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Bio-efficacy of bifenthrin 8 SC against shoot and fruit borer and red spider mite of okra, *Abelmoschus esculentus* (L.) Moench

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Abstract: A field study was conducted to evaluate the relative bio-efficacy of bifenthrin 8 SC @60g, 80g, 100g, 120g, 140g a.i./ha against shoot and fruit borer and red spider mite of okra, *Abelmoschus esculentus* (L.) Moench cv. OH -152 at the Central Research Farm of BCKV, Nadia, West Bengal, for two consecutive seasons. Cypermethrin 10 EC @70g a.i./ha and dicofol 18.5 EC @500g a.i./ha were used as standard treated check in the experiment. Population of beneficial insects like spider, predatory mites and Braconid parasitoid were also recorded during the time of observation on pests' infestation. Among treatments, bifenthrin 8 SC @ 100 to 140g a.i./ha was found significantly ($p \leq 0.05$) superior over treated check cypermethrin 10 EC @ 70g a.i./ha and dicofol 18.5 EC @ 500g a.i./ha to bring down *Earias vittella* and red spider mite (*Tetranychus urticae*) population, respectively, on okra. Bifenthrin 8 SC @ 140g a.i./ha recorded maximum fruit yield (82.3 q/ha during *kharif* 2012 and 53.1q/ha during *rabi* 2012-13) of okra. Also, foliar application of bifenthrin 8 SC did not reveal any significant ($p \leq 0.05$) adverse effect on population of spider, predatory mite and *Braconid* parasitoid in okra crop ecosystem. These findings will facilitate the selection of bifenthrin 8 SC as an effective acaro-insecticides for effective control of shoot and fruit borer and red spider mite of okra.

Keywords: *Abelmoschus esculentus,* Bifenthrin 8 SC, *Earias vittella, Tetranychus urticae*

INTRODUCTION

Okra or Lady's Finger, which is botanically known as *Hibiscus esculentus* L. or *Abelmochus esculentus* (L.) Moench, is an important vegetable of the tropical countries and most popular in India, Nigeria, Pakistan, Cameroon, Iraq and Ghana. The immature fruits can be eaten raw, boiled, or fried. It has good amount of vitamin A and folic acid, besides carbohydrates, phosphorus, magnesium and potassium. The average production of okra in India is about 63.46 lakh tons and productivity 11.9 t/ha during 2013-14 (Anonymous, 2014). One of the major factors for declining its production is the attack of the crop by many arthropod pests which includes shoot and fruit borer, red spider mites, aphids, thrips and whitefly. Among these, shoot and fruit borer, *Earias vittella* (Fabricius) and red spider mite *Tetranychus urticae* (Linnaeus) cause appreciable losses to the crop. Of which, shoot and fruit borer causes a loss of green fruit yield of okra by 49 to 74 per cent (Krishnaiah, 1980) and red spider mite causes a loss of green fruit yield of okra by 19.5 to 27.4 per cent (Saini *et al*., 2011). To mitigate the losses due to these pests, a huge quantity of pesticides is used which may be highly hazardous to the consumers and also contaminate the environment. So there is a need for an environment-friendly acaro-insecticide to tackle the menacing effect of shoot and fruit borer and red spider mite of okra. Therefore, a bio-efficacy study with an acaro-insecticide bifenthrin 8 SC was undertaken in comparison with conventional insecticides and acaricides as standard treated check. Further, the concomitant effect of this bifenthrin 8 SC on the natural enemies associated with okra crop was also
investigated.

