USE OF SYNTHETIC PYRETHROIDS FOR THE CONTROL OF PESTS OF BITTER GOURD (*Momordica charantia* L) AND SNAKE GOURD (*Trichosanthes anguina* L)

BY

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THESIS

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D E C L A R A T I O N

I hereby declare that this thesis entitled "Use of synthetic pyrethroids for the control of pests of bitter gourd (*Momordica charantia* L.) and snake gourd (*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 to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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C E R T I F I C A T E

Certified that this thesis entitled "Use of synthetic pyrethroids for the control of pests of bitter gourd (*Momordica charantia* L.) and snake gourd (*Trichosanthes anguina* L.)" is a record of research work done independently by Sri. KOSARAJU RAVINDRA NATH 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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Introduction

INTRODUCTION

Vegetables have an important role in human diet. Insect pests are one of the major constraints in vegetable production all over the world, especially under tropical conditions. These crops are subject to attack by a series of pests with varying feeding habits from sowing to harvest. This necessitates application of insecticides at different occasions to control the insect pests of these crops. As the products are also consumed without any other processing the insecticides applied on these crops must be essentially of low mammalian toxicity and of less waiting period, but at the same time highly effective against the pests.

Gourds are an important group of vegetables under the broad classification of cucurbits and these are widely cultivated in the country. Of these, bitter gourd (Momordica charantia L.) and snake gourd (Trichosanthes anguina L.) are two important crops with high nutritive value (Arkroyd et al., 1962). These crops suffer severe damage and crop loss due to insect pests like melon fly, spotted beetle, pumpkin beetle, pumpkin caterpillar, snake gourd semilooper, jassids, aphids and others. The damage due to melon fly alone in gourds is estimated as 40 to 80 per cent of the yield (Pruthi, 1941). Control of this pest is still a problem in India though much efforts were made in this regard.

Insecticides belonging to various groups viz. chlorinated hydrocarbons, organophosphates and carbamates have been evaluated against these pests and some are reported to give effective but partial control of the pests (Das et al., 1968; Nagappan et al., 1971; Mote, 1975). Many of these insecticides possess disadvantages like long and undue persistence in the environment, high toxicity to higher animals and other non-target organisms, pest resurgence, pest resistance to insecticides, residue hazards and environmental pollution. The synthetic pyrethroids were reported as a group of pesticides with high insecticidal activity, low mammalian toxicity (Hascoet and Cavelier, 1978) and with moderate persistence on the crop under field conditions (Elliott et al., 1978; Collingwood et al., 1979). At present four synthetic pyrethroids viz. permethrin, fenvalerate, cypermethrin and deltamethrin are available. These insecticides were tried against a wide range of pests on different crops with highly promising results. Reports from workers like Uthamaswamy and Balasubramanian (1978) on Earias insulana; Voon and Chung (1978) on Plutella xylostella, Leucinodes orbonalis and Earias vitella are a few of them. But the efficacy of synthetic pyrethroids against the pests of gourds have not been investigated. Hence in the present

studies permethrin, fenvalerate, cypermethrin and delta-methrin were evaluated in comparison with malathion against the insect pests of bitter gourd and snake gourd. The investigation included field experiments with bitter gourd and snake gourd by spraying the crop with synthetic pyrethroids at two concentrations and the malathion at field dose on need basis for the control of insect pests. The effect of these insecticides on flowering and fruit set were also studied.

Review of literature

REVIEW OF LITERATURE

Literature available on the control of pests of gourds, efficacy of synthetic pyrethroids on the pests of vegetables and the effect of the same on the beneficial fauna are reviewed briefly.

I. Control of the pests of gourds with insecticides other than synthetic pyrethroids

1. Fruit fly

Ayyar (1935) pointed out that biological method of control for fruit flies had numerous difficulties and bait trapping of adult flies was most effective.

Narayanan and Batra (1960) recommended spraying of one per cent malathion emulsion containing some sugar at fortnightly interval for the control of melon fly Dacus cucurbitae as the most effective one.

Spraying of malathion (Chen, 1960), endrin (Sreenivasan and Narayanaswami, 1960 and 1962) was recommended against the melon fly.

Dale and Nair (1966) recommended bait sprays containing one per cent yeast protein and 0.1% malathion for the control of Dacus cucurbitae Coq.

David (1967) stated that carbaryl 0.1% applied three times at fortnightly intervals from the time of flowering gave significant control of fruit fly on bitter gourd followed by trichlorphon, giving high yields.

Das et al. (1968) observed that even the best treatment carbaryl 0.1% tried could afford only 40-60% control of the pest and hence for a more effective control an integrated approach supplementing the cover sprays with the application of aldrin or heptachlor in the soil to destroy the maggots falling for pupation has to be adopted.

Hali (1969) reported that spraying of endrin at biweekly intervals control the pests of bitter gourd.

Nagappan et al. (1971) achieved best results in controlling the melon fly on snake gourd with three applications of fenthion 0.1% at three weeks interval.

David and Kumaraswamy (1975) stated that three to five spray applications of malathion 0.1% or fenthion 0.1% or carbaryl 0.1% at intervals of 15 days commencing from flowering may be useful for the control of fruit flies on gourds.

Mote (1975) obtained best results with tetrachlorvinphos at 0.1% followed by 0.03% fenthion and 0.1% carbaryl in controlling the fruit fly on bitter gourd.

2. Pumpkin beetles

Panji (1965) obtained 48.3 per cent mortality of the adults of Aulacophora foveicollis by application of a dust prepared from dried fruits of Melia azedarach and 10 per cent ethanol extract.

Champ (1966) reported that dimethoate 0.05% controlled the pests Aulacophora hilaris (Boisd.), A. abdominalis (F) and Aphis gossypii of cucurbits.

Kumar and Lal (1966) concluded that phosphomidon and carbaryl were more toxic than DDT to Aulacophora foveicollis.

Bogawat and Pandey (1967) proved that endrin and malathion were less toxic to Aulacophora foveicollis and A. atripennis than BHC.

3. Other pests

Sengupta and Panda (1958) reported that DDT and malathion as wettable powders and endrin as emulsion concentrate gave significant control of Epilachna viginctioctopunctata whereas BHC was ineffective.

Young and Ditman (1959) observed that Sevin was effective against Aphis gossypii and also reported that cucurbits were not increased by any of the insecticides.

Kozhaeva (1965) recommended sprays of 0.05% parathion, 0.3% malathion or trichlorphon or 0.1% anabasine or nicotine

sulphate with 0.2% soap for crop protection on cucurbits.

David (1966) observed that 0.1% sprays of trichlorphon and especially carbaryl, applied three times gave the best control of Epilachna vigintioctopunctata.

II. Control of pests of vegetables with synthetic pyrethroids

Breese (1977) found that cypermethrin was very effective against cabbage pests such Pieris rapae and Plutella xylostella.

Schuster and Clark (1977) reported that permethrin applied weekly at rates ranging from 0.023 to 0.091 kg ai per 945.4 lit/ha against cabbage looper was more effective than other chemicals or Bacillus thuringeinsis.

Su and Rose (1977) conducted experiment for the control of Plutella xylostella, Trichoplusia ni and Lipaphis erysimi on cabbage and found S-5602 and permethrin gave the best control of all the pests and resulted in the highest yield of marketable cabbage.

Tysowsky and Gallo (1977) conducted bioassay tests on the eggs of Heliothis zea, Spodoptera frugiperda and Trichoplusia ni with permethrin (Ambush) and chlordimeform. Permethrin proved as effective as chlordimeform in preventing hatching of the eggs of all the three species.

Grewal et al. (1978) reported that chlorpyriphos, monocrotophos, leptophos, methamidophos, permethrin, quinalphos and endosulfan 0.1% concentrations sprayed @ 520 l/ha had a strong knock down effect on the 3rd instar larvae of Bihar hairy caterpillar Diacrisia obliqua.

Melifronides et al. (1978) reported that permethrin (at 35-175 g/ha), methomyl (at 570 g/ha) and chlorpyriphos (at 572 g/ha) effectively controlled the spring boll worm Earias insulana on okra.

Nilsson (1978) obtained excellent control of Meligethes aeneus on spring rape with fenvalerate than with methoxychlor and fenitrothion.

Uthamaswamy and Balasubramanian (1978) examined the efficacy of several new insecticides including aldicarb (as Temek), fenvalerate (as Sumicidin) and oxamyl (as Vydate) for controlling okra pests. The highest yields of healthy fruits followed by the use of 0.05% fenvalerate (5 sprays). Soil application of aldicarb at 0.75 kg/ha, 10 days after sowing controlled all sucking pests.

Voon and Chung (1978) reported that 50-100 ppm permethrin sprays gave good control of Plutella xylostella on cabbage, Leucinodes orbonalis on egg plant, Earias vitella on okra.

Black and Hewson (1979) found that NRDC-161 could effectively control pea moth, Brassica caterpillars and pollen beetles.

Collingwood and Bourdouxhe (1979) conducted trials with pyrethroids and other insecticides and compared against Agrotis ipsilon on various crops; Darasa laisalis on egg plant, Heliothis armigera on tomato and Plutella xylostella on cabbage and showed that cypermethrin, decamethrin and fenvalerate gave good results.

Collingwood et al. (1979) in their field experiments reported that decamethrin, fenvalerate and cypermethrin gave good control of Dacus spp.

Fullerton (1979) tested 4 insecticides against Plutella xylostella and Crocidolomia binotalis on cabbage. Fenvalerate and cypermethrin afforded outstanding control when applied at 100 ml in 900 litres of water/ha at intervals of 2 weeks.

Komson and Rendell (1979) reported that fenvalerate was very effective against Plutella xylostella and Trichoplusia ni at the very low rate of 3-4.4 g ai/rai (18.75-27.5 g/ha) and it also afforded some control of flea beetles and aphids.

Agnihotri et al. (1980) found that synthetic pyrethroids permethrin, cypermethrin, decamethrin and fenvalerate were

effective in controlling aphid Brevicornyle brassicae on cabbage and cauliflower. The other insecticides tested were endosulfan, DDVP and Sevinol. Residues of all insecticides persist beyond 10 days except decamethrin.

Guistina and Doyran (1980) indicated that the most effective concentrations were 0.75 g/hl for decamethrin and 5 g for cypermethrin against green house tomato white fly Trialeurodes vaporariorum. Both cypermethrin and decamethrin were more effective than bioresmethrin.

Jaganmohan et al. (1980) reported that fenvalerate and permethrin at 0.1 kg toxicant per hectare gave good control of the brinjal leaf hopper Amrasca biguttula biguttula.

Lindquist et al. (1980) compared permethrin applied as a foliar spray and root soak for the control of cabbage looper Trichoplusia ni on green house celery transplants and concluded that root soak is efficacious but not significantly better than foliar sprays and the method is not practical for commercial use.

Olsson (1980) tested Ambush (permethrin) against Meligethes aeneus on rape in field and stated that it gave good results in general and proved to be about equal to fenvalerate, fenitrothion and pirimicarb.

Rai et al. (1980) determined the effectiveness of the synthetic pyrethroids cypermethrin, fenvalerate and permethrin against Amrasca biguttula biguttula on okra and the residues and the residues of the compounds in the fruits. All the compounds tested were found to be effective in controlling the pest for up to 9 days. One the basis of the determination of residues by GLC, a waiting period of 3 days is suggested for permethrin and cypermethrin and 7 days for fenvalerate.

Singh and Sircar (1980) observed that the most toxic compounds against the aphids Lipaphis erysimi and Aphis craccivora were in decreasing order of effectiveness, Decis, fenvalerate and cypermethrin on the basis of their LC_{50}s.

El-Guindy et al. (1981) reported synergistic action for the mixtures of cypermethrin with chlordimeform, endrin and methomyl against Spodoptera littoralis while fenvalerate was synergistic only with chlordimeform.

Mc Clanahan (1981) evaluated the contact action of Epilachna varivestris Muls. by using a potters spray tower. The most toxic materials were the synthetic pyrethroids, carbofuran, methomyl and carbaryl. The least toxic was malathion.

Nimbalkar and Ajri (1981) evaluated the effectiveness of the synthetic pyrethroids cypermethrin, deltamethrin,

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fenvalerate and permethrin, methomyl, diflubenzuron and carbaryl against Leucinodes orbonalis on egg plant on the basis of average percentage of infestation. All the synthetic pyrethroid compounds were superior to the others tested. Treatments with Ripcord (cypermethrin, 5 sprays) resulted in the highest yield.

Penman et al. (1981) stated that the pyrethroid fenvalerate showed significantly faster activity against adult females of Tetranychus urticae than azinphosmethyl. The effect of fenvalerate was not permanent. The LC_{50}s of fenvalerate were similar at 24 and 48 hours (0.056 and 0.51 g ai/lit).

Sudharma (1981) (unpublished) observed that all the synthetic pyrethroids at their higher dosages (fenvalerate 0.02, 0.03 per cent, cypermethrin 0.01, 0.015 per cent and permethrin 0.01, 0.015 per cent) were found to be significantly superior to the highest dose of carbaryl 0.15 per cent at 21 days after spraying against Leucinodes orbonalis.

III. Effect of synthetic pyrethroids on beneficial fauna

Olsson (1978) reported Ambush (permethrin is effective against agricultural pests in Sweden as extremely low rates of application (15-16 g/ha). He also reported that it is not particularly toxic to mammals or birds, but toxic to honey bee (Aphis mellifera).

Wilkinson et al. (1979) tested parasitoid Apanteles margeniventris (Cresson) and adult or nymphal predator, Geocoris punctifer, Hippodamia converges and Podisus maculiventris against synthetic pyrethroids, fenvalerate and permethrin and the O.Ps Sulprofos and profenfos. Survival of the parasitoid and the predators after exposure to maximum and minimum concentrations of the two pyrethroids was from 42-82% while that of O.Ps would range from 14-29%.

Kismir and Sengonga (1980) tried different types of insecticides for their effects on chrysopid predator Chrysopa carnea (Steph.). Decis had little effect on eggs, while the remaining pyrethroids (fenvalerate, cypermethrin and permethrin) caused 70% kill. The synthetic pyrethroids (Decis and fenvalerate) were much less harmful to larvae. The adults of the chrysopid proved very susceptible to all the compounds tested except fenvalerate, which had no effect and cypermethrin which caused 40% mortality.

Pederson (1980) observed that permethrin has a comparatively greater selectivity and suggested that it can be used for the control of Meligettes aeneus on flowering rape without damage to honey bees, provided that the sprays are applied in the early morning or evening when bee forage is reduced.

Shour and Crowder (1980) carried out studies and determined the effects of fenvalerate, permethrin, cis and trans permethrin on the predator Chrysopa carnea Steph. third instar larvae showed a marked level of tolerance to all the pyrethroids tested over a 72 hour period.

Alexandrescu and Hondru (1981) studied on the selectivity of insecticides used in the control of Brevicornye brassicae (L) on cabbage to the beneficial fauna and showed that perimicarb (Fernos 20), Decis, cypermethrin and permethrin had a certain degree of selectivity.

Niemczyk et al. (1981) determined the toxicity of some pyrethroids in lab experiments to several species of predaceous and parasitic insects. None of the compounds tested (permethrin, cypermethrin, fenvalerate and Decis) were found to be toxic to Trichogramma cacoccidae Marchal or Telenomus dalmammi (Ratz) during their development in eggs of Orgyia antiqua (L). Most of the compounds were highly toxic to nymphs of Antocorus neurorans (L), Orius minutus (L) and to larvae of Coccinella septumpunctata L. Bioresmethrin was low in toxicity to all the insects tested, permethrin was fairly low in toxicity, rest highly toxic.

Materials and methods

MATERIALS AND METHODS

Field experiments were undertaken at the Instructional Farm, College of Agriculture, Vellayani, during summer season (February to June) in 1982 to study the efficacy of synthetic pyrethroids on the control of pests of bitter gourd and snake gourd and the effect of these insecticides on the flowering pattern and fruit set. The details of insecticides used in the trials are given below.

Sl. No.	Trade name/ common name	Chemical name	Formulation	Source
1	Ambush Permethrin	3-phenoxybenzyl (±) cistrans 3-(2,2-dichlorovinyl)-2-2-dimethyl cyclopropane -1-carboxylate	50%EC	M/s. Alkali & Chemical corporation of India Ltd., Madras
2	Fenvalerate Fenvalerate	(R,s) -cyano-3-phenoxy benzyl (R,s) -2-(4 chlorophenyl) -3-methylbutyrate	20%EC	M/s. Gharda chemicals (P) Ltd., Thane, (Maharashtra)
3	Ripcord Cypermethrin	-cyano-3-phenoxy benzyl 2,2-dimethyl -3-(2,2-dichloro-vinyl) cyclopropane carboxylate	10%EC	M/s. National Organic Chemical Industries Ltd., Madras
4	Decis Deltamethrin (Decamethrin)	S-(cyano(3-phenoxy-phenyl) methyl cis-(+)-3-2,2-dibromo-ethenyl)-2,2- dimethyl cyclopropane carboxylate (1)	2.5%EC	M/s.Hoechst Pharmaceuticals Ltd., Bombay
5	Bangmal Malathion	S-(1,2-di(ethoxy-carbonyl) ethyl) dimethyl phospho-rothiolothionate	50%EC	M/s.Bangalore Pesticides Ltd., Bangalore.

