Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(4): 1434-1443

Received: 29-05-2018
Accepted: 30-06-2018

TK Balas
Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

VR Virani
Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

KM Parekh
Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Correspondence
TK Balas
Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Comparative efficacy of different insecticides against fruit fly, *Bectrocera cucurbitae* (Coquillet) on cucumber

TK Balas, VR Virani and KM Parekh

Abstract
Investigations were carried out on "Comparative efficacy of different insecticides against fruit fly, *Bectrocera cucurbitae* (Coquillet) on cucumber" at Instructional farm, College of Agriculture, Junagadh Agricultural University, Junagadh during *kharif*-2015 on cucumber variety Dharwad green. The results of the two spraying of Fipronil, Dichlorvos, Polytrin C, Profenophos, Spinosad, Lambda-cyhalothrin, Malathion, Clorantraniliprole and Bifenthrin insecticides against the cucumber fruit fly revealed that Dichlorovos @ 0.05 percent, Lambda-cyhalothrin 0.005 percent and Malathion @ 0.1 percent were found more effective treatments against the pest as compared to other insecticides. Among different treatments the highest ICBR i.e. 1: 62.21 was recorded in the treatment of Dichlorovos @ 0.05 percent followed by Lambda-cyhalothrin 0.005 percent (1: 31.65), Malathion @ 0.1 percent (1: 32.30), Profenophos @ 0.05 percent (1: 15.23) and Bifenthrin 0.005 percent (1: 13.08)

Keywords: Cucumber, *Bectrocera cucurbitae* (Coquillet), insecticides

1. Introduction
Cucumber, *Cucumis sativus* (Linnaeus) is one of the oldest vegetable amongst the cultivated vegetable crops belonging to the family cucurbitaceae and has been in cultivation since 3000 to 4000 years [8]. It is originated in India from where it spreaded to Asia, Africa and Europe. It is one of the most popularly grown during *kharif*, *rabi* and *summer* seasons [8]. The immature fruits of cucumber are used as salad and for pickling. It also consumed as raw and used as astringent and antipyretic [8]. The area, production and productivity of cucumber in country are 25 lakh hectares, 106 lakh tonnes and 6000 kg/ha, respectively during 2011 [9]. The cucumber is produced in the states of India including Gujarat, Andhra Pradesh, Karnataka and hilly parts of North India. The Andhra Pradesh ranks first among all the major cucumber growing States [4]. Fruit fly, *B. cucurbitae* is one of the important insect pests of cucurbit vegetables throughout the India. It has been found to cause about 30 to 100 percent yield loss [6]. Cucurbitaceous fruits are severely damaged either partially or totally rendering them unfit for human consumption by this pest [6]. However, for the control of this pest, many insecticidal molecules have been tested for their effectiveness and out of them some good insecticides have been recommended for the control of this pest. Among these, such pesticide is one of the most important components which are being employed to control of fruit fly in cucumber ecosystem. So, an experiment was carried out with objective "Comparative efficacy of different insecticides against fruit fly, *Bectrocera cucurbitae* (Coquillet) on cucumber" at Instructional farm, College of Agriculture, Junagadh Agricultural University, Junagadh during the year 2015.

2. Materials and Methods
Experiment was conducted at Instructional farm, College of Agriculture, Junagadh Agricultural University, Junagadh, during *kharif* season of the year 2015. All the recommended agronomical practices were followed. All the insecticides were applied in the form of foliar spray with the help of knapsack spryer (15 liter capacity). For deciding the quantity of spray fluid required per plot, the control plot was sprayed with water and determined the required spray fluid. Spray fluid was prepared by mixing measured quantity of water and insecticides. The necessary care will be taken to prevent the drift of insecticides to reach the adjacent plots Care was also taken to rinse the sprayer thoroughly before and after

each spray with soap water to avoid contamination from treatment to treatment. First spray was applied at the initiation pests followed by second sprays at 15 days after first spray. To evaluate the effect of different insecticides, five plants from each net plot area will be tagged with label separately. The fruits from those plants will be harvested periodically as and when they attained the marketable size. The economics of the chemical treatments will also be worked out by calculating the cost benefit ratio. Subsequently the observations will be recorded at three, five, seven and ten days after spray from each treatment.

Table 1: Details of insecticides used for management of cucumber fruit fly

Treatment no.	Name of insecticide	Formulation (%)	Conc. (%)
1.	Fipronil	5 SC	0.01%
2.	Dichlorvos	76 EC	0.05%
3.	Polytrin C	44 EC	0.044%
4.	Profenophos	50 EC	0.05%
5.	Spinosad	45 SC	0.018%
6.	Lambda cyhalothrin	5 EC	0.005%
7.	Malathion	50 EC	0.1%
8.	Clorantraniliprole	40 EC	0.012%
9.	Bifenthrin	10 EC	0.005%
10.	Control	---	—

2.1 Statistical analysis: The damaged and healthy fruits will be sorted out at each picking and observations on percent fruit infestation was taken on number as well as weight basis which is subjected to arc sin transformation and will be statistically analyzed by following RBD. The yield of fruits will be recorded from net plot area of each treatment and converted in hectare basis and then statically analyzed. Thus, the data obtained was transformed into arc sin transformation before statistical analysis.

The data thus obtained will be transformed into appropriate transformation before statistical analysis.

$$\text{Percent fruit damage} = \frac{T_b \times 100}{T_a}$$

Where,

T_a = Total number of healthy fruits

T_b = Total number of damaged fruits

Economics of all treatment will be worked out by considering the price of products, cost of insecticides and labour charges. Cost benefit ratio (CBR) will be also worked out to compare the economics of different insecticidal treatments.

$$\text{Incremental cost: benefit ratio (ICBR)} = \frac{\text{Net realization (₹/ha)}}{\text{Total cost of insecticides (₹/ha)}}$$

Fig 1: Experimental site for comparative efficacy of insecticides on cucumber fruit fly

3. Results and discussion

3.1 Infestation after 1st application

3.1.1 Number basis

On the 3rd day

The data presented in Table 2 and Fig. 2 on infestation of fruit fly recorded at three day after first spray revealed that the treatment of Dichlorovos @ 0.05 percent caused reduction of fruit infestation of 22.46 percent and it was at par with treatment of Lambda-cyhalothrin 0.005 percent (27.37) and Malathion @ 0.1 percent (29.79).

