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ASSESSMENT OF BIO-EFFICACY OF INSECTICIDES AGAINST LEAFHOPPER, *AMRASCA BIGUTTULA BIGUTTULA* (ISHIDA) INFESTING OKRA

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ABSTRACT

A field study was conducted during the *kharif*, 2024 at Department of Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat to assess the efficacy of various insecticides against leafhopper, *Amrasca biguttula biguttula* (Ishida) infesting okra. The performance of insecticides was assessed based on the leafhopper population, yield and economics of the insecticidal treatments. Among nine insecticides evaluated, flonicamid 50 WG and afidopyropen 5 DC exhibited higher efficacy by recording the lowest leafhopper populations of 1.06 and 1.19 leafhoppers/leaf, respectively, along with corresponding fruit yields of 145.69 and 141.06 q/ha. Despite moderate efficacy, imidacloprid 17.8 SL recorded the highest ICBR (1:22.74), followed by beta-cyfluthrin 08.49% + imidacloprid 19.81% OD (1:22.36) and flonicamid 50 WG (1:20.81).

Key words: Okra, leafhopper, *A. biguttula biguttula*, insecticides

Introduction

Okra (*Abelmoschus esculentus* L. Moench), native to Ethiopia, now widely grown in tropical, subtropical, and warm-temperate regions globally and is one of the major commercially cultivated vegetables in India because of its low cultivation requirements, consistent yield, and tolerance to varying moisture conditions. It is an essential part of the human diet, offering vital nutrients such as proteins, carbohydrates, vitamins, calcium, potassium, enzymes and minerals often lacking in diets of developing nations (Benchasri, 2012).

In India, okra is cultivated on 0.56 million hectares, producing 7.31 million metric tons (MT) with a high productivity of 13.17 MT/ha, making the country a major global producer (Anonymous, 2022). Among Indian states, Gujarat leads in area, production, and productivity, with 0.09 million ha under cultivation, yielding 1.15 million MT at 12.29 MT/ha (Anonymous, 2024-25).

More than 72 insect-pests threaten okra production, notably the shoot and fruit borer (*Earias vittella* Fabricius), fruit borer [*Helicoverpa armigera* (Hubner) Hardwick], leaf roller (*Sylepta derogata* Fabricius), leafhopper [*Amrasca biguttula biguttula* (Ishida)], whitefly [*Bemisia tabaci* (Gennadius)], aphid [*Aphis gossypii* (Glover)], solenopsis mealy bug [*Phenacoccus solenopsis* (Tinsley)], dusky cotton bug [*Oxycarenus hyalinipennis* (Costa)], red cotton bug [*Dysdercus koenigii* (Fabricius)], red spider mite [*Tetranychus urticae* (Koch)] and root-knot nematode [*Meloidogyne incognita* Chitwood, 1949] (Kedar *et al.*, 2014). Among these, the leafhopper (*A. biguttula biguttula*) is particularly severe, reducing plant height, fruit weight and quantity leading to yield losses up to 54.04% (Jayasimha *et al.*, 2012; Chauhan *et al.*, 2016; Chaudhari and Dadeech, 1989).

Leafhopper eggs are translucent, slightly oval and

yellow, embedded in leaf midribs. Nymphs are pale yellowish-green and flattened, while adults are wedge-shaped, pale green with black spots on the wings and vertex. Both stages move diagonally and hop actively (Singh *et al.*, 2018). They infest okra throughout its growth by sucking sap from the underside of leaves, leading to yellowing, curling, drying and finally leaf dropping. This causes hopperburn, a toxic reaction from saliva containing proteins, amino acids and enzymes resulting in chlorosis, stunted growth and significant yield reduction (DeLay *et al.*, 2012). Under severe infestation, plants may stop fruiting entirely, greatly reducing economic returns (Jayasimha *et al.*, 2012; Devi *et al.*, 2018).