Experiments for both the crops were laid out in randomised block design with three replications and the lay out is given in Fig. 1.

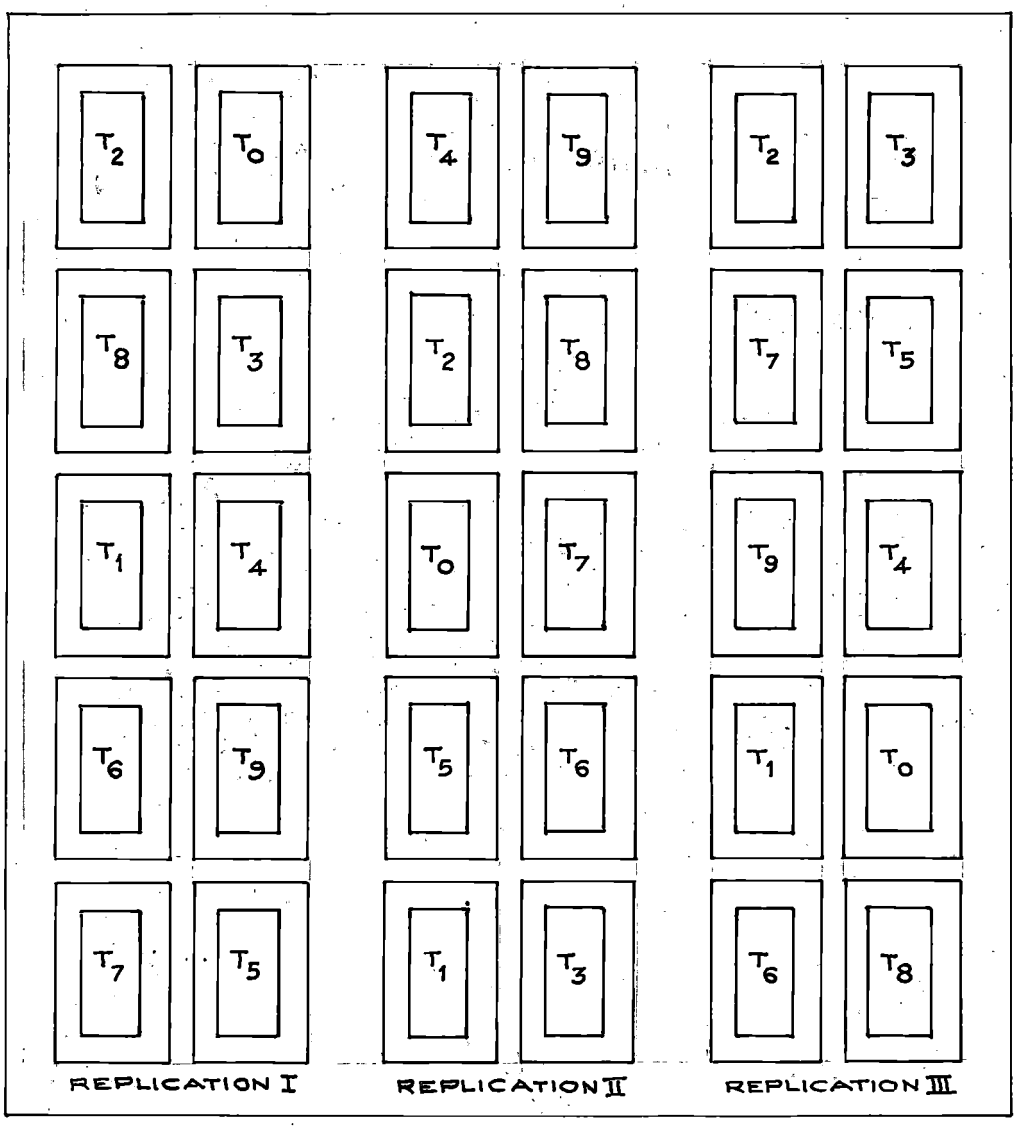
Cultivation of crops

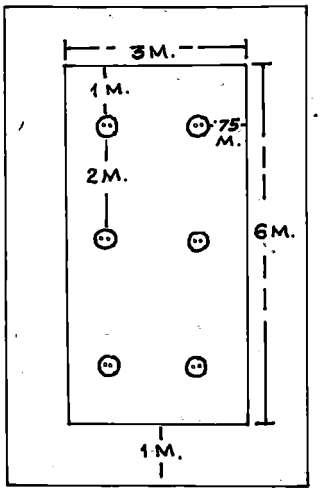
MC-23, a popular variety of bitter gourd, obtained from the College of Horticulture, Vellanikkara, and a local variety of snake gourd obtained from Instructional Farm, Vellayani, were used. For both the crops a spacing of 1.5 x 2 m was given between pits, with a pit size of 0.6m x 0.6 x 0.3 m. Six pits within a plot size of 6 m x 3 m formed one treatment. Four seeds were planted in each pit and two healthy seedlings were kept and others were removed. All cultural operations recommended by Chauhan, D.V.S. (1972) for raising bitter gourd and snake gourd crops were followed. The plots were irrigated twice a day. Plants in each treatment were trained to individual pandals of 7 x 4 m made of iron wire and coir rope over erected poles of 1.5 metre height. For recording observations a net pandal size of 6 x 3 m was marked out.

Application of insecticides

Permethrin at 0.01 and 0.02 per cent (50 and 100 g ai/ha), fenvalerate at 0.01 and 0.02 per cent (50 and 100 g ai/ha), cypermethrin at 0.01 and 0.02 per cent (50 and 100 g ai/ha),

FIG. 1. LAY OUT OF THE FIELD EXPERIMENTS FOR EVALUATING THE SYNTHETIC PYRETHROIDS AGAINST PESTS OF BITTER GOURD AND SNAKE GOURD.





ENLARGED SINGLE PLOT

deltamethrin at 0.0015 and 0.003 per cent (7.5 and 15 g ai/ha) and malathion at 0.1 per cent (500 ml ai/ha) (standard) were tried with an untreated check. Insecticides were applied as foliar spray on need basis whenever the pest status raised to economic injury level. Both the crops received three sprayings each, bitter gourd on 48, 78 and 102 days after sowing and snake gourd on 24, 68 and 101 days after sowing. Five hundred litres of spray fluid was used per hectare and the active ingredient of the insecticide used was calculated on the basis of the quantity of spray fluid applied.

Measured quantities of insecticides were taken and mixed first with a small quantity of water, after which the remaining was added to make up the required volume and thoroughly stirred. A hand compression sprayer of five litre capacity was used for spraying. Spraying were undertaken in the morning hours and care was taken to prevent the drift of the spray fluid to adjacent plots. The check plot was also sprayed with water of the same quantity that was used for other treatments. The sprayer and accessories were thoroughly washed before changing the insecticide.

Recording of data

The results were assessed in terms of pest population and plant parts damaged. Pretreatment counts were taken

one day before spraying and the data tested for homogeneity. Post-treatment counts were taken at 48 hours after spraying and then at weekly intervals. Assessment of the population of different pests and the damage caused were done as detailed below.

1. Melon fly (Dacus cucurbitae Coq.):

The infestation was assessed by recording total number of fruits and infested fruits present in the plot at the time of observation. The infestation was identified by observing the oviposition punctures, gummosis and rotting. Fruits from observation units were harvested as and when they matured and yield under each treatment was recorded in weight and number.

2. Spotted beetle (Henosepilachna viginctioctopunctata (F), aphid (Aphis malvae K.), jassid (Eutettix phycitis Dist.), mirid bug (Engytatus tenuis R.) and pumpkin beetles (Aulacophora foveicollis Lucas, A. lewesi Baly, A. stevens Baly.):

From each plot ten leaves were selected at random from different shoots and insects present were counted and recorded.

3. Pumpkin caterpillar (Margaronia indica Saund.) and snake gourd semilooper (Anadevidia peponis Fb.):

The caterpillars were recorded from another unit of ten leaves selected at random from different shoots in a plot.

Data on flowering pattern and fruit set

In both the crops the number of flowers formed and fruits set under different treatments during the entire crop season were counted at 3 day intervals. The effect of insecticides on fruit set was assessed in terms of percentage of fruits set in relation to the total number offlowers formed and fruits set after the application of insecticides.

Statistical analysis

Square root transformations were used for the observed populations of aphids, jassids, mirid bugs, spotted beetles, pumpkin beetles, pumpkin caterpillars and snake gourd semi-loopers. For melon fly the data on the percentage of infested fruit was transformed into angular values. Yield data of bitter gourd and snake gourd obtained from different harvests also were statistically analysed. The significance of the data was tested using F test at 5% levels adopting the analysis of variance technique.

Results

RESULTS

For bitter gourd the first application of different insecticides was done at 48 days after sowing when the crop was significantly infested with spotted beetle and fruit fly, the second application of the insecticides was given on 78th day after sowing as high infestation with jassid, aphid, spotted beetle and fruit fly was observed, and the third application of insecticides was taken on 102nd day after sowing when the incidence of fruit fly again rose to a significant level.

The insecticides were applied for the first time on snake gourd at 24 days after sowing when high incidence of pumpkin caterpillar and mirid bug along with a low population of snake gourd semilooper were noticed. On 68th day after sowing the second application of insecticides was done when the incidence of fruit fly was considerably high. With the onset of pre-monsoon showers the pumpkin beetles appeared in the field and the population reached significant level, that warrented the third application of insecticides on 101th day after sowing. For both the crops the effect was recorded at 2 days after spraying and then at weekly intervals.

1. Effect of insecticides on the control of spotted beetles of bitter gourd

The data pertaining to the spotted beetle are presented in Table 1. During first spraying though the pretreatment count ranged from 11.33 to 40.00 the population was homogeneous statistically. In the counts taken 2 days after spraying the mean number of spotted beetle observed in control plot was 22.66 while in the treatments it ranged from 0 to 1.33. All the insecticidal treatments including malathion were significantly superior to control and were on par among themselves. The same trend was followed on 9, 16 and 23 days after spraying (DAS) with populations varying from 0.33 to 1.33, 1.00 to 3.33 and 6.33 to 9.33 respectively under different treatments. All the insecticides appeared to be effective up to 23 days after spraying. Plots treated with deltamethrin 0.003 per cent and cypermethrin 0.02 per cent recorded the lowest count of 0.33 at 9 DAS. Fenvalerate 0.02 per cent recorded 1.00 at 16 DAS, and deltamethrin 0.003 per cent recorded 6.33 at 23 DAS as against 25.33, 26.66 and 32.00 in control on 9, 16 and 23 DAS respectively.

At 30 DAS the population was steadily increased with counts varying from 8.66 to 52.00 under treatments against 51.33 under control and the insecticides became ineffective

Table 1. Mean population of spotted beetle under different treatments observed at intervals after the first and second spraying on bitter gourd

Treatments		First spraying						Second spraying	
		Pre-treatment	2 DAS	9 DAS	16 DAS	23 DAS	30 DAS	2 DAS	9 DAS
Permethrin	0.01%	17.66 (4.19)	1.33 (1.48)	1.33 (1.48)	3.33 (1.99)	6.33 (2.66)	14.66 (3.75)	0.33 (1.13)	0.33 (1.14)
,,	0.02%	29.66 (5.51)	0.33 (1.13)	0.66 (1.24)	2.00 (1.71)	6.66 (2.73)	52.00 (7.10)	0.33 (1.13)	0.00 (1.00)
Fenvalerate	0.01%	40.00 (6.28)	0.00 (1.00)	1.00 (1.33)	2.33 (1.72)	8.00 (2.98)	33.00 (5.47)	0.00 (1.00)	0.00 (1.00)
,,	0.02%	31.33 (5.60)	0.33 (1.13)	0.66 (1.27)	1.00 (1.38)	7.33 (2.88)	52.66 (6.93)	0.66 (1.24)	0.66 (1.24)
Cypermethrin	0.01%	12.33 (3.61)	0.66 (1.27)	0.66 (1.27)	2.33 (1.80)	8.33 (3.02)	27.00 (5.09)	0.00 (1.00)	0.33 (1.14)
,,	0.02%	17.66 (4.18)	0.00 (1.00)	0.33 (1.14)	1.66 (1.55)	7.00 (2.80)	8.66 (2.88)	0.00 (1.00)	0.00 (1.00)
Deltamethrin	0.0015%	17.00 (4.13)	0.33 (1.13)	1.33 (1.48)	3.00 (1.98)	9.00 (3.12)	14.66 (3.75)	0.00 (1.00)	0.00 (1.00)
,,	0.003%	20.66 (4.55)	0.00 (1.00)	0.33 (1.14)	1.33 (1.52)	6.33 (2.70)	15.00 (3.90)	0.33 (1.13)	0.33 (1.14)
Malathion	0.1%	11.33 (3.46)	0.33 (1.13)	1.00 (1.38)	3.33 (2.06)	9.33 (3.20)	14.66 (3.92)	5.33 (2.26)	1.00 (1.38)
Untreated control		31.66 (5.68)	22.66 (4.74)	25.33 (5.03)	26.66 (5.16)	32.00 (5.65)	51.33 (7.06)	9.33 (3.17)	2.33 (1.75)

Abstract of ANOVA

Source	df	Mean squares							
Treatments	9	2.88	3.95**	4.20**	3.64**	2.36**	5.97	1.64**	0.17
Error	18	1.23	0.18	0.28	0.31	0.30	3.45	0.26	0.08
C.D. between treatments		NS	0.74	0.91	0.95	0.95	NS	0.89	NS

(Figures in parentheses are transformed values) DAS Days after spraying
** Data significant at 1% level NS Not significant.

in controlling the pest. But plots treated with cypermethrin 0.02 per cent, permethrin 0.01 per cent, deltamethrin 0.0015 per cent, malathion 0.1 per cent and deltamethrin 0.003 per cent recorded lower population ranging from 8.66 to 15.00 eventhough the data was not significant statistically.

At the time of second spraying pretreatment count of spotted beetle ranged from 8.66 to 52.66 but the range was not significant. Observation at 2 days after spraying showed reduction of population in all the plots and the variation was statistically significant among different treatments. All the synthetic pyrethroids in both levels were significantly superior to malathion and untreated control in controlling the spotted beetle. Mean populations under synthetic pyrethroids ranged from 0 to 0.66 against 5.33 and 9.33 under malathion and control respectively. Malathion was also significantly superior to untreated control. The population of spotted beetle was still reduced at 9 DAS and the whole data became not significant.

2. Effect of insecticides on the control of fruit fly of bitter gourd

The effect of the insecticides on fruit fly Dacus cucurbitae observed after first, second and third sprayings is presented in Table 2. In the pretreatment observation

Table 2. Mean percentage of fruits infested per plot by fruit flies under different treatments observed at intervals after the first, second and third sprayings on bitter gourd

Treatments		First spraying					Second spraying					Third spraying		
		Pre-treatment	2 DAS	9 DAS	16 DAS	23 DAS	Pre-treatment	2 DAS	9 DAS	16 DAS	23 DAS	2 DAS	9 DAS	16 DAS
Permethrin	0.01%	55.65 (48.25)	45.00 (42.10)	41.32 (40.00)	36.50 (37.16)	13.23 (21.33)	20.46 (27.01)	16.44 (23.93)	4.38 (12.07)	44.54 (41.87)	58.10 (49.64)	61.18 (51.45)	72.14 (58.14)	72.72 (58.52)
,,	0.02%	45.00 (42.10)	31.64 (34.24)	38.00 (38.08)	36.90 (37.42)	18.50 (25.49)	28.80 (32.25)	16.73 (24.17)	1.68 (7.40)	33.81 (35.54)	54.40 (47.52)	60.77 (51.21)	76.10 (60.73)	71.90 (58.00)
Fenvalerate	0.01%	32.90 (35.00)	24.20 (29.45)	41.32 (40.00)	36.00 (36.85)	23.00 (28.63)	24.49 (29.66)	17.56 (24.78)	6.55 (14.81)	41.08 (39.84)	53.62 (47.08)	53.44 (46.97)	55.12 (47.96)	57.20 (49.14)
,,	0.02%	50.00 (45.00)	25.00 (30.00)	28.00 (31.96)	19.45 (26.18)	18.80 (25.69)	20.58 (26.97)	12.57 (20.77)	6.70 (15.00)	51.51 (45.85)	65.80 (54.22)	62.28 (52.16)	65.40 (53.99)	50.10 (45.03)
Cypermethrin	0.01%	44.34 (41.75)	41.32 (40.00)	45.80 (42.62)	32.80 (34.94)	60.60 (51.13)	45.60 (42.49)	30.70 (33.61)	28.90 (32.53)	46.52 (42.99)	62.02 (51.96)	66.11 (54.38)	67.70 (55.38)	70.72 (57.20)
,,	0.02%	15.30 (23.03)	4.18 (11.75)	6.30 (14.54)	13.86 (21.86)	19.00 (25.84)	20.90 (27.20)	20.40 (26.85)	9.25 (17.69)	31.80 (34.33)	66.50 (54.63)	65.63 (54.13)	59.80 (50.63)	57.64 (49.39)
Deltamethrin	0.0015%	50.00 (45.00)	25.25 (30.17)	35.30 (36.40)	31.13 (33.91)	21.00 (27.29)	28.70 (32.38)	24.50 (29.68)	28.65 (32.36)	49.70 (44.81)	58.35 (49.81)	62.35 (52.02)	64.40 (53.36)	57.54 (49.34)
,,	0.003%	25.00 (30.00)	20.26 (26.75)	27.62 (31.71)	22.12 (28.06)	13.34 (21.43)	38.00 (38.08)	33.60 (35.41)	30.75 (33.68)	38.20 (38.16)	63.40 (52.77)	53.60 (47.05)	54.58 (47.60)	67.88 (55.47)
Malathion	0.1%	55.00 (47.91)	50.00 (45.00)	57.50 (49.31)	48.90 (44.36)	31.78 (34.31)	63.50 (52.83)	57.30 (49.19)	64.80 (53.61)	59.10 (50.26)	58.40 (49.83)	58.68 (49.99)	66.21 (54.40)	68.16 (54.64)
Untreated control		50.00 (45.00)	61.20 (51.49)	75.92 (60.62)	66.60 (54.71)	63.20 (52.67)	73.37 (58.93)	72.30 (58.25)	67.24 (55.08)	97.63 (81.16)	92.92 (74.57)	97.72 (81.31)	99.43 (85.69)	97.64 (81.14)

Abstract of ANOVA

Source	df	Mean squares												
Treatment	9	276.42	343.26	431.70**	262.35**	443.34	534.53	496.12	861.76**	541.47**	186.86	302.68	360.09**	300.10**
Error	18	605.49	274.39	46.73	27.16	297.37	307.41	204.65	208.29	90.91	88.61	185.21	46.79	52.56
C.D. between treatments		NS	NS	9.23	8.94	NS	NS	NS	24.75	16.35	NS	NS	11.71	12.43

(Figures in parentheses are transformed values)

** Significant at 1% level
NS: Not significant
DAS: Days after spraying

FIG.2. MEAN PERCENTAGE OF INFESTED FRUITS BY FRUIT FLY UNDER DIFFERENT TREATMENTS AFTER FIRST SPRAYING ON BITTER GOURD.

