ECO-FRIENDLY PEST MANAGEMENT IN SNAKEGOURD
(*Trichosanthes anguina* L.)

By
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DECLARATION

I hereby declare that this thesis entitled ***"Eco-friendly pest management in snakegourd (Trichosanthes anguina L.)"*** *is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.*

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CERTIFICATE

Certified that this thesis entitled **"Eco-friendly pest management in snakegourd (*Trichosanthes anguina* L.)"** is a record of research work done independently by Mr. SIVAKUMAR. T under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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SIVAKUMAR.T

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INTRODUCTION

INTRODUCTION

Vegetables are rich sources of minerals, fibre, vitamins and many essential nutrients. They form an integral part of our daily diet. Daily per capita recommendation of vegetables in a balanced diet is 285 g (Gopalakrishnan, 1999). However, the average daily per capita consumption of vegetables in Kerala is only 125 g (PPM Cell, 1996). This reflects the low vegetable production in the state. Kerala depends on neighbouring states to meet the requirement of vegetables. Intensive efforts are being taken to boost vegetable production in the state.

Pest incidence is a major constraint in vegetable production, by which both quantity and quality are impaired. In cucurbits, crop loss up to 50 per cent may occur due to fruit fly (Narayanan and Batra, 1960). Leaf feeders, pumpkin beetles and aphids are also serious problems in snakegourd (Nair, 1999). Vegetable farmers usually resort to indiscriminate and injudicious application of chemical pesticides to tackle the pest problem (Rahiman *et al.*, 1986). This has caused deterioration of soil health and environmental pollution. Pesticide residues contaminate both surface water and ground water and enter the food chain, resulting in biomagnification. It has been reported that the residues of pesticides in vegetables at times exceed even the Maximum Residual Limit (MRL) (Santhoshkumar, 1997). Therefore it is imperative to evolve an eco-friendly pest management strategy in vegetables.

A thorough understanding of the extent of crop loss as well as the indigenous practices adopted by farmers to combat pest attack will be helpful for chalking out a suitable pest management strategy. Botanical pesticides are safe, eco-friendly and

effective against pests. Various botanical formulations are available in market. The efficiency of indigenous methods for pest management followed by farmers should be scientifically tested. Assessing the efficiency of these methods during different growth stages of the crops for the management of pests can help evolve a suitable package for the management of pests in snakegourd.

The present study was undertaken with the following objectives.

i) Documentation of different farmers' practices on pest management.

ii) Evaluation of different snakegourd varieties to pest infestations.

iii) Testing the efficiency of different fruit fly traps.

iv) Evolving a suitable eco-friendly pest management strategy against pests of snakegourd.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The present study aims at the eco-friendly pest management strategies against major pests of snakegourd. The relevant work pertaining to major pests and their management practices are reviewed here.

Fruit fly (*Bactrocera cucurbitae* Coq.)

Fruit fly is a major pest of snakegourd and other cucurbits like bittergourd, cucumber etc. It directly causes damage to the economic part of the crop and thus aggravates the problem. The maggots of the fly feed on the internal content of the fruit, leading to fruit decay and loss (Nair, 1995).

Fruit fly pupates in soil. So ploughing of the field will destroy fruit fly pupae, as reported by Narayanan (1953). Wesley (1956) observed that sowing of early or late varieties of cucurbitaceous vegetables and raking up soil under the infested plants during winter months would destroy the hibernating pupae. Raghupathy *et al.* (1997) recommended ploughing and turning over of soil after harvest and collection and burning of infested fruits in deep pits.

Protection of fruits by covering has been reported to exclude the flies from egg laying. Complete protection against fruit flies could be obtained with the use of newspaper bags (Hutson, 1940). Similar observations were made by Fang and Chang (1987). Wen (1988) reported that wrapping of fruits prevented damage by tephritid flies. Jalaja (1989) observed that polythene bag was safe, fool proof and economical for preventing fruit fly damage in bittergourd, compared to cloth or paper bags.

However, bagging was an uneconomic practice in commercial cultivation of bittergourd (Nandakumar, 1999).

Bait trap using attractant and an insecticide has been reported to reduce population of flies considerably. Maximum catch of both sexes of *Dacus cucurbitae* was obtained when a bait containing fermented palm juice (one part), saturated sugar solution (one part) and malathion 50 WP 5.0 g @ 100 ml was used (Lall and Singh, 1960). The infestation of fruit by *D. dorsalis* in mango decreased from 33.7 per cent to 0.6 per cent when a bait trap consisting of methyl eugenol 1.0 per cent and carbaryl 0.1 per cent was used (Lakshmanan *et al.*, 1973). Shah and Patel (1976) observed that leaves of *Ocimum sanctum* attracted male flies of *Dacus* spp. in mango and chikku. Studies in Taiwan showed that methyl eugenol and cue-lure could be used to trap *D. cucurbitae* in cucurbits (Fang and Chang, 1984). Honey at one per cent and fruit traps using palayamkodan or poovan were effective in trapping both the sexes of fruit fly, in bittergourd (Jalaja, 1989).

Pillai *et al.* (1991) recommended the use of bait traps using palayamkodan fruits sprinkled with carbofuran granules @ 1.0 g/ piece for better control of the fruit fly, *D. cucurbitae*. Nasiruddin and Karim (1992) recommended setting up of bait trap of 0.5 g dipterex 80 SP (trichlorfon) with 100 g sweetgourd mash to control *B. cucurbitae* attacking snakegourd. Similar observations were reported by Chowdhury *et al.* (1993). *D. cucurbitae* and *D. dorsalis* could be lured to a trap containing 20 g crushed *O. sanctum* leaves, 0.5 g citric acid and 0.5 g carbofuran in 100 ml water placed in a coconut shell (Reghunath and Indira, 1993). Snakegourd infestation by fruit fly (*D. cucurbitae*) could be effectively controlled by the use of

banana traps coupled with the removal and destruction of infested fruits (KAU, 1996 a ; Nair, 1999). Reghupathy *et al.* (1997) recommended a poison baiting containing saturated sugar solution 5.0 ml and malathion 50 EC 5.0 ml + 100 ml fermented palm juice for controlling fruit flies.

Setting up of a trap containing 5.0 g of wet fish meal in polythene bags (20 x 15 cm) with six holes and a drop of (0.1 ml) dichlorvos in cotton plug inside the bag was found effective in controlling of fruit flies (Reghupathy *et al.*, 1997).

Nandakumar (1999) advocated setting up of coloured coconut shell trap containing carbofuran smeared banana fruit (palayamkodan) alternated with carbofuran poisoned ocimum jaggery trap at 2.0 m spacing in bittergourd.

Chemical pesticides are also in use to control the fruit fly menace. Narayanan and Batra (1960) recommended one per cent malathion emulsion, fenthion or dimethoate with sugar spray at fortnightly intervals. Studies conducted by Dale (1965) showed that a coarse spray with a liquid bait containing one per cent yeast protein and 0.1 per cent malathion was an effective method to control melon fly without the risk of poison hazards or phytotoxicity. Spraying carbaryl 0.1 per cent three times at fortnightly intervals from the time of flowering was effective against *D. cucurbitae* (David, 1967). Das *et al.* (1968) observed that carbaryl 0.1 per cent, malathion 0.05 per cent and dipterex 0.1 per cent sprays were effective in reducing fruit fly infestation in bittergourd. Fruit fly attack was reported to be the lowest when a spray of 0.1 per cent dimethoate or fenthion at tri-weekly intervals commencing from the time of flowering was given (Nagappan *et al.*, 1971). Malathion or fenthion @ 0.1 per cent at fortnightly intervals was found effective by David and Kumaraswamy (1995).

Mote (1975) reported that tetrachlorvinphos at 0.1 per cent gave good control of melon fly and also resulted in the highest yield in bittergourd. He also reported that in cucumber 0.03 per cent fenthion gave better control of fruit fly. Agarwal *et al.* (1987) suggested that spraying plants with 500 g molasses and 50 g malathion in 50 l of water at seven days interval resulted in good control of fruit fly. Four spray applications of 0.2 per cent carbaryl was effective against *D. cucurbitae* and resulted in higher yields (Pareek and Kavadia, 1988). Malathion 50 EC, 0.5 per cent was found to be the most effective insecticide in reducing the number of *D. cucurbitae* infesting bottlegourd and spongegourd in field studies conducted in Rajasthan (Bhatnagar and Yadav, 1992). In a study conducted by Talpur *et al.* (1994) in Pakistan, the greatest yield and the lowest percentage of infestation were recorded with formothion at 600 ml $acre^{-1}$. The incidence of fruit fly could be effectively managed by the application of carbaryl or malathion @ 0.2 per cent + sugar as spray along with banana/ocimum trap (KAU, 1996 a).

Singh and Srivastava (1983) studied the oviposition deterrence and found that ethanolic extract of neem seed kernal (NSK) at 5.0 per cent completely deterred oviposition by *D. cucurbitae* on bittergourd.

Pumpkin beetle

The red pumpkin beetle *Aulacophora foveicollis* Lucas is the most destructive pest of all cucurbitaceous vegetable crops and occurs through out the country. The allied species found are *A. lewesi* (blue) and *A. stevensi* (grey). Adult beetles feed extensively on the leaves, flowers and fruits making holes and cause death of the plant

or retardation of growth. The seedlings when infested, are totally destroyed (Nair, 1999).

Field trails carried out in Uttar Pradesh showed that polythene cages of height 30 cm when used for up to one month after germination protected cucumber seedlings effectively against infestation by *A. foveicollis* (Chaudhary, 1995).

Panji (1965) observed 48.3 per cent mortality of adult *A. foveicollis* (Lucas) by the application of dust prepared from dry fruits of *Melia azadirach* and ten per cent ethanol extract. Fifty per cent antifeedant activity was observed when 0.01 per cent methanolic neem seed kernel extract and 0.4 per cent neem oil were used in a lab study, in musk melon (Gujar and Mehrotra, 1988). Application of neem oil or samadra seed oil at ten per cent concentration was found to be equally effective in controlling the beetles (KAU, 1996 c).

Butani and Verma (1977) observed that dusting of carbaryl 4.0 per cent or spraying @ 0.2 per cent was effective in controlling severe infestation of red pumpkin beetle. Reghupathy *et al.* (1997) recommended spraying of any of these chemicals *viz.*, malathion 50 EC 1 ml l^{-1}, dimethoate 30 EC 2 ml l^{-1}, methyldemeton 25 EC 1 ml l^{-1} and fenthion 100 EC 1 ml l^{-1}. Das and Isahaque (1999) also observed similar results with malathion, but at a higher dose of 0.1 per cent.

Incorporation of carbaryl 10 DP in pits before sowing the seeds was found to destroy the grubs and pupae of pumpkin beetles (KAU, 1996 a). Nandakumar (1999) observed that basal drenching of combination of neem oil (NSO) 3.0 per cent with either dimethoate 0.025 per cent or carbaryl 0.075 per cent was effective against pumpking beetles on bittergourd.

Epilachna beetle

Grubs and adults of epilachna beetle feed on leaves and skeletonize them. Adults and grubs of *E. septima* attack on snakegourd (Nair, 1995)

Mathew (1965) observed that sevin was the best insecticide against adults and grubs of *Epilachna vigintioctopunctata*. Similar observations were made by Jayakumari (1967). Bittergourd was protected against spotted epilachna when sprayed with deltamethrin @ 15.0 g a.i ha^{-1} or cypermethrin @ 100 g a.i ha^{-1} (Ravindranath, 1982). Thomas and Jacob (1991) observed that carbofuran @ 1.5 kg a.i ha^{-1} at sowing, vining and flowering gave effective control of *Henosepilachna vigintioctopunctata*. Carbaryl @ 0.2 per cent is recommended for controlling grubs and adults of *H. vigintioctopunctata* (KAU, 1996 a). Reddy and Rao (1998) observed that fenvalerate, monocrotophos and acephate were effective against epilachna beetles.

Saradamma (1989) found that benzene extracts of *A. indica* reduced population of *H. vigintioctopunctata* in brinjal and bittergourd. Water and acetone extracts of *Clerodendron infortunatum* were found effective in reducing the population of *H. vigintioctopunctata* (Lily, 1995).

Aphids (*Aphis gossypii, A. malvae*)

The greenish brown aphids infest leaves of cucurbitaceous crops. Adults and nymphs feed on leaf sap and cause curling of leaves as a result of which the plant will loose its vigour. *A. malvae* infest bittergourd in South India (Nair, 1995).

Champ (1966) reported that spraying dimethoate @ 0.05 per cent was good in controlling *A. gossypii* in gourds. Ravindranath (1982) observed that spraying permethrin @ 100 g a.i ha^{-1} or fenvalerate @ 100 g a.i ha^{-1} was effective against aphids on bittergourd. Carbofuran 3G was found to control *A. gossypii* in watermelon. Application of dimethoate 0.05 per cent, phosphamidon 0.05 per cent or monocrotophos 0.05 per cent is recommended against aphids (KAU, 1996 a).

Several botanicals were also tried against aphids by many workers. Repellent action of neem seed kernel on aphids and leaf hopper in brinjal was reported by Asari and Nair (1972). Pandey and Srivastava (1983) observed that when 1.0 per cent plant extract of *Lantana camera* var. *aculiata* was used on *A. gossypii*, 61.40 per cent mortality was obtained. In a field experiment using benzene extracts of *Azadirachta indica, Clerodendron infortunatum, Thevetia neriifolia, Nerium oleander* and *Eupatorium odoratum* at 2.0 per cent could reduce the population of *A. gossypii* (Saradamma, 1989). Similar observations were made by Srinath (1990). In a laboratory study, among the four leaf extracts tested, neem at 3 per cent was found to be very effective in controlling *Myzus persicae* (Parihar *et al.*, 1999).

Leaf caterpillars

Snakegourd is attacked by snakegourd caterpillar, *Anadevidia peponis* pumpkin caterpillar, *Diaphania indica, Helicoverpa armigera, Spodoptera litura* as major leaf and fruit attacking caterpillar pests (Nair, 1999).

Thomas (1965) recorded that spore suspension containing 6.25 x 10^9 to 50 x 10^9 spores of *Bacillus thuringiensis* per 100 cc could be used to control

Margaronia indica in gourds. Mathew (1980) observed that larvae of *A. peponis* was found infected by *Bacillus pumilus*.

Ravindranath (1982) studied the effect of certain synthetic pyrethroids on pests of bittergourd and snakegourd and observed that deltamethrin and fenvalerate at 15 g a.i ha^{-1} were significantly superior in controlling pumpkin caterpillar and snakegourd semilooper. Among the different neem based insecticides, neem seed oil (NSO) was found to be the most effective in controlling *Spodoptera litura* (Rao *et al.*, 1990).

Kalavathi *et al.* (1991) observed 100 per cent mortality of *Earias vitella*, *Diaphania indica* and *E. septima* when sprayed with acetone extract of *Vitex negundo* leaves.

Snakegourd semilooper incidence could be reduced by using 0.05 per cent quinalphos, monocrotophos, endosulfan and 0.03 per cent dimethoate (Patil and Bhole, 1993). Larvicidal effect of petroleum ether extracts of neem fruits and leaves against *S. littoralis* was reported by Dimetry *et al.* (1998). Similarly different effects of neem seed kernel extract on egg, larvae and adults of *H. armigera* were reported by Hassan (1999). Neem extracts inhibited feeding of *S. litura* at a concentration of 0.3 per cent and feeding was further reduced at 0.5 per cent of neem extract (Kulkarni, 1999).

MATERIALS AND METHODS

MATERIALS AND METHODS

A study was conducted at the Instructional Farm, College of Agriculture, Vellayani during 1999-2000 to evolve an eco - friendly pest management package in snakegourd. The study covered aspects such as survey, documentation of farmers' practices for pest management, evaluation of snakegourd varieties in relation to pest infestation, testing the efficiency of different traps for trapping fruit fly and a pest management trial.

3.1 Population estimation of pests of snakegourd, their parasites and predators and documentation of farmer's practices through survey

A survey was done based on a prepared and approved questionnaire (Appendix – I) among the ten randomly selected farmers of Kalliyoor and Nedingal area of Thiruvananthapuram district. A plot size of 200 m^2 was selected in case of each farmer and data were collected on pest population, parasites, predators and practices followed by the farmers. Observations were taken at the vegetative, flowering and middle of the fruiting stages. Survey was continued for three seasons during 1999-2000.

3.2 Evaluation of snake gourd varieties in relation to pest infestation

Three varieties *viz.*, Kaumudi, T.A.-19 and Local were grown in an area of 80 m^2 (15 plants each). Individual observations were taken from each variety according to the standard procedures (Nandakumar, 1999).

3.3 Efficiency of banana, tulsi and starch solution cum jaggery trap

Efficiency of three different traps in catching fruit fly (*Bactrocera cucurbitae*) was tested in a plot selected at the Instructional Farm, Vellayani. Traps were kept at a distance so as to minimise the overlapping effect of traps. Each trap was replicated six times and observations were taken at weekly intervals.

