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Efficacy of newer insecticide combinations against brinjal shoot and fruit borer

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Abstract
Field experiments was conducted in *kharif* season during 2017-18 at the farm of Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra) to study the efficacy of newer insecticide combinations against shoot and fruit borer of brinjal. The results revealed that the lowest shoot infestation by *L. orbonalis*, were observed in chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (1.38%), was statistically at par with flubendiamide 19.92% + thiacloprid 19.92% (1.42%), and chlorantraniliprole 8.8% + thiamethoxam17.5% SC (10.47%) was the most superior treatment shows lowest fruit damage was statistically at par with flubendiamide 19.92% + thiacloprid 19.92% (10.78%), followed by chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (11.27%), indoxacarb 14.5% + acetamiprid 7.7% SC (12.52%),), chlorantraniliprole 8.8% + thiamethoxam 17.5% SC (9.22%), was the most superior treatment shows lowest fruit damage was statistically at par with flubendiamide 19.92% + thiacloprid 19.92% (9.64%) on number and weight basis respectively. chlorantraniliprole 8.8 % + thiamethoxam 17.5 % SC registered the highest yield (149q/ha) followed by flubendiamide 19.92% + thiacloprid 19.92% (146q/ha), chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (140q/ha).

Keywords: brinjal, efficacy, insecticide combination, shoot and fruit borer

1. Introduction
Brinjal or eggplant (*Solanum melongena* L.) is an important Solanaceae crop of subtropics and tropics. It is native of India and is grown throughout the country (Choudhary, 1970). It is known as a "King of vegetables"

In India, brinjal is cultivated on an area of 729 thousand ha with an annual production of 12616 thousand million tonnes with productivity of 17.30 tonnes ha^{-1} during 2017-18. The total area under brinjal cultivation is 30 thousand ha in Maharashtra producing 690 thousand million tonnes annually with productivity of 23 tonnes fruits ha^{-1}. The West Bengal is a leading state in brinjal production (2,977 thousand MT) and area (161.50 thousand ha) in India. (Anonymous., 2017).

Insect pests are most limiting factor for accelerating crop yield. Brinjal is attacked by more than 70 insect pests (Subbaratnam and Butani, 1982), of which the major important ones are the shoot and fruit borer (*Leucinodes orbonalis* Guen: Pyralidae), which cause about 70-92 per cent loss in the fruit yields (Vevai, 1970) [8]. The larvae of this pest cause 12-16% damage to shoots and 20-60% damage to fruits, (Maureal *et al.*, 1982). due to overuse and misuse of chemical insecticides, the natural balance has been disturbed leading to enormous problems such as resistance, residues, resurgence, destruction of natural enemies etc. hence, evaluation of combinations of insecticides that useful against shoot and fruit borer of brinjal. There is a constant need to evaluate newer combinations of insecticides with this view study the evaluation of newer insecticide combinations against shoot and fruit borer of brinjal

2. Material and Methods
The experiment was laid out in a randomized block design (RBD) with eight treatments replicated three times. The plot size was 4.5m x 4.5m and. the variety *Manjiri Gota* was used with spacing 75 x 75 cm

2.1 Per cent shoot infestation
For recording shoot infestation, healthy and infested shoots were recorded from 5 randomly selected plants from each plot. Observations were recorded one day before spray and 1, 3, 7, 14 days after treatment. All the infested shoots from selected plants were marked using a ribbon tied around the shoot to avoid recounting during the next observation. Per cent shoot infestation was calculated by using the following formula:

$$\text{Per cent shoot infestation} = \frac{\text{No. of infested shoots}}{\text{Total no. of shoots}} \times 100$$

2.2 Per cent fruit infestation
2.2.1 On number basis
One day before each application of insecticides all infested fruits were harvested from all plots. Picking wise observations were recorded on the number of infested fruits and number of marketable fruits on five randomly selected plants from each plot. The per cent fruit damage was worked out using the formula.

$$\text{Per cent fruit infestation (Number basis)} = \frac{\text{No. of infested fruit}}{\text{Total no. of fruits}} \times 100$$

2.2.2 On weight basis
Picking wise observations were also recorded on the weight of infested fruits and weight of marketable fruits on five randomly selected plants from each plot. The per cent fruit

damage was worked out using the formula:

$$\text{Per cent fruit infestation (Weight basis)} = \frac{\text{Weight of infested fruit}}{\text{Weight of total fruits}} \times 100$$

3. Statistical analysis

The data obtained in number was subjected to transformation using Poisson formula $\sqrt{x+0.5}$ and per cent data was transformed using arc sine transformation before further statistical analysis. The mean data on efficacy were statistically analyzed and subjected to the analysis of variance by adopting the appropriate methods as outlined by Panse and Sukhatme (1978) [5] and Gomez and Gomez (1984) [4] by adopting "Fishers analysis of variance technique".