MATERIALS AND METHODS

The experiment was conducted for two consecutive seasons during *kharif* 2012 and *rabi* 2012 -13 at the Central Research Farm, Gayeshpur, BCKV, Nadia, West Bengal, India. The experimental site was geographically located at 22°58′15.08′N latitude and 88°29′49.18′E longitude with 40 ft elevation from mean sea level. The relative bioefficacy of bifenthrin 8 SC @60g, 80g, 100g, 120g, 140g a.i./ha were evaluated. Cypermethrin 10 EC @70g a.i./ha and dicofol 18.5 EC @500g a.i./ha were used as standard treated check in the experiment. Eight treatments including an untreated control were replicated thrice (Table 1). The acaro-insecticide bifenthrin 8 SC was supplied by the M/S FMC India Pvt. Ltd. Recommended package of practices for raising okra was adopted. Uniform numbers of plants were maintained in each plot. Nitrogen

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was applied in split dosages. For taking observation, ten okra plants from each plot leaving border rows were randomly tagged for taking observation on shoot and fruit borers, red spider mites and beneficial insects. Population of shoot and fruit borer was recorded at 0 (pre-treatment), 1, 5, 10 and 15 days after foliar spray of the insecticides from 10 tagged plants after dissecting out larva from infested shoot and fruit. Three leaves from each top, middle and bottom portion of the tagged plant were taken into consideration for recording the number of red spider mites. Population of red spider mites per 3.14 sq. cm area of leaf was recorded at 0 (pre-treatment), 1, 3, 5, 10 and 15 days after foliar spray of the bifenthrin 8 SC. Foliar spray was given by pneumatic knap-sack sprayer (ASPEE) with hollow cone nozzle delivering 0.2 litre min^{-1} at 15 psi. Spray volume for foliar spray was 500 litre per hectare. Population of beneficial insects like spider, predatory mites and *Braconid* parasitoid were also recorded during the time of observation on pests' infestation. Fruits of okra were harvested at regular interval.

Per cent fruit infestation was calculated as = (Number of infested fruits in a plant/Total number of fruits in a plant) × 100

Reduction of shoot and fruit borers and red spider mite population after spraying of bifenthrin 8 SC was corrected following Henderson and Tilton's formula (Henderson and Tilton, 1955). The formula is cited below:

Corrected % = [1 – {(n in Co before treatment * n in T after treatment) ÷ (n in Co after treatment * n in T before treatment)}] * 100

Where, n = Insect population, T = treated, Co = control

Table 1. Treatment details.

Notations	Treatments	Dose g a.i./ha	Dose (ml/ha)
T_1	Untreated Control	-	-
T_2	Bifenthrin 8 SC	60	750
T_3	Bifenthrin 8 SC	80	1000
T_4	Bifenthrin 8 SC	100	1250
T_5	Bifenthrin 8 SC	120	1500
T_6	Bifenthrin 8 SC	140	1750
T_7	Cypermethrin 10 EC	70	760
T_8	Dicofol 18.5 EC	500	2700

The data thus obtained during experiment were subjected to statistical analysis using Randomized Complete Block Design at 5% level of probability after necessary transformation of the raw data (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of bifenthrin 8 SC on population of *E. vittella* in okra: Experimental results (Table 2) during *kharif* 2012 and *rabi* 2012-2013 revealed no differences among treatments with regard to shoot and fruit borer population in okra immediately at 1day after application (DAA). Significant variations of *E. vittella* population were noticed from 5 DAA till 15 DAA. The data at different intervals revealed significantly least number of shoot and fruit borer at bifenthrin 8 SC @ 140g a.i./ha. It was found at par with other doses of bifenthrin 8 SC like 100 & 120g a.i./ha. Bifenthrin 8 SC @ 100 to 140g a.i./ha was found significantly superior over treated check cypermethrin 10 EC @ 70g a.i./ha to bring down *E. vittella* population on okra.

Effect of bifenthrin 8 SC on reduction of *E. vittella*

Table 2. Effect of bifenthrin 8 SC on population of *E. vittella* in okra during *kharif* 2012 and *rabi* 2012-13 (Mean of two sprays).