3.4 Pest management trial

3.4.1 Raising crops

Snake gourd var. Kaumudi was maintained during the period from November 1999 to February, 2000. The crop was raised in an area of 0.1 ha with a spacing of 2.0 m x 2.0 m. The recommended package of practices of Kerala Agricultural University (KAU, 1996 a) was followed except for the plant protection aspects which were given according to the treatments fixed in the current study. Two plants per pit were maintained.

3.4.2 Pandal and vine separation

Pandal made of wooden poles and coir was erected and vines of individual plants were allowed to grow separately. Intertwining of vines was prevented by separating out vines at weekly interval.

3.4.3 Design of the experiment

Randomized Block Design was adopted for the study. Pits were taken in rows and in each row five pits were taken as one treatment and three plants, discarding the edge plants, were selected as the observational plants.

3.4.4 Treatments

The experiment comprised of 14 treatments.

T_1 – (Neem oil 2.5 per cent + garlic 20 g l^{-1} of spray solution) + covering of fruits + trapping fly using banana trap.

T_2 – (Neem oil 2.5 per cent + garlic 20 g l^{-1} of spray solution) + covering + trapping fly using tulsi trap

T_3 - (Neem oil 2.5 per cent + garlic 20 g l^{-1} of spray solution) + covering + trapping fly using starch - jaggery trap

T_4 – (Neem oil 2.5 per cent + garlic 20 g l^{-1} of spray solution) + Malathion 0.2 per cent bait spray

T_5 – Nimbecidine 0.2 per cent + covering + banana trap

T_6 - Nimbecidine 0.2 per cent +covering + tulsi trap

T_7 - Nimbecidine 0.2 per cent + covering + starch - jaggery trap

T_8 - Nimbecidine 0.2 per cent + Malathion 0.2 per cent bait spray

T_9 – (Malathion 0.1 per cent + Garlic 20 g l^{-1}) + covering + banana trap

T_{10} - (Malathion 0.1 per cent + Garlic 20 g l^{-1}) + covering + tulsi trap

T_{11} –(Malathion 0.1 per cent + Garlic 20 g l^{-1}) + covering + starch – jaggery trap

T_{12} - (Malathion 0.1 per cent + Garlic 20 g l^{-1}) + covering + Malathion 0.2 per cent bait spray

T_{13} – Carbaryl 0.2 per cent + Malathion 0.2 per cent bait spray

T_{14} – Mechanical control

3.4.5 Preparation of pesticides

3.4.5.1 Neem oil – garlic emulsion

Fifty grams of ordinary washing soap was dissolved in 500 ml of water and it was mixed thoroughly with 250 ml of neem oil and made to an emulsion. 200 g garlic was grinded in 300 ml of water and mixed it with neem oil emulsion to get one litre of stock solution. This was made to 10 l and mixed thoroughly to get spray solution.

3.4.5.2 Nimbecidine

Nimbecidine, a formulation from T. Stanes and Company Ltd., Coimbatore, which contained 0.03 per cent azadirachtin, was used @ 2.0 ml l^{-1} of water to obtain 0.2 per cent concentration.

3.4.5.3 Malathion- garlic spray

Malathion 50 EC @ 2.0 ml l^{-1} of water was used. Garlic extract in water was prepared by grinding garlic in a mixer. Extract of 20 g garlic was mixed with one litre of 0.1 per cent of malathion solution prepared.

3.4.5.4 Malathion bait spray

Malathion 50 EC @ 4.0 ml l^{-1} of water was prepared and jaggery was added to the spray solution @ 10 g l^{-1} of spray solution.

3.4.6 Preparation of fruit fly traps

3.4.6.1 Banana trap

Palayamkodan plantain pieces of 3.0 cm length were taken. One cut end was smeared with one gram of carbofuran 3G and placed in coconut shell, with the carbofuran smeared end upwards as per the methodology reported by Pillai *et al.* (1991). The poisoned bait was replaced once in a week.

3.4.6.2 Tulsi trap

A handful of tulsi (*Ocimum sanctum*) leaves (approximately 30 g) were taken and crushed. The extract and crushed leaves were put in a coconut shell with 10 g jaggery and mixed with 50 ml water. The trap was replaced once in a week.

3.4.6.3 Starch solution jaggery trap

Starch solution mixed with 2.0 g yeast and 10 g jaggery was taken in coconut shell. The trap was replaced once in a week.

3.4.6.4 Covering of fruits

Covering of the fruits was done by reusable long polythene covers (75 μ) with tiny holes for movement of air and two small holes at the bottom to drain off rain water (Kapoor, 1993). Covering was done 5-7 days after the flower fall.

3.4.7 Observations of pests and parasites/ predators from the field

Observations were taken according to a standard procedure followed by Nandakumar (1999) which is shown below.

Sl. No.	Pests	Method of observation
1	Epilachna beetle	Number of grubs on five leaves at random per vine
2	Fruit fly	Percentage of fruits affected
3	American serpentine leaf miner	Number of leaves infested out of five leaves at random per vine
4	Aphid	a. Number of adults in five leaves at random per vine b. Number of predatory insects in five leaves at random per vine c. Number of spiders per vine
5	Leaf feeders	Number of leaves infested out of 10 leaves at random per vine
6	Pumpkin beetle	Total number of adults per vine

3.4.8 Yield data

Yield from the observational plants are recorded and expressed in kilograms.

3.4.9 Benefit – cost ratio

Benefit - cost ratio was worked out for all the treatments (including management of vegetative stage pests also) and for fruit fly management alone.

RESULTS

RESULTS

4.1 Survey

A detailed survey for documenting the farmers' cultivation practices, pests and their natural enemies using prescribed proforma was carried out in two snakegourd growing areas *viz.*, Kalliyoor and Nedingal in Thiruvananthapuram district. The data obtained from the survey is presented in Table 1.

4.1.1 Age of the farmers

The farmers engaged in vegetable cultivation in the survey areas were of different age groups. Forty per cent of them were in thirties and thirty per cent were more than fifty years old.

4.1.2 Size of the holding

Size of the holding varied from eight to thirty five cents. Sixty per cent of the farmers had the holding size of 10-20 cents. Only ten per cent of the farmers had the smallest holding size (below 10 cents).

4.1.3 Nature of land

Majority of the farmers (60 per cent) were cultivating vegetables in wet lands. Only 40 per cent were doing vegetable cultivation in garden land.

Table 1. Details of survey conducted among the snakegourd cultivating farmers of Kalliyoor and Nedingal areas of Thiruvananthapuram

	Category	Frequency	Percentage
1.	**Size of holding**		
	< 10 cents	2	10
	10-20 cents	12	60
	>20 cents	6	30
2.	**Nature of land**		
	Wet	12	60
	Garden	8	40
3.	**Age of the farmers**		
	20-30 years	4	20
	30-40 years	8	40
	40-50 years	2	10
	> 50 years	6	30
4.	**Plant spacing**		
	Above POP	2	10
	Same as POP	4	20
	Below POP	14	70
5.	**Variety**		
	Local	7	35
	Improved	13	65

6.	**Source**			
	Own		15	75
	Neighbour farmer		2	10
	KAU/Agriculture department		3	15
7.	**Land preparation**			
	Pit burning	Yes	13	65
		No	7	35
	Intercultural operations	Yes	17	85
		No	3	15
9.	**Irrigation**			
	Channel		6	30
	Pot		14	70
10.	**Fertiliser use**			
	Straight		5	25
	Complex		15	75
	Mixture		0	0
11.	**Fertiliser usage**			
	Above POP		16	80
	Same as POP		0	0
	Below POP		4	20
12.	**Use of FYM**		20	100

13.	**Pesticide usage**			
	Chemicals	Neem oil	3	15
		Quinalphos	17	85
		Carbaryl	16	80
		Monocrotophos	3	15
		Nimbecidin	14	70
		Methyl parathion	6	30
	Dosage	Below POP	8	40
		Same as POP	0	0
		Above POP	12	60
14.	**Use of fruit fly traps**		20	100

4.1.4 Plant spacing

The recommended spacing for snake gourd was 2.0 m x 2.0 m, but only four farmers (20 per cent) followed this spacing. Seventy per cent farmers followed a closer spacing than the recommended one. Ten per cent farmers followed a greater spacing.

4.1.5 Varieties

Improved varieties were widely adopted by farmers. Sixty five per cent farmers used improved varieties such as Kaumudi and T.A.-19.

4.1.5.1 Source

Seventy five per cent farmers used farm-saved seeds. Fifteen per cent farmers procured seeds from Kerala Agricultural University and other developmental agencies.

4.1.6 Land preparation

Pit burning before sowing the seeds and ploughing the field after vine formation were followed by 65 per cent and 85 per cent farmers respectively.

4.1.7 Irrigation

Pot irrigation was adopted by seventy per cent of the farmers. The rest 30 per cent farmers followed channel irrigation.

4.1.8 Fertiliser usage

Both straight and complex fertilizers were used by the farmers. Complex fertilizers were preferred by majority of the farmers (75 per cent). None of the farmers followed the Package of practices recommendations (POP) fertilizers.

4.1.9 Pesticide usage

All the twenty farmers used chemical pesticides. The chemicals were used alone and in combination with botanical commercial formulations. Only three farmers (15 per cent) were using neem oil-garlic emulsion, which is a crude neem preparation. Extensively used pesticide was quinalphos (85 per cent) followed by carbaryl (80 per cent). Among the botanical formulations, nimbecidine was used by 70 per cent. Systemic insecticide like monocrotophos was also used (15 per cent).

4.1.9.1 Pesticide dosage

None of the farmers followed the Package of practices recommendations (POP) for dosage. Higher dose than POP was adopted by 60 per cent of the farmers while 40 per cent of farmers adopted a lower dosage.

4.1.10 Pest incidence in farmers' field and untreated plot

A survey was done during the two seasons of snake gourd cultivation in Kalliyoor and Nedingal areas and a plot without any insecticide treatment was monitored at the Instructional Farm.

All major pests occurred in a lesser intensity in farmers' field compared to non-insecticide treated plot.

Pumpkin beetles occurred mainly during vegetative stage (2. 117 in the first season and 2.018 in the second season) and flowering phases (2.151 in the first season and 1.359 in the second season) in both the cropping seasons. During fruiting it showed a decrease in population (0.517 and 0.633) in both the seasons (Fig. 1).

During first season American serpentine leaf miner (*L. trifolii*) registered a maximum count during vegetative period (0.45) and minimum at fruiting stage (0.067). The same trend was noticed in second season also (Fig.1).

D. indica showed a decreasing trend in population from vegetative stage (2.018 (first season) and 1.817 (second season)) to fruiting stage (0.9355 and 0.983) during both the seasons. The same trend was recorded by the other defoliator, *A. peponis* also with a slight increase in population during flowering stage (Fig.2).

Fruit fly attack was below 16 per cent in all the seasons and at all stages. The pest incidence was higher during second season *i.e.*, May-June to August-September. Maximum fruit fly damage was noticed during fruiting period of second season (15.694). Minimum damage was recorded at flowering period of first season (12.123) (Fig.3).

Epilachna septima incidence was at a lesser intensity and ranged from zero during fruiting stage of second crop to one during vegetative stage of first crop (Fig. 4).

Fig. 1. Mean number of *Aulacophora* sp. and *L. trifolii* in farmers' field and untreated plot

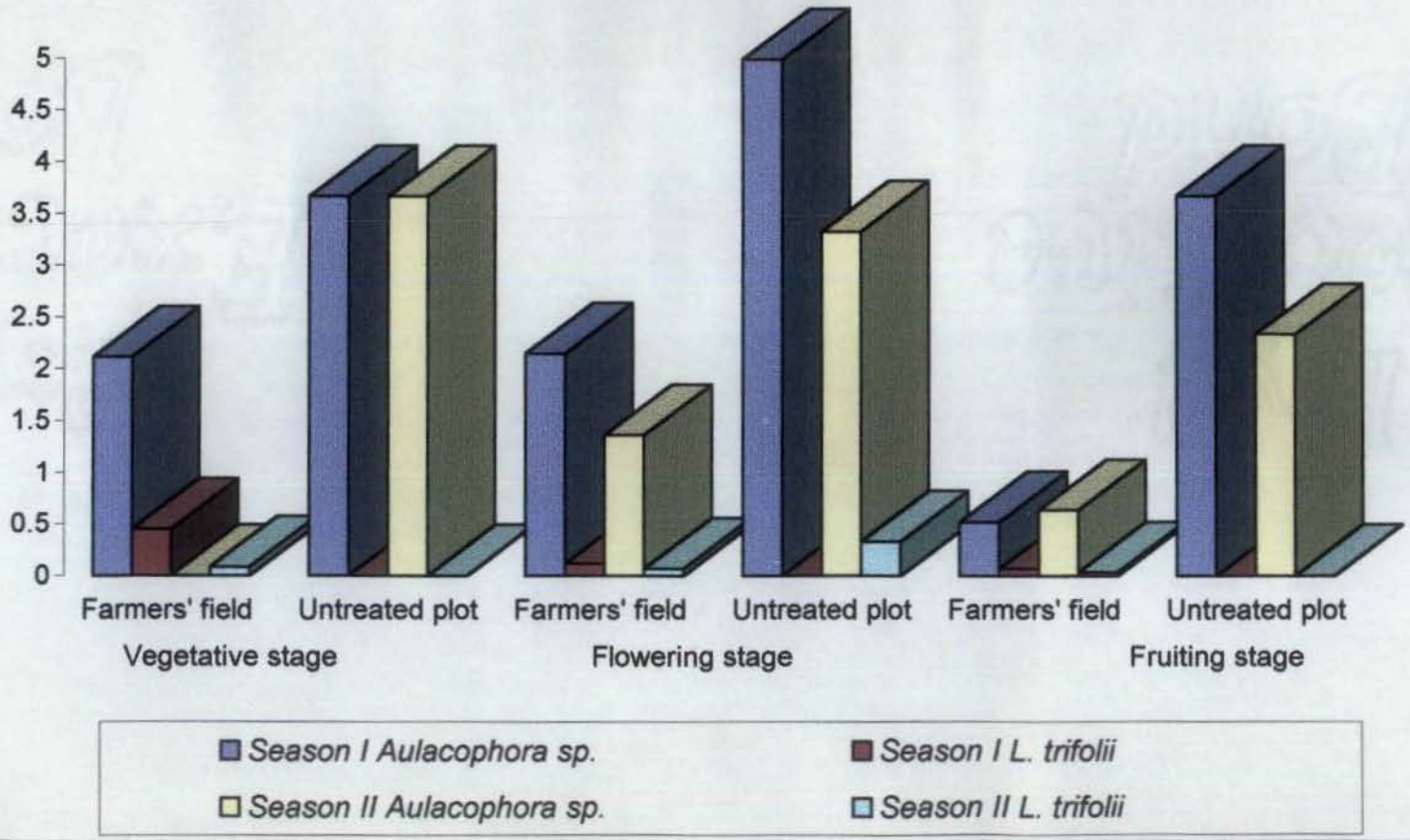
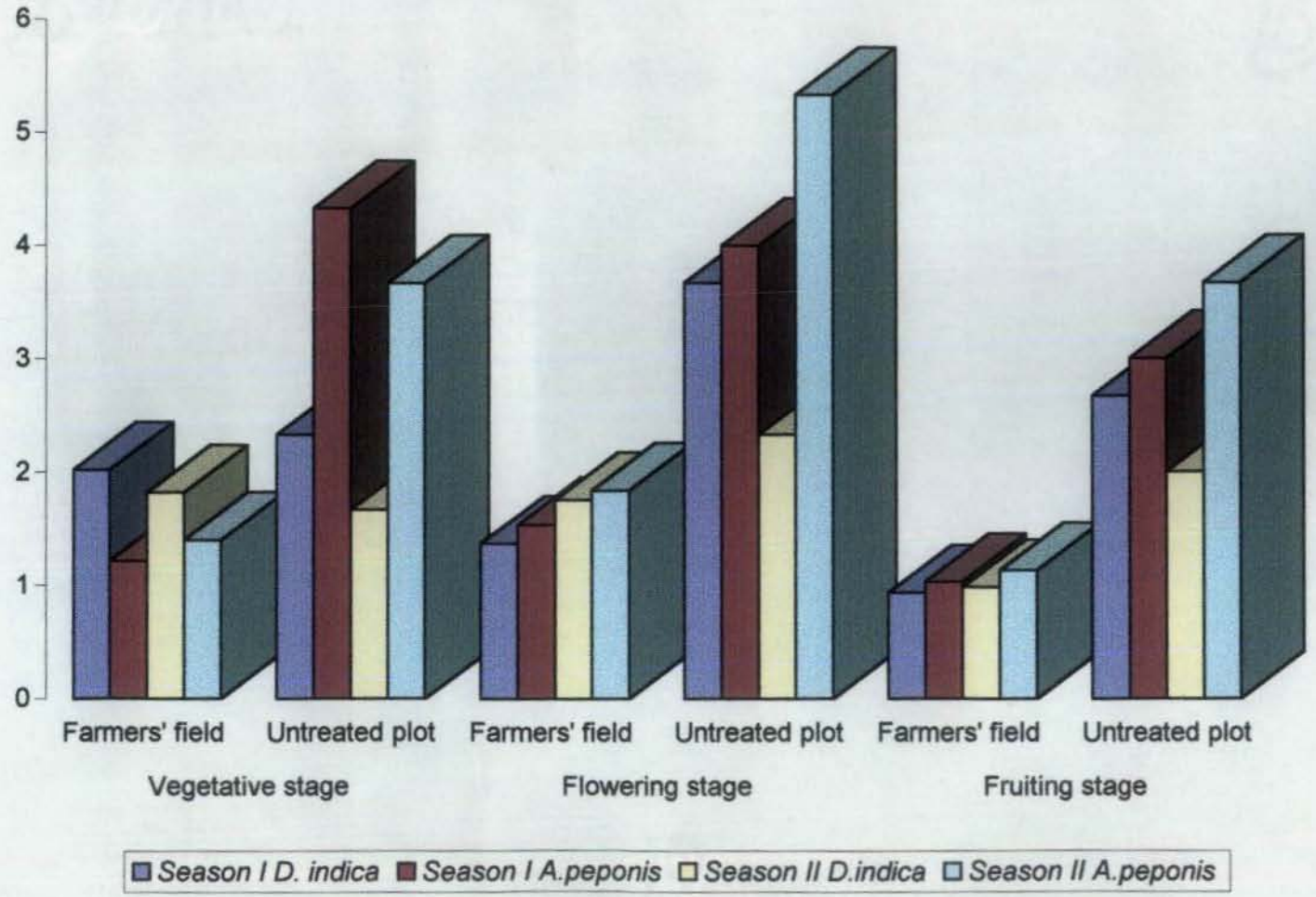


Fig. 2. Mean number of *D. indica* and *A. peponis* in farmers' field and untreated plot



Aphids registered a population count ranging from 0.083 during fruiting stage of second season to 0.717 during vegetative stage of first season. Aphids registered a maximum population during vegetative stage of the crop in first season (Fig. 4).

