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Environment friendly management of thrips and fruit flies on cucumber

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Abstract
An experiment entitled "Environment friendly management of thrips and fruit flies on cucumber" was conducted at PG Research Farm, Department of Agricultural Entomology, Mahatma Phule Krishi Vidyapeeth, Rahuri during *summer* 2022. From the studies on environment friendly management of thrips and fruit flies on cucumber it was found that, the treatment with chemical insecticide tolfenpyrad 15 EC @ 150 g a.i/ha and flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha were found to be most promising treatments against cucumber thrips and fruit fly, respectively with least average survival population of thrips (4.24 thrips/plant) and minimum mean percent fruit damage of 3.96 percent, respectively. However, the treatment T7 (Mulching with polythene sheet of 25 µ size + Cue lure traps+ Azadirachtin 300 ppm) was found equally effective treatment in reducing thrips population (4.45 thrips/plant) and mean percent fruit damage (5.00%) caused by cucumber fruit fly as well. When compared with chemical insecticide treatment, the treatment T7 also gave highest marketable cucumber fruit yield of 331.33 q/ha over rest of the treatments.

Keywords: Cucumber, thrips, fruit fly, environment, insecticide

Introduction
In India, vegetables have occupied the important place in human diet. Among different vegetables Cucumber (*Cucumis sativus*) belonging to Cucurbitaceae family is an important annual vegetable crop widely cultivated round the year in India. The attack of insect pests is one of the significant factors limiting cucumber cultivation, they damage the crop by sucking cell sap and devitalise the plant. Thrips and fruit fly are one of the major and devastating pests of cucumber which causes heavy nuisance to the crop quality as well as yield. Thrips (*Thrips Tabaci* L.) are considered as one of the most devastating pests of cucumber due to its direct feeding habit which leads to damage plant parts such as foliage and flower. (Lall and Singh, 1968) [3]. Another important pest of cucumber is fruit fly, *Bactrocera cucurbitae* belongs to Tephritidae family. It is one of the largest, most diversified and fascinating acalypterate families of order Diptera which includes more than 4200 known species of true flies arranged in 471 genera (Norrbom *et al.*, 1998) [6]. For the complete success or for developing any other strategy for thrips and fruit fly management, this study is helpful in developing efficient management strategies that will prevent ill effects of insecticides (Mir *et al*., 2014) [5]. In India, there are different ways to control this pest such as use of insecticides as chemical control (Dashad *et al*., 1999) [1], combinations of insecticides and plant products (Saikia and Dutta, 1997) [9] and culture filtrates of fungi (Purnima *et al*., 1999) [7]. In this regard the bio efficacy of different treatments on the thrips and fruit flies infesting cucumber was carried out.

Materials and Methods
In order to study the bioefficacy of different treatments on thrips and fruit flies in cucumber, an experiment was carried out during *summer* 2022 at PG Research Farm, Department of Agril. Entomology, MPKV, Rahuri. The crop was sown in 100 m^2 with the spacing of 1.5 x 0.5 m. Observations on number of thrips per plant were taken at one day before spray as pre-count and at 3rd, 7th, 10th day after each spray as post count. Five plants were randomly selected from each treatment plot. Thrips population was recorded on three leaves from each randomly selected and tagged plant. The number of thrips per plant in various treatments on 3rd, 7th, 10th day after each spray were worked out for statistical analysis. The post treatment observations taken at 10 days after first spray were considered as pre-treatment count for second application. While the observations on percent fruit damage due to incidence of cucumber fruit fly, *B. cucurbitae* were recorded on number basis at each picking.

