Biological Forum – An International Journal **14(1): 883-889(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Evaluation of Bio-Efficacy and Phytotoxicity of Flubendiamide 90 + Deltamethrin 60-150 SC (15% W/V) against Pest Complex in Cucumber

Raghavendra Yaligar*, P.R. Badari Prasad, Hanumanthappa Shrihari, Mansoor, Sujay Hurali, R. Jyothi and Suhasini

Krishi Vigyana Kendra, Gangavathi, College of Agriculture, Gangavathi, Agricultural Research Station, Gangavathi, University of Agricultural Sciences, Raichur, (Karnataka) India.

(Corresponding author: Raghavendra Yaligar)*
(Received 05 November 2021, Accepted 06 January, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Insecticides have been the first line of defense against insect pests attacking cucumber on account of their effectiveness, ease of application and immediate results. Compounds with novel modes of action, possessing good insecticidal activity against insect pests infesting cucumber, have been advocated for use in the cucumber ecosystem in recent times in general. Hence, under such circumstances, a newer formulation of insecticide needs to be evaluated for its bio-efficacy against major pests of cucumber as the first line of defense. A field experiment was conducted to evaluate the bio-efficacy and phytotoxicity of Flubendiamide 90 + Deltamethrin 60-150 SC (15% w/v) against cucumber pests like red pumpkin beetle, fruit fly and cucumber moth for two seasons. The treatments were: T_1- Flubendiamide 90 + Deltamethrin 60-150 SC @ 15+10 g a.i./ha; T_2- Flubendiamide 90 + Deltamethrin 60-150 SC @ 18+12g a.i./ha; T_3- Flubendiamide 90 + Deltamethrin 60-150 SC @ 22.5+15g a.i./ha; T_4- Deltamethrin 100 EC @ 15g a.i./ha; T_5- Flubendiamide 480 SC @ 22.5g a.i./ha and T_6- Quinalphos 25 EC @ 250g a.i./ha, and T_7-Untreated check. Results revealed that, treatment Flubendiamide 90 + Deltamethrin 60-150 SC @ 22.5+15g a. i./ha was found to be the most effective dose in reducing the per cent leaf and fruit damage and recorded higher fruit yield. Further, it had less impact on natural enemies and did not cause phytotoxicity to cucumber crop.

Keywords: Bioefficacy, phytotoxicity, red pumpkin beetle, fruit fly and cucumber moth.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a popular and widely grown vegetable all over the country and is reported to have originated in Southern Asia. Cucumber contributes as a good source of nutrition to the consumer and also a very good source of income for small and marginal farmers. Cucumber holds a good position based on nutritional viewpoint as 100g contains 16 calories energy, total fat-0.1g, no cholesterol, sodium 2 mg, potassium-147 mg, total carbohydrates-3.6g, protein-0.7g, iron 1%, magnesium 3%, Vitamin A-2%, Calcium-1%, Vitamin C-4%, while they lack Vitamin D, Vitamin B12 and Vitamin B-6 (Anonymous, 2017). The peel and seeds are the most nutrient-dense part of the cucumber. It contains fiber and beta-carotene, a form of Vitamin A that is good for the eyes.

In India cucumber is grown in an area of 82000 hectares with the production of 1260 metric tons (Anonymous, 2018). However, like other vegetables, its successful and economic cultivation is consistently threatened by many production constraints. The cucumber crop is more prone to insect pests and diseases mainly due to tenderness. The cucumber yield in India is considerably lower because of several factors of which the damage caused by insect pests is most important. It is devastated by an array of pests like the red pumpkin beetle, fruit fly, cucumber moth, jassids, aphids, tobacco caterpillars, leaf miners, spider mites, and fruit borers. However, the major economic damage is caused by the red pumpkin beetle, fruit fly, and cucumber moth.

Red pumpkin beetle, *Aulacophora foveicollis* is a serious and destructive pest of cucurbits in India (Varavadekar and Dumbre, 1992). It belongs to Coleoptera: Chrysomelidae and is widely distributed all over Southeast Asia (Bogawat and Pandey, 1967). Among the cucurbits, cucumber is the most but also bitter gourd, and sponge gourd is equally preferred by

this pest (Khan and Hajela, 1987). The adult beetle is red and lays its eggs at the base of the cucumber stem. The grubs of *A. foveicollis* feed on roots, underground portions, and fruits touching the soil. The adults feed on cotyledons, flowers, and foliage causing holes when creepers are very young and the early sown cucurbits are severely damaged that they may have to be resown (Atwal and Dhaliwal, 2002).