Treatments	Population of *E. vittella* (number / plant)									
	Pretreatment count		Days after application / spraying (DAA)							
			1 DAA		5 DAA		10 DAA		15 DAA	
	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13
T_1	1.62 (2.13)	1.76 (2.63)	1.58 (2.00)	1.83 (2.87)	1.72 (2.47)	1.90 (3.17)	1.74 (2.53)	1.89 (3.10)	1.83 (2.87)	1.93 (3.23)
T_2	1.66 (2.43)	1.60 (2.07)	1.52 (1.90)	1.54 (1.87)	1.42 (1.53)	1.45 (1.60)	1.41 (1.49)	1.41 (1.50)	1.44 (1.58)	1.57 (1.97)
T_3	1.63 (2.17)	1.84 (2.90)	1.44 (1.57)	1.72 (2.47)	1.27 (1.11)	1.41 (1.48)	1.40 (1.45)	1.40 (1.47)	1.37 (1.37)	1.54 (1.90)
T_4	1.59 (2.07)	1.86 (2.97)	1.36 (1.37)	1.60 (2.07)	1.05 (0.60)	1.34 (1.30)	1.12 (0.77)	1.28 (1.13)	1.17 (0.87)	1.35 (1.33)
T_5	1.70 (2.40)	1.70 (2.40)	1.40 (1.47)	1.43 (1.57)	1.00 (0.50)	1.16 (0.87)	1.09 (0.70)	1.12 (0.77)	1.12 (0.77)	1.22 (1.00)
T_6	1.88 (3.07)	1.72 (2.50)	1.41 (1.50)	1.39 (1.43)	1.01 (0.53)	1.13 (0.80)	1.12 (0.77)	1.09 (0.70)	1.15 (0.83)	1.21 (0.97)
T_7	1.76 (2.60)	1.77 (2.67)	1.43 (1.53)	1.61 (2.10)	1.26 (1.09)	1.48 (1.70)	1.42 (1.53)	1.51 (1.80)	1.41 (1.50)	1.55 (1.90)
T_8	1.63 (2.17)	1.74 (2.53)	1.65 (2.23)	1.86 (2.97)	1.47 (1.67)	1.80 (2.77)	1.64 (2.27)	1.83 (2.87)	1.78 (2.70)	1.76 (2.60)
SEm (±)	0.20	0.13	0.14	0.11	0.10	0.13	0.13	0.09	0.09	0.09
LSD (0.05)	NS	NS	NS	NS	0.20	0.28	0.27	0.20	0.20	0.19

Data shown in the table are (x+0.5) square root transformed values, Data in parentheses indicate original values.

Table 3. Effect of bifenthrin 8 SC on reduction of *E. vittella* in okra during *kharif* 2012 and *rabi* 2012-13 (Mean of two sprays).

Treatments	% reduction of *E. vittella* population at days after application / spraying (DAA)							
	1 DAA		5 DAA		10 DAA		15 DAA	
	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13
T_2	20.12 (12.35)	23.90 (16.44)	34.98 (34.90)	35.01 (34.15)	32.98 (32.23)	38.04 (38.27)	36.70 (37.85)	28.82 (23.33)
T_3	28.43 (23.22)	27.68 (21.61)	48.09 (55.36)	48.94 (56.87)	39.83 (41.97)	48.88 (56.78)	45.98 (51.64)	43.77 (47.89)
T_4	32.48 (28.93)	36.74 (35.81)	59.14 (73.07)	52.59 (63.12)	54.59 (65.83)	55.22 (67.46)	54.95 (66.64)	52.63 (62.81)
T_5	36.42 (35.52)	38.68 (39.08)	65.37 (82.36)	56.61 (69.72)	61.08 (76.42)	58.54 (72.78)	60.59 (75.54)	53.57 (64.46)
T_6	41.53 (44.72)	42.93 (46.43)	67.69 (85.41)	58.99 (73.19)	60.74 (74.58)	60.82 (76.23)	61.70 (76.31)	55.21 (67.22)
T_7	37.99 (37.99)	31.01 (26.74)	52.74 (62.92)	43.07 (46.68)	44.34 (49.41)	40.69 (42.59)	48.72 (56.33)	39.50 (40.87)
T_8	6.11 (1.92)	4.22 (1.60)	31.63 (29.76)	12.84 (7.26)	23.81 (17.81)	14.83 (9.57)	11.92 (11.40)	19.90 (17.68)
SEm (±)	4.70	2.38	8.22	4.34	9.33	4.12	9.39	7.32
LSD (0.05)	10.08	5.10	17.64	9.31	20.00	8.83	20.13	15.69

Data shown in the table are (x+0.5) angular transformed values, Data in parentheses indicate original values.