Profenophos @ 0.05 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent and Spinosad 0.018 percent were in the next effective group of treatments caused 32.91, 37.70, 43.44 and 48.54 percent reduce fruit infestation, respectively on the 3rd day after the spray application.

The minimum reduction of fruit infestation 49.91 percent was caused by Polytrin C 0.044 percent followed by Fipronil 0.01 percent in which, 52.41 percent reductuion of infestation was recorded.

On the 5th day

The data presented in Table 2 and Fig. 2 on reduction of fruit infestation of fruit fly recorded at five day after first spray revealed that the treatment of Dichlorovos @ 0.05 percent caused maximum reduction of fruit infestation of 20.50 percent.

Lambda-cyhalothrin 0.005 percent, Malathion @ 0.1 percent, Profenophos @ 0.05 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent and Spinosad 0.018 percent were in the next effective group of treatments caused 24.19, 29.29, 30.42, 34.88, 39.32 and 37.79 percent reduction of fruit infestation, respectively on the 5th day after the application.

The minimum reduction of infestation of 39.53 percent was caused by Polytrin C 0.044 percent followed by Fipronil 0.01 percent in which, 44.45 percent reduction of infestation was recorded.

On the 7th day

The data presented in Table 2 and Fig. 2 on reduction of fruit infestation recorded at seven day after first spray revealed that the treatment of Spinosad 0.018 percent caused maximum reduction of fruit infestation of 00.00 percent and it was at par with treatment of Profenophos @ 0.05 percent 24.78 percent reduction of fruit infestation.

Lambda-cyhalothrin 0.005 percent, Malathion @ 0.1 percent, Polytrin C 0.044 percent, Dichlorovos @ 0.05 percent and Bifenthrin 0.005 percent were in the next effective group of treatments caused 32.87, 39.88, 39.94, 50.00 and 50.25 percent reduction of fruit infestation, respectively on the 7th day after the spray application.

The minimum reduction of fruit infestation of 66.70 percent was caused by Fipronil 0.01 percent.

Increase in damage percentage is due to periodical harvesting of the cucumber fruits. Due to harvesting in earlier days lowest number of fruits with higher damage percentage is recorded. So, efficacy is fumigant is reduced in 7th day after spraying.

On the 10th day

The data presented in Table 2 and Fig. 2 on reduction of fruit infestation of fruit fly recorded at ten day after first spray revealed that the treatment of Profenophos @ 0.05 percent caused maximum reduction of fruit infestation of 20.17 percent and it was at par with treatment of Lambda-cyhalothrin 0.005 percent 26.14 percent reduction of fruit infestation.

Malathion @ 0.1 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent, Spinosad 0.018 percent and Polytrin C 0.044 percent were in the next effective group of treatments caused 26.14, 28.79, 30.67, 32.42 and 35.85 percent reduction of fruit infestation, respectively on the 9th day after the spray application.

The minimum reduction of infestation of 40.89 percent was caused by Dichlorovos @ 0.05 percent followed by Fipronil 0.01 percent in which, 42.88 percent reduction of fruit infestation was recorded.

Increase in damage percentage is due to periodical harvesting of the cucumber fruits. Due to harvesting in earlier days lowest number of fruits with higher damage percentage is recorded. So, efficacy is fumigant is reduced in 10th day after spraying.

3.1.2 Weight basis

On the 3rd day

The data presented in Table 2 and Fig. 3 on infestation of fruit fly recorded at three day after first spray revealed that the treatment of Dichlorovos @ 0.05 percent caused reduction of fruit infestation of 14.18 percent and it was at par with treatment of Lambda-cyhalothrin 0.005 percent (18.41) and Malathion @ 0.1 percent (22.16).

Profenophos @ 0.05 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent and Spinosad 0.018 percent were in the next effective group of treatments caused 24.20, 26.44, 29.51 and 33.80 percent reduce fruit infestation, respectively on the 3rd day after the spray application.

The minimum reduction of fruit infestation 37.47 percent was caused by Polytrin C 0.044 percent followed by Fipronil 0.01 percent in which, 40.18 percent reductuion of infestation was recorded.

On the 5th day

The data presented in Table 2 and Fig. 3 on reduction of fruit infestation of fruit fly recorded at five day after first spray revealed that the treatment of Dichlorovos @ 0.05 percent caused maximum reduction of fruit infestation of 13.46 percent.

Lambda-cyhalothrin 0.005 percent, Malathion @ 0.1 percent, Profenophos @ 0.05 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent and Spinosad 0.018 percent were in the next effective group of treatments caused 18.83, 21.69, 22.92, 26.34, 28.46 and 32.01 percent pest mortality, respectively on the 5th day after the spray application.

The minimum reduction of fruit infestation of 34.49 percent was caused by Polytrin C 0.044 percent followed by Fipronil 0.01 percent in which, 36.23 percent mortality was recorded.

On the 7th day

The data presented in Table 2 and Fig. 3 on reduction of fruit infestation recorded at seven day after first spray revealed that the treatment of Spinosad 0.018 percent caused maximum reduction of fruit infestation of 00.00 percent and it was at par with treatment of Profenophos @ 0.05 percent 4.97 percent reduction of fruit infestation.

Lambda-cyhalothrin 0.005 percent, Malathion @ 0.1 percent, Clorantraniliprole 0.012 percent, Polytrin C 0.044 percent, Dichlorovos @ 0.05 percent and Bifenthrin 0.005 percent were in the next effective group of treatments caused 5.08, 6.05, 6.06, 6.14, 7.14 and 7.17 percent reduction of fruit infestation, respectively on the 7th day after the spray application.

The minimum reduction of fruit infestation of 8.32 percent was caused by Fipronil 0.01 percent.

Increase in damage percentage is due to periodical harvesting of the cucumber fruits. Due to harvesting in earlier days lowest number of fruits with higher damage percentage is recorded. So, efficacy is fumigant is reduced in 7th day after spraying.