The melon fruit fly, *Bactrocera cucurbitae* (Coquillett) is also a serious pest of cultivated cucurbits. It was first reported in India by Lefroy during 1907 which reduced not only the quality of fruits and vegetables but also a serious limiting factor in the production of gourds, cucumber, melon and other cucurbits to the extent that it's growing may become highly unprofitable. Generally, the female fruit flies puncture the soft and tender fruits by their sharp ovipositor and lay the eggs under fruit tissues and gummy fluid oozes from the puncture. The fruit flies also oviposit in the tender plant tissues such as terminals, unopened flowers, young stems, and seedlings which may result in the death of the plant (Kate *et al.*, 2009). After hatching, the maggots feed on the pulp of the fruits by making galleries, and simultaneously the secondary infection also arises, resulting in the rotting of fruits (Gupta and Verma, 1995). The extent of losses caused by *B. cucurbitae* varies from 30 to 100 percent depending on the cucurbit species and season (Dhillon *et al.*, 2005).

The cucumber moth, *Diaphania indica* (Saunders) (Lepidoptera: Crambidae), is a polyphagous pest and is particularly serious on cucurbits. Larvae mainly attack leaves, but also infest flowers and fruits, and cause considerable yield loss during outbreaks. It is also known as the cotton caterpillar and pumpkin caterpillar. This species is mostly distributed in Pakistan, India, Japan, Pacific Islands, Australia, Africa, and South America. On hatching, larvae feed on leaves where they cluster and fold and weave the leaves together. They can also feed on and puncture the skin of young fruit, especially the fruits that touch leaves (Jyothsna *et al.*, 2008).

To control these above-mentioned insect pests, different insecticides are being used in large quantities by farmers except in a few cases where the crop is grown as per Good Agricultural Practices (GAP) for export purposes. Considering the economic importance of pests and fruit, the present study is conducted to study the bioefficacy and phytotoxicity of combination products of flubendiamide and deltamethrin on cucumber.

MATERIALS AND METHODS

The experiment was carried out at the Agricultural Research Station, Kawadimatti, Karnataka, India for two seasons in a Randomized Block Design (RBD) with seven treatments, which were replicated thrice in a net experimental area of 5 m × 5 m each. Cucumber variety Dharwad Green was sown at 1.50 m × 0.75 m spacing. The standard agronomic practices as per the recommendation of UAS Raichur (Anonymous, 2017) were followed except plant protection measures. The details of the experiment are given below.

Treatment details for Bio-efficacy studies.

Tr. No.	Treatment	Dosage (g a.i./ha)	Formulation dose (ml/ha)	Type of application
T_1	Flubendiamide 90 + Deltamethrin 60-150 SC	15+10	167	Foliar
T_2	Flubendiamide 90 + Deltamethrin 60-150 SC	18+12	200	Foliar
T_3	Flubendiamide 90 + Deltamethrin 60-150 SC	22.5+15	250	Foliar
T_4	Deltamethrin 100 EC	15	150	Foliar
T_5	Flubendiamide 480 SC	22.5	47	Foliar
T_6	Quinalphos 25 EC	250	1000	Foliar
T_7	Untreated control (water only)	--	--	

Treatment details for Phytotoxicity studies.

Tr. No.	Treatment	Dosage (g a.i./ha)	Type of application
T_1	Flubendiamide 90 + Deltamethrin 60-150 SC	45+30	Foliar
T_2	Flubendiamide 90 + Deltamethrin 60-150 SC	90+60	Foliar
T_3	Untreated control (water only)	--	

Note: treatments Flubendiamide 90 + Deltamethrin 60-150 SC @ 45+30 and 90+60 are only to assess the phytotoxicity and did not require analysis.

Observations:

Leaf damage by red pumpkin beetle, *Raphidopalpa foveicollis* (Lucas)

The observations on damaged leaves of plants were recorded on five randomly selected and tagged plants from each plot. For this fifteen leaves per plant were observed, five each from the lower, middle, and top parts of the plant. The per cent damage of leaves by the red pumpkin beetle was determined using the formula given by Ali *et al*. (2011).

$$\text{Percent leaf damage} = \frac{\text{No. of leaves damaged}}{\text{Total no. of leaves}} \times 100$$