Table 4. Effect of bifenthrin 8 SC on okra fruit infestation due to *E. vittella* during *kharif* 2012 and *rabi* 2012-13 (Mean of two sprays).

Treatments	% fruit infestation of okra due to *E. vittella*									
	Pretreatment infestation		Days after application / spraying (DAA)							
			1 DAA		5 DAA		10 DAA		15 DAA	
	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13
T_1	23.38 (15.82)	32.08 (28.33)	21.57 (13.82)	25.54 (18.67)	28.87 (23.67)	27.40 (21.33)	31.37 (27.16)	28.82 (23.33)	32.39 (28.77)	30.64 (26.00)
T_2	19.75 (12.07)	25.82 (20.00)	23.45 (15.91)	22.49 (14.67)	20.20 (12.04)	20.51 (12.33)	21.34 (13.30)	19.31 (11.00)	21.99 (14.07)	21.32 (13.33)
T_3	23.35 (15.98)	28.77 (23.33)	22.21 (14.35)	22.03 (14.08)	19.36 (11.01)	19.96 (11.67)	20.65 (12.50)	18.69 (10.30)	21.59 (13.57)	19.49 (11.17)
T_4	29.12 (24.52)	24.04 (16.67)	17.82 (9.45)	22.11 (14.33)	14.27 (6.09)	16.65 (8.33)	16.07 (7.78)	15.67 (7.33)	17.31 (8.98)	17.07 (8.67)
T_5	26.32 (19.84)	28.22 (23.33)	16.87 (8.55)	20.82 (12.67)	13.07 (5.13)	14.71 (6.67)	15.88 (7.75)	13.26 (5.33)	16.93 (8.61)	15.65 (7.33)
T_6	22.63 (14.82)	28.53 (23.33)	15.73 (7.45)	20.51 (12.33)	12.80 (4.99)	13.68 (5.67)	15.95 (7.73)	12.74 (5.00)	16.34 (7.96)	14.77 (6.67)
T_7	25.27 (18.37)	26.13 (20.00)	22.11 (14.29)	21.96 (14.00)	19.38 (11.11)	19.66 (11.33)	23.48 (15.89)	19.31 (11.00)	24.11 (16.76)	21.09 (13.00)
T_8	22.04 (14.45)	23.98 (18.33)	21.52 (13.50)	24.30 (17.00)	24.01 (16.60)	26.54 (20.00)	25.10 (18.17)	26.75 (20.33)	26.98 (20.63)	29.54 (24.33)
SEm (±)	3.57	5.89	1.97	1.60	2.25	1.97	2.05	1.80	1.80	1.54
LSD (0.05)	NS	NS	4.23	3.42	4.82	4.22	4.40	3.85	3.87	3.30

population in okra: Foliar spray of bifenthrin 8 SC @ 60-140g a.i./ha recorded 37.85 to 76.31% and 23.3 to 67.2% reduction of shoot and fruit borer population during 2012 and 2012-13, respectively; the highest being, 76.31% (during 2012) and 67.2% (during 2012-13) marked in bifenthrin 8 SC @ 140g a.i./ha at 15 DAA (Table 3). Bifenthrin 8 SC @ 100-140g a.i./ha were found on par with each other to suppress shoot and fruit borer population in okra. Bifenthrin 8 SC at the mentioned doses were found significantly superior over the treated check (T_7) to suppress *E. vittella* population.

Effect of bifenthrin 8 SC on okra fruit infestation due to *E. vittella*: Significant reduction of fruit infestation of okra due to *E. vittella* was observed till 15 DAA commencing from 1DAA with bifenthrin 8 SC @ 100-140g a.i./ha (Table 4). The treatments were on par with each other but significantly superior to treated check (T_7) to reduce fruit damage of okra by *E. vittella*.

Effect of bifenthrin 8 SC on population of *T. urticae* in okra: Mean data of red spider mite population on okra revealed significantly low population in bifenthrin 8 SC @ 100-140g a.i./ha (Table 5). These treatments were significantly superior to treated check (Dicofol 18.5 EC @500g a.i./ha) to curb *T. urticae* population on okra.