The untreated plot at Instructional Farm, showed a greater incidence of pests compared to farmers' field except in the case of American serpentine leaf miner.

Pumpkin beetles were present through out the crop stage and it registered highest population count during flowering stage in first crop (5.0) and least in fruiting stage of second crop (2.33). Incidence of American serpentine leaf miner was noticed only during second crop (0.33) season at flowering stage (Fig. 1).

D. indica was present in both seasons and all stages of crop with mean value ranging from 1.67 during vegetative stage of second season to 3.67 during flowering stage of first season (Fig. 2).

A. peponis was present in large numbers and crossed Economic Threshold Level (ETL) in several occasions. Maximum population count was registered as 5.33 during flowering period of second crop (Fig. 2).

Fruit fly attack was above 50 per cent during fruiting stage of both seasons (60.0 and 63.63 per cent). Fruit damage of 27.27 per cent and 44.44 per cent was recorded during flowering stage of first and second crop respectively (Fig. 3).

Infestation by epilachna beetle was low during all seasons and stages of crop. The incidence ranged from 1.0 to 0.33. Maximum infestation was noticed during vegetative stage of second crop (1.0) (Fig. 4).

Fig. 3. Mean percentage of fruit damage in farmers' field and untreated plot

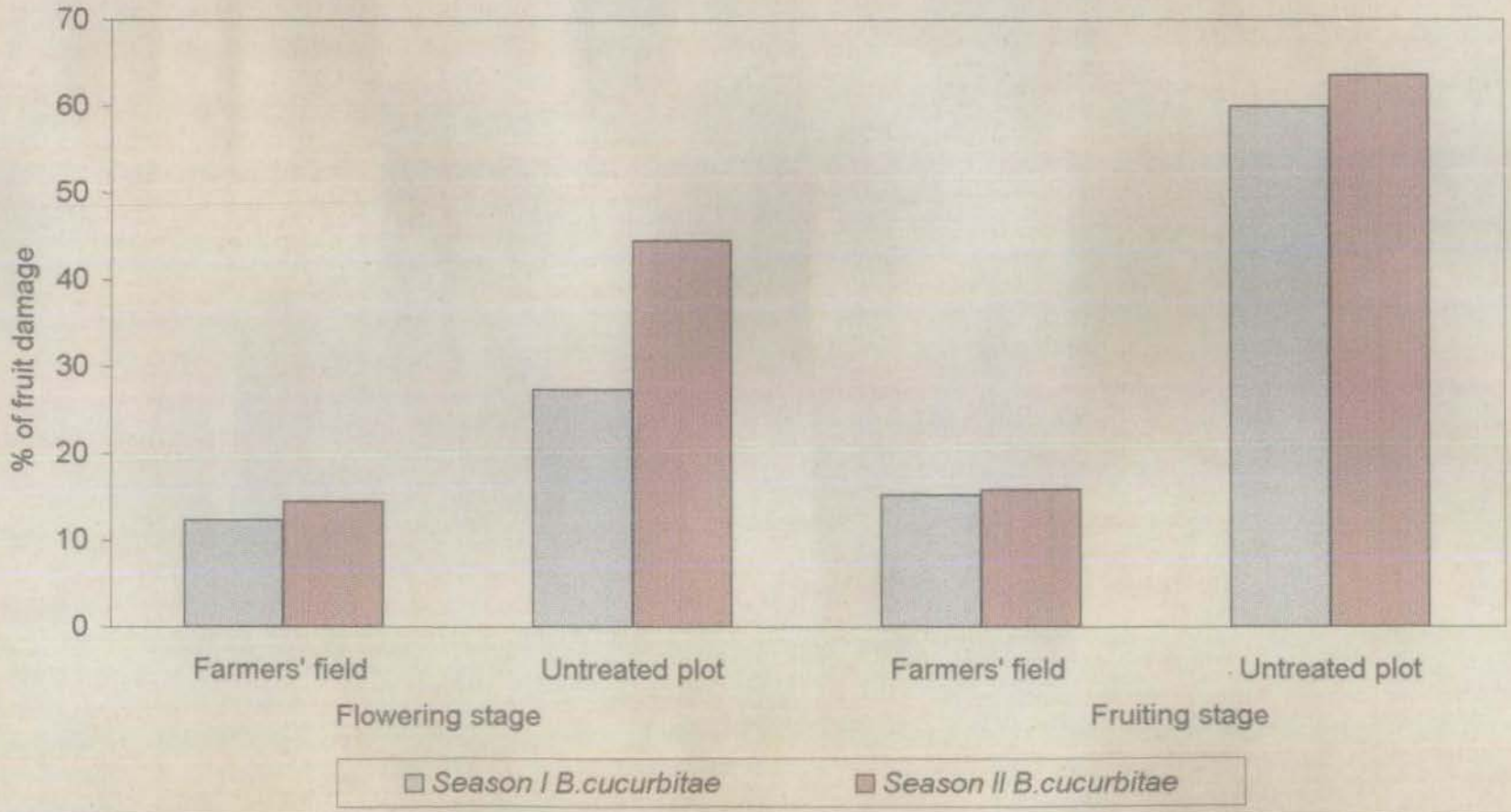
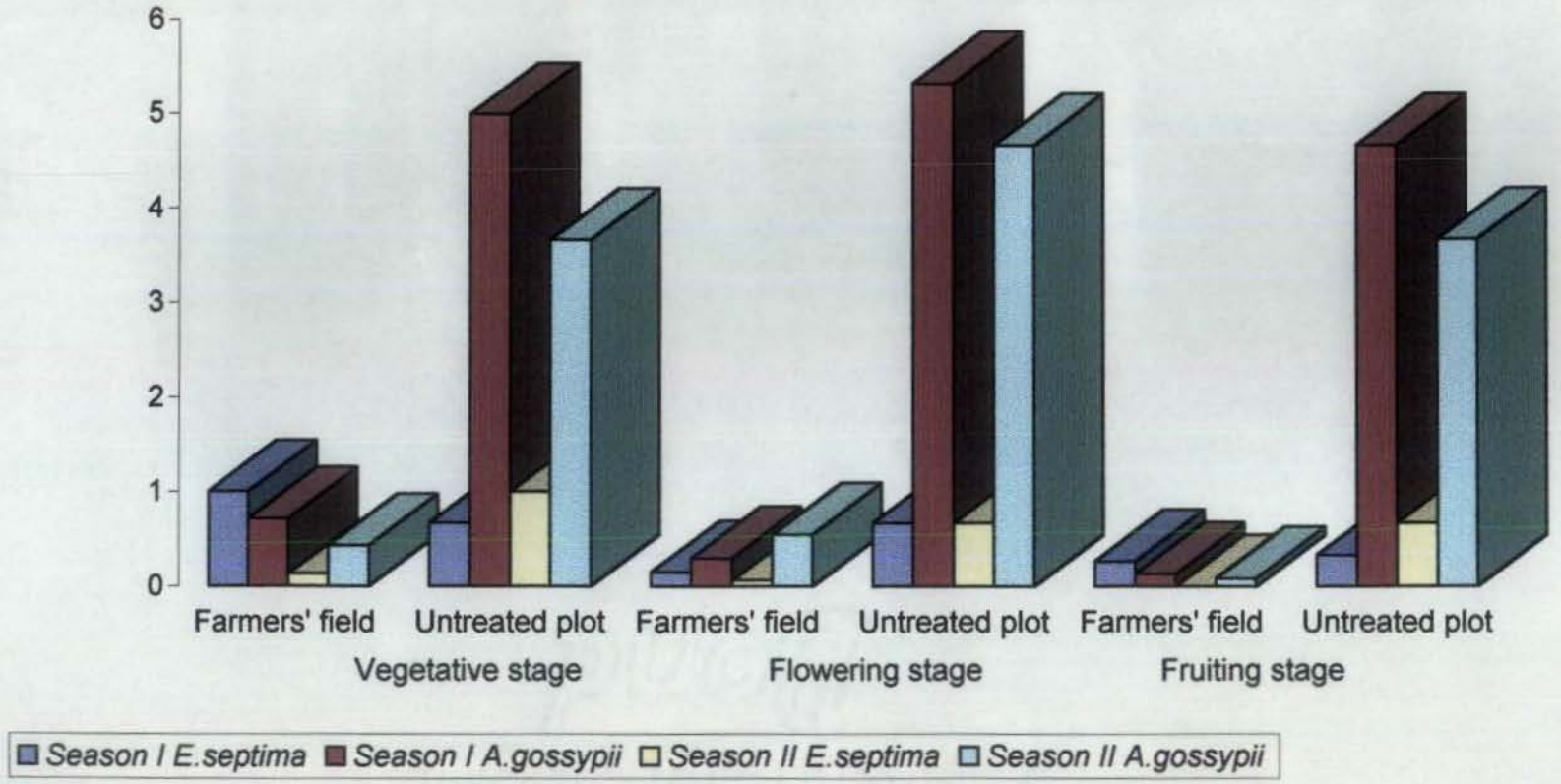


Fig. 4. Mean number of *E. septima* and *A. gossypii* in farmers' field and untreated plot



Aphids were present through out the cropping season and the population count ranged from 3.67 to 5.0. Maximum counts were recorded during first season (5.33 at flowering stage and 5.0 at vegetative stage) (Fig. 4).

4.1.11 Presence of natural enemies in farmers' field and untreated plot

In all the stages of the crop as well as in all seasons, the population of natural enemies like spiders, predatory insects and parasites was very low in farmers' field. Natural enemies were present through out the cropping period in untreated plots. They showed an increase in population during fruiting period in untreated plots and a reverse trend in farmers' field.

Spiders were present in farmers' field and population ranged from 0.05 to 0.284. Maximum population (0.284) was noted during second season of vegetative stage and least at fruiting stages (0.05 and 0.084). Untreated plots registered a spider population ranging from 1.0 to 4.67. Maximum population was at flowering stage (4.33 and 4.67) and minimum (1.0 and 1.67) during vegetative stage as against the observation from farmers' field (Fig. 5).

Maximum predatory population noted from farmers' field was 0.35 during vegetative stage of first season. Untreated plot registered a maximum (3.67) at fruiting stage of first season (Fig. 6).

Parasites were maximum at flowering stage (1.0 and 1.33) in untreated plots. In farmers' field parasites were present with a mean population ranging from 0.016 to 0.083 only. They showed a decline in population count during fruiting stage in farmers' field (Fig. 7).

Fig.5. Mean number of spiders present in farmers' field and untreated plots

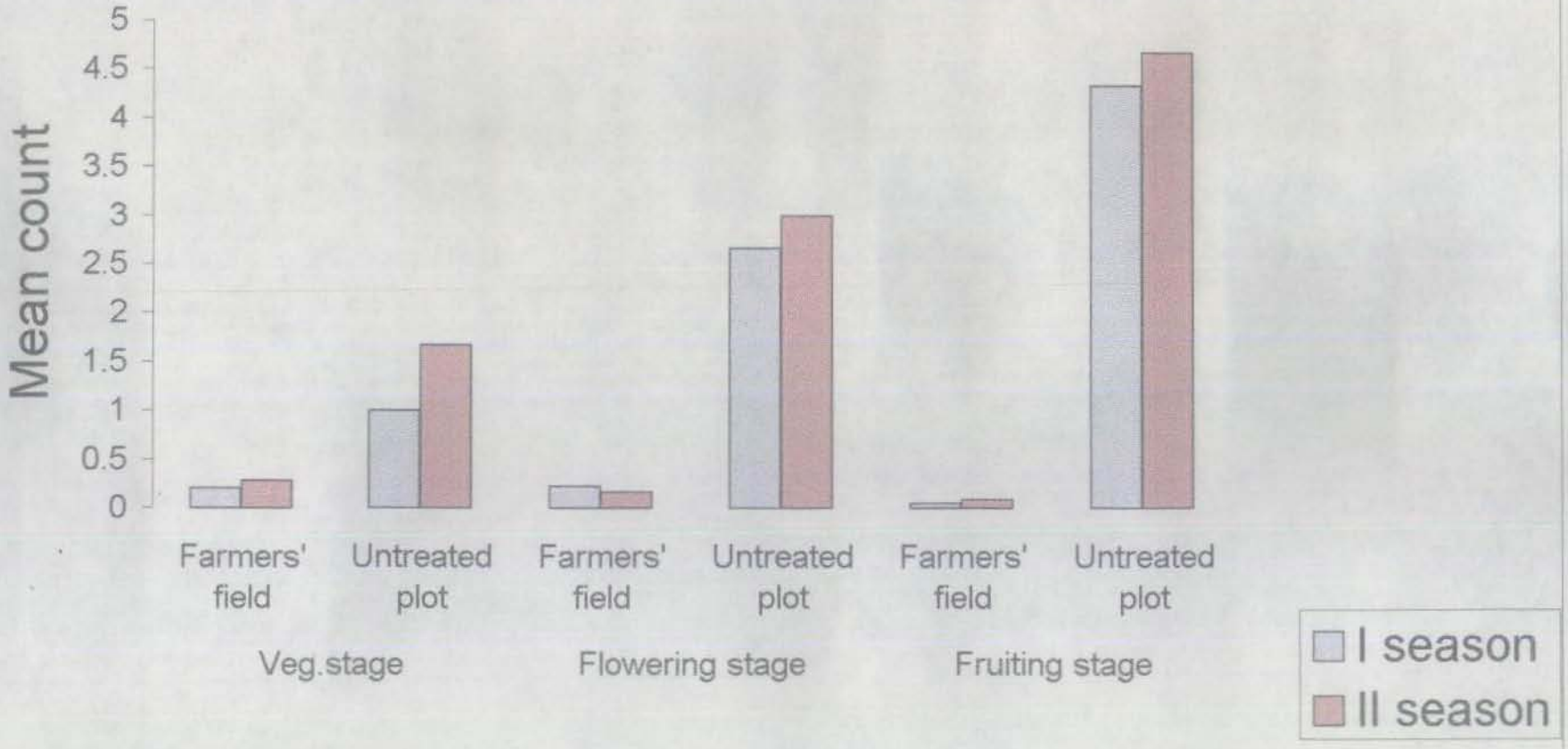


Fig.6. Mean number of predatory insects present in farmers' field and untreated plots