On the 10th day

The data presented in Table 2 and Fig. 3 on reduction of fruit infestation of fruit fly recorded at ten day after first spray revealed that the treatment of Profenophos @ 0.05 percent caused maximum reduction of fruit infestation of 21.16 percent and it was at par with treatment of Lambda-cyhalothrin 0.005 percent 24.32 percent reduction of fruit infestation.

Malathion @ 0.1 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent, Spinosad 0.018 percent and Polytrin C 0.044 percent were in the next effective group of treatments caused 25.16, 27.31, 29.86, 31.32 and 34.43 percent reduction of fruit infestation, respectively on the 9th day after the spray application.

The minimum reduction of fruit infestation of 38.51 percent was caused by Dichlorovos @ 0.05 percent followed by Fipronil 0.01 percent in which, 38.82 percent reduction of fruit infestation was recorded.

Increase in damage percentage is due to periodical harvesting of the cucumber fruits. Due to harvesting in earlier days lowest number of fruits with higher damage percentage is recorded. So, efficacy is fumigant is reduced in 7th day after spraying.

Table 2: Efficacy of different insecticides against *B. cucurbitae* on cucumber crop during *kharif*-2015 (First spray)

No.	Treatments	Concentration	Fruit infestation (%)							
			Number basis				Weight basis			
			3 DAS	5 DAS	7 DAS	10 DAS	3 DAS	5 DAS	7 DAS	10 DAS
T_1	Fipronil 5 SC	0.01%	46.38* (52.41)	41.81* (44.45)	54.76 (66.70)	40.91 (42.88)	39.33 (40.18)	37.01 (36.23)	16.77 (8.32)	38.54 (38.82)
T_2	Dichlorvos 76 EC	0.05%	28.29 (22.46)	26.92 (20.50)	45.00 (50.00)	39.75 (40.89)	22.12 (14.18)	21.52 (13.46)	19.74 (7.14)	38.36 (38.51)
T_3	Polytrin C 44 EC	0.044%	44.95 (49.91)	38.96 (39.53)	39.20 (39.94)	36.78 (35.85)	37.74 (37.47)	35.97 (34.49)	14.35 (6.14)	35.93 (34.43)
T_4	Profenophos 50 EC	0.05%	35.00 (32.91)	33.47 (30.42)	29.85 (24.78)	26.69 (20.17)	29.47 (24.20)	28.60 (22.92)	12.89 (4.97)	27.38 (21.16)
T_5	Spinosad 45 SC	0.018%	44.17 (48.54)	37.93 (37.79)	0.00 (0.00)	34.71 (32.42)	35.55 (33.80)	34.46 (32.01)	0.00 (0.00)	34.03 (31.32)
T_6	Lambda-cyhalothrin 5 EC	0.005%	31.55 (27.37)	29.46 (24.19)	34.98 (32.87)	30.29 (25.44)	25.41 (18.41)	25.71 (18.83)	13.03 (5.08)	29.55 (24.32)
T_7	Malathion 50 EC	0.1%	33.08 (29.79)	32.77 (29.29)	39.16 (39.88)	30.75 (26.14)	28.08 (22.16)	27.75 (21.69)	14.23 (6.05)	30.10 (25.16)
T_8	Clorantraniliprole 40 EC	0.012%	41.23 (43.44)	38.83 (39.32)	54.81 (66.78)	33.63 (30.67)	32.91 (29.51)	32.24 (28.46)	14.25 (6.06)	33.13 (29.86)
T_9	Bifenthrin 10 EC	0.005%	37.88 (37.70)	36.20 (34.88)	45.14 (50.25)	32.45 (28.79)	30.94 (26.44)	30.88 (26.34)	15.53 (7.17)	31.51 (27.31)
T_{10}	Control Untreated (Check)	------	47.95 (55.14)	46.36 (52.37)	43.42 (47.25)	41.61 (44.10)	40.43 (42.06)	39.12 (39.81)	18.41 (9.97)	39.16 (39.87)
S. Em.±			2.42	1.75	1.88	2.08	1.85	1.56	0.65	1.59
C.D. at 5%			7.18	5.21	5.57	6.17	5.50	4.64	1.89	4.73
C.V. %			10.71	8.37	8.41	10.35	9.95	8.63	8.45	8.16

*Arcsine transformation
Figures in parentheses are retransformed values
DAS: Days after spray

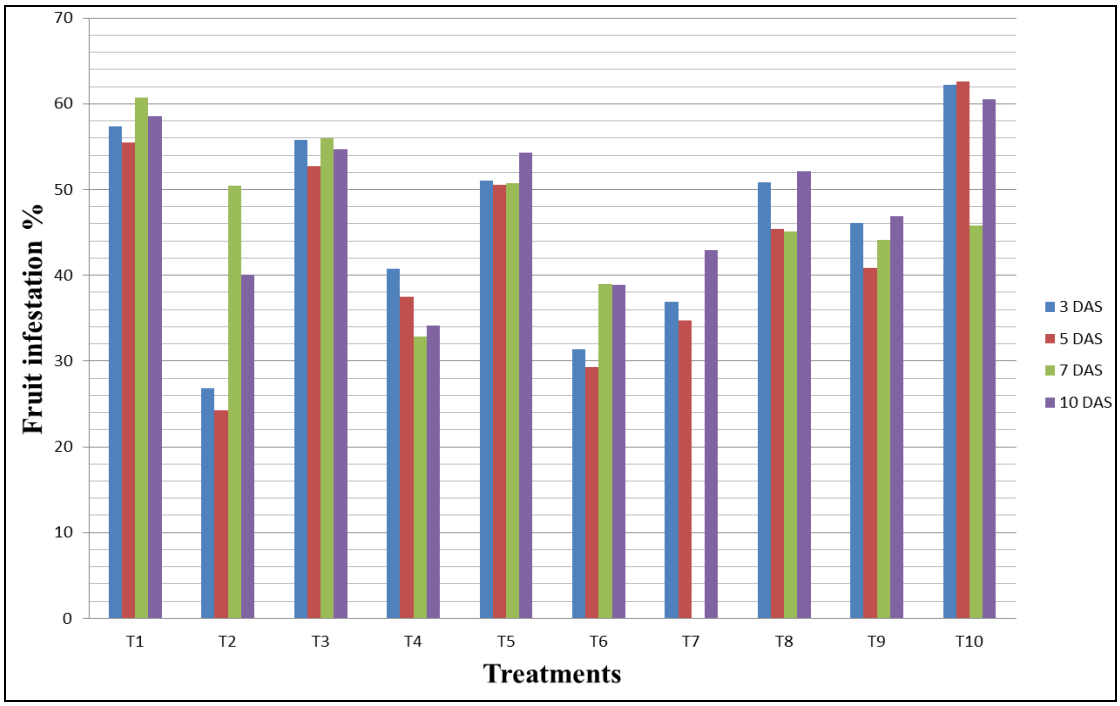

Fig 2: Efficacy of the insecticides against cucumber fruit fly on number basis (first spray)