Percent fruit damage was worked out and transformed into arcsine values for statistical analysis. The data on yield of cucumber fruits from each plot was recorded at the time of each picking and then total yield from the plot (kg/plot) was converted to quintals per hectare. The yield of marketable fruits of cucumber were recorded from each treatment plot and worked out on hectare basis. With a view to evaluate the effect of different treatments on cucumber yield, fruits of net plot were harvested. The percent increase in yield over control was calculated by using formula:

$$\text{Yield increased over control (\%)} = \frac{T - C}{C} \times 100$$

Where
T = Yield of respective treatment (q/ha)
C = Yield of control (q/ha)

Statistical Analysis
The data on number of thrips per plant was transformed into square root trans formation $\sqrt{x + 0.5}$. However, data on percent fruit damage due to fruit fly was transformed into arcsine transformed values and then subjected to statistical analysis. The standard error (SE) and critical difference (CD) at 5% level of probability was calculated to determine efficacy of each treatment. The yield data was then subjected to statistical analysis.

Results and Discussion
1. Bioefficacy of different treatments against thrips, *T. tabaci* on cucumber during summer 2022
A field experiment was carried out to find out the bioefficacy of different environment friendly treatments against thrips on cucumber. Different treatments *viz.* Cue lure traps @ 20/ha, spraying of azadirachtin 300 ppm @ 5 ml/L, soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha (mixed with 25 kg FYM), mulching with polythene sheet of 25 µ size, combination of $T_1 + T_2$ *i.e.* Cue lure traps + azadirachtin 300 ppm, combination of $T_1 + T_2 + T_3$ *i.e.* Soil application of *M. anisopliae* 1.15 WP mixed with 25 kg FYM + Cue lure traps + azadirachtin 300 ppm, combination of $T_1 + T_2 + T_4$ *i.e.* Cue lure traps + azadirachtin 300 ppm + mulching with polythene sheet of 25µ size, tolfenpyrad 15 EC @ 150 g a.i/ha, flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha, water spray and untreated control were evaluated for their efficacy against thrips infesting cucumber during summer 2022. The observations on number of thrips/plant were recorded a day before each spray application as precount and at 3rd, 7th and 10th days after each spray. The post treatment observations taken at 10 days after first spray were considered as pretreatment count for second application.

After first spray
The data on mean number of thrips per plant after first spray revealed that, mean thrips population ranged from 7.09 to 15.86 thrips/plant (Table 1). From the results it was revealed that, treatment with tolfenpyrad 15 EC @ 150 g a.i/ha recorded least mean population of thrips (7.09 thrips/plant) and was followed by the treatments T_7 (Mulching with polythene sheet of 25 µ size + Cue lure traps+ Azadirachtin 300 ppm), (treatment T_2 spraying of azadirachtin 300 ppm) and treatment T_5 (Cue lure traps + Azadirachtin 300 ppm) with 7.40, 7.53, 7.82 thrips/plant, respectively and were at par with each other.

Table 1: Bioefficacy of different treatments against thrips, *T. tabaci* on cucumber after first spray