4. Results and Discussion

Efficacy of newer insecticides combination on shoot infestation caused by *L. orbonalis* after 1st and 2nd spray were presented in table no.1

4.1 First Spray

The data on infestation of *L. orbonalis* on shoots after first spray was presented in Table no.1. Pre-count observations on the per cent shoot infestation caused by shoot borer were ranged from 6.82 to 8.27 %.

The post treatment observations recorded on one day after spraying indicated that in all treated plots no any new damage was found. Three days after spraying plots treated with flubendiamide 19.92% + thiacloprid 19.92% SC and chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC shows lowest shoot damage (zero damage). Next superior treatment was chlorantraniliprole 8.8% + thiamethoxam17.5% SC (1.08%) was statistically at par with indoxacarb 14.5% + acetamiprid 7.7% SC (1.31%), followed by pyriproxyfen 5% + fenpropathrin 15% EC (1.97%), deltamethrin 1% + trizophos 35% EC (1.98%) and buprofezin 15% + acephate 35% WP (2.30%).

Seven day after spray, plots treated with chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (1.30%) was the most superior treatment shows lowest shoot damage was statistically at par with flubendiamide 19.92% + thiacloprid 19.92% SC (1.35%), followed by chlorantraniliprole 8.8% + thiamethoxam17.5% SC (2.41%), indoxacarb 14.5% + acetamiprid 7.7% EC (3.17%), delamerhrins 1% + trizophos 35% EC (3.48%), pyriproxyfen 5% + fenpropathrin 15% EC (4.21%) and buprofezin 15% + acephate 35% WP (4.57%).

Fourteen days after spray, plots treated with chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (4.33%) was the most superior treatment shows lowest shoot damage was statistically at par with flubendiamide 19.92% + thiacloprid 19.92% SC (4.50%) and chlorantraniliprole 8.8% + thiamethoxam17.5% SC (4.68%) followed by indoxacarb 14.5% + acetamiprid 7.7% SC (5.56%), deltamethrin 1% + trizophos 35% EC (6.84%), pyriproxyfen 5% + fenpropathrin 15% EC (7.42%) and buprofezin 15% + acephate 35% WP (8.38%).

4.2 Second spray

The data on infestation of *L. orbonalis* on shoots after first spray was presented in Table no.1.

The post treatment observations recorded on one day after spraying indicated that in all treated plots no any new damage was found except treatment buprofezin 15% + acephate 35% WP (0.37%) observed slight damage. After three days of insecticides spraying, plot treated with buprofezin 15% + acephate 35% WP (0.86%) and pyriproxyfen 5% + fenpropathrin 15% EC (0.73%) shows slight shoot infestation remaining plots were free from shoot damage.

Seven day after spray, plots treated with chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (2.23%) was the most superior treatment shows lowest shoot damage was statistically at par with flubendiamide 19.92% + thiacloprid 19.92% SC (2.40%), chlorantraniliprole 8.8% + thiamethoxam17.5% SC (2.27%), indoxacarb 14.5% + acetamiprid 7.7% SC (2.85%) these was followed by, deltamethrin 1% + trizophos 35% EC (3.19%), pyriproxyfen 5% + fenpropathrin 15% EC (4.53%) and buprofezin 15% + acephate 35% WP (4.72%).

Fourteen days after spray, plots treated with flubendiamide 19.92% + thiacloprid 19.92% SC (3.07%) was the most superior treatment shows lowest shoot damage was statistically at par with chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (3.18%), chlorantraniliprole 8.8% + thiamethoxam17.5% SC (3.38%), indoxacarb 14.7 % + acetamiprid 7.7% SC (3.97%) followed by deltamethrin 1% + trizophos 35% EC (4.31%), pyriproxyfen 5% + fenpropathrin 15% EC (5.17%) and buprofezin 15% + acephate 35% WP (6.23%).

Similar finding were also reported by Sen *et al*., (2017) results revealed that Ampligo 150 ZC (chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC) @ 35 g a.i./ha was recorded lowest per cent of shoot (1.26%) infestation followed by Ampligo 150 ZC (chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC) @ 28 g a.i./ha (1.59% shoot infestation) and chlorantraniliprole 18.5% SC @ 30 g a.i./ha (3.76% shoot infestation), respectively. Sanghamitra *et al*., (2018) [6], also reported that among the treatments, flubendiamide 24% + thiacloprid 24% SC w/v @ 84 + 84 g a.i ha-1 had incredible reduction of shoot and fruit borer.