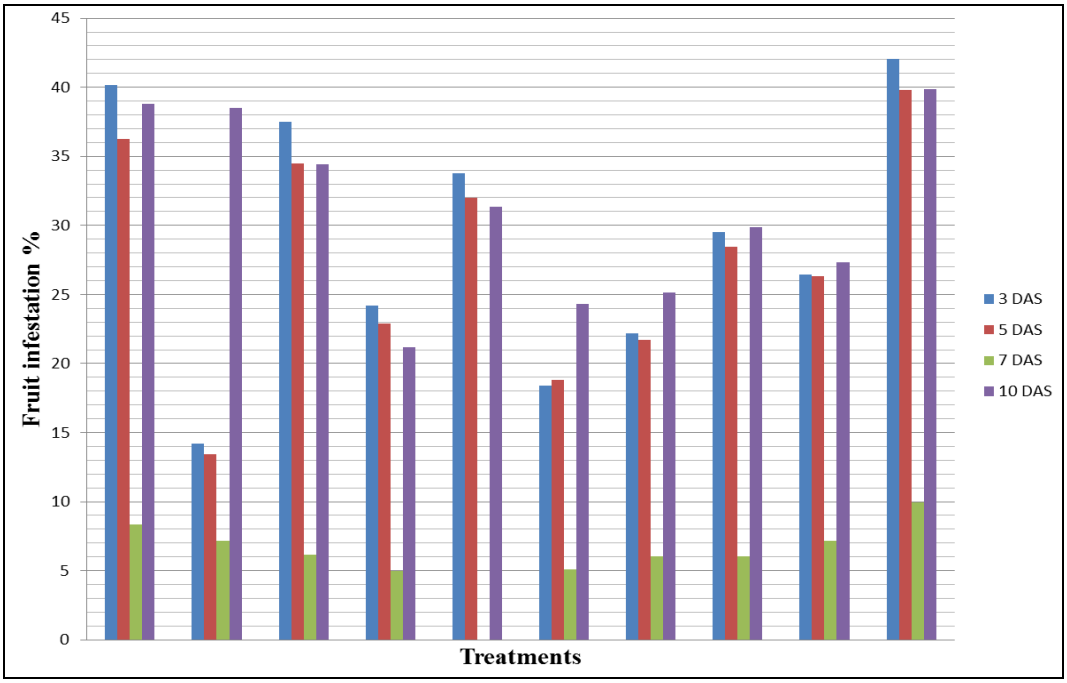

Fig 3: Efficacy of the insecticides against cucumber fruit fly on weight basis (first spray)

3.2 Infestation after 2nd application

3.2.1 Number basis

On the 3rd day

The data presented in Table 3 and in Fig. 4 on infestation of fruit fly recorded at three day after first spray revealed that the treatment of Dichlorovos @ 0.05 percent caused reduction of fruit infestation of 26.85 percent and it was at par with treatment of Lambda-cyhalothrin 0.005 percent (31.39) and Malathion @ 0.1 percent (36.87).

Profenophos @ 0.05 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent and Spinosad 0.018 percent were in the next effective group of treatments caused 40.77, 46.08, 50.79 and 51.08 percent reduction of fruit infestation, respectively on the 3rd day after the spray application.

The minimum reduction of fruit infestation 55.81 percent was caused by Polytrin C 0.044 percent followed by Fipronil 0.01 percent in which, 57.38 percent reductuion of infestation was recorded.

On the 5th day

The data presented in Table 3 and in Fig. 4 on reduction of fruit infestation of fruit fly recorded at five day after first spray revealed that the treatment of Dichlorovos @ 0.05 percent caused maximum reduction of fruit infestation of 24.29 percent.

Lambda-cyhalothrin 0.005 percent, Malathion @ 0.1 percent, Profenophos @ 0.05 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent and Spinosad 0.018 percent were in the next effective group of treatments caused 29.33, 34.76, 37.45, 40.84, 45.43 and 50.52 percent pest mortality, respectively on the 5th day after the spray application.

The minimum reduction of infestation of 52.71 percent was caused by Polytrin C 0.044 percent followed by Fipronil 0.01 percent in which, 55.44 percent reduction of fruit infestation was recorded.

On the 7th day

The data presented in Table 3 and in Fig. 4 on reduction of fruit infestation recorded at seven day after first spray revealed that the treatment of Malathion @ 0.1 percent caused maximum reduction of fruit infestation of 00.00 percent and it was at par with treatment of Profenophos @ 0.05 percent 32.83 percent reduction of fruit infestation.

Lambda-cyhalothrin 0.005 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent, Dichlorovos @ 0.05 percent, Spinosad 0.018 percent and Polytrin C 0.044 percent were in the next effective group of treatments caused 38.96, 44.14, 45.11, 50.46, 50.52 and 52.71 percent reduction of fruit infestation, respectively on the 7th day after the application.

The minimum reduction of fruit infestation of 60.77 percent was caused by Fipronil 0.01 percent.

On the 10th day

The data presented in Table 3 and in Fig. 4 on reduction of fruit infestation of fruit fly recorded at ten day after first spray revealed that the treatment of Profenophos @ 0.05 percent caused maximum reduction of fruit infestation of 34.14percent and it was at par with treatment of Lambda-cyhalothrin 0.005 percent 38.85 percent reduction of fruit infestation.

Dichlorovos @ 0.05 percent, Malathion @ 0.1 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent and Spinosad 0.018 percent percent were in the next effective group of treatments caused 40.04, 42.91, 46.85, 52.08 and 54.27 percent reduction of fruit infestation, respectively on the 9th day after the application.

