacloprid 0.005 per cent, quinalphos 0.05 per cent, malathion 0.1 per cent, dimethoate 0.05 per cent, illipe oil 2 per cent, neem oil-garlic 2 per cent, neem oil 2 per cent, and azadirachtin 0.004 per cent were found to be significantly effective in controlling the damage by *H. vigintioctopunctata*. The extent of damage was only 25.56, 31.11, 37.78, 42.22, 47.78, 51.11, 52.22 and 57.78 per cent in the treatments, respectively at fifteen days after spraying. Imidacloprid 0.005 per cent was the best treatment in

reducing the leaf infestation and this treatment was statistically similar to quinalphos 0.05 per cent and malathion 0.1 per cent.

After second spraying

The same trend was observed when a comparison was made with control (84.44) as that of the first spray. Maximum reduction in the extent of damage by *H. vigintioctopunctata* was obtained with imidacloprid 0.005 per cent (25.56) which recorded same effect as that of malathion 0.1 per cent (37.78), quinalphos 0.05 per cent (31.11) and dimethoate 0.05 per cent (42.22). The treatments *viz.*, neem oil-garlic 2 per cent (47.78), illipe oil 2 per cent (48.89), neem oil 2 per cent (50) and azadirachtin 0.004 per cent (63.34) were also found equally effective in controlling the damage by *H. vigintioctopunctata.*

4.4.2.3 Aulacophora spp.

The percentage of damage caused by *Aulacophora* spp. on the leaves is given in Table 21.

After first spraying

All the treatments were found to be significantly effective in reducing the damage by *Aulacophora* spp. fifteen days after spraying as against control (70.00). Dimethoate 0.05 per cent (36.67), illipe oil 2 per cent (43.33), azadirachtin 0.004 per cent (45.56), neem oil 2 per cent (46.67) and malathion 0.1 per cent (47.78) were statistically similar to imidacloprid 0.005 per cent (33.33) whereas neem oil-garlic 2 per cent (50.00) and quinalphos 0.05 per cent (52.22) recorded higher damage compared to the above treatments.

After second spraying

The same trend was observed as that of the first spray, fifteen days after spraying. The highest reduction in the infestation by *Aulacophora* spp. was observed in plants treated with imidacloprid 0.005 per cent (28.89) which was significantly superior to control (78.89). Dimethoate 0.05 per cent, quinalphos 0.05 per cent, neem oil – garlic 2 per cent, illipe oil 2 per cent, azadirachtin 0.004 per cent, neem oil 2 per cent and malathion 0.1 per cent too recorded significant

reduction in the damage compared to the control (78.89) and the leaf damage ranged from 40.00 to 57.78 per cent, respectively.

4.4.3 Effect of botanicals and chemical insecticides on the spiders

The effect of different botanicals and chemical insecticides on spiders is presented in Table 22.

After first spraying

None of the treatments recorded any significant suppression in the population of spiders observed on the first, third, fifth, seventh and fifteenth day after spraying.

After second spraying

There was significant difference in the population of spiders on the first day, when a comparison was made among the various treatments. Illipe oil 2 per cent, azadirachtin 0.004 per cent, quinalphos 0.05 per cent and malathion 0.1 per cent recorded significantly lower population when compared to control (3.28) and the population of spiders in the treatment ranged from 0.91 to 1.64. Imidacloprid 0.005 per cent (2.00), dimethoate 0.05 per cent (2.00) and neem oil –garlic 2 per cent (2.32) and neem oil 2 per cent (3.97) recorded the same effect as that of control. There was no significant difference in the population of spiders on third, fifth, seventh and fifteenth day, when different treatments were compared.

Table 22 . Effect of botanicals and chemical insecticides on spiders in coccinia after spraying.

Treatment	Mean number of spiders per plant observed at different intervals									
	Days after first spray					Days after second spray				
	1	3	5	7	15	1	3	5	7	15
Azadirachtin 0.004 %	1.64 (1.63)	1.94 (1.72)	2.96 (1.99)	3.65 2.16)	4.32 (2.31)	1.49 (1.58)	2.85 (1.96)	2.96 (1.99)	3.65 (2.16)	4.00 (2.24)
Neem oil+garlic2 %	0.91 (1.38)	2.61 (1.90)	2.96 (1.99)	3.32 (2.08)	3.97 (2.23)	2.32 (1.82)	2.65 (1.91)	2.65 (1.91)	2.32 (1.82)	2.96 (1.99)
Neem oil 2%	2.32 (1.82)	2.32 (1.82)	2.32 (1.82)	2.22 (1.79)	3.65 (2.16)	3.97 (2.23)	3.00 (2.00)	2.22 (1.79)	3.25 (2.06)	3.25 (2.06)
Illipe oil 2 %	1.31 (1.52)	1.94) (1.72)	1.49 (1.58)	2.65 (1.91)	2.96 (1.99)	0.91 (1.38)	2.32 (1.82)	2.65 (1.91)	2.48 (1.87)	4.59 (3.37)
Imidacloprid 0.005 %	0.55 (1.24)	1.00 (1.41)	2.32 (1.82)	1.94 (1.72)	2.65 (1.91)	2.00 (1.73)	1.31 (1.52)	1.31 (1.52)	1.64 (1.63)	2.55 (1.88)
Quinalphos 0.05 %	1.31 (1.52)	2.00 (1.73)	1.59 (1.61)	2.32 (1.82)	3.28 (2.07)	1.64 (1.63)	2.32 (1.82)	1.94 (1.72)	1.94 (1.72)	3.32 (2.08)
Malathion 0.1 %	1.31 (1.52)	1.94 (1.72)	2.32 (1.82)	2.96 (1.99)	3.00 (2.00)	1.64 (1.63)	1.59 (1.61)	2.65 (1.91)	2.55 (1.88)	3.58 (2.14)
Dimethoate 0.05 %	1.31 (1.52)	2.32 (1.82)	2.32 (1.82)	1.94 (1.72)	3.65 (2.16)	2.00 (1.73)	2.65 (1.91)	2.65 (1.91)	2.32 (1.82)	3.32 (2.08)
Control	1.78 (1.67)	2.55 (1.88)	1.94 (1.72)	2.96 (1.99)	2.96 (1.99)	3.28 (2.07)	1.59 (1.61)	3.97 (2.23)	2.22 (1.79)	3.00 (2.00)
CD(0.05)	-	-	-	-	-	0.321	-	-	-	-

DISCUSSION

5. DISCUSSION

Of late, the underexploited tropical vegetable, coccinia has attained the status of a commercial crop in Kerala. Among other constraints, pests are a major limiting factor for its production in the state. Though the plant yields for three to four years, the crop is often destroyed after one to one and a half years of growth on account of the ravages of pests. Due to lack of adequate management strategies farmers are using various types of contact insecticides especially synthetic pyrethroids to control the pests without considering the type of pests, their mode of feeding or severity of damage. This type of unscientific control measures aggravate the pest situation in the field, resulting in complete destruction of the crop.

