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Efficacy of new insecticides against okra shoot and fruit borer, *Earias vitella* (Fb.) (Lepidoptera: Noctuidae)

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ABSTRACT: A field study conducted to evaluate the efficacy of new molecules against okra shoot and fruit borer, *Earias vitella* (Fb.) during rabi and summer season revealed that Chlorantraniliprole 8.8% + Thiamethoxam17.5% SC @ 0.7 ml/l significantly reduced the percentage of shoot and fruit damage. No shoot and fruit infestation was recorded at seven and fourteen days after treatment. It was on par with the standard check Chlorantraniliprole 18.5 SC @ 0.3 ml/l followed by Novaluron 10 EC @ 2 ml/l and Lamdacyhalothrin 4.6% + Chlorantraniliprole 9.3% ZC. Chlorantraniliprole 8.8% + Thiamethoxam17.5% SC treated plots recorded highest total yield of 469.86 and 594.31 g/plant respectively. Maximum marketable yield was also recorded from Chlorantraniliprole 8.8% + Thiamethoxam17.5% SC treated plots respectively. Chlorantraniliprole 8.8% + Thiamethoxam17.5% SC also showed high benefit-cost ratio of 2.42 and 3.12 during rabi and summer season respectively.

KEY WORDS: *Earias vitella,* management, Chlorantraniliprole 8.8%+ Thiamethoxam17.5% SC, Novaluron

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is one of the most important vegetable crop grown throughout the world for its edible green fruits. India ranks first in the world with a production of 6095 MT and an area of 509.02 ha with a productivity of 12.0 MT/ha. In Kerala okra is grown in an area of 2.48 ha with a production of 34.65 MT and productivity of 13.96 MT/ha (Anonymous, 2018). A number of insect pests attack the crop reducing the production and productivity. In which the important and the destructive pest is okra shoot and fruit borer, *Earias vitella* (Fb.) (Lepidoptera: Noctuidae). The infested shoots droop, wither and dry up and larvae bore into the fruits and bore holes are plugged with excreta. Infested fruits become deformed and unfit for consumption. It causes 5.33 to 75.75 percent fruit loss in the field (Pareek and Bhargava, 2003). Though different non-chemical and chemical methods are developed under the IPM strategy, these pests are still in the fields and making the cultivation difficult for farmers. The shoot and fruit borer also developed resistance against the conventional insecticides making it difficult to control (Kranthi *et al*., 2002). Combination of two chemicals with different mode of action is the new strategy to reduce the development of resistance among insects (Kumar *et al*., 2010). New molecules are more tissue-specific and undergo rapid degradation; leaving very less amount of residues in the environment hence reduces

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environment pollution and safe to non target organisms. Pesticide mixtures have broad spectrum of activity, multiple target sites with synergistic action, reduces the number of spray hence reduces the cost, saving time and safe to farmer's health (Anjabapu, 2018). Keeping in this backdrop, this study has been undertaken to evaluate the efficacy of new insecticides against okra shoot and fruit borer *Earias vitella.*

MATERIAL AND METHODS

A field study was carried out in RARS Pilicode sub centre, Karuvachery in two seasons during rabi season (September to December 2018) and summer season (January to April 2019). The experimental material selected for the study was okra, variety Varsha Uphar. The experiment was laid out in Randomized Block Design with 8 treatments (Table 1) and 3 replications. Treatments were applied one at vegetative stage and one at reproductive stage after the incidence of pest. Damage symptoms were recorded at 7 and 14 days after spraying. Observations were taken from six plants and its average was taken. A pre-count was also recorded one day before spraying. The data recorded from field experiment was tabulated and statistical analysis was performed using analysis of variance (ANOVA). Web Agri Stat Package (WASP) was used to compare the significance of each treatment.

RESULTS AND DISCUSSION

Okra shoot damage during rabi season

Seven days after first spray, no shoot damage was observed in T_1 and T_6 as against maximum shoot damage of 77.77 per cent in untreated control. Less shoot damage was noticed in plots treated with T_5 (9.65 per cent) and T_2 (22.04 per cent). T_7, T_3 and T_4 recorded significantly high shoot damage of 61.75 per cent, 51.21 per cent and 35.35 per cent shoot damage respectively. Fourteen days after spraying there was an increase in the shoot damage in T_8 (82.05 per cent) followed by T_7 (63.01 per cent) and T_3 (52.24 per cent). No shoot damage was noticed in plots treated with T_1 and T_6. Less damage was recorded in T_5 (4.11 per cent) followed by T_2 (7.39 per cent). T_4 was significantly different from other treatments with 31.80 per cent shoot damage. Similar trend was observed seven days after second spraying, no shoot damage was noticed in T_1 which was on par with T_6. Maximum shoot damage was recorded in T_8 (83.55 per cent), followed by T_7 (63.81 per cent), T_3 (52.88 per cent) and T_4 (33.76 per cent). Less shoot damage was observed in T_5 (17.26 per cent) followed by T_2 (17.26 per cent). After fourteen days, shoot damage was reduced in T_5 (3.25 per cent), T_2 (7.99 per cent), T_4 (27.60 per cent) and T_3 (47.86 per cent). Highest shoot damage was observed in T_8 (84.64 per cent) followed by T_7 (64.19 per cent) (Table 1).