Tr. No.	Treatment	Dose (g or ml)	Number of thrips/plant				
			Pre-count	3 DAS**	7 DAS	10 DAS	Mean
T_1	Cue lure traps @ 20/ha	-	14.07 (3.79)*	14.87 (3.92)	15.07 (3.94)	16.44 (4.10)	15.46 (3.99)
T_2	Azadirachtin 300 ppm	5 ml/L.	13.33 (3.72)	7.00 (2.74)	7.47 (2.82)	8.13 (2.94)	7.53 (2.83)
T_3	Soil application of *M. anisopliae* 1.15 WP (Mixed with 25 kg FYM)	5 kg/ha	13.20 (3.70)	8.24 (2.96)	8.80 (3.05)	8.81 (3.05)	8.62 (3.02)
T_4	Mulching with polythene sheet of 25 µ size	-	13.87 (3.79)	8.36 (2.98)	9.07 (3.09)	9.40 (3.15)	8.94 (3.07)
T_5	Cue lure traps @ 20/ha + Azadirachtin 300 ppm @ 5ml/L	-	14.20 (3.83)	7.13 (2.76)	8.00 (2.92)	8.33 (2.97)	7.82 (2.88)
T_6	Soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha + Cue lure traps @ 20/ha + Azadirachtin 300 ppm @ 5ml/L	-	13.93 (3.80)	8.12 (2.94)	8.70 (3.03)	8.73 (3.04)	8.52 (3.00)
T_7	Mulching with polythene sheet of 25 µ size + Cue lure traps @ 20/ha+ Azadirachtin 300 ppm @ 5 ml/L	-	13.67 (3.76)	6.87 (2.71)	7.33 (2.80)	8.00 (2.92)	7.40 (2.81)
T_8	Tolfenpyrad 15 EC @ 150 g a.i/ha	2 ml/L.	14.07 (3.82)	6.73 (2.69)	7.13 (2.75)	7.40 (2.80)	7.09 (2.75)
T_9	Flubendiamide 8.33 + Deltamethrin 5.56 SC w/w SC @ 250 g a.i/ha	0.5 ml/L.	13.13 (3.69)	8.02 (2.92)	8.53 (3.00)	8.67 (3.02)	8.41 (2.98)
T_{10}	Water spray @ 500 lit/ha	-	14.40 (3.86)	11.07 (3.39)	12.40 (3.59)	13.73 (3.77)	12.40 (3.59)
T_{11}	Untreated control	-	14.27 (3.84)	15.13 (3.95)	15.93 (4.05)	16.53 (4.13)	15.86 (4.05)
	S.E.(m) ±	-	0.13	0.07	0.08	0.06	0.07
	C.D. at 5%	-	N.S.	0.21	0.24	0.19	0.21

*Figures in the parentheses are ($\sqrt{x + 0.5}$) transformations **DAS- Days after spraying

The next best treatment was treatment with flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha with 8.41 thrips/plant and was found at par with treatment T_6 (Soil application of *M. anisopliae* 1.15 WP + Cue lure traps + Azadirachtin 300 ppm), (treatment T_3 soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha) and (mulching with polythene sheet of 25 µ size) with 8.52, 8.62 and 8.94 thrips/plant, respectively. The water spray was least effective with 12.40 thrips/plant. Whereas untreated control recorded maximum number of thrips (15.86 thrips/plant).

After second spray

Table 2: Bioefficacy of different treatments against thrips, *T. tabaci* on cucumber after second spray

Tr. No.	Treatment	Dose (g or ml)	Number of thrips/plant			
			3 DAS**	7 DAS	10 DAS	Mean
T_1	Cue lure traps @ 20/ha	-	15.93 (4.05)*	15.40 (3.99)	14.60 (3.88)	15.31 (3.98)
T_2	Azadirachtin 300 ppm	5 ml/L.	2.73 (1.80)	1.08 (1.25)	1.53 (1.42)	1.78 (1.51)
T_3	Soil application of *M. anisopliae* 1.15 WP (Mixed with 25 kg FYM)	5 kg/ha	4.67 (2.27)	2.80 (1.82)	3.33 (1.96)	3.60 (2.02)
T_4	Mulching with polythene sheet of 25 µ size	-	5.20 (2.38)	2.93 (1.84)	3.48 (1.99)	3.87 (2.09)
T_5	Cue lure traps @ 20/ha + Azadirachtin 300 ppm @ 5 ml/L	-	3.13 (1.90)	1.20 (1.30)	1.67 (1.47)	2.00 (1.58)
T_6	Soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha + Cue lure traps @ 20/ha + Azadirachtin 300 ppm @ 5 ml/L	-	4.07 (2.14)	2.13 (1.58)	2.87 (1.82)	3.02 (1.88)
T_7	Mulching with polythene sheet of 25 µ size + Cue lure traps @ 20/ha+ Azadirachtin 300 ppm @ 5ml/L	-	2.27 (1.65)	1.07 (1.24)	1.13 (1.27)	1.49 (1.41)
T_8	Tolfenpyrad 15 EC @ 150 g a.i/ha	2 ml/L.	2.20 (1.64)	0.93 (1.19)	1.07 (1.25)	1.40 (1.38)
T_9	Flubendiamide 8.33 + Deltamethrin 5.56 SC w/w SC @ 250 g a.i/ha	0.5 ml/L.	3.93 (2.11)	1.87 (1.54)	2.47 (1.71)	2.76 (1.80)
T_{10}	Water spray @ 500 lit/ha	-	11.40 (3.44)	10.93 (3.38)	12.27 (3.57)	11.53 (3.47)
T_{11}	Untreated control	-	16.73 (4.15)	15.60 (4.00)	14.93 (3.92)	15.75 (4.03)
	S.E.(m) ±	-	0.09	0.11	0.10	0.10
	C.D. at 5%	-	0.28	0.32	0.30	0.31