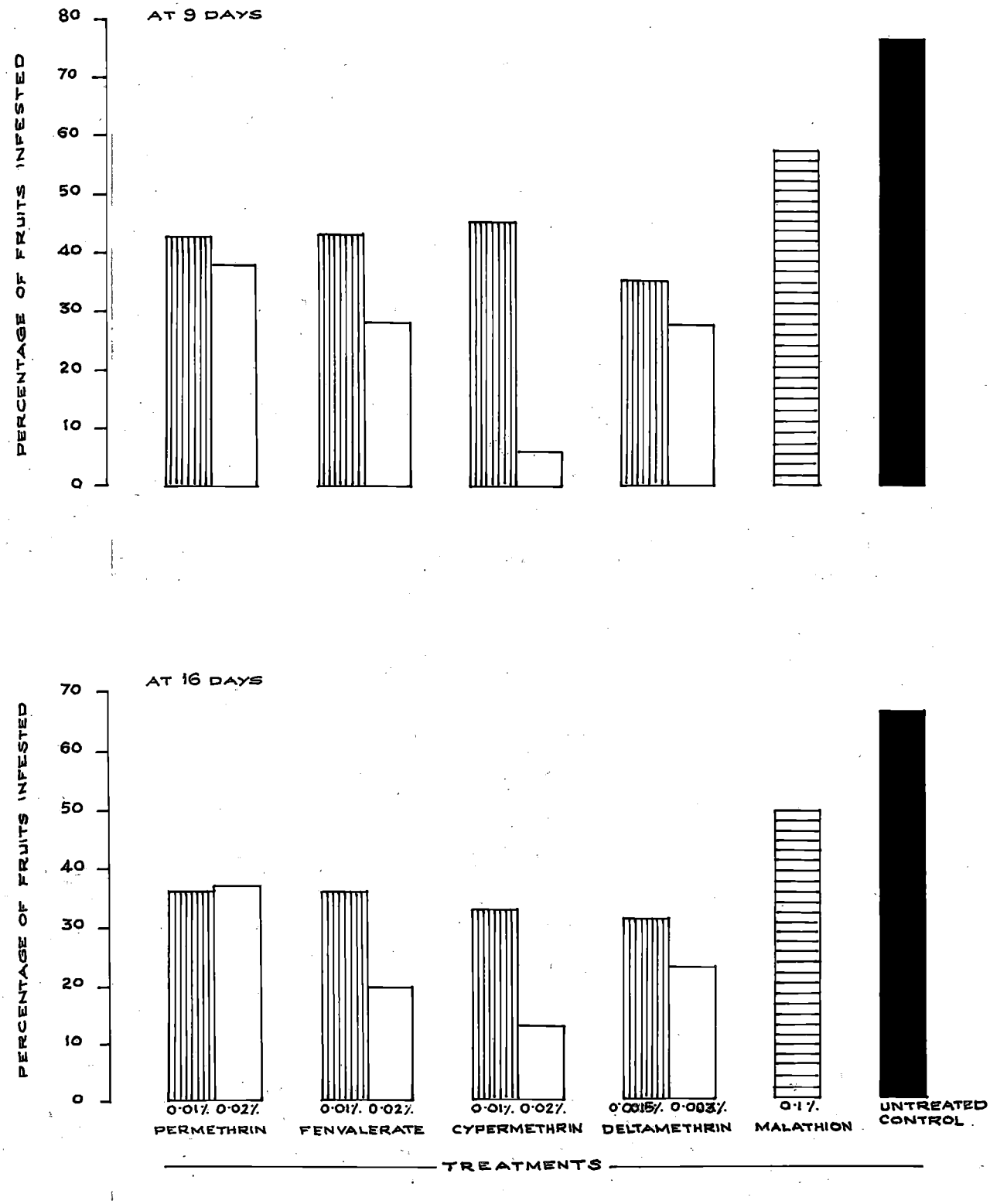


FIG. 3. MEAN PERCENTAGE OF FRUITS INFESTED BY FRUIT FLY UNDER DIFFERENT TREATMENTS AFTER SECOND SPRAYING ON BITTER GOURD.

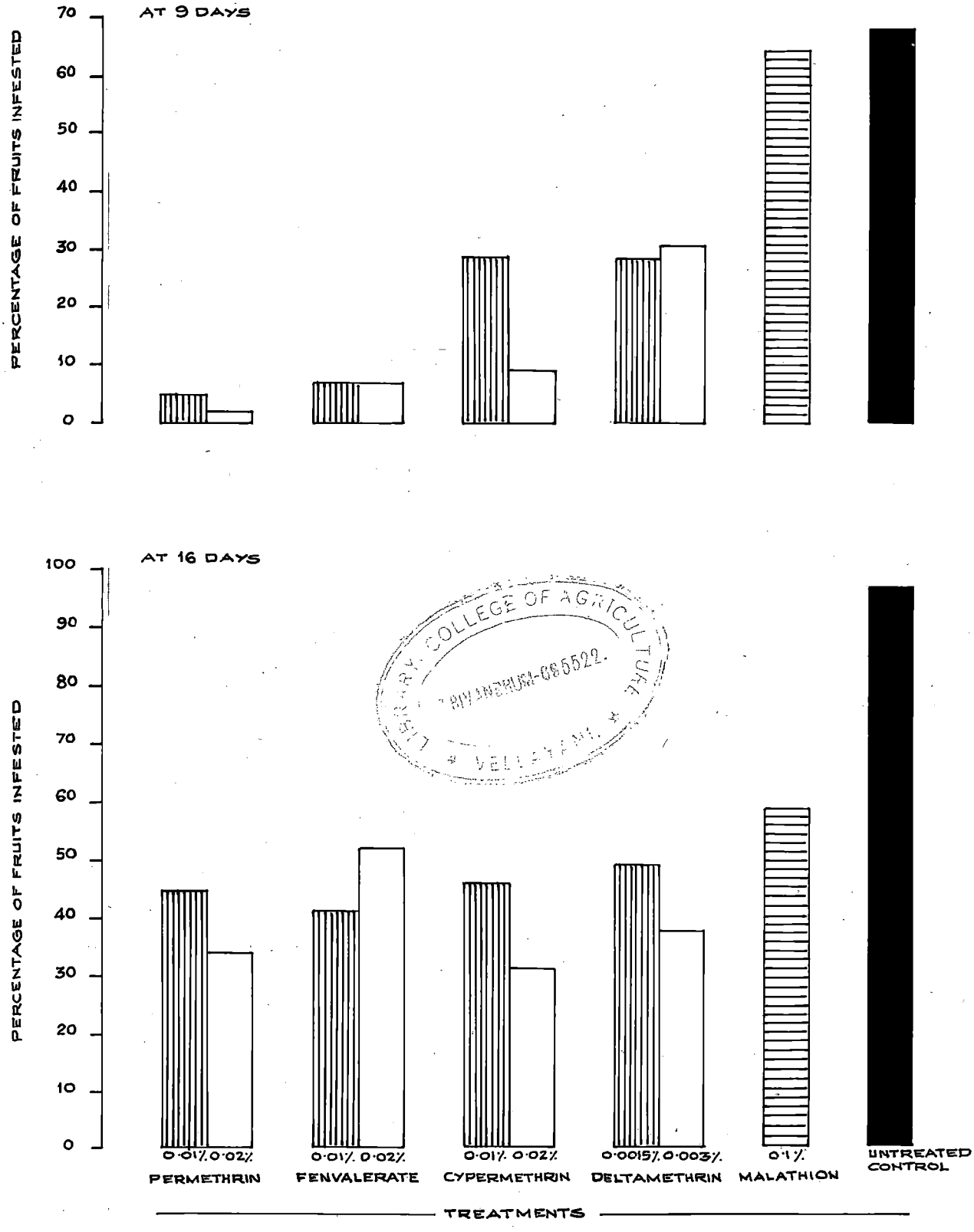
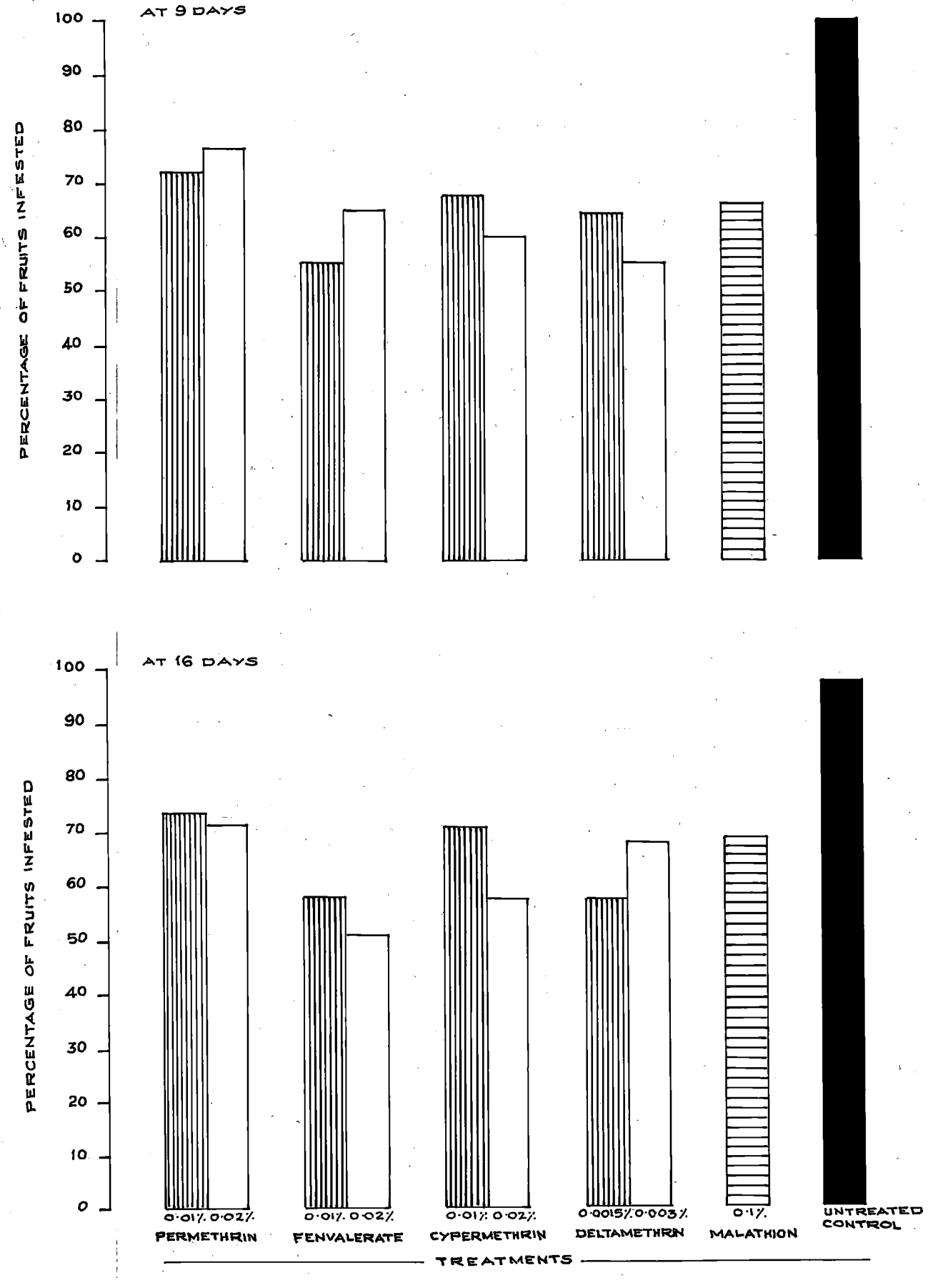


FIG. 4. MEAN PERCENTAGE OF FRUITS INFESTED BY FRUIT FLIES UNDER DIFFERENT TREATMENTS AFTER THIRD SPRAYING ON BITTER GOURD.



during first spraying the mean percentage of infested fruits in different plots varied from 15.30 to 55.00, but the variation was statistically not significant. The data recorded 2 days after spraying did not show significant variation between the treated plots and untreated control, eventhough it ranged from 4.18 to 45.00 per cent as against 50.00 per cent under control. Data collected nine days after spraying showed statistically significant difference between the treatments and control. The percentage of infested fruits varied from 6.30 to 57.5 under different treatments and 75.92 under control. Cypermethrin at 0.02 per cent level recorded the lowest infestation (6.30 per cent) and was significantly superior to all other treatments. The treatments next in effectiveness to cypermethrin 0.02 per cent were deltamethrin 0.02 per cent, fenvalerate 0.02 per cent, deltamethrin 0.0015 per cent, permethrin 0.02 per cent, fenvalerate 0.01 per cent and permethrin 0.01 per cent in the descending order with mean percentage infestations of 27.62, 28.00, 35.30, 38.00, 41.32 and 41.32 respectively. Similarly cypermetherin 0.01 per cent and malathion 0.1 per cent were also effective, but inferior to deltamethrin 0.003 per cent and fenvalerate 0.02 per cent with 45.80 and 57.50 per cent infested fruits respectively. Malathion 0.1 per cent was significantly inferior to all the synthetic pyrethroids except cypermethrin 0.01 per cent.

On 16 days after spraying all the insecticide treatments continued to be effective with percentage of infestations varying from 13.86 to 48.90 over the control of 66.60, but in a different pattern other than in the previous week. Cypermethrin 0.02 per cent, fenvalerate 0.02 per cent and deltamethrin 0.003 per cent treatments were significantly superior to all other treatments and on par among themselves with mean fruit infestations of 13.86, 19.45 and 22.12 per cent respectively. These were followed by deltamethrin 0.0015 per cent, cypermethrin 0.01 per cent, fenvalerate 0.01 per cent and permethrin 0.01 and 0.02 per cent in the descending order of efficacy, the percentage incidence of attacked fruits being 31.13, 32.80, 36.00, 36.50 and 36.90 respectively. These were on par among themselves. Malathion gave significant, but inferior control with 48.90 per cent infested fruits against 66.60 per cent in the control.

The statistical analysis of the data collected at 23 DAS did not show significant variation among the treatments eventhough the percentage of incidence ranged from 13.34 under deltamethrin 0.0015 per cent to 63.2 under control.

The observations during the second spraying recorded at the pretreatment count and two days after spraying showed no significant difference between the various treatments, the

data at 9 DAS was significant and the lowest incidence was recorded in plots treated with permethrin 0.02 per cent with a mean incidence of 1.68 per cent of infested fruits against 67.29 under untreated control. It was closely followed by permethrin 0.01 per cent, fenvalerate 0.01 per cent, fenvalerate 0.02 per cent and cypermethrin 0.02 per cent with 4.38, 6.55, 6.70 and 9.25 per cent infested fruits respectively. All the above treatments were on par and significantly superior to control. The rest of the treatments including malathion (treated check) were ineffective.

The data obtained at 16 DAS was significant and all insecticidal treatments were superior to control with the mean percentage of infested fruits ranging from 31.80 to 59.10 against 97.63 under control. All these treatments were on par among themselves. The treatments in the descending order of effectiveness were cypermethrin 0.02 per cent, permethrin 0.02 per cent, deltamethrin 0.003 per cent, fenvalerate 0.01 per cent, permethrin 0.01 per cent, cypermethrin 0.01 per cent, deltamethrin 0.0015 per cent, fenvalerate 0.02 per cent and malathion 0.1 per cent with mean percentage infestations of 31.80, 33.81, 38.20, 41.08, 44.54, 46.52, 49.70, 51.51 and 59.10 respectively. Observation recorded at 23 DAS did not show any significant effect for the insecticide treatments.