Fruit damage by melon fruit fly, *Bactrocera cucurbitae* (Coquillett). The observations on the fruit fly damage were recorded as per the method followed by Bhatnagar and Yadava (1992) with slight modifications. The observations were recorded before spraying and three, five, seven, and ten days after spraying. In each plot, five plants were selected randomly and tagged to record observations for fruit fly damage on fruits. Per cent fruit damage was also worked out by using formula.

$$\text{Percent fruit damage} = \frac{\text{No. of fruits damaged}}{\text{Total no. of fruits}} \times 100$$

Fruit damage by cucumber moth, *Diaphania indica* (Saunders). The observations on fruit damage by cucumber moth were recorded on five randomly selected and tagged plants from each plot. The observations were recorded before spraying and three, five, seven, and ten days after spraying. Per cent fruit damage was also worked out by using formula.

$$\text{Percent fruit damage} = \frac{\text{No. of fruits damaged}}{\text{Total no. of fruits}} \times 100$$

Impact on natural enemies. Recorded the pre and post-application effect of a test chemical on the number of natural enemies' population *viz*., coccinellids present in the cucumber ecosystem during the study at intervals of before and 10 and 15days after application. Further, these data were subjected to statistical analysis after transforming them to square root transformations.

Fruit yield. The yield (Fruit) of cucumber obtained from each treatment was recorded and computed on a hectare basis and further subjected to statistical analysis.

Phytotoxicity studies. The observation on phytotoxicity symptoms *viz*., chlorosis, necrosis, wilting, vein clearing, hyponasty and epinasty were recorded at 1, 3, 5, 7, and 10 days after application by using the following scale. The details of the phytotoxicity studies are given below.

Phytotoxicity Rating Scale (PRS)

% Injury	Scale	% Injury	Scale
0-10%	1	51-60%	6
11-20%	2	61-70%	7
21-30%	3	71-80%	8
31-40%	4	81-90%	9
41-50%	5	91-100%	10

RESULT AND DISCUSSION

A. Red pumpkin beetle, Raphidopalpa foveicollis (Lucas)

A day before the imposition of treatments, the per cent leaf damage in different treatments varied from 14.60 to 17.56%. After three days of treatment imposition, there was a considerable reduction in leaf damage in all the treated plots, and the lowest leaf damage of 12.00% was recorded in the treatment, flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha followed by its lower dose, flubendiamide 90 + deltamethrin 60-150 SC @ 18+12 g a. i./ha (13.12%). Maximum leaf damage was in the untreated control (30.17%). A similar trend was recorded on the 5th, 7^{th,} and 10th days after the first spray. The per cent reduction of leaf damage over control (% ROC) based on the observations indicated that, highest %ROC of 91.36 was recorded in flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha, followed by 85.84 per cent in flubendiamide 90 + deltamethrin 60-150 SC @ 18+12 g a. i./ha.

Similar trend was observed after 2nd spray. The per cent reduction over control (%ROC) was highest in flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha (100.00%) followed by flubendiamide 90 + deltamethrin 60-150 SC @ 18+12 g a. i./ha (93.70%) (Table 1).

The bioefficacy of flubendiamide and deltamethrin against pumpkin beetle was studied separately by several workers but very little study has so far been conducted on the combination product of flubendiamide and deltamethrin. So, similar studies conducted to evaluate the bioefficacy of flubendiamide and deltamethrin were discussed here to support the present study. These results are in accordance with Ravi Kumar (2014) who reported that flubendiamide +deltamethrin 90+60=150 SC @ 200 ml/ha was most effective, which caused a maximum reduction in the population of red pumpkin beetle on 1st, 3rd, 5^{th,} and 7th day after treatment in all three spray application.

Table 1: Bioefficacy of Flubendiamide 90 + Deltamethrin 60-150 SC (15% SC w/v) against red pumpkin beetle in cucumber (Pooled data of two seasons).