*Figures in the parentheses are ($\sqrt{x + 0.5}$) transformations **DAS- Days after spraying

The data on mean number of thrips per plant after the second spray revealed that, mean thrips population ranged from1.40 to 15.75 thrips/plant (Table 2). From the results it was revealed that, treatment with tolfenpyrad 15 EC @ 150 g a.i/ha recorded least mean population of thrips (1.40 thrips/plant) and was followed by the treatments T_7 (Mulching with polythene sheet of 25 µ size + Cue lure traps+ Azadirachtin 300 ppm), (treatment T_2 azadirachtin 300 ppm) and treatment T_5 (Cue lure traps + Azadirachtin 300 ppm) with 1.49, 1.78, 2.00 thrips/plant, respectively and were at par with each other. The next best treatment was treatment with flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha (2.76 thrips/plant and was found at par with treatments T_6 (Soil application of *M. anisopliae* 1.15 WP + Cue lure traps + Azadirachtin 300 ppm), (treatment T_3 soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha) and mulching with polythene sheet of 25 µ size with 3.02, 3.60 and 3.87 thrips/plant, respectively. The water spray was least effective with 11.53 thrips/plant. Moreover, untreated control recorded highest number of thrips per plant (15.75 thrips/plant).

Pooled mean

From the results of the pooled mean efficacy of treatments against thrips on cucumber after spray revealed that, treatment with tolfenpyrad 15 EC @ 150 g a.i/ha recorded least mean population of thrips (4.24 thrips/plant) and was followed by the treatments T_7 (Mulching with polythene sheet of 25 µ size + Cue lure traps+ Azadirachtin 300 ppm), treatment T_2 (azadirachtin 300 ppm) and treatment T_5 (Cue lure traps + Azadirachtin 300 ppm) with 4.45, 4.66, 4.90 thrips/plant, respectively and were at par with each other. The next best treatment against thrips on cucumber was treatment with flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha (5.43 thrips/plant) and was found at par with treatments T_6 (Soil application of *M. anisopliae* 1.15 WP + Cue lure traps + Azadirachtin 300 ppm), soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha and mulching with polythene sheet of 25 µ size with 5.67, 6.03 and 6.43 thrips/plant, respectively. The water spray was least effective with 11.97 thrips/plant and untreated control had 15.81 thrips/plant population.

Data on mean percent reduction over untreated control (Table 3) showed that the treatment tolfenpyrad 15 EC @ 150 g a.i/ha recorded highest of 73.18 percent reduction in average survival population of thrips over untreated control. However, the treatment with treatment T_7 (Mulching with polythene sheet of 25 µ size + Cue lure traps+ Azadirachtin 300 ppm), treatment T_2 (azadirachtin 300 ppm), treatment T_5 (Cue lure traps + Azadirachtin 300 ppm), treatment T_9 (flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha), treatment T_6 (Soil application of *M. anisopliae* 1.15 WP + Cue lure traps + Azadirachtin 300 ppm), treatment T3 (soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha), treatment T4 (mulching with polythene sheet of 25 µ size), treatment T10 (water spray) and treatment T_1 (cue lure traps) recorded 71.85, 70.52, 68.94, 65.65, 64.13, 61.85, 59.32, 24.28 and 2.78 percent reduction over untreated control, respectively. In the current study, tolfenpyrad 15 EC found to be the most effective treatment in reducing thrips population.