Materials and Methods

The field experiment was carried out at Department of Entomology, Anand Agricultural University, Anand, Gujarat during *kharif*, 2024. Okra variety, Gujarat Okra Hybrid 205 (GOH 205) was raised following standard agronomic practices, excluding insecticidal applications. The experiment involved ten treatments in which nine insecticides *viz.*, Flonicamid 50 WG, 100 g a.i./ha, afidopyropen 5 DC, 50 g a.i./ha, tolfenpyrad 15 EC, 150 g a.i./ha, isocycloseram 10 DC, 20 g a.i./ha, beta-cyfluthrin 08.49 + imidacloprid 19.81 OD, 18 + 42 g a.i./ha, pyriproxyfen 10 EC, 50 g a.i./ha, imidacloprid 17.8 SL, 20 g a.i./ha, sulfoxaflor 21.8 SC, 75 g a.i./ha and broflanilide 20 SC 25 g a.i./ha were evaluated along with untreated control which were laid out in a randomized block design (RBD) with three replications. The first insecticidal application was applied at initiation of leafhopper, followed by a second spray 15 days after first spray. Foliar spray of insecticides were done using a knapsack sprayer equipped with a hollow cone nozzle. Field efficacy of insecticides were assessed from three leaves *viz.*, one from top, middle and bottom canopy were selected from each five randomly selected plants from each net plot area and leafhopper population were noted. The data on number of leafhoppers per leaf were taken before first spray and at 1, 3, 7 and 14 days after each spray. The periodical data of leafhopper population underwent square root transformation $\sqrt{x + 0.5}$ before statistical analysis. Significant differences between insecticidal treatment means were determined using Duncan's New Multiple Range Test (Steel and Torrie, 1980).

Results and Discussion

There was no significant difference of leafhopper population among all treatments were noted before first spray and population was ranged from 5.40 to 5.70 leafhoppers per leaf (Table 1).

First spray

1st Day After Spraying (DAS)

All insecticide application had significantly reduced leafhopper populations compared to control. Flonicamid 50 WG showed superior efficacy (1.52 leafhoppers/leaf), which was statistically at par with afidopyropen 5 DC (1.60 leafhoppers/leaf). Moderate control was achieved by tolfenpyrad 15 EC (2.67 leafhoppers/leaf), isocycloseram 10 DC (2.74 leafhoppers/leaf) and beta-cyfluthrin 08.49 + imidacloprid 19.81 OD (2.89 leafhoppers/leaf) while latter showing comparable efficacy to imidacloprid 17.8 SL (2.89 leafhoppers/leaf) and sulfoxaflor 21.8 SC (4.17 leafhoppers/leaf). The least effective treatments were broflanilide 20 SC (4.25 leafhoppers/leaf) and pyriproxyfen 10 EC (4.30 leafhoppers/leaf), which were statistically at par with each other.

3rd DAS

Flonicamid 50 WG (1.16 leafhoppers/leaf) and afidopyropen 5 DC (1.27 leafhoppers/leaf) demonstrated superior efficacy and statistically found similar in performance. Tolfenpyrad 15 EC (2.36 leafhoppers/leaf) showed moderate efficacy and statistically remained at par to isocycloseram 10 DC (2.56 leafhoppers/leaf), beta-cyfluthrin 08.49 + imidacloprid 19.81 OD (2.56 leafhoppers/leaf), pyriproxyfen 10 EC (2.60 leafhoppers/leaf) and imidacloprid 17.8 SL (2.67 leafhoppers/leaf). Sulfoxaflor 21.8 SC (3.99 leafhoppers/leaf) showed lesser efficacy and was statistically at par with later moderately performed insecticides and also with broflanilide 20 SC (4.12 leafhoppers/leaf) which showed least efficacy.

7th DAS

Flonicamid 50 WG (0.89 leafhoppers/leaf) continued its best performance and remained most effective, statistically comparable to afidopyropen 5 DC (1.04 leafhoppers/leaf). Tolfenpyrad 15 EC (2.06 leafhoppers/leaf) followed in its efficacy, which was statistically at par with isocycloseram 10 DC (1.66 leafhoppers/leaf), beta-cyfluthrin 08.49 + imidacloprid 19.81 OD (2.32 leafhoppers/leaf), pyriproxyfen 10 EC (2.49 leafhoppers/leaf) and imidacloprid 17.8 SL (2.60 leafhoppers/leaf). Sulfoxaflor 21.8 SC (3.91 leafhoppers/leaf) and broflanilide 20 SC (4.04 leafhoppers/leaf) showed the poor control.