The minimum reduction of fruit infestation of 54.66 percent was caused by Polytrin C 0.044 percent followed by Fipronil 0.01 percent in which, 58.55 percent was recorded.

3.2.2 Weight basis

On the 3rd day

The data presented in Table 3 and in Fig. 5 on infestation of fruit fly recorded at three day after first spray revealed that the treatment of Dichlorovos @ 0.05 percent caused reduction of fruit infestation of 18.17 percent and it was at par with treatment of Lambda-cyhalothrin 0.005 percent (21.40) and Malathion @ 0.1 percent (24.64).

Profenophos @ 0.05 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent and Spinosad 0.018 percent

were in the next effective group of treatments caused 26.72, 28.21, 30.61 and 31.67 percent reduce fruit infestation, respectively on the 3rd day after the application.
The minimum reduction of fruit infestation 32.67 percent was caused by Polytrin C 0.044 percent followed by Fipronil 0.01 percent in which, 34.28 percent reductuion of infestation was recorded.

On the 5th day
The data presented in Table 3 and in Fig. 5 on reduction of fruit infestation of fruit fly recorded at five day after first spray revealed that the treatment of Dichlorovos @ 0.05 percent caused maximum reduction of fruit infestation of 16.37 percent.
Lambda-cyhalothrin 0.005 percent, Malathion @ 0.1 percent, Profenophos @ 0.05 percent, Bifenthrin 0.005 percent, Clorantraniliprole 0.012 percent and Spinosad 0.018 percent were in the next effective group of treatments caused 19.38, 22.49, 24.45, 26.59, 28.42 and 29.71 percent reduction of fruit infestation, respectively on the 5th day after the spray application.
The minimum reduction of infestation of 31.29 percent was caused by Polytrin C 0.044 percent followed by Fipronil 0.01 percent in which, 33.23 percent reduction of infestation was recorded.

On the 7th day
The data presented in Table 3 and in Fig. 5 on reduction of fruit infestation recorded at seven day after first spray revealed that the treatment of Malathion @ 0.1 percent caused maximum reduction of fruit infestation of 00.00 percent and it was at par with treatment of Profenophos @ 0.05 percent 4.94 percent reduction of fruit infestation.
Dichlorovos @ 0.05 percent, Lambda-cyhalothrin 0.005 percent, Bifenthrin 0.005 percent, Polytrin C 0.044 percent, Clorantraniliprole 0.012 percent and Spinosad 0.018 percent were in the next effective group of treatments caused 6.15, 6.23, 7.09, 7.35, 8.39 and 8.41 percent reduction of fruit infestation, respectively on the 7th day after the application.
The minimum reduction of fruit infestation of 11.31 percent was caused by Fipronil 0.01 percent.

On the 10th day
The data presented in Table 3 and in Fig. 5 on reduction of fruit infestation of fruit fly recorded at ten day after first spray revealed that the treatment of Profenophos @ 0.05 percent caused maximum reduction of fruit infestation of 20.12 percent and it was at par with treatment of Lambda-cyhalothrin 0.005 percent 21.08 percent reduction of fruit infestation.
Malathion @ 0.1 percent, Bifenthrin 0.005 percent, Dichlorovos @ 0.05 percent, Clorantraniliprole 0.012 percent, Spinosad 0.018 percent and were in the next effective group of treatments caused 23.20, 26.26, 30.32, 30.61 and 32.36 percent reduction of fruit infestation, respectively on the 10th day after the application.
The minimum reduction of fruit infestation of 32.63 percent was caused by Polytrin C 0.044 percent followed by Fipronil 0.01 percent in which, 34.47 percent reduction of fruit infestation was recorded.
These results are broadly supported by the findings of Bhatnagar *et al.* (1992) who also reported the effectiveness of Malathion against *Bectrocera cucurbitae* in bottle gourd, sponge gourd and ridge gourd. Khan *et al.* (1992) also reported high toxicity and reproductive inhibitory effect of Malathion against *Bectrocera cucurbitae* in melon. Another best treatment was Lambda-cyhalothrin in terms of reduction in fruit infestation. The low water solubility and high binding affinity of Lambda-cyhalothrin with plant surface might have contributed in its bioefficacy against fruit flies. These findings fall in line with the results of various previous worker. Oke (2008) observed reduction in *Bectrocera cucurbitae* pupae with the spray of Lambda-cyhalothrin on cucumber. Patel (1989), Sanja (2005) and Patel (1994) recorded lowest fruit infestation by *Bectrocera cucurbitae* in Malathion and Dichlorovos. Sood *et al.* (2004) had reported the efficacy of Dichlorovos and Lambda-cyhalothrin against fruit flies in terms of reduction in fruit infestation and fumigant action. Waseem *et al.* (2009) also found Lambda-cyhalothrin most effective against *Bectrocera cucurbitae* on cucurbits. In spite of best results in terms of reducing the fruit damage, Dichlorovos, Lambda-cyhalothrin and malathion had lower cost benefit ratio followed by other treatments. Thus, the results obtained in the present investigation are indicated that Dichlorovos, Lambda-cyhalothrin and malathion is effective and also economically viable treatment for fruit fly management.

3.3 Economics
The economics of various treatments was worked out on the basis of current market price of cucumber and management cost which includes price of insecticides and labour charges and finally ICBR values for each treatment was worked out and summarized in Table 4 and fig 6.
It is evident from the data presented in Table 4 indicated that the net realization of different treatments varied from 4000 to 60040 ₹/ha. The treatment of Dichlorovos @ 0.05 percent recorded maximum net realization i.e. 60040 ₹/ha, followed Lambda-cyhalothrin 0.005 percent (45740 ₹/ha), Malathion @ 0.1 percent (34240 ₹/ha), Profenophos @ 0.05 percent (24360 ₹/ha), Bifenthrin 0.005 percent (18260 ₹/ha), Clorantraniliprole 0.012 percent (14540 ₹/ha), Spinosad 0.018 percent (10220 ₹/ha), whereas, minimum net realization was observed in the treatment of Polytrin C 0.044 percent (7940 ₹/ha) followed by Fipronil 0.01 percent (4000 ₹/ha).
The ICBR of different treatments were worked out (Table 4). Among different treatments the highest ICBR i.e. 1: 62.21 was recorded in the treatment of Dichlorovos @ 0.05 percent followed by Lambda-cyhalothrin 0.005 percent (1: 31.65), Malathion @ 0.1 percent (1: 32.30), Profenophos @ 0.05 percent (1: 15.23) and Bifenthrin 0.005 percent (1: 13.08).
Whereas, the lowest ICBR was observed in the treatment Clorantraniliprole 0.012 percent (1: 1.94) followed by Spinosad 0.018 percent (1: 0.98), Polytrin C 0.044 percent (1: 5.07) and Fipronil 0.01 percent (1: 1.06).