Table 3: Bioefficacy of different treatments against thrips, *T. tabaci* on cucumber (Pooled mean)

Tr. No.	Treatment	Dose (g or ml)	Number of thrips/plant				Mean percent reduction over control
			3 DAS**	7 DAS	10 DAS	Mean	
T_1	Cue lure traps @ 20/ha	-	15.40 (3.99)	15.23 (3.97)	15.47 (3.99)	15.37 (3.98)	2.78
T_2	Azadirachtin 300 ppm	5 ml/L.	4.87 (2.32)	4.27 (2.18)	4.83 (2.31)	4.66 (2.27)	70.52
T_3	Soil application of *M. anisopliae* 1.15 WP (Mixed with 25 kg FYM)	5 kg/ha	6.30 (2.60)	5.73 (2.49)	6.07 (2.56)	6.03 (2.55)	61.85
T_4	Mulching with polythene sheet of 25 µ size	-	6.67 (2.68)	6.02 (2.55)	6.60 (2.66)	6.43 (2.63)	59.32
T_5	Cue lure traps @ 20/ha + Azadirachtin 300 ppm @ 5 ml/L	-	5.13 (2.37)	4.60 (2.26)	5.00 (2.64)	4.91 (2.32)	68.94
T_6	Soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha + Cue lure traps @ 20/ha+ Azadirachtin 300 ppm @ 5 ml/L	-	5.90 (2.53)	5.30 (2.40)	5.80 (2.51)	5.67 (2.48)	64.13
T_7	Mulching with polythene sheet of 25 µ size + Cue lure traps @ 20/ha +Azadirachtin 300 ppm @ 5 ml/L	-	4.57 (2.25)	4.20 (2.17)	4.57 (2.25)	4.45 (2.22)	71.85
T_8	Tolfenpyrad 15 EC @ 150 g a.i/ha	2 ml/L.	4.47 (2.23)	4.03 (2.12)	4.23 (2.17)	4.24 (2.17)	73.18
T_9	Flubendiamide 8.33 + Deltamethrin 5.56 SC w/w SC @ 250 g a.i/ha	0.5 ml/L.	5.70 (2.49)	5.03 (2.35)	5.57 (2.46)	5.43 (2.43)	65.65
T_{10}	Water spray @ 500 lit/ha	-	11.23 (3.42)	11.67 (3.49)	13.00 (3.67)	11.97 (3.53)	24.28
T_{11}	Untreated control	-	15.93 (4.05)	15.77 (4.03)	15.73 (4.02)	15.81 (4.03)	0.00
	S.E.(m) ±	-	0.08	0.07	0.09	0.08	-
	C.D. at 5%	-	0.25	0.22	0.28	0.25	-

*Figures in the parentheses are (√ x + 0.5) transformations **DAS- Days after spraying

The results of the present findings are in conformity with Walunj *et al.* (2015) [13] who reported that, tolfenpyrad 15 EC showed significant least number of thrips population on pomegranate. Shivaleela and Chowdary also reported that, tolfenpyrad 15 EC was highly effective in controlling thrips on cucumber.

According to Lekha *et al.* (2018) [4] tolfenpyrad 15 EC provided a strong cross spectrum management of the sucking pests in brinjal and registered highest mean reduction of thrips. Rajkumar *et al.* (2002) [8] reported that nimbecidine (azadirachtin 300 ppm) was successful in reducing the damage caused by thrips. The present findings are in line with earlier workers.