Tr. No	Treatment details	Dose (g a.i./ha)	% leaf damage (pumpkin beetle)											
			I Spray					% ROC	II Spray					% ROC
			1DBS	3DAS	5DAS	7DAS	10DAS		1DBS	3DAS	5DAS	7DAS	10DAS	
T_1	Flubendiamide 90 + Deltamethrin 60-150 SC	15+10	17.56 (24.73)	13.78 (21.78)	11.09 (19.37)	8.13 (16.56)	6.21 (14.42)	79.21	12.26 (20.46)	10.78 (19.12)	8.27 (16.60)	5.91 (14.01)	3.55 (10.80)	87.30
T_2	Flubendiamide 90 + Deltamethrin 60-150 SC	18+12	16.12 (23.60)	13.12 (21.22)	10.56 (18.87)	7.27 (15.56)	4.23 (11.59)	85.84	10.30 (18.64)	7.56 (15.83)	5.36 (13.19)	2.75 (9.41)	1.76 (7.36)	93.70
T_3	Flubendiamide 90 + Deltamethrin 60-150 SC	22.5+15	16.52 (23.92)	12.00 (20.25)	9.35 (17.71)	6.89 (15.21)	2.58 (8.57)	91.36	8.16 (16.49)	5.21 (12.73)	3.39 (10.51)	0.00 (0.00)	0.00 (0.00)	100.00
T_4	Deltamethrin 100 EC	15	15.71 (23.33)	14.52 (22.36)	12.10 (20.32)	9.50 (17.94)	8.02 (16.33)	73.15	14.13 (22.02)	12.45 (20.59)	9.25 (17.67)	8.41 (16.74)	6.14 (14.30)	78.04
T_5	Flubendiamide 480 SC	22.5	15.16 (22.90)	14.22 (22.14)	11.61 (19.90)	9.06 (17.50)	6.52 (14.64)	78.17	13.72 (21.73)	9.72 (18.15)	6.73 (14.98)	4.26 (11.90)	3.88 (11.27)	86.12
T_6	Quinalphos 25 EC	250	14.60 (22.45)	16.38 (23.50)	12.44 (20.62)	10.60 (18.87)	9.16 (17.61)	69.34	12.84 (20.98)	10.60 (18.98)	9.10 (17.54)	8.35 (16.78)	7.22 (15.57)	74.17
T_7	Untreated control (water only)	--	16.47 (23.93)	30.17 (33.28)	27.13 (31.35)	26.52 (30.96)	29.88 (33.12)	-	16.32 (23.73)	23.54 (29.00)	22.00 (27.95)	25.81 (30.51)	27.96 (31.90)	-
S.Em.±			0.61	0.75	0.79	1.24	0.97	-	0.96	0.84	0.97	0.75	0.50	-
C.D. (p=0.05)			NS	2.35	2.45	2.73	3.02	-	NS	2.63	3.02	2.34	1.55	-
C.V. (%)			4.47	5.55	6.44	8.03	10.10	-	8.12	7.63	9.93	9.17	6.63	-

Note: DBS=Day before Spray; DAS=Day after Spray; NS-Non Significant; ROC-Reduction over control; Figures in the parentheses are angular transformed values

B. Bactrocera cucurbitae (Coquillett)

A day before the imposition of treatments, the per cent fruit damage in different treatments varied from 8.51 to 9.42%. After three days of treatment imposition, there was a considerable reduction in fruit damage in all the treated plots, and the lowest fruit damage of 2.96% was recorded in the treatment, flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha followed by its lower dose, flubendiamide 90 + deltamethrin 60-150 SC @ 18+12 g a. i./ha (3.54%). Maximum fruit damage was in the untreated control (13.73%). A similar trend was recorded on the 5th, 7^{th,} and 10th days after the first spray. The per cent reduction of fruit damage over control (% ROC) based on the observations indicated that, highest %ROC of 95.75 was recorded in flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha, followed by 92.06 per cent in flubendiamide 90 + deltamethrin 60-150 SC @ 18+12 g a. i./ha.

Similar trend was observed after 2nd spray. The per cent reduction over control (%ROC) was highest in flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha (99.44%) followed by flubendiamide 90 + deltamethrin 60-150 SC @ 18+12 g a. i./ha (95.51%) (Table 2).

Table 2: Bioefficacy of Flubendiamide 90 + Deltamethrin 60-150 SC (15% SC w/v) against fruit fly in cucumber (Pooled data of two seasons)

