STUDIES ON ASH WEEVIL, *Myllocerus subfasciatus* Guerin AND ITS MANAGEMENT ON BRINJAL, *Solanum melongena* L.

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Thesis submitted in part fulfillment of the requirements for the Degree of ***Master of Science (Agriculture) in Agricultural Entomology*** *to the Tamil Nadu Agricultural University, Coimbatore.*

By

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2001

CERTIFICATE

This is to certify that the thesis entitled **STUDIES ON ASH WEEVIL, *Myllocerus subfasciatus* Guerin AND ITS MANAGEMENT ON BRINJAL, *Solanum melongena* L.** submitted in part fulfillment of the requirement for the award of the degree of **Master of Science (Agriculture) in Agricultural Entomology** to the Tamil Nadu Agricultural University, Coimbatore, is a record of bonafide research work carried out by **Ms. S. JAYA PRABHAVATHI** under my supervision and guidance and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journal or magazine.

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it is marvelous in our eyes".

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S. Jaya Prabhavathi

(S. JAYAPRABHAVATHI)

Abstract

ABSTRACT

STUDIES ON ASH WEEVIL, *Myllocerus subfasciatus* Guerin AND ITS MANAGEMENT ON BRINJAL, *Solanum melongena* L.

By

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Investigations on the identification of alternate host plants to *Myllocerus* spp., studies on the impact of time of planting on the population dynamics of brinjal ash weevil, *M. subfasciatus* Guerin. and natural enemies and also damage to the leaves, studies on feeding potential of ash weevils on different hosts, evaluation of varieties/hybrids and germplasm accessions for their relative resistance/susceptibility to brinjal ash weevil, determination of LC_{50} values for selected insecticides for different ash weevils, effect of intercropping coriander with brinjal in different cropping systems and evaluation of bio-control agents, organics and insecticides for the management of ash weevils on brinjal were conducted during 2000-2001.

Investigations made on identification of host plants to *Myllocerus* spp. revealed that *M. subfasciatus* Guerin. was found to feed on sunflower, bhendi and sweet potato; *M. discolor* Boh. on sunflower, pulses, kuppaikeerai, groundnut, gingelly, mango, moringa, pungam, silk cotton tree, pannaikeerai and senkeerai; *M. viridanus* Fab. on sunflower, mango, custard apple,

cotton, mulberry, redgram, deccanhemp, sweet basil and pungam and *M.u. maculosus* Fst. on sunflower, groundnut, cotton and jamun.

Transplantings taken on 15.9.2000 recorded minimum leaf damage (26.65%), less population of ash weevil (1.83 adults per plant) followed by on 15.2.2001 and 1.3.2001 with 27.71 and 28.41 per cent leaf damage and on 1.3.2001, 1.2.2001 and 15.2.2001 with 2.24, 2.47 and 2.51 adults per plant respectively. Maximum natural enemies' population was noticed on 1.2.2001 and 15.2.2001 transplantings with 3.39 and 3.22 adult natural enemies per plant respectively.

The influence of weather parameters on the population dynamics of brinjal ash weevil, leaf damage and natural enemies' population revealed that the leaf damage was significantly and positively correlated with morning RH (r=0.259) and negatively correlated with maximum temperature (r=-0.357), minimum temperature (r=-0.630), evening RH (r=-0.249) and rainfall intensity (r=-0.236). Ash weevil population was significantly and negatively correlated with minimum temperature (r=-0.345) and evening RH (r=-0.645) and positively correlated with sunshine hours (r=0.267). The natural enemies' population was significantly and positively correlated with maximum (r=0.627) and minimum temperatures (r=0.576) and sunshine hours (r=0.252) and negatively correlated with evening RH (r=-0.404) and morning RH (r=-0.417).

The results of the multiple regression analyses indicated that an increase in minimum temperature by 1°C, evening RH by 1 per cent and sunshine by one hour, there would be reduction in leaf damage on brinjal by 1.56, 0.58 and 1.43 per cent respectively. Similarly an increase in evening RH by one per cent and sunshine by one hour, there would be reduction in ash weevil population by 0.174 and 0.262 per plant respectively.

An increase in minimum temperature by 1°C, there would be an increase of natural enemies' population by 0.348 while increase in morning and evening RH by one per cent and sunshine by one hour, there would be reduction in natural enemies population by 0.014, 0.082 and 0.140 respectively. The R^2 values obtained through multiple regression analyses also indicated that six weather factors cumulatively influenced the ash weevil damage (%), population of ash weevil and of total natural enemies per plant to an extent of 53, 65 and 65 per cent respectively.

Among the ash weevils tested, *M. subfasciatus* consumed more leaf area on brinjal followed by *M. discolor* on sunflower, *M. viridanus* on bhendi and *M.u. maculosus* on cotton.

Out of 23 accessions tested, SM 6 was moderately resistant but EP 114 and EP 136 were moderately susceptible to leaf damage of ash weevil by recording lower population of ash weevil on EP 136 and higher natural enemies population was observed on EP 114.

Monocrotophos was found to be more toxic to *M.subfasciatus* on brinjal recording low LC_{50} values, followed by carbosulfan, endosulfan, quinalphos and dichlorvos registering 50 per cent mortality with moderate toxicity to *M. subfasciatus*. Similarly, monocrotophos was more toxic to *M. discolor* on sunflower with low LC_{50} values followed by carbosulfan, quinalphos, endosulfan and phosalone exhibiting moderate toxicity to the weevil.

In the intercropping experiment conducted with coriander, the results revealed that brinjal + two rows of coriander intercropping system was found to be the best in reducing the leaf damage by the ash weevil and its population under unprotected condition but, the same cropping pattern when protected with endosulfan (0.07%) spray four times at fortnightly interval reduced the leaf damage and population of weevil under protected condition. The natural enemies' population was higher in brinjal + 2 rows of coriander as intercrop under unprotected condition.

The healthy fruit yield of brinjal was higher in brinjal as a sole crop followed by brinjal with border coriander, brinjal with two rows and one row of coriander cropping systems under protected condition whereas brinjal + single row of coriander and with border coriander also recorded higher fruit yield when compared to brinjal + 2 rows of coriander and sole crop of brinjal under unprotected condition.

The cost benefit ratio was higher (1:3.20) in brinjal with border coriander crop followed by brinjal with single row and brinjal with two rows of coriander (each 1:3.04) against the sole crop of brinjal which recorded a cost benefit ratio of (1:3.01) under protected condition whereas under unprotected condition, brinjal + single row coriander and border crop each recorded the CBR of 1:2.89.

Experiments conducted for the control of grubs and adults of ash weevils revealed that soil application of carbofuran 3G @ 0.5 kg a.i./ha followed by endosulfan 0.07 per cent @ 1000 ml/ha sprays twice at fortnightly interval were very effective in reducing the percentage of wilting of plants, and of leaf damage and recording lower ash weevil population and higher population of natural enemies and also higher fruit yield with higher CBR which was followed by neem cake @ 250 kg/ha. Spraying of endosulfan followed by dichlorvos, malathion, neemazal each @ 1000 ml/ha, NSKE (5%) and carbaryl @ 1 kg/ha effectively reduced the leaf damage and ash weevil population, and also conserved more population of natural enemies, with higher fruit yield of brinjal and higher CBR.

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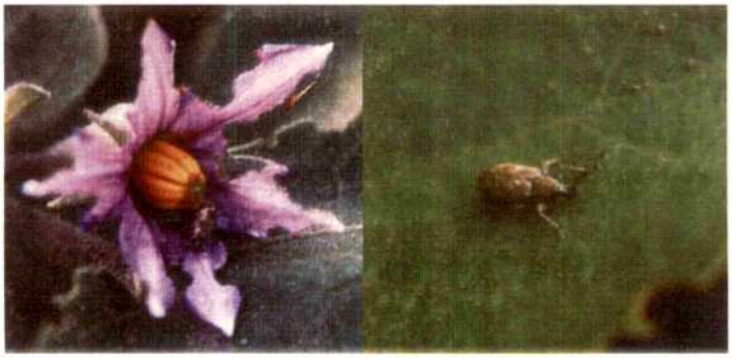

INTRODUCTION

CHAPTER I

INTRODUCTION

Brinjal (Egg plant or Guinea squash) *Solanum melongena* L. has been cultivated in our country since ages and is the native of India. It is also grown in number of other countries around the world. It is the main vegetable of plains and is available more or less throughout the year (Premnath *et al.*, 1984). Brinjal is cultivated for its tender fleshy fruit, used as a vegetable for the preparation of various dishes. Tender brinjal fruits are rich in vitamins A and B_2 and cooked as vegetable curries (Vevai, 1970).

It is an annual crop and grown in all parts of India, except at higher altitudes (Chadha, 1993). Outside India, this is grown in Southern Europe, especially in the Balkans, France and Italy. It is of minor importance in the U.S.A.

Area and production of brinjal in the world are 5.56 lakhs hectares and 89,79,000 million tonnes respectively. Out of the total area, 90 per cent is in Asia and the production is 77,91,000 million tonnes (FAO, 1994). In India, brinjal is cultivated in 4.47 lakh hectares and the production is 58,48,370 tonnes while in Tamil Nadu the area is 7,189 ha and the productivity is 13.08 tonnes (Technical Reports of Asia and Pacific Seed Association, 1995).

Brinjal is known to be attacked by 23 species of insects and 19 diseases causing losses of varying degrees from sowing to harvest in different parts of the year (Gowda and Veeresh, 1984). Brinjal is attacked by more than 36 pests from the time of its planting to harvest (Regupathy *et al.*, 1997). Among them, the ash weevil, the shoot and fruit borer are considered as serious pests. The ash weevil, *Myllocerus subfasciatus* G. is important among the pests affecting the foliage of brinjal plants (Uthamasamy *et al.*, 1973).

On many economically important plants, the weevils of the genus, *Myllocerus* often occur as pests and at times, they assume serious proportions and cause severe damage to the crop, leading to heavy losses. While giving an account of the genus, *Myllocerus,* Siddappaji and Chennabasavanna (1976) reported that it encompassed over 125 species distributed all over the world.

Marshall (1916) reported more than 76 species of *Myllocerus* from the British India including Sri Lanka and Burma and India was apparently, the centre of origin for *Myllocerus*. In recent years, the polyphagous ash weevil, *Myllocerus* spp. which was all along a minor pest, is slowly upsurging and inflicting appreciable damage to many economical important plants. Among the different species, *M. subfasciatus* Guerin, *M. discolor* Boheman, *M. undecimpustulatus maculosus* Fst. and *M. viridanus* Fab. are the dominating species in Tamil Nadu.

During November - December 1999, there was a large scale occurrence of adult grey-weevil, *M. subfasciatus* Guerin on brinjal plants at the Orchard, attached to the Horticultural College and Research Institute, Coimbatore which has led to the detailed studies on management of this weevil.

Ayyar (1920) reported that the weevil, *M. subfasciatus* Guerin, which was considered to be a minor pest of egg plant and other Solanaceous crops, has now assumed a major pest status in Karnataka, often resulting in cent per cent crop loss (Siddappaji, 1976; Tewari and Krishnakumar, 1983).

To effectively combat this pest, information on alternate host plants, feeding potential and seasonal incidence of *Myllocerus* spp. effect of time of planting on population dynamics of ash weevil and natural enemies and also efficacy of different insecticides in controlling *M. subfasciatus* are very essential.

In view of this, the present investigations were made to gather information with the following objectives

1. Studies on identification of alternate host plants to ash weevils.
2. Studies on time of planting and population dynamics of ash weevil and natural enemies.
3. Studies on feeding potential of ash weevils on different host plants.
4. Screening of accessions / cultivars / hybrids of brinjal for their differential susceptibility / resistance to ash weevil and it's damage.
5. Studies on determination of LC_{50} values for selected insecticides for different ash weevils.
6. Studies on effect of intercropping of coriander with brinjal on the population dynamics of ash weevil and natural enemies.
7. Effect of bio-control agents, organics and insecticides for the management of ash weevils on brinjal.

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

The brinjal, *Solanum melongena* L. is being cultivated in India since ages and is a native of India. It is otherwise called as "Egg plant' or 'Aubergines' or 'Guinea squash' and commonly grown in almost all the states of our country and grown in a number of other countries around the world. It is considered to be a vegetable of plain and is available more or less throughout the year (Premnath *et al.,* 1984) and preferred by both poor and rich. Tender brinjal fruits are known to be rich in vitamins A and B_2 and cooked as vegetable curries (Vevai, 1970). From the medicinal point of view, brinjal functions as a good appetiser and aphrodisiac, found useful in 'varta' and 'kaph' ailments. It contains proteins (1.3%), fat (0.5%), carbohydrates (6.4%), calcium (0.02%), phosphorus (0.06), and iron (0.0013%). Such an economically important cash earning crop is known to be devastated by about 23 species of insects and 19 diseases from the time of sowing till harvest and causes losses of varying degrees in different parts of the year (Gowda and Veeresh, 1984). Regupathy *et al.* (1997) also reported that brinjal was attacked by more than 36 pests from the time of its planting till harvest. Among them, the ash weevil and the shoot and fruitborer are considered as serious pests. The ash weevil, *Myllocerus subfasciatus* Guerin is highly important among the pests affecting the foliage of brinjal plants (Uthamasamy *et al*., 1973).

According to Ayyar (1920) the weevil, *M. subfasciatus* was considered to be a minor pest of eggplant and other solanaceous crops. Now it has assumed a major pest status in Karnataka, often resulting cent per cent crop loss (Siddappaji, 1976; Tewari and Kumar, 1983). Available literature on taxonomic position, host range, biology of *Myllocerus* spp. is reviewed here. The literature regarding nature of damage and control of *Myllocerus* spp. are also presented.

2.1. Taxonomic position

M. subfasciatus (Otiorrhynchinae : Curculionidae) was first described by Guerin (1843) from Nilgiris of Tamil Nadu. Later Marshall (1916) gave more detailed description of the species.

M. subfasciatus belongs to

Order	:	Coleoptera
Sub order	:	Polycerata (Polymorpha or Polyphaga)
Division	:	Rhynchophora
Super family	:	Curculionoidea
Family	:	Curculionidae
Sub family	:	Otiorrhynchinae
Genus	:	*Myllocerus*

Fletcher (1919a and 1920), Seniorwhite (1920), Ayyar (1922, 1932 and 1940), Rau (1936), Usman and Puttarudriah (1955), Singh (1960) and Siddappaji (1976) recorded the distribution and host plants of the weevil.

2.2. Host range

The defoliation of sisso trees, (*Dalbergia sissoo* Roxb.) was due to the attack of *Myllocerus* weevils (Stebbing, 1914). Marshall (1916) reported that *Myllocerus* spp. were found to feed on strawberry, *Fragaria vesca,* luceme, *Medicago sativa* Linn., sugarcane, *Saccharum officinarum* Linn., sunflower, *Helianthus annuus* L., pomegranate, *Punica granatum* L., mango, *Mangifera indica* L., ber, *Zizyphus mauritiana* Lamk. and ribbed gourd, *Luffa acutangula* Roxb. at Pusa. Fletcher (1917a) listed the following seventeen plants as hosts of *M. u. maculosus* Fst. *viz.*, redgram, *Cajanus cajan* (L.) Millsp., daincha, *Sesbania aculeata* Poir., sunflower, *H. annuus*; cotton, *Gossypium hirsutum* L., bhendi, *Abelmoschus esculentus* (L.) Moench; deccanhemp, *Hibiscus cannabinus*; sugarcane, *S. officinarum*, sorghum, *Sorghum vulgare* (L.) Moench., pearlmillet, *Pennisetum americanum* (L.) K. Sehum, maize, *Zea mays* Linn., finger millet, *Eleusine coracana* Gaertn., mango, *M. indica*, guava, *Psidium guajava* L., pomegranate, *P. granatum*, apple, *Malus sylvestris*; ber, *Z. mauritiana* and strawberry, *F. vesca* . Pusa collection presented evidences to suggest that the ash weevil adults feed on cotton, in Amristar, Lyallpur and Dehradun, on cotton, *G. hirsutum* and on pearl millet, *P. americanum* in Lahore, on tender mango leaves in Baktiarpur, on cotton, *G. hirsutum*, maize, *Z. mays*, sunflower, *H. annuus*, ber, *Z. mauritiana*, ribbed gourd, *L. acutangula*, bhendi, *A. esculentus*, mango, *M. indica*, sugarcane, *S. officinarum*, pomegranate, *P. granatum* guava, *P. guajava*, strawberry, *F. vesca* and mesta, *H. cannabinus* in Pusa; on cotton in Surat; on maize, *Z. mays;* bhendi, *A.. esculentus* cotton, *G. hirsutum*, and millets in Poona, on apple shoots and branches in Bangalore and on sorghum, *S. vulgare* in Coimbatore (Fletcher, 1919b). *M.u. maculosus*, was reported to feed on ber, *Z. mauritiana* at Pusa (Bihar) by Misra (1919).

Ghosh (1921) observed the larvae of *M. u. maculosus* feed on the roots of maize, *Z. mays* and cotton, *G. hirsutum* in Pusa. Hutson (1924) found the *Myllocerus* spp., attacking the leaves of brinjal. Husain (1925) reported the *M. blandus,* which could cause considerable damage every year and *M. u. maculosus* was common throughout the season. According to Trehan (1929), *M. u. maculosus*, species fed on cotton, *G. hirsutum*; bhendi, *A. esculentus*; maize, *Z. mays*; cumbu, *P. americanum*; redgram, *C. cajan*; pear, *Pyrus communis* L.; peach, *Prunus persica*; plum, *Prunus salicina*; deccanhemp, *H. cannabinus*; sugarcane, *S. officinarum*; mango, *M. indica*; Lucerne, *M. sativa*; sunflower, *H. annuus*; ber, *Z. mauritiana*; ribbed gourd, *L. acutangula*, *Cyamopsis psoraloides* Linn. and *D. sisoo* in different parts of India and only on cotton, *G. hirsutum* in Uttar Pradesh.

Vayssiere and Mimeur (1925) reported that two curculionids found in cotton were *Myllocerus hirtipernis* Hustache, and another species of *Myllocerus* found in numerous on the buds, shoots and young leaves though no damage was known to result from them. Hutson (1928) observed the *Myllocerus* sp. on grape fruit, *Citrus paradisi* in Ceylon. Cotterell (1930) reported that *Myllocerus* spp. were found to be common on the leaves of young and unshaded Cacao, *Theobroma cacao* L. causing defoliation. Young plants of *Acacia decurrens* were reported to be defoliated by the weevil, *M. subfasciatus* which was not previously observed on *Acacia* sp. (Rau, 1936). Marshall (1941) described that *Myllocerus* sp. which was found to feed on ber, *Z. jujuba* in Punjab. Ullah (1940) reported that adults of *Myllocerus laetivirens* Marshall. were known to be fairly common on cotton, *G. hirsutum* migrated to certain varieties of plum, *Prunus salicina* and almond *Prunus armeniaca* L. at New Delhi and defoliated the leaves of these trees.

According to Bose (1943) *M. laetivirens* attacked apple, *M. sylvestris*; pear, *P. communis*; peach, *P. persica*; apricot, *P. armeniaca*; almond, *P. amygdelus*; silver oak, *Grewilia robusta*; rosa, *Rosa* spp. strawberry, *F. vesca*; raspberry, pomegranate, *P. granatum*; citrus, *Citrus* spp.; mango, *M. indica*; ber, *Z. mauritiana*; castor, *Ricinus communis* Linn. and *D. sissoo*. Subramaniam (1965) gave a short account of different species of *Myllocerus* recorded for the first time on moringa, *Moringa oleifera* Lam., at Coimbatore. The *Myllocerus viridanus* Fab; *M. teniclavis* var. *inferior* Marshall;. *M. discolor* var. *variegatus Boh.* and also *M.u. maculosus* occurred on cotton, *Gossypium* spp., castor, *R. communis*, cholam, *S. vulgare* and bhendi, *A. esculentus* and *M. discolor* var. *variegatus* was reported on cholam, *S. vulgare*; maize, *Z. mays*; red gram, *C. cajan* and guava, *P. guajava*. Gupta (1966) observed the occurrence of *M.u. maculosus* adults on cotton, *G. hirsutum*; bhendi, *A. esculentus*; red gram, *C. cajan*; mango *M. indica*; sisso, *D. sissoo*; ber, *Z. mauritiana* and for the first time on groundnut, *A. hypogaea* and brinjal, *S. melongena*. Batra *et al.* (1969) recorded the occurrence of *M. u. maculosus*, *M. discolor* and *M. dentifer* on cumbu in Jaipur. Vevai (1970) reported *M. u. maculosus* as a pest of ragi; *M. u. maculosus* , *M. dentifer* and *M. transmarinus* on bajra but occasionally serious on bajra, *P. americanum*, while *M. discolor* and *M. blandus* were found to feed on tender stems and leaves of wheat, *T. aestivum.* Peswani (1971) observed *M. u. maculosus* adults were found to feed on soybean, *G. max* at Delhi. Singh (1971) recorded *M. discolor* and *M. u.maculosus* for the first time as pests of Litchi (*Litchi chinensis* Sonn.) foliage in India. *M. u. maculosus* was one of the minor pests of castor, *R. communis* in Uttar Pradesh (Srivastava *et al.*, 1972).

The cotton grey weevil, *M. u. maculosus* (Curculionidae : Coleoptera) was reported as regular pest on cotton, *G. hirsutum,* pearl millet, *P. americanum*, greengram, *P. radiatus*; sorghum, *S. vulgare*, soybean. *G. max* and sunflower, *H. annuus* (Sandhu *et al.*, 1973); blackgram, *P. mungo* and cowpea, *V. unguiculata* (Srivastava *et al.*, 1975); pigeonpea, *C. cajan* and maize, *Z. mays* (Nayar *et al.*, 1979). According to Thangavel *et al.* (1974) jute, *Corchorus olitorius* Linn. was severely infested by *M. discolor variegatus*, *M. viridanus* and *M. u. maculosus,* while jute, *C. capsularis* was unaffected by the weevils. Agarwal and Nadkarni (1975) placed on record, the extensive damage caused by *M.u. maculosus* to sorghum leaves in Indore.

Rangarajan *et al.* (1975) observed the infestation of *M. u. maculosus*, *M. viridanus* and *M. discolor* on sunflower, in Tamil Nadu. The alternate host plants for these weevils were pulses millets and neem tree, *Azadirachta indica* A. Juss. Srivastava *et al.* (1975) reported the incidence of these weevils on leguminous crops like greengram, *P. radiata,* soybean, *G. max*, blackgram, *P. mungo* and on cowpea, *V. unguiculata.* Yadav and Singh (1975) recorded the incidence of *Myllocerus* spp., on ragi, *Eleusine coracana* Gaertn. maize, *Z. mays* egg plant, *S. melongena,* cumbu, *P. americanum* , sorghum, *S. vulgare,* soybean, *G. max* and groundnut, *A. hypogaea,* in Northern Bihar. Singh and Butter (1976) recorded a weed, *Corchorus acutangulus* as one of the food plants to this species in Ludhiana.

Litchi, *L. chinensis* Sonn. as one of the host plants of leaf-weevils (*M. delecatulus* Boh., *M. dorsatus* F. and *M. u. maculosus*), during the survey on pests of litchi, *L. chinensis* in Saharanpur and Dehradun districts of Uttar Pradesh (Singh, 1978). An outbreak of *M. u. maculosus* caused severe damage to sorghum at Gwalior, Madhya Pradesh, India and also the adults fed on nutgrass, (*Cyperus rotundus*) and horse-purslane (*Trianthema portulacastrum*), Kankua (*Commelina benghalensis*), barnyard millet (*Echinocloa crusgalli*) and sandhor (*Bothriochloa pertusa*) (Budhiraja *et al.*, 1984). During an extensive survey carried out in eastern Uttar Pradesh, India; the Curculionid *M. u. maculosus* was recorded on pigeonpea (*C. cajan*) for the first time (Shukla *et al.*, 1984).

A survey conducted at Dharwad, Karnataka revealed that Kasturi bhendi (*Hibiscus abelmoschus*), was attacked by *M.u. maculosus* (Rajashekhargouda *et al.*, 1984). Rajamma (1984) recorded *M. viridanus* as a pest of sweet potato, *Ipomoea batatas* (L.) Lam. in Kerala. Bhattacharjee and Ghude (1985) recorded the extensive damage to soybean, *G. max* through defoliation by *M. u. maculosus* at New Delhi.

Nagalingam (1985) reported *M. discolor* and *M. viridanus* to feed regularly throughout the year on orange, *Citrus reticulata* Blanco, acid lime, *C. aurantifolia* and other species of citrus at Tirupati. *M. curvicornis* F. a polyphagous species was recorded as a pest of coconut in India (Ponnamma *et al.*, 1985). Ramamurthy and Ghai (1988) recorded the food plants of *Myllocerus* as citrus, *C. reticulata* , jute, *Corchorus olitorius*, sisso, *D. sisoo*, roses, *Rosa sinensis,* calotropis, *Calotropis gigantea*, sorghum, *S. vulgare,* lucerne, *M. sativa*, redgram, *C. cajan*. and *Acacia arabica.* The incidence of *M.u. maculosus* was recorded on mungbean varieties in Rajasthan (Verma and Henry, 1988).

Immature flower buds with fresh apical leaves of sunflower were invaded by *M. lateralis* Chev. on a monsoon crop of sunflower at Muzaffarnagar. (Goel and Arun Kumar, 1989). In Gujarat, *M. discolor* was recorded on ber fruit (Shah *et al.*, 1990).

Regular surveys conducted in forest plantations in Tamil Nadu, Kerala and Karnataka revealed the presence of *M. viridanus* as defoliators on teak (*Tectona grandis*), herbs (*Cassia tora* and *Solanum violaceum*), shrubs (*Calliandra calothyrsus, Cassia hirsuta* and *Helicteres isora*), trees (*Acacia auriculiformis, Cassia fistula, Eugenia jambolana, Eucalyptus robusta, Pongamia pinnata, Populus deltoides* and *Sapindus tripliatus)* and weeds (*Chromolaea odorata*) (Ahmed, 1989).

Ganapathy *et al.* (1990) reported severe defoliation on seedlings of *Acacia* spp. by the ash weevil, *Myllocerus* sp. at Pudukkottai district in Tamil Nadu. Zaman and Maiti (1994) recorded *Myllocerus* sp. infesting mango, *M. indica* seedlings in nursery in West Bengal. Qing and Nong (1994) observed the tea weevil, *M. aurolineatus* at yuhang, China. Swamy and Rajagobal (1995) observed *M. u. maculosus* Fst. to feed to medicinal plant, *Adhatoda vasica*.

Jothi and Tandon (1995) observed, *Myllocerus* spp. as an important pest of ber (*Z. mauritiana*). *M. laetivirens* was reported as a pest on neem, (*A. indica*) seedlings in Rajasthan, India (Seemakumar *et al.*, 1997). Mohan (1999) discussed *M. curvicornis* as a sporadic pest of coconut.

2.3. Biology of ash weevils

Trehan (1929) observed that *M. maculosus* females laid a maximum of 360 eggs either singly or in batches in 24 days. The egg period varied from 3 to 11 days depending upon the place and weather factors. The larval period was completed in 31 days under natural conditions and 33 days in captivity. The adults survived upto two months in captivity.

Bose (1943) described the life history of *M. laetivirens*. The egg, larval and pupal periods were reported to be 4 to 5 days, 10 months and 4 to 5 days respectively and the adults lived upto 3 months.

Subramaniam (1958) investigated the biology of *M. subfasciatus* in brinjal. The average egg, larval and pupal periods were reported to be 6.7, 66.5 and 10.4 days respectively and the longevity of male and female was 71.9 days and 72.3 days respectively.

According to Gupta (1966), the adults of *M. u. maculosus* on cotton paired 2 to 5 days after emergence and the females oviposited in soil from 4 to 9 days after mating. In the laboratory, upto 339 eggs were laid by a female, in batches over a period of 5 to 28 days and fecundity was high during September and October. The hatching rate was 96 per cent and the egg, larval and pupal stages lasted 3 to 8, 26 to 47 and 3 to 6 days respectively, depending on the season and the adult females lived for 48 days and the males for 39 days.

Pande (1971) studied the life cycle of *M.u. maculosus* on pearl millet and reported that oviposition began 1 to 5 days after copulation. The number of eggs laid by a female ranged from 98 to 350 and the incubation period extended from 3 to 12 days, the four larval stadia were completed from 23 to 40 days, while the pupal period ranged from 3 to 9 days. The complete life cycle took 29 to 58 days. Kishore and Srivastava (1976) investigated the biology of ash weevil, *M.u. maculosus* on sorghum plants and reported that oviposition took place in soil and the egg, larval and pupal stages ranged from 3 to 5, 25 to 30 and 7 to 8 days respectively.

Tayade and Raodeo (1976) cultured the ash weevil, *M.u. maculosus* on cotton and reported that females laid 100 to 250 eggs singly in the soil. The incubation period ranged from 3 to 7 days with an average of 5.1 days. The larval and pupal periods ranged from 28 to 33 days with an average of 30.2 days and 5 to 9 days with an average of 7.0 days respectively. The longevity of adults was upto 25 days.

2.4. Feeding potential of ash weevils

Dhamdhere *et al.* (1986) studied the food preference of grey-weevil, *Myllocerus* spp. on cotton, *G. hirsutum* on different food plants and found that maximum adults were recorded on soybean *G. max* (37% weevil) followed by pearl millet, *P. americanum* (26% weevil) and sorghum (17% weevil) while greengram, *P. radiata,* blackgram, *P. mungo*, cowpea, *V. unguiculata* and pigeonpea, *C. cajan* had 2 to 6 per cent adult weevils and thus the latter four crops were relatively less preferred.

2.5. Screening of cultivars / accessions for their differential susceptibility / resistance to *Myllocerus* spp.

The ash weevil, *M. subfasciatus* is one of the serious pests of brinjal, *S. melongena* under South Indian conditions. Gowda and Veeresh (1984) reported that under severe infestations of weevils not only the yield of the crop was reduced considerably but often the plants succumbed to the injury.

Studies were undertaken to determine the relative susceptibility of 48 improved sorghum lines (varieties and hybrids). Based on the observations, the grades assigned were from 0 (no damage) to 10 (severe damage). Based on these gradings, the lines were divided into three categories *viz.*, less susceptible, moderately susceptible and highly susceptible. None of the lines escaped weevil damage. The lines securing the average grade of 3 or less were categorised as less susceptible, between 3.1 to 5.0 as moderately susceptible and above 5.0 as highly susceptible. The data recorded showed that 5 lines were relatively less susceptible, 14 lines moderately susceptible and 29 lines highly susceptible to cotton grey weevil, *M. u. maculosus* (Kishore *et al.*, 1977).

Kishore and Jotwani (1980) screened forty three ragi (*E. coracana.*) genotypes for their reaction to the grey weevil, *M. maculosus* and found that 11 entries *viz.*, HR 374, Jan 852, B 7-43, PR 1044, PES-S, PES 176, Indaf-5, T 20-1, PES 144, CO 10 and KM 14 were relatively free from the grey weevil damage.

Kundu (1984) evaluated the resistance of fifty exotic varieties of soybean, *G. max* for their reaction to *M. u. maculosus* damage under field conditions at New Delhi, during kharif season of 1983. At 70 days after germination, only one variety, Hernon-237 (from Australia), was completely free of damage by the weevil.

Field screening of 600 germplasms including hybrids of pearl millet, *P. americanum* resulted in the identification of 11 entries, *viz.*, MP 9, MP 15, MP 31, MP 60, MP 71, MP 80, MP 86, MP 95, MP 106, MP 117 and PSB 8 exhibiting multiple resistance to the shootfly, *Atherigona varia soccata* Rond, the stem borer, *Chilo partellus* Swinhoe and grey weevil, *Myllocerus* spp. (Kishore, 1989).

Kishore and Solomon (1990) identified AKSS-SSV 3, AKSS-SSV 5 and HES 2 elite sweet sorghum germplasms were least susceptible to grey weevil, *M. maculosus* damage.

2. 6. Toxicity of insecticides to *Myllocerus* spp.

Laboratory tests

According to Pradhan *et al.* (1958), malathion and parathion were 1.94 and 1.79 times more toxic than DDT while lindane, systox, diazinon, endrin and aldrin were 0.918, 0.515, 0.481, 0.355 and 0.169 times less toxic than DDT to ash weevil adults. Phosphamidon, carbophenothion, carbaryl and endosulfan were more toxic than p-p' DDT to *M. u. maculosus* but dichlorvos was less effective than that of DDT (Kumar and Lal, 1966). Verma *et al.* (1969) observed that based on LC_{50}, parathion, malathion, endrin, mevinphos, isobenzon (Telodrin), and formothion were 19.7, 7.5, 2.9, 2.0, 1.6, and 1.1 times respectively more toxic to ash weevil adults than DDT, while trichlorphon, gamma BHC, phosphamidon, dicrotophos, diazinon, dieldrin, toxaphene, carbaryl, aldrin and BHC were less toxic than DDT. Among the two commercial formulations *viz.*, parathion and methyl parathion, latter compound was 1.5 times more toxic than the former to the ash weevil adults. Based on their LC_{50} values, methyl-parathion and fenthion were 4.42 and 1.45 times more toxic than DDT and the remaining were lesser toxic than DDT.

Among the eight newer insecticides evaluated against the adults of brinjal ash weevil, *M. subfasciatus*, chlorpyriphos 0.1 per cent registered maximum mortality of weevils (Uthamasamy *et al.*, 1973). Through laboratory studies conducted by Gupta and Khurana (1973) showed that methyl parathion and DDT as spray were found to be effective against the adult weevils.

Das and Chatterji (1978), evaluated eight insecticides *viz.*, endosulfan, methyl parathion, fensulfothion, fenthion, fenitrothion, dichlorvos, gamma BHC and carbaryl against the adults of *M. discolor.* The LC_{50} values for the former six insecticides were 58.96, 38.00, 22.50, 17.06, 9.50 and 8.95 times respectively as toxic as gamma BHC, whereas carbaryl was less toxic than gamma BHC.

Singh and Singh (1992) conducted laboratory tests for the residual toxicity of different insecticides against adult grey weevil, *M. u. maculosus* on soybean leaves and found that cypermethrin 25EC (0.008%), fenvalerate 0.4 per cent dust and malathion 5 per cent dust remained toxic to the weevils upto 7 days, effecting 36.66, 40.00 and 33.33 per cent mortality respectively.

Durairaj (1995) reported that malathion at 0.1 per cent was the most effective, causing cent per cent mortality of *M. suspiciens* 24 hr after treatment on pear leaves while dichlorvos, endosulfan, quinalphos, monocrotophos and phosalone were much less effective. Cent per cent kill of *M. laetivirens* was recorded after 24 hr treatment with 0.05 or 0.10 per cent malathion, 0.1 or 0.2 per cent dichlorvos and 0.025 or 0.05 per cent quinalphos on plum leaves (Durairaj, 1996).

On the basis of LT_{50}, the order of efficacy of insecticides in controlling the grey weevil, *M.u. maculosus* was phenthoate (0.1%) > chlorpyrifos (0.1%) > phosalone (0.1%) > phosalone (0.05%) > phenthoate (0.05%) > chlorpyrifos (0.05%) > phosalone (0.025%) > phenthoate (0.025%) > chlorpyrifos (0.025%) (Singh and Marwaha, 2000).

On the basis of PT and LT_{50} values, the order of relative efficacy of grey weevil, *M. u. maculosus* on maize foliage was phenthoate dust (2.0%) followed by DDT (2.0%), malathion (5.0%) and carbaryl dust (2.0%) (Singh and Marwaha, 2000).

2.7. Studies on effect of intercropping on incidence of pests of brinjal

Singh and Singh (1977) reported that intercropping of pearlmillet, *P. americanum* with green gram, *P. radiata* and black gram, *P. mungo* resulted in a considerably low population of grey weevil, *M. u. maculosus.*

Khorsheduzzaman *et al.* (1997) reported that intercropping coriander, *Coriandrum sativum* as a single line, double line or as border crop with brinjal recorded less infestation of *Leucinodes orbonalis* Guenee when compared with untreated and cypermethrin treated sole brinjal crop.

Gupta *et al.* (1999) studied the effect of four spice intercrops *viz.*, fennel, *Foeniculum vulgare*; omum, *Trachyspermum ammi*; coriander, *C. sativum* and nigella, *Nigella sativa* with brinjal, *S. melongena* on the incidence of fruit borer, *L. orbonalis* Guenee.

2.8. Field evaluations

According to Butani and Hashmi (1960), application of Dieldrin (1.5%) dust at 2 kg a.i./ha or drenching with 0.1 per cent dieldrin was effective against the ash weevil, *Myllocerus* spp. in sugarcane. Butani and Sahni (1970) from their field tests at Sisra, Haryana reported that mortality of *M.u. maculosus* was 26 per cent with DDT and 34 per cent with carbaryl. Misra (1970) tested DDT, endrin, lindane, EPN, parathion, malathion and carbaryl at 0.05 and 0.1 per cent concentrations against ash weevil, *M.u. maculosus* adults and the results showed that DDT and endrin were residually effective for a longer period followed by EPN and parathion at both the concentrations.

Application of dieldrin in a spray or dust to soil around the cotton plants reduced the weevil, *M. u. maculosus* grub damage (Ponnuswami and Ramasamy, 1971). Sharma *et al.* (1971) after the application of ultra low volume sprays from aircraft stated that endosulfan concentrate at 1500 ml/ha gave the best results against *Myllocerus* spp. Endosulfan 35 EC at 1250 ml/ha and malathion 50 EC at 1135 ml/ha resulted in good control of *Myllocerus* spp. for 10 days when compared to thiometon 25 EC and dimethoate 30 EC. Dimethoate 30 EC (875 ml/ha), formothion 25 EC (1125 ml/ha), methyl demeton 25 EC (1125 ml/ha) and thiometon 25 per cent (1000 ml/ha) were effective against *Myllocerus* spp. but all except thiometon were toxic to the natural enemies.

Among the six insecticides tested through aerial spraying the treatments leptophos (phosvel) and carbaryl 0.75, fenitrothion 0.5 and chlorpyriphos at 0.2 kg a.i./ha proved reasonably effective against *M. u. maculosus* (Sidhu and Bhalla, 1971).

Application of carbofuran 3G to the soil @ 1.0 kg a.i./kg, disulfotan 10G @ 3.0 kg/ha, carbofuran at 4 per cent as seed dressing and aldicarb at 3.0 kg/ha were very effective against ash weevils, *M.u. maculosus* infesting cotton (Thimmaiah *et al.*, 1971).

Verma *et al.* (1972) stated that ash weevil, *M.u. maculosus*, was effectively controlled by parathion emulsion sprays on soybean, *G. max.* According to Singh *et al.* (1973), monocrotophos and dicrotophos at 0.02 per cent and mephosfolan at 0.05 per cent were effective against ash weevil, *M. u. maculosus* on cotton .