The present investigation was taken up to find out the pests attacking coccinia and their nature and extent of damage, distribution around the year, the relationship between magnitude of the pests with weather parameters and to explore the possibility of managing the pests with commonly available botanicals and chemical insecticides. The results of the study are discussed below.

5.1 OCCURRENCE AND DISTRIBUTION OF THE PESTS

The periodic survey conducted in ten locations of Kalliyoor panchayat in Thiruvananthapuram district revealed that coccinia was infested by four major pests, *viz., S. hemisphaerica, A. spiraecola, B. cucurbitae and L. cephalandrae* and ten minor pests *L. australis, A. obscurus, A. dispersus, H. vigintioctopunctata, A. foveicollis, A. impressa, A. bicolor, D. indica, A. saltator* and *Tetranychus* sp. Very low population of *F. virgata, N. viridula* and *P. ricini* were seen in some of the locations (Table 1). So far no reports from Kerala indicated such a large number of pests damaging coccinia. The only reports available are on mild infestation of *B. cucurbitae, L. cephalandrae* and *F. virgata* (KAU, 2002; Sibyvarghese, 2003 and Suresh, 2004).

The incidence of the pests in different locations varied considerably. While *A. spiraecola, B. cucurbitae, H. vigintioctopunctata, Aulacophora* spp., *D. indica, Tetranychus* sp. were observed in all the locations, *S. hemisphaerica, L. cephalandrae* and *A. obscurus* were recorded from eight, six and five locations respectively. *L. australis* and *A. dispersus* prevailed in four locations. *A. saltator* was noted only at three locations.

Pest incidence depends mainly on the availability of inoculum for fresh infestation either from the neighbouring host or related crops. Continuous or fresh cultivation of the crop in a particular location might have accounted for the variation observed in the incidence of a pest.

With the exception of *A. dispersus* and *Tetranychus* sp., all the major and minor pests were observed throughout the year. Incidence of both *A. dispersus* and *Tetranychus* sp. occurred only in the summer season, conforming to similar observations made by Palaniswami *et al.* (1995).

Major pests of coccinia

S. hemisphaerica

Among the pests of coccinia, *S. hemisphaerica* was found to be the most important. Infestation of the pest commenced with the onset of maturation of the vine and spread gradually to all the parts of the plant including the fruits (Plate 1). Subsequent to infestation, the pest persisted on the plant, multiplying enormously. Desapping by a large number of scale insects from the plant caused yellowing, deformation of infested parts, reduction in fruit set, loss of vigour, branch dieback and ultimately death of the plant. The result agrees with the observations of Beardsley and Gonsalez (1925), Metcalf and Flint (1939), Dekle (1965) and Valand *et al.* (1989) in other vegetables. Though the occurrence of *S. hemisphaerica* on coccinia was reported by a few workers (Nayar *et al.*, 2001; David, 2002) and no report is currently available on its mode of feeding, severity of attack or distribution.

A definite trend was observed in the population dynamics of the pest. The population was low during July to September 2005, later it increased to a significant level during October 2005 to January 2006. Thereafter, a sudden increase in the population was recorded from February 2006 to May 2006 and again a decline in June 2006.

The population observed in rainy and summer seasons clearly showed variation. An increase in the population was recorded during summer (Fig. 5). The finding was supported by the highly significant positive correlation of the population of *S. hemisphaerica* with maximum temperature and significant negative correlation with rain fall (Table 17). The clear cut population fluctuation observed might be due to shorter life cycle and comparatively higher survival rate during summer and wash off of crawlers in rain.

Variation in the population of *S. hemisphaerica* was noticed in different locations (Table 2). Higher population was noted in locations selected from Instructional Farm, Vellayani than in the locations surveyed from farmers' field. The difference in the population dynamics was mainly due to the variation in the plant protection measures adopted in these locations.

An assessment of the plants completely destroyed due to scale infestation at the eight locations was made two months after the period of survey. In all the locations complete destruction of the plants was observed at varying levels (Fig. 1). While the plants in the first, second and fourth locations at the Instructional Farm, Vellayani were completely destroyed, only 30 per cent plants were completely destroyed in the third location. The percentage of plants completely destroyed by the pest was comparatively low in farmers' field and ranged from 4 to 15. It is evident from the results that if infestation of scale insect is left unchecked, it will lead to complete destruction of the plant/ field within a short period.

The commonly recommended botanicals and chemical insecticides for the control of pests of vegetables when evaluated for their efficacy in controlling the scale insect revealed that botanicals failed to control the pest whereas chemical