14th DAS

The higher efficacy at fourteenth day after spray was found in plots treated with flonicamid 50 WG (2.06 leafhoppers/leaf) and afidopyropen 5 DC (2.16 leafhoppers/leaf) which were at par with each other. Tolfenpyrad 15 EC (3.26 leafhoppers/leaf) was next in order and remained at par with isocycloseram 10 DC

Table 1: Bio-efficacy of different insecticides against leafhopper, *A. biguttula biguttula* infesting okra.

Tr. No.	Treatments	Dose (g a.i./ ha)	No. of leafhoppers/leaf					
			Before spray	1 DAS	3 DAS	7 DAS	14 DAS	Pooled
T ₁	Afidopyropen 5 DC	50	2.43(5.40)	1.45 ^a (1.60)	1.33 ^a (1.27)	1.24 ^a (1.04)	1.63 ^a (2.16)	1.41 ^a (1.49)
T ₂	Tolfenpyrad 15 EC	150	2.47(5.60)	1.78 ^b (2.67)	1.69 ^b (2.36)	1.60 ^b (2.06)	1.94 ^b (3.26)	1.75 ^b (2.56)
T ₃	Imidacloprid 17.8 SL	20	2.44(5.45)	1.84 ^{bc} (2.89)	1.78 ^{bcd} (2.67)	1.76 ^b (2.60)	1.98 ^{bcd} (3.42)	1.84 ^b (2.89)
T ₄	Isocycloseram 10 DC	20	2.47(5.60)	1.80 ^b (2.74)	1.75 ^{bc} (2.56)	1.66 ^b (2.26)	1.95 ^b (3.30)	1.79 ^b (2.70)
T ₅	Fonicamid 50 WG	100	2.47(5.60)	1.42 ^a (1.52)	1.29 ^a (1.16)	1.18 ^a (0.89)	1.60 ^a (2.06)	1.37 ^a (1.38)
T ₆	Pyriproxyfen 10 EC	50	2.45(5.50)	2.19 ^d (4.30)	1.76 ^{bc} (2.60)	1.73 ^b (2.49)	1.97 ^{bc} (3.38)	1.91 ^b (3.15)
T ₇	Broflanilide 20 SC	25	2.45(5.50)	2.18 ^d (4.25)	2.15 ^d (4.12)	2.13 ^d (4.04)	2.32 ^d (4.88)	2.20 ^d (4.34)
T ₈	Sulfoxaflor 21.8 SC	75	2.46(5.55)	2.16 ^{cd} (4.17)	2.12 ^{cd} (3.99)	2.10 ^c (3.91)	2.31 ^{cd} (4.84)	2.17 ^c (4.21)
T ₉	Beta-cyfluthrin 08.49 + Imidacloprid 19.81 OD	18 + 42	2.45(5.50)	1.84 ^{bc} (2.89)	1.75 ^{bc} (2.56)	1.68 ^b (2.32)	1.96 ^b (3.34)	1.81 ^b (2.78)
T ₁₀	Control	-	2.49(5.70)	2.54 ^e (5.95)	2.57 ^e (6.10)	2.60 ^e (6.26)	2.67 ^e (6.63)	2.59 ^d (6.21)
S. Em. ± Treatment (T)			0.12	0.10	0.11	0.10	0.10	0.05
Period (P)			-	-	-	-	-	0.03
T × P			-	-	-	-	-	0.10
F test (T)			NS	Sig.	Sig.	Sig.	Sig.	Sig.
C.V. (%)			8.33	9.37	10.10	9.94	8.36	9.56
Note: 1. Figures in parentheses are retransformed values and those outside are $\sqrt{x + 0.5}$ transformed values 2. NS: Non-significant; Sig.: Significant; DAS: Days After Spray 3. Treatment mean(s) with letter(s) in common are not significant by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance 4. Significant parameter and their interaction: P								

(3.30 leafhoppers/leaf) and beta-cyfluthrin 08.49 + imidacloprid 19.81 OD (3.34 leafhoppers/leaf), pyriproxyfen 10 EC (3.38 leafhoppers/leaf) and imidacloprid 17.8 SL (3.42 leafhoppers/leaf). However, imidacloprid 17.80 SL found at par with sulfoxaflor 21.8 SC (4.84 leafhoppers/leaf) and broflanilide 20 S (4.88 leafhoppers/leaf) which were also statistically at par with each other in recording the leafhopper population.