Singh and Vijay (1975) reported that application of dimethoate @ 0.25 to 0.35 kg/ha gave the best control of *M. u. maculosus* adults and other insects on cotton. Sidhu and Dhawan (1976) found that monocrotophos 0.5 kg and dicarbam 1 kg a.i. / ha reduced the population of ash weevils *M. u. maculosus* by 85.7 and 58.4 per cent respectively, within two days of spraying on cotton while monocrotophos was significantly superior to endosulfan and dicarbam was as good as carbaryl.

Abdul Kareem *et al.* (1977) reported that 18 days after treatment with toxaphene 50 EC 0.1 per cent, DDT + toxaphene (Heliotox) 75 EC 0.2 per cent, phorate (Thimet) 10 G 2g/plant, carbofuran (Furadan) 3G 2g/plant, dieldrin 18 EC 0.1 per cent and DDT 0.1 per cent, there was total recovery of wilting plants of cotton which was caused by ash weevil grubs. Butani *et al.* (1977) from their insecticidal investigations inferred that 0.03 per cent dimethyl carbamate, 0.02 per cent phosphamidon, 0.03 per cent monocrotophos, 0.05 per cent tetra chlorvinphos, a mixture of 0.1 per cent carbaryl and molasses (alone or in combination with 0.03 per cent dimethoate), 0.03 per cent endosulfan and 0.03 per cent dicrotophos were more effective against *M. u. maculosus* on cotton.

Rajagopal and Chennabasavanna (1977) stated that four applications of granules of carbofuran 3G @ 1 kg a.i./ha at 20 days interval after sowing gave good control of *Myllocerus* spp. on maize *Z. mays* at Bangalore. Krishnananda (1978) reported that the superior efficacy of monocrotophos and quinalphos against ash weevil, *Myllocerus* spp. on cotton. Menon (1979) found that adult population of weevil, *M.u. maculosus* on the leaves was significantly less on cotton plants when treated with slow release granular formulation of carbofuran 3G or aldicarb 10G than on the untreated plots.

Viswanathan (1979) reported that three sprays of methyl demeton 0.05 per cent followed by seven sprays of phosalone 0.1 per cent or monocrotophos 0.05 per cent or quinalphos 0.05 per cent or endosulfan 0.07 per cent or carbaryl 0.1 per cent and sulphur 0.05 per cent were equally effective as that of 10 sprays of monocrotophos 0.05 per cent or endosulfan 0.05 per cent against ash weevils and other pests of cotton.

Parameswaran and Balasubramanian (1980) reported that soil application of granules of carbofuran 3G @ 1 kg a.i./ ha, phorate 10 G @ 1 kg a.i. / ha and of bendiocarb granules @ 1 kg a.i./ha as well as spraying of phosalone 0.1 per cent, and BHC 0.1 per cent recorded low ash weevil grub incidence.

Sidhu and Dhawan (1981) reported that spraying of carbaryl @ 1.0 kg a.i./ha was found to be highly effective against jassid, aphid, whitefly and grey-weevil on cotton. Monocrotophos was found to be quite effective against the grey weevil on cotton (Butani *et al.*, 1975). While Singh *et al.* (1982) reported that monocrotophos and triazophos were more effective against adult weevils of *M. u. maculosus* infesting hybrid sorghum and their toxicity also persisted for a longer period.

Tewari and Krishnakumar (1983) found that application of aldicarb, phorate, carbofuran, quinalphos, aldrin and lindane were quite effective in reducing the grub population of *M. subfasciatus* and wilting on egg plant, *S. melongena* and thereby increasing the yield and high cost benefit ratio was obtained in case of phorate.

Kashyap *et al.* (1984) found that fenthion and methyl parathion were offering 75-80 per cent control of the defoliating weevil, *M. nigrosuturalis* on peaches in

Himachal Pradesh, upto 14 days after treatment. Budhiraja *et al.* (1984) reported that spray applications of carbaryl (0.1%), UC-51762 (thiodicarb) (0.01%) or monocrotophos (0.04%) caused 80 to 100 per cent mortality of adults of ash weevil, *M. u. maculosus* infesting leaves of hybrid sorghum.

Rajendran (1989) stated that foliar treatments *viz.*, monocrotophos 40 EC, chlorpyriphos 20 EC and quinalphos 25 EC and soil application of quinalphos 1.5 per cent dust, phoxim 5 per cent dust and phosalone 5 per cent dust were found to be on par and superior to other treatments in reducing tuber damage by *M. subfasciatus* on potato in Nilgiris.

Chandramohan and Nanjan (1991) reported that monocrotophos 0.04 per cent spray registered lesser ash weevil, *M. subfasciatus* damage with higher yield and cost benefit ratio in potato.

Cypermethrin 0.04 per cent was very effective followed by dichlorvos 0.05 per cent and phosalone 0.05 per cent. One to three sprays during the flushing time were effective in controlling citrus defoliator, *Myllocerus* spp. in Nagaland (Bakthavatsalam, 1993).

2.8.1. Biological control of weevils

Wilkinson (1929) described the new species of Braconid, *Dinocampus mylloceri* Wilkn. from the adults of *M.u. maculosus* from India. This Braconid is erroneously identified as *Loxocephalus* sp. The Braconid *Isobracon (Iphiaulax) peronatus* cam., recorded from Trinidad is considered by Myers to be associated with the lamiid, *Stirastoma* sp. infesting cacao logs.

Ethyl acetate extract of *C. capsularis* leaf showed complete antifeeding effect to grey weevil, *M. discolor* lasting for three days (Mallick *et al.*, 1980).

Sankaran *et al.* (1989) reported the potentials of the fungus, *Beauveria bassiana* (Bals.) as a bio-control agent against *M. viridanus* under laboratory conditions in teak, *Tectona grandis*.

In West Bengal most of the adults of *M. discolor* were found to be affected by a pathogenic microsporadian *viz.*, *Nosema mylloceri* mainly in the gut epithelia, fat bodies and haemocytes. The spores of the parasite measured 4.89 to 6.19 μm (Ghosh, 1990).

Karthikeyan *et al.* (1998) reported the *Olios* sp. which was found to attack *M. viridanus* on neem tree, *A. indica*.

Wu and Sun (1994) observed that the strain 871 of the entomogenous fungus, *B. bassiana* isolated from the adults of tea brown weevil, *Myllocerinus aurolineatus* in Fujian Province, China. Mortality of inoculated larvae was more than 90 per cent at 10-28°C in the laboratory. In the field, application of soil containing the fungus @ 15-30 kg/ha achieved more than 80 per cent control of weevil grubs. Sprays of spore suspension (100-200 million spores / litre, @ 7.5 - 15.0 kg/ha) resulted in more than 95 per cent adult mortality on the 10^{th} day after spraying. Application to one thousand hectare area of tea plantations resulted in 79-91 per cent control of the curculionid in the year of application and its population was reduced by 65 per cent of the adults in the following year.

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

3.1. Studies on identification of alternate host plants to ash weevils, *Myllocerus* spp.

Different species of *Myllocerus* occurring on wild as well as cultivated plants were observed during 1999-2001. Frequent field visits were made at regular intervals in the cropped area of the farms attached to the Tamil Nadu Agricultural University, Coimbatore, farmers' fields at Thondamuthur area and also in the Botanical Garden, Coimbatore and collected adult insects as well as the host plants were also identified.

3.2. Studies on effect of time of planting on the population dynamics of ash weevil and natural enemies

The experiments were conducted at the Insectary of Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore using the variety CO 2 with the spacing of 75 x 50 cm. A total of twelve plantings was taken up at fortnightly interval, for which brinjal nursery was also raised periodically for each fortnightly planting. Fortnightly planting of brinjal was taken up with a plot size of 20 m^2 per replication and two such replications were maintained for each planting.

In each plot, 50 plants were maintained; of which ten plants were selected at random and tagged. Observations were made on the incidence of ash weevil and its damage as well as the population of natural enemies at fortnight interval.

The data recorded on the incidence of ash weevils, damage potential in terms of per cent damage to leaves and the population of natural enemies (spider, *oxyopes* spp. and coccinellid beetle, *Menochilus sexmaculatus* Desb.) on brinjal were correlated in relation to weather parameters and multiple regression equations were fitted.

Plate-1. ALTERNATE HOST PLANTS OF *Myllocerus* spp.

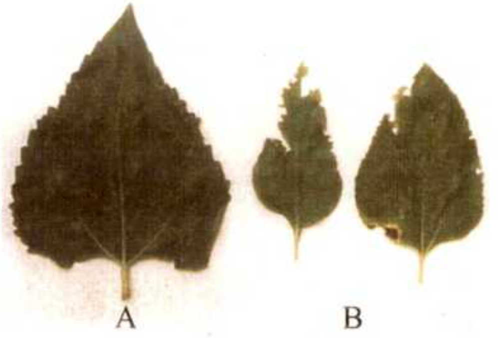

Plate-1a. Sunflower,
Helianthus annuus L.

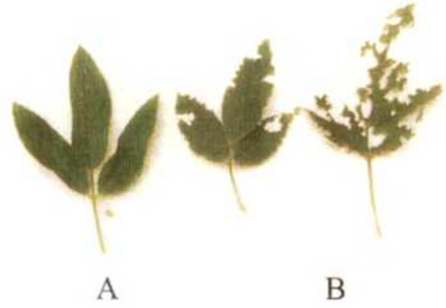

Plate-1b. Red gram,
cajanus cajan (L.) Millsp.

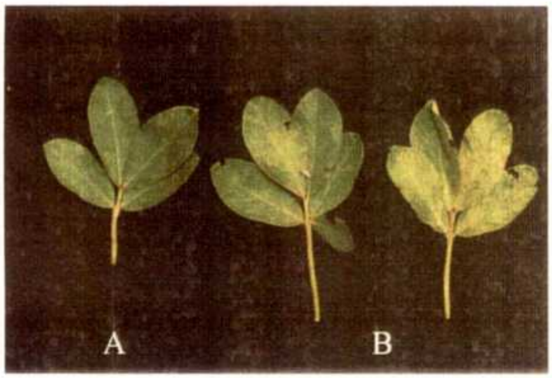

Plate-1c. Groundnut,
Arachis hypogaea L.

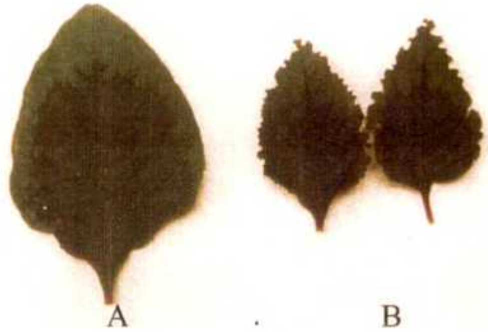

Plate-1d. Senkeerai,
Amaranthus blitum L.

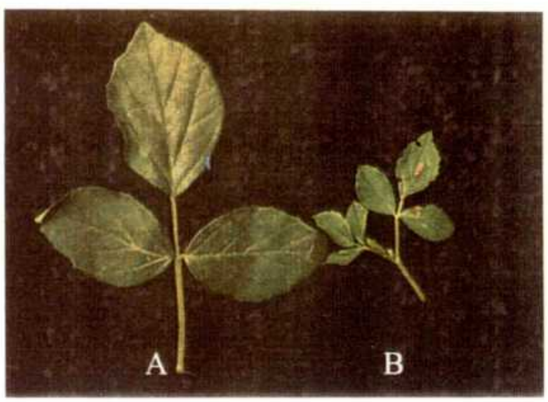

Plate-1e. Clusterbeans,
Cyamopsis tetragonaloba (L.) Taub.

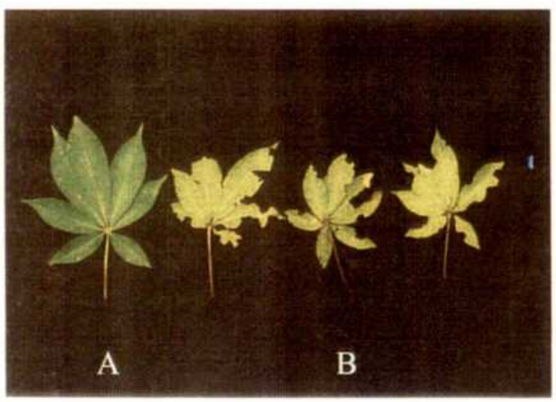

Plate-1f. Silk cotton tree,
Ceiba pentandra L.

A - Healthy Leaf   B - Affected Leaf

Plate-2. ALTERNATE HOST PLANTS OF *Myllocerus* spp. contd.,

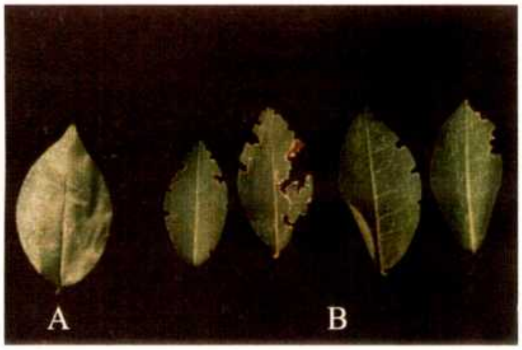

Plate-2a. West Indian Cherry,
Malphigia punicifolia L.

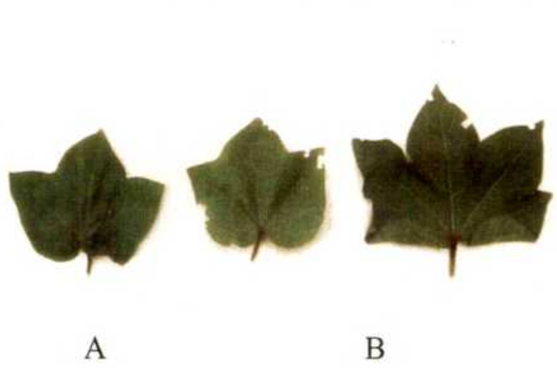

Plate-2b. Cotton,
Gossypium hirsutum L.

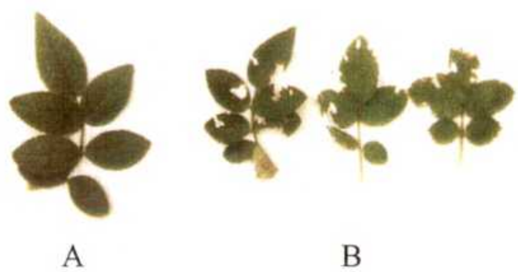

Plate-2c. Rose,
Rosa chinensis Jacq.

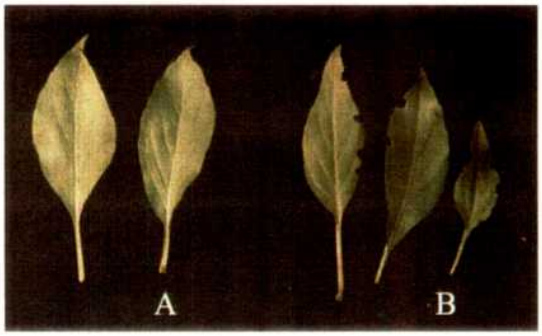

Plate-2d. Sweet basil,
Ocimum basilicum L.

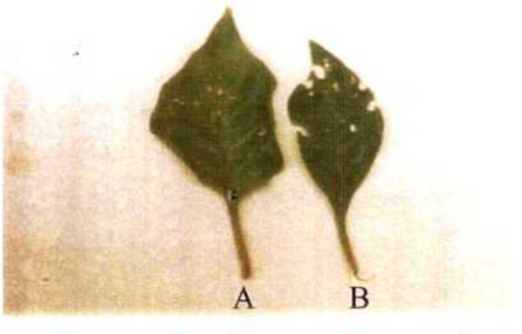

Plate-2e. Pannaikeerai,
Celosia argentea L.

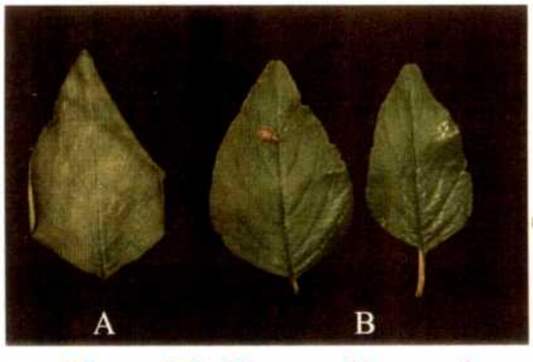

Plate-2f. Kuppaikeerai,
Amaranthus viridis L.

A - Healthy Leaf   B - Affected Leaf

3.3. Studies on feeding potential of ash weevils on host plants

Adult ash weevils, irrespective of the sex and species, collected from unsprayed fields were starved for 12 hrs. Pre-starved adult weevils were placed in petridish @ 1 insect per leaf and this set up was maintained for each species of *Myllocerus* which were replicated ten times. The weevils were allowed to feed the leaves for 24 h. The area of each leaf consumed was measured by finding out the area of leaf before the release of weevil and 24 h. after release of weevil. The differences in leaf area was taken as the leaf area consumed by the weevil (cm^2) by using leaf area meter in the laboratory conditions with a room temperature (32 ± 2°C) and RH of 80 ± 5 per cent. The above study was conducted with ash weevils *viz*., *M. subfasciatus* infesting brinjal crop, *M. viridanus* F. infesting Ground nut, *Arachis hypogaea* L, bhendi, *Abelmoschus esculentus* (L.) Moench, and West Indian Cherry, *Malphigia punicifolia* L.; *M. u. maculosus* Desb. on cotton *Gossypium hirsutum* L. and *M. discolor* on sunflower, *Helianthus annus* L.

3.4. Screening of accessions/cultivars/hybrids of brinjal for their differential susceptibility/ resistance to ash weevil damage

The existing pre-release cultivars/accessions/hybrids available at the Department of Olericulture, Tamil Nadu Agricultural University Orchard (22) Coimbatore, were screened along with susceptible check 'C0 2' to the brinjal pests in the field. Standard agronomic practices for brinjal crop were followed. The entries screened were as follows.

1) EP - 12	9) EP - 46	17) BB - 45
2) PLR - 1	10) P - 76	18) SM - 6
3) EP - 138	11) EP - 167	19) AB - 2
4) EP - 147	12) AB - 258	20) Gulabi
5) EP - 25	13) SM - 100	21) JB - 2
6) EP - 114	14) Annamalai	22) EP - 79
7) EP - 136	15) SM - 5	(23) susceptible check 'C0 2'.
8) SM - 12 and	16) SM - 13	

Plate-3a. Healthy Flower

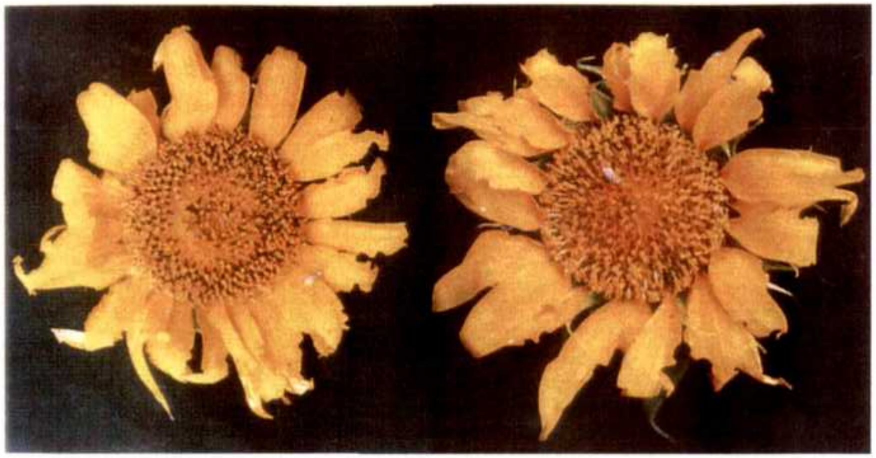

Plate-3b. Affected Flower

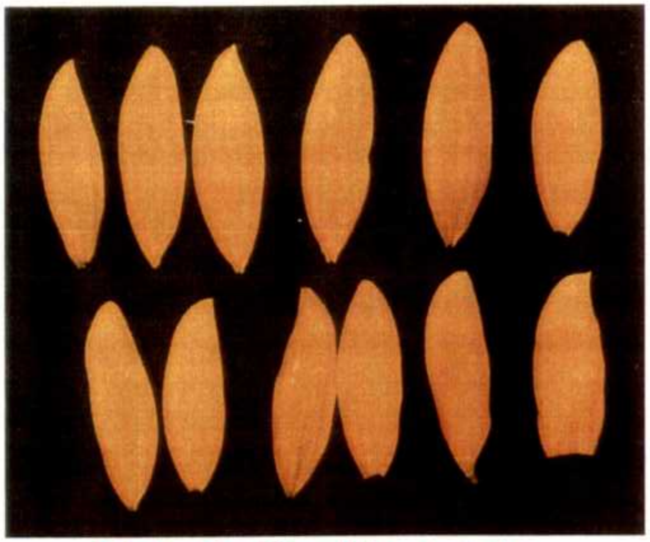

Plate-3c. Healthy petals

Plate-3d. Affected petals

Plate-3. CHARACTERISTIC NOTCHING DUE TO ASH WEEVIL *M.discolor* Boh. ON SUNFLOWER

Plate-4a. Leaf damage by ash weevil - closer view

Plate-4b

Plate-4c

Plate-4. LEAF DAMAGE BY ASH WEEVIL IN THE NURSERY

3.4.1. Method of screening

The intensity of damage on brinjal was graded as follows:

Grade	Damage rating (%)	Grading
1	01-20	Resistant
2	21-30	Moderately Resistant
3	31-40	Moderately susceptible
4	41-50	Susceptible
5	>50	Highly susceptible

3.5. Studies on determination of LC_{50} for selected insecticides for different ash weevil adults

The LC_{50} values for selected insecticides *viz.*, neem oil, dichlorvos, monocrotophos, phosalone, quinalphos, carbosulfan, endosulfan against *M. subfasciatus* on brinjal leaf and also *Myllocerus discolor* Boh. on sunflower leaf were determined. For this, graded doses of each insecticide were prepared for evaluation which were replicated thrice. The adult weevils, collected from the unsprayed field were utilised for each experiment which were kept at room temperature (32± 2°C) and RH (80±5%) for 12 hours as pre-starvation period. By following the 'Leaf Dip Bioassay' method, leaf discs of six cm diameter were cut and dipped in aqueous emulsion of the formulated insecticides with 0.1 per cent teepol for five seconds and air dried (Shivaramabhat, 1999). Ten insects (irrespective of sex) in each species were allowed to feed on the treated leaf discs, kept in petriplates and the mortality of ash weevil adults was recorded 24 hours after treatment. The moribund insects were counted as dead. The data on percentages of mortality were subjected to statistical scrutiny to determine the LC_{50} values for each insecticide.

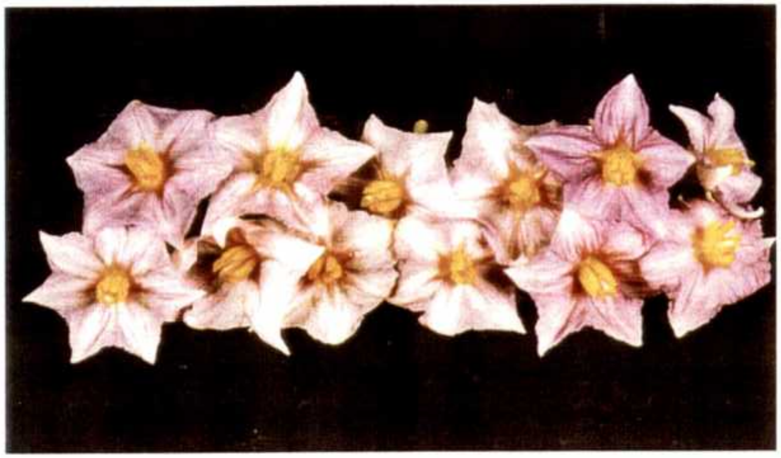

Plate-5a. Healthy flowers

Plate-5b Affected flowers

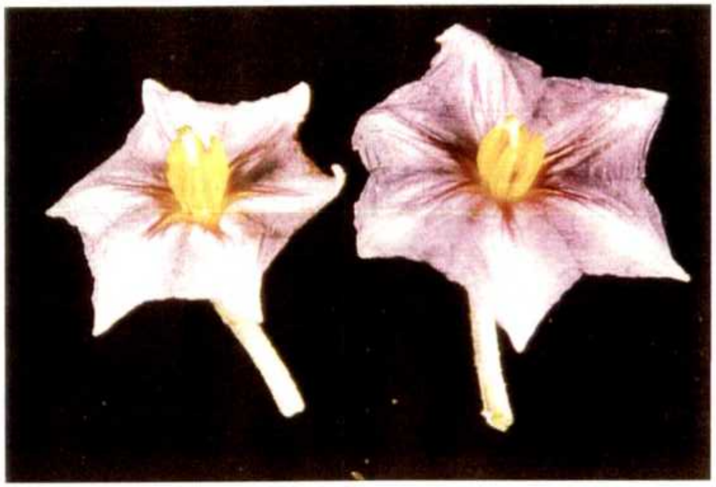

Plate-5c. Closer view - Healthy flowers

Plate-5d. Closer view - Affected flowers

Plate-5. CHARACTERISTIC NOTCHING DUE TO ASH WEEVIL, *M.subfasciatus* Guerin DAMAGE ON BRINJAL FLOWERS

3.6. Studies on effect of intercropping of coriander with brinjal on the population dynamics of ash weevil and natural enemies

The effect of brinjal - coriander intercropping on the incidence of *M. subfasciatus* was evaluated under field condition. The experiment was laid in an area of 400 m^2 (10 cents). The plots which had plant protection were separated from the plots of untreated check at a distance of 100 m to avoid drift of chemicals from the protected field to the unprotected field. The experiments were carried out in a randomised block design and the treatments were replicated three times with a plot size of 12 m^2 (4 x 3 m) for each replication. The brinjal variety grown was CO 2 and the coriander variety grown was CO 3. Forty five days old brinjal seedlings were transplanted in the main field at a spacing of 75 x 50 cm. After thirty days of transplanting of brinjal seedlings, coriander seeds were sown with a spacing of 35 cm either in one row or two rows as intercrop. All the standard package of practices recommended for brinjal were followed.

3.6.1. Treatment details

Cropping system

Brinjal - Coriander intercropping

Treatments - 8 (2 sets (4 in each set) first set without plant protection and the second set with plant protection)

Replications - 3

Design - RBD

The treatments included were,

Set I

1. Brinjal as a sole crop.
2. Brinjal with single row of coriander as intercrop.
3. Brinjal with two rows of coriander as intercrop.
4. Brinjal having a border row of coriander.

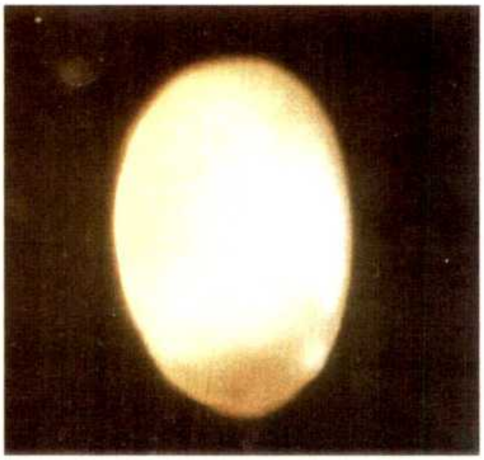

Plate-6a. Egg

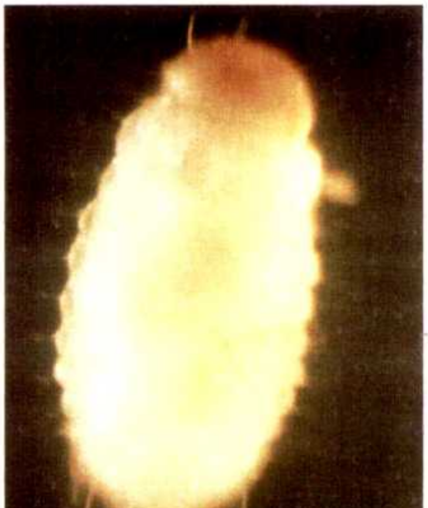

Plate-6b. Grub

Plate-6c. Adult

Plate-6. Egg, Grub and Adult stage of *Myllocerus subfasciatus* Guerin

Plate-7. Studies on date of planting of brinjal (Field view)

Plate-8a. Sole crop of brinjal

Plate-8b. Brinjal intercropped with coriander

Set II

5. Brinjal as a sole crop + application of endosulfan 35 EC 0.07 per cent (2 ml/lit)
6. Brinjal with single row of coriander as an intercrop + application of endosulfan 35 EC 0.07 per cent (2 m/lit).
7. Brinajl with 2 rows of coriander as an intercrop + application of endosulfan 35 EC 0.07 per cent (2 ml/lit).
8. Brinjal having a border row of coriander + application of endosulfan 35 EC 0.07 per cent (2 ml/lit).

3.6.2. Time of application of treatments

Application of endosulfan 0.07 per cent (2 ml/lit) was done against *M. subfasciatus* when the ash weevil damage was increased.

3.7. Effect of bio-control agents, organics and insecticides for the management of ash weevils on brinjal

Two field experiments were conducted for the management of ash weevil on brinjal at the Orchard of Tamil Nadu Agricultural University, Coimbatore in a randomised block design, replicated thrice with a plot size of 12 m^2 (net).

3.7.1. EXPERIMENT - I

Control of ash weevil grubs

In this experiment, the treatments consisted of soil application of treatments T_1 to T_8 which were given for the control of grubs. For the control of adults of ash weevils, spraying of endosulfan 0.07% (@ 2 ml/lit.) thrice at 15 days interval was given, commencing the first round after noticing the incidence of adult weevils on 45 DAT.

Treatment structure

T_1 - Soil application of neem cake once @ 250 kg / ha as basal

T_2 - Soil application of *Pseudomonas fluorescens* 2.5 kg/ha at 30 and 60 DAP

T_3 - Drenching of chlorpyriphos 20 EC 0.1% (5 ml/lit. of water) @ 1000 lit. spray fluid / ha at monthly interval thrice (i.e basal, 30 and 60 DAP).

T_4 - Basal application of carbofuran 3 G @ 0.5 kg a.i./ha

T_5 - Spot application of lindane 1.5% dust @ 50 kg/ha at the time of transplanting

T_6 - Spot application of malathion 5% dust @ 50 kg/ha at the time of transplanting

T_7 - Spot application of chlorpyriphos 1.5% dust @ 50 kg/ha at the time of transplanting

T_8 - Untreated check

DAP - Days after transplanting

Assessment of ash weevil damage

Observations were made on the damage caused by grubs of ash weevil from the time of planting at 15 days interval. By counting the total number of plants and affected (wilted) plants per plot, the percentage of wilted plants was worked out. The damage to the leaves due to adult weevils was assessed by counting the total number of leaves and damaged leaves from ten randomly selected plants per plot before treatment, 3, 7, 10 and 15 days after each round of spraying and percentage of damage to leaves was worked out. The population of adult weevil and natural enemies (spider, *Oxyopes* sp., coccinellid beetle, *M.sexmaculatus* and chrysopid, *Chrysoperla carnea*) was also recorded from ten randomly selected plants in the above lines and the mean population per plant was worked out.

Plate-9. GENERAL VIEW OF BRINJAL FIELD EXPERIMENT

Plate-9a

Plate-9b

3.7.2. Experiment II

Control of ash weevil adults

As a general treatment for the control of ash weevil grubs, soil application of carbofuran 3G @ 0.5 kg a.i./ha was given at the time of transplanting. In this experiment, the treatments consisted of foliar application of treatments T_1 to T_7 which were given for the control of adult weevils.

Treatment structure

T_1	-	Neem Azal T/S 1% @ 2 ml/lit. of water
T_2	-	NSKE - 5% @ 50g /lit. of water
T_3	-	Endosulfan 0.07% @ 2 ml/lit. of water
T_4	-	Dichlorvos 76 SC 0.15% @ 2 ml/lit. of water.
T_5	-	Malathion 50 EC 0.1% @ 2 ml/lit. of water
T_6	-	Carbaryl 50 WP 0.1% @ 2 g/lit. of water
T_7	-	Untreated check

The first round of treatments (sprays) was given as soon as the incidence of adult weevil / its damage was noticed i.e., 45 days after transplanting and subsequent three rounds of sprays were given at 15 days interval. The damage due to adult weevils to the leaves was assessed by counting the total number of leaves and damaged leaves. The population of adult weevils and natural enemies (spider, *Oxyopes* sp., coccinellids, *M. sexmaculatus* and chrysopid, *C. carnea*) was also recorded from ten randomly selected plants in the above lines and the mean population per plant was worked out in each observation.

3.8. Yield data

During each picking, in both the experiments the fruit yield was recorded in each plot and the yield of healthy fruits for each treatment from all the pickings was pooled and worked out on hectare basis. Similarly in the intercropping experiment, the grain yield of coriander was recorded for each treatment and worked out on hectare basis.

3.9. Cost benefit ratio

The additional yield of healthy fruits obtained in the treated plots over control was recorded and the total income derived from each treatment was worked out. In intercropping experiment along with the yield of healthy fruits, grain yield of coriander obtained from the intercropped plots were recorded and the total income derived from each treatment was worked out. Finally the cost benefit ratio was worked out for all the treatments, using the following formula as recommended by Selvaraj and Sundara Babu (1994).

$$\text{Cost benefit ratio} = \frac{\text{Cost of produce}}{\text{Cost of cultivation} + \text{Cost of plant protection}}$$

3.10. Statistical analysis

The percentage data obtained from the field experiment were subjected to arcsine (angular) transformation, while the data on the population of ash weevils and natural enemies were transformed into $\sqrt{x+0.5}$ before carrying out the statistical analysis. Critical different values were calculated at five per cent probability level and the treatment mean values of the experiment were compared using Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results

CHAPTER VI

RESULTS

4.1. Identification of alternate host plants to *Myllocerus* weevils

M. subfasciatus G. was recorded as a minor pest on sunflower, bhendi, and sweet potato. *M. discolor* Boh. occurred on different crops as a major pest such as sunflower, redgram, amaranthus and also groundnut, blackgram, gingelly, mango, moringa, clusterbean, cowpea, pungam, silkcotton tree, pannaikeerai and senkeerai as a minor pest. In case of sunflower, *M. discolor* fed voraciously on petals also.

M. viridanus F. was found to feed on bhendi, teak, moringa, rose, West Indian cherry, sunflower, mango, custard apple, cotton, mulberry, red gram, deccanhemp, sweetbasil and pungam as a minor pest at Coimbatore.

M. u. maculosus Fst. was found to feed on different crops such as sunflower, groundnut, cotton and jamun (Table 1).

4.2. Studies on effect of time of planting on the population dynamics of ash weevil, its' leaf damage and natural enemies' population on brinjal

4.2.1. Leaf damage

From the experiments conducted on different dates of transplanting, the data gathered on the percentage of leaf damage by ash weevil on brinjal at fortnightly interval were statistically analysed to fix the optimum dates of transplanting which were best suited for reducing the damage of ash weevil on brinjal (Table 2).

15 DAT

Table 2 depicts, the statistical analysis of data on the percentage of damage to leaves by brinjal ash weevil, *M. subfasciatus* recorded from different dates of transplantings revealed that the percentage of ash weevil damage on 15 DAT ranged from 28.95 to 55.23 per cent. Among the different dates of transplantings, transplanting taken on 15.9.2000 recorded

Table 1. Identification of alternate host plants to ash weevil *Myllocerus* spp.(1999-2001)

S.No.	Common name	Scientific name	Family	Species	Period of occurrence	Place	Status
1.	Sunflower	*Helianthus annus* L.	Compositae	*M. discolor* Boh	Jan.– April	TNAU	Major*
				M. viridanus F.	Feb. – March	TNAU	Minor
				M. subfasciatus. G	July – Aug.	TNAU	Minor
				M. u. maculosus Fst.	Sep. – Dec.	TNAU	Major
2.	Groundnut	*Arachis hypogea* L.	Leguminosae	*M. viridanus* F.	July – Aug.	TNAU, TMR	Major
				M.u. maculosus Fst.	July – Aug.	TNAU	Minor
				M. discolor Boh	Feb. – March	TMR	Minor
3.	Bhendi	*Abelmoschus esculentus* (L.) Moench	Malvaceae	*M. viridanus* F.	Feb. – March	TNAU	Major
				M. subfasciatus G.	Feb. – March	TNAU	Minor
4.	Blackgram	*Phaseolus mungo* Roxb.,	Leguminosae	*M. discolor* Boh.	March – April	TMR	Minor
5.	Gingelly	*Sesamum indicum* L.	Pedaillaceae	*M. discolor* Boh.	March – April	TMR	Minor
6.	Sweetbasil	*Ocimum basilicum* L.	Labiatae	*M. viridanus* F.	Feb. - March	TNAU	Minor
7.	Guava	*Psidium guajava* L.	Myrtaceae	*M. viridanus* F.	Jan. – April	TNAU	Minor
8.	Mango	*Mangifera indica* L.	*Anacardiaceae*	*M. discolor* Boh.	March – April	TNAU	Minor
				M. viridanus F.	March – April	TNAU	Minor
9.	Custard apple	*Annona squamosa* L.	Annonaceae	*M. viridanus* F.	March – April	TNAU	Minor
10.	Teak	*Tectona grandis*	Verbanaceae	*M. viridanus* F.	February – April	Ukkadum, TNAU	Major

Table 1. Contd...

S.No.	Common name	Scientific name	Family	Species	Period of occurrence	Place	Status
11.	Cotton	*Gossypium hirsutum* L.	Malvaceae	*M.u. maculosus* Fst.	July – Aug.	TNAU	Major
				M. viridanus F.	March – April	TNAU	Minor
12.	Moringa	*Moringa oleidera* Lam.		*M. viridanus* F.	Nov. – March	TNAU	Major
				M. discolor Boh.	Ceb. – March.	TNAU	Minor
13.	Mulberry	*Morus alba* L.	Moraceae	*M. viridanus* F.	March – April	TNAU	Minor
14.	Rose	*Rosa chinensis* Jacq.	Rosaceae	*M. viridanus* F.	March – April	B.G.	Major
15.	Redgram	*Cajanus cajan* (L.) Millsp.	Leguminosae	*M. discolor* Boh	Nov. – March	TNAU, TMR	Major
16.	Sapota	*Achras zapota* L.	Sapotaceae	*M. viridanus* F.	Nov. – March	TNAU, TMR	Minor
17.	Clusterbeans	*Cyamopsis tetragonaloba* (L.) Taub.	Leguminosae	*M. discolor* Boh.	March – April	TMR	Minor
18.	Cowpea	*Vigna sinensis* Savi.	Leguminosae	*M. discolor* Boh.	March – April	TMR	Minor
19.	Jamun	*Syzygium cumini* Skeels.		*M.u. maculosus* Fst	March – April	TMR	Minor
20.	Deccanhemp	*Hibiscus cannabinus*	Malvaceae	*M. viridanus* F.	March – April	TMR	Minor
21.	Kuppaikeerai	*Amaranthus viridis* L.	Amaranthaceae	*M. discolor* Boh	March – April	TMR	Major
22.	Pungam	*Pongamia glabra* L.	Leguminosae	*M. discolor* Boh	June– Sep.	TNAU	Minor
				M. viridanus F.			
23.	West Indian Cherry	*Malphigia punicifolia* L.	Malphiginaceae	*M. viridanus* F.	Feb. – April	TNAU	Major
24.	Silk cotton tree	*Ceiba pentandra* L.	Bombacaceae	*M. discolor* Boh.	March – April	TNAU	Minor
25.	Pannaikeerai	*Celosia argentea* L.	Amaranthaceae	*M. discolor* Boh.	March – April	TMR	Minor
26.	Senkeerai	*Amaranthus blitum* L.	Amaranthaceae	*M. discolor* Boh.	March – April	TMR	Minor
27.	Sweet potato	*Ipomea batatus* L.	Convulvulaceae	*M. subfasciatus* G.	March – April	TMR	Minor

* Also feeds voraciously on flower petals
TNAU - Tamil Nadu Agricultural University Campus
TMR - Thondamuthur village

minimum leaf damage of 28.95 per cent followed by transplantings on 1.10.2000, 1.3.2001, 15.2.2001, 16.10.2001 and on 31.10.2000 which recorded 29.01, 33.42, 34.79, 35.18 and 36.41 per cent respectively.