Tr. No	Treatment details	Dose (g a.i./ha)	% Fruit damage (fruit fly)											
			I Spray					% ROC	II Spray					% ROC
			1DBS	3DAS	5DAS	7DAS	10DAS		1DBS	3DAS	5DAS	7DAS	10DAS	
T_1	Flubendiamide 90 + Deltamethrin 60-150 SC	15+10	9.13 (17.48)	5.47 (13.32)	3.57 (10.79)	3.21 (10.20)	2.58 (9.08)	79.32	7.12 (15.42)	4.76 (12.53)	2.72 (9.34)	2.09 (8.14)	1.80 (7.44)	83.31
T_2	Flubendiamide 90 + Deltamethrin 60-150 SC	18+12	9.01 (17.45)	3.54 (10.83)	1.31 (6.56)	1.12 (6.07)	0.99 (5.70)	92.06	8.65 (17.09)	2.56 (9.09)	0.90 (5.44)	0.61 (4.46)	0.48 (3.98)	95.51
T_3	Flubendiamide 90 + Deltamethrin 60-150 SC	22.5+15	9.07 (17.51)	2.96 (9.90)	1.04 (5.85)	0.77 (5.03)	0.53 (4.16)	95.75	7.04 (15.37)	2.03 (8.18)	0.55 (4.23)	0.31 (3.19)	0.06 (1.40)	99.44
T_4	Deltamethrin 100 EC	15	9.22 (17.66)	6.36 (14.60)	4.49 (12.23)	3.94 (11.44)	4.01 (11.54)	67.86	9.75 (18.18)	4.24 (11.87)	3.59 (10.85)	3.29 (10.44)	3.04 (10.03)	71.82
T_5	Flubendiamide 480 SC	22.5	8.51 (16.89)	4.61 (12.38)	3.27 (10.41)	2.20 (8.52)	2.41 (8.93)	80.68	8.89 (17.33)	3.17 (10.25)	2.24 (8.60)	1.72 (7.53)	1.56 (7.16)	85.54
T_6	Quinalphos 25 EC	250	9.42 (17.82)	7.72 (16.12)	5.51 (13.56)	5.31 (13.31)	6.97 (15.30)	45.00	9.01 (17.45)	5.54 (13.60)	4.21 (11.83)	3.98 (11.50)	4.44 (12.16)	58.85
T_7	Untreated control (water only)	--	9.37 (17.81)	13.73 (21.73)	13.00 (21.12)	12.23 (20.46)	12.48 (20.68)	-	8.95 (17.39)	10.04 (18.46)	9.71 (18.14)	9.58 (18.01)	10.79 (19.16)	-
S.Em.±			0.70	0.68	0.44	0.46	0.49	-	0.47	0.53	0.54	0.45	0.57	-
C.D. (p=0.05)			NS	2.13	1.38	1.42	1.55	-	NS	1.65	1.68	1.35	1.79	-
C.V. (%)			6.99	8.41	6.68	7.38	8.02	-	4.88	7.66	9.55	8.33	11.36	-

Note: DBS=Day before Spray; DAS=Day after Spray; NS-Non Significant; ROC-Reduction over control; Figures in the parentheses are angular transformed values

C. Cucumber moth, Diaphania indica (Saunders)

A day before the imposition of treatments, the per cent fruit damage in different treatments varied from 7.52 to 10.30%. After three days of treatment imposition, there was a considerable reduction in fruit damage in all the treated plots, and the lowest fruit damage of 1.70% was recorded in the treatment, flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha followed by its lower dose, flubendiamide 90 + deltamethrin 60-150 SC @ 18+12 g a. i./ha (2.22%). Maximum fruit damage was in the untreated control (7.99%). A similar trend was recorded on the 5th, 7^{th,} and 10th days after the first spray. The per cent reduction of fruit damage over control (% ROC) based on the observations indicated that, highest %ROC of 99.08 was recorded in flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha, followed by 98.10 per cent in flubendiamide 90 + deltamethrin 60-150 SC @ 18+12 g a. i./ha.

Similar trend was observed after 2nd spray. The per cent reduction over control (%ROC) was 100.00% in treatments flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha and flubendiamide 90 + deltamethrin 60-150 SC @ 18+12 g a. i./ha (Table 3).

Table 3: Bioefficacy of Flubendiamide 90 + Deltamethrin 60-150 SC (15% SC w/v) against cucumber moth in cucumber (Pooled data of two seasons).