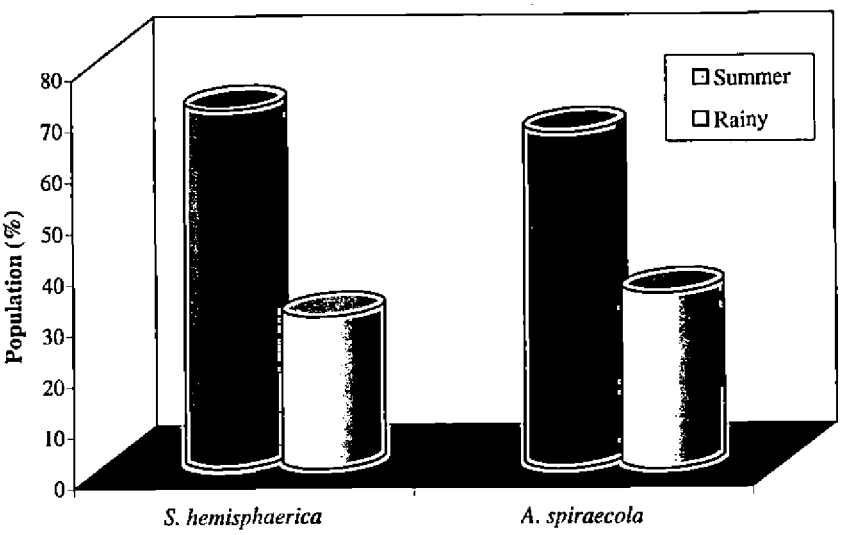


Fig. 5. Seasonal variation in the population of major sucking pests in coccinia

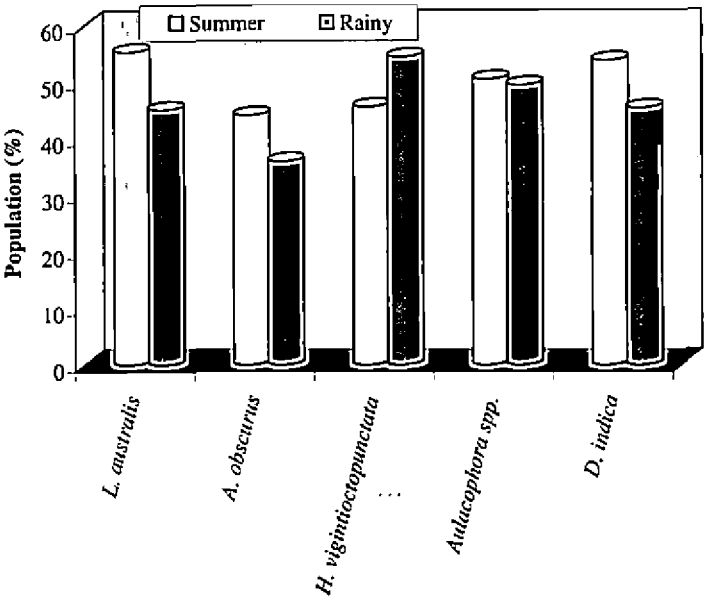


Fig. 6. Seasonal variation in the population of minor pests in coccinia

insecticides protected the crop up to fifteen days. Imidacloprid 0.005 per cent extended protection for 60 days (Fig. 8). The long lasting effect of imidacloprid on scale insect obtained in the present study was supported by the findings of Irulandi *et al.* (2000) and Rebek and Saief (2003).

A. spiraecola

Another major pest of coccinia observed in the study was *A. spiraecola.* The aphid attacked the tender portions of the plant resulting in growth retardation. Colonies of the pest were also seen on the flowers and fruits, arresting the fruit formation and resulting in huge yield reduction. Similar damage caused by related species of the aphid has been reported on other cucurbitaceous crops (Chinta *et al.,* 2002 and Brown, 2003). Eventhough *A. spiraecola* attained the status of a major pest in the present study; the pest has not been reported from the crop so far.

Population of *A. spiraecola* was high during December 2005 to May 2006. Comparison of the population in summer and rainy period showed a two fold increase in summer (Fig. 5). The variation in the population during the two seasons might probably be due to the shorter life cycle and increased fecundity in summer and longer developmental period and wash off of various stages during the rainy season. A positive correlation of the population build up of *A. spiraecola* with maximum temperature and negative effect with rainfall was also observed. The results were in agreement with the observations of Prasad and Logisenan (1997).

As in the case of scale insect comparatively lower population was recorded in all the locations in the farmers' field. The type of insecticides used and the frequency of application might have accounted for the variation in the population observed. Both botanicals and chemical insecticides were effective in controlling *A. spiraecola.*

While the botanical and chemical insecticides viz., malathion, quinalphos and dimethoate effectively reduced the population of the pest up to 15 days,

imidacloprid afforded longer protection which lasted for 45 days after spraying (Fig. 9). The result obtained in the study corroborates with the findings of various workers on aphids in other crops. The population of aphid was managed with Neem Azal (Chandrasekaran, 2001), neem oil-garlic emulsion (Sivakumar, 2001), neem oil (Regunath and Gokulapalan, 1999), illipe oil (Venkatarami Reddy *et al.*, 2002), imidacloprid (Patil *et al.*, 2002), quinalphos (Mandal *et al.*, 2000), dimethoate (Regupathy *et al.*, 2003) and malathion (Chauhan *et al.*, 1988). The superiority of imidacloprid in controlling the aphids was supported by Misra (2002) and MichaelRaj and Punnaiah (2003). Since aphids are soft bodied insects without any protective covering on the body, botanicals too were found effective in controlling the pest, besides the chemical insecticides.

B. cucurbitae

B. cucurbitae which attacked the fruits of coccinia was also identified as a major pest of coccinia. Different species of *Bactrocera* have been reported either as major (Kapoor, 1993) or minor (KAU, 2002 and Suresh, 2004) pests of coccinia. Ever since the cultivation of coccinia was intensified in Kerala, *B. cucurbitae* became a very important pest of the crop and the severity of the pest infestation has been well documented recently by Jiji *et al.* (2006). Contradictory results are also available on the preference of *B. cucurbitae* to coccinia among other cucurbits. While coccinia was observed to be the most preferred host of B. cuccurbitae by Patel and Patel (1998), was recorded as a less preferred host by Choubey and Yadav (2000) and Vidya (2005).

The extent of damage caused by *B. cucurbitae* ranged from 1.96 to 21.66 per cent during the period of observation (Table 9). As in the case of the other major sucking pests of coccinia, the season wise damage (Fig. 7) was more pronounced in summer (62.88 per cent) than in rainy season (37.12 per cent). Strong positive correlation was observed between percentage damage and maximum temperature and significant negative correlation with rainfall. The key determinants of fruit fly abundance are host availability, temperature and relative humidity (Shukla and Prasad, 1985).