Pooled over periods

The pooled data of first spray revealed flonicamid 50 WG (1.38 leafhoppers/leaf) and afidopyropen 5 DC (1.49 leafhoppers/leaf) are the equally and the most effective insecticides. Moderate control was achieved by tolfenpyrad 15 EC (2.56 leafhoppers/leaf), isocycloseram 10 DC (2.70 leafhoppers/leaf), beta-cyfluthrin 08.49 + imidacloprid 19.81 OD (2.78 leafhoppers/leaf), imidacloprid 17.8 SL (2.89 leafhoppers/leaf) and pyriproxyfen 10 EC (3.15 leafhoppers/leaf) which were statistically at par with each other. Sulfoxaflor 21.8 SC (4.21 leafhoppers/leaf) and broflanilide 20 SC (4.34 leafhoppers/leaf) performed the lowest efficacy with no significant difference between them (Table 1).

Second spray

1st DAS

The same trend of efficacy of insecticides was also

observed after second spray. The most effective insecticides at first day after second spray were flonicamid 50 WG (1.01 leafhoppers/leaf) and afidopyropen 5 DC (1.14 leafhoppers/leaf) which were at par with each other. Whereas, least effectiveness was performed by sulfoxaflor 21.8 SC (4.43 leafhoppers/leaf) and broflanilide 20 SC (4.52 leafhoppers/leaf) with relatively higher leafhopper population compared to other insecticides. Remaining insecticides showed moderate efficacy with leafhopper population ranging between 2.19 to 3.00 leafhoppers per leaf (Table 2).

3rd DAS

On the third day after second spraying, flonicamid 50 WG (0.67 leafhopper/leaf) and afidopyropen 5 DC (0.82 leafhopper/leaf) proved to be the most effective treatments, with both performing on par with each other. Tolfenpyrad 15 EC (1.84 leafhoppers/leaf), isocycloseram 10 DC (2.03 leafhoppers/leaf), beta-cyfluthrin 08.49 + imidacloprid 19.81 OD (2.10 leafhoppers/leaf), pyriproxyfen 10 EC (2.16 leafhoppers/leaf) and imidacloprid 17.8 SL (2.29 leafhoppers/leaf) exhibited moderate control and were statistically at par with each other. Sulfoxaflor 21.8 SC (3.91 leafhoppers/leaf) and broflanilide 20 SC (4.21 leafhoppers/leaf) showed least efficacy compared with other insecticides.

7th DAS

Table 2: Bio-efficacy of different insecticides against leafhopper, *A. biguttula biguttula* infesting okra (Second spray).