Effect of bifenthrin 8 SC on reduction of *T. urticae*

Table 5. Effect of bifenthrin 8 SC on population of *T. urticae* in okra during *kharif* 2012 and *rabi* 2012-13 (Mean of two sprays).

Treatments	Population of *T. urticae* (number / 3.14cm^2 leaf area)											
	Pretreatment count		Days after application / spraying (DAA)									
			1 DAA		3DAA		5 DAA		10 DAA		15 DAA	
	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13
T_1	4.79 (22.50)	4.58 (20.52)	5.19 (26.50)	4.83 (22.87)	5.65 (31.50)	5.35 (28.10)	5.83 (33.60)	5.48 (29.50)	6.25 (38.60)	5.92 (34.50)	6.05 (36.30)	5.98 (35.23)
T_2	4.60 (20.75)	4.52 (20.09)	4.26 (17.75)	4.19 (17.10)	4.53 (20.06)	3.68 (13.10)	3.98 (15.40)	3.25 (10.10)	3.35 (10.77)	3.27 (10.20)	4.08 (16.19)	3.54 (12.13)
T_3	5.10 (25.86)	4.35 (18.52)	4.51 (20.20)	4.04 (15.81)	4.36 (18.50)	3.52 (11.90)	3.83 (14.18)	3.07 (8.95)	3.25 (10.08)	2.96 (8.34)	3.72 (13.38)	3.48 (11.63)
T_4	5.05 (25.23)	4.88 (23.57)	4.25 (17.88)	4.27 (17.89)	3.22 (10.38)	3.29 (10.39)	2.86 (7.87)	2.57 (6.20)	2.40 (5.32)	2.45 (5.60)	2.94 (8.16)	2.38 (5.18)
T_5	5.20 (26.81)	5.04 (25.15)	4.22 (17.81)	4.07 (16.17)	3.05 (9.81)	2.94 (8.20)	2.43 (5.96)	1.96 (3.37)	1.94 (3.53)	1.71 (2.52)	2.72 (6.97)	1.75 (2.63)
T_6	5.41 (28.85)	5.10 (26.51)	4.00 (15.50)	4.00 (15.50)	2.22 (4.50)	2.58 (6.17)	1.67 (2.61)	1.30 (1.22)	1.41 (1.57)	1.23 (1.02)	2.46 (5.57)	1.42 (1.53)
T_7	4.43 (19.22)	4.29 (18.56)	4.12 (16.55)	4.17 (16.88)	4.44 (19.22)	4.28 (17.89)	4.03 (15.73)	4.19 (17.06)	4.46 (19.36)	4.19 (17.10)	5.08 (25.34)	4.45 (19.30)
T_8	4.99 (24.41)	4.76 (22.41)	4.07 (16.07)	3.99 (15.40)	2.92 (8.07)	2.98 (8.40)	2.80 (7.40)	2.24 (4.53)	2.90 (7.95)	2.17 (4.23)	3.45 (11.43)	3.03 (8.77)
SEm (±)	0.41	0.35	0.43	0.22	0.50	0.20	0.43	0.20	0.27	0.22	0.20	0.19
LSD (0.05)	NS	NS	NS	NS	1.06	0.43	0.92	0.42	0.59	0.46	0.44	0.40

Data shown in the table are (x+0.5) square root transformed values, Data in parentheses indicate original values.

Table 6. Effect of bifenthrin 8 SC on reduction of *T. urticae* in okra during *kharif* 2012 and *rabi* 2012-13 (Mean of two sprays).