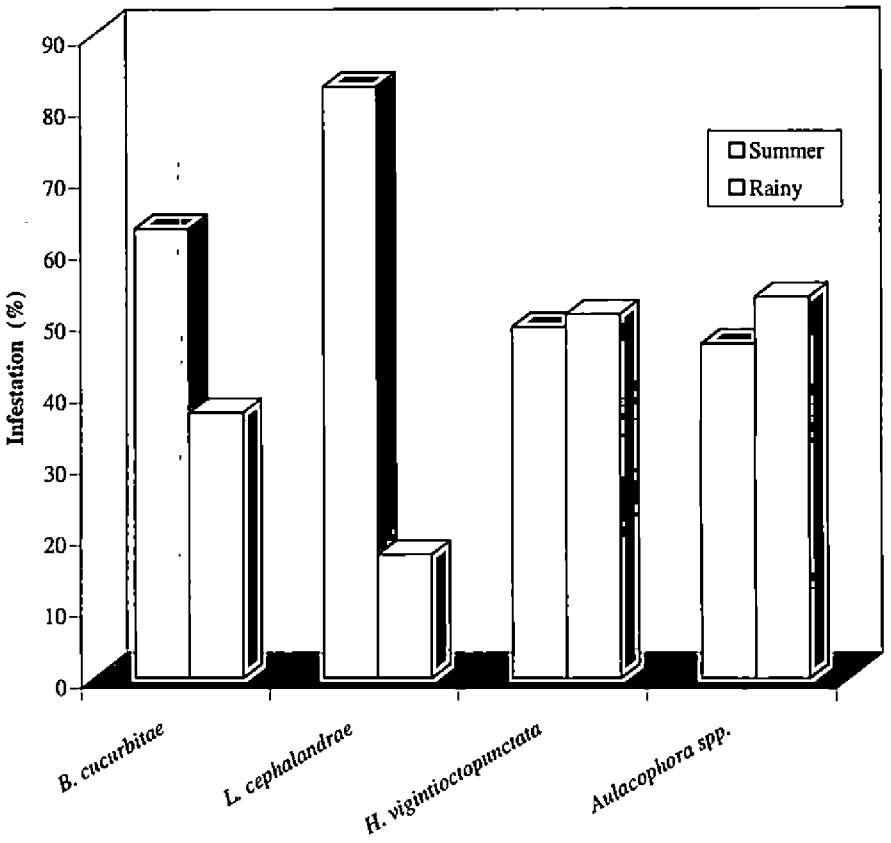


Fig. 7. Seasonal variation in the damage caused by various pests of coccinia

Significant variation in the damage caused by *B. cucurbitae* was observed in various locations, the extent of damage ranging from 6.24 to 29.14 per cent. Higher damage was noticed in three locations in the Instructional Farm and one location in the farmers' field (Table 9). In this context, it is to be observed that location wise variation in the attack of *B. cucurbitae* may be due to the continuous cultivation of the crop in an area and / or failure in destruction of pests in the previous crop residues which acted as the inoculum of fresh cultivation. Fruit fly caused 24 to 43 per cent damage (Choubey and Yadav, 2000).

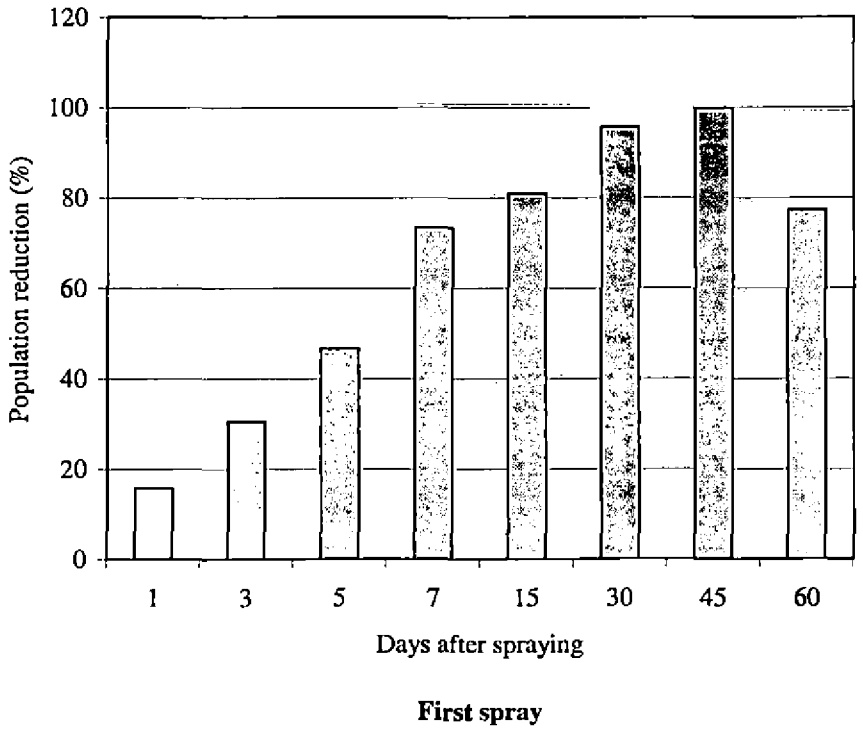
Data generated in the present study revealed that chemical insecticides reduced the damage by fruit flies from 42 to 76 per cent, imidacloprid being the most effective insecticide. With the exception of neem oil 2 per cent all the other botanicals too reduced fruit fly damage, the extent of reduction ranging from 40 to 44 per cent (Table 21). Toxic effect of malathion 0.5 per cent (Kosaraju, 1982) to fruit fly was reported earlier. A few reports showed the antifeedant and hormonal effects of neem products on fruit flies (Sivendrasingh, 2003).

L. cephalandrae

Feeding of *L. cephalandrae* caused the formation of galls on the stem of coccinia and gave a deformed shape to petioles and even tendrils. The observations are in line with the findings of Mani (1973) and Nayar *et al.* (2001). Further growth of the vine was arrested beyond the point of attack.

The distribution of *L. cephalandrae* over a period of one year clearly indicated five fold increase in the infestation in summer than rainy season (Fig. 7). The observation was supported by the strong positive relationship between maximum temperature and intensity of damage and a negative relationship between rainfall and damage intensity. The botanicals and chemical insecticides tested were ineffective against the pest.