30 DAT

The percentage of leaf damage on 30 DAT ranged from 24.26 to 50.50 per cent. The transplanting taken on 15.9.2000 recorded the minimum damage of 24.26 per cent followed by transplantings on 1.10.2000, 1.3.2001, 15.2.2001, 1.3.2001 and on 31.10.2000 recorded 26.55, 30.80, 31.25, 34.63 and 34.78 per cent respectively.

45 DAT

The percentage of leaf damage recorded on 45 DAT ranged from 24.60 to 43.59 per cent. The transplanting taken on 15.9.2000, recorded the minimum damage of 24.60 per cent followed by transplantings taken on 1.10.2000 (26.03%), 1.3.2001 (30.50%), 15.2.2001 (30.77%), 1.2.2001 (34.23%) and on 15.1.2001 (34.79%).

60 DAT

The percentage of leaf damage by ash weevil recorded on 60 DAT was minimum on 15.9.2000 transplanting (27.19%) followed by transplantings taken on 1.10.2000 (27.23%), 15.2.2001 (29.13%), 1.3.2001 (29.88%), 1.2.2001 (33.30%) and on 2.1.2001 (33.95%).

75 DAT

Among the different dates of transplantings, the transplanting taken on 15.9.2000 recorded less ash weevil damage to leaves (17.49%) followed by on 15.2.2001 (27.76%), 1.3.2001 (27.90%), 1.2.2001 (29.30%), 15.1.2001 (31.84%) and on 15.12.2000 (31.95%).

90 DAT

The transplanting taken on 15.2.2001 recorded the minimum damage of 23.41 per cent followed by on 15.9.2000 (23.43%) 1.3.2001 (25.79%), 1.2.2001 (26.72%), 15.1.2001 (27.16%) and on 2.1.2001 (29.74%).

105 DAT

Among the different dates of transplantings, transplanting taken on 15.2.2001 recorded less leaf damage of 21.91 per cent followed by transplanting taken on 1.2.2001 (22.04%), 15.1.2001 (25.24%), 1.3.2001 (25.53%), 2.1.2001 (28.65%) and on 30.11.2000 (32.60%).

120 DAT

The statistical analysis of data on percentage of leaf damage recorded from different dates of transplantings, the transplanting taken on 15.2.2001 recorded the minimum damage of 22.63 per cent followed by transplanting on 1.3.2001 (23.41%), 15.1.2000 (25.82%), 1.2.2001 (27.05%), 1.2.2001 (28.93%) and on 15.11.2000 (31.39%).

The cumulative effect of different dates of plantings, in reducing the percentage of leaf damage by the ash weevil was in the order of 90 DAT (30.92%) <120 DAT (31.52%) < 105 DAT (31.69%) < 75 DAT (33.98%) < 30 DAT (34.63%) < 60 DAT (34.77%) < 45 DAT (34.83%) < 15 DAT (36.80%).

Considering the significance of different dates of plantings, the order of significance in recording less percentage of leaf damage was on 15.9.2000 (26.65%) < 15.2.2001 (27.71%) < 1.3.2001 (28.40%) < 1.2.2001 (31.16%) < 15.1.2000 (31.76%) <2.1.2000 (31.16%) < 1.10.2000 (33.18%) < 15.11.2000 (37.14%) <31.10.2000 (37.60%) < 16.10.2000 (38.05%) < 30.11.2001(30.39%) < 15.12.2000 (40.51%)

4.2.2. Adult population of ash weevil

15 DAT

Table 3 depicts, the statistical analysis of data on the population of adult ash weevils recorded from different dates of transplantings revealed that the ash weevil population on 15 DAT ranged from 0.25 to 3.30 adults. Among the different dates of transplantings, transplanting taken on 15.9.200 recorded less adult population of 0.25 adult per plant followed by transplanting on 1.10.2000, 16.10.2000, 15.11.2000, 31.10.2000 and on 2.1.2001 recorded 0.35, 0.65, 1.25, 1.35 and 2.55 adults per plant respectively.

Table 2. Data on ash weevil, *M. subfasciatus* damage to leaves of brinjal in different dates of transplanting

DOP	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	120 DAT	Mean
15.9.2000	28.95 (32.55)^{c}	24.26 (29.50)^{e}	24.60 (29.65)^{f}	27.19 (31.40)^{f}	17.49 (24.69)^{h}	23.43 (28.94)^{e}	35.57 (36.60)^{bc}	31.72 (34.27)^{cd}	26.65 (30.95)^{e}
1.10.2000	29.01 (32.55)^{c}	26.55 (31.00)^{de}	26.03 (30.65)^{ef}	27.23 (31.44)^{f}	39.94 (39.20)^{bc}	37.00 (37.46)^{ab}	40.49 (39.51)^{ab}	39.22 (38.76)^{ab}	33.18 (35.07)^{bcd}
16.10.2000	35.18 (36.38)^{b}	37.34 (37.66)^{b}	37.55 (37.79)^{bc}	36.05 (36.90)^{bc}	44.02 (41.56)^{b}	35.49 (36.56)^{ab}	35.26 (36.41)^{bc}	43.48 (41.25)^{a}	38.05 (38.06)^{ab}
31.10.2000	36.41 (37.11)^{b}	34.78 (36.13)^{bc}	37.05 (37.49)^{bc}	36.03 (36.88)^{bc}	35.84 (36.77)^{cde}	39.55 (38.97)^{a}	43.44 (41.23)^{a}	37.69 (37.87)^{b}	37.60 (37.81)^{ab}
15.11.2000	38.45 (38.31)^{b}	35.42 (36.51)^{bc}	43.59 (41.31)^{a}	38.91 (38.59)^{bc}	37.34 (37.66)^{cd}	37.13 (37.54)^{ab}	34.94 (36.23)^{c}	31.39 (34.07)^{cd}	37.14 (37.53)^{abc}
30.11.2000	37.49 (37.75)^{b}	35.75 (36.69)^{bc}	36.89 (37.39)^{bc}	49.54 (44.73)^{a}	50.39 (45.22)^{a}	32.79 (34.93)^{bc}	32.60 (34.80)^{cd}	31.66 (34.23)^{cd}	38.39 (38.22)^{ab}
15.12.2000	55.27 (48.00)^{a}	50.50 (45.29)^{a}	42.46 (40.65)^{ab}	41.30 (39.99)^{b}	31.95 (34.41)^{efg}	32.85 (34.97)^{bc}	34.58 (36.01)^{c}	35.25 (36.38)^{bc}	40.51 (39.46)^{a}
2.1.2001	37.57 (37.80)^{b}	34.81 (36.13)^{bc}	39.54 (38.96)^{abc}	33.95 (35.63)^{cde}	34.02 (35.67)^{def}	29.74 (33.05)^{cd}	28.65 (32.36)^{de}	27.05 (31.33)^{def}	33.16 (35.12)^{bcd}
15.1.2001	37.53 (37.77)^{b}	37.00 (37.46)^{b}	34.79 (36.14)^{cd}	34.74 (36.11)^{cd}	31.84 (34.32)^{efg}	27.16 (31.40)^{de}	25.24 (30.15)^{ef}	25.82 (30.51)^{ef}	31.76 (34.23)^{cde}
1.2.2001	37.62 (37.83)^{b}	37.14 (37.54)^{b}	34.23 (35.80)^{cd}	33.295 (35.22)^{cde}	29.300 (32.77)^{fg}	26.715 (31.10)^{de}	22.035 (27.99)^{f}	28.925 (32.53)^{de}	31.16 (33.85)^{de}
15.2.2001	34.79 (34.14)^{b}	31.26 (33.99^{cd})	30.77 (33.69)^{de}	29.13 (32.66)^{ef}	27.76 (31.79)^{g}	23.410 (28.9304)^{e}	21.91 (27.91)^{f}	22.63 (28.38)^{f}	27.71 (31.69)^{de}
1.3.2001	33.42 (35.32)^{bc}	30.81 (33.71)^{cd}	30.50 (33.52)^{de}	29.88 (33.13)^{def}	27.89 (31.88)^{g}	25.79 (30.52)^{de}	25.53 (30.34)^{ef}	23.41 (28.94)^{f}	28.40 (32.17)^{de}
Mean	36.80 (37.29)^{a}	34.64 (35.98)^{ab}	34.83 (36.10^{ab}	34.77 (36.07)^{ab}	33.98 (35.50)^{ab}	30.92 (33.70)^{b}	31.64 (34.11)^{b}	31.52 (34.05)^{b}	

Mean of two replications. DOP - Date of Planting; DAT - Days after transplanting
Figures in parentheses are arcsin transformed values
In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

30 DAT

The adult population per plant on 30 DAT ranged from 0.65 to 3.50 adults per plant. The transplanting taken on 1.10.2000 recorded the minimum adult population of 0.65 followed by transplanting on 15.9.2000, 16.10.2000, 15.11.2000, 31.10.2000 and on 1.2.2001 recording 0.70, 1.75, 2.35, 2.65 and 2.80 adults per plant respectively.

45 DAT

The population of adults' recorded on 45 DAT ranged from 0.35 o 3.55 adults per plant. The transplanting taken on 15.9.2000 recorded the minimum population of 0.35 adult followed by transplantings taken on 1.10.2000 (0.85 adults), 1.3.2001 (2.1 adults), 16.10.2000 (2.65 adults), 15.11.2001 (2.7 adults) and on 1.2.2001 (2.80 adults) per plant.

60 DAT

The adult population recorded on 60 DAT was minimum on 15.9.2000 transplanting (1.00 adult per plant) followed by transplanting taken on 1.10.2000 (1.25 adults), 1.3.2001 (2.2 adults), 1.2.2001 (2.55 adults), 15.2.2001 (2.65 adults) and on 15.12.2000 (2.70 adults) per plant.

75 DAT

Among the different dates of transplantings, the transplanting taken on 1.3.2001 recorded minimum ash weevil population of 2.10 adults per plant followed by on 15.9.2000, 1.2.2001, 15.2.2001 (2.50 adults), 1.10.2000 (2.65 adults) and on 15.1.2001 (3.10 adults) per plant.

90 DAT

The transplanting taken on 1.3.2001 recorded the minimum adult population of 2.00 per plant followed by on 1.2.2001 (2.10 adults), 15.2.2000 (2.25 adults), 15.9.2000 (2.90 adults), 2.1.2001 (3.05 adults), on 15.1.2001 (3.10 adults) per plant.

105 DAT

Among the different dates of transplantings, transplanting taken on 1.3.2001 recorded minimum adult population of 1.95 / plant followed by transplanting taken on 1.2.2001 (2.00 adults), 15.2.2001 (2.05 adults), 15.1.2001 (2.90 adults), 2.1.2001 (2.95 adults) and on 15.11.2000 (3.45 adults) per plant.

120 DAT

The statistical analysis of data on population of adult ash weevils recorded from different dates of transplantings indicated that the transplanting taken on 1.2.2001 and 1.3.2001 recorded the minimum population of 1.90 and 1.90 adults per plant respectively followed by 15.2.2001 (2.00 adults), 15.2.2000 and 15.1.2001 (2.65 adults), 2.1.2001 (2.70 adults) and 15.11.2000) (3.25 adults) per plant.

The cumulative effect of different dates of plantings, in reducing the population of adult ash weevil was in the order of 15 DAT (2.00) <30DAT (2.45) C 45 DAT (2.60) < 60 DAT (2.79)< 90DAT (3.16) < 75DAT (3.18) < 120 (3.30) < 105 DAT (3.39 adults) per plant.

Considering the significance of different dates of plantings, the order of significance in recording less population of adult ash weevil was on 15.9.2000 (1.91) < 1.3.2001 (2.24) < 1.10.2000 (2.36) < 1.2.2001 (2.47) < 15.2.2001 (2.51) < 15.11.2000 (2.98) < 15.12.2000 (3.06) < 2.1.2001 and 15.1.2001 (3.11) < 16.10.2000 (3.18), 31.10.2000 (3.51) < 30.11.2000 (3.96) per plant.

4.2.3. Natural enemies population

15 DAT

Table 4 depicts, the statistical analysis of data on the population of natural enemies' recorded from different dates of transplanting revealed that the natural enemies'

Table 3. Data on the population dynamics of adult ash weevil, *M. subfasciatus* in different dates of transplanting

DOP	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	120 DAT	Mean
15.9.2000	0.250 (0.87)^{f}	0.70 (1.09)^{e}	0.35 (0.92)^{g}	1.00 (1.22)^{e}	2.50 (1.73)^{f}	2.90 (1.84)^{e}	3.65 (2.04)^{b}	3.90 (2.10)^{d}	1.83 (1.46)^{d}
1.10.2000	0.35 (0.92)^{f}	0.65 (1.07)^{e}	0.85 (1.16)^{f}	1.25 (1.32)^{e}	2.65 (1.71)^{f}	3.35 (1.96)^{cd}	4.55 (2.25)^{a}	5.25 (2.39)^{a}	2.36 (1.61)cd
16.10.2000	0.65 (1.07)^{e}	1.75 (1.49)^{d}	2.65 (1.77)^{d}	3.35 (1.96)^{b}	3.55 (2.01)^{cd}	4.10 (2.14)^{a}	4.65 (2.27)^{a}	4.75 (2.29)^{b}	3.18 (1.88)^{abc}
31.10.2000	1.35 (1.36)^{d}	2.65 (1.77)^{bc}	3.35 (1.96)^{ab}	3.45 (1.99)^{b}	4.25 (2.18)^{b}	4.05 (2.13)^{ab}	4.45 (2.22)^{a}	4.50 (2.24)^{bc}	3.51 (1.98)^{ab}
15.11.2000	1.25 (1.32)^{d}	2.35 (1.69)^{c}	2.70 (1.79)^{cd}	3.30 (1.95)^{b}	3.85 (2.09)^{bc}	3.65 (2.04)^{bc}	3.45 (1.99)^{a}	3.25 (1.94)^{e}	2.98 (1.85)^{abc}
30.11.2000	3.30 (1.95)^{a}	2.90 (1.84)^{b}	3.45 (1.99)^{ab}	4.35 (2.20)^{a}	4.70 (2.28)^{a}	4.45 (2.22)^{a}	4.40 (2.21)^{a}	4.10 (2.14)^{cd}	3.96 (2.11)^{a}
15.12.2000	2.65 (1.77)^{c}	2.90 (1.84)^{b}	3.10 (1.89)^{bc}	2.70 (1.79)^{c}	3.25 (1.94)^{de}	3.55 (2.01)^{c}	3.65 (2.04)^{a}	2.65 (1.77)^{f}	3.06 (1.88)^{abc}
2.1.2001	2.55 (1.75)^{c}	3.45 (1.99)^{a}	3.55 (2.01)^{a}	3.35 (1.96)^{b}	3.25 (1.94)^{de}	3.05 (1.88)^{de}	2.95 (1.86)^{c}	2.70 (1.79)^{f}	3.11 (1.89)^{abc}
15.1.2001	2.90 (1.84)^{abc}	3.50 (1.99)^{a}	3.45 (1.99)^{ab}	3.35 (1.96)^{b}	3.10 (1.89)^{e}	3.10 (1.87)^{de}	2.90 (1.84)^{c}	2.65 (1.77)^{f}	3.12 (1.90)^{abc}
1.2.2001	3.10 (1.89)^{ab}	2.80 (1.82)^{b}	2.80 (1.82)^{cd}	2.55 (1.75)^{c}	2.50 (1.73)^{f}	2.10 (1.61)^{f}	2.00 (1.58)^{d}	1.90 (1.55)^{g}	2.47 (1.72)^{bcd}
15.2.2001	2.85 (1.83)^{bc}	2.85 (1.83)^{b}	2.90 (1.84)^{cd}	2.65 (1.77)^{c}	2.50 (1.73)^{f}	2.25 (1.66)^{f}	2.05 (1.59)^{d}	2.00 (1.58)^{g}	2.51 (1.73)^{bcd}
1.3.2001	2.80 (1.82)^{bc}	2.90 (1.84)^{b}	2.10 (1.61)^{e}	2.20 (1.64)^{d}	2.10 (1.61)^{g}	2.00 (1.58)^{f}	1.95 (1.57)^{d}	1.90 (1.55)^{g}	2.24 (1.65)cd
Mean	2.00 (1.53)^{c}	2.45 (1.69)^{bc}	2.60 (1.73)^{abc}	2.79 (1.79)^{ab}	3.18 (1.91)^{ab}	3.16 (1.91)^{ab}	3.39 (1.96)^{a}	3.30 (1.93)^{a}	

Mean of two replications. DOP - Date of Planting; DAT - Days after transplanting

Figures in parentheses are $\sqrt{x+0.5}$ values

In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

population on 15 DAT ranged from 0.30 to 2.80 adults per plant. Among the different dates of transplantings, transplanting taken on 15.2.2001 recorded more natural enemies' population of 2.80 adults followed by transplanting on 1.2.2001, 1.3.2001, 15.1.2001, 15.12.2k and on 31.10.2k which recorded 2.70, 2.45, 2.35, 1.25 and 0.90 adults per plant respectively.

30 DAT

The natural enemies' population per plant on 30 DAT ranged from 0.30 to 3.00 adults per plant. The transplanting taken on 15.1.2001 recorded the maximum adult natural enemies' of 3.00 per plant followed by on 15.2.2001, 1.3.2001, 15.1.2001, 31.10.2000 and on 2.1.2001 recorded 3.00, 2.90, 2.70, 1.90, 1.35 and 1.30 per plant respectively.

45 DAT

The population of natural enemies'recorded on 45 DAT ranged from 0.85 to 3.10 adults per plant. The transplanting taken on 1.2.2001 recorded the maximum population of 3.10 adult natural enemies' followed by transplantings taken on 15.2.2001 (3.00), 1.3.2001 (2.90), 15.1.2001 (2.00), 2.1.2001 (1.90) and on 15.12.2k (1.75) per plant.

60 DAT

The adult population of natural enemies' recorded on 60 DAT was maximum on 1.2.2001 transplanting (3.45 adults per plant) followed by transplantings taken on 15.2.2001 (3.10 adults) 1.3.2001 (2.95 adults), 2.1.2001, 15.1.2001 (2.10 adults and on 15.12 2k (1.90 adults) per plant.

75 DAT

Among the different dates of transplantings, the transplanting taken on 1.2.2001 recorded the maximum natural enemies' population (3.50 adults) followed by on 1.3.2001 (3.20 adults), 15.2.2001 (3.10 adults), 15.1.2001 (2.45 adults), 2.1.2001 (2.20 adults) and on 15.12.2k (2.10 adults) per plant.

90 DAT

The transplanting taken on 1.2.2001 recorded the maximum natural enemies' population of 3.70 per plant followed by on 15.2.2001 (3.45 adults), 1.3.2001 (3.25 adults), 15.1.2001 (2.65 adults), 31.10.2k (2.50 adults), and on 1.10.2k, 16.10.2k, 15.12.2k, 2.1.2001 each with 2.30 adults per plant.

105 DAT

Among the different dates of transplantings, transplanting taken on 1.2.2001 recorded the maximum natural enemies' population of 3.80/plant followed by transplanting taken on 15.2.2001 (3.70 adults), 1.3.2001 (3.30 adults), 15.1.2001, 1.10.2k (2.70 adults), and on 31.10.2k (2.60 adults) per plant.

120 DAT

The statistical analysis of data on population of natural enemies' recorded from different dates of transplantings, the transplanting taken on 1.2.2001 recorded higher natural enemies' population of 3.85 adults per plant followed by 15.2.2001 (3.70 adults), 1.3.2001 (3.35 adults), 15.1.2001 (2.80 adults) and on 15.9.2k, 1.10.2k (2.7 adults) per plant.

The cumulative effect of different dates of plantings, in increasing the population of natural enemies' was in the order of 120 DAT (2.79) > 105 DAT (2.67) > 90 DAT (2.49) > 75 DAT (2.21) > 60 DAT (2.06) > 45 DAT (1.78) > 30 DAT (1.45) > 15 DAT (1.31) adult natural enemies' per plant.

Considering the significance of different dates of plantings, the order of significance in recording more population of adult natural enemies' was on 1.2.2001 (3.39) > 15.2.2001 (3.22) > 1.3.2001 (3.01) > 15.1.2001 (2.37) > 15.12.2000 (2.00) > 2.1.2001 (1.91) > 31.10.2k (1.83) > 1.10.2000 (1.66) > 16.10.2000 (1.63) > 15.9.2000 (1.43) > 30.11.2000 (1.42) > 15.4.2000 (1.27) per plant.

Table 4. Data on total natural enemies population in different dates of transplanting (No. of adults per plant)

DOP	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	120 DAT	Mean
15.9.2000	0.45 (0.97)^{ef}	0.40 (0.95)^{f}	0.85 (1.16)^{de}	1.25 (1.32)^{f}	1.55 (1.43)^{de}	1.90 (1.55)^{c}	2.35 (1.69)^{c}	2.70 (1.79)^{cd}	1.43 (1.36)
1.10.2000	0.55 (1.02)^{e}	0.70 (1.09)^{e}	1.25 (1.32)^{c}	1.60 (1.45)^{de}	1.50 (1.41)^{e}	2.30 (1.67)^{b}	2.70 (1.79)^{c}	2.70 (1.79)^{cd}	1.66 (1.44)
16.10.2000	0.30 (0.89)^{f}	0.65 (1.07)^{e}	1.35 (1.36)^{c}	1.70 (1.48)^{d}	1.85 (1.53)^{cde}	2.30 (1.67)^{b}	2.50 (1.73)^{c}	2.35 (1.67)^{de}	1.63 (1.43)
31.10.2000	0.90 (1.18)^{d}	1.35 (1.36)^{cd}	1.10 (1.26)^{cd}	1.70 (1.48)^{d}	1.90 (1.55)^{cd}	2.50 (1.73)^{b}	2.60 (1.76)^{c}	2.60 (1.76)^{cd}	1.83 (1.51)
15.11.2000	0.65 (1.07)^{de}	0.30 (0.89)^{f}	0.80 (1.14)^{e}	1.30 (1.34)^{ef}	1.55 (1.43)^{de}	1.60 (1.45)^{c}	1.80 (1.52)^{d}	2.15 (1.63)^{e}	1.27 (1.31)
30.11.2000	0.65 (1.07)^{de}	0.50 (0.99)^{ef}	1.30 (1.34)^{c}	1.55 (1.43)^{def}	1.65 (1.47)^{de}	1.70 (1.48)^{c}	1.90 (1.55)^{d}	2.10 (1.61)^{e}	1.42 (1.37)
15.12.2000	1.25 (1.32)^{c}	1.65 (1.47)^{bc}	1.75 (1.49)^{b}	1.90 (1.55)^{cd}	2.10 (1.61)^{bc}	2.30 (1.67)^{b}	2.40 (1.70)^{c}	2.65 (1.77)^{cd}	2.00 (1.58)
2.1.2001	0.65 (1.07)^{de}	1.30 (1.34)^{d}	1.90 (1.55)^{b}	2.10 (1.61)^{c}	2.20 (1.64)^{bc}	2.30 (1.67)^{b}	2.30 (1.67)^{c}	2.50 (1.73)^{c}	1.91 (1.54)
15.1.2001	2.35 (1.69)^{b}	1.90 (1.55)^{b}	2.00 (1.58)^{b}	2.10 (1.61)^{c}	2.45 (1.72)^{b}	2.65 (1.77)^{b}	2.70 (1.79)^{c}	2.80 (1.82)^{c}	2.37 (1.69)
1.2.2001	2.70 (1.79)^{ab}	3.00 (1.87)^{b}	3.10 (1.89)^{a}	3.45 (1.99)^{a}	3.50 (1.99)^{a}	3.70 (2.05)^{a}	3.80 (2.07)^{a}	3.85 (2.09)^{a}	3.39 (1.97)
15.2.2001	2.80 (1.82)^{a}	2.90 (1.84)^{a}	3.00 (1.87)^{a}	3.10 (1.89)^{ab}	3.10 (1.89)^{a}	3.45 (1.98)^{a}	3.70 (2.05)^{ab}	3.70 (2.05)^{ab}	3.22 (1.93)
1.3.2001	2.45 (1.72)^{ab}	2.70 (1.79)^{a}	2.90 (1.84)^{a}	2.95 (1.86)^{b}	3.20 (1.92)^{a}	3.25 (1.94)^{b}	3.30 (1.95)^{b}	3.35 (1.96)^{b}	3.01 (1.87)
Mean	1.31 (1.30)^{d}	1.45 (1.35)^{a}	1.78 (1.49)^{c}	2.06 (1.59)^{b}	2.21 (1.64)^{b}	2.49 (1.72)^{a}	2.67 (1.77)^{a}	2.79 (1.81)^{a}	

Mean of two replications. DOP - Date of Planting; DAT - Days after transplanting

Figures in parentheses are $\sqrt{x+0.5}$ values

In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

4.2.4. Studies on correlations between the weather parameters and the incidence of ash weevil on brinjal and also multiple regression analysis

4.2.4.1. Correlations between weather parameters and leaf damage by ash weevil

Correlation studies made between weather parameters and leaf damage by ash weevil indicated that leaf damage was significantly and positively correlated with morning RH ($r = 0.259$) and negatively correlated with maximum temperature ($r = -0.036$), minimum temperature ($r = -0.630$), evening RH ($r = -0.249$), and rainfall intensity ($r = -0.236$) (Table 5).

The regression equation relating to the leaf damage fitted with weather parameters is given below.

Prediction equation,

$$Y = 113.77 - 0.488 (X_1) - 1.562 (X_2) + 0.046 (X_3) - 0.580 (X_4) + 0.018 (X_5) - 1.423 (X_6)$$

The partial regression co-efficients of different weather parameters and their significance are furnished in Table 6.

The results of the multiple regression analysis indicated that significant relationship was found to exist with the leaf damage and minimum temperature and evening RH and sunshine hours, indicating that when there is an increase in minimum temperature by 1°C, evening RH by 1 per cent and sunshine by one hour, there would be reduction in leaf damage on brinjal by 1.56, 0.58 and 1.43 per cent respectively.

The R^2 value of 0.53 revealed that the weather parameters cumulatively contributed 53 per cent for leaf damage on brinjal by the ash weevil.

Table 5. Correlation between the weather parameters and percentage of leaf damage by ash weevil

	Y_3	X_1	X_2	X_3	X_4	X_5	X_6
Y_3	1.000	-0.357**	-0.630**	0.259*	-0.249*	-0.236*	-0.019
X_1			0.786**	-0.219*	-0.597**	-0.092ns	0.539
X_2				-0.325**	-0.056ns	0.219*	0.132 ns
X_3					0.042ns	0.066ns	-0.025ns
X_4						0.514	-0.741**
X_5							-0.494**

* Significant at 5% level
** Significant at 1% level
ns nonsignificant

X_1 Maximum temperature (°C)
X_2 Minimum temperature (°C)
X_3 Morning RH (%)
X_4 Evening RH (%)
X_5 Rainfall intensity (mm)
X_6 Sunshine (hours)

Table 6. Partial regression coefficients of weather parameters and their significance for the percentage of leaf damage due to ash weevil, *M. subfasciatus*

Variables		Partial regression co-efficient (b)	Standard error	Significance
X_1	Maximum temperature (°C)	-0.488	0.701	-0.70ns
X_2	Minimum temperature (°C)	-1.562	0.776	-2.01*
X_3	Morning RH (%)	0.046	0.040	1.16ns
X_4	Evening RH (%)	-0.580	0.167	-3.48**
X_5	Rainfall intensity (mm)	0.012	0.298	0.04ns
X_6	Sunshine (hours)	-1.428	0.511	-2.80**

$R^2 = 0.53$**

NS - Non significant

** - Significant at 1% level

* - Significant at 5% level

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4.2.4.2. Correlation between weather parameters and ash weevil adult population

Correlation between weather parameters and ash weevil population revealed that the ash weevil adult population was significantly and negatively correlated with minimum temperature (r = -0.345) and evening RH (r = -0.645) and positively correlated with sunshine hours (r = 0.267) and not significant with maximum temperature, morning RH and intensity of rainfall (Table 7).

The regression equation relating to ash weevil population fitted with weather parameter is given below.

Prediction equation

$$Y = 18.01 - 0.181 (X_1) - 0.003 (X_2) + 0.002 (X_3) -0.174 (X_4) + 0.001 (X_5) - 0.262 (X_6)$$

The partial regression co-efficients of different weather parameters and their significance are furnished in the Table 8.

The results revealed that significant relationships were found to exist between the ash weevil population and evening RH and sunshine hours revealing that an increase in evening RH by one per cent and sunshine by one hour, there would be reduction in ash weevil population by 0.174 and 0.262 per plant respectively and the R^2 value of 0.65 showed that all the six weather parameters influenced the adult weevil population by 65 per cent.

4.2.4.3. Correlation between weather factors and natural enemies' population

Correlation between total natural enemies' population and weather parameters indicated that the natural enemies' population was significantly and positively correlated with maximum (r = 0.627) and minimum temperatures (r = 0.576) and sunshine hours (r = 0.252) and negatively correlated with evening RH (r = - 0.404) and morning RH (r = -0.417) and not significant with rainfall intensity (Table 9).

Table 7. Correlation between the weather parameters and population of ash weevil, *M. subfasciatus*

(n=96)

	Y_3	X_1	X_2	X_3	X_4	X_5	X_6
Y_3	1.000	0.054ns	-0.345**	0.087ns	-0.645**	-0.092ns	0.267**
X_1			0.786**	-0.219*	-0.597**	-0.092ns	0.539**
X_2				-0.325**	-0.056ns	0.219*	0.132ns
X_3					0.042ns	0.066ns	-0.025ns
X_4						0.514**	0.741**
X_5							-0.494**

* Significant at 5% level
** Significant at 1% level
ns nonsignificant

X_1 Maximum temperature (°C)
X_2 Minimum temperature (°C)
X_3 Morning RH (%)
X_4 Evening RH (%)
X_5 Rainfall intensity (mm)
X_6 Sunshine (hours)

Table 8. Partial regression coefficients of weather parameters and their significance for the ash weevil population

Variables		Partial regression co-efficient (b)	Standard error	Significance
X_1	Maximum temperature (°C)	-0.181	0.097	-1.86ns
X_2	Minimum temperature (°C)	-0.003	0.108	-0.03ns
X_3	Morning RH (%)	0.002	0.006	0.42ns
X_4	Evening RH (%)	-0.174	0.023	-7.51**
X_5	Rainfall intensity (mm)	-0.001	0.041	0.02ns
X_6	Sunshine (hours)	-0.262	0.071	-3.70**

$R^2 = 0.65$**

NS - Non significant

** - Significant at 1% level

* - Significant at 5% level

Table 9. Correlation between the weather parameters and natural enemies population

(n=96)

	Y_3	X_1	X_2	X_3	X_4	X_5	X_6
Y_3	1.000	0.627**	0.576**	-0.404**	-0.417**	-0.125ns	0.252*
X_1			0.786**	-0.219*	-0.597**	-0.092ns	0.539**
X_2				-0.325**	-0.056ns	0.219*	0.132ns
X_3					0.042ns	0.066ns	-0.025ns
X_4						0.514**	-0.741**
X_5							-0.494**

* Significant at 5% level
** Significant at 1% level
ns nonsignificant

X_1 Maximum temperature (°C)
X_2 Minimum temperature (°C)
X_3 Morning RH (%)
X_4 Evening RH (%)
X_5 Rainfall intensity (mm)
X_6 Sunshine (hours)

The regression equation relating to the natural enemies' population fitted with weather parameters is given below.

Prediction equation,

$$Y = 3.54 - 0.092 (X_1) + 0.348 (X_2) -0.014 (X_3) - 0.083 (X_4) - 0.030 (X_5) - 0.140 (X_6)$$

The partial regression co-efficients of different weather parameters and their significance are furnished in Table 10.

The results indicated the significant relationship between the natural enemies' population and minimum temperature, morning and evening RH and sunshine hours which revealed that an increase in minimum temperature by 1°C, there would be an increase in natural enemies' population by 0.348 while increase in morning and evening RH by one per cent each and sunshine by one hour, there would be reduction in natural enemies' population by 0.013, 0.083 and 0.140 per plant respectively and the R^2 value predicted that weather parameters contributed 56 per cent towards natural enemies' population.

4.3. Feeding potential of ash weevils on different host plants

Among the various host plants fed to ash weevils, it was noticed that brinjal was the most preferred host for *M. subfasciatus* which consumed a leaf area of 22.14 cm^2 while *M. discolor* consumed 20.50 cm^2 leaf area on sunflower. *M.u. maculosus* consumed 10.79 cm^2 leaf area on cotton, followed by *M. viridanus* fed an area of 11.19 cm^2 on bhendi. No significant differences could be observed in the feeding behaviour of different species of *Myllocerus* on brinjal, sunflower, cotton and bhendi. In case of *M. viridanus* fed on groundnut and West Indian Cherry only negligible leaf area of 6.18 cm^2 and 1.47 cm^2 respectively when compared to other species of *Myllocerus*. However from the above results, higher leaf area was fed by *M. subfasciatus* followed by *M. discolor* Boh., *M. viridanus* and *M.u. maculosus*. Among the host plants, *M. viridanus* ash weevils could feed more leaf area of groundnut followed by on bhendi and West Indian Cherry (Table 11).

Table 10. Partial regression coefficients of weather parameters and their significance for the total natural enemies population ash weevil population

Variables		Partial regression co-efficient (b)	Standard error	Significance
X_1	Maximum temperature (°C)	-0.092	0.093	-0.99ns
X_2	Minimum temperature (°C)	0.348	0.103	3.38**
X_3	Morning RH (%)	-0.014	0.005	-2.59*
X_4	Evening RH (%)	-0.083	0.022	-3.74**
X_5	Rainfall intensity (mm)	-0.030	0.040	-0.77ns
X_6	Sunshine (hours)	-0.140	0.068	-0.206*

$R^2 = 0.65$**

NS - Non significant

** - Significant at 1% level

* - Significant at 5% level

Table 11. Feeding potential of ash weevils, *Myllocerus* spp. on different host plants (cm^2)

S.No.	Host plants	Ash weevil, *Myllocerus* spp.	Mean area of leaf consumed within 24 hr (cm^2)
1.	Cotton, *Gossypium hirsutum* L.	*M. u. maculosus*	10.792^{b}
2.	Sunflower, *Helianthus annus* L.	*M. discolor*	20.500^{a}
3	Brinjal, *Solanum melongena* Guenee.	*M. subfasciatus*	22.138^{a}
4.	Groundnut, *Arachis hypogea* L.	*M. viridanus*	6.177^{c}
5.	Bhendi, *Abelmoschus esculentus* (L.)	*M. viridanus*	11.192^{b}
6.	West Indian Cherry, *Malphigia punicifolia*	*M. viridanus*	1.473^{d}

Means followed by a common letter are not significantly different at the 5% level by DMRT.

Regarding the feeding potential of ash weevil on different host plants by different species of *Myllocerus* indicated that brinjal, *M. subfasciatus* caused 54.63 per cent leaf damage on brinjal followed by *M. viridanus* on groundnut by 38.96 per cent. *M. discolor.* caused 28.79 per cent leaf damage on sunflower, while *M. viridanus* which caused 28.51 per cent leaf damage on bhendi followed by *M.u. maculosus* on cotton (24.40 per cent) (Table 12).

4.4. Screening of brinjal varieties, hybrids and germplasm accessions under field condition

4.4.1. Leaf damage

The results of the study revealed that the percentage of leaf damage on brinjal due to ash weevil on 15 DAT was less on SM 6 (22.82%) followed by on Annamalai, SM 100, EP 46, Gulabi, JB 2, SM 12, EP 136, BB 45, EP 114 and EP 167, recording 22.89, 23.97, 24.02, 23.34, 24.72, 25.74, 26.16, 26.18 and 26.56 per cent respectively. The maximum leaf damage was observed on the susceptible check CO 2 recording 68.72 per cent.

30 DAT

Among the different varieties of brinjal screened, the percentage of leaf damage due to weevil on 30 DAT was less on SM 6 followed by on EP 136, EP 114, Annamalai, PLR 1, P 76, EP 12, AB 2, EP 138, SM 100 and JB 2 recording 28.64, 30.87, 31.83, 32.99, 33.55, 33.69, 34.71, 35.09, 35.80 and 35.80 per cent respectively.

45 DAT

The per cent leaf damage due to ash weevil on 45 DAT was relatively less on EP 167 (30.51%) followed by on P 76 (30.90%), EP 136 (31.72%), SM 6 (31.85%), SM 12 (32.37%), EP 136 (31.72%), SM 6 (31.85%), SM-12 (32.37%), EP 46 (33.27%), AB 258 (33.50%), JB 2 (33.88%), EP 114 (34.01%), SM 100 (34.02%) and EP 79 (34.15%).

Table 12. Feeding potential of ash weevils, *Myllocerus* spp. on different host plants (%)

S.No.	Host plants	Ash weevil, *Myllocerus* spp.	Mean area of leaf consumed within 24 hr (%)
1.	Cotton, *Gossypium hirsutum* L.	*M. u. maculosus*	24.40[c]
2.	Sunflower, *Helianthus annus* L.	*M. discolor*	28.79[c]
3	Brinjal, *Solanum melongena* Guenee.	*M. subfasciatus*	54.63[a]
4.	Groundnut, *Arachis hypogea* L.	*M. viridanus*	38.96[b]
5.	Bhendi, *Abelmoschus esculentus* (L.)	*M. viridanus*	28.51[c]
6.	West Indian Cherry, *Malphigia punicifolia*	*M. viridanus*	14.88[d]

Means followed by a common letter, are not significantly different at the 5% level by DMRT.