Tr. No	Treatment details	Dose (g a.i./ha)	% Fruit damage (cucumber moth)											
			I Spray					% ROC	II Spray					% ROC
			1DBS	3DAS	5DAS	7DAS	10DAS		1DBS	3DAS	5DAS	7DAS	10DAS	
T_1	Flubendiamide 90 + Deltamethrin 60-150 SC	15+10	9.21 (17.62)	3.81 (11.16)	3.01 (9.86)	1.91 (8.55)	1.58 (6.97)	81.94	7.28 (15.61)	3.76 (11.08)	2.16 (8.24)	1.62 (7.30)	0.98 (5.67)	90.85
T_2	Flubendiamide 90 + Deltamethrin 60-150 SC	18+12	8.13 (16.53)	2.22 (8.43)	0.81 (5.16)	0.60 (4.42)	0.16 (2.31)	98.10	6.57 (14.82)	1.82 (7.74)	0.38 (3.54)	0.00 (0.00)	0.00 (0.00)	100.00
T_3	Flubendiamide 90 + Deltamethrin 60-150 SC	22.5+15	9.62 (18.05)	1.70 (7.48)	0.45 (3.85)	0.38 (3.54)	0.08 (1.62)	99.08	6.47 (14.73)	1.62 (7.30)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	100.00
T_4	Deltamethrin 100 EC	15	7.52 (15.90)	6.97 (15.30)	4.45 (12.14)	3.39 (10.61)	2.95 (9.88)	66.28	8.03 (16.45)	4.72 (12.54)	3.12 (10.16)	2.90 (9.68)	2.12 (8.22)	80.22
T_5	Flubendiamide 480 SC	22.5	10.30 (18.71)	4.76 (12.59)	2.12 (8.22)	0.97 (5.64)	0.76 (4.99)	91.31	7.07 (15.47)	2.81 (9.64)	1.62 (7.30)	0.95 (5.59)	0.69 (4.76)	93.56
T_6	Quinalphos 25 EC	250	8.08 (16.50)	5.40 (13.43)	4.75 (12.58)	3.73 (11.13)	3.00 (9.96)	65.71	6.42 (14.67)	4.82 (12.67)	3.81 (11.25)	2.60 (9.26)	2.19 (8.50)	79.57
T_7	Untreated control (water only)	--	9.23 (17.67)	7.99 (16.41)	6.37 (14.61)	6.79 (15.09)	8.75 (17.19)	-	7.20 (15.55)	9.63 (18.07)	11.26 (19.59)	11.82 (20.09)	10.72 (19.10)	-
S.Em.±			0.46	0.57	0.58	0.29	0.48	-	0.42	0.43	0.53	0.41	0.44	-
C.D. (p=0.05)			NS	1.78	1.81	0.90	1.48	-	NS	1.35	1.64	1.28	1.37	-
C.V. (%)			4.67	8.18	10.62	5.96	10.89	-	4.72	6.63	10.63	9.62	11.55	-

Note: DBS=Day before Spray; DAS=Day after Spray; NS-Non Significant; ROC-Reduction over control; Figures in the parentheses are angular transformed values

The bioefficacy of flubendiamide and deltamethrin against cucumber moth was studied separately by several workers but very little study has so far been conducted on the combination product of flubendiamide and deltamethrin. Balikai and Mallapur (2007) reported that flubendiamide 480 SC @ 60 g a.i./ha afforded the highest protection against Gherkin fruit borer with 91.3 and 90.5 per cent during the first season and 89.1 and 87.0 per cent during the second season, respectively over the untreated check and produced higher marketable fruit yield of 10.45 and 10.24 t/ha during the first season and 9.65 and 9.52 t/ha during the second season, respectively.

Natural enemies

Coccinellids: Effect of insecticidal treatments on the natural enemies' *viz.*, Coccinellids was assessed and the results are presented in Table 4.

Table 4: Impact of Flubendiamide 90 + Deltamethrin 60-150 SC (15% SC w/v) on natural enemies in cucumber ecosystem (Pooled data of two seasons).

Tr. No	Treatment details	Dose (g a.i./ha)	Coccinellids		
			1 DBS	10 DAS	15 DAS
T_1	Flubendiamide 90 + Deltamethrin 60-150 SC	15+10	3.72(2.17)	2.17(1.78)	3.10(2.02)
T_2	Flubendiamide 90 + Deltamethrin 60-150 SC	18+12	3.75(2.18)	1.88(1.70)	2.90(1.97)
T_3	Flubendiamide 90 + Deltamethrin 60-150 SC	22.5+15	3.21(2.05)	1.56(1.60)	2.75(1.93)
T_4	Deltamethrin 100 EC	15	3.78(2.19)	1.78(1.67)	2.89(1.97)
T_5	Flubendiamide 480 SC	22.5	3.73(2.17)	2.51(1.87)	3.20(2.05)
T_6	Quinalphos 25 EC	250	3.35(2.09)	1.84(1.68)	2.60(1.89)
T_7	Untreated control (water only)	--	3.53(2.13)	3.62(2.15)	4.50(2.35)
S.Em.±			0.01	0.01	0.01
C.D. (p=0.05)			NS	0.03	0.04
C.V. (%)			5.28	7.13	5.76

Note: DBS=Day before spray; DAS= Day after spray; NS-Non Significant; Figures in the parentheses are $\sqrt{x+0.5}$ transformations

The results indicated that there was no major adverse effect due to insecticidal treatments on the natural enemy population though there was some reduction initially after the treatment, the population recovered subsequently. Hence, flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha and 18+12 g a. i./ha found relatively less hazardous.