An interesting phenomenon observed in the present investigation was that the galls formed consequent to the attack of *L.cephalandrae* also served as a site for multiplication of *B. cucurbitae*. The finding was in conformity with the



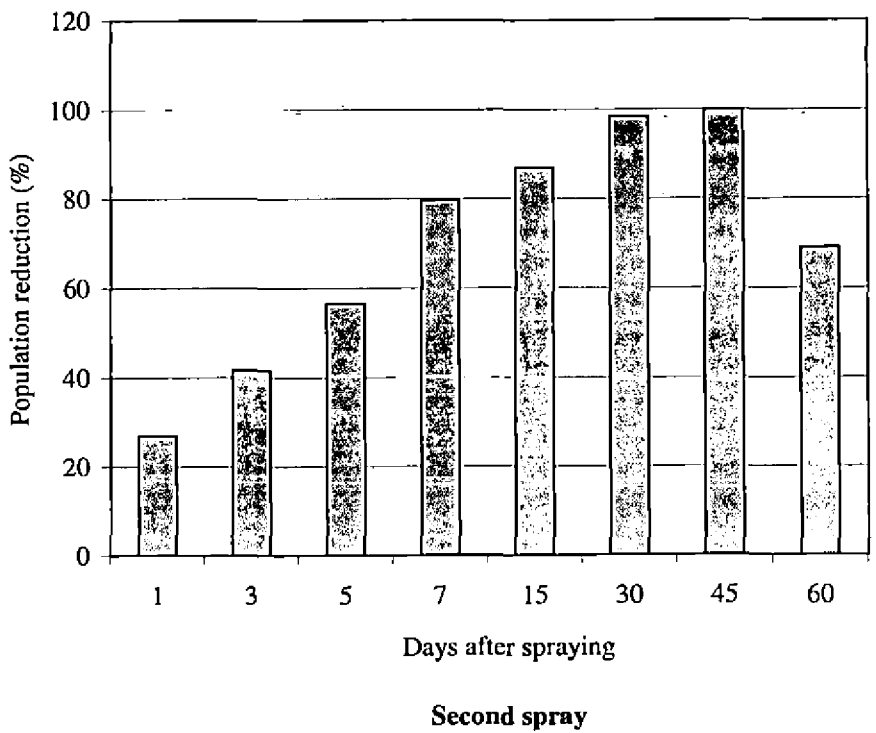


Fig. 8. Reduction in population of *S. hemisphaeraca* in coccinia after treatment with imidacloprid over precount

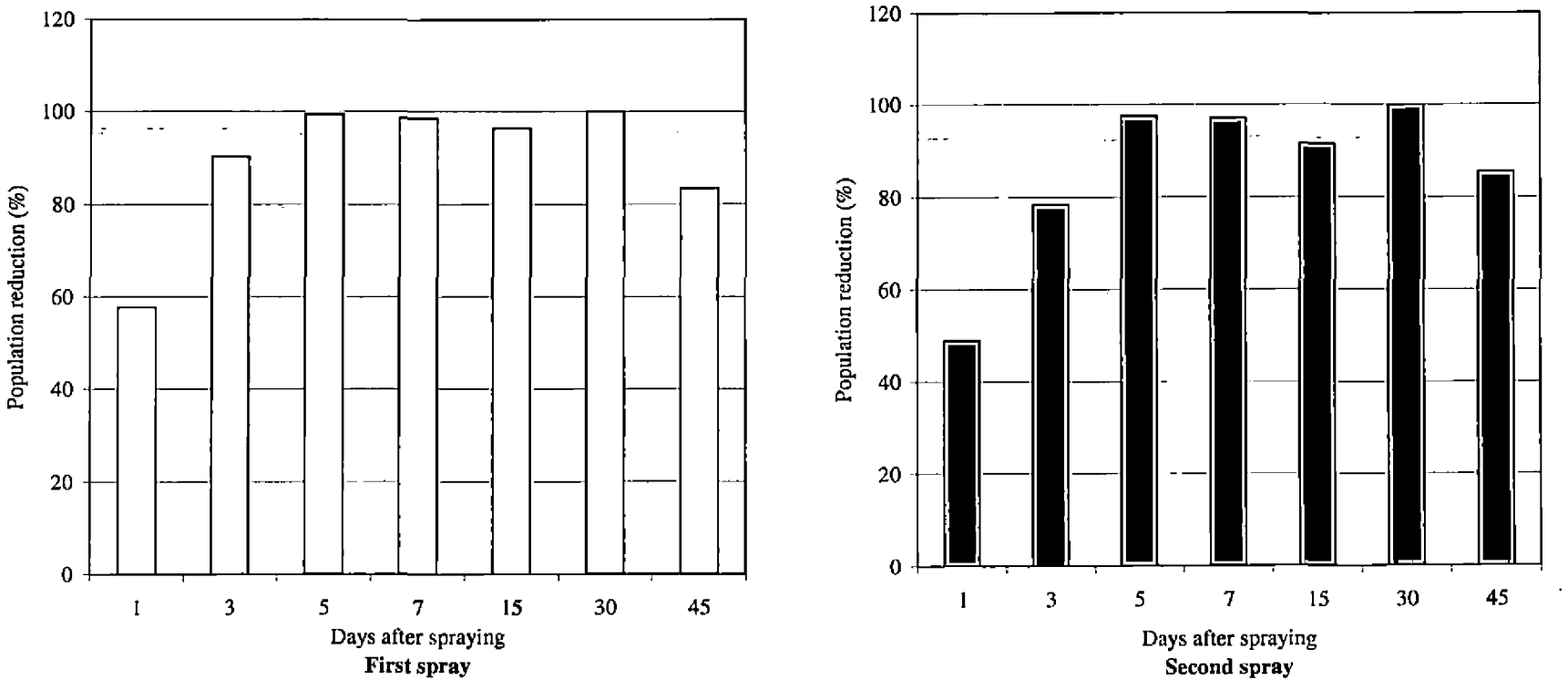


Fig. 9. Reduction in population of *A. spiraecola* in coccinia after treatment with imidacloprid over precount

observations of Bhatia and Mahto (1968) and Dharmaraju and Edwin (1968). Detailed study on the extent of development of fruit flies in fruits and galls of coccinia showed that 80.00 per cent of the fruits and 30.00 per cent of the galls collected from the field were infested with *B. cucurbitae* (Fig. 3). However, the mean number of *B. cucurbitae* that *emerged* from a single fruit (8.33) and a gall (8.00) was on par (Fig. 4). Thus, the results indicated that the fruit fly could multiply in large numbers even in the absence of fruits. The tendency of the pest to oviposit in the galls might probably be due to its inability to discriminate between the succulent galls and the fleshy fruits.