5. Efficacy of newer combination insecticides on fruit infestation caused by *L. orbonalis.*

5.1 Number basis

The data on brinjal fruit infestation caused by *L. orbonalis* of two sprays are presented in Table No.2.

5.1.1 Third spray

Pre-treatment count of fruit infestation on number basis caused by *L. orbonalis* ranged from 26.13-29.65 per cent.

All the insecticides were found to be significantly superior over untreated control in managing *L. orbonalis* on brinjal fruits. After first picking plots treated with chlorantraniliprole 8.8% + thiamethoxam17.5% SC (12.23%) was the most superior treatment shows lowest fruit damage chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (13.20%) followed by indoxacarb 14.5% + acetamiprid 7.7% SC (15.04%), deltamethrin 1% + trizophos 35% EC (15.99%), pyriproxyfen 5%+ fenpropathrin 15% EC (18.19%) and buprofezin 15% + acephate 35% WP (19.94%).

5.1.2 Fourth spray

All the insecticides were found to be significantly superior in reducing infestation of *L. orbonalis* on brinjal fruits over untreated control. after second picking plots treated with chlorantraniliprole 8.8% + thiamethoxam17.5% SC (8.70%) was the most superior treatment shows lowest fruit damage was statistically at par with flubendiamide 19.92% + thiacloprid 19.92% SC (8.95%) and chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (9.34%) followed by indoxacarb 14.5% + acetamiprid 7.7% SC (10.00%), deltamethrin 1% + trizophos 35% EC (10.40%), pyriproxyfen 5% + fenpropathrin 15% EC (14.37%) and buprofezin 15% + acephate 35% WP (16.21%)

5.2 Weight basis

The data on brinjal fruit infestation caused by *L. orbonalis* of two sprays are presented in Table No.2.

5.2.1 Third spray

After third spray observed that all the insecticide combinations were found to be significantly superior in minimizing the pest incidence over untreated control. The observations recorded prior to insecticide application clearly revealed that the infestation was very high (27.12% to 30.29%). After first picking plots treated with chlorantraniliprole 8.8% + thiamethoxam17.5% SC (10.36%) was the most superior treatment shows lowest fruit damage on weight basis was statistically at par with flubendiamide 19.92% + thiacloprid 19.92% SC (10.78%) followed by chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (11.77%), indoxacarb 14.5% + acetamiprid 7.7% SC (12.07%), deltamethrin 1% + trizophos 35% EC (12.69%), pyriproxyfen 5% + fenpropathrin 15% EC (16.40%) and buprofezin 15% + acephate 35% WP (17.08%).

5.2.2 Fourth spray

Overall effect after 3rd and 4th spray, plots treated with chlorantraniliprole 8.8% + thiamethoxam17.5% SC (9.22%) was the most superior treatment shows lowest fruit damage was statistically at par with flubendiamide 19.92% + thiacloprid 19.92% SC (9.64%) and chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (10.94%), indoxacarb 14.5% + acetamiprid 7.7% SC (11.56%), deltamethrin 1% + trizophos 35% EC (11.97%), followed by pyriproxyfen 5% + fenpropathrin 15% EC (15.74%).

Similar finding were also reported by Sen *et al*., (2017) [7] results revealed that Ampligo 150 ZC (chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC) @ 35 g a.i./ha was recorded lowest per cent of fruit (2.49%) infestation followed by Ampligo 150 ZC (chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC) @ 28 g a.i./ha (2.97% fruit infestation) and chlorantraniliprole 18.5% SC @ 30 g a.i./ha (3.32% fruit infestation), respectively. Sanghamitra *et al*., (2018) [6], also reported that among the treatments, flubendiamide 24% + thiacloprid 24% SC w/v @ 84 + 84 g a.i ha-1 had incredible reduction of shoot and fruit borer. The mean per cent reduction over control of two consecutive seasons was recorded as 96.62 and 98. 25 per cent, respectively for shoot and fruit borer in flubendiamide 24%+thiacloprid 24% SC w/v @ 84 + 84 g a.i ha-1, followed by flubendiamide 24% + thiacloprid 24% SC w/v @ 72 + 72 g a.i ha-1 (88.98 and 88.90 per cent, respectively) and thiaclorid 21.7% SC w/w @ 180 g a.i ha-1 (85.86 and 88.33 per cent, respectively.