60 DAT

The leaf damage due to ash weevil was less on 60 DAT on SM 6 (25.72%) followed by on P 76 (33.04%), BB 45 (33.15%), AB 2 (33.60%), EP 138 (34.19%), EP 114 (34.26%), SM 12 (34.33%), SM 100 (34.51%), EP 79 (34.8%), PLR 1 (35.03%) and on AB 258 (35.23%).

75 DAT

The per cent leaf damage due to ash weevil recorded on 75 DAT was less on entries EP 114, followed by on SM 6, EP 79, EP 138, P 76, SM 13, Gulabi, EP 147, AB 2, Annamalai and EP 136 recording 25.01, 29.44, 33.48, 33.72, 33.85, 34.26, 34.70, 34.79, 34.86, 34.89 and 35.00 per cent damage respectively.

90 DAT

Observations made on 90 DAT indicated that the leaf damage by ash weevil was minimum on EP 114 (27.63%), followed by on SM 6 (30.48%), SM 13 (33.77%), EP 136 (33.57%), EP 46 (34.72%), EP 138 (34.74%), SM 5 (34.75%), AB 258 (35.37%), SM 12 (35.46%, EP 12 (35.52%) and Gulabi (35.79%).

105 DAT

The minimum percentage of leaf damage recorded on 105 DAT was on EP 114 followed by on SM 6, EP 136, SM 13, SM 12, EP 167, AB 258, Annamalai, SM 5, EP 147 and EP 46 recording 27.93, 32.15, 32.94, 33.40, 33.65, 34.69, 34.89, 35.97, 35.98, 36.52 and 36.67 percentage respectively.

120 DAT

The ash weevil damage recorded on 120 DAT was minimum on EP 136 (31.44) followed by on PLR 1 (33.48%), SM 12 (34.67%), SM 100 (35.98%, EP 147 (36.34%), EP 138 (36.41%), EP 25 (37.16%), EP 114 (37.43%), AB 258 (37.57%), EP 46 (37.63%) and on SM 13 (37.84%) (Table 13).

Table 13. Screening of brinjal accessions / varieties / hybrids for their resistance to leaf damage due to ash weevil (percentage)

Sl.No.	VARIETIES	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	120 DAT	Mean	Grade
1.	EP 12	30.31 (33.37)^{bcd}	37.08 (37.51)$^{b-e}$	34.57 (36.01)$^{b-f}$	36.23 (37.00)^{cd}	36.82 (37.36)$^{b-e}$	35.52 (36.58)$^{c-f}$	37.95 (38.03)^{bc}	33.69 (35.48)^{cde}	35.27 (36.42)^{b}	MR
2.	PLR 1	33.11 (35.08)^{b}	33.48 (35.34)^{gh}	34.99 (36.26)$^{b-e}$	35.03 (36.28)^{cd}	34.93 (36.23)$^{c-f}$	36.41 (37.10)$^{b-f}$	37.13 (37.54)^{bc}	32.99 (35.04)^{def}	34.76 (36.12)^{b}	MR
3.	EP 138	27.54 (31.62)$^{c-f}$	36.41 (37.11)^{def}	37.03 (37.48)^{b}	34.19 (35.77)^{cd}	33.72 (35.49)^{ef}	34.74 (36.11)^{def}	36.98 (37.44)^{bc}	35.09 (36.33)^{bcd}	34.46 (34.93)^{b}	MR
4.	EP 147	30.63 (33.57)^{bc}	36.34 (37.07)^{def}	36.05 (36.89)^{bcd}	35.53 (36.58)^{cd}	34.79 (36.14)$^{c-f}$	36.42 (37.12)$^{b-f}$	36.52 (37.18)^{bc}	36.85 (37.37)^{b}	35.39 (36.49^{b}	MR
5.	EP 25	26.99 (31.29)$^{c-g}$	37.16 (37.56)$^{b-e}$	36.75 (37.32)^{b}	37.20 (37.58)^{bc}	37.89 (37.99)^{bc}	38.38 (38.28)^{bc}	38.59 (38.40)^{bc}	36.87 (37.38)^{b}	36.23 (36.98)^{b}	MR
6.	EP 114	26.18 (30.77)$^{d-g}$	37.43 (37.72)$^{b-e}$	34.01 (35.67)$^{b-f}$	34.26 (35.82)^{cd}	25.01 (30.00)^{h}	27.63 (31.71)^{h}	27.93 (31.89)^{d}	30.87 (33.75)^{f}	30.42 (33.42)^{de}	MR
7.	EP 136	25.74 (30.48)^{efg}	31.44 (34.10)^{i}	31.72 (34.28)^{def}	34.36 (35.88)^{cd}	35.00 (36.26)$^{b-f}$	33.57 (35.41)^{f}	32.94 (35.01)^{bcd}	28.64 (32.35)^{g}	31.68 (34.23)^{cdf}	MR
8.	EP 79	27.83 (31.83)$^{c-f}$	38.43 38.31)^{bcd}	34.15 (35.76)$^{b-f}$	34.81 (36.15)^{cd}	33.48 (35.35)^{f}	36.92 (37.41)$^{b-e}$	37.91 (38.00)^{bc}	36.56 (37.20)^{b}	35.01 (36.26)^{d}	MR
9.	EP 46	24.02 (29.31)^{fg}	37.64 (37.84)$^{b-e}$	33.27 (35.22)^{bf}	35.37 (36.49)^{cd}	35.51 (36.58)$^{b-f}$	34.72 (36.10)^{def}	36.67 (37.27)^{bc}	36.58 (37.22)^{b}	34.22 (35.76)^{b}	MR
10.	P 76	27.49 (31.61)$^{c-f}$	38.80 (38.53)^{bc}	30.90 (33.76)^{ef}	33.04 (35.08)^{d}	33.85 (35.57)^{ef}	37.12 (37.52)^{bcd}	40.12 (39.29)^{b}	33.55 (35.39)^{cde}	34.36 (35.85)^{d}	MR
11.	EP 167	26.56 (31.01)$^{c-g}$	39.01 (38.65)^{bcd}	30.51 (33.48)^{f}	35.99 (36.86)^{cd}	35.45 (36.53)$^{b-f}$	36.18 (36.97)$^{b-f}$	34.69 (36.07)^{bc}	36.27 (37.03)^{b}	34.33 (35.84)^{b}	MR
12.	AB 258	26.57 (31.02)$^{c-g}$	37.57 (37.80)$^{b-e}$	33.50 (35.35)$^{b-f}$	35.23 (36.41)^{cd}	38.04 (38.08)^{b}	35.37 (36.49)$^{c-f}$	34.89 (36.20)^{bc}	36.01 (36.87)^{bc}	34.65 (36.03)^{b}	MR
13.	IM 100	23.97 (29.29)$^{f-g}$	35.98 (36.85)^{ef}	34.02 (35.67)$^{b-f}$	34.51 (35.97)^{cd}	35.11 (36.32)$^{b-f}$	35.84 (36.76)$^{b-f}$	36.94 (37.42)^{bc}	35.80 (36.75)^{bc}	34.02 (35.64)^{dc}	MR
14.	Annamalai	22.89 (28.57)^{g}	37.05 (37.49)^{cde}	36.88 (37.39)^{b}	36.10 (36.92)^{cd}	34.89 (36.19)$^{c-f}$	36.17 (36.96)$^{b-f}$	35.97 (36.85)^{bc}	31.83 (34.34)^{ef}	33.97 (35.60)^{bbc}	MR
15.	SM 5	26.87 (31.19)$^{c-g}$	38.35 (38.26)^{bcd}	35.17 (36.35)$^{b-e}$	36.63 (37.23)^{cd}	35.03 (36.28)$^{b-f}$	34.75 (36.12)^{def}	35.98 (36.85)^{bc}	36.38 (37.09)^{b}	34.90 (36.18)^{b}	MR
16.	SM 12	25.71 (30.45)^{efg}	34.67 (36.07)^{fg}	32.37 (34.66)$^{c-f}$	34.33 (35.86)^{cd}	35.77 (36.73)$^{b-f}$	35.46 (36.52)$^{c-f}$	33.65 (35.44)^{bcd}	36.48 (37.15)^{b}	33.56 (35.37)$_{bc}$	MR
17.	SM 13	30.25 (33.34)^{bcd}	37.84 (37.96)$^{b-e}$	34.88 (36.19)$^{b-e}$	35.84 (36.77)^{cd}	34.26 (35.82)^{def}	33.77 (35.51)^{ef}	33.40 (35.29)^{bcd}	36.71 (37.29)^{b}	34.62 (36.03)^{b}	MR
18.	BB 45	26.16 (30.71)$^{d-g}$	39.32 (38.83)^{b}	36.59 (37.21)^{bc}	33.15 (36.35)^{cd}	37.18 (37.57)^{bcd}	38.88 (38.57)^{b}	38.05 (38.08)^{bc}	35.99 (36.86)^{bc}	35.67 (36.63)^{b}	MR
19.	SM 6	22.82 (28.5142)^{g}	32.42 (34.70)^{hi}	31.85 (34.24)^{def}	25.72 (30.44)^{e}	29.44 (32.85)^{g}	30.48 (33.50)^{g}	32.15 (34.51)^{cd}	28.10 (32.01)^{g}	29.12 (32.62)^{e}	SR
20.	AB 2	28.72 (32.40)^{cde}	38.15 (38.14)$^{b-e}$	34.76 (36.11)$^{b-e}$	33.60 (35.36)^{d}	34.86 (36.18)$^{c-f}$	36.72 (37.29)$^{b-f}$	38.74 (38.49)^{bc}	34.71 (36.09)^{bcd}	35.03 (36.27)^{b}	MR
21.	Gulabi	24.34 (29.56)^{fg}	37.75 (37.91)$^{b-e}$	34.84 (36.17)$^{b-e}$	40.23 (39.36)^{b}	34.70 (36.08)^{def}	35.79 (36.73)$^{b-f}$	39.20 (38.76)^{bc}	36.59 (37.22)^{b}	35.43 (36.48)^{b}	MR
22.	JB 2	24.72 (29.75)^{efg}	38.48 (38.34)^{bcd}	33.88 (35.58)$^{b-f}$	36.57 (37.20)^{cd}	35.35 (36.46)$^{b-f}$	38.19 (38.17)^{bc}	39.09 (38.69)^{bc}	35.80 (36.75)^{bc}	35.26 (36.38)^{b}	MR
23.	CO 2	68.72 (56.03)^{a}	64.21 (53.27)^{a}	67.98 (55.54)^{a}	68.68 (55.97)^{a}	71.67 (57.85)^{a}	72.96 (58.67)^{a}	60.31 (50.97)^{a}	66.32 (54.54)^{a}	67.61 (55.34)^{a}	HS

Mean of five replications. DAT - Days after transplanting. SR - Slightly resistant : MR - Moderately resistant ; HS - Highly susceptible
Figures in parentheses are arc sin transformed values.
In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

4.4.2. Adult ash weevil population

The statistical analysis of the data indicated that the adult population of ash weevil per plant on 15 DAT, was less on EP 136 (0.20) followed by on P 76, SM 5, SM 6, AB 2, PLR 1, EP 147, Gulabi, JB 2, SM 12 and SM 13 recording 0.40, 0.40, 0.80, 0.80, 1.00, 1.00, 1.00, 1.00 and 1.00 adults respectively. The maximum adult population was observed on susceptible check CO 2 recording 3.00 adults per plant (Table 14).

30 DAT

The adult population per plant was minimum on EP 136 and Gulabi (0.80) followed by EP 147 (1.00), EP 25 (1.00), BB 45 (1.00), EP 138 (1.20), EP 79 (1.2), SM 100 (1.2), SM 13 (1.2), SM 6 (1.2) and on AB 2 (1.2) respectively.

45 DAT

Among the different varieties of brinjal screened, the adult population per plant on 45 DAT was less on SM 13 (1.4) followed by on SM 6 (1.6), Gulabi (1.6), AB 258 (1.6), SM 100 (1.6), EP 136 (1.6), EP 25 (1.6), JB 2 (1.8), BB 45 (1.8), EP 46 (1.8) and on EP 79 (1.8) adult per plant respectively.

60 DAT

The ash weevil population recorded on 60 DAT was minimum on SM 6 (0.8) followed by on EP 138 (1.0), EP 167 (1.2), SM 12 (1.2), AB 258 (1.4), SM 5 (1.4), EP 136 (1.6), P 76 (1.6), SM 100 (1.6), Annamalai (1.6) and on SM 13 (1.6) adults per plant respectively.

75 DAT

The adult population recorded on 75 DAT was less on EP 46 (1.2) followed by on EP 138 (1.4), P 76 (1.4), EP 167 (1.6), AB 258 (1.6), EP 79 (1.6), EP 136 (1.6), EP 114 (1.6), EP 147 (1.8), PLR 1 (1.8) and on Annamalai (1.8) adults per plant.

90 DAT

The adult population on 90 DAT was less on EP 167, SM 6 and Gulabi (1.2) followed by JB 2 (1.4), SM 13 (1.4), EP 12 (1.4), EP 79 (1.6), AB 258 (1.6), SM 12 (1.6), AB 2 (1.8), SM 5 (1.8) and on EP 46 (1.8), EP 136 (1.8) adults per plant.

105 DAT

The adult population observed on 105 DAT was minimum on SM 6 (1.4) followed by on SM 12, EP 136, EP 12, EP 25, EP 114, EP 79, EP 167, SM 100 SM 5, AB 258 and on Annamalai recording 1.6, 1.6, 1.8, 1.8, 1.8, 1.8, 1.8, 1.8, 2.0 and 2.0 adults per plant respectively. The maximum adult population was recorded on susceptible check (5.8 adults per plant).

120 DAT

Among the different varieties of brinjal screened, the adult population of ash weevil on 120 DAT was less on EP 114 (1.4), followed by on SM 6 (1.8), EP 138 (2.0), EP 25 (2.0), EP 147 (2.2), PLR 1 (2.4), Gulabi (2.4), EP 79 (2.6), P 76 (26), EP12 (2.8) and on EP 136 (2.8) adults per plant. The maximum population was recorded on the susceptible check recording 6 adults per plant.

4.4.3. Natural enemies' population

15 DAT

The results of the study revealed that the natural enemies' population (Spider, Coccinellid and Chrysopid on 15 DAT was maximum on CO 2 (3.4) followed by on P 76 (1.8), EP 136 (1.6), SM 13 (1.6), BB 45 (1.6), SM 6 (1.6), Gulabi (1.4), SM 12 (1.4), SM 5 (1.4), Annamalai (1.4), SM 100 (1.4) and on AB 258 (1.4) adults per plant.

Table 14. Screening of brinjal accessions / varieties / hybrids for their resistance to adult ash weevil population

Sl.No.	VARIETIES	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	120 DAT	Mean
1.	EP 12	1.60 (1.27)^{b}	1.40 (1.88)^{bc}	2.00 (1.41)^{b}	1.80 (1.33)$^{b-e}$	2.2 (1.49)^{bcd}	1.40 (1.19)^{bc}	1.80 (1.35)^{b}	2.80 (1.68)$^{b-e}$	1.88^{bc}
2.	PLR 1	1.00 (0.87)$^{b-e}$	1.80 (1.33)^{b}	2.00 (1.41)^{b}	2.00 (1.41)$^{b-e}$	1.80 (1.33)^{bcd}	2.20 (1.48)^{bc}	2.20 (1.48)^{b}	2.40 (1.56)$^{b-e}$	1.91^{bc}
3.	EP 138	1.20 (1.03)^{bcd}	1.20 (1.11)^{bc}	2.20 (1.48)^{b}	1.00 (1.03)^{ef}	1.40 (1.19)^{cd}	2.00 (1.39)^{bc}	2.40 (1.56)^{b}	2.00 (1.41)^{def}	1.68^{bcd}
4.	EP 147	1.00 (0.95)^{bcd}	1.00 (1.03)^{bc}	2.20 (1.47)^{b}	2.40 (1.53)^{bcd}	1.80 (1.33)^{bcd}	1.80 (1.31)^{bc}	2.20 (1.49)^{b}	2.20 (1.49)$^{c-f}$	1.83^{bc}
5.	EP 25	1.20 (1.03)^{bcd}	1.00 (0.95)^{bc}	1.60 (1.25)^{b}	2.60 (1.59)^{bcd}	2.20 (1.45)^{bcd}	1.80 (1.35)^{bc}	1.80 (1.31)^{b}	2.00 (1.41)^{def}	1.78^{bcd}
6.	EP 114	1.40 (1.19)^{bc}	1.60 (1.27)^{bc}	2.20 (1.48)^{b}	3.2 (1.75)^{b}	1.60 (1.25)^{cd}	2.20 (1.48)^{bc}	1.80 (1.33)^{b}	1.40 (1.19)^{f}	1.93^{bc}
7.	EP 136	0.20 (0.38)^{a}	0.80 (0.79)^{c}	1.60 (1.17)^{b}	1.60 (1.25)$^{c-f}$	1.60 (1.27)^{bcd}	1.80 (1.31)^{bc}	1.60 (1.27)^{b}	2.80 (1.68)$^{b-e}$	1.50^{cd}
8.	EP 79	1.20 (1.11)^{bc}	1.20 (1.03)^{bc}	1.80 (1.33)^{b}	2.00 (1.39)$^{b-e}$	1.60 (1.27)^{bcd}	1.60 (1.27)^{bc}	1.80 (1.33)^{b}	2.60 (1.61)$^{b-e}$	1.73^{bcd}
9.	EP 46	0.60 (0.70)^{cde}	1.60 (1.27)^{bc}	1.80 (1.31)^{b}	2.20 (1.45)$^{b-e}$	1.20 (1.11)^{d}	1.80 (1.31)^{bc}	2.40 (1.53)^{b}	3.40 (1.85)^{bc}	1.88^{bc}
10.	P 76	0.40 (0.54)^{de}	1.40 (1.19)^{bc}	2.60 (1.61)^{b}	1.60 (1.27)$^{b-e}$	1.40 (1.19)^{cd}	2.20 (1.48)^{bc}	2.20 (1.48)^{b}	2.60 (1.61)$^{b-e}$	1.80^{bcd}
11.	EP 167	1.40 (1.19)^{bc}	1.40 (1.19)^{bc}	2.40 (1.56)^{b}	1.20 (1.11)^{def}	1.60 (1.27)^{bcd}	1.20 (1.11)^{c}	1.80 (1.35)^{b}	3.20 (1.79)^{bc}	1.78^{bcd}
12.	AB 258	1.20 (1.03)^{bcd}	1.00 (0.87)^{bc}	1.60 (1.22)^{b}	1.40 (1.19)^{def}	1.60 (1.27)^{bcd}	1.60 (1.27)^{bc}	2.00 (1.41)^{b}	3.60 (1.91)^{b}	1.78^{bcd}
13.	IM 100	1.20 (1.03)^{bcd}	1.20 (1.11)^{bc}	1.60 (1.27)^{b}	1.60 (1.27)$^{b-e}$	2.60 (1.59)^{bc}	2.40 (1.51)^{bc}	1.80 (1.33)^{b}	2.40 (1.56)$^{b-e}$	1.85^{bc}
14.	Annamalai	1.20 (1.03)^{bcd}	1.40 (1.19)^{bc}	2.20 (1.47)^{b}	1.60 (1.27)$^{b-e}$	1.80 (1.33)^{bcd}	2.80 (1.61)^{b}	2.00 (1.41)^{b}	3.00 (1.69)$^{b-e}$	2.00^{b}
15.	SM 5	0.40 (0.54)^{de}	1.40 (1.19)^{bc}	2.60 (1.62)^{b}	1.40 (1.19)^{def}	1.80 (1.35)^{bcd}	1.80 (1.33)^{bc}	1.80 (1.33)^{b}	3.00 (1.69)$^{b-e}$	1.78^{bcd}
16.	SM 12	1.002 (1.03)^{bcd}	1.60 (1.25)^{bc}	2.40 (1.56)^{b}	1.20 (1.17)^{def}	2.20 (1.45)^{bcd}	1.60 (1.27)^{bc}	1.60 (1.27)^{b}	2.80 (1.66)$^{b-e}$	1.80^{bcd}
17.	SM 13	1.002 (1.03)^{bcd}	1.20 (1.11)^{bc}	1.40 (1.17)^{b}	1.60 (1.27)$^{b-e}$	1.80 (1.33)^{bcd}	1.40 (1.19)^{bc}	2.00 (1.41)^{b}	3.00 (1.74)^{bcd}	1.68^{bcd}
18.	BB 45	1.20 (1.11)^{bc}	1.00 (0.95)^{bc}	1.80 (1.33)^{b}	2.20 (1.45)$^{b-e}$	3.00 (1.69)^{b}	2.20 (1.46)^{bc}	2.20 (1.48)^{b}	3.20 (1.79)^{bc}	2.10^{b}
19.	SM 6	0.80 (0.79)$^{b-e}$	1.20 (1.11)^{bc}	1.60 (1.25)^{b}	0.80 (0.79)^{f}	1.80 (1.33)^{bcd}	1.20 (1.03)^{c}	1.40 (1.19)^{b}	1.80 (1.35)^{ef}	1.33^{d}
20.	AB 2	0.80 (0.86)$^{b-e}$	1.20 (1.11)^{bc}	2.00 (1.41)^{b}	3.00 (1.69)^{bc}	1.60 (1.25)^{cd}	1.80 (1.33)^{bc}	2.40 (1.56)^{b}	3.40 (1.85)^{bc}	2.03^{b}
21.	Gulabi	1.00 (0.95)^{bcd}	0.80 (0.79)^{c}	1.60 (1.22)^{b}	1.80 (1.33)$^{b-e}$	1.80 (1.33)^{bcd}	1.20 (1.10)^{c}	2.20 (1.49)^{b}	2.40 (1.56)$^{b-e}$	1.60^{bcd}
22.	JB 2	1.00 (0.95)^{bcd}	1.60 (1.27)^{bc}	1.80 (1.33)^{b}	1.60 (1.27)$^{b-e}$	1.80 (1.33)^{bcd}	1.40 (1.19)^{bc}	2.00 (1.41)^{b}	3.00 (1.73)^{bcd}	1.78^{bcd}
23.	CO 2	3.002 (1.75)^{a}	3.40 (1.05)^{a}	4.80 (2.20)^{a}	5.60 (2.37)^{a}	5.40 (2.32)^{a}	6.00 (2.46)^{a}	5.80 (2.41)^{a}	6.00 (2.46)^{a}	5.00^{a}

Mean of five replications. DAT - Days after transplanting. Figures in parentheses are $\sqrt{x + 0.5}$ values.

In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

30 DAT

The population of natural enemies' recorded on 30 DAT was maximum on susceptible check (4.2) followed by on AB 258 (1.8), EP 12 (1.6), SM 13 (1.6), Gulabi (1.6), BB 45 (1.4), SM 100 (1.4), P 76 (1.4), EP 79 (1.4), EP 136 (1.4), EP 136 (1.4), PLR 1 (1.4) and on EP 138 (1.2) adults per plant.

45 DAT

Observations made on 45 DAT indicated that the population of natural enemies' was maximum on CO 2 (6.2) followed by JB 2 (2.6), AB 2 (2.6), Gulabi (2.4), SM 13 (2.4), EP 138 (2.4), EP 12 (2.2), EP 167 (2.2), AB 258 (2.2), SM 5 (2.0), BB 45 (2.0), EP 46 (2.0) and on EP 25 (2.0 per plant).

60 DAT

The population of natural enemies' on 60 DAT was maximum on susceptible check (6.6) followed by on EP 167 (3.4), AB 258 (3.0), JB 2 (2.8), AB 2 (2.8), P 76 (2.6), EP 25 (2.6), EP 114 (2.4), Annamalai (2.4), Gulabi (2.2) and on SM 100 (2.2) natural enemies' population per plant.

75 DAT

The natural enemies' population on 75 DAT was maximum on susceptible check (6.0) followed by on JB 2 (3.0), Gulabi (2.8), EP 25 (2.8), SM 12 (2.6), SM 13 (2.6), SM 5 (2.4), EP 12 (2.4), PLR 1 (2.2), P 76 (2.2) and on SM 6 (2.2) adult natural enemies' per plant.

90 DAT

The natural enemies' population observed on 90 DAT was maximum on CO 2 (6.4) followed by on P 76 (2.8) EP 167 (2.8), EP 114 (2.8), EP 25 (2.8), Annamalai (2.6), PLR 1 (2.6), EP 12 (2.4), EP 136 (2.4), EP 46 (2.4) and on EP 147 (2.2) adult natural enemies' per plant.

105 DAT

Observations made on 105 DAT revealed that the population was high on susceptible check, CO 2 (2.40) followed by on EP 25 (2.2), EP 12 (2.0), SM 6 (1.8), EP 79 (1.8), PLR 1 (1.6), EP 46 (1.6), EP 138 (1.4), EP 147 (1.4), EP 136 (1.4) and on P 76 (1.2) natural enemies' population per plant.

120 DAT

The population of natural enemies on 120 DAT was maximum on susceptible check, EP 114 (1.6) followed by on EP 138 (1.00), EP 138 (1.00) natural enemies' population per plant (Table 15).

4.5. Determination of LC_{50} values for selected insecticides to *Myllocerus* spp.

4.5.1. Studies on dosage-mortality response of *M. subfasciatus* to insecticides

The lethal doses of neem oil, dichlorvos, monocrotophos, phosalone, quinalphos, carbosulfan and endosulfan for adult weevils of *M. subfasciatus* infesting brinjal is given in the Table 16. .

Among the insecticides tested, monocrotophos was more toxic to *M. subfasciatus* with least LC_{50} value of 0.0338 ml/lit. followed by carbosulfan with 0.0395 ml/lit. to obtain fifty per cent mortality of population. Endosulfan, quinalphos and dichlorvos also registered moderate toxicity to *M. subfasciatus* requiring LC_{50} values of 0.0463, 0.0665 and 0.0780 ml/lit. respectively. Among the insecticides tested, phosalone resulted in less toxicity while the neem oil was the least effective to the weevil, in registering the LC_{50} values of 0.1061 and 11.8592 ml/lit respectively. The decreasing order of toxicity of tested insecticides in terms of LC_{50} (ml/litre) was monocrotophos (0.0338) > carbosulfan (0.0395) > endosulfan (0.0463) > quinalphos (0.0665) > dichlorvos (0.0780) > neem oil (11.8592).

Table 15. Screening of brinjal accessions / varieties / hybrids against natural enemies population in brinjal

Sl.No.	VARIETIES	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	120 DAT	Mean
1.	EP 12	1.00 (0.95)^{bc}	1.60 (1.27)^{bc}	2.20 (1.48)^{b}	2.00 (1.41)$^{c-g}$	2.40 (1.56)^{bcd}	2.40 (1.56)^{bc}	2.00 (1.41)^{ab}	0.60 (0.63)^{abc}	1.78^{b}
2.	PLR 1	1.00 (0.95)^{bc}	1.40 (1.19)^{bcd}	1.60 (1.27)^{bc}	2.00 (1.39)$^{c-g}$	2.20 (1.47)$^{b-e}$	2.60 (1.62)^{b}	1.60 (1.27)$^{a-d}$	1.00 (0.95)^{abc}	1.68^{b}
3.	EP 138	1.20 (1.11)^{bc}	1.20 (1.11)^{bcd}	2.40 (1.53)^{b}	2.002 (1.43)$^{b-f}$	1.60 (1.27)^{de}	1.80 (1.33)^{bcd}	1.40 (1.19)$^{a-e}$	1.00 (0.87)^{abc}	1.58^{b}
4.	EP 147	1.00 (0.95)^{bc}	0.40 (0.54)^{e}	1.80 (1.33)^{bc}	2.20 (1.48)$^{b-f}$	2.00 (1.41)$^{b-e}$	2.20 (1.48)^{bcd}	1.40 (1.19)$^{a-e}$	0.60 (0.63)^{abc}	1.45^{b}
5.	EP 25	1.00 (0.95)^{bc}	1.00 (0.95)$^{b-e}$	2.00 (1.32)^{bc}	2.60 (1.59)^{bcd}	2.80 (1.67)^{bc}	2.80 (1.67)^{b}	2.20 (1.48)^{a}	0.60 (0.70)^{abc}	1.88^{b}
6.	EP 114	1.40 (1.09)^{bc}	1.20 (1.11)^{bcd}	1.60 (1.07)^{bc}	2.40 (1.56)$^{b-e}$	1.80 (1.33)^{cde}	2.80 (1.67)^{b}	0.002 (0.23)^{h}	1.60 (1.17)^{ab}	1.90^{b}
7.	EP 136	1.60 (1.25)^{b}	1.40 (1.19)^{bcd}	1.80 (1.33)^{bc}	1.40 (1.19)^{efg}	1.60 (1.27)^{de}	2.40 (1.56)^{bc}	1.40 (1.19)$^{a-e}$	0.80 (0.79)^{abc}	1.55^{b}
8.	EP 79	1.002 (1.03)^{bc}	1.40 (1.19)^{bcd}	1.80 (1.33)^{bc}	2.002 (1.43)$^{b-f}$	1.80 (1.35)$^{b-e}$	2.00 (1.41)^{bcd}	1.80 (1.35)^{abc}	0.40 (0.54)^{bc}	1.53^{b}
9.	EP 46	1.002 (1.03)^{bc}	0.80 (0.79)^{de}	2.00 (1.39)^{bc}	1.40 (1.09)^{fg}	1.20 (1.11)^{e}	2.40 (1.56)^{bc}	1.60 (1.27)$^{a-d}$	0.60 (0.63)^{abc}	1.38^{b}
10.	P 76	1.80 (1.35)^{b}	1.40 (1.19)^{bcd}	1.60 (1.27)^{bc}	2.60 (1.62)^{bcd}	2.20 (1.49)$^{b-e}$	2.80 (1.67)^{b}	1.20 (0.93)$^{b-f}$	0.40 (0.47)^{bc}	1.75^{b}
11.	EP 167	1.20 (1.11)^{bc}	1.20 (1.11)^{bcd}	2.20 (1.48)^{b}	3.40 (1.82)^{b}	1.60 (1.25)^{de}	2.80 (1.67)^{b}	0.80 (0.79)$^{d-g}$	0.60 (0.70)^{abc}	1.73^{b}
12.	AB 258	1.40 (1.19)^{b}	1.80 (1.33)^{b}	2.20 (1.49)^{b}	3.00 (1.74)^{bc}	1.80 (1.35)$^{b-e}$	2.20 (1.47)^{bcd}	0.20 (0.38)^{gh}	0.40 (0.54)^{bc}	1.63^{b}
13.	IM 100	1.40 (1.19)^{b}	1.40 (1.19)^{bcd}	1.60 (1.25)^{bc}	2.20 (1.49)$^{b-e}$	1.80 (1.33)^{cde}	1.80 (1.33)^{bcd}	0.60 (0.70)$^{e-h}$	0.60 (0.63)^{abc}	1.43^{b}
14.	Annamalai	1.40 (1.19)^{b}	0.60 (0.63)^{e}	1.80 (1.33)^{bc}	2.40 (1.56)$^{b-e}$	1.80 (1.33)^{cde}	2.60 (1.61)^{b}	0.02 (0.23)^{h}	0.40 (0.54)^{bc}	1.38^{b}
15.	SM 5	1.40 (1.19)^{b}	1.00 (0.95)$^{b-e}$	2.00 (1.39)^{bc}	1.60 (1.27)$^{d-g}$	2.40 (1.56)^{bcd}	2.00 (1.41)^{bcd}	0.80 (0.86)$^{c-g}$	0.40 (0.54)^{bc}	1.45^{b}
16.	SM 12	1.40 (1.19)^{b}	1.00 (0.95)$^{b-e}$	1.40 (1.19)^{bc}	1.80 (1.35)$^{c-g}$	2.60 (1.56)^{bcd}	2.00 (1.41)^{bcd}	0.40 (0.54)^{fgh}	0.60 (0.63)^{abc}	1.40^{b}
17.	SM 13	1.60 (1.27^{b}	1.60 (1.27)^{bc}	2.40 (1.56)^{b}	2.00 (1.41)$^{c-g}$	2.60 (1.62)^{bcd}	1.60 (1.27)^{bcd}	0.40 (0.47)^{fgh}	0.20 (0.38)^{c}	1.55^{b}
18.	BB 45	1.60 (1.27^{b}	1.40 (1.19)^{bcd}	2.00 (1.41)^{bc}	1.80 (1.33)$^{c-g}$	1.80 (1.33)^{cde}	1.40 (1.19)^{cd}	0.40 (0.54)^{fgh}	0.60 (0.70)^{abc}	1.38^{b}
19.	SM 6	1.60 (1.27)^{b}	0.80 (0.86)^{cde}	1.20 (0.93)^{c}	1.20 (1.03)^{g}	2.20 (1.49)$^{b-e}$	1.40 (1.11)^{d}	1.80 (1.33)^{abc}	0.20 (0.38)^{c}	1.48^{b}
20.	AB 2	1.002 (1.03)^{bc}	1.20 (1.11)^{bcd}	2.60 (1.61)^{b}	2.80 (1.68)^{bc}	1.80 (1.25)^{de}	2.00 (1.41)^{bcd}	0.20 (0.38)^{gh}	0.80 (0.79)^{abc}	1.55^{b}
21.	Gulabi	1.40 (1.19)^{b}	1.60 (1.27)^{bc}	2.40 (1.53)^{b}	2.20 (1.49)$^{b-e}$	2.80 (1.67)^{bc}	1.40 (1.19)^{cd}	0.20 (0.38)^{gh}	0.40 (0.54)^{bc}	1.55^{b}
22.	JB 2	0.60 (0.70)^{c}	1.20 (1.11)^{bcd}	2.6 (1.62)^{b}	2.80 (1.68)^{bc}	3.00 (1.74)^{b}	2.00 (1.41)^{bcd}	0.40 (0.54)^{fgh}	0.40 (0.54)^{bc}	1.63^{b}
23.	CO 2	3.40 (1.85)^{a}	4.20 (2.04)^{a}	6.2 (2.49)^{a}	6.60 (2.58)^{a}	6.00 (2.45)^{a}	6.40 (2.53)^{a}	2.40 (1.56)^{a}	1.60 (1.27)^{a}	4.13^{a}

Mean of five replications. DAT - Days after transplanting. Figures in parentheses are $\sqrt{x + 0.5}$ values.

In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

Table 16. Determination of LC_{50} values of insecticides to *Myllocerus subfasciatus* adults on brinjal

Treatments	No. of insects tested	Chi-2 Value	b	LC_{50} (ml/lit)	(Fiducial limits) (95% confidence limits		Regression equation
					Upper	Lower	Y = a±bx
Neem oil	100	0.7173	1.7250	11.8592 (1.1859)	34.6309	4.0611	3.1473±1.7250x
Dichlorvos	100	0.9382	0.7272	0.0780 (0.0060)	0.1178	0.0516	5.8056±0.7272x
Monocrotophos	100	34.0071	2.5711	0.0338 (0.0012)	0.0379	0.0302	8.7809±34.0071x
Phosalone	100	8.0879	1.8727	0.1061 (0.0037)	0.1223	0.0920	6.8249±8.0879x
Quinalphos	100	1.2376	1.0495	0.0665 (0.0017)	0.0846	0.0525	6.2344±1.2376x
Carbosulfan	100	1.5386	0.8957	0.0395 (0.0016)	0.0520	0.0301	6.2565±1.5386x
Endosulfan	100	18.4773	2.1789	0.0463 (0.0016)	0.0526	0.0407	7.9083±18.4773x

Values in parentheses are given in percentage

4.5.2. Dosage mortality response of *M. discolor* Boh. to insecticides

Table 17 depicts the lethal doses of neem oil, dichlorvos, carbosulfan, quinalphos, carbosulfan and endosulfan, for the adult weevils of *M. discolor* attacking sunflower.

Among the insecticides tested, monocrotophos was more toxic to *M. discolor* with the least LC_{50} value of 0.0346 ml/lit followed by carbosulfan which required 0.0603 ml/lit to kill fifty per cent population of adult weevils. Quinalphos, endosulfan and phosalone registered moderate toxicity to *M. discolor* Boh. with LC_{50} values of 0.0782, 0.0834, 0.0879 ml/lit respectively. Among the insecticides treated, dichlorvos, had less toxicity and neem oil was the least effective when compared to other insecticides. The decreasing order of toxicity (LC_{50} in terms of ml/lit.) of tested insecticides was monocrotophos (0.0346) > carbosulfan (0.0603) > quinalphos (0.0782) >endosulfan (0.0834) > phosalone (0.0879) > dichlorvos (0.1463) > neem oil (20.72).

4.6. Studies on the effect of intercropping coriander with brinjal

4.6.1. Effect of intercropping on leaf damage by ash weevil

The leaf damage by the ash weevil was recorded at weekly interval from 45 DAT both in protected and unprotected crops. The observations made on 45 DAT revealed that per cent leaf damage varied from 41.59 to 45.82 per cent among the treatments which were all on par with each other. The data on 52 DAT indicated that the leaf damage by the weevil was minimum in brinjal when intercropped with double rows of coriander (36.57%) followed by brinjal with border coriander (36.97%) and brinjal + single row of coriander (37.09%) which were on par as against 40.37 per cent leaf damage on sole crop of brinjal under protected condition i.e., 7 days after the first spray of endosulfan 0.07 per cent while in untreated check the damage was 53.33 per cent. However, under unprotected condition, brinjal with two rows of coriander, coriander as border crop, and one row of coriander recorded the leaf damage of 40.43, 44.25 and 44.58 per cent respectively.

Plate-10. Determination Of LC_{50} Values For Different Insecticides

Table 17. Determination of LC_{50} values of insecticides to *Myllocerus discolor* adults on sunflower

Treatments	No. of insects tested	Chi-2 Value	B	LC_{50} (ml/lit.)	(Fiducial limits) (95% confidence limits		Regression equation
					Upper	Lower	Y = a±bx
Neem oil	100	3.2101	1.5501	20.720 (2.072)	79.7150	5.3862	2.9529±1.5501x
Dichlorvos	100	0.7161	1.0285	0.1463 (0.0111)	0.1842	0.1162	5.8585±1.0285x
Monocrotophos	100	9.2222	2.6301	0.0346 (0.0012)	3.8691	3.0974	8.8419±2.6301x
Phosalone	100	11.1332	1.8712	0.0879 (0.0031)	0.1005	7.6932	6.9756±1.8712x
Quinalphos	100	1.8464	2.3990	0.0782 (0.0020)	8.7626	6.9772	7.6553±2.3990x
Carbosulfan	100	6.7161	1.4724	0.0603 (0.0024)	7.1345	5.1031	6.7954±1.4724x
Endosulfan	100	2.1997	1.7216	0.0834 (0.0029)	9.6339	0.0722	6.8575±1.7216x

Values in parentheses are given in percentage

The observations recorded at 59 DAT under protection (i.e., 15 days after first spray) indicated that less leaf damage was recorded in brinjal + 2 rows of coriander (34.83%), followed by in brinjal with coriander as border crop and coriander as single row recorded leaf damage of 35.50 and 35.81 per cent respectively, which were on par while sole crop of brinjal recorded 38.08 and 54.33 per cent damage both under unproteccted and protected conditions respectively. Brinjal when intercropped with coriander recorded the leaf damage ranging from 38.36 to 43.50 per cent under unprotected condition which were on par.