Minor pests of coccinia

Sucking pests

The sucking pests found infesting coccinia at a moderate level included *L. australis, A. obscurus, A. dispersus* and *Tetranychus sp.* Mild attack of *F. virgata* and *N. viridula* was also noticed. *L. australis, Tetranychus* sp. and *N. viridula* as pests of coccinia are being reported for the first time.

Nymphs and adults of *L. australis* sucked sap from the tender vines and fruits, resulting in the formation of thickened areas on the vines and thickened spots on the fruits (Plate 3). Similar damage by the pest was reported from other cucurbits (Regupathy *et al.*, 2003). Only very low population of the pest was recorded from the four locations in the Instructional Farm throughout the year (Table 4). The population was significantly and positively correlated with maximum temperature.

Sucking of sap from the vines by the nymphs and adults of *A. obscurus* resulted in general weakening of the plants. Similar damage by the pest was reported from other cucurbits (Regupathy *et al.*, 2003). The population percentage noticed in summer and rainy period was 55.10 and 44.90, respectively (Fig. 6). Significant positive correlation with maximum temperature and negative correlation with rainfall between the population was observed.

The spiralling white fly was observed to be a dry season pest. The damage caused by the pest was observed only from February to June 2006 (Table 13). The occurrence of the pest in coccinia was reported earlier by Prathapan (1996) and Muralikrishna (1999). The nymphs and adults congregated on the underside of the leaves and feeding of the pest resulted in yellowish discolouration of the leaves. Damage by the pest observed in coccinia paralleled with the reports of Rani (2004) from other crops. High temperature favoured the multiplication of the pest and high rainfall suppressed the infestation.

The only non insect pest observed in the field was *Tetranychus* sp. The mite was seen during summer at all the locations. The damage to the leaves was high and went even up to 27.62 per cent (Table 14).

N. viridula and *F. virgata* sucked sap from tender parts of the plant and fruits. Though earlier reports indicated the occurrence of *F. virgata* as pest of coccinia (David, 2002 and Sibyvarghese, 2003), no reports are available on the incidence of *N. viridula* on coccinia.

Beetle pests

H. vigintioctopuntata, three species of *Aulacophora* and *A. saltator* were the coleopteran pests found attacking coccinia in the survey. *H. vigintioctopuntata, A. impressa and A. bicolor* as pests of coccinia are being reported for the first time.

As in other cucurbits, the grubs and adults of *H. vigintioctopuntata* scraped the green leaf tissues and skeletonised the leaves. Population of the pest (Fig. 6) was high during the rainy season (54.39 per cent) contrary to the abundance of all the other pests during summer. Significant negative relationship was observed only with maximum temperature and population of the pest. The plant products and chemical insecticides tested effectively reduced the leaf damage, the effect being more pronounced in chemical treatments than in botanicals (Table 21). Various workers have reported the effectiveness of neem products against the pest (VenkataramiReddy *et al.*, 1990). The efficacy of

quinalphos (Rajgopal and Trivedi, 1989), dimethoate (Regupathy *et al.*, 2003) and malathion (Jhansirani, 2001) has also been reported.

Irregular holes appeared on the leaves, flowers and fruits of coccinia due to the attack of *Aulacophora* spp. Similar observations were made by Nair (1999) in other cucurbits. The population of the pest was less during the rainy period (47.50 per cent) than in summer (52.50 per cent) (Fig. 6). No significant relationship was noticed between the weather parameters and damage caused by the pest. Though all the botanicals and chemical insecticides tested were effective in reducing the damage caused by *Aulacophora* spp., imidacloprid was found superior (Table 21). The effectiveness of neem products (Sivakumar, 2001), quinalphos (Krishnamoorthy and Krishnakumar, 2001) and dimethoate and malathion (Regupathy *et al.*, 2003) had been reported earlier.

Out of the ten locations surveyed, complete damage by *A. saltator* was observed only in three locations in the Instructional Farm wherein 4 to 12 per cent of the plants were damaged (Fig. 4). The occurrence of three species of *Apomecyna* was reported from coccinia by Nayar *et al.* (2001). David (2002) reported withering of vines by the beetle. However, complete destruction of the plants as observed in the present study has not been reported earlier.

Lepidopteran pests

The lepidopteran pests recorded in the survey were *D. indica* and *P. ricini*. *D. indica* damaged the leaves, flowers and fruits. The leaves were completely eaten by the larvae and holes were made on the fruits. Even though mild infestation of *D. indica* was recorded from all the ten locations around the year (Table 8), population of the pest was comparatively higher during the summer than the rainy season (Fig. 6). The observations were supported by the significant positive correlation with maximum temperature and negative correlation with rainfall. Only mild infestation of *P. ricini* was observed in a few locations.

5.2 NATURAL ENEMIES OF PESTS OF COCCINIA

Predators

The predators recorded in the study included spiders, a coccinellid and a syrphid (Table 15 and Plate 6). The three species of spiders observed in the survey were *O. shweta, Thomisius* sp. and *Tetragnatha* sp. The spiders were present throughout the year in all the locations. *Tetragnatha* sp. and *Oxyopes* spp. were reported from bittergourd (Nandakumar and Saradamma, 1996) and five other vegetable ecosystems (Manu and Hebsybai, 2006). The plant protection chemicals tested were safe to the spiders. The safety of neem products to spiders was reported by Manu (2005). Abundance of spiders was also unaffected by imidacloprid (Kunel *et al.*, 1999) and malathion (Mishra and Mishra, 2002).