During the third spraying the mean pretreatment fruit infestation varied from 53.62 to 92.92 per cent and showed no significant difference between treatments. The data on the percentage of fruit infestation recorded at 2 days after spraying also were not significant but the data recorded 9 days after spraying exhibited significant variation between treatments. All the insecticide treatments were significantly superior to control with the mean percentage of infestation ranging from 54.58 to 76.10 as against 99.43 under control. The minimum incidence was observed in plots treated with deltamethrin 0.003 per cent and fenvalerate 0.01 per cent with mean incidence of 54.58 and 55.12 per cent of infested fruits followed by cypermethrin 0.02 per cent, deltamethrin 0.0015 per cent, fenvalerate 0.02 per cent, malathion 0.1 per cent, cypermethrin 0.01 per cent and permethrin 0.01 per cent with mean incidence of 59.80, 64.40, 65.40, 66.21, 67.70 and 72.12 per cent respectively and were on par among themselves. Permethrin 0.02 per cent with mean incidence of 76.10 per cent was also significantly superior to control but inferior to deltamethrin 0.003 per cent and fenvalerate 0.01 per cent. Observations at 16 DAS showed significant variation between treatments and all the treatments were superior to control with the mean percentage of infested fruits varying from 50.10 to 72.72 against 97.64 under

control. Among the treatments fenvalerate 0.02 per cent ranked first with a mean incidence of 50.10 per cent of infested fruits. It was followed by fenvalerate 0.01 per cent, deltamethrin 0.0015 per cent, cypermethrin 0.02 per cent, deltamethrin 0.003 per cent, malathion 0.1 per cent and cypermethrin 0.01 per cent with mean incidence of 57.21, 57.54, 57.64, 67.68, 68.16 and 70.72 respectively and were on par. Permethrin 0.02 and 0.01 per cent were inferior to fenvalerate 0.02 per cent with mean incidence of 71.90 and 72.72 per cent attacked fruits respectively.

3. Effect of insecticides on the control of jassid and aphid of bitter gourd

The data collected on the efficacy of insecticides in controlling jassid and aphid are presented in Table 3. Though the mean pretreatment count of jassid showed a wide range of populations from 23.33 to 92.33 per plot, on statistical analysis the data was found not significant.

The mean population observed at 2 DAS varied significantly among the different treatments and all the insecticides except permethrin 0.01 per cent and deltamethrin 0.0015 per cent effectively controlled the pest with populations varying from 1.33 to 19.00 as against 43.00 under control. Among the effective treatments fenvalerate 0.02 recorded the lowest

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Table 3. Mean population of jassids and aphids observed under different insecticide treatments at intervals after second spraying on bitter gourd

	Jassids			Aphids		
	Pre-treatment	2 DAS	9 DAS	Pre treatment	2 DAS	9 DAS
Permethrin 0.01%	61.33 (6.99)	22.33 (4.80)	18.66 (3.91)	607.33 (19.83)	92.00 (9.51)	25.00 (4.81)
,, 0.02%	28.66 (5.43)	14.66 (3.75)	17.33 (3.77)	14.33 (3.85)	8.00 (2.73)	9.33 (2.77)
Fenvalerate 0.01%	59.33 (7.39)	7.00 (2.65)	16.33 (4.06)	162.66 (12.20)	39.66 (6.09)	23.00 (4.53)
,, 0.02%	70.66 (8.20)	1.33 (1.47)	15.33 (3.73)	42.80 (6.81)	20.66 (4.51)	27.33 (4.77)
Cypermethrin 0.01%	86.33 (9.08)	5.33 (2.48)	13.33 (3.72)	199.66 (13.43)	44.00 (6.13)	44.66 (6.11)
,, 0.02%	92.33 (9.36)	12.00 (3.42)	14.66 (3.73)	120.00 (10.90)	40.33 (6.07)	36.33 (5.67)
Deltamethrin 0.0015%	77.00 (8.02)	40.66 (6.42)	19.33 (4.46)	355.66 (16.32)	167.00 (12.79)	67.66 (7.78)
,, 0.003%	51.66 (7.09)	19.00 (4.37)	23.33 (4.86)	593.00 (21.44)	145.00 (11.49)	85.66 (8.43)
Malathion 0.1%	78.00 (8.53)	13.00 (3.67)	21.00 (4.64)	94.33 (9.01)	17.66 (4.30)	40.33 (5.69)
Untreated control	23.33 (4.75)	43.00 (6.58)	26.00 (4.92)	26.00 (4.94)	92.33 (9.57)	44.33 (6.56)

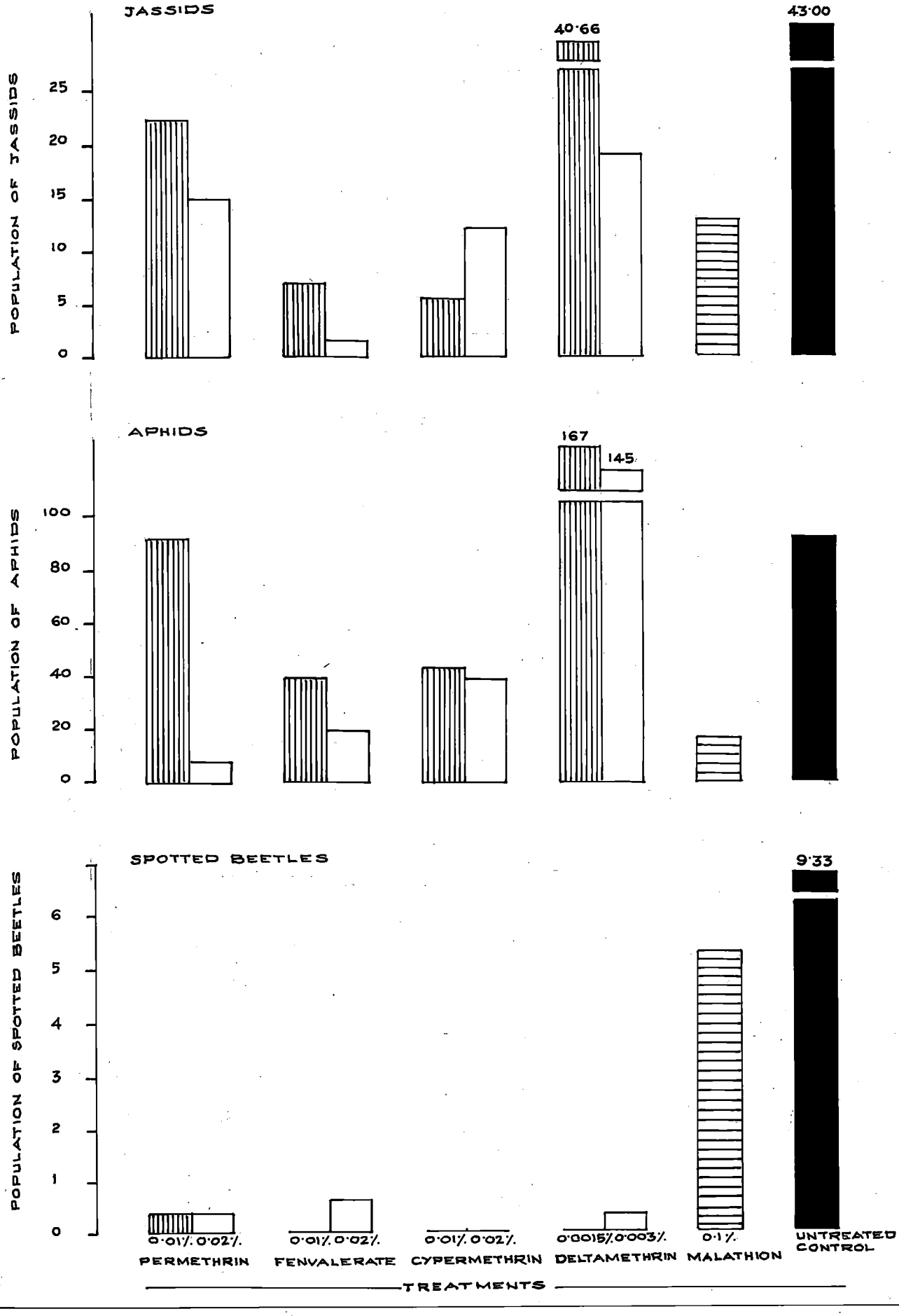
Abstract of ANOVA

Source	df	Mean squares					
Treatment	9	6.69	8.33**	5.45	90.89	30.78**	6.57
Error	18	3.79	1.27	2.65	86.25	7.48	8.62
C.D. between treatments		NS	1.93	NS	NS	4.69	NS

(Figures within parenthesis are transformed values)

DAS Days after spraying. ** Significant at 1% level
NS Not significant

FIG 5. MEAN POPULATION OF INSECT PESTS UNDER DIFFERENT TREATMENTS OBSERVED AT TWO DAYS AFTER SECOND SPRAYING ON BITTER GOURD.



mean population of 1.33 jassids per plot followed by cypermethrin 0.01 per cent and fenvalerate 0.01 per cent with mean populations of 5.33 and 7.00 jassids respectively. All the three treatments were on par among themselves. Cypermethrin 0.02 per cent, malathion 0.1 per cent, permethrin 0.02 per cent and deltamethrin 0.003 per cent were also significantly superior to untreated control but inferior to fenvalerate 0.02 per cent with mean populations of 12.00, 13.00, 14.66 and 19.00 jassids respectively. Observation taken on 9 days after spraying did not show significant difference between any of the treatments.

With regard to the incidence of aphid the pretreatment population was homogeneous as a whole though the population per plot ranged from 14.33 to 607.33. The observation taken two days after spraying indicated significant difference between the populations under various treatments. The insecticide treatments of permethrin 0.02 per cent, malathion 0.1 per cent and fenvalerate 0.02 per cent were effective in controlling aphid with the mean populations of 8.00, 17.66 and 20.66 aphids per plot against 92.33 under control and they were on par among themselves. All the other insecticides were ineffective. Data collected at 9 days after spraying were not significant statistically eventhough the mean population per plot varied from 9.33 under permethrin

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0.02 per cent to 85.66 under deltamethrin 0.003 per cent.

4. Effect of insecticides on the percentage of fruit damage during the whole cropping season in bitter gourd

The data on the number of fruits formed and the mean percentage of fruits damaged by fruit flies during the entire cropping season are presented in Table 4. With regard to the total number of fruits formed, plots treated with permethrin 0.02 per cent ranked top followed by deltamethrin 0.003 per cent with 83.33 and 80.66 fruits respectively against 60.33 under control, but the difference was not significant. Observation on the mean percentage of fruit damage caused by fruit flies during the entire crop season showed significant variation between treatments. All the insecticide treatments reduced the percentage of fruit damage significantly over control with the mean percentage of damage ranging from 35.56 to 59.30 as against 86.66 under control. Among the insecticides, fenvalerate 0.02 per cent recorded the least damage with a mean of 35.56 per cent closely followed by permethrin 0.02 per cent with 37.30 per cent damage. Deltamethrin 0.003 per cent, fenvalerate 0.01 per cent, cypermethrin 0.02 per cent, deltamethrin 0.0015 per cent were also on par with them with mean percentage damage of

Table 4. Mean percentage of fruits damaged by fruit flies under different treatments during the whole cropping season on bitter gourd

Treatments		Mean No. of fruits formed	Mean No. of fruits damaged	Mean percentage of fruits damaged	Percentage reduction of damage over control
Permethrin	0.01%	60.00	30.33	50.66 (46.49)	34.00
,,	0.02%	83.33	28.66	37.33 (37.64)	49.33
Fenvalerate	0.01%	73.66	33.00	46.63 (43.08)	40.03
,,	0.02%	71.33	26.33	35.56 (36.60)	51.10
Cypermethrin	0.01%	66.33	32.00	53.08 (46.75)	33.58
,,	0.02%	58.00	26.66	48.31 (44.03)	38.35
Deltamethrin	0.0015%	71.66	32.66	50.25 (45.14)	36.41
,,	0.003%	80.00	29.33	42.90 (40.03)	43.76
Malathion	0.1%	60.33	34.00	59.33 (50.30)	27.33
Untreated control		60.33	52.33	86.66 (68.53)	--

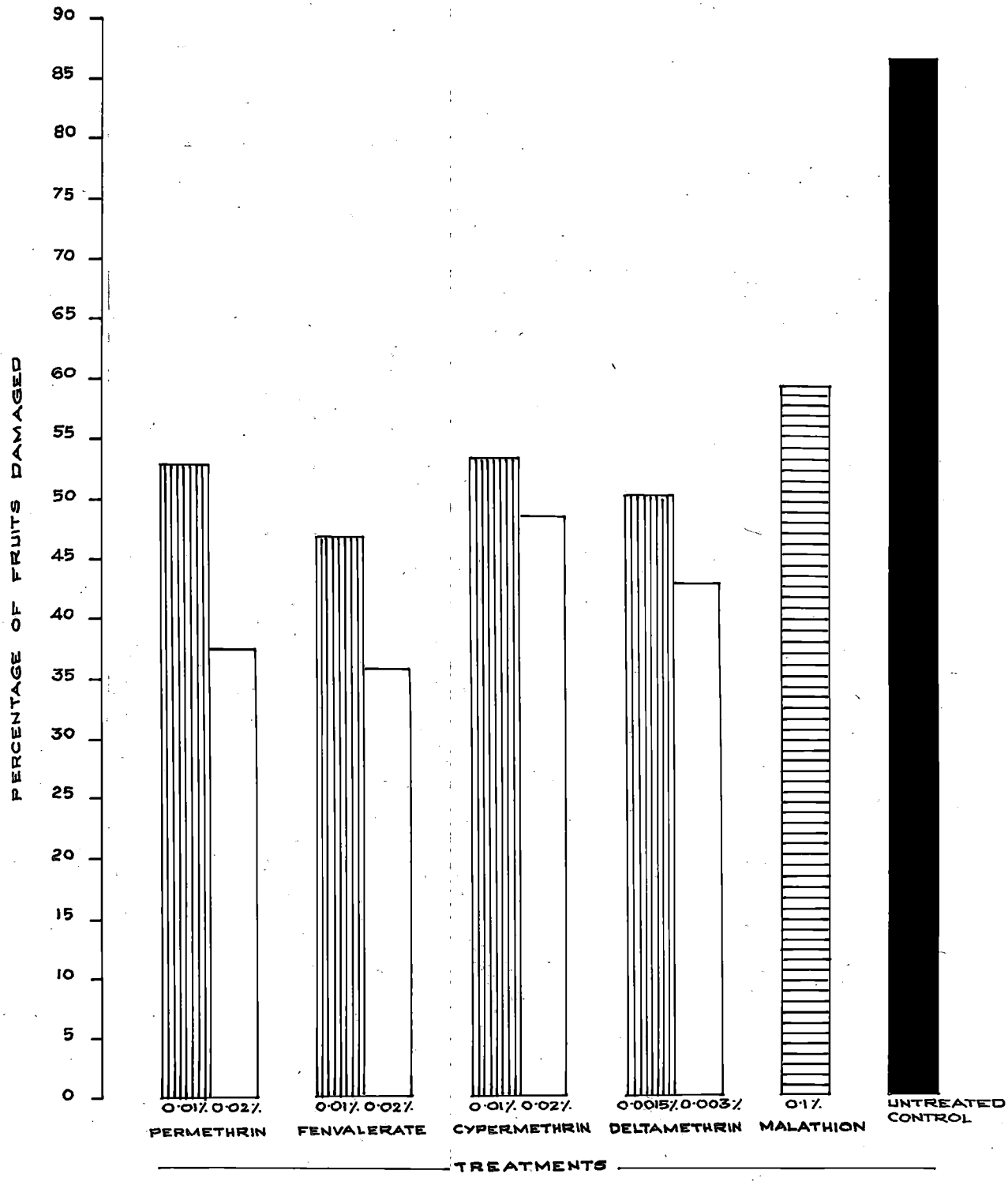
Abstract of ANOVA

Source	df	Mean squares	
Treatment	9	283.56	241.48**
Error	18	193.64	23.71
C.D. between treatments		NS	8.35

(Figures in parentheses are transformed values)

** Significant at 1% level. NS Not significant.

FIG. 6. EFFECT OF SYNTHETIC PYRETHROIDS ON THE PERCENTAGE OF FRUIT FLY DAMAGE DURING THE CROP SEASON IN BITTER GOURD.



42.90, 46.63, 48.31 and 50.25 respectively. The other treatments viz. permethrin 0.01 per cent, cypermethrin 0.01 per cent and malathion 0.1 per cent with mean percentage damage of 52.66, 53.08 and 59.33 respectively were significantly superior to untreated control but inferior to cypermethrin 0.02 per cent and fenvalerate 0.02 per cent.