2. Bioefficacy of different treatments against thrips, *T. tabaci* on cucumber during summer 2022

A field experiment was carried out to find out the bioefficacy of different treatments against fruit fly, *B. cucurbitae* infesting cucumber. Different treatments *viz.* Cue lure traps @ 20/ha, azadirachtin 300 ppm @ 5 ml/L, soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha (mixed with 25kg FYM), mulching with polythene sheet of 25 µ size, combination of (T_1 + T_2) *i.e.* Cue lure traps + azadirachtin 300 ppm, combination of (T_1 + T_2 + T_3) *i.e.* Cue lure traps + azadirachtin 300 ppm, soil application of *M. anisopliae* 1.15 WP mixed with 25 kg FYM, combination of (T_1 + T_2 + T_4) *i.e.* Cue lure traps + azadirachtin 300 ppm + mulching with polythene sheet of 25 µ size, tolfenpyrad 15 EC @ 150 g a.i/ha, flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha, water spray and untreated control were evaluated for their efficacy against fruit flies infesting cucumber during summer 2022. The data on percent fruit damage due to fruit fly on cucumber was recorded at the day of 1st picking as pre count and at 2nd, 3rd, 4th and 5th pickings and presented in Table 4.

From the data pertaining to mean efficacy of various treatments against fruit fly on cucumber after five pickings, it was observed that, percent fruit damage of varied from 3.96 to 25.03 percent (Table 4). All the treatments were found to be significantly superior over untreated control in reducing percent fruit damage due to cucumber fruit fly. Moreover, the treatment with flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha was found to be the most promising with minimum percent fruit damage of 3.96 percent which was followed by the treatment T_7 (Mulching with polythene sheet of 25 µ size + Cue lure traps + Azadirachtin 300 ppm) which recorded 5.00 percent fruit damage and were at par with each other. However, the next best treatment was T_6 (Soil application of *M. anisopliae* 1.15 WP + Cue lure traps + Azadirachtin 300 ppm) with 6.65 percent fruit damage and was followed by treatment T5 (Cue lure traps + Azadirachtin 300 ppm), Cue lure traps @ 20/ha and Azadirachtin 300 ppm @ 5 ml/L with 7.93, 8.57 and 9.25 percent fruit damage, respectively and were at par with each other. The next effective treatment soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha with 10.88 percent fruit damage and was found at par with treatment consisted mulching

Table 4: Bioefficacy of different treatments against fruit fly, *B. cucurbitae* on cucumber during summer 2022

Tr. No.	Treatment	Dose (g or ml)	Fruit damage (%)						Mean percent reduction over control
			Picking 1	Picking 2	Picking 3	Picking 4	Picking 5	Mean	
T_1	Cue lure traps @ 20/ha	-	12.33 (20.53)*	8.33 (16.78)	7.20 (15.56)	6.61 (14.89)	8.40 (16.84)	8.57 (17.02)	65.76
T_2	Azadirachtin 300 ppm	5 ml/L.	14.42 (22.30)	8.75 (17.21)	7.35 (15.72)	7.12 (15.47)	8.59 (17.04)	9.25 (17.71)	63.04
T_3	Soil application of *M. anisopliae* 1.15 WP (Mixed with 25 kg FYM)	5 kg/ha	14.26 (22.13)	11.93 (20.21)	9.95 (18.38)	8.55 (17.00)	9.70 (18.14)	10.88 (19.26)	56.53
T_4	Mulching with polythene sheet of 25 µ size	-	13.61 (21.58)	12.94 (21.08)	10.60 (19.00)	9.97 (18.40)	13.37 (21.44)	12.10 (20.36)	51.65
T_5	Cue lure traps @ 20/ha + Azadirachtin 300 ppm @ 5ml/L	-	14.64 (22.43)	7.10 (15.45)	6.05 (14.24)	5.59 (13.67)	6.27 (14.49)	7.73 (16.35)	69.11
T_6	Soil application of *M. anisopliae* 1.15 WP + Cue lure traps@ 20/ha + Azadirachtin 300 ppm @ 5ml/L	-	12.18 (20.42)	6.66 (14.96)	4.60 (12.38)	4.61 (12.39)	5.21 (13.19)	6.65 (14.94)	73.43
T_7	Mulching with polythene sheet of 25 µ size + Cue lure traps @ 20/ha+ Azadirachtin 300 ppm @ 5ml/L	-	13.07 (21.13)	5.98 (14.15)	2.41 (8.93)	1.59 (7.24)	1.96 (8.04)	5.00 (12.92)	80.02
T_8	Tolfenpyrad 15 EC @ 150 g a.i/ha	2 ml/L.	14.07 (22.03)	14.13 (22.08)	12.19 (20.43)	10.88 (19.25)	14.00 (21.97)	13.05 (21.18)	47.86
T_9	Flubendiamide 8.33 + Deltamethrin 5.56 SC w/w SC @ 250 g a.i/ha	0.5 ml/L.	14.39 (22.22)	4.73 (12.56)	2.39 (8.89)	1.45 (6.92)	1.10 (6.02)	3.96 (11.47)	84.17
T_{10}	Water spray@ 500 lit/ha	-	15.33 (23.05)	22.22 (28.12)	23.27 (28.83)	30.00 (33.21)	28.19 (32.07)	23.80 (29.06)	4.91
T_{11}	Untreated control	-	12.17 (20.33)	23.09 (28.70)	24.95 (29.96)	34.33 (35.87)	30.60 (33.58)	25.03 (30.32)	0.0
	S.E.(m) ±	-	1.05	0.76	1.15	1.12	1.31	1.15	-
	C.D. at 5%	-	NS	2.29	3.47	3.37	3.93	3.45	-