Table 1: Effect of newer insecticides combination against brinjal shoot infestation caused by *L. orbonalis*

Sr. No	Treatment	Conc. (%)	Per cent shoot infestation after 1st spray					Per cent shoot infestation after 2nd spray			
			PTC	1DAS	3DAS	7DAS	14DAS	1DAS	3DAS	7DAS	14DAS
1	Pyriproxyfen 5EC + Fenpropathrin 15%EC	0.020	8.27 (16.67)	0 (0.00)	1.97 (8.06)	4.21 (11.81)	7.42 (15.77)	0 (0.00)	0.73 (2.84)	4.53 (13.27)	5.17 (13.00)
2	Deltamethrin 1EC + Trizophos 35%EC	0.06	6.82 (15.10)	0 (0.00)	1.98 (8.08)	3.48 (10.71)	6.84 (15.12)	0 (0.00)	0 (0.00)	3.19 (10.22)	4.31 (11.89)
3	Indoxacarb 14.5% + Acetamiprid 7.7% SC	0.018	7.22 (15.56)	0 (0.00)	1.31 (5.36)	3.17 (10.18)	5.56 (13.58)	0 (0.00)	0 (0.00)	2.85 (9.68)	3.97 (11.40)
4	Flubendiamide19.92% + Thiacloprid 19.92% SC	0.020	7.76 (16.06)	0 (0.00)	0 (0.00)	1.35 (6.62)	4.50 (12.04)	0 (0.00)	0 (0.00)	2.4 (8.78)	3.07 (10.09)
5	Buprofezin 15% + Acephate 35% WP	0.125	8.21 (16.62)	0 (0.00)	2.30 (8.61)	4.57 (12.32)	8.38 (16.76)	0.37 (2.02)	0.86 (4.33)	4.72 (12.45)	6.23 (14.34)
6	Chlorantraniliprole 8.8% + Thiamethoxam 17.5% SC	0.026	7.39 (15.75)	0 (0.00)	1.08 (4.87)	2.41 (8.90)	4.68 (12.46)	0 (0.00)	0 (0.00)	2.27 (8.65)	3.38 (10.47)
7	Chlorantraniliprole9.3% + Lambda Cyhalothrin 4.6% ZC	0.006	6.90 (15.20)	0 (0.00)	0 (0.00)	1.30 (6.53)	4.33 (12.00)	0 (0.00)	0 (0.00)	2.23 (8.57)	3.18 (10.16)
8	Untreated Control	-	7.50 (15.87)	1.81 (6.29)	4.62 (12.37)	6.85 (15.13)	9.16 (17.59)	2.36 (8.82)	4.3 (11.96)	8.01 (16.41)	11.15 (19.42)
	S.E±		0.29	1.13	1.40	0.61	0.98	0.73	1.2	0.66	0.94
	CD at 5 %		NS	3.47	4.30	1.89	3.01	2.25	3.6	2.3	2.88

Table 2: Effect of insecticide combinations on brinjal fruit infestation caused by *L. orbonalis* on number and weight basis after (3rd and 4th spray)

Tr. No.	Treatment	Conc. (%)	PTC	Per cent fruit infestation		Per cent fruit infestation	
				Number basis		Weight basis	
				3rd spray	4th spray	3rd spray	4th spray
T1	Pyriproxyfen 5% + Fenpropathrin 15%EC	0.020	27.74 (31.75)	18.19 (22.23)	14.37 (25.22)	16.40 (22.8)	15.07 (23.8)
T2	Deltamethrin 1% + Trizophos 35% EC	0.06	26.13 (31.13)	15.99 (18.79)	10.40 (23.53)	12.69 (19.5)	11.24 (20.8)
T3	Indoxacarb 14.5% + Acetamiprid 7.7% SC	0.018	27.02 (31.40)	15.04 (18.37)	10.00 (22.78)	12.07 (19.3)	11.05 (20.2)
T4	Flubendiamide19.92% + Thiacloprid 19.92% SC	0.020	28.52 (32.04)	12.60 (17.33)	8.95 (20.75)	10.78 (16.8)	8.50 (19.0)
T5	Buprofezin 15% + Acephate 35% WP	0.125	27.18 (31.49)	19.94 (23.67)	16.21 (26.50)	17.08 (23.40)	15.86 (24.38)
T6	Chlorantraniliprole 8.8% + Thiamethoxam 17.5% SC	0.026	29.04 (32.84)	12.23 (17.07)	8.70 (20.37)	10.36 (16.45)	8.10 (18.71)
T7	Chlorantraniliprole 9.3%+ Lambda Cyhalothrin 4.6% ZC	0.006	26.88 (30.97)	13.20 (17.77)	9.34 (21.25)	11.77 (18.47)	10.12 (20.01)
T8	Control	-	29.65 (32.93)	35.52 (39.02)	39.69 (36.54)	35.52 (38.48)	38.77 (36.54)
	SE±		1.41	1.07	1.13	1.07	1.13
	C.D.		NS	3.28	3.48	3.28	3.48
	C.V		7.52	8.48	8.56	8.48	8.56

Figures in parenthesis are Arc sin transformed values DAS – Days after spray

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