5. Effect of insecticides on flowering pattern and fruit set in bitter gourd

The data relating to the flowering pattern and mean percentage of fruit set under different treatments during the crop season are presented in Table 5. The data on flower formation indicated no significant difference between any of the treatments and hence appeared that insecticides had no effect on the flower formation and pattern of flowering. Flowering continued for five fortnights commencing from the first flower formation at days after sowing. The combined means of the number of flowers formed in all the plots during first, second, third, fourth and fifth fortnights were 14.30 20.83, 21.56, 17.23 and 4.69 respectively. Maximum flower formation was in third fortnight followed by second and fourth fortnights. Mean percentage of fruit set in various plots did not show any significant difference between the plots treated with insecticide and control plot. Maximum

Table 5. Mean number of flowers fromed and percentage of fruit set under various treatments in bitter gourd

Treatments		Fortnights of flowering					Total No. ofoflowers formed	Total No. of fruits set	Mean percentage of fruit set
		a	b	c	d	e			
Permethrin	0.01%	14.00	18.33	18.00	16.00	4.66	70.66	60.00	83.71(66.20)
,,	0.02%	17.33	23.66	24.66	21.66	6.66	94.00	83.33	88.01(69.73)
Fenvalerate	0.01%	17.66	22.66	23.33	16.00	4.33	84.00	73.66	86.78(68.68)
,,	0.02%	13.00	23.00	24.00	17.00	5.00	82.00	71.33	86.55(68.50)
Cypermethrin	0.01%	13.33	21.33	22.66	16.33	4.33	78.00	66.33	83.08(65.71)
,,	0.02%	12.00	17.33	17.66	15.33	5.33	67.66	58.00	85.30(67.45)
Deltamethrin	0.0015%	13.66	23.00	23.00	17.00	4.00	80.66	71.66	87.66(69.43)
,,	0.003%	16.33	23.33	24.00	20.66	4.00	88.33	80.00	88.50(70.18)
Malathion	0.1%	13.33	18.00	19.33	16.66	4.66	71.33	60.33	83.31(65.89)
Untreated control		12.66	17.66	19.33	16.00	4.00	69.66	60.33	85.66(67.69)
Combined mean		14.30	20.83	21.56	17.23	4.69			

Abstract of ANOVA

Source	df	Mean squares					
Treatment	9	12.22	13.04	21.84	28.22	8.40	8.32
Error	18	7.43	7.92	18.21	25.12	6.04	7.18
C.D. between treatments		NS	NS	NS	NS	NS	NS

(Figures in parentheses are transformed values)

NS : Not significant.

a: 39-54 days after sowing
b: 54-69 days after sowing
c: 69-84 days after sowing
d: 84-99 days after sowing
e: 99-114 days after sowing

percentage fruit set was noticed in plots treated with deltamethrin 0.003 per cent (88.50 per cent) and the least under cypermethrin 0.01 per cent (83.08 per cent).

6. Effect of insecticides on the control of pumpkin caterpillar, snake gourd semilooper and mirid bug of snake gourd

The data collected on the efficacy of insecticides in controlling pumpkin caterpillar, snake gourd semilooper and mirid bug are presented in Table 6. The mean pretreatment count of pumpkin caterpillar varied only from 18.00 to 24.33 in different plots and the population was homogeneous. Observation made two days after spraying recorded significant reduction in the pest population in all the plots treated with insecticides, with mean population ranging from 0.66 to 5.66 per plot as against 14.33 in control plot. The lowest population of 0.66 was in the plots which received fenvalerate 0.02 per cent. It was followed by deltamethrin 0.003 per cent, fenvalerate 0.01 per cent, permethrin 0.02 per cent, deltamethrin 0.0015 per cent, cypermethrin 0.01 and 0.02 per cent with mean number of 1.00, 1.33, 1.66, 2.00, 2.33 and 2.66 caterpillars respectively and all these treatments were on par among themselves. Similarly permethrin 0.01 percent and malathion 0.1 per cent also were significantly superior to

Table 6. Mean population of insect pests under different treatments observed at intervals after first spraying on snake gourd

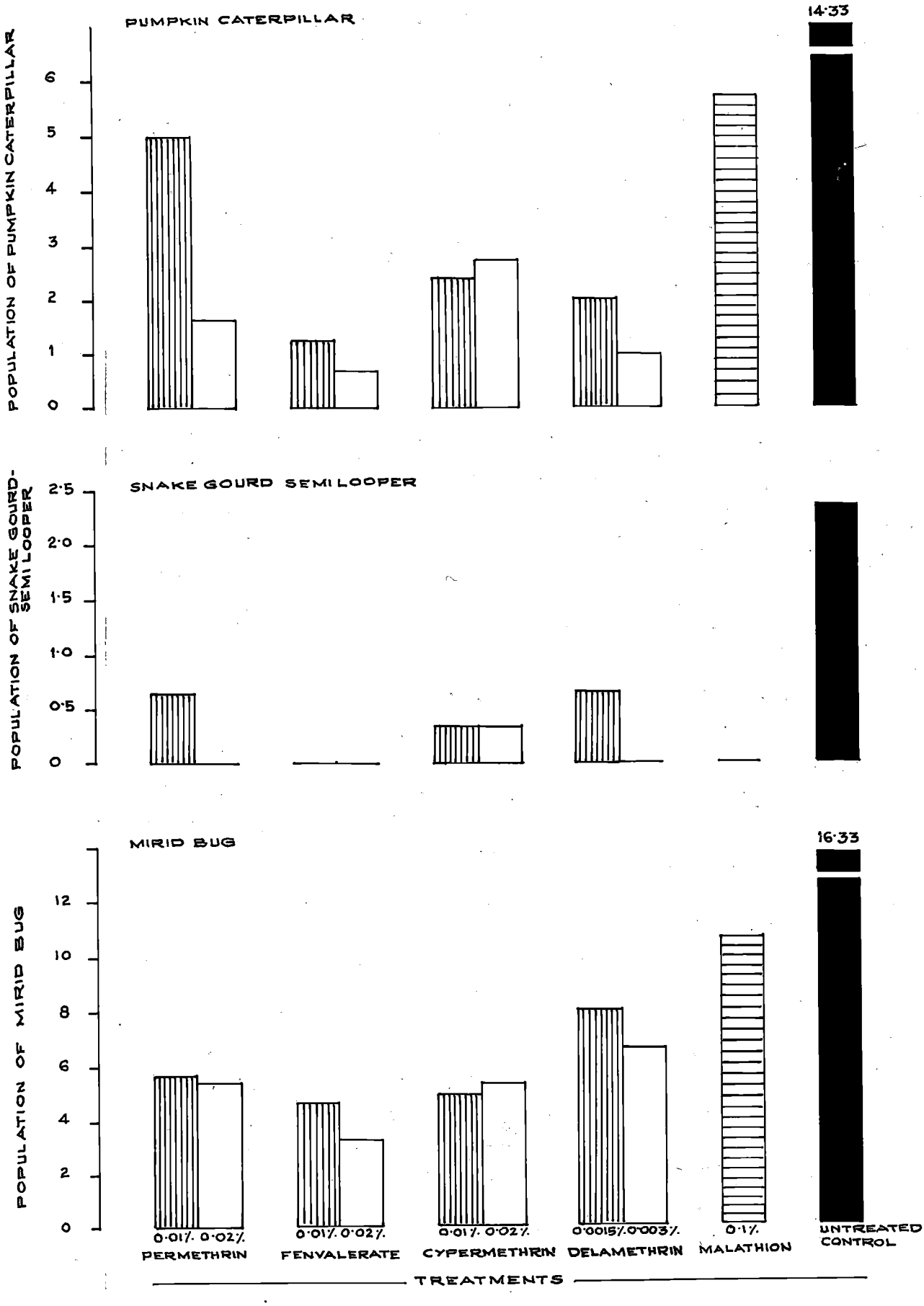
Treatments		Pumpkin caterpillar			Snake gourd semilooper		Mirid bug		
		Pretreatment	2 DAS	9 DAS	Pretreatment	2 DAS	Pretreatment	2 DAS	9 DAS
Permethrin	0.01%	24.33 (5.06)	5.00 (2.39)	1.00 (1.38)	5.66 (2.51)	0.66 (1.24)	12.00 (3.38)	5.66 (2.32)	14.33 (3.72)
,,	0.02%	20.00 (4.49)	1.66 (1.61)	0.00 (1.00)	1.33 (1.48)	0.00 (1.00)	14.33 (3.59)	5.33 (2.24)	13.00 (3.43)
Fenvalerate	0.01%	18.66 (4.34)	1.33 (1.52)	0.00 (1.00)	1.66 (1.57)	0.00 (1.00)	16.00 (3.98)	4.66 (2.12)	15.66 (3.94)
,,	0.02%	17.33 (4.18)	0.66 (1.27)	0.00 (1.00)	2.33 (1.82)	0.00 (1.00)	17.33 (4.10)	3.33 (1.99)	13.66 (3.65)
Cypermethrin	0.01%	18.33 (4.39)	2.33 (1.79)	0.66 (1.27)	1.66 (1.57)	0.33 (1.14)	14.00 (3.54)	5.00 (2.20)	14.33 (3.75)
,,	0.02%	23.66 (4.93)	2.66 (1.98)	0.66 (1.24)	5.66 (2.57)	0.33 (1.14)	18.00 (4.16)	5.33 (2.26)	12.00 (3.42)
Deltamethrin	0.0015%	21.33 (4.69)	2.00 (1.73)	0.33 (1.14)	4.66 (2.24)	0.66 (1.24)	19.33 (4.20)	8.00 (2.80)	20.33 (4.36)
,,	0.003%	20.00 (4.49)	1.00 (1.38)	0.00 (1.00)	3.00 (1.98)	0.00 (1.00)	15.00 (3.65)	6.66 (2.57)	16.00 (3.95)
Malathion	0.1%	19.66 (4.55)	5.66 (2.42)	1.33 (1.48)	2.00 (1.69)	0.00 (1.00)	18.66 (4.18)	10.66 (3.20)	17.66 (4.19)
Untreated control		18.00 (4.33)	14.33 (3.95)	2.33 (1.82)	3.33 (2.06)	2.33 (1.79)	13.63 (3.69)	16.33 (4.07)	19.00 (4.34)

Abstract of ANOVA

Source	df	Mean squares							
Treatments	9	0.30	1.81**	0.18	0.45	0.46**	0.53	1.28**	0.35
Error	18	1.14	0.24	0.08	0.29	0.04	1.58	0.24	0.57
C.D. between treatments		NS	0.84	NS	NS	0.35	NS	0.85	NS

** Significant at 1% level. NS: Not significant. DAS: Days after spraying
(Figures in parentheses are transformed values)

FIG. 7. MEAN POPULATION OF INSECT PESTS UNDER DIFFERENT TREATMENTS OBSERVED AT TWO DAYS AFTER FIRST SPRAYING ON SNAKE GOURD.



control with mean populations of 5.00 and 5.66 per plot, but inferior to both doses of fenvalerate, deltamethrin 0.003 per cent and cypermethrin 0.02 per cent. At 9 DAS the mean population of the pest became insignificant in all the plots including control. No further build up of population of this pest was noticed even in control plots during subsequent observations.

The pretreatment data relating to snake gourd semilooper showed no significant variation between different plots and the range was only 1.33 to 5.66. The observation taken two days after spraying showed significant effect for all insecticides over control with a mean population range of zero to 0.66 larvae per plot as against 2.33 under control. All these treatments were on par among themselves. This pest was not present for any further observation in treated and control plots.

The count of mirid bug before the application of insecticides exhibited no significant variation statistically and mean population in different plots ranged from 12.00 to 19.33. The data collected at 2 days after spraying showed significant effectiveness for all the insecticide treatments against the pest over control. The least occurrence of 3.33 mirids was observed in plots treated with fenvalerate

0.02 per cent and was the most effective one. Other insecticides except malathion 0.1 per cent were on par with this and their order of efficacy in the descending manner were fenvalerate 0.01 per cent, cypermethrin 0.01 per cent, permethrin 0.02 per cent, cypermethrin 0.02 per cent, permethrin 0.01 per cent, deltamethrin 0.003 and 0.0015 per cent with mean populations of 4.66, 5.00, 5.33, 5.66, 6.66 and 8.00 mirids respectively against control population of 16.33. Malathion 0.1 per cent with a mean number of 10.6 mirids per plot was inferior to all the above insecticide treatments except both doses of deltamethrin. Analysis of the data collected at 9 days after spraying showed no significant difference between any of the treatments and the mean population varied from 12.00 to 20.33 per plot.

7. Effect of insecticides on the control of fruit fly of snake gourd

Data on the incidence of fruit fly infestation and the control brought by insecticides during second and third spraying are presented in Table 7. The pretreatment count did not show any significant variation between different plots. Similarly the observation taken at 2 days after spraying also was not showing any significant reduction in

Table 7. Mean percentage of fruits infested by fruit flies observed under different treatments at intervals after second and third spraying on snake gourd

Treatments		Second spraying					Third spraying		
		Pretreatment	2 DAS	9 DAS	16 DAS	23 DAS	Pretreatment	2 DAS	9 DAS
Permethrin	0.01%	27.37(31.55)	20.43(26.88)	23.64(29.10)	16.32(23.83)	29.60(32.97)	80.14(63.54)	88.27(69.97)	97.63(81.16)
,,	0.02%	32.19(34.56)	18.60(25.57)	13.00(21.12)	8.02(16.40)	26.60(31.06)	90.92(72.46)	96.28(80.89)	99.40(85.57)
Fenvalerate	0.01%	36.78(37.33)	20.02(26.59)	16.99(24.31)	14.01(21.95)	26.25(30.82)	88.25(69.96)	90.93(71.81)	99.29(85.17)
,,	0.02%	34.45(35.93)	16.20(23.74)	7.93(16.30)	9.18(17.63)	26.00(30.66)	66.60(48.78)	80.34(64.56)	97.72(81.31)
Cypermethrin	0.01%	50.00(45.00)	27.80(31.82)	29.21(32.70)	11.28(16.93)	26.90(31.24)	71.74(57.89)	87.88(69.61)	90.92(72.46)
,,	0.02%	22.00(27.97)	14.96(22.76)	11.32(19.66)	8.50(19.61)	28.78(32.44)	80.71(63.93)	90.29(71.83)	98.80(83.12)
Deltamethrin	0.0015%	21.23(27.44)	10.82(19.19)	13.04(21.18)	19.20(17.64)	26.27(30.81)	65.80(54.21)	73.00(59.00)	99.41(85.50)
,,	0.003%	36.20(36.99)	13.94(21.91)	15.92(23.52)	15.76(23.39)	27.24(31.47)	90.28(71.81)	90.93(72.45)	92.92(74.50)
Malathion	0.1%	35.90(36.81)	13.35(21.41)	17.16(24.47)	18.80(25.70)	36.96(37.45)	72.72(58.52)	88.64(70.65)	97.70(81.30)
Untreated control		25.09(31.06)	38.00(38.08)	41.10(39.86)	41.30(39.98)	49.82(44.91)	99.29(85.17)	99.60(86.10)	100.00(90.00)

Abstract of ANOVA

Source	df	Mean squares							
Treatment	9	81.66	91.54	141.98*	147.43**	61.57	512.43	501.02	428.15
Error	18	118.20	124.18	46.26	39.58	36.96	262.89	309.18	438.96
C.D. between treatments		NS	NS	11.66	10.79	NS	NS	NS	NS

(Figures in parentheses are transformed values)

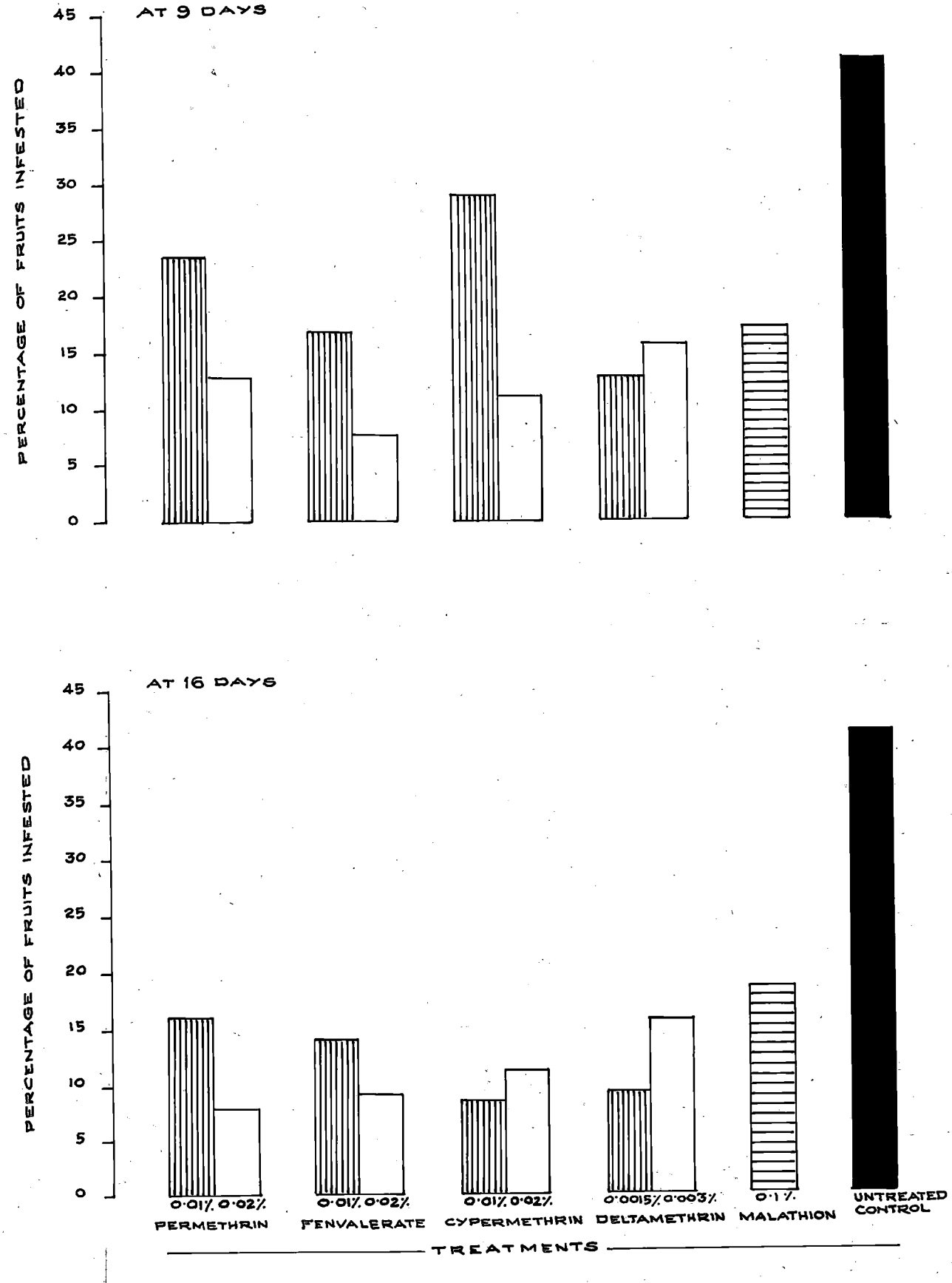
DAS: Days after spraying.