Treatments	% reduction of *T. urticae* population at days after application / spraying (DAA)									
	1 DAA		3DAA		5 DAA		10 DAA		15 DAA	
	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13
T_2	31.68 (27.65)	23.91 (23.14)	33.81 (30.99)	44.61 (49.42)	45.29 (50.54)	52.82 (63.19)	56.74 (69.92)	56.04 (68.66)	45.65 (51.13)	52.98 (63.56)
T_3	35.80 (34.29)	27.28 (22.24)	42.53 (45.89)	46.17 (52.01)	51.51 (61.00)	54.34 (65.88)	61.12 (76.59)	58.75 (72.97)	54.87 (66.86	52.33 (62.56)
T_4	39.65 (40.76)	32.85 (30.29)	58.49 (72.47)	54.56 (66.13)	63.28 (79.74)	64.73 (81.73)	69.44 (87.66)	67.95 (85.91)	62.83) (78.98	68.80 (86.92)
T_5	42.24 (45.25)	35.69 (37.69)	61.82 (76.55)	60.18 (74.86)	69.17 (86.66)	72.20 (90.67)	75.01 (93.02)	75.85 (93.62)	66.05) (83.42)	75.47 (93.38)
T_6	47.47 (54.34)	37.92 (39.06)	70.69 (89.00)	63.89 (80.08)	76.94 (94.19)	78.83 (95.73)	80.13 (96.90)	80.60 (97.08)	69.69 (87.95)	78.78 (96.09)
T_7	31.31 (27.03)	14.76 (16.26)	31.91 (28.17)	19.96 (21.07)	42.26 (45.25)	25.94 (26.89)	39.81 (41.05)	37.35 (37.63)	20.85 (17.98)	33.33 (31.68)
T_8	41.60 (44.11)	35.91 (35.02)	61.03 (76.56)	58.04 (71.96)	63.37 (79.91)	67.54 (85.25)	64.32 (81.22)	69.98 (88.03)	57.29 (70.82)	61.32 (76.99)
SEm (±)	1.90	8.26	4.72	7.69	3.94	7.41	2.28	4.44	5.71	4.63
LSD (0.05)	4.08	17.72	10.12	16.49	8.45	15.89	4.89	9.51	12.25	9.93

Data shown in the table are (x+0.5) angular transformed values, Data in parentheses indicate original values

in okra: Reduction of *T. urticae* on okra ranged from 51.1 to 87.9% and 63.6 to 96.1% during 2012 and 2012-13, respectively due to application of bifenthrin 8 SC @ 60-140g a.i./ha at 15 DAA (Table 6). Bifenthrin 8 SC @ 100-140g a.i./ha was on par with regard to reduction of red spider mite population but significantly superior over other doses of bifenthrin and treated check (T_8). Bifenthrin @100g a.i./ha was also significantly superior to dicofol 18.5 EC @ 500g a.i./ha to check infestation of *T. urticae* on okra.

Effect of bifenthrin 8 SC on natural enemies in okra crop ecosystem: Foliar application of bifenthrin 8 SC did not reveal any significant adverse effect on population of spider in okra crop ecosystem (Table 7). Spraying of bifenthrin 8 SC had no significant detrimental effect on population of *Braconid* parasitoid population of *E. vittella* in okra crop (Table 8). No significant bad effect on predatory mite population was observed with foliar spray of bifenthrin 8 SC in okra crop (Table 9).

Effect of bifenthrin 8 SC on yield okra: Total fruit yield of okra was found maximum in bifenthrin 8 SC @ 140g a.i./ha, being, 82.3 q/ha and 53.1 q/ha, respectively during 2012 and 2012-13 (Table 10). Fruit yield

Table 7. Population of spider on okra crop during *kharif* 2012 and *rabi* 2012-13.