Tr. No.	Treatments	Dose (g a.i./ ha)	No. of leafhoppers/leaf				
			1 DAS	3 DAS	7 DAS	14 DAS	Pooled
T ₁	Afidopyropen 5 DC	50	1.28 ^a (1.14)	1.15 ^a (0.82)	1.00 ^a (0.50)	1.29 ^a (1.16)	1.18 ^a (0.89)
T ₂	Tolfenpyrad 15 EC	150	1.64 ^b (2.19)	1.53 ^b (1.84)	1.40 ^b (1.46)	1.66 ^b (2.26)	1.56 ^b (1.93)
T ₃	Imidacloprid 17.8 SL	20	1.75 ^b (2.56)	1.67 ^b (2.29)	1.55 ^b (1.90)	1.74 ^b (2.53)	1.68 ^b (2.32)
T ₄	Isocycloseram 10 DC	20	1.69 ^b (2.36)	1.59 ^b (2.03)	1.45 ^b (1.60)	1.67 ^b (2.29)	1.60 ^b (2.06)
T ₅	Flonicamid 50 WG	100	1.23 ^a (1.01)	1.08 ^a (0.67)	0.91 ^a (0.33)	1.25 ^a (1.06)	1.12 ^a (0.75)
T ₆	Pyriproxyfen 10 EC	50	1.87 ^b (3.00)	1.63 ^b (2.16)	1.51 ^b (1.78)	1.73 ^b (2.49)	1.68 ^b (2.32)
T ₇	Broflanilide 20 SC	25	2.24 ^c (4.52)	2.17 ^c (4.21)	2.08 ^c (3.83)	2.13 ^c (4.04)	2.15 ^c (4.12)
T ₈	Sulfoxaflor 21.8 SC	75	2.22 ^c (4.43)	2.10 ^c (3.91)	1.93 ^c (3.22)	2.12 ^c (3.99)	2.09 ^c (3.87)
T ₉	Beta-cyfluthrin 08.49 + Imidacloprid 19.81 OD	18 + 42	1.72 ^b (2.46)	1.62 ^b (2.10)	1.49 ^b (1.70)	1.69 ^b (2.36)	1.63 ^b (2.16)
T ₁₀	Control	-	2.62 ^d (6.36)	2.58 ^d (6.20)	2.55 ^d (6.00)	2.51 ^d (5.80)	2.56 ^d (6.05)
S. Em. ± Treatment (T)			0.10	0.10	0.09	0.09	0.05
Period (P)			-	-	-	-	0.03
T × P			-	-	-	-	0.10
F test (T)			Sig.	Sig.	Sig.	Sig.	Sig.
C.V. (%)			9.87	10.20	10.32	8.94	9.81
Note: 1. Figures in parentheses are retransformed values and those outsidess are $\sqrt{x + 0.5}$ transformed values 2. NS: Non-significant; Sig.: Significant; DAS: Days After Spray 3. Treatment mean(s) with letter(s) in common are not significant by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance 4. Significant parameter and their interaction: P							

Flonicamid 50 WG remained the most effective treatment, recording the lowest leafhopper population of 0.33 leafhopper/leaf, and was statistically at par with afidopyropen 5 DC (0.50 leafhopper/leaf), the next most effective option. Sulfoxaflor 21.8 SC (3.22 leafhoppers/leaf) and broflanilide 20 SC (3.83 leafhoppers/leaf) were among the least effective treatments compared to other insecticides but still showed significant superiority over the untreated control (6.00 leafhoppers/leaf). Remaining insecticides showed moderate efficacy with leafhopper population ranging between 1.46 to 1.90 leafhoppers per leaf.

14th DAS

The higher efficacy was performed by flonicamid 50 WG with leafhopper population of 1.06 leafhoppers/leaf which was at par with afidopyropen 5 DC (1.16 leafhoppers/leaf). Sulfoxaflor 21.8 SC (3.22 leafhoppers/leaf) and broflanilide 20 SC (3.83 leafhoppers/leaf) performed inferior compared to other insecticides but significant superiority over the untreated control (6.00 leafhoppers/leaf). Remaining insecticides were subordinate to highly effective insecticides which showed moderate efficacy with leafhopper population ranging between 2.26 to 2.53 leafhoppers/leaf.

Pooled over periods

The pooled data of second spray of insecticides indicated that flonicamid 50 WG with leafhopper population of 0.75 leafhopper/leaf outperformed other

tested insecticides but was at par with afidopyropen 5 DC (0.89 leafhopper/leaf). Sulfoxaflor 21.8 SC (3.87 leafhoppers/leaf) and broflanilide 20 SC (4.13 leafhoppers/leaf) continued least efficacy compared to other insecticides. Remaining insecticides showed moderate efficacy with leafhopper population ranging from 1.93 to 2.32 leafhoppers per leaf (Table 2).

Pooled over periods and sprays

The most effective insecticide which surpassed other insecticides was flonicamid 50 WG with leafhopper population of 1.06 leafhoppers/leaf and was at par with afidopyropen 5 DC (1.19 leafhoppers/leaf). Tolfenpyrad 15 EC (2.22 leafhoppers/leaf), isocycloseram 10 DC (2.39 leafhoppers/leaf), beta-cyfluthrin 08.49 + imidacloprid 19.81 OD (2.46 leafhoppers/leaf), imidacloprid 17.8 SL (2.60 leafhoppers/leaf) and pyriproxyfen 10 EC (2.74 leafhoppers/leaf) had moderate efficacy whereas, sulfoxaflor 21.8 SC (4.04 leafhoppers/leaf) and broflanilide 20 SC (4.25 leafhoppers/leaf) found least effective among tested insecticides (Table 3).