*Figures in the parentheses are arcsine transformed value

with polythene sheet of 25 µ size and tolfenpyrad 15 EC @ 150 g a.i/ha with 12.10 and 13.05 percent fruit damage, respectively. The water spray was found to be least effective treatment with 23.80 percent fruit infestation. Highest percent fruit damage of 25.03 percent was recorded in untreated control.

The data on mean percent reduction over control showed that, the treatment with flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha recorded highest of 84.17 percent reduction over control in mean percent fruit damage by cucumber fruit fly over untreated control. However, the treatment T_7 (Mulching with polythene sheet of 25 µ size + Cue lure traps+ Azadirachtin 300 ppm), T_6 (Soil application of *M. anisopliae* 1.15 WP + Cue lure traps + Azadirachtin 300 ppm), T_5 (Cue lure traps + Azadirachtin 300 ppm), Cue lure traps @ 20/ha, Azadirachtin 300 ppm @ 5 ml/L, soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha, mulching with polythene sheet of 25 µ size, tolfenpyrad 15 EC @ 150 g a.i/ha and water spray recorded 80.02, 73.43, 69.11, 65.76, 63.04, 56.53, 51.65, 47.86 and 4.91 percent reduction over control, respectively. In the present study, flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha was found to be the most effective treatment in reducing percent fruit damage caused by cucumber fruit fly.

The result of present findings are in conformity with Yaligar *et al*. (2022) [4] who reported that, flubendiamide 90 + deltamethrin 60 – 150 SC (15% w/v) @ 22.5 + 15 g a.i/ha was found to be the most effective dose in reducing percent fruit damage caused by fruit fly. Divya *et al*. (2019) [2] reported that cue lure traps placed at 10 m distance for each replication and found out that combination of jar trap + cue lure + ME disc was effective in controlling fruit fly.

Srinivas *et al*. (2018) [11] reported that, azadirachtin 300 ppm was able to reduce overall mean percent fruit infestation in cucumber significantly. Vargas *et al*. (2009) [12] who tested different traps with methyl eugenol and cue lure and observed that *B. cucurbitae* was captured in cue lure traps. The results of present findings are in lines with earlier workers.