Treatments	Number of spiders/plant									
	Pretreatment count		Days after application / spraying							
			1 DAA		5 DAA		10 DAA		15 DAA	
	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13
T_1	0.75 (0.07)	0.79 (0.13)	0.73 (0.03)	0.75 (0.07)	0.75 (0.07)	0.73 (0.03)	0.75 (0.07)	0.75 (0.07)	0.80 (0.13)	0.77 (0.10)
T_2	0.73 (0.03)	0.75 (0.07)	0.75 (0.07)	0.75 (0.07)	0.79 (0.13)	0.73 (0.03)	0.77 (0.10)	0.75 (0.07)	0.77 (0.10)	0.73 (0.03)
T_3	0.75 (0.07)	0.73 (0.03)	0.77 (0.10)	0.75 (0.07)	0.77 (0.10)	0.75 (0.07)	0.77 (0.10)	0.77 (0.10)	0.79 (0.13)	0.75 (0.07)
T_4	0.75 (0.07)	0.79 (0.13)	0.73 (0.03)	0.77 (0.10)	0.75 (0.07)	0.73 (0.03)	0.77 (0.10)	0.75 (0.07)	0.73 (0.03)	0.73 (0.03)
T_5	0.75 (0.07)	0.77 (0.10)	0.75 (0.07)	0.75 (0.07)	0.73 (0.03)	0.75 (0.07)	0.75 (0.07)	0.75 (0.07)	0.79 (0.13)	0.75 (0.07)
T_6	0.73 (0.03)	0.75 (0.07)	0.75 (0.07)	0.77 (0.10)	0.77 (0.10)	0.75 (0.07)	0.73 (0.03)	0.73 (0.03)	0.77 (0.10)	0.75 (0.07)
T_7	0.75 (0.07)	0.75 (0.07)	0.73 (0.03)	0.73 (0.03)	0.75 (0.07)	0.73 (0.03)	0.73 (0.03)	0.71 (0.00)	0.75 (0.07)	0.75 (0.07)
T_8	0.77 (0.10)	0.75 (0.07)	0.73 (0.03)	0.75 (0.07)	0.75 (0.07)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.77 (0.10)	0.75 (0.07)
SEm (±)	0.02	0.06	0.02	0.05	0.04	0.04	0.06	0.05	0.04	0.05
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Data shown in the table are (x+0.5) square root transformed values, Data in parentheses indicate original values.

Table 8. Population of *Braconid* parasitoid on okra crop during *kharif* 2012 and *rabi* 2012-13.

Treatments	Number of parasitized larvae of *E. vittella* /plant									
	Pretreatment count		Days after application / spraying							
			1 DAA		5 DAA		10 DAA		15 DAA	
	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13
T_1	0.73 (0.03)	0.75 (0.07)	0.71 (0.00)	0.71 (0.00)	0.73 (0.03)	0.73 (0.03)	0.77 (0.10)	0.73 (0.03)	0.71 (0.00)	0.71 (0.00)
T_2	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.75 (0.07)	0.75 (0.07)	0.75 (0.07)	0.75 (0.07)	0.75 (0.07)	0.75 (0.07)
T_3	0.71 (0.00)	0.73 (0.03)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.75 (0.07)	0.71 (0.00)
T_4	0.71 (0.00)	0.75 (0.07)	0.71 (0.00)	0.73 (0.03)	0.73 (0.03)	0.71 (0.00)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)
T_5	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.77 (0.10)	0.71 (0.00)	0.75 (0.07)	0.73 (0.03)
T_6	0.71 (0.00)	0.73 (0.03)	0.71 (0.00)	0.71 (0.00)	0.75 (0.07)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.71 (0.00)
T_7	0.71 (0.00)	0.73 (0.03)	0.71 (0.00)	0.71 (0.00)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)
T_8	0.73 (0.03)	0.73 (0.03)	0.71 (0.00)	0.73 (0.03)	0.73 (0.03)	0.71 (0.00)	0.75 (0.07)	0.71 (0.00)	0.73 (0.03)	0.71 (0.00)
SEm (±)	0.02	0.04	0.02	0.02	0.04	0.03	0.06	0.03	0.04	0.02
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Data shown in the table are (x+0.5) square root transformed values**,** Data in parentheses indicate original values.

of okra in bifenthrin 8 SC @ 100-140g a.i./ha were found on par with each other.