* Significant at 5% level

** Significant at 1% level

NS: Not significant.

FIG.8. MEAN PERCENTAGE OF FRUITS INFESTED BY FRUIT FLY UNDER DIFFERENT TREATMENTS AFTER SECOND SPRAYING ON SNAKE GOURD.



the percentage of infested fruits in the plots which received insecticides. The data collected at 9 days after second spraying showed significant difference between treatments. All the insecticide treatments except permethrin 0.01 per cent and cypermethrin 0.01 per cent were superior to control and reduced the infestation significantly. The least infestation was recorded in plots which received fenvalerate 0.02 per cent with a mean percentage incidence of 7.93. It was followed by cypermethrin 0.02 per cent, permethrin 0.02 per cent, deltamethrin 0.0015 and 0.003 per cent, fenvalerate 0.01 per cent and malathion 0.1 per cent in the descending order of efficacy with mean percentage of infested fruits of 11.32, 13.00, 13.04, 15.92, 16.99 and 17.16 respectively as against 41.0 per cent under control. These treatments were on par among themselves. The data obtained at 16 days after spraying also showed significant effects for all the insecticides over control. The effective treatments in their descending order of efficacy were permethrin 0.02 per cent, cypermethrin 0.01 per cent, fenvalerate 0.02 per cent, deltamethrin 0.0015 per cent, cypermethrin 0.02 per cent, fenvalerate 0.01 per cent, deltamethrin 0.003 per cent, permethrin 0.01 per cent and malathion 0.1 per cent with infestation varying from 8.02 to 18.80 per cent as against 41.30 per cent in control and all insecticides

were on par among themselves. The mean percentage of infested fruits at 23 days after spraying did not show any significant variation between the treatments eventhough the mean percentage of infestation per plot varied from 26.00 to 49.82 under different treatments.

During third spraying the pretreatment observation did not show any significant variation in the percentage of infested fruits by fruit fly. At 2 days after spraying there was rapid increase in the incidence of fruit fly attack in all the plots and the percentage infestation varied from 73.00 to 99.60 under different treatments. The data collected at 9 days after spraying also was not significant. The insecticides were ineffective in controlling the pest during this spraying.

8. Effect of third application of insecticides on the control of pumpkin beetles of snake gourd

The observations collected on the control of pumpkin beetles are presented in Table 8. The pretreatment population was homogeneous with a mean population varying from 14.00 to 19.33 per plot. The observation at 2 days after third spraying showed significant control of pumpkin beetles in all plots which received insecticides. Higher doses of all

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Table 8. Mean population of pumpkin beetles observed at intervals under different treatments after third application of insecticides on snake gourd

Treatments		Pretreatment	2 DAS	9 DAS
Permethrin	0.01%	16.00(4.05)	8.33(3.04)	13.00(3.59)
,,	0.02%	16.33(4.03)	6.00(2.49)	13.66(3.74)
Fenvalerate	0.01%	14.66(3.82)	7.33(2.69)	12.66(3.60)
,,	0.02%	16.00(4.05)	5.33(2.29)	12.00(3.45)
Cypermethrin	0.01%	15.33(3.79)	7.33(2.69)	13.33(3.78)
,,	0.02%	14.00(3.65)	4.00(1.95)	16.33(4.07)
Deltamethrin	0.0015%	17.33(4.13)	6.33(2.57)	13.00(3.59)
,,	0.003%	15.66(3.90)	3.66(1.90)	12.66(3.54)
Malathion	0.1%	17.00(4.09)	9.66(3.14)	15.66(3.90)
Untreated control		19.33(4.15)	21.00(4.46)	18.66(4.22)

Abstract of ANOVA

Source	df	Mean squares		
Treatment	9	0.32	1.54**	0.09
Error	18	0.14	0.13	0.14
C.D. between treatments		NS	0.60	NS

(Figures in parentheses are transformed values)

** Significant at 1% level
NS:Not significant
DAS: Days after spraying.

the synthetic pyrethroids used were significantly superior to other treatments and were on par among themselves. The treatments in the descending order of efficacy were deltamethrin 0.003 per cent, cypermethrin 0.02 per cent, fenvalerate 0.02 per cent and permethrin 0.02 per cent with mean populations of 3.66, 4.00, 5.33 and 6.00 respectively as against 21.00 under control. Similarly deltamethrin 0.0015 per cent, fenvalerate 0.01 per cent, cypermethrin 0.01 per cent and permethrin 0.01 per cent also were significantly superior to control but inferior to deltamethrin 0.003 per cent and cypermethrin 0.02 per cent. The standard, malathion 0.1 per cent with a mean population of 9.66 pumpkin beetle was significantly inferior to the higher doses of all the synthetic pyrethroids. Data recorded at 9 days after spraying the mean population of pumpkin beetles did not indicate any effectiveness for the insecticides over control.

9. Effect of insecticides on the percentage of fruit damage by fruit fly in snake gourd

The data on the number of fruits formed and the percentage of fruits damaged by fruit fly during the entire crop season are presented in Table 9. Observation on the number of fruits formed during the whole season did not have any significant variation under different treatments. The

Table 9. Mean percentage of fruits damaged by fruit flies under different treatments during the crop season in snake gourd

Treatments		Mean No. of fruits formed	Mean No. of fruits damaged	Mean percentage of fruits damaged	Percentage reduction of damage over control
Permethrin	0.01%	48.00	13.33	27.68 (31.72)	38.72
,,	0.02%	41.33	9.96	23.31 (28.87)	43.09
Fenvalerate	0.01%	43.66	11.66	26.15 (30.77)	40.25
,,	0.02%	50.00	8.66	17.70 (24.85)	48.70
Cypermethrin	0.01%	42.00	11.00	25.49 (30.24)	40.91
,,	0.02%	53.00	10.33	19.34 (26.07)	47.06
Deltamethrin	0.0015%	48.33	10.00	20.09 (26.63)	46.31
,,	0.003%	47.33	10.00	20.67 (27.03)	45.73
Malathion	0.1%	50.66	17.33	34.00 (35.67)	32.40
Untreated Control		42.00	27.66	66.40 (54.7)	—

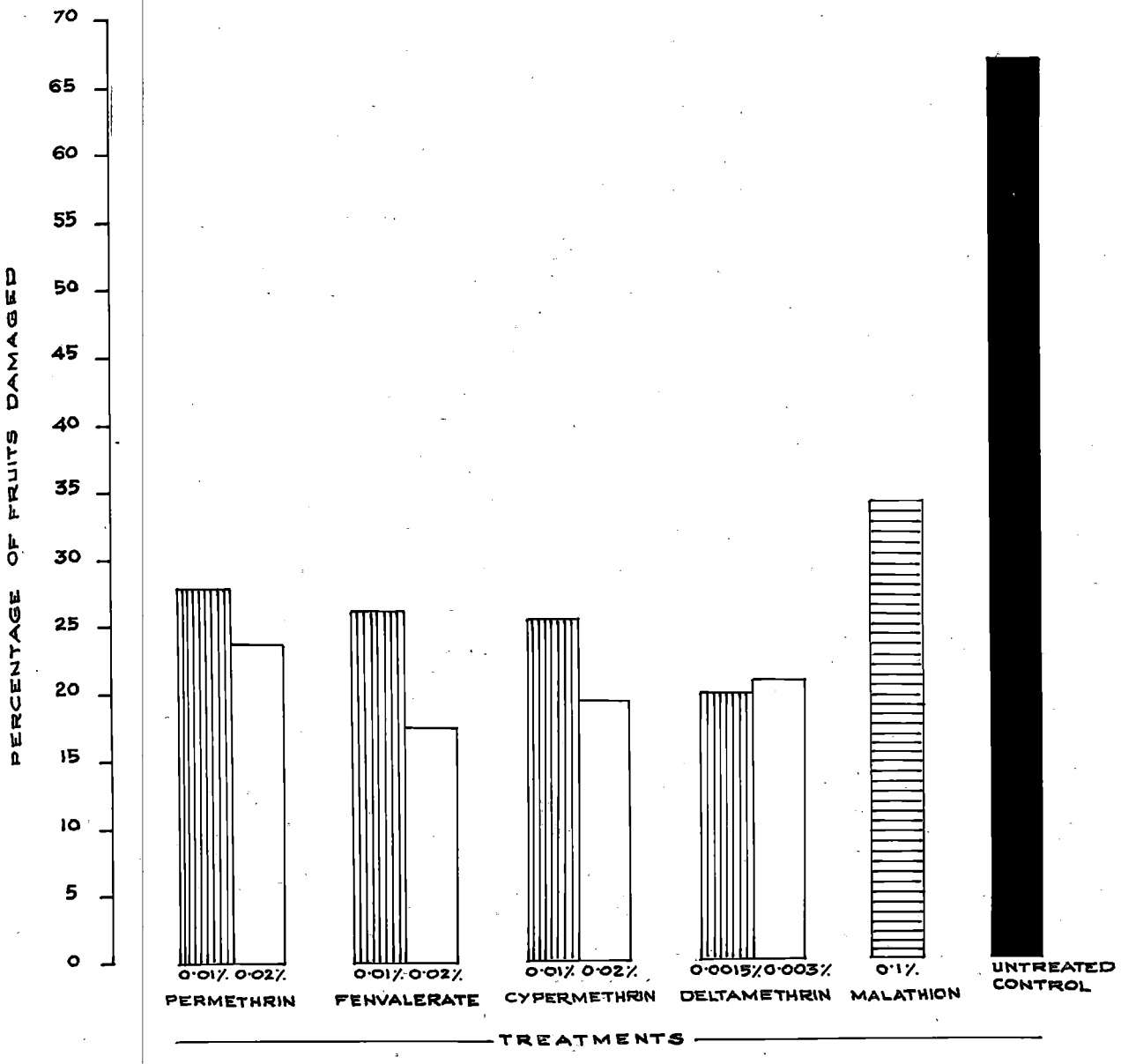
Abstract of ANOVA

Source	df	Mean squares	
Treatment	9	51.07	224.65**
Error	18	30.01	32.43
C.D. between treatments		NS	9.77

** Significant at 1% level. NS: Not significant.

(Figures in parentheses are transformed values)

FIG.9. EFFECT OF SYNTHETIC PYRETHROIDS ON THE PERCENTAGE OF FRUIT FLY DAMAGE DURING THE CROP SEASON IN SNAKE GOURD.



mean number of fruits ranged from 41.33 to 53.00 against 42.00 under control. The data on the percentage of fruits damaged by fruit fly during the whole season exhibited significant variation between treatments. The most effective treatment was fenvalerate 0.02 per cent with a mean of 17.7 per cent damaged fruits, closely followed by cypermethrin 0.02 per cent, deltamethrin 0.0015 per cent, deltamethrin 0.003 per cent, permethrin 0.02 per cent, fenvalerate 0.01 per cent, cypermethrin 0.01 per cent and permethrin 0.01 per cent with mean percentage of 19.34, 20.09, 20.67, 23.31, 25.49, 26.15 and 27.68 respectively against 66.40 under control. All the above treatments were on par among themselves and superior to control. Malathion 0.1 per cent also reduced the damage significantly (34.00%), but was significantly inferior to fenvalerate 0.02 per cent.

10. Effect of insecticides on the flowering pattern and fruit set in snake gourd

The data relating to the flowering pattern and mean percentage of fruit set in snake gourd is presented in Table 10. The first flower was formed on 47 days after sowing. The observations recorded on the various fortnights showed only insignificant variation between the different treatments including control, overruling any effect for the

Table 10. Mean number of flowers formed and percentage of fruit set under various treatments in snake gourd

Treatments		a	b	c	d	Total No. of flowers formed	Total No. of fruits set	Mean percentage of fruit set
Permethrin	0.01%	9.66	19.00	20.66	8.66	58.00	48.00	82.59(65.34)
,,	0.02%	7.00	20.00	18.33	8.00	53.33	41.33	78.17(62.45)
Fenvalerate	0.01%	9.00	18.00	19.00	7.33	53.53	43.66	82.03(64.93)
,,	0.02%	9.33	22.00	20.66	10.00	62.00	50.00	80.76(63.94)
Cypermethrin	0.01%	6.00	19.33	19.33	7.66	52.33	42.00	80.06(63.49)
,,	0.02%	9.33	20.66	23.33	10.33	63.66	53.00	83.11(65.79)
Deltamethrin	0.0015%	6.66	21.00	20.00	9.66	57.33	48.33	84.80(67.09)
,,	0.003%	7.00	20.33	20.00	9.66	56.66	47.33	83.50(66.04)
Malathion	0.1%	9.33	22.66	19.00	10.33	61.00	50.66	82.91(65.58)
Untreated control		7.66	19.66	18.00	6.66	52.00	42.00	81.03(63.19)

Abstract of ANOVA

Source	df	Mean squares					
Treatment	9	10.42	3.51	6.10	5.61		8.28
Error	18	12.36	16.89	6.41	5.33		4.36
C.D. between treatments		NS	NS	NS	NS		NS

(Figures in parentheses are transformed values)

NS: Not significant.

a: 47 to 62 days after sowing
b: 62 to 77 days after sowing
c: 77 to 92 days after sowing
d: 92 to 107 days after sowing

insecticides on the flowering pattern and the number of flowers formed. The combined means of the flowers formed in all the plots for the first, second, third and fourth fortnights were 8.06, 20.38, 19.73 and 8.92 respectively. The second and third fortnights after the commencement of flowering appeared to be the peak period of flowering, and the flower formation ceased with fourth fortnight.

Observation on the percentage of fruit set indicated no significant variation in plots under different treatments. The plots treated with deltamethrin 0.0015 per cent showed maximum fruit set 84.80 per cent and permethrin 0.02 per cent recorded the least 77.12 per cent as against 81.03 in control plots.

Discussion

DISCUSSION

Efficacy of four synthetic pyrethroids viz. permethrin, fenvalerate, cypermethrin and deltamethrin, each at two doses, was studied against the pests of bitter gourd and snake gourd in a field experiment using malathion as standard. Bitter gourd crop was free from any pest infestation for the first six weeks after sowing. Later the crop was infested by spotted beetle, fruit fly, jassid and aphid and was sprayed thrice at 48, 78 and 102 days after sowing.

Incidence of spotted beetle and fruit fly warrented the first application of the insecticides. All the treatments were effective against spotted beetle up to 23 days after spraying (DAS) and were on par. Deltamethrin (15 g ai/ha) and cypermethrin (100 g ai/ha) gave consistent results up to 23 DAS, whereas other insecticides varied in their efficiency during different weeks. Even though fenvalerate gave effective initial control, the population of the pest in plots treated with this insecticide varied widely at different intervals. As the standard, malathion, was on par with the different synthetic pyrethroids no superiority can be claimed for the pyrethroids over malathion for the control of spotted beetle. The second application of the insecticides also gave effective control of the spotted beetle at 2 DAS, and

all the synthetic pyrethroids were superior to the standard malathion. On ninth day after spraying the population was seen highly reduced in all the treatments and control to an insignificant level, and so the persistent effect of the insecticides could not be ascertained. The significant control of the spotted beetle exhibited by the synthetic pyrethroids in both the sprayings indicated the efficiency of these insecticides. Mc Clanahan (1981) has reported the superiority of the synthetic pyrethroids over malathion in their toxicity against Epilachna varivestis Muls. and in the present study the synthetic pyrethroids are also found effective against Epilachna viginctioctopunctata.