Fruit yield: The pooled data on fruit yield of cucumber revealed that significantly higher yield (23.31 q/ha) was obtained in flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha, followed by flubendiamide 90 + deltamethrin 60-150 SC @ 18+12 g a. i./ha (21.25 q/ha). The lowest fruit yield of 10.56 q/ha was recorded in the untreated control (Table 5).

Phytotoxicity: The data on phytotoxicity symptoms revealed that flubendiamide 90 + deltamethrin 60-150 SC @ 45+30 g a. i./ha and 90+60 g a. i./ha did not cause phytotoxicity in any form (yellowing, necrosis, leaf injury, epinasty, hyponasty and vein clearing) **(**Table 6).

Table 5: Impact of Flubendiamide 90 + Deltamethrin 60-150 SC (15% SC w/v) on fruit yield in cucumber (Pooled data of two seasons).

Treatment details	Fruit yield (q/ha)		
	Kharif	Rabi	Pooled
Flubendiamide 90 + Deltamethrin 60-150 SC	17.16	16.62	16.89
Flubendiamide 90 + Deltamethrin 60-150 SC	22.16	20.33	21.25
Flubendiamide 90 + Deltamethrin 60-150 SC	24.41	22.20	23.31
Deltamethrin 100 EC	17.26	16.16	16.71
Flubendiamide 480 SC	18.20	18.16	18.18
Quinalphos 25 EC	14.34	12.51	13.43
Untreated control (water only)	11.52	9.60	10.56
S.Em.±	0.14	0.13	0.04
C.D. (p=0.05)	0.45	0.41	0.11
C.V. (%)	5.77	5.56	5.62

Table 6: Phytotoxic effect due to Flubendiamide 90 + Deltamethrin 60-150 SC (15% SC w/v) on cucumber crop.

Tr. No.	Treatments	Dose/ha	Phytotoxicity Symptoms					
		g a.i.	Leaf Injury	Wilting	Vein clearing	Necrosis	Epinasty	Hyponasty
		a.	Before spray					
1	Flubendiamide 90 + Deltamethrin 60-150 SC	45+30	0	0	0	0	0	0
2	Flubendiamide 90 + Deltamethrin 60-150 SC	90+60	0	0	0	0	0	0
3	Untreated check (Water spray)	---	0	0	0	0	0	0
		b.	1 Days after spray					
1	Flubendiamide 90 + Deltamethrin 60-150 SC	45+30	0	0	0	0	0	0
2	Flubendiamide 90 + Deltamethrin 60-150 SC	90+60	0	0	0	0	0	0
3	Untreated check (Water spray)	---	0	0	0	0	0	0
		c.	3 Days after spray					
1	Flubendiamide 90 + Deltamethrin 60-150 SC	45+30	0	0	0	0	0	0
2	Flubendiamide 90 + Deltamethrin 60-150 SC	90+60	0	0	0	0	0	0
3	Untreated check (Water spray)	---	0	0	0	0	0	0
		d.	5 Days after spray					
1	Flubendiamide 90 + Deltamethrin 60-150 SC	45+30	0	0	0	0	0	0
2	Flubendiamide 90 + Deltamethrin 60-150 SC	90+60	0	0	0	0	0	0
3	Untreated check (Water spray)	---	0	0	0	0	0	0
		e.	7 Days after spray					
1	Flubendiamide 90 + Deltamethrin 60-150 SC	45+30	0	0	0	0	0	0
2	Flubendiamide 90 + Deltamethrin 60-150 SC	90+60	0	0	0	0	0	0
3	Untreated check (Water spray)	--	0	0	0	0	0	0
		f.	10 Days after spray					
1	Flubendiamide 90 + Deltamethrin 60-150 SC	45+30	0	0	0	0	0	0
2	Flubendiamide 90 + Deltamethrin 60-150 SC	90+60	0	0	0	0	0	0
3	Untreated check (Water spray)	--	0	0	0	0	0	0

CONCLUSIONS

Among all the tested chemicals flubendiamide 90 + deltamethrin, 60-150 SC @ 22.5+15g a. i./ha was found to be significantly superior in reducing the per cent leaf damage and per cent fruit damage caused by pumpkin beetle, fruit fly, and cucumber moth by suppressing the population. The plots treated with flubendiamide 90 + deltamethrin 60-150 SC @ 22.5+15g a. i./ha produced the maximum fruit yield than other treatments and had less impact on natural enemies so it can be used for the

effective management of cucumber pests in the field. Further, flubendiamide 90 + deltamethrin 60-150 SC @ 45+30 g a. i./ha and 90+60 g a. i./ha did not cause phytotoxicity to cucumber crop.