The population of *M. sexmaculatus* and *P. serratus* observed in the survey was comparatively low. They were found feeding on *A. spiraecola* only in a few locations.

Parasitoid

The larvae of *D. indica* were found parasitized by *Apanteles* sp. Earlier workers also reported parasitism of *Apanteles* sp. on *D. indica* in coccinia (Patel and Kulkarny, 1956).

The study thus revealed that pests are a major impediment in the cultivation of the perennial vegetable, coccinia. An array of pests was recorded from the vegetable, some of which could be devastating. The persistent scale insect *S. hemisphaerica* was one such pest noted to be of potential threat to the crop. Notwithstanding , the propensity of the fruit fly to breed in the galls of *L. cephalandrae* portends a probable calamitous out break of the fly, if concomitant occurrence of the pests occur in a crop. Obviously, close monitoring of the crop and timely adoption of adequate plant protection measures are imminent to offset such a perilous situation. Though both the botanicals and chemical insecticides assayed were effective to some extent in tackling several pests, imidacloprid 0.005 per cent conferred better and longer protection, especially from the

hemipteran pests. Undoubtedly, in the absence of a sustainable management package, judicious use of the insecticides could be a thoughtful choice for protecting the crop in a crisis.

SUMMARY

6. SUMMARY

Coccinia, being an underexploited vegetable, the damage caused by various pests were neither highlighted nor adequate management strategies developed so far. The farmers are using synthetic pyrethroids regularly to control the pests without considering the type of pests. Synthetic pyrethroids are not suitable for sapsuckers or internal feeders. Thus, the pest situation in the field has aggravated day-by-day resulting in huge loss in production. The present investigation was carried out to document the pests of coccinia, their nature and extent of damage, their relationship with weather parameters for one year and to evaluate the effect of some of the commonly used botanicals and chemical insecticides for the management of the pests. The major findings are summarized below.

Analysis of the pest fauna of coccinia in the locations at monthly intervals showed that the crop was attacked by two hemipterans and two dipterans as major pests and thirteen other pests, which were of minor status.

Out of the seventeen pests documented, the incidence of *A. spiraecola, L. australis, N. viridula, H. vigintioctopunctata, A. impressa, A. bicolor* and *Tetranychus* sp. as pests of coccinia was reported for the first time.

The most severe pest observed in coccinia was *S. hemisphaerica.* It sucked sap from the plant in large numbers from mature vines and gradually spread to all parts of the plant, caused deformation of the infested parts, loss of vigour and ultimately death of the whole plant.

S. hemisphaerica was recorded from eight locations and distributed throughout the year. The infestation was more in summer than in rainy periods. Highly significant positive correlation of *S. hemisphaerica* with maximum temperature and negative correlation with rainfall was noticed.

Complete destruction of the plants by *S. hemisphaerica* in eighteen month old plants from eight locations was reported which ranged from 4 to 100 per cent.

Comparatively, chemical insecticides were more effective in suppressing the population of *S. hemisphaerica* than botanicals. Among the chemical insecticides imidacloprid 0.005 per cent gave protection for two months whereas other chemical insecticides controlled the pest only upto 15 days.

The nymphs and adults of *A. spiraecola* sucked sap from tender vines, flowers and tender fruits and resulted in growth retardation, reduction in fruit set and huge yield loss.

A. spiraecola was observed in all the locations surveyed. Two fold increase in the population was seen in summer as compared to rainy season. Higher population of aphids was recorded from the fields in the Instructional Farm than at farmers' field. Temperature and rainfall influenced the population of *A. spiraecola* significantly.

All the botanicals and chemical insecticides evaluated were found to manage the aphids effectively for fifteen days. The effect of imidacloprid on aphids lasted for forty five days.

B. cucurbitae was noticed as a major pest of coccinia. It caused a heavy loss to the fruits by the oviposition punctures made by the females and feeding the internal content of the fruits by the grubs causing damage upto 21.66 per cent.

The pest infestation was noticed in all the locations throughout the year. Higher damage was recorded in summer season. The maximum temperatue and rainfall had significant positive and negative correlation respectively with extent of damage.

Azadirachtin 0.004 per cent, neem oil-garlic 2 per cent, illipe oil 2 per cent and imidacloprid 0.005 per cent, quinalphos 0.05 per cent, malathion 0.1 per cent and dimethoate 0.05 per cent significantly reduced the extent of damage. The reduction in the damage with effective botanicals ranged 40 to 44 per cent and that with chemical insecticides ranged from 42 to 76 per cent.

L. cephalandrae was noticed as one of the major pest of coccinia. Swellings were formed on tender vines by the feeding activity of the maggots present inside. Further growth of the vines was arrested.

The infestation by *L. cephalandrae* was started in six month old plants in all the six locations and thereafter it was seen throughout the period of observation. Five fold increase in the damage was recorded in summer than in rainy season. Strong positive correlation was observed between maximum temperature and intensity of damage and negative relationship with rainfall. All the treatments evaluated were not effective for the management of the pest.

An important finding noticed in the present investigation was that the galls produced by the attack of *L. cephalandrae* served as breeding place for *B. cucurbitae*. Eighty per cent of the fruits and thirty per cent of the galls harboured fruitfly larvae. The mean number of fruitflies emerged from a fruit and a gall was 8.33 and 8.00, respectively.

H. vigintioctopunctata, A. foveicollis, A. impressa, A. bicolor and *A. saltator* were the coleopteran pests recorded from various locations. *H. vigintioctopunctata* and *Aulacophora* spp. were observed in all the location throughout the year. Location wise and seasonal variations were also noticed. *A. saltator* was seen only in three locations where complete destruction of 4 to 12 per cent plants was recorded.

The minor sucking pests found attacking coccinia was *L. australis*, *A. obscurus*, *A. dispersus*, *Tetranychus sp.*, *F. virgata* and *N. viridula*. Due to desapping activity of these pests the vigour of the plant was reduced. Among the sucking pests *A. dispersus* and *Tetranychus sp.* were observed as summer season pests. *L. australis* and *A. obscurus* were noticed throughout the year only in four and five locations respectively. *F. virgata* and *N. viridula* were seen in some of the location and only in few observations.