Regarding the control of fruit fly, synthetic pyrethroids gave satisfactory control during the first spraying. The effect of spraying was not manifested in the first observation taken at 2 DAS, at 9 DAS showed the efficacy of all the synthetic pyrethroids at their higher doses. Though all of them were superior to the standard malathion, cypermethrin (100 g ai/ha) was the most effective one and was significantly superior to all other synthetic pyrethroids. But its lower dose (50 g ai/ha) was only on par with the standard indicating the necessity of a higher dosage for a better control of this pest. Deltamethrin (15 g ai/ha) and fenvalerate

(100 g ai/ha) were next in effectiveness to cypermethrin (100 g ai/ha) and were superior to lower dose of cypermethrin (50 g ai/ha). At the third observation a more or less similar trend was seen as in the second observation. Though all of the treatments were effective, cypermethrin and deltamethrin at both levels and fenvalerate at the higher level were significantly superior to the standard in reducing the infestation of fruit fly. The period under second and third observations alone contained protected fruits, the synthetic pyrethroids especially cypermethrin, fenvalerate and deltamethrin and the more potent insecticides controlled the infestation of fruit fly during the period. Hence acted as potential insecticides which proved their superiority over malathion. At the second spraying there was no significant reduction in damaged fruits at the first post-treatment observation made at 2 DAS. Permethrin and fenvalerate at both the doses and cypermethrin at the higher dose alone could reduce the fruit fly infestation at 9 DAS. But at 16 DAS all the insecticides including malathion gave effective control and though not of significant variation, cypermethrin and permethrin (at 100 g ai/ha) were more effective. During the third application, at 16 DAS fenvalerate (100 g ai/ha) was the most effective synthetic

pyrethroid and was superior to permethrin. But none of the synthetic pyrethroids was superior to the standard malathion. In general the synthetic pyrethroids controlled fruit flies effectively in all the three sprayings and fenvalerate and permethrin were superior to the standard malathion. These insecticides are found promising against melon fruit fly and also could retain the fruit fly incidence at a lower level than under the malathion treatment during the entire fruiting season. When the overall effect of the insecticides against the fruit fly was observed, as reflected in the percentage of damage during the whole fruiting season, fenvalerate (100 g ai/ha), permethrin (100 g ai/ha) and deltamethrin (15 g ai/ha) were found superior to the standard malathion. The results obtained separately for the different applications agree with the overall effect observed throughout the cropping season. This indicate higher persistent toxicity of these insecticides over others and its retention on the crop control the pest for a more prolonged period. Though the other synthetic pyrethroids could reduce the pest infestation up to a period of 16 days after spraying, the insecticides might not have persisted on the plants to reduce the fruit fly infestation. Das et al. (1968) has reported that the presence of insecticide on the foliage

of the crop kill the flies which rest or move on them. Accordingly in the present studies the deposit of the more persistent synthetic pyrethroids viz. fenvalerate, permethrin and deltamethrin on the leaves, at their higher doses might have played a role in reducing the fruit fly infestation. Collingwood et al. (1979) has reported that decamethrin, fenvalerate and cypermethrin gave good control of Dacus spp. In the present study in addition to these insecticides permethrin was also found to give persistent control of fruit fly in the long run.

With regard to control of jassid on bitter gourd, the effect of the insecticides was retained only for 2 DAS and at the ninth day the population showed no significant variation between the treatments and control. All the insecticides except the lower dose of permethrin and deltamethrin were effective. Fenvalerate at both the levels and cypermethrin at the lower level were found superior to other treatments including the standard, malathion. Jaganmohan et al. (1980) has reported similar results with brinjal leaf hopper. The ineffectiveness of the synthetic pyrethroid to give a long standing control of the sucking insects is well known from earlier works. Rai et al. (1980) also could observe the control of jassid only for a period of 9 days.

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While assessing the relative efficacy against aphids it was found that even at 2 DAS permethrin (100 g ai/ha) and fenvalerate (100 g ai/ha) alone were able to give significant control of the pest in addition to the standard malathion. The data were insignificant at 9 DAS and the population in plots treated with deltamethrin exceeded that in control and indicated inducement of the reproductive potential as reported by Chelliah (1980) with Brown plant hopper. Cauquil and Guillausmont (1981) got some control of the aphids with fenvalerate alone, of all synthetic pyrethroids tested and that too had only an intermediate action. But Singh and Sircar (1980) found that the synthetic pyrethroids decamethrin (7.5 - 25 g ai/ha), fenvalerate (50 - 150 g ai/ha), cypermethrin (50 - 150 g ai/ha) and permethrin (75 - 250 g ai/ha) were effective against cabbage aphids. The present findings with bitter gourd aphid is in partial agreement with the above observation. Fenvalerate and permethrin could control the pest, but for a short period as reported by Jaganmohan et al. (1981).

Regarding the effect of synthetic pyrethroids on the flowering pattern of the crop it was indicated that none of the insecticides including malathion affected the flower formation as well as the flowering pattern. The same phenomenon was observed by Young and Ditman (1959) with the

conventional insecticides like Thiodon, Ethion, malathion Dibrom and Sevin. With synthetic pyrethroids no such work was recorded on the gourds. The flowering period was found as five fortnights commencing with the first flower formation.

The mean percentage of fruit set observed under the different treatments did not show any variation between the different insecticides and the untreated control. As these are monoecious crops and cross pollination being the rule, the insect association in the pollination is an important factor for fruit set (Free, 1970). The present study indicated that the synthetic pyrethroids or malathion have not affected the pollination and so can be used safely on this crop even at the flowering stage. Pederson (1980) also has recommended permethrin for the control of Meligethes aeneus on flowering rape. Sudharma (1981) observed similar results in her studies with synthetic pyrethroids on brinjal.

The snake gourd crop was sprayed thrice on 24th, 68th and 101th days after sowing as the crop was infested with pumpkin caterpillar, snake gourd semilooper, mirid bug, pumpkin beetle and fruit fly at different stages of crop growth. The first application of the insecticides was done against pumpkin caterpillar, snake gourd semilooper and mirid bug. All the insecticides including the standard were

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effective when compared to the untreated control against pumpkin caterpillar at 2 DAS. But at 9 DAS the test population was reduced to a very low level in all the treatments, so that no significant variation could be observed among the different treatments. Fenvalerate at both the levels and deltamethrin (15 g ai/ha) were more effective and were significantly superior to permethrin (50 g ai/ha) and malathion, the standard.

The population of snake gourd semilooper was low in the pretreatment count and all the insecticides including malathion controlled the pest effectively. As observed with pumpkin caterpillar this pest also was viped out subsequently. Earlier reports are available on the effectiveness of the synthetic pyrethroids against the defoliating caterpillar pests like Plutella xylostella and Trichoplusia ni (Su and Rose, 1977; Black and Hewson, 1979; Fullerton, 1979; Komson and Rendell, 1979) on cabbage where permethrin, fenvalerate, cypermethrin and deltamethrin gave good control. The present observation on the effective control of snake gourd semilooper and pumpkin caterpillar with synthetic pyrethroids are new findings. But in the case of mirid bug all the synthetic pyrethroids reduced its population at 2 DAS along with the standard and all the pyrethroids except

deltamethrin were significantly superior to malathion. Thus in the present study deltamethrin was found ineffective against mirid bug too, as in the case of other sucking insects. No synthetic pyrethroid had significant effect on the mirid bug at 9 DAS as found with other sucking insects.

Regarding the efficacy of these insecticides against fruit fly of snake gourd, no significant effect could be brought on the incidence at 2 DAS. But at 9 DAS, except the lower doses of permethrin and cypermethrin, all others including the standard were effective and none of the synthetic pyrethroids was superior to the standard. Deltamethrin at lower dose, though was ineffective against fruit flies at 9 days after second spraying in bitter gourd, it was found effective in snake gourd. Cypermethrin at lower level was ineffective in both the crops at the same stage. The difference in the results observed between the two crops during this particular observation may be due to the lesser number of fruits present in the snake gourd than in bitter gourd. But at 16 DAS all the insecticides were effective and the standard was the lesst effective though the variation was not significant. The results obtained during this observation for both the crops were more or less in general agreement, in spite of the change in the order of effectiveness. At 23 DAS, no treatment showed significant effect over

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untreated control. However, in the case of the two effective observations none of the synthetic pyrethroids was proved superior to the standard, malathion.

The results of the third spraying were not significant at 2 and 9 DAS. Though the percentage of infested fruits was very high at the time of application of the insecticides, the number of fruits available per plot were comparatively less and majority of them were already infested. Further production of new fruits was rather meagre as the flowering ceased with the 4th fortnight commencing from the date of first flowering (Table 10). Thus the presence of already infested fruits in the absence of new fruit formation might have been the reason for the non-effectiveness of the insecticides and hence the application of the insecticide at the fag end of the crop was not beneficial.

Regarding the overall incidence of fruit fly damage during the entire crop season, all the insecticides could control the damage significantly over control. Fenvalerate (100 g ai/ha) was proved superior to the standard since it could give a significantly higher control of fruit fly than with malathion. The results obtained on both the crops were comparable in respect of this insecticide. Though permethrin and deltamethrin also were superior to the standard on bitter gourd they were not found so in the case of snake gourd.

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The pumpkin beetles present at the last stage of the crop could be controlled by these insecticides only for a period of 2 DAS. Eventhough all the insecticides were significantly effective against this pest, deltamethrin (15 g ai/ha) and cypermethrin (100 g ai/ha) were superior to the lower dose of cypermethrin and permethrin. But the higher dose of all the synthetic pyrethroids were significantly superior to malathion, the standard. These results are in confirmation with the finding of Pradhan et al. (1958) on the control of Aulacophora foveicollis with malathion where he got only about 50% kill at 1% in a direct spray. Hence these insecticides have emerged as a more efficient measure for the control of this pest. As the grubs of this beetle live in soil and the adults emerge with the onset of premonsoon showers, new overlapping adult population may be infesting the crop from time to time. The insects which infested the crop afresh after the application of insecticide during the premonsoon showers might have received only a sublethal dose of the insecticide and as such was found not effective at 9 DAS. Nilsson (1978), Black and Hewson (1979) and Rivard and Clement (1980) have reported excellent control of beetle pests like Meligethes aeneus of rape, pollen beetles and Anthonomus signatus with synthetic pyrethroids. Efficient control of pumpkin beetles with synthetic pyrethroids is a new finding.

The study on the effect of synthetic pyrethroids on the flowering pattern and flower formation on snake gourd indicated that neither the synthetic pyrethroids nor the standard had no effect on it. This observation endorsed the other findings obtained with bitter gourd which was explained already. The period of flowering was four fortnights commencing from the first flower formation. Regarding the percentage of fruit set in snake gourd a similar trend as seen in bitter gourd, without any significant variation between the different insecticides and untreated control, was observed. Being this too an insect pollinated crop (Free, 1970), the result has ruled out any harmful effect on insect pollinators. However, the percentage of fruit set in snake gourd was lesser than in bitter gourd.

The relative efficacy of the different insecticides against the various pests infested bitter gourd and snake gourd are represented in Table 11. The synthetic pyrethroid permethrin at its lower dose (50 g ai/ha) could control the spotted beetle and fruit fly of bitter gourd, pumpkin caterpillar, snake gourd semilooper, mirid bug, fruit fly and pumpkin beetles of snake gourd, whereas permethrin (100 g ai/ha) could control the jassid and aphid too in addition to the pests mentioned above. The higher dosage could

Table 11. The relative efficacy of different insecticides

Bitter gourd

Treatments		Spotted beetles				
		I spraying				II spraying
		2 DAS	9 DAS	16DAS	23DAS	2 DAS
Permethrin	0.01%	+	+	+	+	x
"	0.02%	+	+	+	+	x
Fenvalerate	0.01%	+	+	+	+	x
"	0.02%	+	+	+	+	x
Cypermethrin	0.01%	+	+	+	+	x
"	0.02%	+	+	+	+	x
Deltamethrin	0.0015%	+	+	+	+	x
"	0.003%	+	+	+	+	x
Malathion (Standard)	0.1%	+	+	+	+	+

Snake gourd

Treatments		I spraying		
		Pumpkin caterpillar	Snake gourd semilooper	Mirid bug
		2 DAS	2 DAS	2 DAS
Permethrin	0.01%	+	+	x
"	0.02%	+	+	x
Fenvalerate	0.01%	x	+	x
"	0.02%	x	+	x
Cypermethrin	0.01%	+	+	x
"	0.02%	+	+	x
Deltamethrin	0.0015%	+	+	+
"	0.003%	x	+	+
Malathion (Standard)	0.1%	+	+	+

x Significantly superior to standard

\+ Significantly superior to control

\- Ineffective

against various pests of bitter gourd and snake gourd

Fruit fly						Percentage of damage during entire crop season	Jassids	Aphids
I spraying		IIspraying		IIIspraying			IIspraying	IIspraying
9DAS	16DAS	9DAS	16DAS	9DAS	16DAS		2DAS	2DAS
x	+	+	+	+	+	+	-	-
x	+	+	+	+	+	x	+	+
x	+	+	+	+	+	+	+	-
x	x	+	+	+	+	x	x	+
+	x	-	+	+	+	+	+	-
x	x	+	+	+	+	+	+	-
x	x	-	+	+	+	+	-	-
x	x	-	+	+	+	x	+	-
+	+	-	+	+	+	+	+	+

II spraying		Percentage of damage during entire crop season	III spraying
Fruit fly			Pumpkin beetles
9 DAS	16DAS		2 DAS
-	+	+	+
+	+	+	x
+	+	+	+
+	+	x	x
-	+	+	+
+	+	+	x
+	+	+	+
+	+	+	x
+	+	+	+

reduce the fruit damage significantly over the standard and was more effective against the pumpkin beetles also. Fenvalerate (50 g ai/ha) controlled spotted beetle, fruit fly and jassid of bitter gourd, pumpkin caterpillar, snake gourd semilooper, mirid bug, fruit fly and pumpkin beetles of snake gourd. The two doses of this insecticide varied in respect of the control of fruit fly, jassid and aphid on bitter gourd, pumpkin caterpillar, pumpkin beetles and fruit fly of snake gourd. The higher dose was significantly superior to the standard. This was the only one insecticide which could give a significantly superior control of fruit fly over the standard in both the crops during the entire crop season and hence was found as an insecticide of greater efficiency and practical utility. Cypermethrin (50 g ai/ha) also could control such pests as spotted beetle, fruit fly and jassid of bitter gourd and all the pests of snake gourd. Even the higher dose of this insecticide was not able to give significant control of aphid. Either of the doses did not vary much in their efficacy for the control of the different pests over the standard. Deltamethrin (7.5 g ai/ha) could control all the pests of bitter gourd and snake gourd except jassid and aphid of bitter gourd. Though the higher dose was able to control jassid, it was ineffective against aphid and the

control of sucking insects was not consistent. This insecticide was significantly superior to the standard for the control of fruit fly of bitter gourd and pumpkin beetles of snake gourd. The standard malathion also was significantly effective over the untreated control against all the pests observed under bitter gourd and snake gourd.

Summary

SUMMARY

Effect of four synthetic pyrethroids viz. permethrin, fenvalerate, cypermethrin each at 50 g and 100 g ai/ha and deltamethrin at 7.5 g and 15 g ai/ha with reference to a standard, malathion at 500 ml ai/ha on the pests of bitter gourd and snake gourd was evaluated in a field experiment undertaken at the Instructional Farm, College of Agriculture, Vellayani, during summer season in 1982. Both the crops were sprayed thrice on need basis at 48, 78 and 102 days after sowing on bitter gourd and 24, 68 and 101 days after sowing on snake gourd.

Results of the experiment conducted on bitter gourd showed that the spotted beetle was controlled effectively by all the insecticides including the standard for a period of 23 days after spraying. All the insecticide treatments were on par in their effectiveness but fenvalerate at both levels, cypermethrin at 100 g ai/ha and deltamethrin at 15 g ai/ha were seen more effective during the different observations. With the second application also the population of spotted beetle was significantly brought down at 2 days after spraying and all the synthetic pyrethroids were superior to the standard. But the control obtained by any of the insecticide at 9 days after spraying was not significant, as the pest population was low subsequently.

The jassid infestation was effectively controlled by all the insecticides except lower doses of deltamethrin and permethrin for a period of 2 days after second spraying. The effect was not significant at 9 days after spraying against this insect. The aphid population also was reduced by the second application of permethrin and fenvalerate at higher doses and the standard. There was no control at 9 days after spraying and the effect of synthetic pyrethroids, in general, against this pest was not satisfactory. Cont..3 - 67

After D.S.T. In the study to ascertain the variation caused by these insecticides on the flowering pattern and fruit set of the crop, it was observed that insecticides could significantly affect neither the flowering pattern nor the fruit set, there by indicating harmless nature of these insecticides against pollinators. The flowering pattern was for a period of five fortnights.

The experiment conducted for the control of different pests of snake gourd showed that the pumpkin caterpillar, snake gourd semilooper and mirid bug could be controlled with the first spraying and all the insecticides were effective. Deltamethrin at higher dosage and fenvalerate at both the levels were significantly superior to the standard against pumpkin caterpillar. The data were not significant at 9 days after spraying because of the insignificant level

Cont..3 -

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Fruit fly affecting bitter gourd also was controlled significantly by all the insecticides up to 16 days after spraying, but the data obtained at 2 days after spraying were not significant for all the three sprayings. Cypermethrin at 100 g ai/ha was superior to all the other treatments and was closely followed by fenvalerate at 100 g ai/ha and deltamethrin (15 g ai/ha) at 9 days after spraying. At 16 days after spraying, except permethrin at both levels and lower dose of fenvalerate, all other synthetic pyrethroids were superior to the standard.