Table 3: Efficacy of different insecticides against *B. cucurbitae* on cucumber crop during *kharif*-2015 (Second spray)

No.	Treatments	Concentration	Fruit infestation (%)							
			Number basis				Weight basis			
			3 DAS	5 DAS	7 DAS	10 DAS	3 DAS	5 DAS	7 DAS	10 DAS
T_1	Fipronil 5 SC	0.01%	49.24* (57.38)	48.12* (55.44)	51.22 (60.77)	49.92 (58.55)	35.84 (34.28)	35.20 (33.23)	19.65 (11.31)	35.95 (34.47)
T_2	Dichlorvos 76 EC	0.05%	31.21 (26.85)	29.53 (24.29)	45.26 (50.46)	39.25 (40.04)	25.23 (18.17)	23.86 (16.37)	14.36 (6.15)	33.41 (30.32)
T_3	Polytrin C 44 EC	0.044%	48.34 (55.81)	46.55 (52.71)	48.45 (56.01)	47.67 (54.66)	34.86 (32.67)	34.01 (31.29)	15.73 (7.35)	34.83 (32.63)
T_4	Profenophos 50 EC	0.05%	39.68 (40.77)	37.73 (37.45)	34.96 (32.83)	35.76 (34.14)	31.12 (26.72)	29.64 (24.45)	12.85 (4.94)	26.65 (20.12)
T_5	Spinosad 45 SC	0.018%	45.62 (51.08)	45.30 (50.52)	45.43 (50.75)	47.45 (54.27)	34.25 (31.67)	33.03 (29.71)	16.86 (8.41)	34.67 (32.36)
T_6	Lambda-cyhalothrin 5 EC	0.005%	34.07 (31.39)	32.79 (29.33)	38.62 (38.96)	38.56 (38.85)	27.56 (21.40)	26.12 (19.38)	14.46 (6.23)	27.33 (21.08)
T_7	Malathion 50 EC	0.1%	37.39 (36.87)	36.13 (34.76)	0.00 (0.00)	40.93 (42.91)	29.76 (24.64)	28.31 (22.49)	0.00 (0.00)	28.80 (23.20)
T_8	Clorantraniliprole 40 EC	0.012%	45.45 (50.79)	42.38 (45.43)	45.06 (45.11)	46.19 (52.08)	33.59 (30.61)	32.21 (28.42)	16.84 (8.39)	33.59 (30.61)
T_9	Bifenthrin 10 EC	0.005%	42.75 (46.08)	39.72 (40.84)	41.64 (44.14)	43.19 (46.85)	32.08 (28.21)	31.04 (26.59)	15.44 (7.09)	30.82 (26.26)
T_{10}	Control Untreated (Check)	-----	52.04 (62.16)	52.30 (62.61)	42.59 (45.79)	51.08 (60.53)	38.38 (38.55)	40.59 (42.34)	14.64 (6.39)	36.99 (36.19)
S. Em.±			2.00	1.92	2.01	2.12	1.73	1.38	0.76	1.70
C.D. at 5%			5.93	5.69	5.96	6.28	5.14	4.06	2.25	5.04
C.V. %			8.12	8.08	8.83	8.33	9.29	9.16	9.33	9.10

*Arcsine transformation
Figures in parentheses are retransformed values
DAS: Days after spray

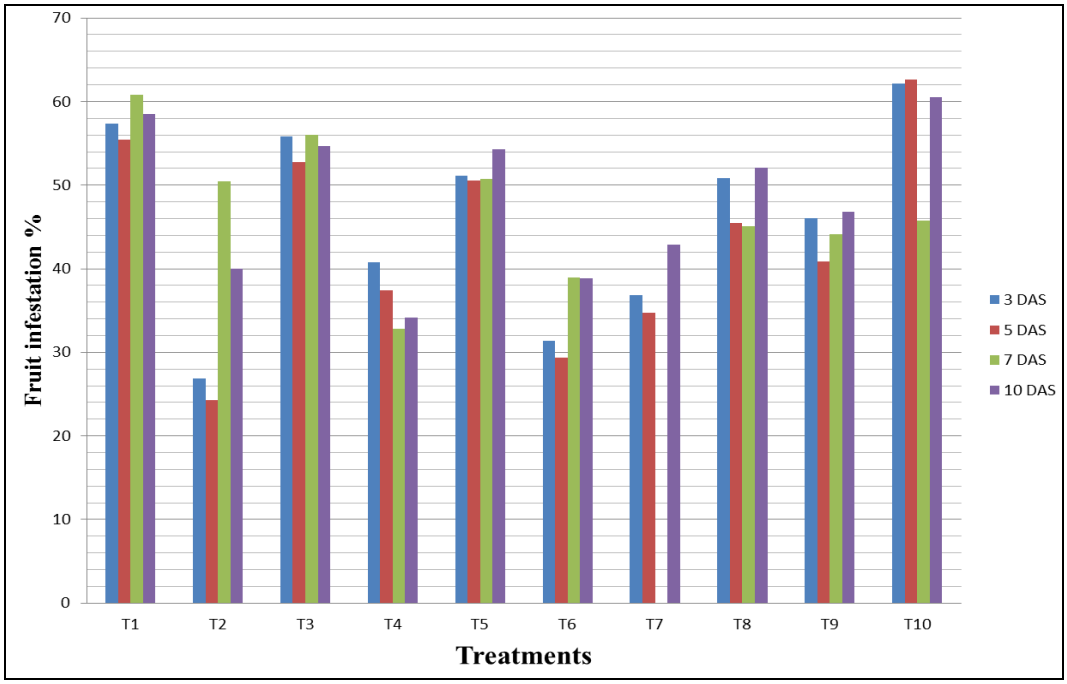

Fig 4: Efficacy of the insecticides against cucumber fruit fly on number basis (Second spray)