Two lepidopteran pests were recorded in the present study. Eventhough the caterpillars of *D. indica* was observed as a minor pest, it was seen in all the

locations throughout the year. The larvae damaged the leaves, flowers and fruits. Comparatively higher population of the larvae was observed in summer. Mild infestation of the leaves by *P. ricini* was recorded from very few locations.

The natural enemies observed in the survey were three species of spider predators, two species of insect predators and one parasitoid. Only the spiders were present throughout the year in all the locations. The treatments tried for the management of the pests of coccinia were safe to the spiders.

The results of the study clearly showed that coccinia was infested by a large number of pests, some of which were very harmful. The findings emphasized the need for assessment of the types of pests and their intensity of damage prior to the adoption of plant protection measures for effective management of the pests.

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APPENDICES

APPENDIX-1

Weather parameters recorded during June 2005 – July 2006

Months	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Number of rainy days
	Maximum	Minimum	Morning	Evening		
June 2005	29.60	22.50	91.9	75.6	242.40	17
July 2005	29.80	23.30	93.5	77.9	321.40	20
September 2005	30.18	23.09	90.1	71.1	89.50	9
October 2005	30.00	26.20	92.3	75.9	201.40	17
November 2005	30.50	23.02	91.9	71.5	180.10	22
December 2005	29.80	23.20	94.4	73.8	165.40	21
January 2006	31.04	23.00	94.9	70.06	88.90	7
February 2006	31.03	22.30	93.3	70.8	22.45	3
March 2006	32.30	22.10	92.3	65.5	0.40	1
April 2006	32.50	24.10	94.2	66.6	30.30	5
May 2006	32.90	25.10	90.5	68.3	35.00	5
June 2006	31.60	25.20	90.6	75.5	175.50	11
July 2006	31.50	26.10	90.9	75.8	123.20	7

APPENDIX - II

Population of *S. hemisphaerica* before application of treatments

Treatments	Precount	
	First spray	Second spray
Azadirachtin 0.004 per cent	26.93	22.89
Neem oil + garlic 2 per cent	24.52	24.03
Neem oil 2 per cent	22.30	24.47
Illipe oil 2 per cent	19.89	26.70
Imidacloprid 0.005 per cent	20.07	23.89
Quinalphos 0.05 per cent	25.78	16.55
Malathion 0.1 per cent	15.41	16.37
Dimethoate 0.05 per cent	15.41	22.70
Control	31.55	22.33

APPENDIX - III

Population of *A. spiraecola* before application of treatments

Treatments	Precount	
	First spray	Second spray
Azadirachtin 0.004 per cent	64.8	48.79
Neem oil + garlic 2 per cent	79.13	56.56
Neem oil 2 per cent	69.50	77.52
Illipe oil 2 per cent	78.83	124.53
Imidacloprid 0.005 per cent	66.60	104.62
Quinalphos 0.05 per cent	49.07	95.52
Malathion 0.1 per cent	90.13	112.22
Dimethoate 0.05 per cent	85.17	95.06
Control	57.63	72.29

PESTS OF COCCINIA (*Coccinia grandis* (L.)Voigt.) AND THEIR MANAGEMENT

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Abstract of the
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ABSTRACT

The occurrence, distribution and magnitude of pests of coccinia in ten locations of Kaliiyoor Panchayat in Thiruvananthapuram district were studied in a survey conducted at monthly intervals for one year. A field trial was carried out to evaluate the efficacy of various botanicals and chemical insecticides in managing the pests of the crop in the Instructional Farm, College of Agriculture, Vellayani.

The results of the survey revealed that the dominant pests in coccinia were scale insect *Saissetia hemispherica* (Targ.), aphid *Aphis spiraecola* Patch, fruit fly *Bactrocera cucurbitae* Coq. and gall fly *Lasioptera cephalandrae* Mani. The minor pests recorded were leaf footed bug *Leptoglossus australis* F., pentatomid bug *Aspongopus obscurus* F., epilachna beetle *Henosepilachna vigintioctopunctata* F., pumpkin beetles *viz.*, *Aulacophora foveicolllis* (Lucas), *Aulacophora impressa* Fabricius, *Aulacophora bicolor* Weber, vine borer *Apomecyna saltator* Fabricius leaf folder *Diaphania indica* Saunders and red spider mite *Tetranychus* sp. Very low infestation of green stink bug *Nezara viridula* Linn., mealy bug *Ferrisia virgata* (Ckll.) and woolly bear *Pericallia ricini* Fb.

The infestation of coccinia by *A. spiraecola*, *L. australis*, *N. viridula*, *H. vigintioctopunctata*, *A. bicolor*, *A. impressa* and *Tetranychus* sp. was reported for the first time.

Location wise variations in the incidence and distribution of the pest were noticed. All the major and minor pests except *A. dispersus* and *Tetranychus* sp. were observed through out the year. These pests were found only in summer season. Seasonal occurrence of the pests showed higher population and more damage in summer than rainy season. Five fold increase in the damage was caused by *L. cephalandrae* in summer.

Among the various natural enemies observed, only the spiders were seen in all the locations throughout the year.

Correlation studies revealed strong positive correlation between maximum temperature and population of the pests and extent of damage. Rainfall had significant negative relationship with both population and extent of damage.

An important finding of the present investigation was that the galls of *L. cephalandrae* served as the site for multiplication of *B. cucurbitae*. Eighty per cent of the fruits and thirty per cent of the galls showed infestation by *B. cucurbitae*. The number of fruit flies emerged from fruit and gall did not show any variation.

Evaluation of botanicals and chemical insecticides against pests and spiders revealed that botanicals were effective in controlling all the pests except *S. hemispherica* and *L. cephalandrae* and the chemical insecticides were comparatively more effective in the management of the pests other than *L. cephalandrae*. Imidacloprid offered long lasting protection of the crop from *S. hemispherica* and *A. spiraecola*. All the treatments tried were safe to spiders.

The findings of the study clearly indicated that coccinia is severely infested with two hemipteran and two dipteran pests resulting in heavy yield loss. Imidacloprid which was found to be the best treatment could be recommended for the management of the pests especially the hemipteran pests. The treatments failed to manage *L. cephalandrae*.