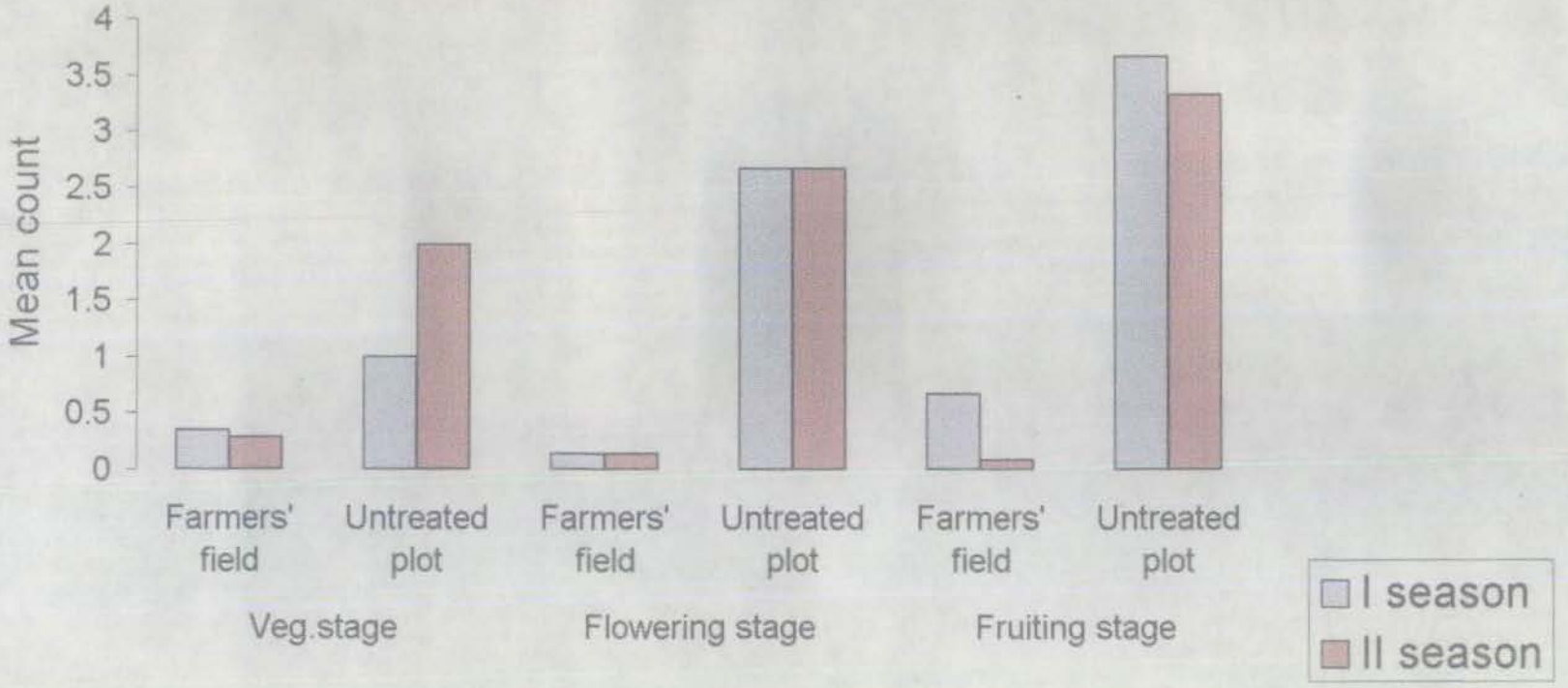
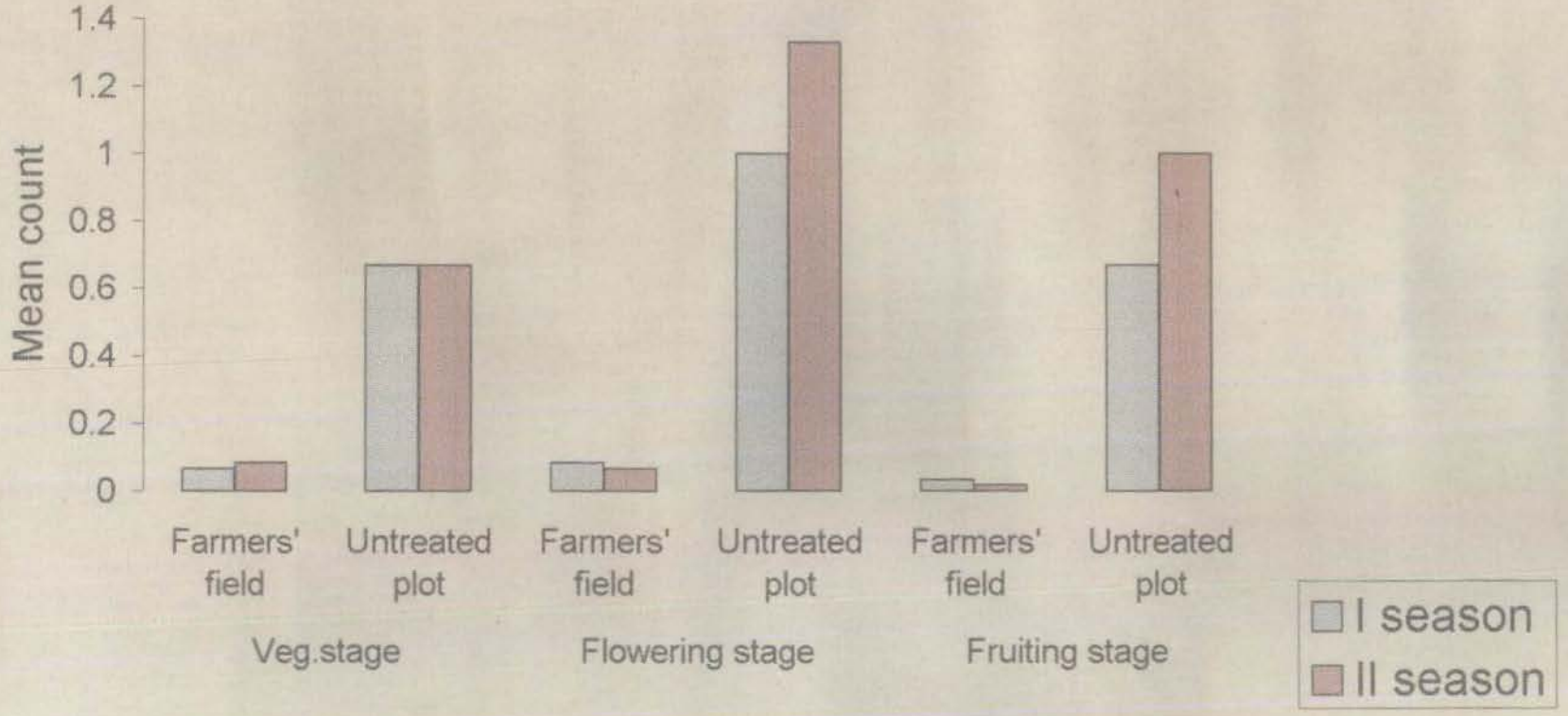


Fig.7. Mean number of parasites present in farmers' field and untreated plots



4.2 Testing the efficiency of different fruit fly traps

Banana trap comprising of palayamkodan fruit and carbofuran 3G gave maximum catch of flies in all the observations taken during five weeks of bearing season of crop (Plate 1).

The mean number of flies caught in the banana trap ranged from 4.667 to 9.333 during five weeks after setting of traps (Fig. 8). Starch jaggery trap showed a maximum catch of 8.833 flies during five weeks after setting of traps (Plate 2). Tulsi trap comprising of *Ocimum* leaves, jaggery and carbofuran 3G gave a mean population range from 2.333 to 6.833 only (Plate 3).

All the traps recorded maximum number of flies count during five weeks after setting up of traps.

4.3 Evaluation of snake gourd varieties to pest infestation.

Three varieties, Kaumudi, T.A.-19 and Local, were tested to assess the difference in intensity of pest infestation. Among the three varieties tested, Kaumudi showed minimum infestation towards major pest like *A. foveicollis*, *D. indica*, *A. peponis* and *B. curcurbitae*.

Kaumudi showed the lowest infestation of pumpkin beetles (Table 2) with a mean value of 4.355. This was significantly lower when compared to the incidence in other varieties. Local variety recorded the highest percentage of pest incidence (5.656).

There was an increasing trend in *D. indica* attack (Table 3). Lowest infestation of *D. indica* was noticed in Kaumudi (3.933) which was significantly

Plate 1. Banana fruit fly trap with palayamkodan fruit piece

Plate 2. Starch-jaggery fruit fly trap

Fig.8. Mean number of fruit flies caught in different traps

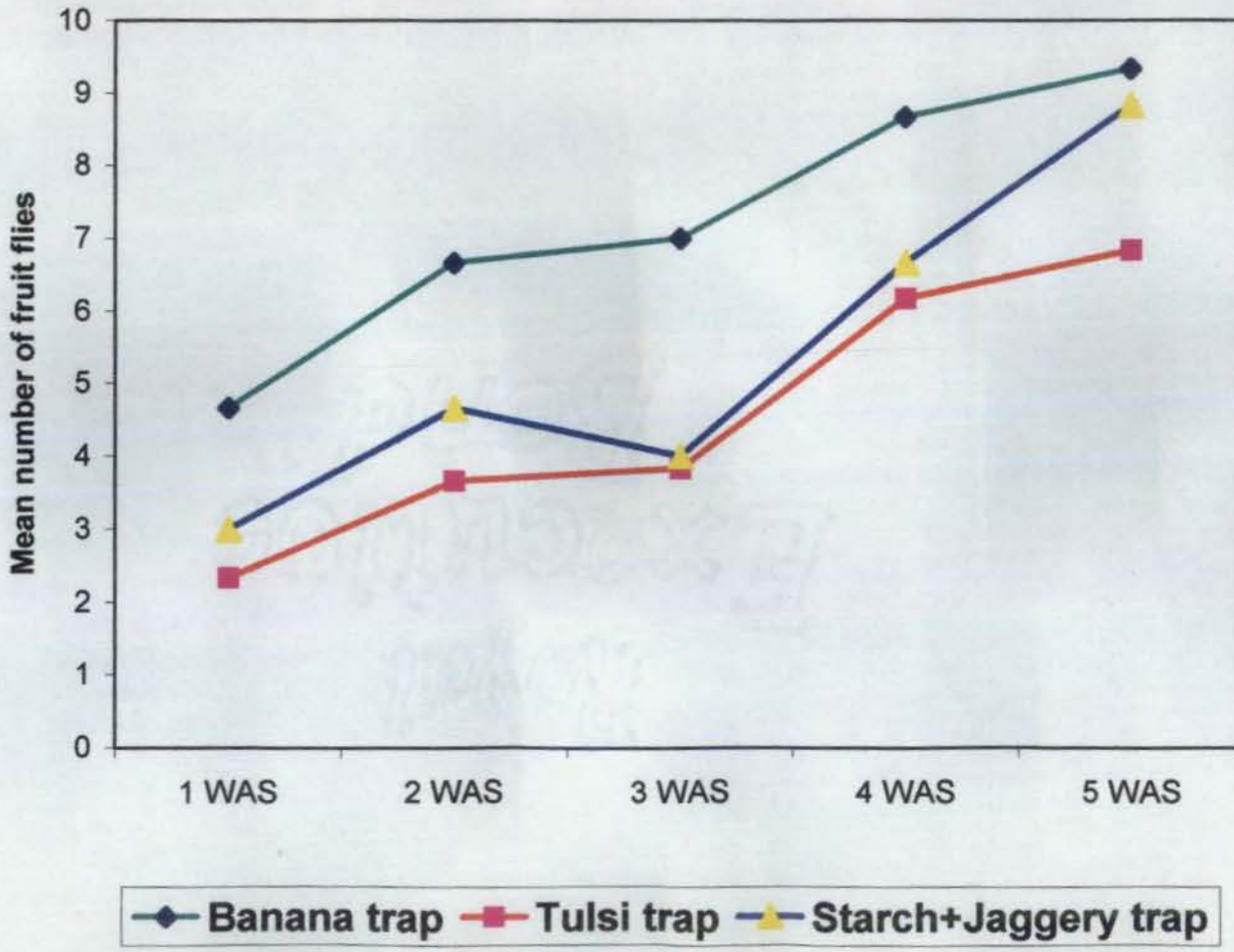


Plate 3. Ocimum- jaggery fruit fly trap

Table 2. Mean population count of pumpkin beetle, *Aulacophora* sp. on different snakegourd varieties

Varieties	3WAS	4WAS	5WAS	6WAS	7WAS	Mean	CD
Kaumudi	3.555	4.388	3.778	5.165	4.89	4.355	
TA-19	4.5	5.222	5.833	4.888	5.388	5.166	
Local	5.61	5.612	5.915	5.837	5.278	5.656	0.3292

Table 3. Mean population count of leaf caterpillar, *D.indica* on different snakegourd varieties

Varieties	3WAS	4WAS	5WAS	6WAS	7WAS	Mean	CD
Kaumudi	3.167	3.833	5.888	4.387	4.388	3.933	
TA-19	4.0	4.833	5.167	5.39	5.055	4.889	
Local	4.278	4.888	5.445	5.277	5.5	5.078	0.4294

Table 4. Mean population count of snakegourd semilooper, *A.peponis* on different snakegourd varieties

Varieties	3WAS	4WAS	5WAS	6WAS	7WAS	Mean	CD
Kaumudi	1.722	3.11	3.723	5.057	5.223	3.767	
TA-19	2.557	4.113	4.498	5.0	4.778	4.189	
Local	2.887	3.945	4.278	5.002	4.555	4.133	0.4024

Table 5. Mean population count of *Spodoptera litura* on different snakegourd varieties

Varieties	3WAS	4WAS	5WAS	6WAS	7WAS	Mean	CD
Kaumudi	0.0	0.555	0.5	0.0	1.388	0.489	
TA-19	0.39	0.777	0.667	0.0	0.555	0.478	
Local	0.778	0.278	0.612	0.0	0.222	0.378	0.3363

Table 6. Mean population count of ASLM, *Liriomyza trifolii* on different snakegourd varieties

Varieties	3WAS	4WAS	5WAS	6WAS	7WAS	Mean	CD
Kaumudi	0.112	0.167	0.833	0.445	0.612	0.434	
TA-19	0.833	0.055	0.778	0.613	0.5	0.556	
Local	0.777	0.89	0.055	0.502	0.278	0.5	0.3345

different from the other varieties tested. The incidence in T.A.-19 (4.889) and Local varieties (5.078) were similar in reaction towards the leaf eating caterpillar.

The specific pest of snake gourd *A. peponis* increased with the developmental stages of plant. Kaumudi was significantly different from T.A.-19 and Local, and had the lowest infestation with a mean value of 3.767 (Table 4).

There was mild infestation of *S. litura* and *L. trifolii* during the crop season (Table 5 and 6). The infestation of these pests occurred in an erratic pattern over the field. All the three varieties tested were on par with respect to the infestation by these pests.

The varieties tested showed significant difference in fruit fly infestation Kaumudi registered lowest infestation (23.349) which was significantly different from T.A.-19 and Local. T.A.-19 and Local recorded an infestation percentage of 28.657 and 36.667 respectively (Table 7). Kaumudi recorded maximum yield (15.667 kg) and differed significantly from other varieties (Table 8).

4.4 Pest management trial in snakegourd in field.

Field experiment was carried out at the Instructional Farm, College of Agriculture, Vellayani to evolve an eco - friendly package for the management of major pests of snake gourd. Observations were recorded on pests and natural enemies. Percentage changes in the mean population count of pests with respect to previous observations during each spraying were recorded (Table 10, 12, 14 and 16). The major pests present during the crop season were *A. peponis, D. indica, A. stevensi* and *B. cucurbitae.*

Table 7. Mean percentage of fruit damage by fruit flies on different snakegourd varieties

Sl.No.	Variety	Percentage fruit damage
1.	Kaumudi	23.349
2.	T.A-19	28.657
3.	Local	36.660
CD		3.4106

Table 8. Mean yield of different snakegourd varieties

Sl.No.	Variety	Yield in kilograms
1.	Kaumudi	15.667
2.	T.A-19	13.778
3.	Local	9.613
CD		1.1367

4.4.1 Management of pumpkin beetle

A. stevensi was the major pumpkin beetle species present in the field (Plate 4). The mean population of pumpkin beetle in various treatments are given in Table 9. One week after the first spraying, treatment involving carbaryl 0.2 per cent showed minimum number of beetles (0.105), which was followed by neem oil garlic emulsion (T_1 – T_4) (0.511) and malathion – garlic emulsion (T_9 – T_{12}) (0.57). All treatments differed significantly from control (3.109).

Two weeks after application of treatments, carbaryl recorded lowest population (0.557) which was equally effective as malathion - garlic emulsion (1.167) and these two treatments differed significantly from the other treatments and control (5.11).

In the second spraying also carbaryl 0.2 per cent recorded lowest mean count of beetles (0.655), which was equally effective as malathion - garlic spray.

During second week of second spraying, malathion-garlic emulsion showed best results in managing the beetle population (0.945), all other three treatments (T_1-T_4, T_5- T_8 and T_{13}) were equally effective.

Maximum population decline was noticed in plots treated with carbaryl (-97.95) during first round spraying (Table 10). The same trend was noticed in second spraying also (- 84.06). Lowest buildup was registered in neem oil - garlic emulsion treated plots during second week after second spraying.