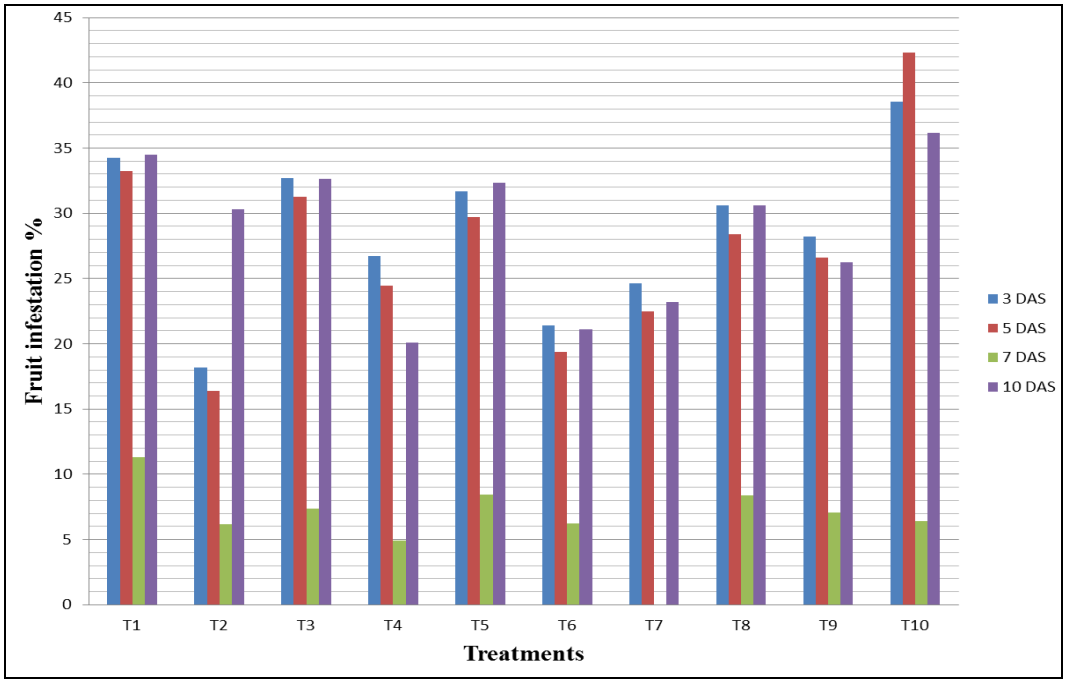

Fig 5: Efficacy of the insecticides against cucumber fruit fly on weight basis (Second spray)

Table 4: Economics of different treatments for the control of fruit fly in cucumber during *Kharif* 2015

S. No	Treatment	Quantity of insecticide required for two sprays (lit /ha)	Price of insecticide per lit or kg (Rs.)	Total cost of insecticide including labour charges (Rs/ha)	Cucumber fruit yield (kg/ha)	Gross realization (Rs/ha)	Net realization (Rs/ha)	Cost benefit ratio (CBR)
1	Fipronil 5 SC 0.01%	2.80	1160	3748	3243	64860	4000	1 : 1.06
2	Dichlorvos 76 EC 0.05%	0.92	505	965	6045	120900	60040	1 : 62.21
3	Polytrin C 44 EC 0.044%	1.40	760	1564	3440	68800	7940	1 : 5.07
4	Profenophos 50 EC 0.05%	1.40	785	1285	4261	85220	24360	1 : 18.95
5	Spinosad45 SC 0.018%	0.56	17700	10412	3554	71080	10220	1 : 0.98
6	Lambda-cyhalothrin 5 EC 0.005%	1.40	675	1445	5330	106600	45740	1 : 31.65
7	Malathion 50 EC 0.1%	2.80	200	1060	4755	95100	34240	1 : 32.30
8	Clorantraniliprole 40 EC 0.012%	0.42	16583	7465	3770	75400	14540	1 : 1.94
9	Bifenthrin 10 EC 0.005%	0.70	1280	1396	3956	79120	18260	1 : 13.08
10	Control untreated (Check)	----	----	----	3043	60860	---	---

Labour charges Rs. 250/day
Market value cucumber fruits have been calculated @ Rs. 20/kg.