Second spray

The observations recorded at 66 DAT under protection, indicated that the leaf damage was the lowest (28.08%) in brinjal + 2 rows of coriander followed by brinjal with border coriander (30.19%) and brinjal + single row of coriander (30.77 %) which were on par, while the leaf damage was 34.92 per cent on sole crop of brinjal with second spray of endosulfan 0.07 per cent as against the 57.50 per cent in untreated control. Under unprotected condition, brinjal with intercrop of coriander recorded the leaf damage ranging from 35.45 to 42.08 per cent.

The data obtained at 73 DAT under protection revealed that the brinjal with intercrop of coriander, the leaf damage was ranging from 28.86 per cent to 31.73 per cent which were on par followed by sole crop with 33.33 per cent under unprotected condition, brinjal with two rows of coriander, coriander as border crop, and one row of coriander recorded the leaf damage of 37.00 per cent, 37.67 per cent and 43.17 per cent respectively, which were on par as against 58.50 per cent leaf damage on untreated check.

Third spray

Results from the subsequent observations made on 80 DAT indicated that the leaf damage was minimum in brinjal + 2 rows of coriander (25.39%) followed by brinjal with border coriander (27.00%) and brinjal with single row of coriander (27.82%) which were on par with the leaf damage of 32.25 per cent in sole crop of brinjal under protected condition after the third spray with endosulfan 0.07 per cent as against 60 per cent on sole brinjal crop under untreated condition. However, under unprotected condition, brinjal with two rows of coriander, with border coriander and with single row of coriander recorded the leaf damage to an extent of 33.38, 35.17, and 37.42 per cent respectively.

The results obtained on 87 DAT indicated that leaf damage was 25.63, 26.28 and 28.02 per cent when brinjal intercropped with two rows of coriander, coriander as border crop and with single row of coriander respectively, as against 30.35 per cent in sole crop of brinjal under protected condition. The above cropping systems recorded 34.16, 33.80 and 34.67 per cent leaf damage respectively as against 61.50 per cent in brinjal under unprotected condition.

Fourth spray

The results obtained from the fourth spray at 94 DAT indicated that minimum leaf damage was observed in brinjal + two rows of coriander (22.17%) followed by border coriander (25.17%), single row of coriander (26.33%) and sole crop (30.23%) with protection which were on par. However, under unprotected condition, brinjal with 2 rows of coriander, border crop of coriander and single row of coriander recorded the leaf damage of 31.00, 33.92 and 34.17 per cent respectively as against 67.75 per cent in untreated check.

The observations recorded at 105 DAT indicated that less leaf damage was recorded in brinjal with two rows of coriander (17.08%) followed by border crop of coriander (18.50%) and single row of coriander (22.90%) which were on par with sole crop of brinjal (28.88%) with protection. Under unprotected condition, the above cropping systems recorded 29.08, 31.25 and 32.53 per cent leaf damage respectively as against 69.93 per cent in brinjal as sole crop (Table 18).

Table 18. Effect of Intercropping on the percentage of damage to leaves of brinjal by ash weevil (Season : November 2000 - April 2001)

Treatments	Percentage of damaged leaves by ash weevil								
	I spray			II spray		III spray		IV spray	
	PTC (45 DAT)	7 DAS (52 DAT)	15 DAS (59 DAT)	7 DAS (66 DAT)	15 DAS (73 DAT)	7 DAS (80 DAT)	15 DAS (87 DAT)	7 DAS (94 DAT)	15 DAS (101 DAT)
Unprotected									
Brinjal + single row of coriander	44.41 (41.78)^{a}	44.58 (41.89)^{b}	43.90 (41.27)^{b}	42.08 (40.44)^{c}	35.25 (38.20)^{b}	37.42 (37.71)^{b}	34.67 (30.07)^{b}	34.17 (35.77)^{b}	32.53 (34.77)^{b}
Brinjal + two rows of coriander	42.75 (40.83)^{a}	40.43 (39.48)^{cd}	38.36 (38.26)^{c}	35.45 (36.54)^{c}	37.00 (37.46)^{bc}	33.38 (35.29)^{c}	33.14 (35.15)^{bc}	31.00 (33.83)^{b}	29.08 (32.63)^{c}
Brinjal with border coriander	44.15 (41.64)^{a}	44.25 (41.69)^{bc}	43.00 (40.98)v	39.67 (39.04)^{b}	37.67 (37.86)^{b}	35.17 (36.37)^{bc}	33.80 (35.53)^{b}	33.92 (35.62)^{b}	31.25 (33.99)^{bc}
Protected									
Sole brinjal	45.75 (42.56)^{a}	40.37 (39.44)^{cd}	38.08 (38.10)^{c}	34.92 (36.22)^{c}	33.33 (35.26)^{cd}	32.25 (34.60)^{c}	30.35 (33.43)^{cd}	30.23 (33.35)^{bc}	28.88 (32.51)^{c}
Brinjal + single row of coriander	42.58 (40.73)^{a}	37.09 (37.51)^{d}	35.81 (36.74)^{cd}	30.77 (33.69)^{d}	31.73 (34.27)^{de}	27.82 (31.83)^{d}	28.02 (31.94)^{de}	26.33 (30.87)^{cd}	22.90 (28.56)^{d}
Brinjal + two rows of coriander	41.59 (40.15)^{a}	36.57 (37.20)^{d}	34.83 (36.17)^{d}	28.08 (31.98)^{d}	28.86 (32.47)^{e}	25.39 (30.22)^{d}	25.63 (30.42)^{e}	22.17 (33.83)^{b}	17.08 (24.41)^{e}
Brinjal with border coriander	41.69 (40.21)^{a}	36.97 (37.44)^{d}	35.50 (36.57)^{cd}	30.19 (33.31)^{d}	28.92 (32.53)^{e}	27.00 (31.28)^{d}	26.28 (30.33)^{e}	25.17 (30.04)^{de}	18.50 (25.46)^{e}
Control (Sole brinjal without protection)	45.82 (42.59)^{a}	53.33 (46.91)^{a}	54.24 (47.43)^{a}	57.50 (49.32)^{a}	58.50 (49.89)^{a}	60.00 (50.77)^{a}	61.50 (51.65)^{a}	67.75 (55.40)^{a}	69.93 (59.75)^{e}

Protected - Application of endosulfan @ 0.07% (1000 ml/ha);
Pre-treatment count (PTC) ; Days after spray (DAS); Days after transplanting (DAT);
Mean of three replications; Figures in parenthesis are arc sin transformed values
Means followed by same letters are not significantly different at 5% level by DMRT

4.6.2. Effect of intercropping systems on adult population of ash weevil

The adult population of ash weevil, *M. subfasciatus* before treatment ranged from 5.23 to 6.90 per cent. The statistical analysis of the data on adult population 7 and 15 days after the first, second, third and fourth sprays under protection with endosulfan 0.07 per cent indicated that the population was found to be less which ranged from 4.23 to 4.10; from 3.63 to 3.37; from 3.03 to 2.33 and from 2.47 to 1.93 per plant respectively in brinjal + 2 rows of coriander. The other treatments *viz*., brinjal with coriander as border crop (from 4.43 to 2.23 per plant) and coriander as single line (from 4.63 to 3.07 per plant) were on par, followed by the sole crop (from 5.73 to 4.30 per plant) in recording still lesser population of weevils. Under unprotected condition, brinjal when intercropped with coriander in different systems, recorded the population of weevils which ranged from 5.53 to 5.10 on 52 DAT and from 3.73 to 4.07 per plant on 101 DAT but were superior to untreated check recording 6.60 to 5.53 per plant (Table 19).

4.6.3. Population of natural enemies

The total population of natural enemeies *viz*., the spider, the coccinellid, and the green lace wing before imposing treatments ranged from 0.03 to 0.17 per plant.

The statistical analysis of data on natural enemies' population 7 and 15 days after first, second, third and fourth sprays under protection indicated that maximum population recorded in the cropping system of brinjal + two rows of coriander was ranging from 0.17 to 0.53 per plant, followed by brinjal + single row of coriander from 0.07 to 0.37 per plant and brinjal with border coriander from 0.03 to 0.33 per plant when compared to less population in sole crop of brinjal (0.03 to 0.37). Under the unprotected condition, the natural enemies' population was higher in brinjal with single row coriander (from 0.10 to 0.67 per plant) followed by brinjal with border coriander (from 0.10 to 0.56 per plant) and two rows of coriander (0.13 to 0.53 / plant) when compared to less population in sole crop of brinjal (from 0.40 to 0.80 per plant) (Table 20).

Table 19. Effect of Intercropping on the adult ash weevil population on brinjal (Season : November 2000 - April 2001)

Treatments	Total population of adults (No. per plant)								
	I spray			II spray		III spray		IV spray	
	PTC (45 DAT)	7 DAS (52 DAT)	15 DAS (59 DAT)	7 DAS (66 DAT)	15 DAS (73 DAT)	7 DAS (80 DAT)	15 DAS (87 DAT)	7 DAS (94 DAT)	15 DAS (101 DAT)
Unprotected									
Brinjal + single row of coriander	5.23 (2.39)[d]	5.53 (2.46)[bc]	5.43 (2.44)[b]	5.23 (2.39)[b]	5.03 (2.35)[b]	4.63 (2.27)[c]	4.47 (2.23)[c]	4.23 (2.18)[bc]	4.07 (2.14)[b]
Brinjal + two rows of coriander	6.40 (2.63)[ab]	5.10 (2.37)[c]	4.80 (2.30)[c]	4.43 (2.22)[cd]	4.37 (2.21)[cd]	4.20 (2.17)[d]	4.10 (2.14)[d]	3.90 (2.09)[d]	3.73 (2.06)[c]
Brinjal with border coriander	6.90 (2.72)[a]	5.23 (2.39)[c]	5.10 (2.37)[bc]	4.70 (2.28)[c]	4.43 (2.22)[e]	4.50 (2.24)[c]	4.27 (2.18)[cd]	4.00 (2.12)[cd]	3.73 (2.06)[c]
Protected									
Sole brinjal	6.60 (2.61)[ab]	5.73 (2.49)[b]	5.47 (2.44)[b]	5.33 (2.42)[b]	5.22 (2.39)[b]	5.07 (2.36)[b]	4.87 (2.32)[b]	4.53 (2.24)[b]	4.30 (2.19)[b]
Brinjal + single row of coriander	6.03 (2.56)[bc]	4.63 (2.26)[d]	4.43 (2.22)[d]	4.23 (2.18)[d]	4.03 (2.13)[de]	3.80 (2.07)[e]	3.50 (2.00)[e]	3.23 (1.93)[e]	3.07 (1.88)[d]
Brinjal + two rows of coriander	6.60 (2.66)[ab]	4.23 (2.18)[d]	4.10 (2.14)[d]	3.63 (2.03)[f]	3.37 (1.97)[f]	3.03 (1.88)[g]	2.33 (1.68)[g]	2.47 (1.72)[f]	1.93 (1.56)[f]
Brinjal with border coriander	6.47 (2.64)[ab]	4.43 (2.22)[d]	4.17 (2.16)[d]	3.93 (2.11)[e]	3.70 (2.05)[e]	3.30 (1.95)[f]	3.07 (1.89)[f]	2.57 (1.75)[f]	2.23 (1.65)[e]
Control (Sole brinjal without protection)	5.53 (2.46)[cd]	6.60 (2.66)[a]	6.80 (2.70)[a]	6.80 (2.70)[a]	6.40 (2.63)[a]	6.47 (2.64)[a]	6.17 (2.58)[a]	5.80 (2.51)[a]	5.53 (2.46)[a]

Protected - Application of endosulfan @ 0.07% (1000 ml/ha);
Pre-treatment count (PTC) ; Days after spray (DAS);

Mean of three replications; Values within parantheses are $\sqrt{x + 0.5}$ transformed values
Means followed by small letters in common within columns are not significantly different at 5% level by DMRT

Table 20. Effect of Intercropping on the total natural enemies population on brinjal (Season : November 2000 - April 2001)

Treatments	Total population of natural enemies per plant								
	I spray			II spray		III spray		IV spray	
	PTC (45 DAT)	7 DAS (52 DAT)	15 DAS (59 DAT)	7 DAS (66 DAT)	15 DAS (73 DAT)	7 DAS (80 DAT)	15 DAS (87 DAT)	7 DAS (94 DAT)	15 DAS (101 DAT)
Unprotected									
Brinjal + single row of coriander	0.17 $(0.46)^{a}$	0.10 $(0.39)^{bc}$	0.43 $(0.69)^{b}$	0.17 $(0.46)^{cd}$	0.47 $(0.72)^{b}$	0.50 $(0.74)^{b}$	0.50 $(0.74)^{b}$	0.47 $(0.72)^{b}$	0.67 $(0.85)^{b}$
Brinjal + two rows of coriander	0.13 $(0.43)^{a}$	0.13 $(0.43)^{b}$	0.37 $(0.64)^{b}$	0.30 $(0.59)^{bc}$	0.40 $(0.67)^{b}$	0.47 $(0.72)^{b}$	0.53 $(0.74)^{b}$	0.63 $(0.83)^{ab}$	0.53 $(0.76)^{c}$
Brinjal with border coriander	0.13 $(0.43)^{a}$	0.10 $(0.39)^{bc}$	0.47 $(0.72)^{ab}$	0.23 $(0.52)^{bcd}$	0.47 $(0.72)^{b}$	0.53 $(0.76)^{b}$	0.50 $(0.74)^{b}$	0.50 $(0.74)^{b}$	0.57 $(0.79)^{bc}$
Protected									
Sole brinjal	0.10 $(0.37)^{a}$	0.03 $(0.28)^{c}$	0.20 $(0.50)^{c}$	0.40 $(0.67)^{b}$	0.13 $(0.43)^{d}$	0.10 $(0.39)^{d}$	0.23 $(0.53)^{d}$	0.10 $(0.37)^{d}$	0.37 $(0.64)^{d}$
Brinjal + single row of coriander	0.07 $(0.316)^{a}$	0.07 $(0.33)^{bc}$	0.20 $(0.50)^{c}$	0.13 $(0.43)^{d}$	0.17 $(0.46)^{cd}$	0.10 $(0.39)^{d}$	0.30 $(0.59)^{cd}$	0.13 $(0.43)^{cd}$	0.37 $(0.64)^{d}$
Brinjal + two rows of coriander	0.03 $(0.28)^{a}$	0.17 $(0.46)^{b}$	0.23 $(0.53)^{c}$	0.20 $(0.49)^{cd}$	0.27 $(0.56)^{c}$	0.20 $(0.50)^{c}$	0.33 $(0.62)^{c}$	0.23 $(0.53)^{c}$	0.53 $(0.76)^{c}$
Brinjal with border coriander	0.07 $(0.32)^{a}$	0.03 $(0.28)^{c}$	0.27 $(0.56)^{c}$	0.20 $(0.49)^{cd}$	0.20 $(0.50)^{cd}$	0.17 $(0.46)^{cd}$	0.27 $(0.56)^{cd}$	0.17 $(0.46)^{cd}$	0.33 $(0.62)^{d}$
Control (Sole brinjal without protection)	0.17 $(0.46)^{a}$	0.40 $(0.67)^{a}$	0.57 $(0.78)^{a}$	0.70 $(0.87)^{a}$	0.67 $(0.85)^{a}$	0.70 $(0.87)^{a}$	0.77 $(0.90)^{a}$	0.80 $(0.92)^{a}$	0.80 $(0.92)^{a}$

Protected - Application of endosulfan @ 0.07% (1000 ml/ha)
Pre-treatment count (PTC) ; Days after spray (DAS);

Mean of three replications; Figures in parenthesis are $\sqrt{x + 0.5}$ transformed values
Means followed by small letters in common within the colours are not significantly different at 5% level by DMRT

4.6.4. Yield

Statistical analysis of the fruit yield of brinjal obtained from all the pickings from various treatments revealed that the highest yield (14.62 t/ha) was recorded in sole brinjal crop followed by brinjal with border coriander (14.58 t/ha), brinjal + single row of coriander (13.54 t/ha), brinjal + two rows of coriander (13.06 t/ha) with need based applications of insecticides when compared to 12.01, 11.92 and 10.83 t/ha in the treatments brinjal + single row of coriander, brinjal + border crop of coriander and brinjal + double rows of coriander respectively, as against 8.54 t/ha in sole crop of brinjal without protection.

Considering the grain yield of coriander, higher yields were obtained when coriander was raised as intercrop in two rows with brinjal (323.61 kg/ha), followed by single row of coriander with brinjal (247.78 kg/ha) and as border crop coriander with brinjal (204.17 kg/ha). The coriander when raised as two rows, border crop and as well as coriander as single line with brinjal under unprotected condition recorded the yield of 200.00, 186.11 and 175.00 kg/ha respectively which were on par with each other (Table 21).

4.6.5. Cost benefit ratio

Considering the Cost Benefit Ratio (CBR) worked out for different treatments, the CBR was the highest (1:3.20) in brinjal with border coriander crop followed by brinjal with single row of coriander (1:3.04), brinjal with two rows of coriander (1:3.04) and sole brinjal (1:3.01) with need based plant protection as against brinjal + border coriander crop (1:2.89), brinjal with single row of coriander (1:2.67) and brinjal + two rows of coriander (2.67) without protection, whereas untreated brinjal plots recorded the lowest CBR (1:2.16) (Table 22).

Table 21. Yield data (per ha) in the intercropping experiment. Season : November 2000 to April 2001

Treatments	Brinjal fruit yield (12 m^2)	Brinjal fruit yield (t/ha)	Coriander grain yield / (12 m^2) in grams	Coriander grain yield (kg/ha)
Unprotected				
Brinjal + single row of coriander	15.23	12.01[bc]	210.00	175.00[c]
Brinjal + two rows of coriander	13.00	10.83[d]	240.00	200.00[c]
Brinjal with border coriander	14.31	11.92[c]	223.33	186.11[c]
Protected				
Sole brinjal	18.17	14.62[a]	-	-
Brinjal + single row of coriander	16.25	13.54[b]	297.33	247.78[b]
Brinjal + two rows of coriander	16.08	13.06[b]	388.33	323.61[a]
Brinjal with border coriander	17.50	14.58[a]	245.00	204.17[c]
Control (Sole brinjal without protection)	10.25	8.54[e]	-	-

(Mean of three observations)
Means followed by small letters in common within the columns are not significantly different at 5 per cent level in DMRT.

Table 22. Intercropping experiment BC ratio

Treatments	No. of sprays	Estimated healthy brinjal fruit yield (t/ha)	Estimated grain yield of coriander (kg/ha)	Additional yield	Gross income (Rs.)	Additional Income (Rs.)	Cost of cultivation + cost of treatments (Rs.)	Net income (Rs.)	BC ratio
Brinjal + single row of coriander	-	12.01^{bc}	175.00^{c}	4.15	65300.00	20750.00	22560.00	40440.00	1:2.89
Brinjal + two rows of coriander	-	10.83^{d}	200.00^{c}	2.29	60150.00	11450.00	22560.00	48700.00	1:2.67
Brinjal with border coriander	-	11.92^{c}	186.11^{c}	3.38	65183.33	16900.00	22560.00	42623.33	1:2.89
Protected									
Sole brinjal	4	14.62^{a}	-	6.60	73100.00	33000.00	24316.00	48784.00	1:3.01
Brinjal + single row of coriander	4	13.54^{b}	247.78^{b}	5.00	75133.40	25000.00	24700.00	50253.00	1:3.04
Brinjal + two rows of coriander	4	13.06^{b}	323.61^{a}	4.52	75008.30	22600.00	24700.00	50128.30	1:3.04
Brinjal with border coriander	4	14.58^{a}	204.17^{c}	6.04	79025.10	30200.00	24700.00	54145.10	1:3.20
Control (Sole brinjal without protection)	-	8.54^{e}	-	-	42700.00	-	19800.00	22900.00	1:2.16

Cost of cultivation : Brinjal Rs.19,800/- Coriander Rs.1,800/-

Price of fruits: Rs.5/- per kg Price of grains Rs.30/- per kg

Mean of three replications.

Means followed by small letters in common within the mm are not significantly different at 5% level in DMRT.

4.7. Effect of bio-control agents, organics and insecticides for the management of ash weevils on brinjal

4.7.1. Experiment I

4.7.1.1. Percentage of wilting of plants

The percentage of wilting of plants due to ash weevil damage was noticed from 7 DAT to 35 DAT.

The statistical analysis of data indicated that chlorpyriphos 20 EC @ 1000 ml/ha was significantly superior to other treatments in recording the lowest wilting percentage of 3.33, 2.22, 1.11, 1.11 and 0.003 on 7, 14, 21, 28 and 35 DAT respectively. The extent of wilting of plants recorded in other treatments on the above periods was in the order of carbosulfan 3G @ 0.5 kg a.i./ha (3.33, 2.22, 2.22, 2.22 and 1.11 per cent) > neem cake 250 kg/ha (4.89, 3.78, 2.22, 2.22 and 2.22 per cent) > lindane 1.5%, dust @ 50 kg/ha (7.35, 3.33, 2.67, 2.67 and 2.67 per cent) > malathion 5% dust @ 50 kg/ha (7.35, 4.89, 3.78, 3.78 and 3.84 per cent) > chlorpyriphos 1.5% dust (7.62, 6.07, 4.96, 4.96 and 3.89) > *Pseudomonas fluorescens* 2.5 kg/ha (12.18, 12.46, 4.89, 3.78 and 4.89 per cent) which were on par with each other (Table 23).

4.7.1.2. Leaf damage

The pre-treatment observation on percentage of leaf damage due to ash weevil ranged from 20.50 to 38.54. The final leaf damage due to the cumulative effect as reflected after the third spray ranged from 17 per cent in carbofuran 3G @ 0.5 kg a.i/ha which was significantly superior to other treatments, followed by neem cake 250 kg /ha (18.34%), lindane 1.5% dust @ 50 kg/ha (19.5%) while in untreated check, it was 58.59 per cent. The other treatments in the order of their efficacy was chlorpyriphos 20 EC @ 1000 ml/ha (19.83%) < malathion 5% dust @ 50 kg/ha (23.25%) < chlorpyriphos 1.5% dust @ 50 kg/ha (25.42%) < *Pseudomonas fluorescens* @ 2.5 kg/ha (26.50%) (Table 24).

Table 23. Experiment I : Effect of Soil application of treatments on percentage of wilting of plants due to ash weevil in brinjal

Treatments	7 DAT	14 DAT	21 DAT	28 DAT	35 DAT
Neem cake @ 250 kg/ha	4.89 (12.49)[c]	3.78 (8.98)[c]	2.22 (7.01)[b]	2.22 (7.01)[b]	2.22 (7.01)[bc]
Pseudomonas fluorescens @ 2.5 kg/ha	12.18 (20.41)[ab]	12.46 (20.64)[ab]	4.89 (12.49)[b]	3.78 (8.98)[b]	4.89 (12.49)[b]
Chlorpyriphos 20EC @ 1000ml/ha.	3.33 (10.52)[c]	2.22 (7.01)[c]	1.11 (3.50)[b]	1.11 (3.50)[b]	0.003 (0.19)[c]
Carbofuran 3G @0.5 kg a.i./ha	3.33 (10.52)[c]	2.22 (7.01)[c]	2.22 (7.01)[b]	2.22 (7.01)[b]	1.11 (3.50)[bc]
Lindane 1.5% D @50kg/ha	7.35 (15.35)[bc]	3.33 (10.52)[c]	2.67 (5.48)[b]	2.67 (5.48)[b]	2.67 (5.48)[bc]
Malathion 5% D @50kg/ha	7.35 (15.35)[bc]	4.89 (12.49)[c]	3.78 (8.98)[b]	3.78 (8.98)[b]	3.84 (6.62)[bc]
Chlorpyriphos 1.5% D @50kg/ha	7.62 (15.60)[bc]	6.07 (13.63)[bc]	4.96 (10.12)[b]	4.96 (10.12)[b]	3.89 (9.09)[bc]
Untreated check	14.44 (22.31)[a]	19.99 (26.51)[a]	20.19 (26.66)[a]	21.11 (27.34)[a]	22.22 (28.11)[a]

Mean of three replications. DAT - Days after transplanting
Figures in parentheses are arcsin transformed values.
In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

Table 24. Experiment I : Effect of treatments on ash weevil damage to leaves of brinjal (%)

Treatments	I Spray					II Spray				III Spray			
	PTC	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS
Neem cake @ 250 kg/ha	21.95 (27.94)^{f}	22.35 (28.21)^{e}	21.43 (27.58)^{ef}	21.50 (27.63)^{e}	26.47 (30.96)^{d}	25.07 (30.04)^{e}	24.29 (29.53)^{g}	23.49 (28.99)^{f}	24.42 (29.61)^{f}	21.32 (27.49)^{f}	20.27 (26.75)^{g}	19.42 (26.14)^{f}	18.34 (25.35)^{f}
Pseudomonas fluorescens @ 2.5 kg/ha	33.93 (35.63)^{b}	34.07 (35.71)^{b}	33.41 (35.31)^{b}	32.30 (34.63)^{b}	35.40 (36.51)^{b}	34.83 (36.17)^{b}	34.48 (35.96)^{b}	33.50 (35.37)^{b}	34.50 (35.97)^{b}	31.89 (34.38)^{b}	30.77 (33.69)^{b}	28.15 (32.04)^{b}	26.50 (30.98)^{b}
Chlorpyriphos 20EC @ 1000 ml/ha	21.42 (27.57)^{g}	20.88 (27.19)^{f}	20.28 (26.77)^{g}	20.03 (26.59)^{g}	26.52 (30.99)^{d}	25.90 (30.59)^{d}	25.55 (30.36)^{f}	24.29 (29.53)^{e}	25.00 (30.00)^{e}	22.05 (28.01)^{e}	21.42 (27.57)^{f}	20.33 (26.80)^{e}	19.83 (26.45)^{e}
Carbofuran 3G @ 0.5 kg a.i./ha	20.50 (26.92^{h}	21.92 (27.91)^{e}	21.25 (27.45)^{f}	21.00 (27.78)^{f}	26.77 (31.16)^{d}	24.25 (29.50)^{f}	23.46 (28.97)^{h}	22.61 (28.39)^{g}	23.08 (28.71)^{g}	20.20 (26.71)^{g}	19.00 (25.84^{h}	18.08 (25.16)^{g}	17.00 (24.35)^{g}
Lindane 1.5% D @ 50 kg/ha	25.96 (30.63)^{e}	21.75 (27.80)^{e}	22.00 (27.97)^{e}	21.76 (27.80)^{e}	26.76 (31.15)^{d}	26.17 (30.77)^{d}	26.28 (30.84)^{e}	23.18 (28.78)^{fg}	24.25 (29.50)^{f}	22.40 (28.25)^{e}	21.82 (27.85)^{e}	20.46 (26.89)^{e}	19.50 (26.20)^{e}
Malathion 5% D @ 50 kg/ha	28.12 (32.02)^{d}	28.02 (31.96)^{d}	27.44 (31.59)^{d}	26.75 (31.14)^{d}	34.15 (35.76)^{c}	33.34 (35.27)^{c}	32.52 (34.77)^{d}	30.79 (33.70)^{d}	31.00 (33.84)^{d}	26.44 (30.94)^{d}	25.67 (30.44)^{d}	24.25 (29.50)^{d}	23.25 (28.83)^{d}
Chlorpyriphos 1.5% D @ 50 kg/ha	32.08 (34.50)^{c}	32.25 (34.60)^{c}	31.42 (34.09)^{c}	31.08 (33.88)^{c}	35.13 (36.35)^{b}	34.41 (35.91)^{b}	33.48 (35.35)^{c}	32.60 (34.82)^{c}	33.18 (35.17)^{c}	30.43 (33.48)^{c}	28.72 (32.40)^{c}	27.00 (31.31)^{c}	25.42 (30.28)^{c}
Untreated check	38.54 (38.37)^{a}	39.10 (38.70)^{a}	40.63 (39.60)^{a}	41.16 (39.91)^{a}	42.97 (40.96)^{a}	43.63 (41.34)^{a}	44.44 (41.81)^{a}	46.16 (42.80)^{a}	47.89 (43.79)^{a}	53.33 (46.91)^{a}	54.75 (47.73)^{a}	56.02 (48.46)^{a}	58.59 (49.94)^{a}

Mean of three replications PTC - Pre treatment count; DAS - Days after spray.
Application of endosulfan 0.07% @ 1000 ml/ha on 45 DAT
Figures in parentheses are arcsin transformed values
In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

4.7.1.3. Population of adult ash weevil

The pre-treatment population of ash weevil ranged from 2.5 to 4.1 adults per plant. The final population of ash weevil, due to the cumulative effect of three sprays i.e., on 15^{th} day after the third spray, was less in carbofuran 3 G @ 0.5 kg a.i. /ha (1.73 / plant) which was significantly superior to other treatments, followed by neem cake 250 kg/ha (1.96 adults per plant), chlorpyriphos 20 EC @ 1000 ml/ha (2.47 adults) as against 6.17 adults per plant recorded in untreated check. The other treatments in the order of their efficacy was lindane 1.5% dust @ 50 kg/ha (2.67 adults per plant) < malathion 5% dust @ 50 kg/ha (2.83 adults per plant) < chlorpyriphos 1.5% dust @ 50 kg/ha (3.17 adults per plant) < *Pseudomonas fluorescens* @ 2.5 kg/ha (3.47 adults per plant) (Table 25).

4.7.1.4. Natural enemies

The observations made on natural enemies' indicated that the pre-treatment natural enemies' population ranged from 0.167 to 3.70 per plant. The final observations made on population of natural enemies 15^{th} day after the third spray per plant was maximum in untreated check plots followed by the plots treated with carbofuran 3G @ 0.5 kg a.i./ha (2.47 adult natural enemies/ plant) which was significantly superior to other treatments. The population of natural enemies next in order was higher in plots treated with neem cake @ 250 kg / ha (1.87 adult natural enemies/plant) > chlorpyriphos 20 EC @ 1000 ml/ha (1.00 adult natural enemies/plant) > chlorpyriphos 1.5% dust @ 50 kg/ha (0.93 adult natural enemies/plant > *Pseudomonas fluorescens* @ 2.5 kg/ha (0.87 natural enemies' population per plant) > lindane 1.5% dust @ 50 kg/ha (0.80 natural enemies per plant) (Table 26).

4.7.1.5. Yield

The statistical analysis of yield data revealed that higher brinjal fruit yield was recorded in carbofuran 3G @ 0.5 kg a.i./ha treated plots (11.70 t/ha) followed by neem

Table 25. Experiment I : Effect of treatments on the adult ash weevil population of brinjal per plant

Treatments	I Spray					II Spray				III Spray			
	PTC	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS
Neem cake @ 250 kg/ha	2.63 (1.77)^{e}	2.53 (1.74)^{f}	2.40 (1.70)^{f}	2.30 (1.67)^{f}	2.37 (1.69)^{f}	2.03 (1.59)^{f}	2.00 (1.58)^{f}	2.10 (1.61)^{g}	3.63 (2.03)^{d}	3.27 (1.94)^{d}	3.10 (1.89)^{d}	2.40 (1.70)^{f}	1.97 (1.57)^{g}
Pseudomonas fluorescens @ 2.5 kg/ha	3.73 (2.06)^{b}	3.63 (2.03)^{b}	3.53 (2.01)^{b}	3.43 (1.98)^{b}	3.30 (1.95)^{b}	2.80 (1.82)^{c}	2.57 (1.75)^{d}	2.50 (1.73)^{d}	3.80 (2.07)^{cd}	3.63 (2.03)^{bc}	3.60 (2.02)^{b}	3.53 (2.01)^{b}	3.47 (1.99)^{b}
Chlorpyriphos 20EC @ 1000 ml/ha	3.47 (1.99)^{b}	3.40 (1.98)^{c}	2.73 (1.79)^{e}	2.60 (1.76)^{e}	2.80 (1.82)^{c}	2.40 (1.70)^{e}	2.47 (1.72)^{e}	2.40 (1.70)^{e}	3.20 (1.92)^{e}	3.23 (1.92)^{d}	3.00 (1.87)^{d}	2.70 (1.79)^{e}	2.47 (1.72)^{f}
Carbofuran 3G @0.5 kg a.i./ha	2.50 (1.73)^{e}	2.70 (1.79)^{e}	2.37 (1.69)^{f}	2.23 (1.65)^{f}	2.63 (1.77)^{de}	2.57 (1.75)^{d}	2.67 (1.78)^{c}	2.60 (1.76)^{c}	3.30 (1.95)^{e}	2.97 (1.86)^{e}	2.80 (1.82)^{e}	2.10 (1.61)^{g}	1.73 (1.49)^{h}
Lindane 1.5% D @ 50 kg/ha	2.90 (1.84)^{d}	2.77 (1.81)^{e}	2.73 (1.79)^{e}	2.67 (1.78)^{e}	2.57 (1.75)^{e}	2.60 (1.76)^{d}	2.47 (1.72)^{e}	2.33 (1.68)^{f}	3.63 (2.03)^{d}	3.57 (2.02)^{c}	3.27 (1.94)^{c}	3.00 (1.87)^{d}	2.67 (1.78)^{e}
Malathion 5% D @ 50 kg/ha	3.17 (1.92)^{c}	3.03 (1.88)^{d}	3.00 (1.87)^{d}	2.83 (1.83)^{d}	2.73 (1.79)^{cd}	2.73 (1.79)^{c}	2.67 (1.78)^{c}	2.57 (1.75)^{cd}	3.90 (2.09)^{bc}	3.67 (2.04)^{bc}	3.50 (2.00)^{b}	3.27 (1.94)^{c}	2.83 (1.83)^{d}
Chlorpyriphos 1.5% D @ 50 kg/ha	3.50 (2.00)^{b}	3.40 (1.98)^{c}	3.23 (1.93)^{c}	3.03 (1.88)^{c}	3.37 (1.97)^{b}	3.17 (1.92)^{b}	3.10 (1.89)^{b}	3.03 (1.88)^{b}	4.09 (2.14)^{b}	3.77 (2.07)^{b}	3.63 (2.03)^{b}	3.47 (1.99)^{b}	3.17 (1.92)^{c}
Untreated check	4.10 (2.14)^{a}	4.33 (2.19)^{a}	4.47 (2.23)^{a}	4.70 (2.28)^{a}	4.83 (2.31)^{a}	5.50 (2.45)^{a}	5.57 (2.46)^{a}	5.67 (2.48)^{a}	5.80 (2.51)^{a}	5.90 (2.53)^{a}	5.97 (2.54)^{a}	6.07 (2.56)^{a}	6.17 (2.58)^{a}

Mean of three replications PTC - Pre treatment count; DAS - Days after spray.

Figures in parentheses are $\sqrt{x + 0.5}$ values

In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

Table 26. Experiment I : Effect of treatments on the natural enemies population of brinjal per plant

Treatments	I Spray					II Spray				III Spray			
	PTC	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS
Neem cake @ 250 kg/ha	0.43 (0.97)^{b}	0.57 (1.03)^{c}	0.53 (0.02)^{c}	0.73 (1.11)^{c}	0.97 (1.21)^{c}	1.00 (1.23)^{c}	0.80 (1.14)^{c}	1.04 (1.24)^{c}	1.37 (1.37)^{c}	1.23 (1.32)^{c}	1.13 (1.28)^{c}	1.40 (1.38)^{c}	1.87 (1.54)^{c}
Pseudomonas fluorescens @ 2.5 kg/ha	0.23 (0.86)^{c}	0.33 (0.91)^{d}	0.13 (0.79)^{d}	0.47 (0.98)^{d}	0.60 (1.05)^{d}	0.57 (1.03)^{d}	0.43 (0.97)^{d}	0.67 (1.08)^{d}	0.67 (1.08)^{e}	0.60 (1.05)^{e}	0.57 (1.03)^{ef}	0.50 (1.00)^{ef}	0.87 (1.17)^{de}
Chlorpyriphos 20EC 1000 ml/ha	0.20 (0.84)^{c}	0.23 (0.86)^{de}	0.20 (0.83)^{d}	0.20 (0.84)^{e}	0.27 (0.88)^{e}	0.50 (1.00)^{de}	0.40 (0.95)^{d}	0.77 (1.12)^{d}	0.93 (1.19)^{d}	0.80 (1.14)^{d}	0.73 (1.09)^{d}	0.63 (1.06)^{d}	1.00 (1.23)^{d}
Carbofuran 3G @ 0.5 kg a.i./ha	0.50 (0.99)^{b}	0.73 (1.11)^{b}	0.83 (1.15)^{b}	1.07 (1.25)^{b}	1.77 (1.50)^{b}	1.57 (1.44)^{b}	1.37 (1.37)^{b}	1.73 (1.49)^{b}	2.20 (1.64)^{b}	1.93 (1.56)^{b}	2.00 (1.58)^{b}	2.13 (1.62)^{b}	2.47 (1.72)^{b}
Lindane 1.5% D @ 50 kg/ha	0.13 (0.79)^{c}	0.17 (0.82)^{ef}	0.27 (0.88)^{d}	0.13 (0.79)^{e}	0.30 (0.89)^{e}	0.40 (0.95)^{ef}	0.30 (0.89)^{e}	0.63 (1.06)^{d}	0.73 (1.11)^{e}	0.67 (1.08)^{de}	0.63 (1.06)^{de}	0.57 (1.03)^{de}	0.80 (1.14)^{de}
Malathion 5% D @ 50 kg/ha	0.10 (0.77)^{c}	0.10 (0.78)^{f}	0.17 (0.81)^{d}	0.20 (0.84)^{e}	0.67 (1.08)^{d}	0.30 (0.89)^{f}	0.23 (0.86)^{f}	0.60 (1.05)^{d}	0.60 (1.05)^{e}	0.50 (0.99)^{e}	0.50 (1.00)^{f}	0.40 (0.95)^{f}	0.67 (1.08)^{e}
Chlorpyriphos 1.5% D @ 50 kg/ha	0.17 (0.82)^{c}	0.20 (0.84)^{ef}	0.13 (0.79)^{d}	0.10 (0.78)^{e}	0.30 (0.89)^{e}	0.17 (0.82)^{g}	0.10 (0.78)^{g}	0.60 (1.05)^{d}	0.63 (1.06)^{e}	0.50 (1.00)^{e}	0.37 (0.93)^{g}	0.30 (0.89)^{g}	0.93 (1.19)^{d}
Untreated check	1.00 (1.22)^{a}	1.33 (1.35)^{a}	1.80 (1.52)^{a}	2.07 (1.60)^{a}	2.37 (1.69)^{a}	3.70 (2.05)^{a}	3.57 (2.02)^{a}	3.80 (2.07)^{a}	3.80 (2.07)^{a}	3.93 (2.11)^{a}	4.00 (2.12)^{a}	4.13 (2.15)^{a}	4.33 (2.19)^{a}

Mean of three replications PTC - Pre treatment count; DAS - Days after spray.