Plate 4. ***A. stevensi*** **feeding on foliage**

Plate 5. ***A. peponis*** **larvae feeding the foliage**

Table 9. Mean population count of pumpkin beetles *Aulacophora* sp. at different intervals after the application of treatments

Treatments	24 hrs. before first spraying	1 week after first spraying	2 weeks after first spraying	3 weeks after first spraying	1week after second spraying	2 weeks after second spraying	3 weeks after second spraying
T1-T4	5.222	0.511 (1.227)	1.500	4.055	1.093 (1.444)	1.250	1.216 (1.481)
T5-T8	5.945	1.097 (1.447)	2.778	4.918	1.148 (1.459)	1.722	1.737 (1.647)
T9-T12	5.890	0.570 (1.251)	1.167	3.444	0.767 (1.321)	0.945	0.791 (1.336)
T13	5.113	0.105 (1.051)	0.557	4.110	0.655 (1.287)	1.000	0.319 (1.149)
T14	6.113	3.109 (2.027)	5.110	6.110	6.844 (2.801)	5.333	5.887 (2.624)
CD (Grouped)	1.9953	0.1208	0.4651	0.7795	0.1804	0.5766	0.2089
CD(Grouped-Single)	3.1549	0.1909	0.7354	1.2325	0.2853	0.9117	0.3303
CD (Single)	3.9907	0.2415	0.9311	1.5590	0.3609	1.1532	0.4178

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

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jaggery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jaggery trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

Table 10. Percentage changes in the mean population count of pumpkin beetles *Aulacophora* sp. at different intervals after the application of treatments

Interval	Treatments				
	T1-T4	T5-T8	T9-T12	T13	T14
1 week after first spraying	-90.21	-81.55	-90.32	-97.95	-49.15
2 weeks after first spraying	193.49	153.24	104.72	431.20	64.38
3 weeks after first spraying	170.33	77.05	195.21	638.28	19.57
1 week after second spraying	-73.06	-76.65	-77.73	-84.06	12.01
2 weeks after second spraying	14.41	49.95	23.19	52.6	22.07
3 weeks after second spraying	2.71	0.01	16.33	-68.09	10.37

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jaggery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jaggery trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

4.4.2 Management of snake gourd semilooper, *A. peponis*

A. peponis is the specific pest of snakegourd (Plate 5). Observations on snake gourd semilooper is presented in Table 11. Carbaryl 0.2 per cent (Treatment 13) (0.439) followed by neem oil-garlic emulsion (0.767) and malathion - garlic emulsion (0.876) were effective in reducing the caterpillar population. Population decline was maximum in the neem oil - garlic treatment (-79.23 per cent) followed by carbaryl 0.2 per cent during one week after first spraying (-79.19 per cent). All treatments were significantly different from the control plot observation (Table 12).

Population build up of the pest was maximum in plot treated with chemical pesticides, carbaryl 0.2 per cent (203.71 per cent).

During second and third week after first spraying, carbaryl 0.2 per cent was effective in reducing the population level of the pest and it was statistically on par with the treatments 1-4 (neem oil - garlic emulsion) and treatment 5-8 (nimbecidine 0.2 per cent). Carbaryl 0.2 per cent (Treatment 13) showed same trend during second spraying also. Treatment 13 registered maximum population decline (-53.4 per cent) followed by neem oil - garlic emulsion (Treatment 1-4) (-52.7 per cent) during first week of second spraying.

Plots treated with carbaryl 0.2 per cent registered highest increase in population build up of pest after two weeks in both the sprayings (203.71 and 57.5) whereas nimbecidine showed lowest build up in both the sprayings (53.7 and 2.9). Population count on control plot was significantly higher than the other treatment plots.

Table 11. Mean population count of snakegourd semilooper, *A.peponis* at different intervals after the application of treatments

Treatments	24 hrs. before first spraying	1 week after first spraying	2 weeks after first spraying	3 weeks after first spraying	1week after second spraying	2 weeks after second spraying	3 weeks after second spraying
T1-T4	3.694	0.767 (1.526)	1.360	2.333	1.104 (1.449)	1.360	1.222 (1.489)
T5-T8	3.083	1.373 (1.540)	2.111	3.223	1.837 (1.684)	1.890	1.799 (1.667)
T9-T12	2.665	0.876 (1.368)	1.640	2.222	1.213 (1.487)	1.138	1.046 (1.429)
T13	2.110	0.439 (1.199)	1.333	1.667	0.777 (1.333)	1.223	0.527 (1.236)
T14	2.553	2.555 (1.885)	4.223	5.22	4.526 (2.351)	3.887	4.366 (2.316)
CD (Grouped)	1.2224	0.1281	0.4051	0.4921	0.1547	0.8744	0.1914
CD(Grouped-Single)	1.9327	0.2025	0.6405	0.7780	0.2446	1.3825	0.3026
CD (Single)	2.4447	0.2562	0.8101	0.9841	0.3094	1.7487	0.3828

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

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jaggery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jaggery trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

Table 12. Percentage changes in the mean population count of snakegourd semilooper, *A.peponis* at different intervals after the application of treatments

Interval	Treatments				
	T1-T4	T5-T8	T9-T12	T13	T14
1 week after first spraying	-79.23	-55.46	-67.13	-79.19	0.06
2 weeks after first spraying	77.22	53.70	87.17	203.71	65.31
3 weeks after first spraying	71.57	52.67	35.47	25.01	23.6
1 week after second spraying	-52.7	-43.01	-45.42	-53.4	-13.29
2 weeks after second spraying	23.23	2.9	6.12	57.5	14.13
3 weeks after second spraying	-10.13	-5.0	-8.1	-56.96	12.33

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jaggery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jaggery trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

4.3.3 Management of leaf caterpillar, *D. indica*.

D. indica infestation was less (Plate 6) when compared to *A. peponis* and the population on different treatments are presented in Table 13. In first spraying, carbaryl (Treatment 13) gave 100 per cent control of the pest, followed by neem oil-garlic emulsion and malathion - garlic emulsion, which were on par.

A population build up of 100 per cent was registered by carbaryl and it was the maximum among the all treatments. The same trend was (37.57) noticed in second spraying also. Population build up was the lowest among the treatments involving nimbecidine and neem oil - garlic emulsion during first spraying (Table 14).

In second spraying minimum population count was recorded in plots treated with carbaryl (0.319) followed by neem oil-garlic emulsion treated plots (0.449). The treatments effect of carbaryl 0.2 per cent, neem oil- garlic emulsion and malathion-garlic emulsion were statistically on par.

All the treatment plots, including control, showed a decline in population during the third week of second spraying.

4.4.4 Management of aphids, *A. gossypii*

A. gossypii was present in large numbers (Plate 7) in almost all plots during the experiment (Table 15). Aphid population crossed the economic threshold level (ETL) during the pre-count. One week after first spraying, carbaryl showed best result with a mean count of zero, followed by malathion - garlic emulsion (0.284). All the four treatments (T_1-T_4, T_5-T_8, T_9-T_{12} and T_{13}) were on par and they differed significantly from the control plot (7.509).

Plate 6. *D. indica* larva feeding the foliage

Plate 7. Colony of *A. gossypii* on snakegourd leaf

Table 13. Mean population count of leaf caterpillar, *D.indica* at different intervals after the application of treatments

Treatments	24 hrs. before first spraying	1 week after first spraying	2 weeks after first spraying	3 weeks after first spraying	1week after second spraying	2 weeks after second spraying	3 weeks after second spraying
T1-T4	1.388	0.298 (1.139)	0.528	0.971	0.449 (1.199)	0.595 (1.258)	0.434 (1.189)
T5-T8	0.775	0.574 (1.254)	0.973	1.582	0.781 (1.327)	0.967 (1.399)	0.786 (1.333)
T9-T12	1.750	0.327 (1.149)	0.583	1.083	0.539 (1.235)	0.632 (1.276)	0.544 (1.239)
T13	0.780	0.0 (1.0)	0.557	1.110	0.319 (1.149)	0.439 (1.199)	0.319 (1.149)
T14	1.443	1.554 (1.598)	2.557	2.663	3.768 (2.184)	4.329 (2.308)	1.554 (1.598)
CD (Grouped)	0.7059	0.0924	0.3178	0.3947	0.1918	0.1623	0.1799
CD(Grouped-Single)	1.1161	0.1461	0.5025	0.6241	0.3032	0.2566	0.2844
CD (Single)	1.4117	0.1847	0.6356	0.7894	0.3835	0.3246	0.3598

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

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jaggery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jaggery trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

Table 14. Percentage changes in the mean population count of leaf caterpillar, *D.indica* at different intervals after the application of treatments

Interval	Treatments				
	T1-T4	T5-T8	T9-T12	T13	T14
1 week after first spraying	-78.41	-25.98	-81.34	-100.0	7.68
2 weeks after first spraying	76.31	69.57	78.63	100.0	64.51
3 weeks after first spraying	83.72	62.64	85.69	99.39	4.17
1 week after second spraying	-53.76	-50.6	-50.28	-71.25	41.47
2 weeks after second spraying	32.57	23.69	17.36	37.57	14.92
3 weeks after second spraying	-27.0	-18.69	-13.99	-27.31	-64.11

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jaggery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jaggery trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

Table 15. Mean population count of aphids *A.gossypii* at different intervals after the application of treatments

Treatments	24 hrs. before first spraying	1 week after first spraying	2 weeks after first spraying	3 weeks after first spraying	1week after second spraying	2 weeks after second spraying	3 weeks after second spraying
T1-T4	7.473	1.374 (1.509)	2.079 (1.740)	5.266 (2.429)	0.757 (1.324)	2.258 (1.802)	3.139 (2.032)
T5-T8	5.445	1.260 (1.494)	3.063 (2.002)	8.418 (3.047)	1.696 (1.638)	3.061 (1.994)	4.659 (2.371)
T9-T12	4.833	0.284 (1.127)	2.456 (1.848)	6.523 (2.737)	0.909 (1.372)	2.232 (1.778)	2.549 (1.880)
T13	5.553	0.0 (1.0)	0.713 (1.309)	17.718 (4.326)	0.319 (1.149)	2.102 (1.761)	0.799 (1.341)
T14	6.337	7.509 (2.917)	12.168 (3.629)	17.718 (4.326)	14.999 (3.999)	16.219 (4.150)	12.024 (3.608)
CD (Grouped)	3.8917	0.3939	0.4609	0.6012	0.2941	0.2874	0.4432
CD(Grouped-Single)	6.1532	0.6228	0.7286	0.9505	0.4649	0.4545	0.7008
CD (Single)	7.7833	0.7878	0.9216	1.2023	0.5881	0.5749	0.8864

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

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jaggery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jaggery trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

Treatment involving carbaryl 0.2 per cent showed maximum population build up in first and second spraying, with a value of 100.0 per cent and 558.7 per cent respectively, whereas malathion-garlic emulsion recorded a build up of 765.94 during two weeks after first spraying (Table 16).

Observations taken after one week of second spraying showed carbaryl 0.2 per cent with the least count of aphids (0.319) followed by neem oil - garlic emulsion (0.757). The treatments *viz.*, neem oil - garlic emulsion and malathion- garlic emulsion were statistically on par and differed significantly from the control plot population count.

4.4.5 Management of fruit flies.

The attack of fruit flies was managed by using different bait traps, bait sprays and covering of fruits. Mean number of fruit flies trapped in different bait traps which were kept in the main field are given in (Fig. 9) and corresponding fruit damage in Table 17.

Maximum catch of flies were obtained in traps using banana fruits (1.722, 1.222 and 1.108). There was zero per cent of fruit damage also in these plots (T_1, T_5, and T_9). In Treatment 2, where covering of fruits and keeping tulsi trap were practised, zero per cent fruit fly damage was recorded. Treatments 1, 2, 3, 5, 6, 7, 9, 10 and 11 were on par with respect to fruit damage by flies. All the above mentioned treatments differed significantly from the control plot observation. Plots which received only the bait spraying using malathion without any traps and covering during

Table 16. Percentage changes in the mean population count of aphids, *A.gossypii* at different intervals after the application of treatments

Interval	Treatments				
	T1-T4	T5-T8	T9-T12	T13	T14
1 week after first spraying	-81.62	-76.85	-94.13	-100.0	18.5
2 weeks after first spraying	51.35	143.06	765.94	100.0	62.05
3 weeks after first spraying	153.29	174.79	165.56	415.07	45.62
1 week after second spraying	-85.63	-79.85	-86.06	-91.31	15.35
2 weeks after second spraying	198.41	77.82	145.43	558.7	8.13
3 weeks after second spraying	39.04	54.47	14.21	61.96	25.86

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jaggery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jaggery trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

Fig.9. Mean count of fruit flies caught in different traps kept in main field

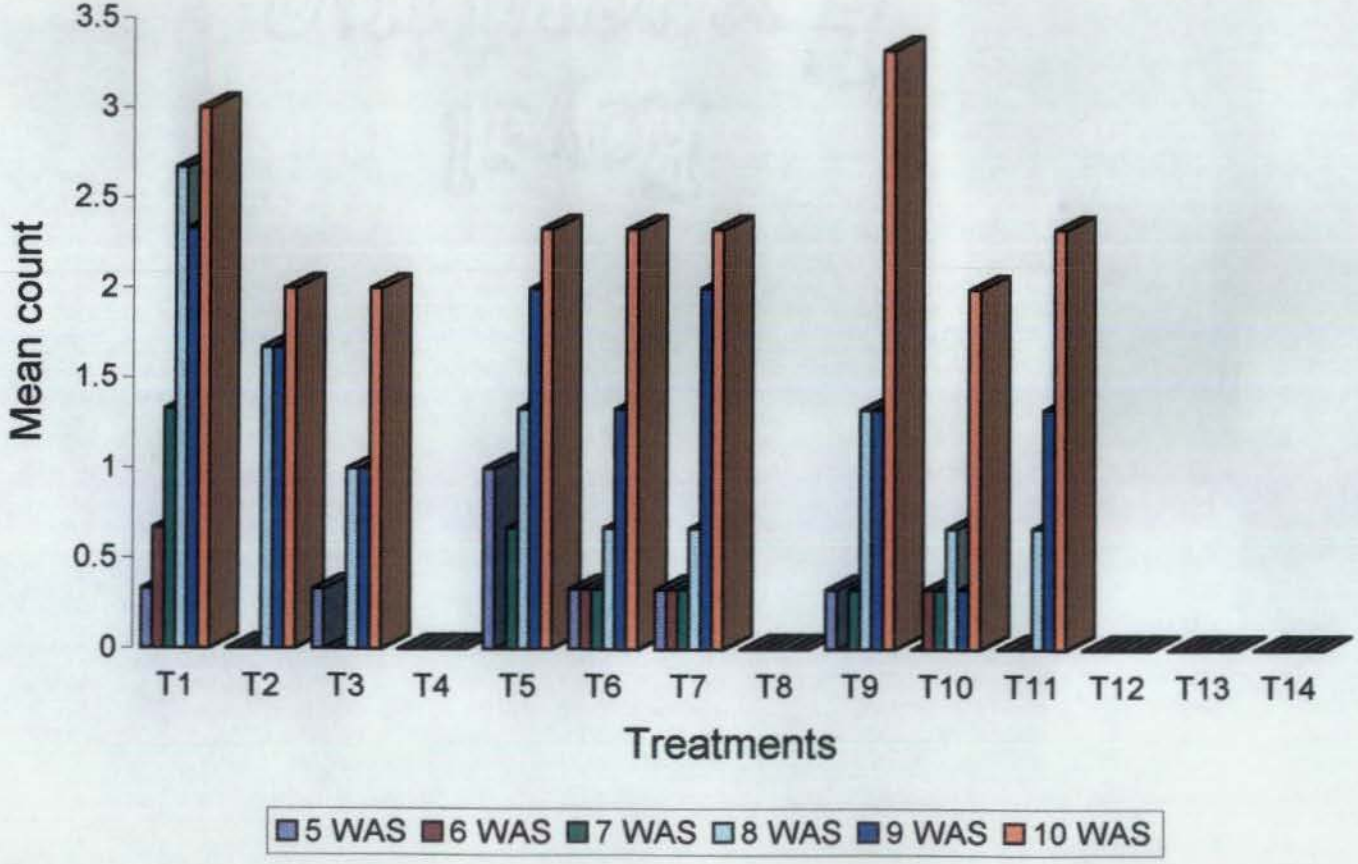


Table 17. Mean percentage of fruit damaged due to the attack of fruit flies

Treatments	Mean percentage of fruit damage
T1	0.0(0)
T2	0.0 (0)
T3	2.11 (4.85)
T4	16.11 (23.29)
T5	0.0 (0)
T6	3.33 (6.14)
T7	2.11 (4.85)
T8	24.83 (29.87)
T9	0.0 (0)
T10	0.33 (1.91)
T11	4.22 (6.96)
T12	16.89 (24.03)
T13	24.07 (28.86)
T14	34.17 (35.66)
CD	10.6442

Figures in parenthesis are angular transformed values

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jaggery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jaggery trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

flowering and fruiting showed a higher percentage of fruit damage by fruit flies (29.87 (T_8), 28.86 (T_{13}), 24.03 (T_{12}) 23.29 (T_4)).

4.4.6 Natural enemy population in main field

4.4.6.1 Spiders

Population of spiders in all the plots were not significantly different before the spraying (Plate 8). One week after the first spraying the treatments showed significant difference (Table 18). Spiders registered maximum population (1.333) in control plots which was statistically on par with plots received neem oil treatment (T_1 -1.0; T_2 - 0.89; T_3 - 0.89). The least population was recorded with carbaryl (0.533). Slow build up of spider population was noticed in the following week. Control plot (2.0) was significantly different from other treatments. Neem oil sprayed plots (T_1, T_2, T_3 and T_4) were on par.