3. Effect of different treatments on yield of cucumber during summer 2022

The data pertaining to marketable fruit yield of cucumber is presented in Table 5. Among the treatments, highest fruit yield of 331.33 q/ha was harvested from plots with treatment T_7 (Mulching with polythene sheet of 25 µ + Cue lure traps + Azadirachtin 300 ppm) followed by T_9 (flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha) and T_6 (Soil application of *M. anisopliae* 1.15 WP + Cue lure traps + Azadirachtin 300 ppm) with 305.00 and 310.00 q/ha, respectively and were at par with each other. Next best treatments were T_5 (Cue lure traps + Azadirachtin 300 ppm), T_8 (tolfenpyrad 15 EC @ 150 g a.i/ha), T_1 (cue lure traps), T_2 (azadirachtin 300 ppm), T_3 (soil application of *M. anisopliae* 1.15 WP @ 5 kg/ha) and T_4 (mulching of polythene sheet of 25 µ) with 300.67, 299.67, 290.00, 285.10, 281.67 and 272.67 q/ha, respectively and were at par with each other. The treatment T_{10} (water spray) recorded 245.33 q/ha and untreated control recorded 240.33 q/ha fruit yield of cucumber.

Table 5: Effect of different treatments on yield of cucumber during summer 2022

Tr. No.	Treatment	Dose (g or ml)	Marketable fruit yield (q/ha)	Percent increase in yield over control
T_1	Cue lure traps	20/ha	290.00	20.66
T_2	Azadirachtin 300 ppm	5 ml/L.	285.10	18.62
T_3	Soil application of *M. anisopliae* 1.15 WP (Mixed with 25 kg FYM)	5 kg/ha	281.67	17.20
T_4	Mulching with polythene sheet of 25 µ size	-	272.67	13.45
T_5	Cue lure traps + Azadirachtin 300 ppm	-	300.67	25.10
T_6	Soil application of *M. anisopliae* 1.15 WP (Mixed with 25 kg FYM) + Cue lure traps + Azadirachtin 300 ppm	-	310.00	28.98
T_7	Mulching with polythene sheet of 25 µ size + Cue lure traps+ Azadirachtin 300 ppm	-	331.33	37.86
T_8	Tolfenpyrad 15 EC @ 150 g a.i/ha	2 ml/L.	299.67	24.69
T_9	Flubendiamide 8.33 + Deltamethrin 5.56 SC w/w SC @ 250 g a.i/ha	0.5 ml/L.	305.00	26.90
T_{10}	Water spray @ 500 lit/ha	-	245.33	2.08
T_{11}	Untreated control	-	240.33	0.00
	S.E.(m) ±	-	8.80	-
	C.D. at 5%	-	26.47	-

Conclusion

From the study it can be concluded that,

1. From the bioefficacy study, it was found that, being a chemical insecticide the treatment with tolfenpyrad 15 EC @ 150 g a.i/ha was found promising in reducing thrips population (4.24 thrips/plant). However, the treatment T_7 (Mulching with polythene sheet of 25 µ size + Cue lure traps+ Azadirachtin 300 ppm), with 4.45 thrips/plant, T_2 (Azadirachtin 300 ppm) with 4.66 thrips/plant and treatment T_5 (Cue lure traps + Azadirachtin 300 ppm) with 4.91 thrips/plant were equally effective in reducing thrips population as compared to chemical insecticide *i.e.* tolfenpyrad 15 EC. The treatment tolfenpyrad 15 EC @ 150 g a.i/ha recorded highest of 73.18 percent reduction in average survival population of thrips over untreated control.
2. From the bioefficacy study, it was revealed that, being a chemical insecticide the treatment with flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha was found most promising treatment with least percent fruit damage of 3.96 percent. However the treatment T_7 (Mulching with polythene sheet of 25 µ size + Cue lure traps+ Azadirachtin 300 ppm) was found equally effective treatment against cucumber fruit fly with 5.00 percent fruit damage and also obtained highest marketable yield of 331.33 q/ha. The treatment flubendiamide 8.33% + deltamethrin 5.56% w/w SC @ 250 g a.i/ha recorded highest of 84.17 percent reduction over control in mean percent fruit damage of fruit fly over untreated control.

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