Figures in parentheses are $\sqrt{x+0.5}$ values

In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

cake @ 250 kg/ha (11.17 t/ha), chlorpyriphos 20 EC @ 1000 ml/ha (10.83 t/ha) and lindane 1.5% dust @ 50 kg/ha (9.19 t/ha), malathion 5% D @50kg/ha (8.36t/ha), chlorpyriphos 1.5% D@ 50kg/ha as against only 6.00 t/ha in untreated check (Table 27).

4.7.1.6. Cost Benefit ratio

Considering Cost Benefit Ratio (CBR) worked out for different treatments, highest CBR was obtained in carbofuran 3G @ 0.5 kg a.i./ha (1:2.71) followed by chlorpyriphos 1.5 per cent D @ 50 kg/ha (1:2.65), neem cake @ 250 kg/ha (1:2.46), chlorpyriphos 20EC @ 1000 ml/ha (1:2.41), lindane 1.5 per cent D @ 50 kg/ha (1:2.04), malathion 5 per cent D @ 50 kg/ha (1:1.84), *P. fluorescens* @ 2.5 kg/ha (1:1.77) as against untreated check which recorded lowest CBR (1:1.52) (Table 28).

4.7.2. Experiment II : Effect of foliar application of insecticides on ash weevil damage, adult population and natural enemies'

4.7.2.1. Leaf damage

The per cent leaf damage due to ash weevil before treatment ranged from 34.45 to 36.55 per cent (Table 29).

The results obtained on 3rd, 7th, 10th and 15th day after the first spray with different treatments indicated that the per cent leaf damage was minimum (32.17, 30.43, 29.30 and 35.48 per cent respectively) in endosulfan 0.07% @ 1000 ml/ha followed by dichlorvos 76 SC @ 1000 ml/ha (recording 33.58, 32.05, 30.64 and 37.07 per cent leaf damage respectively) while in control, it was 39.26, 40.60, 42.86 and 45.10 per cent leaf damage respectively. The order of efficacy of other treatments was malathion 50 EC @ 1000 ml /ha (35.25, 34.12, 33.54 and 38.65 per cent on 3,7,10,15 DAS respectively) < neem Azal T/S 1% @ 1000 ml/ha (35.93, 34.42, 33.99 and 39.90 per cent on 3,7,10,15 DAS respectively) < NSKE 5% (36.10, 35.47, 35.35, 40.72 per cent on 3,7,10,15 DAS respectively) < carbaryl 50 WP @ 1 kg/ha (36.76, 36.26, 35.91, 41.07 per cent on 3, 7, 10, 15 DAS respectively).

Table 27. Experiment I: Effect of soil treatments on the yield of brinjal fruits : (Season: November 2000 to April 2001)

Treatments	No. of treatments applied	Brinjal yield (kg/plot) 12 m^2	Brinjal yield (t/ha)
Neem cake @ 250 kg/ha	1	13.40	11.17[b]
Pseudomonas fluorescens @ 2.5 kg/ha	2	9.40	7.83[e]
Chlorpyriphos 20 EC @1000 ml/lit	3	13.00	10.83[b]
Carbofuran 3G @ 0.5 kg a.i./ha	1	14.03	11.70[a]
Lindane 1.5% D @ 50 kg/ha	1	11.03	9.19[c]
Malathion 5% D @ 50 kg/ha	1	10.03	8.36[d]
Chlorpyriphos 1.5% D @ 50 kg/ha	1	9.53	7.94[de]
Untreated check	-	7.20	6.00[f]

(Mean of three observations)
Means followed by small letters in common within the columns are not significantly different at 5 per cent level in DMRT.

Table 28. Experiment I : Effect of treatments of soil application BC ratio

Treatments	No. of treatments applied	Brinjal yield (kg/plot) 12 m^2	Brinjal yield (t/ha)	Additional yield of brinjal (t/ha)	Gross income (Rs.)	Additional Income (Rs.)	Cost of cultivation + cost of treatments (Rs.)	Net income (Rs.)	BC ratio
Neem cake @ 250 kg/ha	1+3	13.40	11.17^b	5.17	57850.00	25850.00	23537.00	34313.00	1:2.46
Pseudomonas fluorescens @ 2.5 kg/ha	2+3	9.40	7.83^e	3.40	39150.00	17000.00	22137.00	17013.00	1:1.77
Chlorpyriphos 20EC @ 1000 ml/ha	3+3	13.00	10.83^b	7.00	54150.00	35000.00	22437.00	31713.00	1:2.41
Carbofuran 3G @ 0.5kg a.i./ha	1+3	14.03	11.70^a	8.03	58500.00	40150.00	21572.00	36928.00	1:2.71
Lindane 1.5% D @ 50 kg/ha	1+3	11.03	9.19^c	5.03	45950.00	25150.00	22537.00	23413.00	1:2.04
Malathion 5% D @ 50 kg/ha	1+3	10.03	8.36^d	4.03	41800.00	20150.00	22737.00	19063.00	1:1.84
Chlorpyriphos 1.5% D @ 50 kg/ha	1+3	9.53	7.94^{de}	3.53	39700.00	17650.00	24037.00	15663.00	1:1.65
Untreated check	-	7.20	6.00^f	-	30000.00	-	19800.00	10200.00	1:1.52

Cost of cultivation : Brinjal Rs.19,800/-

Price of fruits : Rs.5/- per kg

Mean of three replications.

Means followed by small letters in common within the columns are not significantly different at 5% level in DMRT.

The results obtained on 3rd,7th,10th and 15th day after the second spray with different treatments revealed that the per cent leaf damage was minimum (34.17, 32.10, 30.28 and 32.44 per cent respectively) in endosulfan 0.07% @ 1000 ml/ha followed by dichlorvos 76 SC @ 1000 ml/ha recording 36.04, 33.62, 32.33 and 32.33 per cent leaf damage respectively while in control it was 47.14, 48.68, 50.00 and 52.24 per cent leaf damage respectively. The other treatments in the order of their efficacy was malathion 50 EC @ 1000 ml/ha (37.75, 35.78, 34.45 and 34.98 per cent leaf damage on 3,7,10,15 DAS respectively) < Neem Azal T/S 1% @ 1000 ml/ha (38.10, 36.27, 35.08, 35.97 per cent leaf damage on 3,7,10 and 15 DAS respectively) < NSKE 5% (39.37, 38.31, 36.43 and 37.10 per cent leaf damage on 3, 7, 10 and 15 DAS respectively) < carbaryl 50 WP @ 1 kg/ha (40.44, 39.54, 38.10 and 39.28 per cent on 3,7,10,15 DAS respectively).

The results obtained on 3rd, 7th, 10th, and 15th day after the third spray with different treatments revealed that the per cent leaf damage was minimum (30.20, 27.21, 24.67 and 25.46 per cent respectively) in endosulfan 0.07% @ 1000 ml/ha followed by dichlorvos 76 SC @ 1000 ml/ha recording 31.67, 30.28, 28.47 and 29.32 per cent leaf damage respectively while in control, it was 53.91, 55.65, 58.38 and 60.50 per cent leaf damage respectively. The other treatments in the order of their efficacy was malathion 50 EC @ 1000ml/ha (33.35, 32.33, 30.89 and 30.97 per cent leaf damage on 3, 7, 10 and 15 DAS respectively) <Neem Azal T/S 1% @ 1000ml/ha (34.20, 32.97,32.22 and 32.96 per cent leaf damage on 3,7, 10 and 15 DAS respectively) < NSKE 5% @ 50g/lit. (36.21, 34.65,33.05 and 33.92 per cent leaf damage on 3,7, 10 and 15 DAS respectively)< carbaryl 50 WP @ 1kg /ha (38.47, 36.08, 35.24 and 36.25 per cent on 3,7,10 and 15 DAS respectively).

The results obtained on 3rd, 7th, 10th and 15th day after the fourth spray with different treatments revealed that the per cent leaf damage was minimum in endosulfan 0.07% @ 1000 ml/ha which recorded 22.58, 22.43, 20.35 and 18.93 per cent leaf damage

Table 29. Experiment II: Effect of foliar treatments on ash weevil damage to leaves of brinjal per plant (%)

Treatments	PTC	I Spray				II Spray				III Spray				IV Spray			
		3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS
Neem Azal T/S 1% @ 1000 ml/ha	35.92 (36.82)^{a}	35.93 (36.83)^{c}	34.42 (35.92)^{d}	33.99 (35.66)^{c}	39.90 (39.17)^{c}	38.10 (38.12)^{d}	36.27 (37.03)^{d}	35.08 (36.32)^{d}	35.97 (36.85)^{d}	34.20 (35.79)^{d}	32.97 (35.04)^{d}	32.22 (34.59)^{d}	32.96 (35.04)^{d}	30.52 (33.53)^{d}	27.76 (31.79)^{d}	26.92 (31.25)^{d}	26.08 (30.71)^{d}
NSKE 5% @ 50 g/lit	34.45 (35.94)^{a}	36.10 (36.93)^{c}	35.47 (36.55)^{c}	35.35 (36.48)^{b}	40.72 (39.65)^{b}	39.37 (38.86)^{c}	38.31 (38.24)^{c}	36.43 (37.12)^{c}	37.10 (37.52)^{c}	36.21 (36.99)^{c}	34.65 (36.06)^{c}	33.05 (35.09)^{c}	33.92 (35.62)^{c}	32.38 (34.68)^{c}	30.33 (33.42)^{c}	28.50 (32.27)^{c}	28.00 (31.95)^{c}
Endosulfan 0.07% @ 1000 ml/ha	34.45 (35.94)^{a}	32.17 (34.55)^{f}	30.43 (33.48)^{f}	29.30 (32.77)^{e}	35.48 (36.56)^{f}	34.17 (35.77)^{f}	32.10 (34.51)^{f}	30.28 (33.39)^{g}	32.44 (34.72)^{g}	30.20 (33.34)^{g}	27.21 (31.44)^{f}	24.67 (29.78)^{g}	25.46 (30.30)^{g}	22.58 (28.37)^{g}	22.43 (28.27)^{f}	20.35 (26.81)^{g}	18.93 (25.79)^{g}
Dichlorvos 76SC @1000 ml/ha	35.28 (36.44)^{a}	33.58 (35.42)^{e}	32.05 (34.48)^{e}	30.64 (33.61)^{d}	37.07 (37.50)^{e}	36.04 (36.89)^{e}	33.62 (35.44)^{e}	32.33 (34.68)^{f}	33.69 (35.48)^{f}	31.67 (34.25)^{f}	30.28 (33.38)^{e}	28.47 (32.25)^{f}	29.32 (32.78)^{f}	25.35 (30.23)^{f}	23.24 (28.82)^{f}	22.20 (28.11)^{f}	20.42 (26.86)^{f}
Malathion 50EC @1000 ml/ha	34.60 (36.03)^{a}	35.25 (36.42)^{d}	34.12 (35.74)^{d}	33.54 (35.39)^{c}	38.65 (38.44)^{d}	37.75 (37.91)^{d}	35.78 (36.74)^{d}	34.45 (35.94)^{e}	34.98 (36.26)^{e}	33.35 (35.27)^{e}	32.33 (34.65)^{d}	30.89 (33.76)^{e}	30.97 (33.81)^{e}	28.23 (32.09)^{e}	26.34 (30.88)^{e}	25.08 (30.06)^{e}	22.53 (28.34)^{e}
Carbaryl 50WP @ 1kga.i./ha	36.30 (37.05)^{a}	36.76 (37.32)^{b}	36.26 (37.02)^{b}	35.91 (36.82)^{b}	41.07 (39.85)^{b}	40.44 (39.49)^{b}	39.54 (38.96)^{b}	38.18 (38.16)^{b}	39.28 (38.81)^{b}	38.47 (38.33)^{b}	36.08 (36.92)^{b}	35.24 (36.42)^{b}	36.25 (37.02)^{b}	35.13 (36.35)^{b}	32.42 (34.71)^{b}	30.18 (33.33)^{b}	30.00 (33.21)^{b}
Untreated Check	35.24 (36.40)^{a}	39.26 (38.79)^{a}	40.60 (39.58)^{a}	42.86 (40.89)^{a}	45.10 (42.19)^{a}	47.14 (43.36)^{a}	48.68 (44.24)^{a}	50.00 (44.99)^{a}	52.24 (46.29)^{a}	53.91 (47.24)^{a}	55.65 (48.25)^{a}	58.38 (49.83)^{a}	60.50 (51.06)^{a}	63.52 (52.85)^{a}	64.33 (53.33)^{a}	65.25 (53.88)^{a}	67.25 (55.09)^{a}

Mean of three replications. PTC - Pre-treatment count; DAS : Days after spray
First spray on 35 days after transplanting.
Figures in parentheses are arcsin transformed values.
In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

respectively while in the control it was 63.52, 64.33, 65.25 and 67.25 per cent leaf damage respectively. The other treatments in order of their efficacy was malathion 50 EC @ 1000 ml/ha (28.23, 26.34, 25.08 and 22.53 per cent leaf damage on 3,7,10 and 15 DAS respectively) < neem azal T/S 1per cent @ 1000 ml/ha (30.52, 27.76, 26.92 and 26.08%) leaf damage on 3, 7, 10 and 15 DAS respectively. < NSKE 5 per cent (32.38, 30.33, 28.50 and 28.00 per cent leaf damage on 3, 7, 10 and 15 DAS respectively) < Carbaryl 50 WP @ 1 kg a.i./ha (35.13, 32.42, 30.18 and 30 per cent leaf damage on 3, 7, 10 and 15 DAS respectively).

4.7.2.2. Adult weevil population

The pre-treatment population ranged from 4.00 to 4.40 adults per plant (Table 30).

The results obtained on 3^{rd},7^{th},10^{th} and 15^{th} day after the first spray with different treatments revealed that the population of adult ash weevils was minimum in endosulfan 0.07 per cent 1000 ml/ha which recorded 3.87, 3.43, 3.17 and 4.17 adults per plant respectively followed by dichlorvos 76 SC @ 1000 ml/ha (3.97, 3.70, 3.47 and 4.47 respectively) which were significantly superior to other treatments. The next in order in reducing the adult weevil population by different treatments was malathion 50 EC @ 1000 ml/ha (3.97, 3.70, 3.47 and 4.47 adults per plant respectively) < neem azal T/S 1 per cent @ 1000 ml/ha (4.10, 3.97, 3.73 and 4.70 adults per plant respectively) < NSKE 5 per cent (4.17, 4.07, 3.90 and 4.80 adults per plant respectively) < carbaryl 50 WP @ 1 kg/ha (4.23, 4.13, 4.07 and 4.63 adults respectively)

The results obtained after the second round of spray with different treatments on 3, 7, 10 and 15 DAS indicated that the population of adult ash weevils was minimum in endosulfan 0.07 per cent @ 1000 ml/ha which recorded 3.67, 3.33, 3.10 and 3.97 adults per plant respectively followed by dichlorvos 76 SC @ 1000 ml/ha (3.93, 3.63, 3.50 and

4.13 per plant respectively) which were significantly superior to other treatments. The next in order in reducing the adult weevil population by different treatments was malathion 50 EC @ 1000 ml/ha (4.17, 4.03, 3.83 and 4.27 adults per plant respectively) < neem azal T/S 1 per cent @ 1000 ml/ha (4.37, 4.23, 4.13 and 4.37 adults per plant respectively) < NSKE 5 per cent (4.50, 4.40, 4.30 and 4.43 adults per plant respectively) < carbaryl 50 WP @ 1 kg/ha (4.60, 4.53, 4.40 and 4.47 adults per plant respectively).

The results obtained on 3rd, 7th, 10th and 15th day after the third round spray with different treatments revealed that the population of adult ash weevils was minimum in endosulfan 0.07 per cent @ 1000 ml/ha which recorded 3.73, 3.60, 3.40 and 3.50 adults per plant respectively followed by dichlorvos 76SC @ 1000 ml/ha (4.00, 3.83, 3.73 and 3.80 adults respectively) which were significantly superior to other treatments. The next in order in reducing the adult weevil population by different treatments was malathion 50 EC @ 1000 ml/ha (4.13, 4.00, 3.93 and 4.00 adults respectively) < NSKE 5 per cent (4.30, 4.27, 4.20 and 4.30 adults respectively) < carbaryl 50 WP @ 1 kg/ha (4.40, 4.33, 4.27 and 4.37 adults respectively) against the untreated check (5.93, 6.03, 6.37 and 6.50 adults respectively).

The results obtained on 3rd, 7th, 10th and 15th days after the fourth round of spray with different treatments revealed that the population of adult ash weevils was minimum in endosulfan 0.07 per cent @ 1000 ml/ha which recorded 3.27, 2.97, 2.70 and 2.23 adults per plant respectively followed by dichlorvos 76 SC @ 1000 ml/ha (3.53, 3.33, 3.30 and 2.90 adults respectively) which were significantly superior to other treatments. The order of efficacy of treatments in reducing the adult weevil population was malathion 50 EC @ 1000 ml/ha (3.83, 3.63, 3.47 and 3.03 adults on 3, 7, 10 and on 15 DAS respectively) < neem azal T/S 1% @ 1000 ml/ha (3.90, 3.80, 3.57 and 3.30 adults on 3, 7, 10, and on 15 DAS respectively) < NSKE 5 per cent (4.03, 3.93, 3.80 and

Table 30. Experiment II: Effect of foliar treatments on the population of adult ash weevil per plant

Treatments	PTC	I Spray				II Spray				III Spray				IV Spray			
		3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS
Neem Azal T/S 1% @ 1000 ml/ha	4.17 (2.16)^{bc}	4.10 (2.15)^{cd}	3.97 (2.13)^{c}	3.73 (2.06)^{c}	4.70 (2.28)^{bc}	4.37 (2.21)^{c}	4.23 (2.18)^{d}	4.13 (2.15)^{d}	4.37 (2.21)^{bc}	4.27 (2.18)^{c}	4.13 (2.15)^{c}	4.07 (2.14)^{cd}	4.17 (2.16)^{c}	3.90 (2.09)^{d}	3.80 (2.07)^{c}	3.57 (2.02)^{d}	3.30 (1.95)^{d}
NSKE 5% @ 50 g/lit	4.10 (2.15)^{bc}	4.17 (2.16)^{bc}	4.07 (2.14)^{bc}	3.90 (2.09)^{b}	4.80 (2.30)^{b}	4.50 (2.24)^{b}	4.40 (2.21)^{c}	4.30 (2.192^{c}	4.43 (2.22)^{b}	4.30 (2.19)^{bc}	4.27 (2.18)^{b}	4.20 (2.17)^{bc}	4.30 (2.19)^{b}	4.03 (2.13)^{c}	3.93 (2.11)^{b}	3.80 (2.07)^{c}	3.57 (2.02)^{c}
Endosulfan 0.07% @ 1000 ml/ha	4.40 (2.21)^{a}	3.87 (2.08)^{f}	3.43 (1.98)^{e}	3.17 (1.92)^{e}	4.17 (2.16)^{e}	3.67 (2.04)^{f}	3.33 (1.96)^{g}	3.10 (1.89)^{g}	3.97 (2.11)^{e}	3.73 (2.06)^{f}	3.60 (2.03)^{f}	3.40 (1.98)^{f}	3.50 (2.00)^{f}	3.27 (1.94)^{f}	2.97 (1.86)^{f}	2.70 (1.79)^{f}	2.23 (1.65)^{f}
Dichlorvos 76SC @1000 ml/ha	4.00 (2.12)^{c}	3.97 (2.11)^{e}	3.70 (2.05)^{d}	3.47 (1.99)^{d}	4.47 (2.23)^{d}	3.93 (2.11)^{e}	3.63 (2.03)^{f}	3.50 (2.00)^{f}	4.13 (2.15)^{d}	4.00 (2.12)^{e}	3.83 (2.08)^{e}	3.73 (2.06)^{e}	3.80 (2.07)^{e}	3.53 (2.01)^{e}	3.33 (1.96)^{e}	3.30 (1.95)^{e}	2.90 (1.84)^{e}
Malathion 50EC @1000 ml/ha	4.23 (2.18)^{ab}	4.07 (2.14)^{d}	3.80 (2.07)^{d}	3.63 (2.03)^{c}	4.60 (2.26)^{cd}	4.17 (2.16)^{d}	4.03 (2.13)^{e}	3.83 (2.08)^{e}	4.27 (2.18)^{c}	4.13 (2.15)^{d}	4.00 (2.12)^{d}	3.93 (2.11)^{d}	4.00 (2.12)^{d}	3.83 (2.08)^{d}	3.63 (2.03)^{d}	3.47 (1.99)^{d}	3.03 (1.88)^{e}
Carbaryl 50WP @ 1kga.i./ha	4.10 (2.15)^{bc}	4.23 (2.18)^{b}	4.13 (2.15)^{b}	4.07 (2.14)^{b}	4.63 (2.27)^{c}	4.60 (2.26)^{b}	4.53 (2.24)^{b}	4.40 (2.21)^{b}	4.47 (2.23)^{b}	4.40 (2.21)^{b}	4.33 (2.19)^{b}	4.27 (2.18)^{b}	4.37 (2.21)^{b}	4.17 (2.16)^{b}	4.03 (2.13)^{b}	3.967 (2.113)^{b}	3.83 (2.08)^{b}
Untreated Check	4.37 (2.21)^{a}	4.50 (2.24)^{a}	4.73 (2.29)^{a}	4.80 (2.30)^{a}	5.13 (2.37)^{a}	5.37 (2.42)^{a}	5.53 (2.46)^{a}	5.67 (2.48)^{a}	5.87 (2.52)^{a}	5.93 (2.53)^{a}	6.03 (2.56)^{a}	6.37 (2.62)^{a}	6.50 (2.65)^{a}	6.67 (2.68)^{a}	6.97 (2.73)^{a}	7.10 (2.76)^{a}	7.37 (2.81)^{a}

Mean of three replications. PTC - Pre-treatment count; DAS : Days after spray
First spray on 35 days after transplanting.
Figures in parentheses are arcsin transformed values.
In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

3.57 adults per plant on 3, 7, 10 and on 15 DAS respectively) < carbaryl 50 WP @ 1 kg/ha (4.17, 4.03, 3.97 and 3.83 adults per plant on 3, 7, 10 and on 15 DAS respectively) against the untreated check which recorded 6.67, 6.97, 7.10 and 7.37 adults per plant on 3, 7, 10 and 15 DAS respectively.

4.7.2.3. Natural enemies' population

The population of natural enemies' before treatment ranged from 3.00 to 3.37 per plant (Table 31).

The results obtained on 3rd, 7th, 10th and 15th day after the first spray with different treatments indicated that the natural enemies' population was maximum in the untreated check which was significantly superior to other treatments in recording higher population of 3.57, 3.63, 3.80 and 3.90 adults per plant respectively. Next in order of recording high population of natural enemies'/plant was in endosulfan 0.07 per cent @ 1000 ml/ha (2.67, 2.53, 2.33 and 2.13 adults per plant respectively) > neem azal T/S 1 per cent @ 1000 ml/ha (2.80, 2.37, 2.00 and 1.87 adults per plant respectively) > NSKE 5 per cent (2.60, 2.60, 1.90 and 1.57 adults per plant respectively) > dichlorvos 76 SC @ 1000 ml/ha (2.36, 1.63, 1.37 and 1.33 adults respectively) > malathion 50 EC @ 1000 ml/ha (2.00, 1.13, 1.27 and 1.07 adults respectively) > carbaryl 50 WP @ 1 kg/ha (1.83, 1.00, 1.20 and 1.00 adults respectively).

The results obtained on 3rd, 7th, 10th and 15th day after the second round spray with different treatments indicated that the natural enemies' population was maximum in untreated check recording the higher population of 4.00, 4.10, 4.20 and 4.43 adults respectively. The order in efficacy of treatments in recording high population of natural enemies' / plant was in endosulfan 0.07 per cent @ 1000 ml/ha (2.10, 2.00, 2.43 and 2.567) > neem azal T/S 1 per cent @ 1000 ml/ha (1.867, 1.803, 2.003 and 2.23) > NSKE

5 per cent (1.50, 1.40, 1.73 and 2.00) > dichlorvos 76 SC @ 1000 ml/ha (1.13, 1.11, 1.30 and 1.73) > malathion 50 EC @ 1000 ml/ha (1.13, 1.11, 1.30 and 1.73) > carbaryl 50 WP @ 1 kg/ha (0.87, 0.73, 1.07 and 1.40).

The results obtained on 3^{rd}, 7^{th}, 10^{th} and 15^{th} day after the third round of spray with different treatments revealed that the natural enemies' population was maximum in the untreated check which was significantly superior to other treatments in recording higher population of 4.57, 4.57, 4.70 and 4.80 natural enemies'/plant followed by endosulfan 0.07 per cent @ 1000 ml/ha (2.37, 2.20, 2.00 and 2.33 adults respectively) > neem azal T/S 1 per cent @ 1000 ml/ha (2.13, 2.00, 1.80 and 1.93 adults respectively) > NSKE 5 per cent (1.80, 1.60, 1.50 and 1.80 adults respectively) > dichlorvos 76 SC @ 1000 ml/ha (1.60, 1.40, 1.07 and 1.37 adults respectively) > malathion 50 EC @ 1000 ml/ha (1.20, 1.00, 0.93 and 1.07 adults respectively) > carbaryl 50 WP @ 1 kg/ha (1.17, 0.80, 0.67 and 1.73 adults respectively).

The results obtained on 3^{rd}, 7^{th}, 10^{th} and 15^{th} days after the fourth spray with different treatments indicated that the natural enemies' population was maximum in the untreated check which was significantly superior to other treatments in recording higher population of 4.83, 5.00, 5.20 and 5.37 adults per plant respectively. Next in order of recording high population of natural enemies'/plant was in endosulfan 0.07 per cent @ 1000 ml/ha (1.93, 1.80, 2.00 and 2.03 adults per respectively) > neem azal T/S 1 per cent @ 1000 ml/ha (1.63, 1.67, 1.83 and 1.90 adults respectively) > NSKE 5 per cent (1.40, 1.23, 1.50 and 1.67 adults respectively) > dichlorvos 76 SC @ 1000 ml/ha (1.00, 0.87, 1.00 and 1.07 adults respectively) > malathion 50 EC @ 1000 ml/ha (0.87, 0.80, 0.93 and 1.00 adults respectively) > carbaryl 50 WP @ 1 kg/ha (0.67, 0.60, 0.73 and 0.80 adults respectively).

Table 31. Experiment II: Effect of foliar treatments on the population of total natural enemies - (per plant)

Treatments	PTC	I Spray				II Spray				III Spray				IV Spray			
		3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS
Neem Azal T/S 1% @ 1000 ml/ha	3.07 (1.89)^{bc}	2.80 (1.82)^{b}	2.37 (1.69)^{c}	2.00 (1.58)^{c}	1.87 (1.54)^{c}	1.87 (1.54)^{c}	1.80 (1.52)^{c}	2.00 (1.58)^{c}	2.23 (1.65)^{c}	2.13 (1.62)^{c}	2.00 (1.58)^{c}	1.80 (1.52)^{c}	1.93 (1.56)^{c}	1.63 (1.46)^{c}	1.67 (1.47)^{c}	1.83 (1.53)^{c}	1.90 (1.55)^{bc}
NSKE 5% @ 50 g/lit	3.00 (1.87)^{c}	2.60 (1.76)^{b}	2.60 (1.76)^{b}	1.90 (1.55)^{c}	1.57 (1.44)^{d}	1.50 (1.42)^{d}	1.40 (1.38)^{d}	1.73 (1.49)^{d}	2.00 (1.58)^{d}	1.80 (1.52)^{d}	1.60 (1.45)^{d}	1.50 (1.42)^{d}	1.80 (1.52)^{c}	1.40 (1.38)^{d}	1.23 (1.32)^{d}	1.50 (1.42)^{d}	1.67 (1.47)^{c}
Endosulfan 0.07%@ 1000 ml/ha	3.00 (1.87)^{c}	2.67 (1.78)^{b}	2.53 (1.74)^{bc}	2.33 (1.68)^{b}	2.13 (1.62)^{b}	2.10 (1.61)^{b}	2.00 (1.58)^{b}	2.43 (1.71)^{b}	2.57 (1.75)^{b}	2.37 (1.69)^{b}	2.20 (1.64)^{b}	2.00 (1.58)^{b}	2.33 (1.68)^{b}	1.93 (1.56)^{b}	1.80 (1.52)^{b}	2.00 (1.58)^{b}	2.03 (1.59)^{b}
Dichlorvos 76SC @1000 ml/ha	3.17 (1.91)^{abc}	2.37 (1.69)^{c}	1.63 (1.46)^{d}	1.37 (1.37)^{d}	1.33 (1.35)^{e}	1.13 (1.28)^{e}	1.11 (1.27)^{e}	1.30 (1.34)^{e}	1.73 (1.49)^{e}	1.60 (1.45)^{e}	1.40 (1.38)^{e}	1.07 (1.25)^{e}	1.37 (1.37)^{d}	1.00 (1.23)^{e}	0.87 (1.17)^{e}	1.00 (1.23)^{e}	1.07 (1.25)^{d}
Malathion 50EC @1000 ml/ha	3.30 (1.95)^{ab}	2.03 (1.58)^{d}	1.13 (1.28)^{e}	1.27 (1.33)^{d}	1.07 (1.25)^{f}	0.90 (1.18)^{f}	0.73 (1.11)^{f}	1.00 (1.23)^{f}	1.533 (1.43)^{f}	1.20 (1.31)^{f}	1.00 (1.23)^{f}	0.93 (1.19)^{e}	1.07 (1.25)^{e}	0.87 (1.17)^{e}	0.80 (1.14)^{e}	0.93 (1.19)^{e}	1.00 (1.23)^{d}
Carbaryl 50WP @ 1kga.i./ha	3.27 (1.94)^{ab}	1.833 (1.53)^{d}	1.00 (1.23)^{e}	1.20 (1.30)^{d}	1.00 (1.23)^{f}	0.87 (1.17)^{f}	0.73 (1.11)^{f}	1.07 (1.25)^{f}	1.403 (1.38)^{g}	1.17 (1.29)^{f}	0.80 (1.14)^{g}	0.67 (1.08)^{f}	1.73 (1.11)^{f}	0.67 (1.08)^{f}	0.60 (1.05)^{f}	0.73 (1.11)^{f}	0.800 (1.14)^{e}
Untreated Check	3.37 (1.97)^{a}	3.57 (1.97)^{a}	3.63 (2.03)^{a}	3.80 (2.07)^{a}	3.90 (2.10)^{a}	4.00 (2.12)^{a}	4.10 (2.15)^{a}	4.20 (2.17)^{a}	4.43 (2.22)^{a}	4.57 (2.24)^{a}	4.57 (2.25)^{a}	4.70 (2.28)^{a}	4.80 (2.30)^{a}	4.83 (2.31)^{a}	5.00 (2.35)^{a}	5.20 (2.39)^{a}	5.37 (2.42)^{a}

Mean of three replications. PTC - Pre-treatment count; DAS : Days after spray
First spray on 35 days after transplanting.
Figures in parentheses are arcsin transformed values.
In a column means followed by the same letter(s) are not significantly different at 5% level in DMRT.

4.7.2.4. Yield

The statistical analysis of yield data indicated that the maximum brinjal fruit yield was recorded in endosulfan 0.07% @ 1000 ml/ha (12.53 t/ha) followed by Neem Azal T/S 1% @ 1000 ml/ha, dichlorvos 76 SC @ 1000 ml/ha, NSKE 5%, malathion 50 EC @ 1000 ml/ha, and carbaryl 50 WP @ 1 kg/ha which recorded the fruit yield of 11.82, 11.75, 11.33, 10.89 and 10.06 t/ha, respectively as against 5.89 t/ha in untreated check (Table 32).

4.7.2.5. Cost Benefit ratio

Considering the Cost Benefit Ratio (CBR), worked out for different treatments, higher CBR (1:2.86) was obtained in endosulfan 0.07 per cent 1000 ml/ha followed by dichlorvos 76 SC @ 1000 ml/ha (1:2.66), malathion 50 EC @ 1000 ml/ha (1:2.59), neem azal T/S 1 per cent @ 1000 ml/ha (1:2.57), NSKE 5 per cent (1:2.25) and carbaryl 50 WP @ 1 kg/ha (1: 2.23) as against untreated check which recorded only 1: 1.49 CBR (Table 33).

Table 32. Experiment II : Yield data of brinjal fruits in the effect of treatments of foliar application (Season: November 2000 to April 2001)

Treatments (Sprays)	No. of treatments applied	Brinjal yield (kg/plot) 12 m^2	Brinjal yield (t/ha)
Neem Azal T/S 1% @ 1000 ml/lha	4	14.20	11.83[b]
NSKE 5% @ 50 g/lit	4	13.60	11.33[bc]
Endosulfan 0.07% @ 1000 ml/ha	4	15.03	12.53[a]
Dichlorvos 76SC @ 1000 ml/ha	4	14.10	11.75[b]
Malathion 50EC @ 1000 ml/ha	4	13.07	10.89[c]
Carbaryl 50WP @ 1kg/ha	4	12.07	10.06[d]
Untreated Check	4	7.07	5.89[e]

(Mean of three observations)
Means followed by small letters in common within the columns are not significantly different at 5 per cent level in DMRT.

Table 33. Experiment II : Effect of treatments of foliar application BC ratio

Treatments	No. of sprays applied	Brinjal yield (kg/plot) 12 m^2	Brinjal yield (t/ha)	Additional yield of brinjal (t/ha)	Gross income (Rs.)	Additional Income (Rs.)	Cost of cultivation + cost of treatments (Rs.)	Net income (Rs.)	BC ratio
Neem Azal T/S 1% @ 1000 ml/ha	4	14.20	11.83^b	5.94	59150.00	29700.00	22950.00	36200.00	1:2.57
NSKE 5% @ 50g/lit	4	13.60	$11.33b^c$	5.44	56650.00	27200.00	25200.00	31450.00	1:2.25
Endosulfan 0.07% @ 1000 ml/ha	4	15.03	12.53^a	6.44	62650.00	33200.00	21880.00	29450.00	1:2.86
Dichlorvos 76SC @ 1000 ml/ha	4	14.10	11.75^b	5.86	58750.00	29300.00	22080.00	36670.00	1:2.66
Malathion 50EC @ 1000 ml/ha	4	13.07	10.89^c	5.00	54450.00	25000.00	21040.00	33410.00	1:2.59
Carbaryl 50WP @ 1kg/ha	4	12.07	10.06^d	4.17	50300.00	20850.00	22500.00	27800.00	1:2.23
Untreated Check	4	7.07	5.89^e	-	29450.00	-	19800.00	9650.00	1:1.49

Cost of cultivation : Brinjal Rs.19,800/-

Price of fruits : Rs.5/- per kg

Mean of three replications.

Means followed by small letters in common within the columns are not significantly different at 5% level in DMRT.

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Discussion

CHAPTER V
DISCUSSION

The ash weevil, *M. subfasciatus* G. which was considered to be a minor pest of brinjal and other solanaceous crops (Ayyar, 1920), now assumed a major pest status in Karnataka, often resulting cent per cent crop loss (Siddappaji, 1976; Tewari and Krishnakumar, 1983). Brinjal ash weevil, *M. subfasciatus* continues to damage by adult feeding almost throughout the year. A large number of other species of *Myllocerus* are active and confine their feeding to certain parts of the year, mostly from March to November. Other species like *M. viridanus* F., *M. dentifer* F. and *M. discolor* Boh. are known to be the pests of crops in South India (Ayyar, 1922). With this in view, research was taken up to develop management strategies for the ash weevil, *M. subfasciatus*. The results obtained from various experiments are discussed below.

5.1. Identification of alternate host plants to *Myllocerus* spp.

In the present study, *M. subfasciatus* was recorded as a major pest on brinjal and on alternate hosts *viz.*, sunflower, bhendi and sweet potato and brinjal as a major host to this weevil is in confirmity with the findings of Seniorwhite (1920). Subramaniam (1958) and Nayar *et al.* (1979) reported that *M. subfasciatus* as a pest of potato, the grubs infested the tubers within the soil by making small holes in it and feeding on the flesh. A similar observation was made by Seniorwhite (1920) who observed this species damaging potato leaves and flowers. Fletcher (1920) reported that the larvae of *Myllocerus* spp. are abundant among the roots of wild and cultivated species of grasses in soils having a tolerable limit of moisture over a longer period.

Fletcher (1914, 1917a) and Ayyar (1920) reported *M. subfasciatus* as a pest on brinjal, potato, apple and (Rau, 1936) on *Acacia decurrens*.

The present investigation also indicated that the weevil, *M. discolor* was recorded as a major pest on sunflower but survived on alternate hosts *viz*., pulses, amaranthus, groundnut, mango, moringa, gingelly and silk cotton while groundnut as a major host to *M. discolor* is in accordance with the report of Fletcher (1917b). A similar observation was made by Fletcher (1917b) stating that the above pest on gogu (*Hibiscus cannabinus*) and young leaves of wheat. Misra (1917) had indexed this as Indian fruit pest on mango, guava and ber. This species was also reported on *Moringa oleifera* by Subramaniam (1965).

5.2. Studies on time of planting and the population dynamics of ash weevil and natural enemies'

The observations made in fortnightly plantings on the leaf damage on brinjal by *M. subfasciatus* and population of this species recorded at fortnightly interval during 2000-2001 indicated that the leaf damage on brinjal by this ash weevil varied from 26.65 to 40.51 per cent, the adult weevil population ranged from 1.83 to 3.96 adults per plant and the total natural enemies' population from 1.27 to 3.39 per plant. Among the different dates of plantings, seedlings when transplanted on 15.9.2000 recorded minimum leaf damage (26.65%), less population of ash weevil (1.83 adults per plant) followed by on 15.2.2001, 1.3.2001 with 27.71, 28.41 per cent leaf damage and on 1.3.2001, 1.2.2001, 15.2.2001 with 2.24, 2.47 and 2.51 adults per plant respectively (Fig. 1 and 2). In case of natural enemies' population, maximum population of 3.39 and 3.22 adults per plant was noticed in 1.2.2001 and 15.2.2001 plantings respectively. The differences may be due to different ecological conditions under which the study was conducted.

Siddappaji (1976) reported that the adults of *M. subfasciatus* were found to be very active and breed throughout the year. Subramaniam (1965) reported that *M. u. maculosus* was predominantly found during November to December on moringa.