Kodandaram *et al.*, (2017), Kumar *et al.*, (2018), Kumari *et al.*, (2020), Barot and Patel (2022), Kaur *et al.*, (2022) and Rakesh *et al.*, (2024) also reported flonicamid 50 WG as the most effective insecticide against leafhopper. Barot and Patel (2022) further highlighted afidopyropen 5 DC as equally effective, along with flonicamid and tolfenpyrad. Additionally, Bharpoda *et al.*

Table 2: Bio-efficacy of insecticides against leafhopper, *A. biguttula biguttula* infesting okra (Pooled: First spray and second spray).

Tr. No.	Treatments	Dose (g a.i./ ha)	No. of leafhoppers/leaf		
			First spray	Second spray	Pooled over periods and sprays
T ₁	Afidopyropen 5 DC	50	1.41 ^a (1.49)	1.18 ^a (0.89)	1.30 ^a (1.19)
T ₂	Tolfenpyrad 15 EC	150	1.75 ^b (2.56)	1.56 ^b (1.93)	1.65 ^b (2.22)
T ₃	Imidacloprid 17.8 SL	20	1.84 ^b (2.89)	1.68 ^b (2.32)	1.76 ^b (2.60)
T ₄	Isocycloseram 10 DC	20	1.79 ^b (2.70)	1.60 ^b (2.06)	1.70 ^b (2.39)
T ₅	Flonicamid 50 WG	100	1.37 ^a (1.38)	1.12 ^a (0.75)	1.25 ^a (1.06)
T ₆	Pyriproxyfen 10 EC	50	1.91 ^b (3.15)	1.68 ^b (2.32)	1.80 ^b (2.74)
T ₇	Broflanilide 20 SC	25	2.20 ^c (4.34)	2.15 ^c (4.12)	2.18 ^c (4.25)
T ₈	Sulfoxaflor 21.8 SC	75	2.17 ^c (4.21)	2.09 ^c (3.87)	2.13 ^c (4.04)
T ₉	Beta-cyfluthrin 08.49 + Imidacloprid 19.81 OD	18 + 42	1.81 ^b (2.78)	1.63 ^b (2.16)	1.72 ^b (2.46)
T ₁₀	Control	-	2.59 ^d (6.21)	2.56 ^d (6.05)	2.58 ^d (6.16)
S. Em. ±		Treatment (T)	0.05	0.05	0.04
		Period (P)	0.03	0.03	0.02
		Spray (S)	-	-	0.02
		T × P	0.10	0.10	0.07
		T × S	-	-	0.05
		P × S	-	-	0.03
		T × P × S	-	-	0.10
F test (T)			Sig.	Sig.	Sig.
C.V. (%)			9.14	9.52	9.65
Note: 1. Figures in parentheses are retransformed values and those outside are $\sqrt{x + 0.5}$ transformed values 2. Sig.: Significant; DAS: Days After Spray 3. Treatment mean(s) with letter(s) in common are not significant by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance 4. Significant parameters and their interaction: P, S and P × S					

Table 4: Economics of different insecticides against leafhopper, *A. biguttula biguttula* infesting okra.