In second spraying also the same trend was noticed. One week after the second spraying, control plot (4.0) showed highest population count and the same trend was noticed in the second (4.333) and third weeks after second (5.113) spraying.

4.4.6.2 Predators

Mean population count of predators are presented in Table 19. In all the observations made, the highest population count was registered by control plots and it was significantly different from other treatments (Plate 9). After one week in first spraying, control plot recorded the maximum population (2.0) and carbaryl treated plots recorded the minimum (0.22). Two weeks after first spraying also control plot

Plate 8. ***Argiope*** **sp.predating on** ***A. peponis*** **larva**

Plate 9. Syrphid maggot feeding on aphids

Table 18. Mean population count of spiders at different intervals after the application of treatments

Treatments	24 hrs. before first spraying	1 week after first spraying	2 weeks after first spraying	3 weeks after first spraying	1week after second spraying	2 weeks after second spraying	3 weeks after second spraying
T1	1.330	1.000	1.223	1.557	0.780	1.220	2.557
T2	1.220	0.890	1.333	1.890	0.890	1.223	2.223
T3	1.113	0.890	1.113	1.780	0.557	1.333	2.443
T4	1.333	0.557	1.443	1.557	0.443	1.223	1.667
T5	0.890	0.780	0.777	1.333	0.443	0.890	1.887
T6	1.447	0.433	0.890	1.000	0.667	0.890	1.777
T7	1.777	0.433	0.780	1.000	0.557	0.887	1.780
T8	1.553	0.780	0.670	0.887	0.443	0.780	1.557
T9	1.337	0.557	0.777	1.113	0.333	0.890	1.557
T10	1.667	0.557	0.557	1.330	0.667	0.780	1.777
T11	1.557	0.777	0.667	1.000	0.220	0.890	1.667
T12	1.333	0.670	0.890	1.223	0.667	1.000	1.443
T13	1.003	0.553	0.667	1.000	0.220	0.443	1.110
T14	1.667	1.333	2.0	3.223	4.000	4.333	5.113
CD	NS	0.4535	0.5382	0.7638	0.5669	0.6735	0.7567

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jageery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jagerry trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

Table19. Mean population count of predators at different intervals after the application of treatments

Treatments	24 hrs. before first spraying	1 week after first spraying	2 weeks after first spraying	3 weeks after first spraying	1week after second spraying	2 weeks after second spraying	3 weeks after second spraying
T1	0.890	0.789	1.220	2.000	1.000	1.557	2.000
T2	1.000	0.667	1.333	1.333	0.890	1.333	1.780
T3	1.777	0.670	1.000	1.890	1.223	1.330	1.557
T4	1.333	0.443	0.780	0.890	0.670	0.780	0.780
T5	1.110	0.557	1.000	1.110	0.890	1.110	1.110
T6	1.667	0.667	1.220	1.000	0.780	0.890	1.220
T7	1.003	0.553	0.890	1.223	0.777	0.890	1.110
T8	1.447	0.443	0.557	1.110	0.667	0.777	1.000
T9	1.33	0.443	0.780	1.110	0.557	0.780	1.000
T10	1.223	0.667	0.780	0.890	0.667	0.890	0.890
T11	1.110	0.667	0.780	0.890	0.667	0.780	0.890
T12	1.667	0.443	0.890	0.780	0.443	0.780	1.000
T13	1.890	0.222	0.557	0.777	0.443	0.557	0.780
T14	2.000	2.000	2.890	2.780	2.443	2.777	3.777
CD	NS	0.4537	0.4127	0.5133	0.4855	0.5157	0.5438

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jageery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jagerry trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

showed highest population of predatory insects (2.89) which was significantly different from other treatments and followed by neem oil treated plots (T_2 - 1.333, T_1 - 1.22) and nimbecidine treated plots (T_6 - 1.22). T_1, T_2, T_3, T_5 and T_6 were on par. The same trend was noticed in second spraying also.

4.4.6.3 Parasites

There was no significant difference among the treatments before spraying and data obtained at different intervals are presented in Table 20. After two weeks, all the treatments except control (T_{14}) were on par, in first spraying. In second spraying also the same trend was noticed (Plate 10).

4.5 Yield data

The mean yield data recorded in Table 21 revealed significant differences among treatments. The average yield of snakegourd fruits per vine or plant varied from 24.557 kg/plant in plots which received the treatment 'neem oil-garlic emulsion + covering +banana trap' (T_1) to 6.667 kg/plant in control plots (T_{14}). The yield of control plot was significantly low from the rest of treatments. The plots treated with 'neem oil – garlic emulsion + covering + banana fruit trap' (T_1) gave highest yield (24.557 kg/plant) which differed significantly from the rest and was followed by malathion - garlic emulsion + covering + banana fruit trap' (T_9). There was no significant difference among the treatments T_9, T_5, T_2, T_3, T_{10} and T_{11}.

Table 20. Mean population count of parasites at different intervals after the application of treatments

Treatments	24 hrs. before first spraying	1 week after first spraying	2 weeks after first spraying	3 weeks after first spraying	1week after second spraying	2 weeks after second spraying	3 weeks after second spraying
T1	1.223	0.333	0.443	0.670	0.110	0.443	0.667
T2	0.443	0.223	0.333	0.443	0.223	0.333	0.443
T3	0.333	0.223	0.447	0.447	0.220	0.333	0.330
T4	0.220	0.220	0.220	0.333	0.000	0.223	0.223
T5	0.557	0.110	0.110	0.110	0.000	0.333	0.333
T6	0.777	0.110	0.110	0.333	0.110	0.220	0.223
T7	0.887	0.110	0.333	0.333	0.110	0.223	0.220
T8	0.333	0.000	0.333	0.333	0.110	0.110	0.220
T9	0.333	0.000	0.110	0.333	0.000	0.110	0.220
T10	0.667	0.333	0.220	0.223	0.000	0.110	0.110
T11	0.443	0.110	0.333	0.443	0.110	0.110	0.110
T12	0.667	0.000	0.333	0.333	0.000	0.110	0.110
T13	0.667	0.000	0.000	0.110	0.000	0.000	0.110
T14	0.890	1.553	1.533	1.890	1.567	1.890	2.220
CD	NS	0.4736	0.4798	0.4444	0.4431	0.4701	0.4816

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jageery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jagerry trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

Plate 10. ***D. indica*** **parasitised by** ***A. taragamae***

Table 21. Mean yield of snakegourd fruits per plot for different treatments

Treatments	Yield in kg
T1	24.557
T2	20.667
T3	20.557
T4	15.670
T5	20.223
T6	16.000
T7	170443
T8	13.113
T9	20.667
T10	20.443
T11	17.110
T12	14.553
T13	14.447
T14	6.667
CD	3.3561

Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jaggery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jaggery trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

4.6 Benefit-Cost ratio

Benefit-cost ratio of pest management for one hectre was worked out and is presented in the Table 22. The highest ratio (1.957) was obtained in treatment involving neem - oil garlic emulsion + covering + banana trap (T_1) and the least (0.52) in T_6 (nimbecidine + covering + tulsi trap).

Table 22. Benefit cost ratio of different treatments taken as a package

Treatments	Cost (A)	Benefit (B)	Net profit (C=B-A)	Benefit-Cost ratio
T1	190452.24	306958.75	116506.51	1.953
T2	177118.94	258333.75	81214.81	1.364
T3	177118.94	256958.75	79839.81	1.341
T4	91308.077	195875.0	104566.93	1.757
T5	182396.71	252791.25	70394.54	1.183
T6	169063.41	200000.0	30936.59	0.520
T7	169063.41	218041.25	48977.84	0.823
T8	83252.544	163916.25	80663.71	1.355
T9	186285.58	258333.75	72048.17	1.210
T10	172952.29	255541.25	82588.96	1.388
T11	172952.29	213875.0	40922.71	0.688
T12	87141.666	181916.25	94774.59	1.592
T13	87141.666	180583.75	93442.09	1.570
T14	23808.266	83333.75	59525.484	1.000

Treatments

T_1 – (Neem oil 2.5 %+ garlic 20 g l^{-1}) + covering + banana trap.
T_2 – (Neem oil 2.5 %+ garlic 20 g l^{-1}) + covering + tulsi trap
T_3 - (Neem oil 2.5 % + garlic 20 g l^{-1}) + covering + starch jaggery trap
T_4 – ((Neem oil 2.5 % + garlic 20 g l^{-1}) + Malathion 0.2 % bait spray
T_5 – Nimbecidine 0.2 % + covering + banana trap
T_6 - Nimbecidine 0.2 % +covering + tulsi trap
T_7 - Nimbecidine 0.2 % + covering + starch jaggery trap
T_8 - Nimbecidine 0.2 % + Malathion 0.2 % bait spray
T_9 – (Malathion 0.1 % + Garlic 20 g l^{-1}) + covering + banana trap
T_{10} - (Malathion 0.1 % + Garlic 20 g l^{-1}) + covering + tulsi trap
T_{11} –(Malathion 0.1 % + Garlic 20 g l^{-1}) + covering + starch jaggery
T_{12} - (Malathion 0.1 % + Garlic 20 g l^{-1}) + covering + Malathion 0.2 % bait spray
T_{13} – Carbaryl 0.2 % + Malathion 0.2 % bait spray
T_{14} – Mechanical control

DISCUSSION

DISCUSSION

5.1 Survey

A survey was conducted in two important snakegourd growing tracts of Thiruvananthapuram district to record the farmers' practices and the major pests and their natural enemies. The survey covered age of farmers, size of holding, nature of land, plant spacing, variety, source of seeds, methods of land preparation and irrigation, fertilizer usage and plant protection methods adopted by the farmers.

Sixty per cent of the farmers preferred to cultivate snakegourd in wet lands due to the availability of water and ease in intercultural operations. It was observed that young generation was reluctant to take up agriculture.

Farmers adopted to high density of planting. The spacing was well below the recommended one (2.0 m x 2.0 m), as each farmer wanted to utilise their cultivable area to the maximum extent possible.

The surveyed area was popular for vegetable cultivation. Farmer extension services like Kerala Horticultural Development Programme (KHDP) was well established. The knowledge on improved varieties among the farmers was wide spread (65 per cent). However, majority (75 per cent) of the farmers used farm saved seeds and did not approach the Department of Agriculture or the University for seeds as it was more economic than purchasing seeds from elsewhere.

Bonny (1991) observed that experience in vegetable cultivation had significant positive association with the extent of adoption of improved vegetable cultivation practices. Similar trend was observed in the present findings also. Farmers

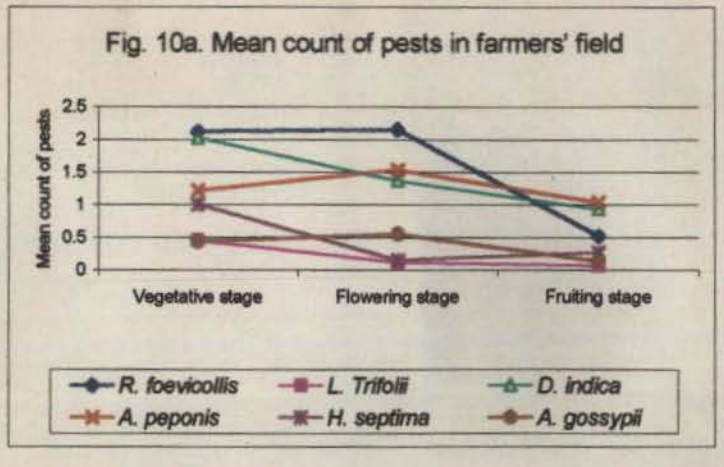
were aware of the importance of pit burning, ploughing and intercultural operation and irrigation. However, significant difference was observed between the recommended practices and actual practices with respect to fertiliser and pesticide dosage. This variation was also observed in the KHDP survey of 1994-'95 (KAU, 1996 d).

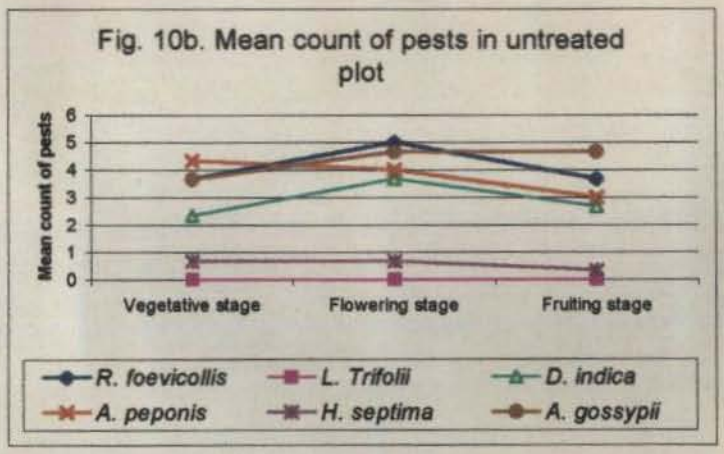
It was observed that eighty five per cent of the farmers were using quinalphos as the main chemical pesticide and all of them were using combinations of chemicals and botanical formulations.

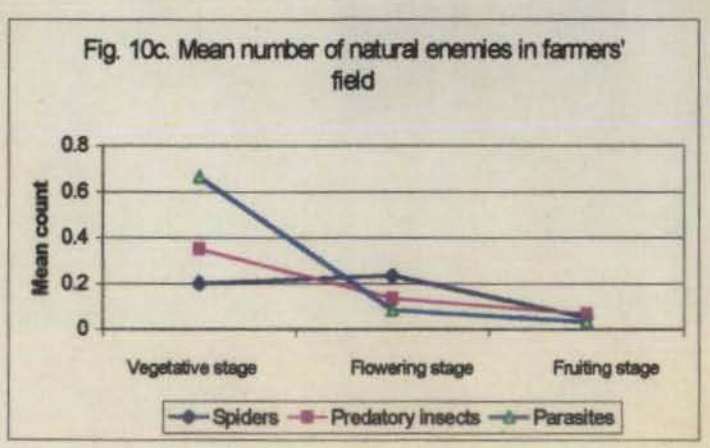
Fruit fly traps were widely adopted by the farmers (100 per cent). All the surveyed farmers were using fruit fly traps using palayamkodan fruit, starch solution and tulsi leaves. The adoption of fruit fly traps was reported by Beegum (1999) and Jayapalan (1999) also.

Farmers considered fruit flies as the most serious pest and took adequate measures to protect the crop. Majority of the farmers carried out a prophylatic spraying to ward off all the pests and hence the population of pests in farmers' field was less, compared to the untreated plot kept at the Instructional Farm of the College of Agriculture, Vellayani. Fruit flies caused up to 63.63 per cent damage when the plots were left untreated. The farmers resorted to continuous spraying of pesticides in order to protect the crop. The indiscriminate use of pesticides (Rahiman *et al.*, 1986; Santhoshkumar, 1997) was in practice inspite of the extension activities of KHDP. The pest infestation in farmers' field was lower compared to untreated plots (Fig. 10a, 10b and 11a, 11b).