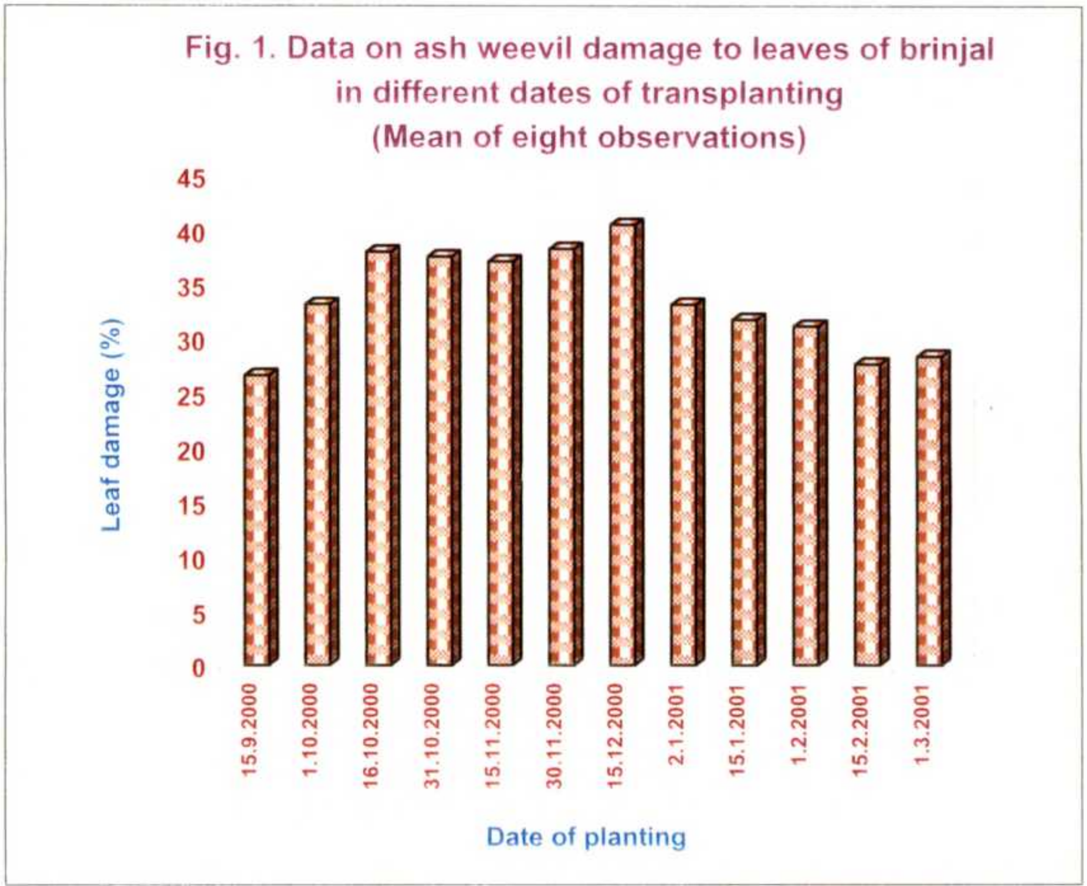


Fig. 1. Data on ash weevil damage to leaves of brinjal
in different dates of transplanting
(Mean of eight observations)
Leaf damage (%)
45
40
35
30
25
20
15
10
5
0
15.9.2000
1.10.2000
16.10.2000
31.10.2000
15.11.2000
30.11.2000
15.12.2000
2.1.2001
15.1.2001
1.2.2001
15.2.2001
1.3.2001
Date of planting

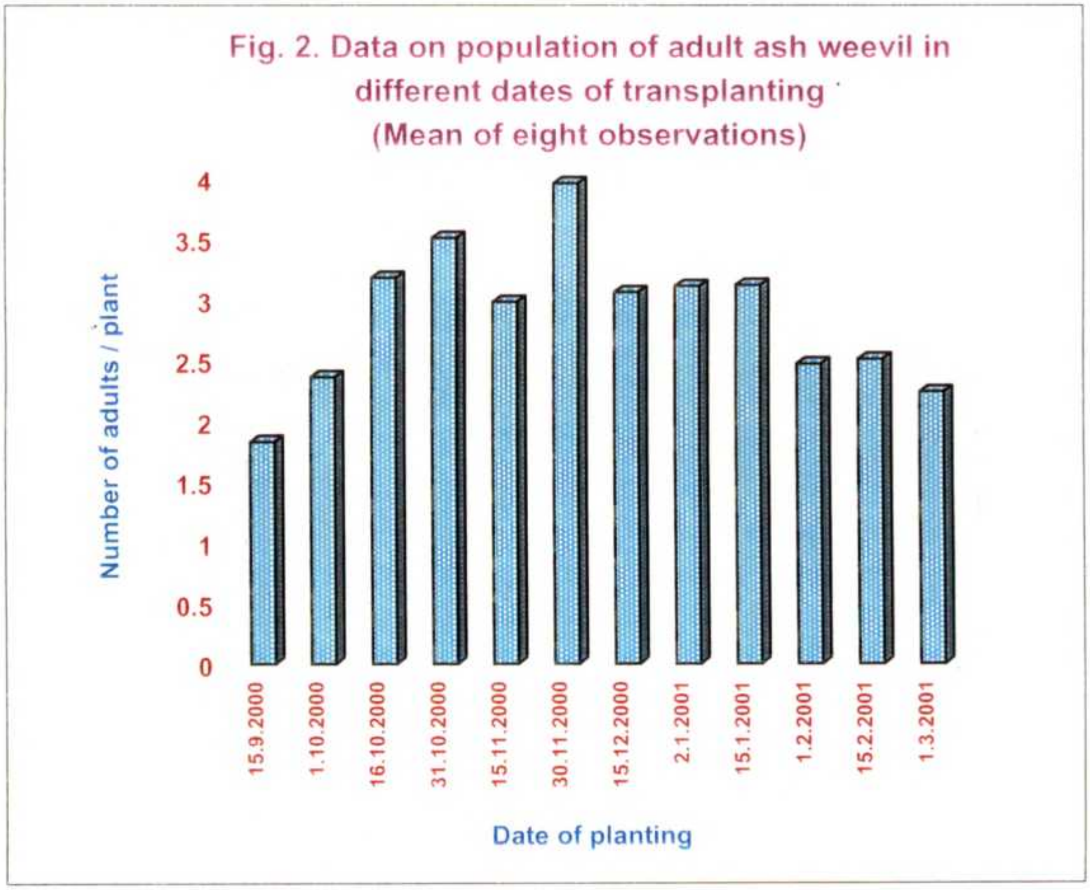


Fig. 2. Data on population of adult ash weevil in
different dates of transplanting
(Mean of eight observations)
Number of adults / plant
4
3.5
3
2.5
2
1.5
1
0.5
0
15.9.2000
1.10.2000
16.10.2000
31.10.2000
15.11.2000
30.11.2000
15.12.2000
2.1.2001
15.1.2001
1.2.2001
15.2.2001
1.3.2001
Date of planting

5.2.1. Influence of weather factors on population dynamics of ash weevil, leaf damage percentage and natural enemies' on brinjal

From the experiments conducted on different dates of planting on population dynamics of pest, data gathered on the mean population of ash weevil, leaf damage percentage and natural enemies' population per plant at fortnightly interval were correlated with six weather parameters and multiple regression analyses were made to determine the extent of influence of weather parameters on the incidence of ash weevil.

5.2.2. Leaf damage percentage

In the present study, correlation between the weather - parameters and leaf damage by the ash weevil revealed that leaf damage was significantly and positively correlated with morning RH and negatively correlated with maximum and minimum temperatures, evening RH and rainfall intensity.

The predicted regression equation fitted through multiple regression analysis relating to the weather parameters and leaf damage exhibited that increase in minimum temperature by 1°C, evening RH by one per cent and sunshine by one hour, there would be reduction in leaf damage in brinjal by 1.562, 0.580 and 1.428 per cent respectively.

5.2.3. Ash weevil population

In the present study, correlation between weather parameters and ash weevil population indicated that the ash weevil population was significantly and negatively correlated with maximum temperature, evening RH and positively correlated with sunshine hours.

The prediction equation fitted with ash weevil population and weather factors indicated that an increase in evening RH by 1 per cent and sunshine by 1 hr, there would be reduction in ash weevil population by 0.174 and 0.262 per plant respectively.

5.2.4. Natural enemies' population

The correlations worked out between total natural enemies' population and weather parameters revealed that the population had positive correlations with maximum and minimum temperatures and negative correlations with morning and evening RH.

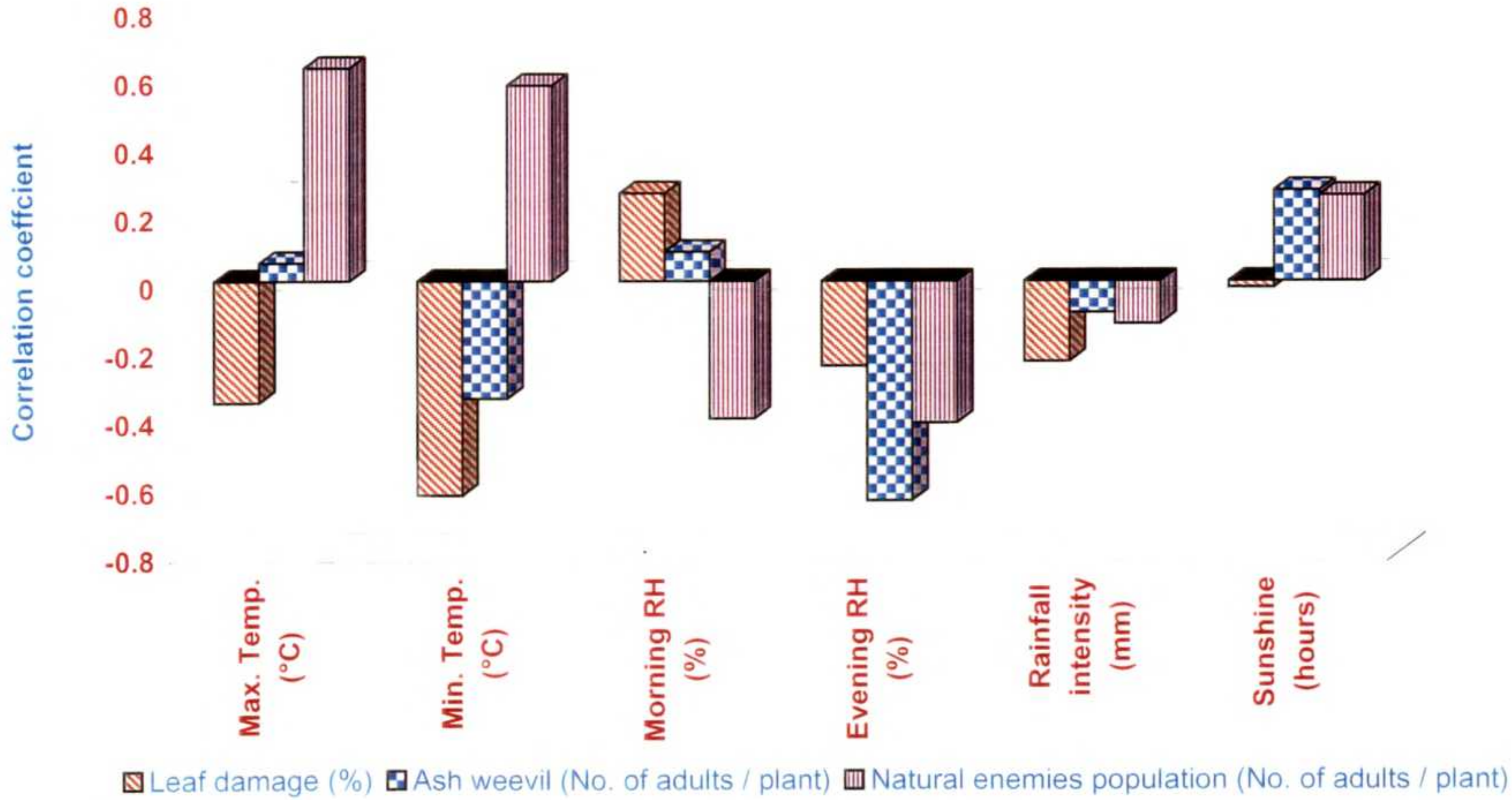
The prediction equation fitted with natural enemies' population and weather factors showed that an increase in minimum temperature by 1°C, there would be an increase in natural enemies' populations by 0.348 per plant while increasing in morning and evening RH each by one per cent and sunshine by 1 hr, there would be reduction in natural enemies' population by 0.014, 0.083 and 0.140 per plant respectively (Fig. 3).

The R^2 values obtained through multiple regression analyses also indicated that the six weather factors cumulatively influenced the ash weevil damage (%) and the population of ash weevil and total natural enemies' per plant to the extent of 53.00, 65.00 and 56.00 per cent respectively.

5.3. Feeding potential of ash weevils

The present investigation revealed that the preference of host plants by different species of *Myllocerus*, in consuming more area of leaf was in the order of *M. subfasciatus* on brinjal, > *M. discolor* on sunflower, > *M.u. maculosus* on cotton > *M. viridanus* on bhendi. With regard to the area of leaf consumption, *M. subfasciatus* consumed more on brinjal (54.62%) followed by *M. viridanus* on groundnut (38.96%), *M. discolor* on sunflower (28.97%) and *M.u. maculosus* on cotton (24.40%).

Fig. 3. Simple correlations between effective weather parameters and percentage of leaf damage by ash weevil, population of ash weevil and natural enemies per plant



5.4. Screening of varieties / cultivars / hybrids for their differential susceptibility/ resistance to ash weevils

The control methods advocated are not fully effective and become costly and hazardous. Therefore varieties found resistant to *Myllocerus subfasciatus* in brinjal are discussed here under.

5.4.1. Leaf damage percentage

All the 23 accessions tested were found to be damaged by the ash weevil, *M. subfasciatus*. None of the accessions tested were immune or absolutely resistant to ash weevil leaf damage. Among the accessions tested, SM 6 was moderately resistant but EP 114, EP 136, Annamalai, EP 46 and P 76 were moderately susceptible to ash weevil damage. All the other accessions were found to be susceptible.

5.4.2. Ash weevil population

Among the 23 accessions tested, lower population of ash weevil was recorded on SM 6 followed by EP 136, EP 138, SM 13 and EP 25 and other accessions harboured high population of ash weevil.

5.4.3. Natural enemies' population

Higher natural enemies' population was observed on EP 114, followed by EP 25, EP 12, P 76 and EP 167 and other accessions recorded less population of natural enemies'.

5.5. Determination of LC_{50} values for selected insecticides for different ash weevils

Many workers have studied effectiveness of various insecticides in terms of lethal dosage. But, it is equally essential to evaluate the insecticides in terms of LC_{50} to get economic and effective control of the pest for long period in crop like brinjal.

5.5.1. LC_{50} values for selected insecticides for *M. subfasciatus* in brinjal

In the present investigation, monocrotophos was more toxic to *M. subfasciatus* with low LC_{50} value followed by carbosulfan, endosulfan, quinalphos and dichlorvos with moderate toxicity to *M. subfasciatus*. Among the insecticides tested, phosalone exhibited less toxicity while neem oil was the least in its' effectiveness against *M. subfasciatus*. Uthamasamy *et al.* (1973) reported that among the eight newer insecticides evaluated against the adults of brinjal ash weevil, *M. subfasciatus*, chlorpyriphos (0.1%), registered the maximum mortality of weevils. Gupta and Khurana (1973) showed that methyl parathion as spray was found to be very effective against adult weevils, *M. subfasciatus* (Fig. 4).

5.5.2. LC_{50} values for selected insecticides for M. discolor on sunflower

In the present study, monocrotophos was more toxic to *M. discolor* with the low LC_{50} value followed by carbosulfan, quinalphos, endosulfan and phosalone which exhibited moderate toxicity to the weevil. The least toxicity was observed in dichlorvos and neem oil. The reason for least toxicity in neem oil might be due to the poor toxic effect but the presence of only repellant property against this pest (Fig. 5).

5.6. Intercropping experiment

Monocultures and modern high yielding cultivars with a narrow genetic base are subject to increasing losses by pests. This is because monoculture reduces the diversity of pest species which tend to explode in numbers as they have a greater potential for building up their numbers under conditions of reduced competition. On the other hand, intercropping has beneficial effect in reducing the damage due to insect pests (Palaniappan, 1985) (Fig. 6 and 7).

Fig. 4. Determination of LC_{50} values of insecticides to *Myllocerus subfasciatus* Guerin adults on brinjal

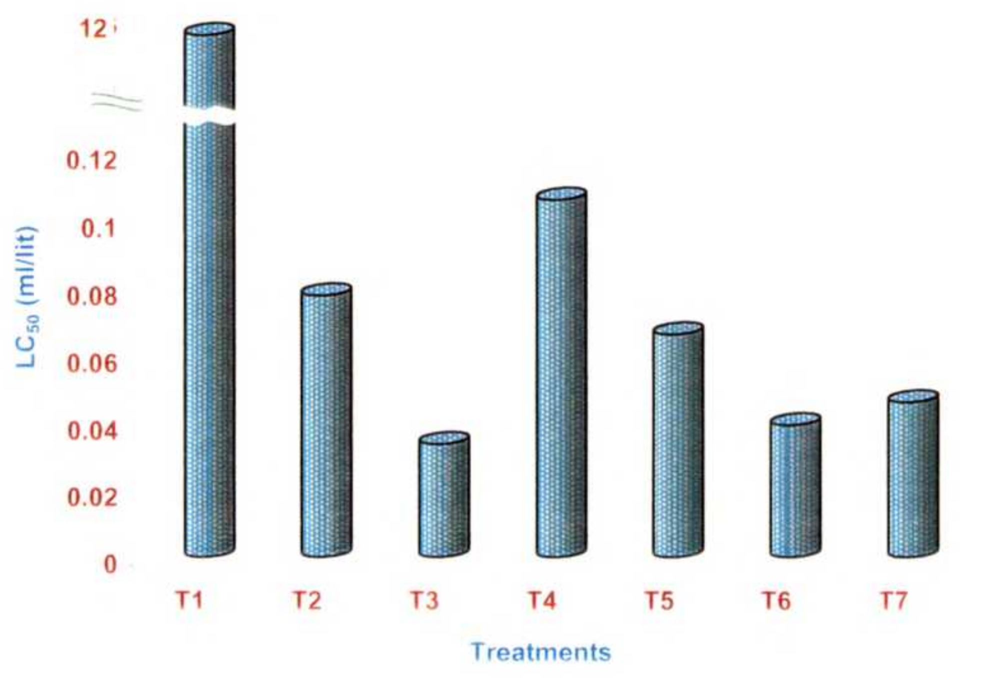
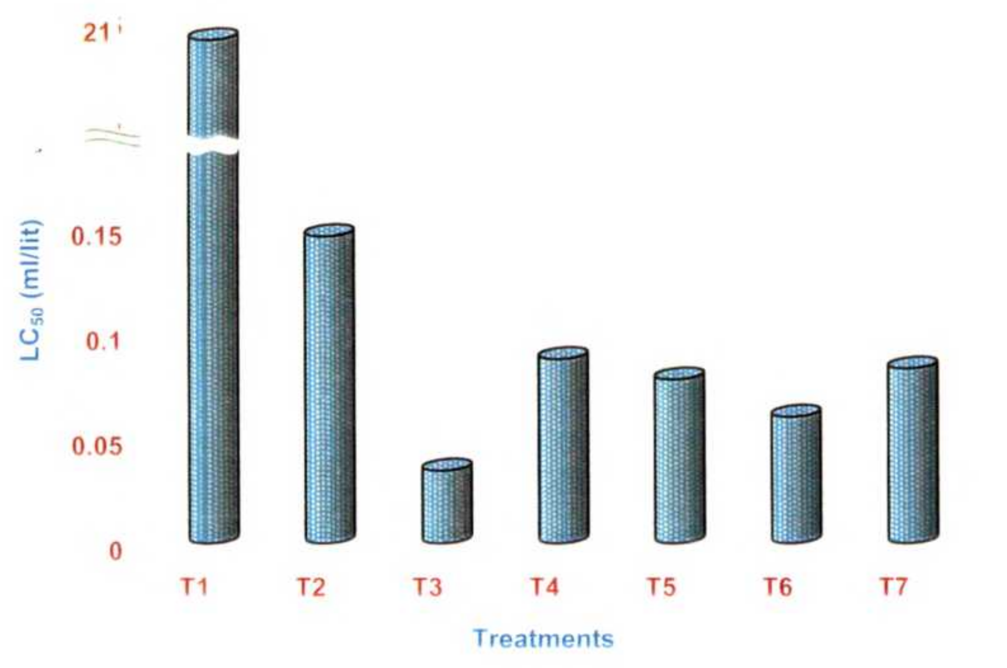


Fig. 5. Determination of LC_{50} values of insecticides to *Myllocerus discolor* Boh. adults on sunflower



5.6.1. Studies on the effect of intercropping coriander with brinjal on the incidence of ash weevil, leaf damage and natural enemies'

In the experiment conducted with cropping system approach with respect to insecticide treated and untreated conditions, the leaf damage percentage and adult ash weevil population on brinjal was minimum in the treatment consisting of brinjal + 2 rows of coriander under unprotected condition.

In the protected field, single application of endosulfan 0.07 per cent after initial count, significantly reduced the leaf damage and adult weevil population in all the intercropping treatments, but the lowest leaf damage and lesser adult population were recorded on brinjal + two rows of coriander as intercrop treatment.

The leaf damage and adult population in the protected brinjal + two rows of coriander treatment, differed significantly in recording less leaf damage and less ash weevil population when compared with same treatment under unprotected condition. This might be due to the cumulative effect of intercropping of coriander under unprotected condition. The significant effect of intercropping in reducing the pest damage on sole crop was very well documented by Singh and Singh (1977) who reported that intercropping of blackgram and greengram with pearl millet (sole crop) reduced the population of grey weevil, *M. u. maculosus* Fst. on pearl millet. Varun *et al.* (1994) who reported that intercropping of spice crop *viz.*, coriander, onion, garlic, methi, fennel, nigella and ajawaim in sugarcane (sole crop) reduced the incidence of sugarcane early shoot borer, *Chilo infuscatellus* Snell. and intercropping coriander (*Coriandrum sativum*) in a single line and double lines or as border crop with brinjal recorded less infestation of shoot and fruitborer, *Leucinodes orbonatis* G. on brinjal and the fruits harvested from the brinjal + coriander as a single line and brinjal + two lines of coriander recorded less fruit damage by the borer, when compared to it's damage in the sole crop of brinjal (Khorsheduzzaman *et al.*, 1997).

Unprotected

T1	Brinjal + single row of coriander
T2	Brinjal + two rows of coriander
T3	Brinjal with border coriander
	Protected
T4	Sole brinjal
T5	Brinjal + single row of coriander
T6	Brinjal + two rows of coriander
T7	Brinjal with border coriander
T8	Control (Sole brinjal without protection)

Fig. 6. Effect of intercropping on percentage of damage to leaves of brinjal by ash weevil

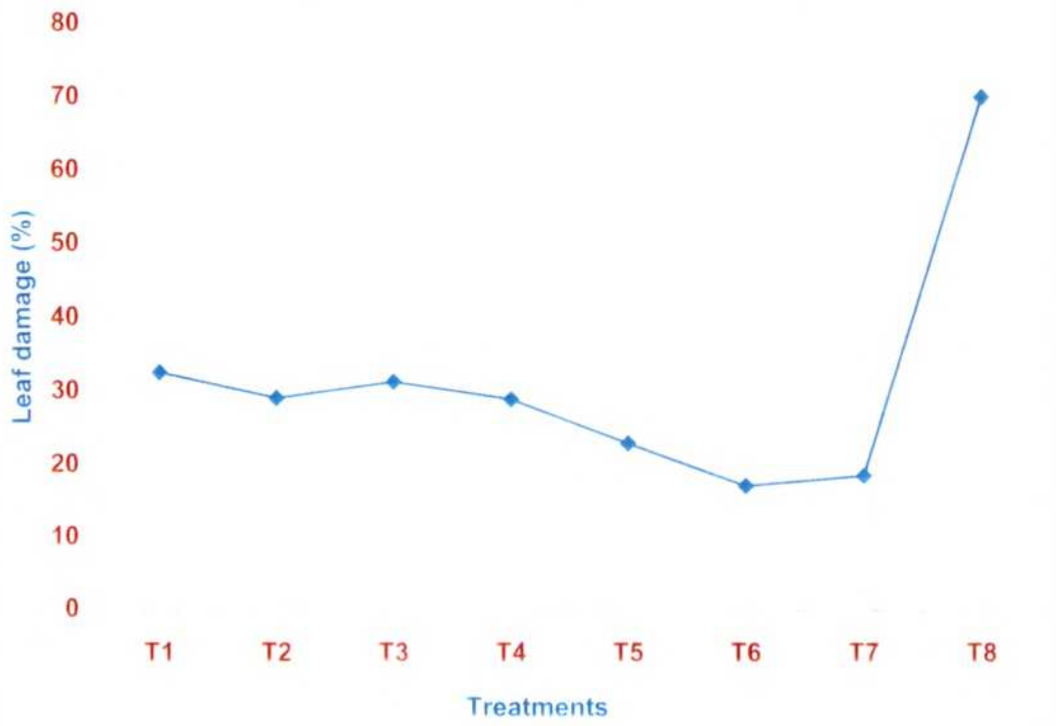
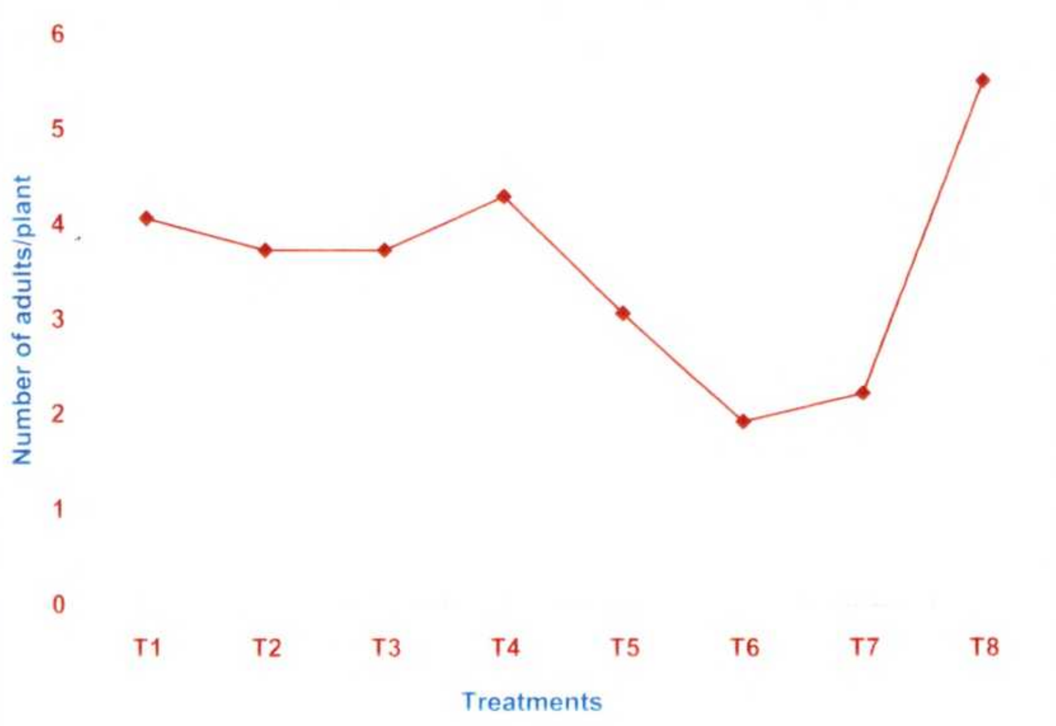


Fig. 7. Effect of intercropping on ash weevil population



Gupta *et al.* (1999) reported that intercropping with three rows of nigella in brinjal recorded the lowest damage of brinjal shoot and fruit borer.

Herbivor'es host may be attacked by a particular entomophagous insect on the same plant species but not on other host plants. The variation in choice of plants might be due to the differences in the semiochemicals produced by various plants. Kalyanasundaram (1995) reported that the extent of parasitization on *Plutella xylostella* Linn. by *Cotesia plutellae* was higher when tomato was intercropped with cauliflower, when compared to the other intercrops like onion, mustard and cluster beans with cauliflower.

Ho *et al.* (1995) also reported that the hexane extract of coriander and ethyl acetate extract of coriander and of garlic were more effective in repelling *Tribolium castaneum* whereas the hexane extract of coriander was found to be effective against *Sitophilus zeamays*.

In the current study, the repellant property of coriander as reported by the earlier researchers may be the cause for less leaf damage and less ash weevil population on brinjal when it was intercropped with coriander.

In the present study, the total population of various natural enemies' *viz*., spiders, coccinellids and *Chrysoperla* in each treatment recorded at weekly interval was higher on brinjal when coriander was intercropped or raised as border crop especially under unprotected condition, when compared to other treatments.

5.6.2. Yield

The yield of brinjal healthy fruits was higher in sole crop of brinjal followed by brinjal with border coriander, brinjal with single row coriander, and brinjal with two rows of coriander cropping systems under protected condition. The above cropping systems under unprotected condition recording higher fruit yield was in the order of brinjal + single row of coriander > brinjal + border crop of coriander > brinjal + two rows of coriander.

Similar results were obtained earlier by Gupta *et al.* (1999) who reported that intercropping brinjal with 3 rows of nigella, fennel, omum and coriander, reduced the infestation of *Leucinodes orbonalis* on brinjal significantly but maximum fruit yield was recorded from the monocrop of brinjal. Abhilash (2000) also reported that brinjal intercropped with single row coriander, double rows coriander and border row coriander reduced the infestation of *L. orbonalis* but recorded higher fruit yield in sole crop of brinjal (Fig. 8a).

With regard to grain yield of coriander, maximum yield was obtained in brinjal with 2 rows of coriander cropping system followed by single row of coriander with brinjal and as border crop of coriander under protected condition. But the order of cropping systems recording higher yield of coriander was brinjal with two rows of coriander > border crop of coriander > single line of coriander under unprotected condition (Fig. 8b).

5.6.3. Cost Benefit ratio

The economics of intercropping and cost benefit ratio were analysed for various cropping systems. The results indicated that the cost benefit ratio was the highest in brinjal + border coriander crop (1:3.2) followed by brinjal with single row of coriander (1:3.04), brinjal with two rows of coriander (1:3.04) and sole crop of brinjal (1:3.01) under protected condition but in the unprotected conditions, the cost benefit ratio was higher in brinjal with border coriander crop (1:2.89) and brinjal with single row of coriander crop (1:2.89) followed by brinjal + two rows of coriander (1:2.67) (Fig. 9).

The present results revealing the intercropping of coriander with brinjal in reducing the ash weevil damage is in consonance with the earlier findings of Khorsheduzzaman *et al.* (1997) who stated that intercropping with brinjal reduced the incidence of *L. orbonalis* and highest cost benefit ratio was obtained from plots which had single line coriander, intercropped with brinjal, followed by brinjal + coriander in double lines, brinjal + coriander as a border crop when compared to sole crop of brinjal,

Fig. 8a. Intercropping experiment - Fruit yield of brinjal

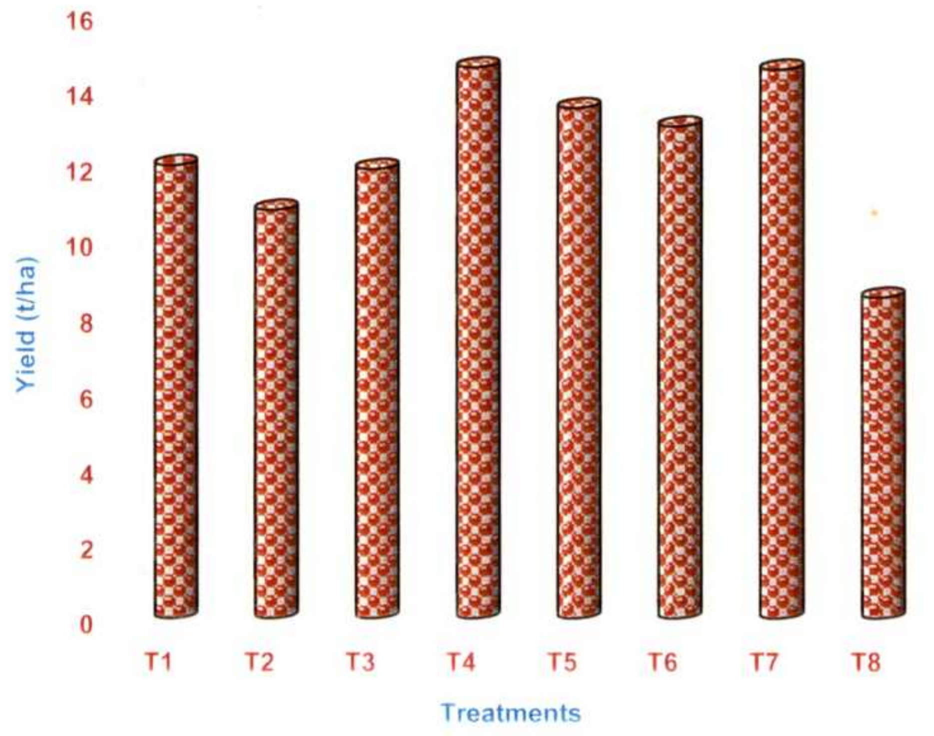


Fig. 8b. Intercropping experiment - Grain yield of coriander

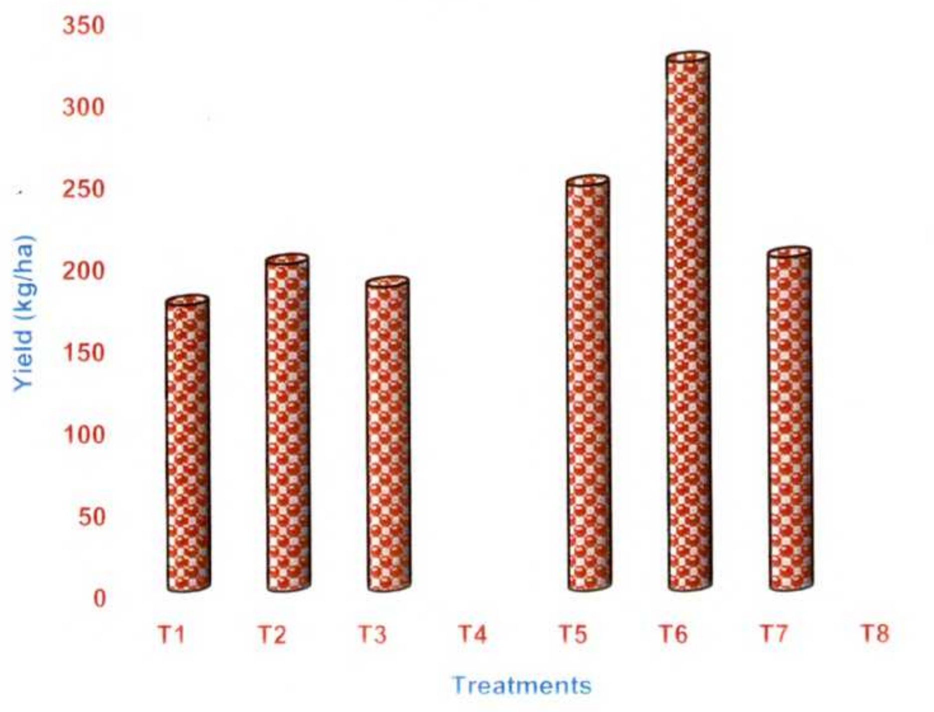
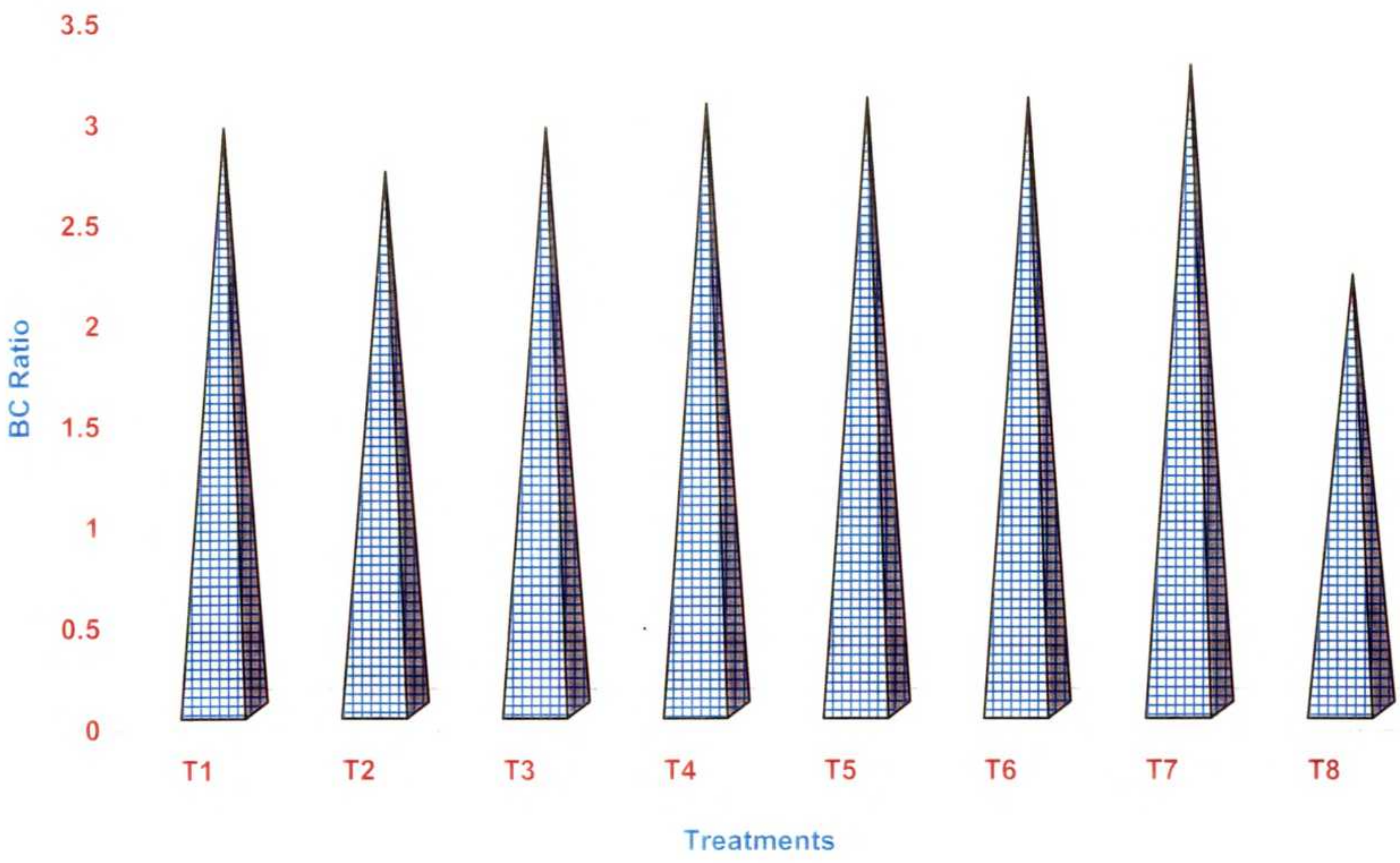


Fig. 9. Intercropping experiment on BC Ratio



treated with cypermethrin. Abhilash (2000) reported that highest cost benefit ratio was obtained in brinjal with border coriander crop followed by brinjal + single row of coriander and brinjal + two rows of coriander with endosulfan treated condition.