Tr. No.	Treatments	QIR	Price	COI	LC	TCPP	FY	NGOC	NR	ICBR
T1	Afidopyropen 5 DC	2.00	3750	7500	3504	11004	141.06	47.43	142290	1:12.93
T2	Tolfenpyrad 15 EC	2.00	2800	5600	3504	9104	128.77	35.14	105420	1:11.58
T3	Imidacloprid 17.8 SL	0.225	1150	259	3504	3763	122.15	28.52	85560	1:22.74
T4	Isocycloseram 10 DC	0.400	11408	4563	3504	8067	126.25	32.62	97860	1:12.13
T5	Flonicamid 50 WG	0.400	10000	4000	3504	7504	145.69	52.06	156180	1:20.81
T6	Pyriproxyfen 10 EC	1.00	1900	1900	3504	5404	124.36	30.73	92190	1:17.06
T7	Broflanilide 20 SC	0.250	48380	12095	3504	15599	112.53	18.90	56700	1:3.63
T8	Sulfoxaflor 21.8 SC	0.625	4375	2734	3504	6238	116.45	22.82	68460	1:10.97
T9	Beta-cyfluthrin 08.49 + Imidacloprid 19.81 OD	0.400	2000	800	3504	4304	125.71	32.08	96240	1:22.36
T10	Control	-	-	-	-	-	93.63	-	-	-

QIR: Quantity of insecticide required for 2 applications (kg or litre/ha); **COI:** Cost of insecticide (Rs/ha);
LC: Labour Cost (Rs/ha); **Price:** Price (Rs/kg of liter) **TCPP:** Total cost of plant protection (Rs/ha); **FY:** Fruit yield (q/ha);
NGOC: Net gain over control (q/ha); **NR:** Net Realization (Rs/ha)

Note:

- Labour charges-**
 - Semi skilled labour : Rs. 487/- per day $\times$ 2 labours = 974.00 Rs./ha
 - Farm labour : Rs. 389/- per day $\times$ 2 labours = 778.00 Rs./ha
 - Labour charge for one spray : Rs. 778.00 + Rs. 974.00 = 1752.00 Rs./ha
 - Total labour charge for two sprays : Rs. 1752.00 $\times$ 2 sprays = 3504.00 Rs./ha
- Price of okra-** Rs. 3000/q (Rs. 30.00/kg)

(2014), Mandal *et al.*, (2015), Sathyan *et al.*, (2016), and Kumari *et al.*, (2020) reported imidacloprid 17.8 SL as an effective insecticide, while Maity *et al.*, (2017) found pyriproxyfen to be successful against okra leafhoppers.

Economics

The data on economics of various insecticides evaluated in bio-efficacy presented in Table 4 revealed that the highest net realization was achieved with flonicamid 50 WG (Rs. 156180/ha), followed by afidopyropen 5 DC (Rs. 142290/ha) and tolfenpyrad 15 EC (Rs. 105420/ha). Other treatments, in descending order of profitability, included isocycloseram 10 DC (Rs. 97860/ha), beta-cyfluthrin 08.49 + imidacloprid 19.81 OD (Rs. 96240/ha), pyriproxyfen 10 EC (Rs. 92190/ha), imidacloprid 17.8 SL (Rs. 85560/ha) and sulfoxaflor 21.8 SC (Rs. 68460/ha). The lowest net return was recorded with broflanilide 20 SC (Rs. 56700/ha). Imidacloprid 17.8 SL obtained the highest incremental cost-benefit ratio (ICBR) of 1:22.74 in midst of its moderate yield followed by beta-cyfluthrin 08.49 + imidacloprid 19.81 OD (1:22.36), flonicamid 50 WG (1:20.81), pyriproxyfen 10 EC (1:17.06), afidopyropen 5 DC (1:12.93), isocycloseram 10 DC (1:12.13), tolfenpyrad 15 EC (1:11.58) and sulfoxaflor 21.8 SC (1:10.97). The least ICBR was demonstrated by broflanilide 20 SC (1:3.63) indicating its lesser potential to reduce leafhopper incidence and increase yield with higher cost of insecticide making it last option for management of leafhoppers infesting okra.

Conclusion

From present investigation it can be concluded that among nine evaluated insecticides, flonicamid 50 WG and afidopyropen 5 DC were highly effective against leafhopper, *A. biguttulabiguttula* infesting okra whereas, sulfoxaflor 21.8 SC and broflanilide 20 SC were least effective. Imidacloprid 17.8 SL (1:22.74) was most economical despite its moderate efficacy due to lower cost followed by beta-cyfluthrin 08.49 + imidacloprid 19.81 OD (1:22.36) and flonicamid 50 WG (1:20.81) whereas, the lowest ICBR value compared to other tested insecticides was observed from broflanilide 20 SC (1:3.63) treatment.

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