Fig .10. Comparison of pests and natural enemies between the farmers' field and untreated plot during season I







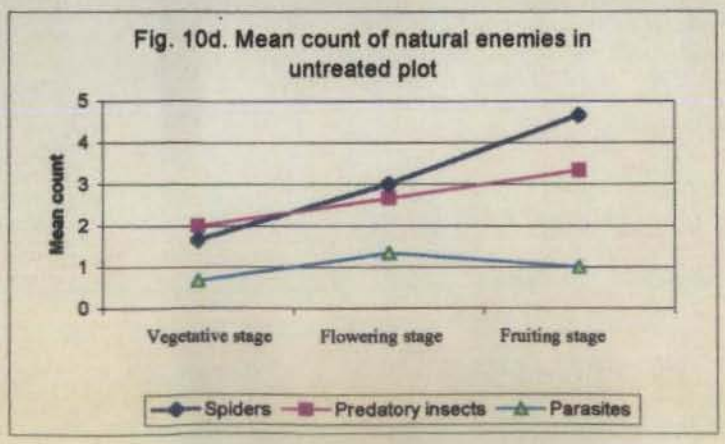
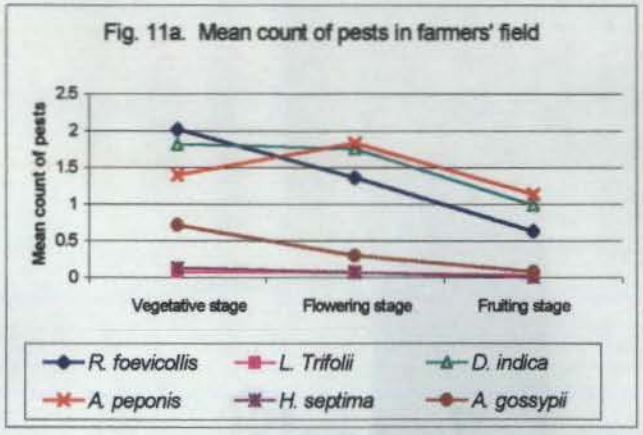
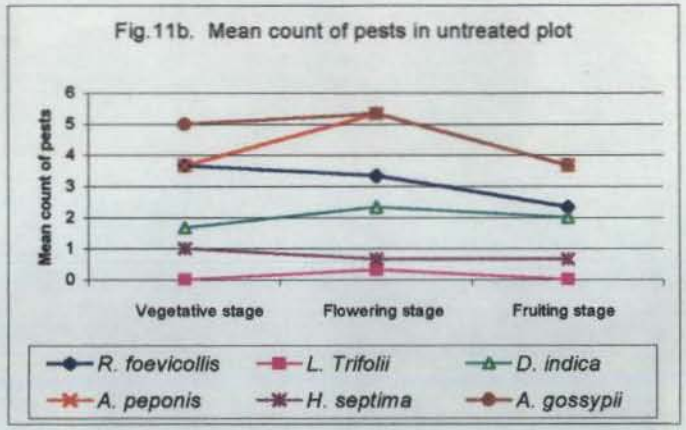
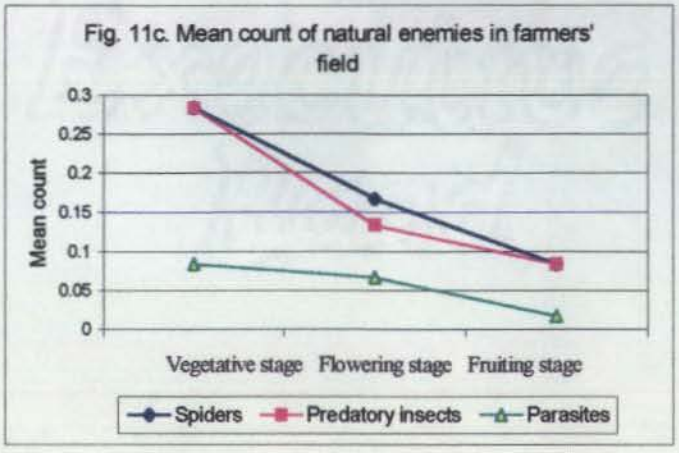
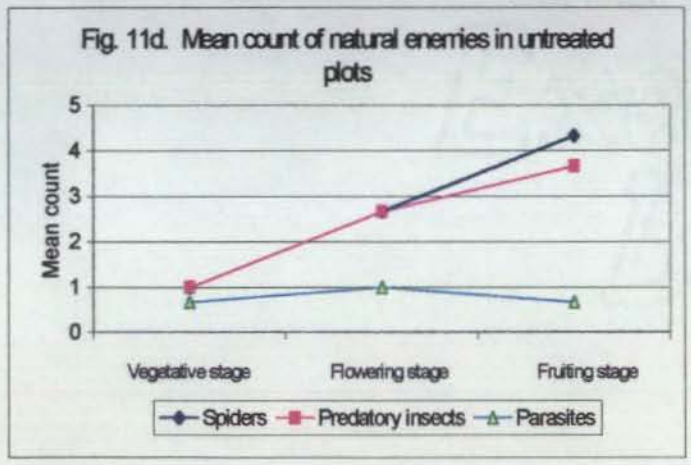


Fig .11. Comparison of pests and natural enemies between the farmers' field and untreated plot during season II









The natural enemy population between the farmers' field and untreated plot showed significant difference. The presence of natural enemies during all the three stages of observations was less in farmers' field (Fig. 10c, 10d and 11c, 11d). The population of natural enemies showed a clear increasing trend in untreated plot whereas in farmers' field it showed a declining trend in both the seasons. There was almost ten fold increase in population of natural enemies in the untreated plot than farmers' field in both the seasons. The population of all the three categories of natural enemies showed an increase from vegetative to fruiting stage of the crop whereas farmers' field registered a steady as well as low population count. In the untreated plots, as population of natural enemies increased from vegetative to fruiting stage, a corresponding decline in pest population was also noticed in both the seasons. Nandakumar (1999) reported that the natural enemies were low due to the indiscriminate use of pesticides in bitter gourd. Similar observations were made by Bernice (2000) in brinjal fields. Patel *et al.* (1976) observed that spider abundance and species composition declined in groundnut fields due to pesticide application. In cotton ecosystems Pfrimmer (1964) reported similar observations.

5.2 Testing the efficiency of different fruit fly traps

Three different fruit fly traps, *viz.*, banana trap (palayamkodan fruit pieces + carbofuran 3G), tulsi trap (crushed leaves of *Ocimum sanctum* + carbofuran 3G) and starch - jaggery trap (starch solution - jaggery + yeast + carbofuran 3G) were tested during flowering and fruiting stages of the snakegourd crop. Among the different traps tested, banana trap was found to be superior to the other traps. Banana traps

showed a high persistence (7.267) in catching both sexes of flies over a period of time. The effectiveness of banana fruit fly traps was reported earlier by Jalaja (1989). Pillai *et al.* (1991) and KAU (1996 c). The preference to banana traps over the other traps might be due to the attraction towards a more preferred food by the fruit flies. These traps were found to be very easy to install and maintain in field, and did not require any physical strain and had no spill over problem. Nandakumar (1999) suggested yellow coloured coconut shell trap containing carbofuran 3G + banana fruit alternated with carbofuran poisoned ocimum - jaggery trap for trapping the flies.

5. 3 Evaluation of snakegourd varieties with respect to pest infestation

Kaumudi, T.A.-19 and local varieties of snakegourd were tested to evaluate their reaction towards major pests. Out of the three varieties evaluated, Kaumudi showed superiority, having minimum levels of infestation by fruit flies, pumpkin beetles and leaf eating caterpillars. Among the three varieties tested, Kaumudi registered the lowest percentage of fruit fly damage (23.34 per cent). The observation was contrary to the earlier results (KAU, 1996 b). The thick and tough fruit skin of this variety might have contributed to the low incidence of pests. Pal *et al.* (1984) reported similar observation in bittergourd. Out of the 69 varieties he tested, two varieties which had tough and thick fruit rind, showed low infestation by fruit flies. The lowest infestation of pests in Kaumudi resulted in significantly higher yield, compared to the other varieties.

The highest yield also was recorded by this variety. Kaumudi registered the lowest infestation by pumpkin beetles (4.35) which was significantly less than the other two varieties tested. Similar trend was observed in *D. indica* also. The incidence of snakegourd semilooper, *A. peponis* was the lowest in the case of Kaumudi, and the other two varieties were on par. *S. litura* and *L. trifolii* were not at significant levels during the present study and they did not show any significant difference in occurrence among the varieties.

5.4 Main field experiment

Carbaryl was the most effective in controlling pumpkin beetle (0.1048), but the subsequent population build up was the highest (431.20 per cent). Neem oil - garlic emulsion and malathion - garlic emulsion were equally effective. Malathion - garlic emulsion showed the least build up percentage of population. Effect of malathion on pumpkin beetles has been reported by many workers (Butani and Verma, 1977; Reghupathy *et al.*, 1997; Das and Isahaque, 1999). During the second spraying also the same trend was observed. Neem oil garlic emulsion registered the least build up of population (14.41 per cent). The findings of the present study indicated that eventhough carbaryl could control pumpkin beetle, it was better to adopt either neem oil-garlic or malathion - garlic emulsion as it helped for the least build up of pests after the application. The effect of neem oil and other plant parts on pumpkin beetle, *A. foveicollis* has been reported earlier (Panji, 1965; Gujar and Mehrotra, 1988; KAU, 1996 c).

A. peponis was well controlled by carbaryl 0.2 per cent (0.439) (Table 11). However as in other cases the population build up was maximum (203.71). Neem oil - garlic emulsion (T_1 - T_4) and malathion - garlic emulsion (T_9 - T_{12}) were effective treatments. Neem oil - garlic treatment showed the least build up of pests. Residual effect of carbaryl lasted long and it showed the best results over three weeks in both spraying. However, neem oil - garlic and malathion - garlic were equally effective as carbaryl two weeks after spraying. The persistent effect of neem oil - garlic emulsion may be because of its antifeedant activity (Pradhan, 1962; Joshi and Ramaprasad, 1975 and Kulkarni, 1999) or growth inhibitory effect (Sharma *et al.*, 1980; Schmutterer, 1990; Dimetry *et al.*, 1998; Hassan, 1999). Neem oil garlic emulsion was the best option of controlling the snake gourd semilooper, *A. peponis* since it was effective in controlling the pest in terms of number and build up percentage.

Among the treatments tested, carbaryl 0.2 per cent was found to control *D. indica* in both sprayings, but as in many other cases, it showed a rise in population build up to the tune of 100 per cent and 37.57 per cent, respectively. The high percentage of population build up may be due to the absence of parasites and less number of spiders in the carbaryl treated plots. The parasites and spiders were seriously affected by the chemical. In general, population of *D. indica* showed a decline in build up percentage towards the end of the crop (Table 14) and it may be due to the reduction in the number of fresh leaves.

Neem seed oil emulsion was found to give good control of *A. gossypii* in chillies at five per cent concentration (Santhoshkumar, 1999). Similar results were

reported by Reghunath and Gokulapalan (1996) in the case of *A. craccivora* and in *A. gossypii* (Reghunath and Gokulapalan, 1999).

In the current study also neem oil mixed with garlic was found to be very effective in controlling aphids with a low population build up, compared to chemicals. Similar observations were made by Santhoshkumar (1999) and Parihar *et al.* (1999) in the case of *Myzus persicae*. Neem and other plant extracts were safer to coccinellid predators (Srinath, 1990; Patel and Yadav, 1993 and Bernice, 2000). The lowest population build up was observed in control plots since the natural enemies were present in large numbers which checked the pest population from flaring up. There might have been a shift of natural enemies from the treated plots to control plots also.

Fruit flies (*B. cucurbitae*) are the major pests of cucurbits as it directly damage the economic part. In the current study as an eco-friendly practice covering of fruits along with setting up of traps and bait spray with malathion 0.2 per cent were tested. Covering the fruits gave good results in preventing the flies from attacking the fruits (Table 17 and 21). The damage by the flies was on par in all treatments involving covering. Covering of fruits prevented flies from oviposition. The use of polythene bags to protect the fruits was well supported by the observations made by Jalaja (1989). Similar observations were made by Fang and Chang (1987), Wen (1988) and Kapoor (1993). The cropping season also coincided with the least active time of fruit flies as reported by Fang and Chang (1987) and Kapoor (1993). In the present study low catch of fruit flies was noticed. During December to February the pest will be less active as they overwinter during this period. This might be the reason of low catch of flies in different traps kept in the main field (Fig. 9). The effectiveness of covering

and bait spray for the management of fruit flies has been earlier reported (Wen, 1988; Jalaja, 1989; Kapoor, 1993; Reghunath and Indira, 1993; Pillai *et al.*, 1991; KAU, 1996 a; Reghunath and Gokulapalan, 1999).

Occurrence of natural enemy population, mainly spiders, predators and parasites was observed in the main field experiment. After the spraying, control plot recorded the highest population count (T_{14}). Plots which received chemical treatments, especially carbaryl (T_{13}), recorded the least count. The application of chemical insecticides caused the destruction of natural enemies like spiders (Table 18). The spider population is not much affected by the neem oil - garlic spraying. The predators recorded were coccinellid predators and syrphids. The highest count of these predators was recorded in control plots, throughout the crop season (Table 19). Only two weeks after spraying, the treated plots showed any difference. Among the treatments, neem oil-garlic was found safe for the predators. Parasites were present in the plots and *Apanteles taragamae* was the most prominent one. The population of the parasites was drastically reduced after spraying and it took almost three weeks to restore the same situation (Table 20). The population in the control plot remained almost unchanged throughout the experiments. Parasites, being very delicate insects, were seriously affected by the application of chemicals. The chemicals directly and getting into the body of parasites through contaminated host might have contributed to the drastic reduction of parasite population in the field. The destruction of natural enemies caused by the application of chemical pesticides has been reported by Pfrimmer (1964), Patel *et al.* (1976), Bindu (1997), Nandakumar (1999), Santhoshkumar (1999) and Bernice (2000). In the current study, neem oil -garilc

treatment (T_1 T_4) was found safer to natural enemies. Similar findings were reported by many workers (Srivastava and Parmar, 1985; Thakur *et al.*, 1988; TNAU, 1992; Srinath, 1990; Patel and Yadav, 1993; Chakraborthy and Chatterjee, 1999 and Bernice, 2000).

The highest yield (24.556 kg) was obtained from plots treated with (neem oil 2.5 per cent + garlic 20 g) + covering + banana trap (T_1). The treatments T_9 (Malathion 0.1 per cent + garlic 20 g l^{-1} + covering + banana trap), T_2 (neem oil 2.5 per cent + garlic 20 g l^{-1}) + covering + tulsi trap, T_3 (neem oil 2.5 per cent + garlic 20 g l^{-1}) + covering + starch-jaggery trap, T_{10} (Malathion 0.1 per cent + garlic) + covering + tulsi trap, T_5 nimbecidine 0.2 per cent + covering + banana trap and T_7 nimbecidine 0.2 per cent + covering + starch-jaggery trap were found to be equally effective. Covering with polythene bags and trapping of flies recorded the highest yield in earlier experiments also (Jalaja, 1989).

Among the four treatments tried to control the vegetative stage pests, neem oil-garlic treatment was the costliest (Rs. 39722.221). This treatment registered higher yield (Table 21) when used along with covering + banana trap. The population build up of different pests was low and the natural enemy population was the least affected. Thus neem oil-garlic emulsion was found to be an eco-friendly viable recommendation against the pests of snakegourd during vegetative stage. Covering fruits with reusable polythene bags along with banana trap was effective against fruit fly attack. Excluding the cost of treatments in vegetative stage, the projected cost for one hectre for covering + banana trap setting is Rs. 150730.55 and covering + tulsi or starch - jaggery trap is Rs. 137397.21 as shown below (Table 23).

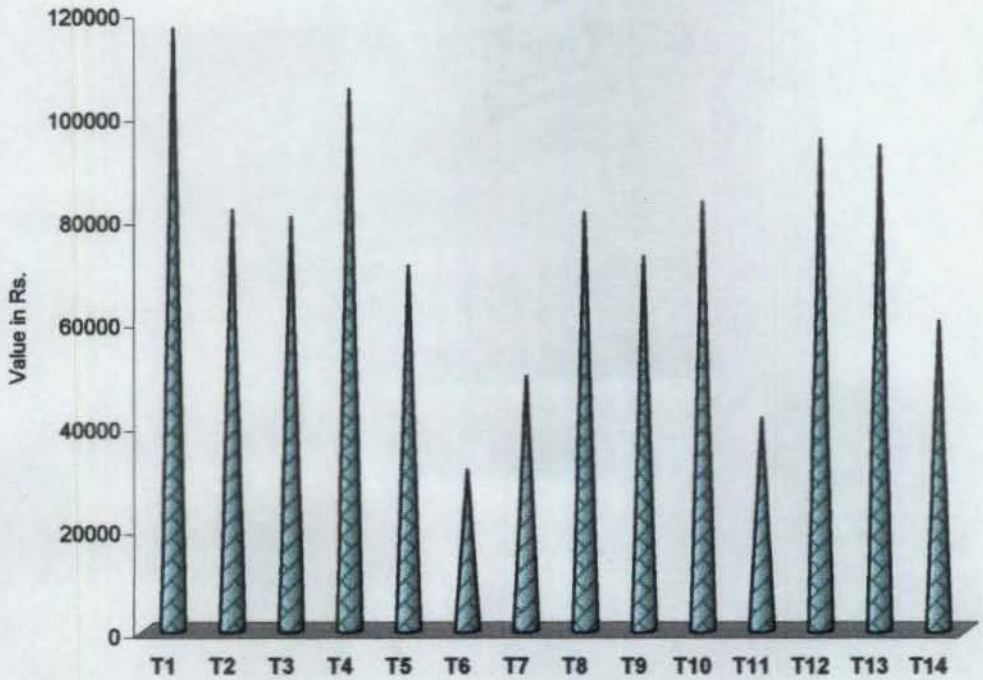
Table 23.