5.7. Effect of bio-control agents, organics and insecticides for the management of ash weevils on brinjal

5.7.1. Experiment I: Effect of soil application of insecticides against the grubs of ash weevils

The results obtained from the experiment conducted for the control of ash weevil grubs revealed the superior efficacy of soil applicationof carbofuran 3G @ 0.5 kg a.i./ha, neem cake @ 250 kg/ha, lindane 1.5 D @ 50 kg/ha, chlorpyriphos 25 EC @ 1000 ml/ha and malathion 5D @ 50 kg/ha, chlorpyriphos 1.5 D @ 50 kg/ha followed by three sprays with endosulfan 0.07 per cent at fortnightly interval in reducing the wilting of plants, of leaf damage and of ash weevil population.

Among the effective treatments, soil application of carbofuran 3G @ 0.5 kg a.i./ha followed by endosulfan 0.07 per cent sprays thrice at fortnightly interval were very effective in reducing the percentage of wilting of plants and of leaf damage by ash weevil and also recorded higher population of natural enemies' and higher fruit yield which was found to be superior to other treatments, followed by neem cake @ 250 kg/ha. The superior efficacy of carbofuran 3G in reducing the population of grubs of *M. subfasciatus* and it's damage on leaves of brinjal is in confirmity with the findings of Tewari and Krishna Kumar (1983) who found out that application of aldicarb, phorate and carbofuran were quite effective in reducing the grub population of *M.subfasciatus* and wilting of eggplants and also recorded higher yield. Rajagopal and Chennabasavanna (1977) reported that soil application of granules of carbofuran 3G @ 1 kg a.i. /ha afforded good control of *Myllocerus* spp. on maize.

Similarly soil application of granules of carbofuran 3G @ 1kg a.i./ha recorded low ash weevil grub incidence as reported by Menon (1979) and Parameswaran and Balasubramanian (1980) on cotton (Fig. 10, 11 and 12).

5.7.2. Yield

In the experiment conducted with spray formulations against ash weevil grubs, higher fruit yield was obtained in the plots treated with carbofuran 3G @ 0.5 kg a.i./ha (11.70 t/ha) followed by in neem cake @ 250 kg/ha, chlorpyriphos 20 EC @ 1000 ml/ha, lindane 1.5 per cent D @ 50 kg/ha, malathion 5 per cent D @ 50 kg/ha and *P. fluorescens* @ 2.5 kg/ha plots which recorded the fruit yield of 11.17, 10.83, 9.19, 8.36, 7.94 and 7.83 t/ha respectively as against untreated check recorded the lowest yield of 6.00 t/ha. Tewari and Krishnakumar (1983) found that soil application of phorate 10 G recorded the highest yield of brinjal (Fig. 13).

5.7.3. Cost Benefit ratio

Considering the Cost Benefit Ratio (CBR) for all the treatments, carbofuran 3G @ 0.5 kg a.i/ha treated plots recorded the highest CBR of 1: 2.71 followed by neem cake @ 250 kg/ha, chlorpyriphos 20 EC @ 1000 ml/ha, lindane 1.5 per cent D @ 50 kg/ha, malathion 5 per cent D @ 50 kg/ha and *P. fluorescens* @ 2.5 kg/ha, chlorpyriphos 1.5 per cent D @ 50 kg/ha recorded the CBR's of 1:2.46, 1:2.41, 1:2.04, 1:1.84, 1:1.77 and 1:1.65 respectively, as against the lowest CBR of 1:1.52 in untreated check (Fig. 14).

5.7.4. Experiment II. Effect of foliar application of insecticides against the adults of ash weevil

The results of the experiments conducted for the control of adult ash weevils and their damage elucidated that the order of efficacy of treatments in reducing the ash weevil population and its' damage to the leaves and increasing the population of natural enemies'

T1	Neem cake @ 250 kg/ha
T2	*Pseudomonas fluorescens* @ 2.5 kg/ha
T3	Chlorpyriphos 20EC @ 1000ml/ha.
T4	Carbofuran 3G @0.5 kg a.i./ha
T5	Lindane 1.5% D @50kg/ha
T6	Malathion 5% D @50kg/ha
T7	Chlorpyriphos 1.5% D @50kg/ha
T8	Untreated check

Fig. 10. Effect of soil application of treatments on percentage of wilting of plants due to ash weevil in brinjal

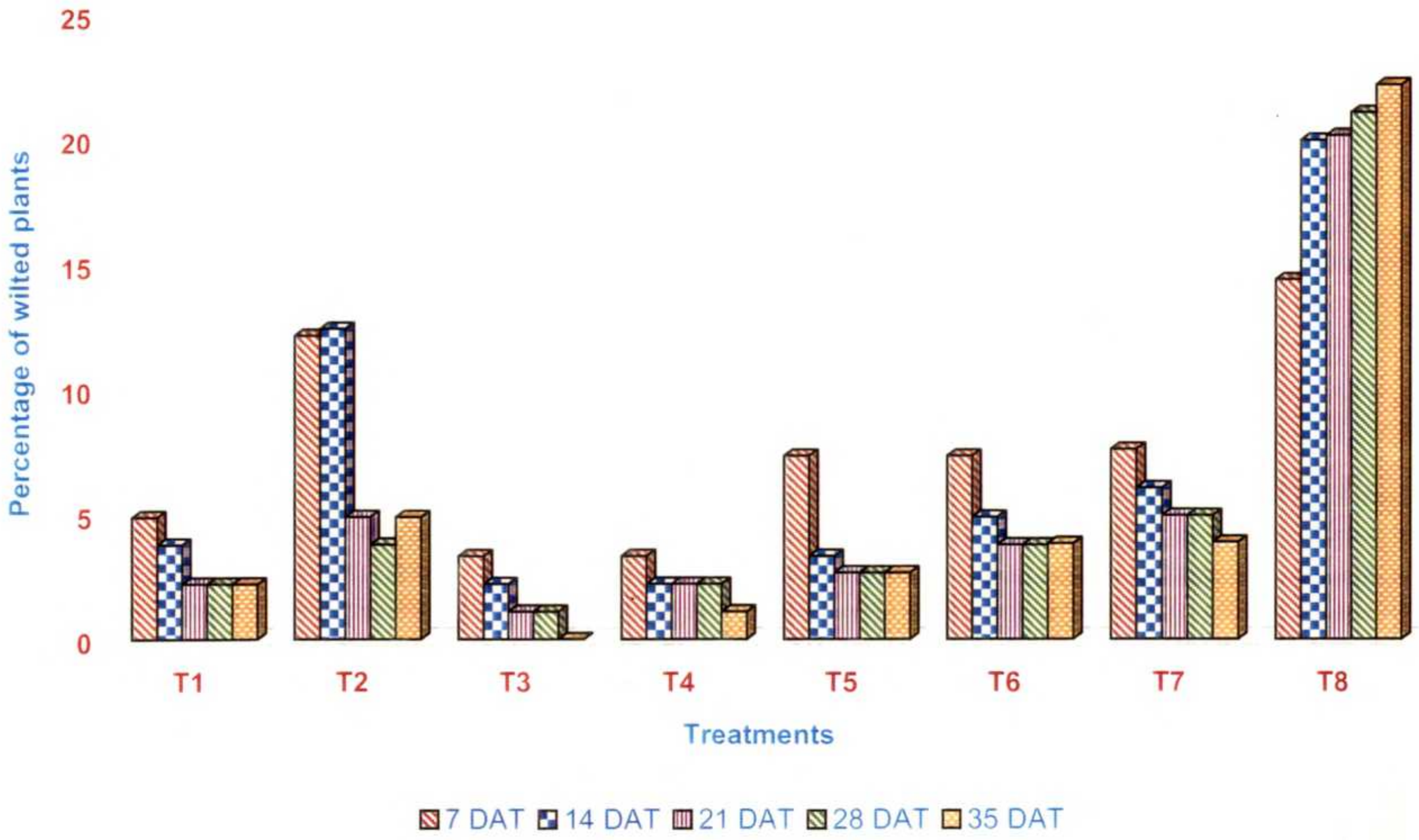


Fig. 11. Effect of soil application of treatments on percentage of damage to leaves of brinjal by ash weevil

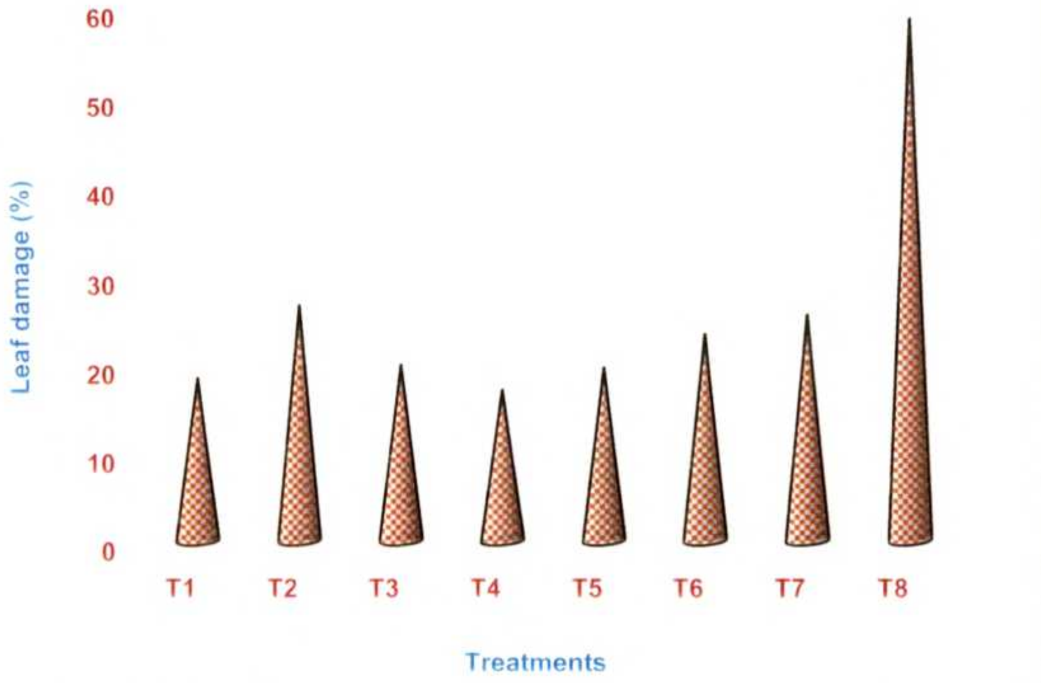
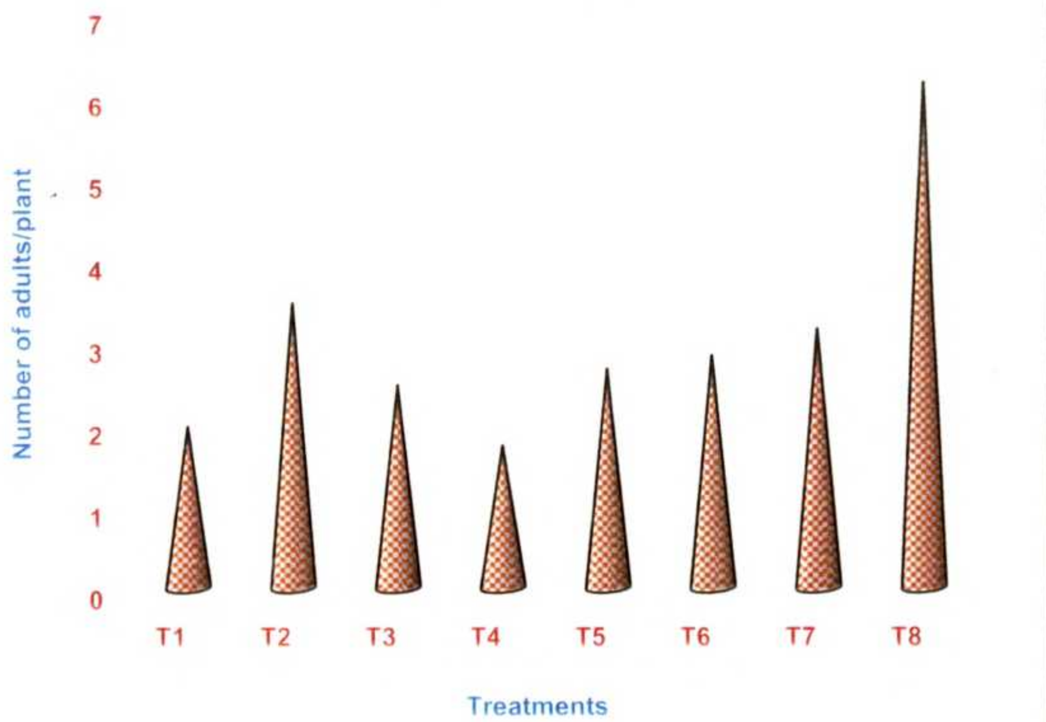


Fig. 12. Effect of soil application of treatments on ash weevil population



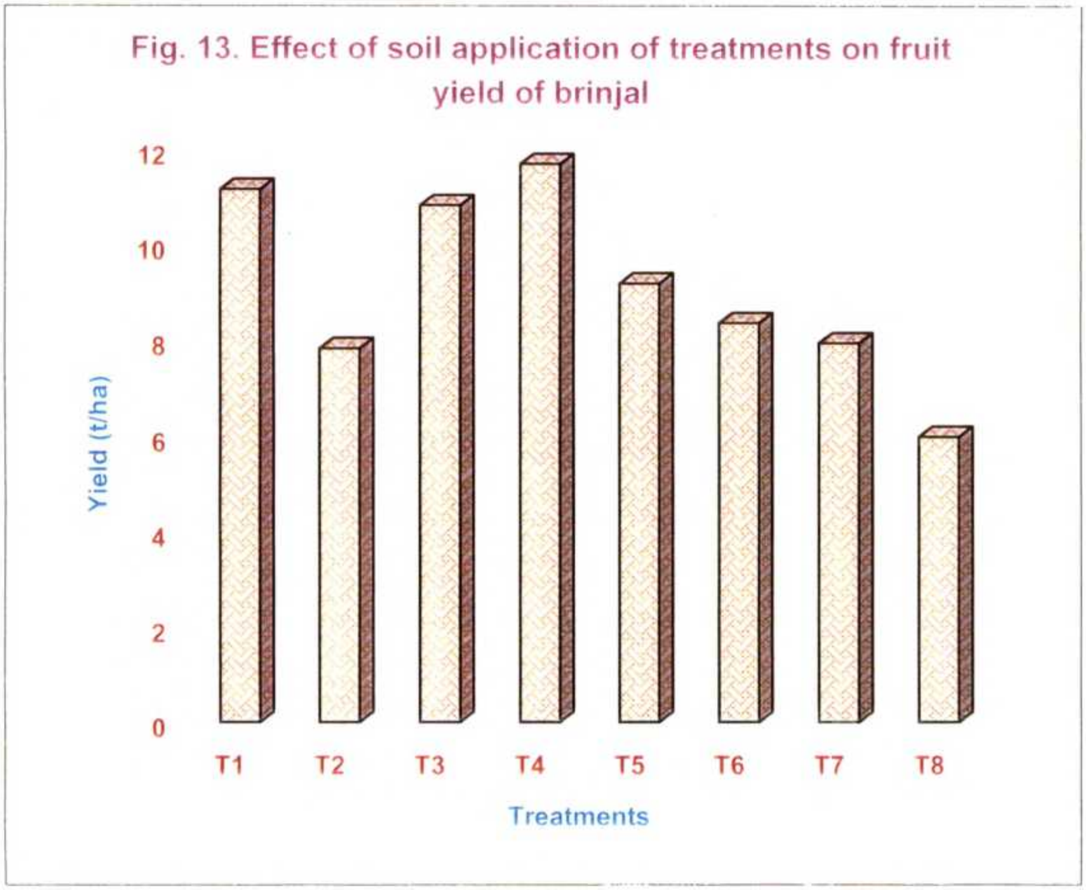


Fig. 13. Effect of soil application of treatments on fruit yield of brinjal
Yield (t/ha)
0
2
4
6
8
10
12
T1
T2
T3
T4
T5
T6
T7
T8
Treatments

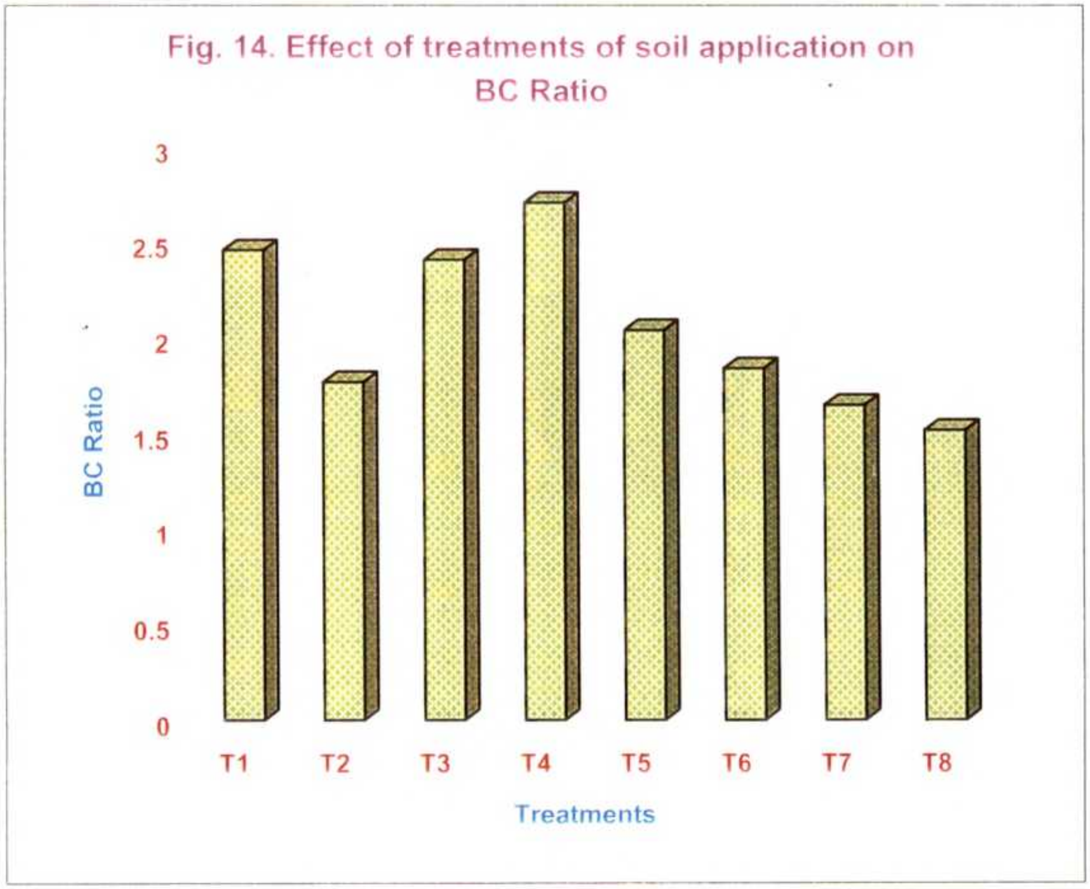


Fig. 14. Effect of treatments of soil application on BC Ratio
BC Ratio
0
0.5
1
1.5
2
2.5
3
T1
T2
T3
T4
T5
T6
T7
T8
Treatments

15 days after the third spray was endosulfan (0.07%) > dichlorvos (1000 ml/ha) > malathion (1000 ml/ha) > neem azal T/S 1 per cent (1000 ml/ha), > NSKE 5 per cent > carbaryl 50 WP (1 kg/ha). The superior efficacy of endosulfan 0.07 per cent (@ 1000 ml/ha) in effectively reducing the leaf damage, ash weevil population and conserving more population of natural enemies' and also recording higher fruit yield of brinjal is in consonance with the results of Sharma *et al.* (1971) who reported that endosulfan 35 EC @ 1000 ml/ha gave the best results in controlling *Myllocerus* spp. Shah (1979) reported that spraying of 0.07 per cent endosulfan resulted in the lowest percentage of shoot and fruit damage by the fruit borer on brinjal, while Yien (1985) stated that endosulfan spray @ 0.75 kg a.i./ha was found to be highly effective in reducing the shoot and fruitborer in brinjal (Fig. 15 and 16).

5.7.5. Yield

In the second field experiment, conducted with spray formulations against the ash weevil adults, the order of efficacy of different treatments in recording higher fruit yield was with endosulfan 0.07% @ 1000 ml/ha > neem azal T/S 1% @ 1000 ml/ha > dichlorvos 76 SC @ 1000 ml/ha > malathion 50 EC @ 1000 ml/ha > carbaryl 50 WP @ 1 kg/ha which were on par. This finding is in confirmity with the results of Sharma *et al.* (1971) who reported that endosulfan 35 EC @ 1000 ml/ha gave the best results in controlling *Myllocerus* spp. (Fig. 17).

5.7.6. Cost Benefit ratio

The economics of treatments and their cost benefit ratios were worked out for different treatments. The results indicated that cost benefit ratio was higher (1:2.86) in endosulfan 0.07 per cent @ 1000 ml/ha followed by dichlorvos 76 SC @ 1000 ml/ha, malathion 50 EC @ 1000 ml/ha, neem azal T/S 1 per cent @ 1000 ml/ha, NSKE 5 per cent and carbaryl 50 WP @ 1 kg/ha recorded the CBR's of 1:2.66, 1:2.59, 1:2.57, 1:2.25 and 1: 2.23, respectively as against the lowest CBR in untreated check (1:1.49) (Fig. 18).

T1	Neem Azal T/S 1%@ 1000 ml/ha
T2	NSKE 5% @ 50 g/lit
T3	Endosulfan 0.07%@ 1000 ml/ha
T4	Dichlorvos 76SC @1000 ml/ha
T5	Malathion 50EC @1000 ml/ha
T6	Carbaryl 50WP @ 1kga.i./ha
T7	Untreated Check

Fig. 15. Effect of foliar application of treatments on percentage of damage to leaves of brinjal by ash weevil

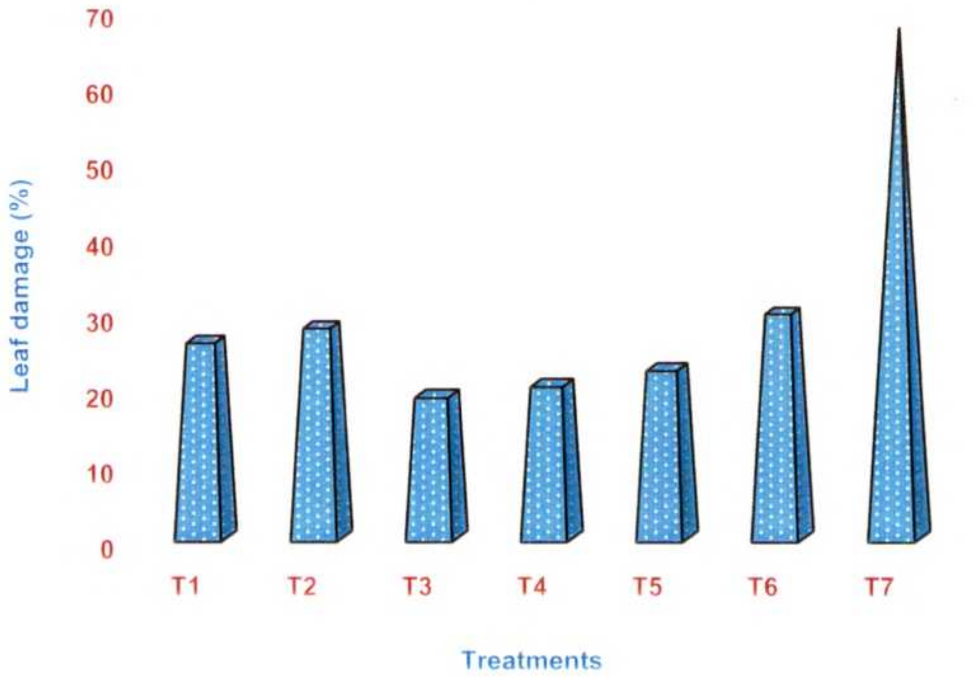


Fig. 16. Effect of foliar application of treatments on ash weevil population

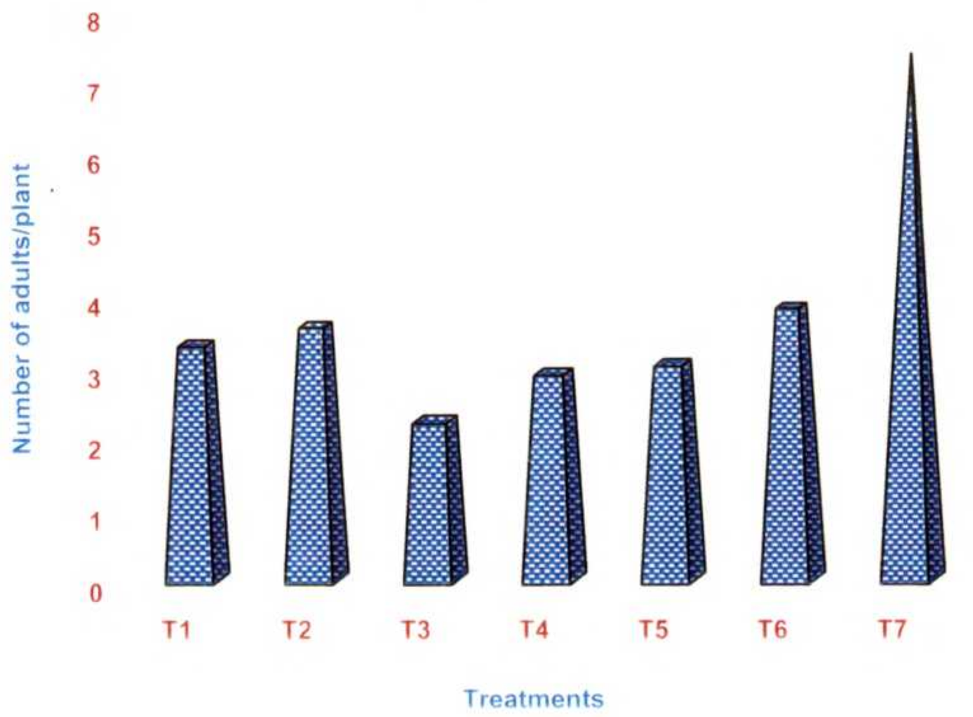


Fig. 17. Effect of foliar application of treatments on fruit yield of brinjal

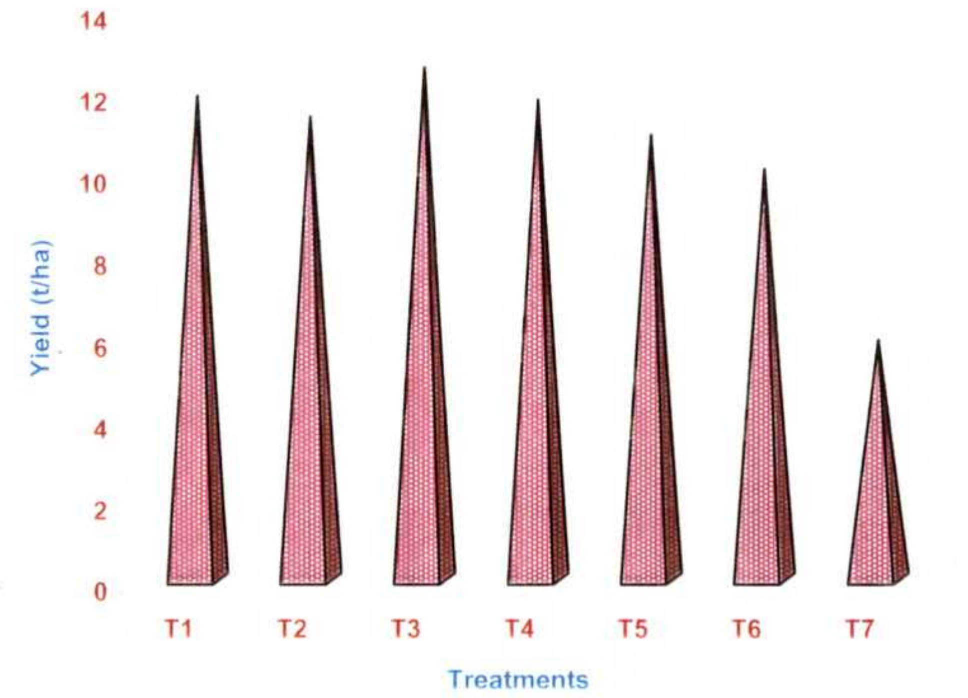
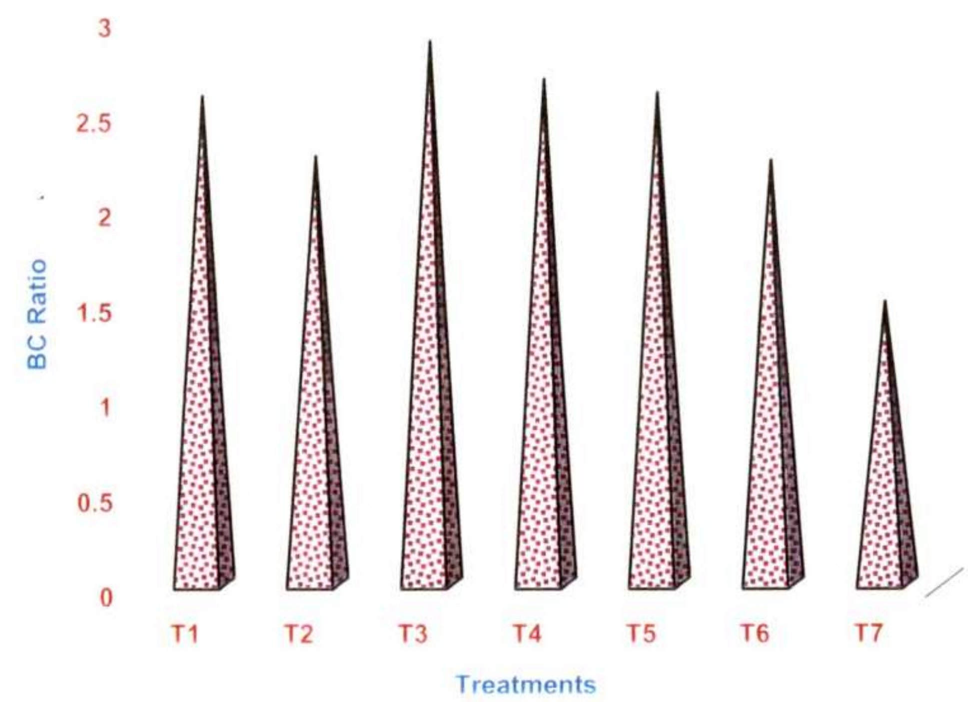


Fig. 18. Effect of treatments of foliar application on BC Ratio



Summary

CHAPTER VI

SUMMARY

Investigations were carried out in the field to identify the alternate host plants to *Myllocerus* spp., to study the impact of time of planting on the population dynamics of ash weevil, leaf damage and dynamics of natural enemies; feeding potential of *Myllocerus* spp. on different hosts, evaluation of the brinjal accessions for their differential susceptibility / resistance to brinjal ash weevil, *M. subfasciatus* determination of LC_{50} values for selected insecticides against *M. subfasciatus* and *M. discolor*; the effects of intercropping coriander with brinjal on the incidence of *M. subfasciatus* and evaluation of the efficacy of different insecticides, bio-control agents and organics for the management of ash weevils on brinjal. Field experiments were conducted at the orchard and also at the insectary of TNAU, Coimbatore. The results of these investigations are summarised below.

➢ Identification of alternate hosts to *Myllocerus* spp.

Brinjal was recorded as a major host while sunflower, bhendi and sweet potato as alternate hosts to *M. subfasciatus*. Sunflower was recorded as a major host to *M. discolor* but it survived on alternate hosts *viz.*, on pulses, amaranthus, groundnut, mango, moringa, sesame and silkcotton. *M. viridanus* was found to feed on bhendi, teak, moringa, rose and West Indian Cherry as major hosts and on sunflower, mango, custard apple, cotton, mulberry, redgram, deccanhemp, sweet basil and pungam as minor hosts. *M.u. maculosus* was found to feed on sunflower, groundnut, cotton and jamun.

➢ Studies on impact of different dates of planting on ash weevil population and it's damage

*The leaf damage by the weevil, *M. subfasciatus* ranged from 26.65 to 40.52 per cent. Plantings taken on 15.9.2000 and 15.2.2001 recorded low leaf damage of 26.65 and 27.71 per cent respectively.

*Ash weevil population ranged from 1.91 to 3.96 adults per plant in different dates of plantings. Planting taken on 15.9.2000 recorded 1.91 adults/plant followed by 1.3.2001 recorded less population of adults per plant (2.24 adults / plant).

*Natural enemies' population ranged from 1.27 to 3.39 adults per plant in different dates of plantings. However, planting taken on1.2.2001 (3.39) followed by 15.2.2001 (3.22) recorded maximum population of natural enemies per plant.

➢ **Influence of weather factors**

*Leaf damage by the ash weevil was significantly and positively correlated with morning RH and negatively correlated with maximum temperature, minimum temperature, evening RH and rainfall intensity and multiple regression analyses indicated that when there is an increase in minimum temperature by 1°C, evening RH by one per cent and sunshine by one hour, there would be reduction in leaf damage on brinjal by 1.56, 0.58 and 1.43 per cent respectively.

*Ash weevil population was significantly and negatively correlated with maximum temperature, evening RH and positively correlated with sunshine hours and regression analyses revealed that an increase in evening RH by one per cent and sunshine by one hour, there would be reduction in ash weevil population by 0.174 and 0.262 adults per plant respectively.

*Natural enemies had positive correlations with maximum and minimum temperatures and negative correlations with morning and evening RH. The prediction equation fitted with weather factors and natural enemies' population and showed that an increase in minimum temperature by 1°C, there would be an increase in natural enemies population by 0.348 while increase in morning and evening RH each by one per cent and sunshine by 1 hr, there would be reduction in natural enemies population by 0.014, 0.083 and 0.140 per plant respectively.

*The R^2 values obtained through multiple regression analyses also indicated that six weather factors cumulatively influenced the ash weevil damage (%), population of ash weevil and of total natural enemies per plant to the extent of 53, 65 and 65 per cent respectively.

- **Feeding potential of *Myllocerus* spp.**

M. subfasciatus consumed more leaf area (cm^2) on brinjal followed by *M. discolor* on sunflower, *M. u. maculosus* on cotton and *M. viridanus* on bhendi.

*With regard to the percentage of area of leaf consumption by *M. subfasciatus* was higher on brinjal (54.62%) followed by *M. viridanus* on groundnut (38.96%), *M. discolor* on sunflower (28.79%) and *M.u. maculosus* on cotton (24.40%).

- **Evaluation of brinjal accessions**

*The variety SM-6 was moderately resistant to *M. subfasciatus* but EP 114, EP 136, Annamalai, EP 46 and P 76 were moderately susceptible to leaf damage by the weevil on brinjal. SM 6 recorded lower population of weevils followed by EP 136, EP 138, SM 13 and EP 25 while higher natural enemies' population was observed on EP 114 followed by EP 25, EP 12, P 76 and EP 167.

- **Determination of LC_{50} values for different insecticides against *Myllocerus* spp.**

Insecticides were evaluated in terms of LC_{50} against *M. subfasciatus* adults on brinjal and *M. discolor* adults on sunflower. Among the insecticides tested, monocrotophos was more toxic to both the species recording the least LC_{50} values of 0.0338 and 0.0346 ml/lit respectively, followed by carbosulfan with 0.0395 and 0.0603 ml/lit respectively.

➢ Intercropping experiments

*Intercropping coriander with brinjal revealed that coriander with brinjal in single row, double rows and as border crop reduced the ash weevil population and it's damage to the leaves on brinjal and also increased the natural enemies' population both under protected and unprotected conditions. Among the cropping systems, brinjal with double rows of coriander was found to be the best cropping pattern, recording less percentage of leaf damage ranging from 40.43 to 29.08 and also from 41.59 to 17.08 under unprotected and protected condition respectively as against the sole crop of brinjal which recorded the percentage of leaf damage ranging from 45.75 to 28.88 with protection and from 45.82 to 69.93 per cent under unprotected condition.

*Brinjal with two rows of coriander was found to be superior in reducing the ash weevil population ranging from 4.23 to 1.93 adults per plant and from 5.10 to 3.73 adults per plant under protected and unprotected conditions respectively. The sole crop with protection reduced the ash weevil population from 5.73 to 4.30 adults per plant as against sole crop of brinjal under unprotected condition (6.60 to 5.53 adults per plant).

*The natural enemies' population was higher on brinjal when coriander was intercropped or raised as border crop specially under unprotected condition, when compared to the above treatments under protected condition.

*The healthy fruit yield of brinjal was higher in brinjal as a sole crop (14.62 t/ha) followed by brinjal with border coriander (14.58 t/ha), brinjal with single row of coriander (13.54 t/ha) and brinjal with two rows of coriander (13.06 t/ha) cropping systems under protected conditions, whereas brinjal + single row of coriander (12.01 t/ha) and with border coriander (11.92 t/ha) also recorded higher fruit yield when compared to brinjal + 2 rows of coriander (10.83 t/ha) and sole crop of brinjal (8.54 t/ha) under unprotected conditions.

*The cost benefit ratio was higher (1:3.20) in brinjal with border coriander crop followed by brinjal with single row and two rows of coriander (each 1:3.04) against the sole crop of brinjal which recorded a CBR of (1:3.01) whereas under unprotected condition, brinjal + single row coriander and border crop each recorded the CBR of 1:2.89.

➢**Effect of bio-control agents, organics and insecticides for the management of ash weevil grubs and adults on brinjal**

*Soil application of carbofuran 3G @ 0.5 kg a.i./ha followed by endosulfan 0.07 per cent sprays thrice at fortnightly interval were very effective in reducing the percentage of wilting of plants, of leaf damage, and of ash weevil population and also recorded higher population of natural enemies and higher fruit yield, with CBR of 1: 2.71 which was followed by neem cake @ 250 kg/ha (1:2.46).

*Spraying of endosulfan dichlorvos, malathion, neemazal each @ 1000 ml/ha NSKE (5%) and carbaryl @ 1 kg/ha effectively reduced the leaf damage and ash weevil population, conserved more population of natural enemies and recorded higher fruit yield of brinjal and higher CBR of 1:2.86, 1:2.66, 1:2.59, 1:2.57, 1:2.25 and 1:2.23 respectively

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