Among the insecticides tested, bifenthrin 8 SC @ 100 to 140g a.i./ha was found significantly superior over other treatment in managing *E. vitella* and red spider mite. Ameta *et al* (2008) also reported that bifenthrin 10 EC @ 80g a.i./ha effectively control leafhopper, *Amrasca biguttula biguttula* Ishida, whitefly, *Bemisia tabaci* Gennadius and shoot and fruit borer, *Leucinodes orbonalis* Guenee in brinjal. Bifenthrin was also found to be effective against leafhopper, *Amrasca biguttula biguttula* and borer, *E. vitella* (Gupta *et al*., 2009). Present observation with regard to the efficacy of bifenthrin are in agreement with the findings of Sinha and Nath (2011) who found bifenthrin to be effective against fruit borer, *Helicoverpa armigera* (Hübner) in tomato. Similar results were also reported by Dodia *et al*. (2009) against fruit borer, *H. armigera*

Table 9. Population of predatory mite on okra during *kharif* 2012 and *rabi* 2012-13.

Treatments	Number of predatory mite /3.14 cm^2 leaf									
	Pretreatment count		Days after application / spraying							
			1 DAA		5 DAA		10 DAA		15 DAA	
	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13	2012	2012-13
T_1	0.77 (0.10)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.77 (0.10)	0.71 (0.00)	0.75 (0.07)	0.75 (0.07)	0.80 (0.13)	0.73 (0.03)
T_2	0.73 (0.03)	0.73 (0.03)	0.75 (0.07)	0.75 (0.07)	0.77 (0.10)	0.75 (0.07)	0.73 (0.03)	0.73 (0.03)	0.77 (0.10)	0.75 (0.07)
T_3	0.75 (0.07)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.75 (0.07)	0.75 (0.07)	0.73 (0.03)	0.71 (0.00)	0.79 (0.13)	0.75 (0.07)
T_4	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.77 (0.10)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)
T_5	0.73 (0.03)	0.73 (0.03)	0.75 (0.07)	0.73 (0.03)	0.73 (0.03)	0.75 (0.07)	0.75 (0.07)	0.71 (0.00)	0.79 (0.13)	0.77 (0.10)
T_6	0.73 (0.03)	0.71 (0.00)	0.73 (0.03)	0.71 (0.00)	0.77 (0.10)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.77 (0.10)	0.77 (0.10)
T_7	0.75 (0.07)	0.73 (0.03)	0.73 (0.03)	0.71 (0.00)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)	0.73 (0.03)
T_8	0.77 (0.10)	0.73 (0.03)	0.73 (0.03)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.75 (0.07)	0.71 (0.00)	0.75 (0.07)	0.73 (0.03)
SEm (±)	0.05	0.03	0.04	0.03	0.03	0.03	0.05	0.03	0.05	0.04
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Data shown in the table are (x+0.5) square root transformed values**,** Data in parentheses indicate original values.

Table 10. Effect of bifenthrin 8 SC on yield of okra during *kharif* 2012 and *rabi* 2012-13.

Treatments	Total fruit yield (q/ha)	
	2012	2012-13
T_1	55.0	44.7
T_2	63.8	47.7
T_3	73.7	49.5
T_4	75.3	50.4
T_5	78.8	52.3
T_6	82.3	53.1
T_7	72.9	48.6
T_8	68.9	46.5
SEm (±)	7.44	1.74
LSD (0.05)	15.95	3.67

of tomato. Therefore, bifenthrin 8 SC @ 100 can be safely recommended to manage the infestation of shoot and fruit borer, *E. vitella* and red spider mite, *T. urticae* on okra.

Conclusion

The results of the present study indicated that bifenthrin 8 SC @100 to 140g a.i./ha to be the most effective for managing shoot and fruit borer (*E. vittella*) and red spider mite (*T. urticae*) population of okra. Maximum fruit yield of okra was obtained with bifenthrin 8 SC @ 140g a.i./ha (82.3 q/ha and 53.1 q/ha during *kharif* 2012 and *rabi* 2012-13, respectively). Also, spraying of bifenthrin 8 SC did not have any significant adverse effect on population of natural enemies (spider, predatory mite and *Braconid* parasitoid) in okra crop ecosystem. The insecticides look promising and could be used in future for controlling these insect and mite pests and be safe at the same time to natural enemies. Thus, bifenthrin 8 SC @100 to 140g a.i./ha can be recommended to the farmer for enhancing yield of okra by reducing damage by *E. vitella* and *T. urticae.*

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