Benefit- cost ratio of different treatments followed to manage fruit flies

Treatments	Cost	Benefit	Net profit	Benefit-Cost ratio
Covering + banana trap	150730.55	272694.58	121964.303	2.049
Covering + tulsi trap	137397.21	237958.33	100561.12	1.689
Covering + starch - jaggery trap	137397.21	229625.0	92227.79	1.549
Malathion bait spray	87141.664	180569.15	93427.79	1.570
Control	23808.266	83333.75	59525.484	1.000

When bait spray was practised, the cost was less (Rs. 87141.664), compared to covering + trap setting as it required less labour and material cost. Eventhough the cost for covering + trapping was high, it was compensated by high yield due to full protection as evident from high benefit - cost ratio (Table 22). The net profit was the maximum (Rs. 116506.51) for the treatment involving neem oil - garlic emulsion during vegetative stage and covering + banana trap during flowering and fruiting stages (Fig. 12). In the current study no additional labour was engaged for covering newly emerged fruits. It was done along with harvesting. Benefit - cost ratio (Fig. 13) revealed that the eleven treatments could give profits since their ratio was greater than 1.0. The highest ratio (1.957) was recorded by neem oil - garlic emulsion + covering + banana trap (T_1) which resulted in the highest yield due to the low attack of fruit flies. However, the treatments T_4 (1.757), T_{12} (1.572) and T_{13} (1.57), which followed T_1 registered a high benefit - cost ratio. This was not because of high yield but due to the low cost incurred. In these treatments extra cost was not incurred because no covering or trap setting was carried out. Eventhough the cost of trap setting and maintenance

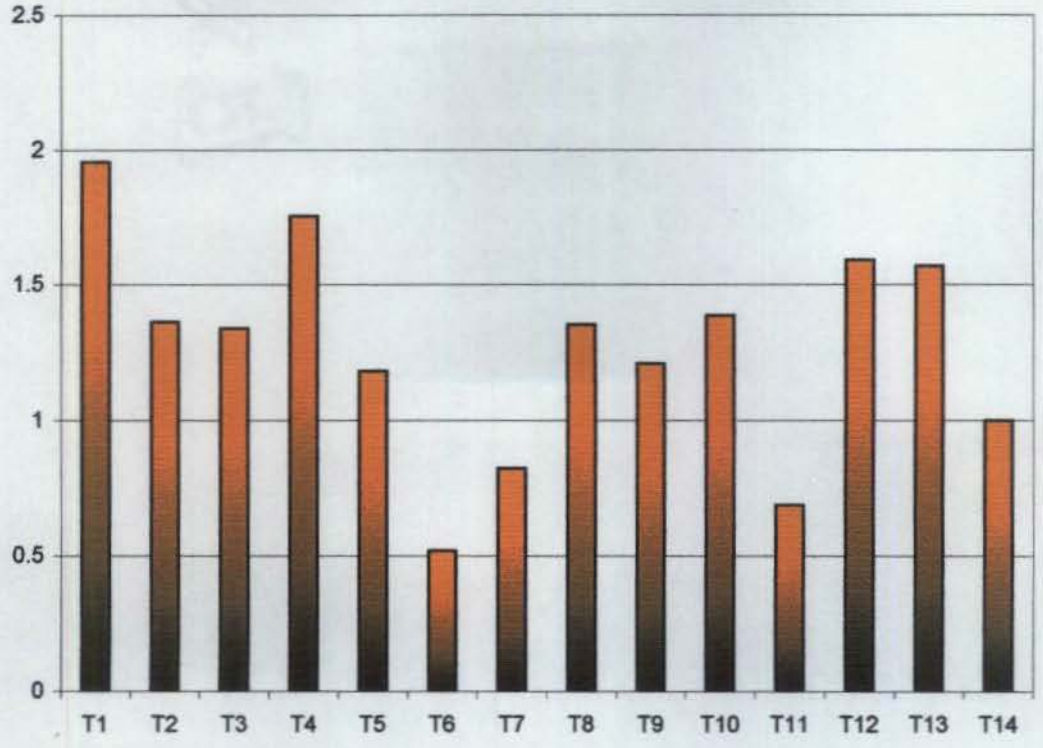
Fig.12. Net profit of different treatments



Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
2 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + tulsi trap
3 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + starch-jaggery trap
4 (Neemoil 2.5%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
5 Nimbecidine 0.2% + covering + banana trap
6 Nimbecidine 0.2% + covering + tulsi trap
7 Nimbecidine 0.2% + covering + starch-jageery trap
8 Nimbecidine 0.2% + Malathion 0.2% bait spray
9 (Malathion 0.1%+garlic 20g l^{-1}) + covering + banana trap
10 (Malathion 0.1%+garlic 20g l^{-1}) + covering + tulsi trap
11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jagerry trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

Fig.13. Benefit cost ratio of different treatments



Treatments

1 (Neemoil 2.5%+garlic 20g l^{-1}) + covering + banana trap
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11 (Malathion 0.1%+garlic 20g l^{-1}) + covering + starch-jaggery trap
12 (Malathion 0.1%+garlic 20g l^{-1}) + Malathion 0.2% bait spray
13 Carbaryl 0.2% + Malathion 0.2% bait spray
14 Control

and covering involved more cost over the bait spraying, it could be compensated with high yield obtained from the plots with neem oil - garlic emulsion + covering + banana trap (T_1).

SUMMARY

SUMMARY

Snakegourd is one of the main cucurbits grown in Kerala. It is heavily attacked by many insects. Farmers usually resort to chemical methods of pest management. Indiscriminate and over use of hazardous chemicals lead to environmental as well as health problems. The present study was taken up for evolving an eco-friendly pest management strategy against the major pests of snakegourd. The main objectives of the study were :

i) Documentation of different farmers' practices on pest management.

ii) Evaluation of different snakegourd varieties in relation to pest infestations.

iii) Testing the efficiency of different fruit fly traps.

iv) Evolving a suitable eco-friendly pest management strategy against the pests of snakegourd.

In order to fulfill the above objectives, field survey and field experiments were conducted.

A detailed survey was conducted among the snakegourd cultivating farmers in Kalliyoor and Nedingal area, being the vegetable growing pockets of Thiruvananthapuram district. Different farmers' practices, incidence of pests and presence of their natural enemies were compared with the untreated control plot at the Instructional Farm, College of Agriculture, Vellayani. Survey was carried out in two seasons (February-March to May- June and May-June to August-September). The survey revealed that sixty per cent of the farmers possessed 10-20 cents of land and they preferred wet lands for cultivation. Recommended spacing was followed by a

few farmers only (20 per cent). The recommended pesticide or fertilizer dosages were followed by none of the farmers.

The farmers in the surveyed area showed a tendency towards adoption of chemical pesticides for pest management. The crude preparation of neem oil emulsion was prepared and used by only 15 percent, while large fraction (70 per cent) of them were using neem formulations like nimbecidine. Among the chemicals, quinalphos was the most popular and used by 85 per cent of the farmers. Carbaryl was used by 80 per cent. Most of the farmers were found using these chemicals in rotation or in combination. The systemic insecticide like monocrotophos was sprayed by 15 per cent. Sixty per cent of the surveyed farmers were practising a higher dose than the recommended one.

The survey revealed that pest infestation in farmers' field was very low, compared to the untreated plot and this may be due to the indiscriminate use of pesticides. The major pests present in farmers' field were, *Bactrocera cucurbitae*, *Anadevidia peponis, Diaphania indica, Epilachna septima, Aulacophora* sp., *Aphis gossypii* and *Liriomyza trifolii*. Pumpkin beetles were noticed mainly during vegetative and flowering stages in both the seasons. The pests like *D. indica, A. peponis, L. trifolii* also showed the same trend. The drastic decrease of chewing and sucking pests feeding on vegetative parts during fruiting stage may be due to a combined effect of frequent pesticide application and reduction in number of fresh leaves. There was not much variation in the incidence of pests regarding season between farmers' field and untreated plot except in the case of fruit flies. Farmers' field showed fruit damage by flies ranging from 12.123 per cent to 15.694 per cent

which is lesser than the damage in the untreated plot where it ranged from 27.27 per cent to 63.63 per cent. Observations from untreated plot revealed that fruit damage up to 63.63 per cent may occur if the plots are unprotected and thereby emphasising the need for a better management practice against fruit flies.

In farmers' field the population of natural enemies like spiders, predators and parasites were very less in the initial stages than the untreated plots. This difference in population was significant at the fruiting stage. This may be due to the frequent and indiscriminate use of chemical pesticides. But a reverse trend in the natural enemy population *i.e.*, an increase in population from vegetative to fruiting stage was noticed in untreated plot and there was ten fold increase in the natural enemy population compared to the farmers' fields.

Three snakegourd varieties *viz.*, Kaumudi, T.A.-19 and Local were tested against pest infestation. Kaumudi registered the lowest infestation of pumpkin beetles (4.355), *D. indica* (3.933) and *A. peponis* (3.767). The Local variety tested showed maximum infestation by all pests. The varieties T.A. –19 (4.189) and Local (4.133) were on par in the case of *A. peponis* infestation. There was significant difference among the treatments regarding fruit fly damage and yield. Kaumudi registered the lowest fruit damage (23.349 per cent) where as the maximum damage was registered by the Local variety (36.66 per cent). Kaumudi recorded highest yield (15.667) which differed significantly from the other varieties.

Three fruit fly traps were tested to assess their efficacy in catching fruit flies. Among the three traps tested, banana trap consisting of palayamkodan fruit pieces and

carbofuran 3G was the best. The mean number of flies caught in banana trap ranged from 4.667 to 9.333.

Field evaluation of fourteen treatments was carried out at the Instructional Farm, College of Agriculture, Vellayani during 1999-2000. The field experiment was statistically laid out in randomised block design (RBD) with three replications. Chemical insecticides were found to be very effective in controlling the pests of snakegourd at vegetative and flowering period, but the pest population build up was the highest with them. Carbaryl 0.2 per cent, recorded maximum reduction in mean population of pumpkin beetles (0.105), *A.peponis* (0.439), *D.indica* (0.0) and *A.gossypii* (0.0), but population build up was calculated two weeks after spraying as 431.20, 203.71, 100.0 and 100.0 per cent respectively. The natural enemy population was also found affected by the chemical, carbaryl 0.2 per cent (spiders (0.553), predators (0.222) and parasites (0.0)) and it took three weeks to regain a population mean as that of pre-spraying condition. Neem oil - garlic emulsion was effective in controlling pests while conserving natural enemies. The maximum population of natural enemies were registered in the plots received neem oil-garlic emulsion (spiders (1.0), predators (0.789) and parasites (0.333)).

The practice of covering of fruits was very effective in preventing the flies from attacking the fruits. Utilizing the labourers engaged for harvesting effectively to cover the newly emerged fruits, covering can be made an economic practice to manage fruit flies. Covering prevented flies from egg laying which in turn reduced fruit damage and increased yield. Treatments involving covering + banana trap (T_1, T_5 and T_9) showed zero per cent fruit damage. Covering + tulsi trap (T_2, T_6 and T_{10}) and

covering + starch-jaggery trap (T_3, T_7 and T_{11}) were on par with covering + banana trap (T_1, T_5 and T_9) regarding fruit damage.

Maximum yield (24.557) was recorded from plot which received neem oil-garlic emulsion + covering + banana trap (T_1) and it was significantly different from control and other treatments. Covering the fruit and setting up of traps at the rate of two traps for three plants gave the best protection against fruit flies.

Benefit - cost ratio was worked out for all treatments. Treatments involving neem oil - garlic emulsion (2.5 per cent) spraying at vegetative stages + covering fruit and banana trap setting at flowering and fruiting stages gave the highest ratio (1.938).

Spraying neem oil-garlic emulsion, on need basis, at vegetative stages and setting up of banana fruit fly traps and covering the fruits with reusable polythene covers were found to be the best eco- friendly and economical package for the management of major pests affecting snakegourd.

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APPENDICES

APPENDIX-I

PROFORMA FOR THE DOCUMENTATION OF PEST AND NATURAL ENEMY OCCURRENCE AND FARMERS' PRACTICES IN SNAKEGOURD

1. Location

   District

   Block

   Panchayat

   Season

2. Name of the farmer

3. Address

4. Size of the holding - Total
   Vegetables
   Snakegourd

5. Nature of land Wet land Garden land

   Area

6. Plant density (plant/cent)

Spacing

7. Crop details

Crop	Area	Season (Month of sowing to month of last harvest)	Variety	Source	Nature of land

8. Farmers Practice

Land preparation

1. Pit Burning

2. Ploughing

3. Irrigation

4. Intercultural operations

9. Fertiliser usage

	Quantity	Time of application
Organic		
FYM		
Poultry manure		
Inorganic		
Urea		
Sp/Mp		
MOP		

10. Pest Management

A. Pest incidence on Main crop : Snake gourd

I. Pests	Vegetative Stage				Flowering Stage				Fruiting Stage			
	Natural enemy		Ctrl. Prac.		Natural enemy		Ctrl. Prac.		Natural enemy		Ctrl. Prac.	
	Predator	Parasite	Chemical	Others	Predator	Parasite	Chemical	Others	Predator	Parasite	Chemical	Others

	Vegetative stage	Flowering Stage	Fruiting Stage
Name of Chemical			
ml/Spray			
No. of spray			
Interval of sprays			
No. of spray load			

B. Pest incidence in other crops in near by field

APPENDIX- II

Period	Time	RH (Per cent)	Maximum (^{0}C)	Minimum (^{0}C)	Rf (mm)
November 28-December 4	7.22	95.14	–	23.38	6.42
	14.22	74.28	29.10		0
December 5-December 11	7.22	94.57	–	21.557	0
	14.22	64.42	31.81	–	–
December 12- December 18	7.22	94.42	–	22.90	0
	14.22	67.00	30.02	–	–
December 19- December 25	7.22	93.28	–	20.8	0.05
	14.22	60.00	30.62	–	–
December 26-January 1	7.22	93.42	–	20.57	0
	14.22	60.00	30.84	–	–
January 2-January 8	7.22	94.71	–	22.45	1.40
	14.22	60.70	31.17	–	–
January 9-January 15	7.22	94.71	–	22.67	1.22
	14.22	66.14	30.60	–	–
January 16-January 22	7.22	95.71	–	21.57	0
	14.22	61.00	30.82		–
January 23- January 29	7.22	95.71	–	20.40	0
	14.22	58.28	31.02	–	–
January 30- February 5	7.22	94.14	–	21.82	10.057
	14.22	55.57	30.84	–	–
February 6- February 12	7.22	92.57	–	23.17	4.342
	14.22	65.85	30.95	–	–
February 13- February 19	7.22	92.28	–	22.24	0
	14.22	61.28	30.81	–	–
February 20- February 26	7.22	90.57	–	22.857	0
	14.22	66.285	31.085	–	–
February 27- March 4	7.22	91.42	–	23.114	0
	14.22	61.714	31.30	–	–
March 5- March 11	7.22	88.14	–	23.62	0.875
	14.22	65.85	31.80	–	–
March 12- March 18	7.22	85.42	–	23.574	0.485
	14.22	63.57	31.785	–	–
March 19- March 25	7.22	87.28	–	23.04	0
	14.22	64.14	32.22	–	–

ECO-FRIENDLY PEST MANAGEMENT IN SNAKEGOURD
(*Trichosanthes anguina* L.)

By
SIVAKUMAR, T.

ABSTRACT OF THE THESIS
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ABSTRACT

A study was conducted to document farmers' practices for pest control, record the population of pests of snakegourd and their natural enemy complex in farmers' field, as well as to evolve an eco – friendly package of practices for pest management. The survey conducted in the farmers' field revealed that the farmers were resorting to indiscriminate use of pesticides. The recommended pesticide/ fertilizer dosage was not practised by the farmers. Quinalphos was the most widely used pesticide followed by carbaryl. The frequency of spraying was the highest at fruiting stage.

The major pests observed in the field were *B. cucurbitae, A.peponis, D. indica, E. septima, Aulacophora* sp. *A. gossypii* and *L. trifolii.* A very low population of pests and their natural enemies were present in the farmers' fields compared to untreated plot maintained in the Instructional Farm, Vellayani. In the untreated plot there was ten fold population of natural enemies compared to farmers' field. Fruit flies were found to be serious pests causing 63.63 per cent loss in unprotected field and this emphasised the importance and necessity for fruit fly management in snakegourd fields.

Three fruit fly traps *viz.*, were tested to assess their efficacy in catching fruit flies. Among the three traps tested, banana traps consisting of palayamkodan fruit pieces and carbofuran were the best.

Three snakegourd varieties *viz.*, Kaumudi, T.A. –19 and Local, were tested against insect infestation. Kaumudi had the lowest infestation by pests like pumpkin beetle (*Aulacophora* sp.), leaf eating caterpillar (*Diaphania indica*),

snakegourd semilooper (*Anadevidia peponis*) and fruit fly (*Bactrocera cucurbitae*). Kaumudi recorded the minimum fruit fly damage and consequently, the highest yield.

Field evaluation of fourteen treatments was carried out at the Instructional Farm, Vellayani during 1999-2000. Chemical insecticides were found to be very effective in controlling the pests of snakegourd at vegetative and flowering period, but the pest population build up was the highest with them. Neem oil – garlic emulsion was the best in controlling the pest menace with the least impact on natural enemies. Population build up of pests was also low in case of neem oil – garlic emulsion.

The practice of covering fruits was very effective in preventing the flies from attacking the fruits. Covering the fruits and setting up of banana traps at the rate of two traps for three plants gave the best protection against the fruit flies. The treatments involving neem oil – garlic 2.5 per cent spray at vegetative stages + covering the fruits and banana trap setting at flowering and fruiting stages gave the highest yield and benefit – cost ratio (1.938). Spraying neem oil –garlic emulsion 2.5 per cent, on need basis, at vegetative stages and setting up of banana fruit fly traps and covering the fruits with reusable polythene covers was found to be the best eco-friendly and economical package for the management of major pests affecting snakegourd.