The fruit fly control obtained with the second spraying was also of a significant nature and the effect persisted up to 16 days after spraying as in the previous case. All the insecticide treatments including malathion were on par, but permethrin at 100 g ai/ha was most effective considering both the observations at 9 and 16 days after spraying. Further control of fruit fly was obtained by the third spraying where all the insecticides reduced the intensity of pest infestation significantly till 16 days after spraying as observed with the other two sprayings and deltamethrin and fenvalerate at higher dose were superior to permethrin. When the percentage of fruits infested by fruit fly was considered for entire crop season, fenvalerate, permethrin and deltamethrin at their higher doses were found significantly superior to standard in the descending order.

Contd... 68

of pest incidence. Snake gourd semilooper was controlled with the first spraying for a period of 2 days and all the insecticides were on par. Here also the pest population was insignificant at 9 days after spraying. The mirid bug infestation was significantly controlled by all the insecticides for a period of 2 days after spraying. The standard was inferior to all the synthetic pyrethroids except to the two doses of deltamethrin. No insecticide could control the mirid bug at 9 days after spraying.

The second spraying was done against fruit fly damage and the incidence could be brought under control for a period of 16 days excluding the first two days after spraying. At 9 days after spraying all the insecticides except permethrin and cypermethrin at their lower dose were effective. At 16 days after spraying all the insecticides including standard were significantly effective and were on par. But the third spraying could not bring any control of the fruit fly as the spraying was done at the fag end of the crop. When the percentage incidence of fruit fly damage observed during the entire crop season was considered, it was found that all the insecticides could reduce the fruit fly infestation along with standard and fenvalerate at 100 g ai/ha was significantly superior to the standard, malathion. Infestation

by the pumpkin beetles was observed at the last stage of the crop and the insecticides could control the pest for a period of 2 days after the third spraying. All the synthetic pyrethroids at their higher doses were significantly superior to standard against the pest. The studies on the effect of the insecticides on flowering pattern as well as fruit set of the snake gourd crop showed that the insecticides had no effect on flowering pattern or fruit set. The flowering continued for a period of four fortnights after the first flowering.

References

REFERENCES

Agnihotri, N.P., Jain, H.K., Rai, S. and Gajbhiye, V.T. (1980). Relative toxicity and residues of synthetic pyrethroids on cabbage and cauliflower. Indian J. Ent., 42 : 712-722.

Alexandrescu, S. and Hondru, N. (1981). Selectivity of some insecticides used for the control of the cabbage aphid Brevicornyne brassicae L. on cabbage crops. Analele Institutului de cercetari pentru Protectia Planetor, 16 : 375-383.

* Arkroyd, W.R., Patwardhan, V.N. and Ranganathan, S. (1962). Nutritive value of Indian Foods. Government of India.

Ayyar, T.V.R. (1935). Fruit flies and their economic importance in S. India. Madras Agric. J., 23 : 127-137.

Black, I.A. and Hewson, R.T. (1979). Trials in the U.K. with NRDC 161 - a synthetic pyrethroid insecticide. Proceedings, British crop protection conference - Pests and Diseases, 2 : 377-386.

Bogawat, J.K. and Pandey, S.N. (1967). Food preference in Aulacophora spp. Indian J. Ent., 29 : 349-352.

Breese, M.H. (1977). The potential for pyrethroids as Agricultural, Veterinary and Industrial insecticides. Pesticide Science, 8 : 264-269.

* Cauquil, J. and Guillaumont, M. (1979). The action on Aphis gossypii Glover of some specific insecticides used in the protection of cotton crops. Congress on the control of insects in the tropical environment. Report of the proceedings, Part I - Tropical crops, 55-66.

Champ, B.K. (1966). Some effects of DDT, dieldrin, dimethoate and fenthion on growth of cucumbers. J. Agric. Anim Sci., 23 : 333-335.

Chauhan, D.V.S. (1965). Vegetable production in India. Ram Prasad and Sons, Agra-3. 3rd Ed., 352 pp.

Chelliah, S. (1980). Influence of insecticide sprays on B.P.H. resurgence IRRN, 5:10-11.

Chen, K.H. (1960). Studies on the melon fly control. Agri. Res., 9 : 43-51.

* Collingwood, E.F. and Bourdouxe, L. (1979). Prospects offered by the synthetic pyrethroids in the control of various insects of market - garden crops in Senegal. Congress on the control of insects in the tropical environment. Report of the Proceedings, Part I - Tropical Crops : 481-489.

* Collingwood, E.F., Bourdouxhe, L. and Diouf, M. (1979). Report of the pesticide trials in 1976-1979 First Part : Insecticides. Proceedings of a MAPPS seminar Kuala Lumpur : 93.

Dale, D. and Nair, M.R.G.K. (1966). Studies on the relative toxicity of some insecticides to adults of Dacus cucurbitae (Coquillett) when used in bait sprays. Agri. Res. J. Kerala, 4 : 74-77.

Das, N.M., Remamony, K.S. and Nair, M.R.G.K. (1968). Control of the melon fly Dacus cucurbitae Coquillett with some newer synthetic insecticides applied as cover sprays. Agri. Res. J. Kerala, 6 : 43-45.

David, A.L. (1966). Trials with insecticides for the control of brinjal leaf beetle (Epilachna viginctiocto-punctata Fabr.) and fruit borer (Leucinodes orbonalis Guen.) Indian J. Agric. Sci., 36 : 153-160.

David, A.L. (1967). Experiments on the control of the bitter gourd fruit fly Dacus cucurbitae Coq. S. Indian Hort., 15 : 64-69.

David, B.V. and Kumaraswamy, T. (1975). Elements of Economic Entomology. Popular Book Depot. Madras, 1st Ed. 504 pp.

El-Guindy, M.A., Madi, S.M. and Abdel-Sattar, M.M. (1981). Joint action of pyrethroids with several insecticides on the Egyptian cotton leaf worm Spodoptera littoralis (Boisd.) International pest control, 23 : 99-101.

Elliott, M., Janes, N.F. and Potter, C. (1978). The future of pyrethroids in insect control. Ann. Rev. Entomol., 23 : 443-469.

Free, J.B. (1970). Insect pollination of crops. Academic Press, London and New York, 1st Ed. 544 pp.

* Fullerton, R.A. (1979). Use of synthetic pyrethroids fenvalerate and cypermethrin to control diamond back moth Plutella xylostella (L) and the large cabbage moth Crocidolomia binotalis (Zeller) in Rarotonga Cookes. Fiji Agri. J., 41 : 49-51.

Grewal, G.S., Singh, G. and Sandhu, S.S. (1978). Chemical control of Bihar hairy caterpillar Diacrisia obliqua Walker infesting sesame. Indian J. Agri. Science, 48 : 598-600.

* Guistina, W.D. and Doyran, S. (1980). Research on the dosage and schedule of treatment with two halogenated pyrethroids applied to the green house white fly, Trialeurodes vaporariorum (West.) Phytiatrie Phytopharmacie, 27 : 307-312.

Hali, R. (1969). Bitter gourd, a Kerala favourite. Indian Fmg., 19 ( ) : 30-31.

* Hascoet, M.M. and Cavelier, M.A. (1978). Synthetic pyrethroids. Comptes Rendus des seances de l' Academie d' Agriculture de France, 64 : 1371-1378.

Jaganmohan, N., Krishnaiah, K. and Krishna kumar, N.K. (1981). Chemical control of mustard aphid, Lipaphis erysimi Kart. and leaf webber, Crocidolomia binotalis Zell. on cabbage. Pesticides, 15(2) : 29-32.

Jaganmohan, N., Kumar, N.K. and Prasad, V.G. (1980). Control of leaf hopper (Amrasca biguttula biguttula Ishida) and fruit borer (Leucinodes orbonalis Guen. on brinjal. Pesticides, 14(7) : 19-21.

* Kismir, A. and Sengonga, C. (1980). An investigation into the effect of chemical preparations applied in the Cukurova region against cotton pests on the insect predator Anisochrysa carnea (Stephens) (Neuroptera : Chrysopidae). Ya et Kileri Uzerinde bir arastirma Turkiye Bitki Koruma Dergisi, 4 : 243-250.

* Komson, A. and Rendell, C.H. (1979). Insect control on cabbage using three volume application rates of insecticide. Thai Journal of Agricultural Science, 12 : 181-189.

* Kozhaeva, K. (1965). The melon aphid on cotton. Zashch. Rast. Vredit Bolez., 9 : 36-37.

Kumar, K. and Lal, R. (1966). Comparative toxicity of some insect pests of crops. Indian J. Ent., 28 : 258-264.

Lindquist, R.K., Simonet, D.E. and Krueger, H.R. (1980). Comparison of permethrin applied as a foliar spray and root soak for cabbage looper control on green house Chrysanthemum cuttings and Celery transplants. J. Econ. Entomol., 73 : 381-384.

Mc Clanahan, R.J. (1981). Effectiveness of insecticides against the Mexican bean beetle. J. Econ. Entomol., 74 : 163-164.

* Melifronides, I.D., Zyngas, J.P. and Markoullis, G. (1978). Control of spiny boll worm (Earias insulana) in cyprus. Mediterraneanne Pour la protection des planter, 8 : 37-41.

Mote, U.N. (1975). Control of fruit fly (Dacus cucurbitae) on bitter gourd and cucumber. Pesticides, 9(8) : 36-37.

Nagappan, K., Kamalanathan, S., Santhanaraman, T. and Ayyasamy, M.K. (1971). Insecticidal trial for the control of the melon fly, Dacus cucurbitae Coq. infesting snake gourd, Trichosanthes anguina. Madras agric. J., 58 : 688-690.

Nair, M.R.G.K. (1970). Insects and Mites of Crops in India. Indian Council of Agricultural Research, New Delhi, pp.404.

Narayanan, E.S. and Batra, H.N. (1960). Fruit flies and their control. Indian Council of Agricultural Research Institute, New Delhi, 1st Ed., 68 pp.

* Niemczyk, E., Miszczak, M. and Olszak, R. (1981). The toxicity of pyrethroids to predaceous and parasitic insects. Roczniki Nauk Rolniczych, E, 9 : 105-115.

* Nilsson, C. (1978). Tests of Sumicidin against the rape beetle on spring rape. Annals of Applied Biology, 92 : 76-82.

Nimbalkar, R.B. and Ajri, D.S. (1981). Efficacy of synthetic pyrethroids and two newer compounds against brinjal shoot and fruit borer Leucinodes orbonalis Guen. Indian J. Ent., 43 : 202-204.

* Olsson, R. (1978). Ambush - a new insecticide for Swedish agriculture. Plant Protection Conference, Uppasala, Vaxtskyadrrapporter Jordbruk (4) : 142-148.

* Olsson, R. (1980). Results from our own field tests with Ambush in 1979. Plant Protection Conference, Special part, 12 : 115.

* Panji, H.R. (1965). Some observations on the insecticidal activity of the fruit of Derek (Melia azedarach). Res. Bull. Punjab Univ. (N.S.) Sci., 15 : 3-4.

Pederson, F.D. (1980). Permethrin - toxicity to bees and other useful arthropods. Annals of Applied Biology, 94 : 34-43.

Penman, D.R., Chapman, R.B. and Jesson, K.E. (1981). Effects of fenvalerate and azinphos methyl on 2-spotted spider mite and phytoseiid mites. Entomologia Experimentalis et Applicata, 30 : 91-97.

Pradhan, S., Jotwani, M.G. and Rai, B.K. (1958). Bioassay of Insecticides VIII. Relative toxicity of some insecticides to red pumpkin beetle Aulacophora foveicollis Lucas. (Coleoptera : Chrysomelidae). Indian J. Ent., 20 : 104-107.

* Pruthi, H.S. (1941). Report of the Imperial Entomologist. Sci. Rep. agric. Res. Inst., New Delhi, 1939-40 : 102-114.

Rai, S., Jain, H.K. and Agnihotri, N.P. (1980). Bio-efficacy and dissipation of synthetic pyrethroids in Okra. Indian J. Ent., 42 : 657-660.

* Rivard, I. and Clement, A. (1980). Control of the tarnished plant bug (Lygus lineolaris) on rasp berry. Resume des Recherches, Station de Recherches Sain Jean Quebec, 9 : 18-19.

Schuster, D.J. and Clark, R.K. (1977). Cabbage looper control on cabbage with formulations of Bacillus thuringiensis and synthetic pyrethroid. J. Econ. Entomol., 70 : 366-368.

Sengupta, G.C. and Panda, N. (1958). Insecticidal control of Epilachna viginctioctopunctata (F). J. Econ. Entomol., 51 : 749.

Shour, M.H. and Crowder, L.A. (1980). Effects of pyrethroid insecticides on common green lace wing. J. Econ. Entomol., 73 : 306-309.

Singh, D.S. and Sircar, P. (1980). Relative toxicity of pyrethroids to Lipaphis erysimi Kalt. and Aphis craccivora Koch. Indian J. Ent., 42 : 597-605.

Sreenivasan and Narayanaswamy, P.S. (1960). Beating the pests of bittergourd. Indian Fmg., 10(7) : 17.

Sreenivasan and Narayanaswamy, P.S. (1962). Insecticidal control of the fruit fly Dacus cucurbitae on snake gourd. Madras agric. J., 49 : 309-310.

* Su, C.Y. and Rose, R.I. (1977). Field testing of new synthetic pyrethroid insecticides for the control of cruciferous insect pests. Plant Protection Bull. (Taiwan), 19 : 13-20.

Sudharma, K. (1981). (Unpublished). Chemical control of brinjal fruit and shoot borer in relation to pollination and terminal residues on fruits. Thesis submitted in partial fulfilment of the requirement for the degree Master of Science in Agriculture to Kerala Agricultural University, 65 pp.

* Tysowsky, M. and Gallo, T. (1977). Ovicidal activity of Ambush - a synthetic pyrethroid insecticide on corn ear worm and cabbage looper. Flo. Entomol., 60 : 287-290.

Uthamaswamy, S. and Balasubramanian, M. (1978). Efficacy of some insecticides in controlling the pests of Bendi, Abelmoschus esculentus (L) Moench. Pesticides, 12(5) : 39-41.

Voon, C.H. and Chung, G.F. (1978). Permethrin, a synthetic pyrethroid insecticide for the control of Lepidopterous pests. A report of the Proceedings of the plant protection conference, Kuala Lumpur, 287-298.

Wilkinson, J.D., Briever, K.D. and Ignoffo, C.M. (1979). Synthetic pyrethroid and organophosphate insecticides against the parasitoid Apanteles marginiventris and predators Podisus maculiventris. J. Econ. Entomol., 72 : 473-475.

Young, J.R. and Ditman, L.P. (1959). The effectiveness of some insecticides on several vegetable crops. J. Econ. Entomol., 52 : 477-481.

* Original not seen

ABSTRACT

In a field experiment conducted at the Instructional Farm, College of Agriculture, Vellayani, during the summer season in 1982, the efficacy of four synthetic pyrethroids viz. permethrin, fenvalerate, cypermethrin and deltamethrin, on the pests of bitter gourd and snake gourd in comparison with the standard, malathion, was evaluated. Both the crops were sprayed thrice on need basis for controlling the various pests which infested the crops at different growth stages. Spotted beetle observed on bitter gourd at the time of first spraying was controlled by all the synthetic pyrethroids along with the standard for a period of 23 days after spraying. Fruit fly of the bitter gourd also was controlled by all the three sprayings and all the insecticides were effective in most occasions. Cypermethrin at higher dose was superior to the standard during the first spraying followed by fenvalerate and deltamethrin. In the second spraying deltamethrin was not so effective whereas permethrin was found more effective. Again in the third spraying deltamethrin and fenvalerate were more effective. The fruit fly damage observed for the entire crop season revealed the superiority of fenvalerate, permethrin and deltamethrin at their higher doses over the standard. Jassid on bitter gourd was controlled by all the insecticides except permethrin and cypermethrin at their lower dose for a

period of 2 days after the spraying. But aphid could be controlled only with permethrin and fenvalerate at their higher dose along with the standard malathion for a period of 2 DAS. The fruit set and the flowering pattern were not affected by any of these insecticides.

The first spraying on snake gourd controlled the pumpkin caterpillar, snake gourd semilooper and the mirid bug for a period of 2 days after the spraying by all the insecticides and the population of caterpillar pests was reduced subsequently. But the insecticides became ineffective against mirid bug 2 days after spraying (further). Deltamethrin at higher dose and fenvalerate at both the doses were more effective than the standard against pumpkin caterpillar, while deltamethrin was only on par with the standard against mirid bug. The second spraying of the insecticides could control the fruit fly of snake gourd up to 16 DAS and pyrethroids were on par with the standard, though permethrin and cypermethrin at their lower dose were ineffective at 9 DAS. The third spraying of the insecticide did not give any significant control of the fruit fly, but controlled the pumpkin beetles and all the synthetic pyrethroids at their higher dose were significantly superior to the standard, malathion. The percentage of fruit set and flowering pattern in snake gourd was also not affected by any of the insecticide treatments.