REFERENCES

Ali, H., Ahmad, S., Hassan, G., Amin A. and Naeem, M. (2011). Efficacy of different botanicals against red pumpkin beetle, *Aulacophora foveicollis* (Lucas) in bittergourd. *Pakistan Journal of Weed Science Research*, *17*(1): 65-71.

Anonymous.(2017). Sudarita Besaya Kramagalu. University of Agriculture Sciences, Raichur, pp.7-40.

Anonymous (2017). USDA Food composition Database. National Agriculture Library, *38*(5): 6-12.

Anonymous (2018). Pocket Book of Agricultural Statistics 2017-18, Directorate of Economics & Statistics, Ministry of Agriculture & Farmers Welfare Department of Agriculture, Cooperation & Farmers Welfare, Government of India, New Delhi, pp. 122.

Atwal, A. S. and Dhaliwal, G. S. (2002). Agricultural Pests of South Asia and their Management. Kalyani publishers, pp. 262-263.

Balikai, R. A. and Mallapu, C. P. (2017). Bioefficacy of flubendiamide 480 SC (Fame 480 SC) against fruit borer in Gherkin. *International Journal of Horticulture*, *7*(28): 250-261.

Bhatnagar, K. N. and Yadava, S. R. S. (1992). An insecticidal trial for reducing the damage of some cucurbitaceous fruits due to *Dacus cucurbitae* Coq. *Indian J. Entomol*, *54*(1): 66-69.

Bogawat, J. K. and Pandy, S. N. (1967). Food preference by *Aulacophora spp*. *Indian journal of entomology*, *29:* 349-352.

Dhillon, M. K., Naresh, J. S., Singh R. and Sharma, N. K. (2005). Evaluation of bitter gourd (*Momordica charantia* L.) genotypes for resistance to melon fruit fly (*Bactrocera cucurbitae*). *Indian Journal of Plant Protection*, *33*(1): 55-59.

Gupta, B. L. and Verma, A. K. (1995). Host-specific demographic studies of the melon fruit fly, *Dacus cucurbitae* Coquillett (Diptera: Tephritidae). *Journal of Insect Sciences*, *89*(1): 87-89.

Jyothsna, M., Reddy D. J. and Reddy, C. N. (2008). Efficacy of selective insecticides against pumpkin caterpillar (*Diaphania indica* Saunders) on Gherkin. *Progressive Research*, *8*: 66-268.

Kate, A. O., Bharodi, R. K., Joshi, M. D., Pardeshi A. M. and Makadia, R. R. (2009). Seasonal incidence of fruit fly, *Bactrocera cucurbitae* (Coquillet) on cucumber. *Asian sciences*, *4*(2): 83-84.

Khan, M. Z. and Hajela, K. P. (1987). Studies on *Aulacophora foveicollis* Lucas (Coleoptera : Chrysomelidae) food preference and extent of damage. *Indian Journal of Entomology*, *49*: 457-459.

Ravi Kumar (2014). Population dynamics and management of red pumpkin beetle (*Aulacophora foveicollis* Lucas.) in cucumber. *M.Sc. Thesis*, Maharana Pratap University of agriculture and technology, Udaipur, Rajasthan. pp.1-120.

Varavadekar, Y. R. and Dumbre, R. B. (1992). Laboratory studies on bionomics and hostpreference of *Raphidopalpa spp. Journal of Maharashtra Agricultural University*, *17*: 254-257.

How to cite this article: Raghavendra Yaligar, P.R. Badari Prasad, Hanumanthappa Shrihari, Mansoor, Sujay Hurali, R. Jyothi and Suhasini (2022). Evaluation of Bio-Efficacy and Phytotoxicity of Flubendiamide 90 + Deltamethrin 60-150 SC (15% W/V) Against Pest Complex in Cucumber. *Biological Forum – An International Journal*, *14*(1): 883-889.