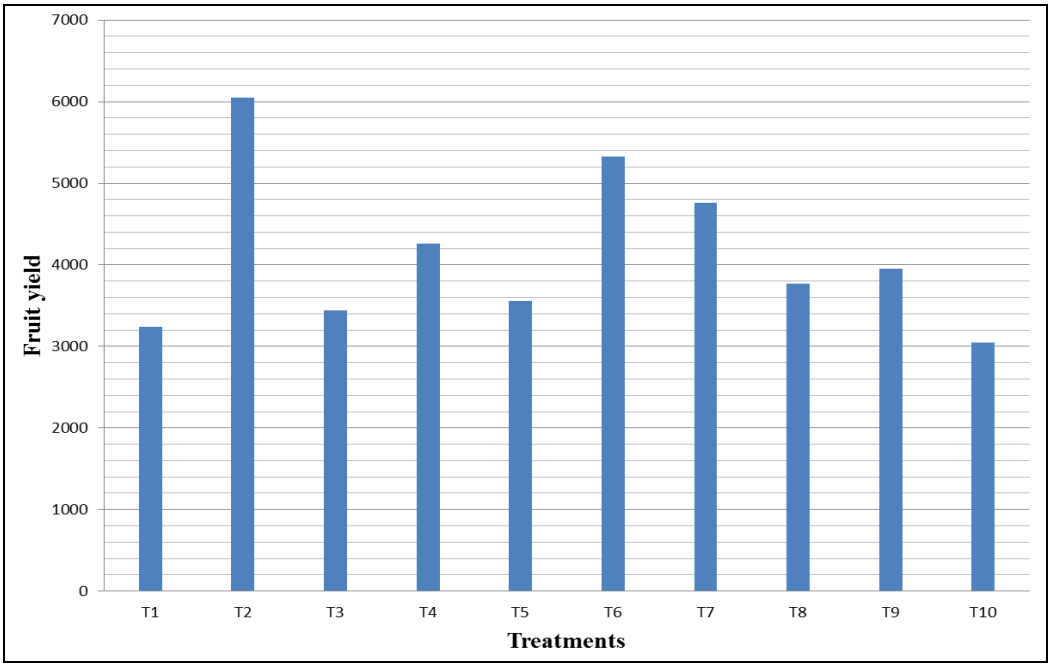

Fig 6: Treatment wise yield of cucumber fruit production

4. Conclusion

Thus, the results of the two spraying of the insecticides against the cucumber fruit fly revealed that Dichlorovos @ 0.05 percent, Lambda-cyhalothrin 0.005 percent and Malathion @ 0.1 percent were more effective treatments against the pest as compared to other treatments. Among the various insecticides, Dichlorovos @ 0.05 percent recorded the highest fruit yield i.e. 6045 kg/ha which was found statistically at par with Lambda-cyhalothrin 0.005 percent (5330 kg/ha), Malathion @ 0.1 percent (4755 kg/ha) and Profenophos @ 0.05 percent (4261 kg/ha). The treatment of Dichlorovos @ 0.05 percent recorded maximum net realization i.e. 60040 ₹/ha, followed Lambda-cyhalothrin 0.005 percent (45740 ₹/ha), Malathion @ 0.1 percent (34240 ₹/ha). Among different treatments the highest ICBR i.e. 1: 62.21 was recorded in the treatment of Dichlorovos @ 0.05 percent followed by Lambda-cyhalothrin 0.005 percent (1: 31.65), Malathion @ 0.1 percent (1: 32.30).

5. Future Prospective

Prospects for using this knowledge alongside genomic information in Tephritidae to develop novel strategies of potential practical importance for resistance management of this pest against insecticides. Also there is possibilities of insect control or eradication through the use of sexually sterile males and cue lure baited traps.

6. Acknowledgement

The authors are thankful to Dr. D. M. Jethva, Associate Research Scientist, Bio control Research Laboratory, Department of Entomology, College of Agriculture, JAU, Junagadh for necessary support during study, also thankful to Professor and Head, Department of Entomology, JAU, Junagadh, The Principle and Dean, College of Agriculture, JAU, Junagadh and Director of Research and Dean P. G. Studies, JAU, Junagadh

7. References

1. Alim MA, Hossain MA, Khan M, Khan SA, Islam MS, Khalequzzaman M *et al*. Seasonal variations of melon fly, *Bectrocera cucurbitae* (Coquillet) (Diptera: Tephritidae) in different agricultural habitats of Bangladesh. ARPN Journal of Agricultural and Biological Science. 2012; 7:11.
2. Bhatnagar KN, Yadava SRS. An insecticidal trial for reducing the damage of some cucurbitaceous fruits due to *Bectrocera cucurbitae* (Coquillet). Indian J Ent. 1992; 54(1):66-69.
3. Bose TK, Kabir J, Maity TK, Parthasarathy VA, Som MG. Cucumber in vegetable crops. Vol. 1, Kalyani Publishers, Ludhiana, 2002, 493-494.
4. Khan L, Inayatullah C, Manzoor Ul Haq. Control of melon fly, *Bectrocera cucurbitae* (Coquillet) (Diptera: Trypetidae) on melon in Pakistan. Trop. Pest Manag. 1992; 38(3):261-264.
5. Oke OA. Effectiveness of two insecticides to control melon fruit fly *Bactrocera cucurbitae* (Coquillet) in cucmber (*Cucumis sativus* L.). European J. Sci. Res. 2008; 22(1): 84-86.
6. Pareek BE, kavadia VS. Relative preference of fruit fly, *Bectrocera Cucurbitae* (Coquillet) on different cucurbits. Indian J Ent. 1974; 56(1):72-75.
7. Patel MM. Studies on bionomics and control of cucurbit fruit fly *Bectrocera cucurbitae* (coquillet) under Junagadh condition. M. Sc. (Agri.) thesis submitted to G.A.U, Junagadh, 1994.
8. Patel NV. Biology of fruit fly, *Bectrocera cucurbitae* (Coquillet) on cucurbits and chemical control on bitter gourd. M.Sc. (Agri.) thesis submitted to G.A.U, Navsari, 1989.
9. Ranganath HR, Suryanarayan MA, Kumari VK. Management of melon fly in cucurbits in south Adaman. Insect Environment. 1997; 3(2):32-33.
10. Sanja HG. Biology, population dynamics and chemical control of melon fruit fly (*Dacus cucurbitae* Coquillet) on bitter gourd. M.Sc. (Agri.) thesis submitted to J.A.U, Junagadh, 2005.
11. Sheikh K, Desh R. Bio-efficacy of certain insecticides and biopesticides against melon fruit flies, *Bectrocera spp*. Pest Manag. In Horti. Ecosy. 2012; 18(2):143-148.

12. Shivarkar DT, Dumbre RB. Bionomics and chemical control of cucurbits fruit fly, *Bectrocera cucurbitae* (Coquillet). J Maharashtra Agric. Univ. 1985; 103:298-300.
13. Sood N, Sharma DC. Bioefficacy and persistant toxicity of different insecticides and neem derivatives against cucurbits fruit fly, *Bectrocera cucurbitae* (Coqillet) on summer squash. Pesticide Research Journal, 2004; 16(2):22-25.
14. Thamburaj S, Singh N. Text Books of Vegetables, Tuber crops and Spices. Vol., Kalyani publishers, Ludhiana. 2003; 3:254-261.
15. Vanitha SM, Chaurasia SNS, Singh PM, Naik PS. Vegetable Statistics. *Technical Bulletin*, IIVR, Varanasi. 2013; 51:223.
16. Waseem MA, Nagangoud A, Patil BV, Hussain PA. Efficacy of some insecticides against melon fly, *Bectrocera cucurbitae* (Coquillett) on cucumber. Karnataka J Agric. Sci. 2009; 22(3):701-702.