Okra shoot damage during summer season:

Seven days after treatment no shoot damage was reported in T_1 and it was on par with T_6 as against maximum damage was observed in T_8 (81.56 per cent). T_7 (58.89 per cent), T_3 (49.87 per cent) and T_4 (40.45 per cent) showed significantly high shoot damage. T_5 and T_2 recorded less shoot damage of 21.61 per cent and 24.48 per cent respectively. After fourteen days no shoot damage was observed in T_1 and T_6. There was a gradual increase in the shoot damage in T_8 (83.29 per cent) and T_7 (59.01 per cent). T_3 and T_4 recorded significantly higher shoot damage of 49.10 and 37.81 per cent respectively. T_5 and T_2 reduced the damage to 17.19 and 19.28 per cent respectively. Seven days after spraying T_1 and T_6 were on par with each other with no shoot damage. Maximum shoot damage was observed in T_8 (77.54 per cent). T_7 and T_3 recorded 46.98 and 38.24 per cent shoot damage respectively. Less damage was reported in T_5 (8.00 per cent) and T_2 (16.78 per cent). The same trend was followed after fourteen days of spraying. Shoot damage was reduced to 6.62, 14.06, 20.45 and 37.96 per cent in T_5, T_2, T_4 and T_3 respectively. They are significantly different from each other. The highest shoot damage was record in T_8 (74.79 per cent) and T_7 was significantly different from T_8 with 47.33 per cent shoot damage (Table 1).

Table 1. Percentage of shoot damaged by *Earias vitella* in okra treated with different insecticides during rabi season (September to December 2018) and summer season (January to April 2019)

Treatments	Shoot damaged in rabi season (%)					Shoot damaged in summer season (%)				
		First spray		Second spray			First spray		Second spray	
	1 DBT	7 DAT	14 DAT	7 DAT	14 DAT	1 DBT	7 DAT	14 DAT	7 DAT	14 DAT
T_1 - Chlorantraniliprole 8.8% + Thiamethoxam 17.5% SC	68.40	0.00 (0.59)	0.00 (0.59)	0.00 (0.59)	0.00 (0.59)	75.2	0.00 (0.59)	0.00 (0.59)	0.00 (0.59)	0.00 (0.59)
T_2 -Lambda cyhalothrin 4.6% + Chlorantraniliprole 9.3% ZC	65.50	22.04 (27.93)	7.39 (15.55)	17.26 (24.37)	7.99 (16.37)	71.66	24.48 (29.62)	19.28 (25.94)	16.78 (24.17)	14.06 (22.00)
T_3 - Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% ZC	64.72	51.21 (45.69)	52.24 (46.28)	52.88 (46.66)	47.86 (43.77)	60.16	49.87 (44.92)	49.10 (44.48)	38.24 (38.19)	37.96 (38.03)
T_4 - Flubendiamide 19.92% w/w + Thiacloprid 19.92% w/w	67.52	35.35 (36.45)	31.80 (34.31)	33.76 (35.52)	27.60 (31.69)	78.15	40.45 (39.48)	37.81 (37.94)	22.83 (28.53)	20.45 (26.88)
T_5 - Novaluron 10 EC	67.18	9.65 (17.98)	4.11 (11.53)	9.34 (17.59)	3.25 (10.29)	73.5	21.61 (27.64)	17.19 (24.49)	8.00 (16.37)	6.62 (14.85)
T_6 - Chlorantraniliprole 18.5 SC (check)	64.26	0.00 (0.59)	0.00 (0.59)	0.00 (0.59)	0.00 (0.59)	67.18	0.00 (0.59)	0.00 (0.59)	0.00 (0.59)	0.00 (0.59)
T_7 - Thiamethoxam 25 WG (check)	60.78	61.75 (51.81)	63.01 (52.56)	63.81 (53.05)	64.19 (53.28)	63.09	58.89 (50.15)	59.01 (50.19)	46.98 (43.27)	47.33 (43.48)
T_8 - Absolute control	70.16	77.77 (61.97)	82.05 (64.97)	83.55 (66.18)	84.64 (67.11)	78.29	81.56 (64.17)	83.29 (65.97)	77.54 (62.02)	74.79 (59.98)
C.D.(0.05%)		3.70	3.52	4.52	3.95		4.21	3.02	4.28	3.27

Figures in parentheses are arc sine transformed values. DAT- Days after treatment, DBT- Day before treatment

Okra fruit damage during rabi season:

Seven days after second spray no fruit infestation was recorded from T_1 and T_6, they were statistically on par followed by T_5 (7.91 per cent). T_8 (89.03 per cent) recorded highest fruit infestation followed by T_7 (67.98 per cent) and T_3 (51.49 per cent). T_2 and T_4 recorded 13.79 and 30.98 per cent damage respectively. Data recorded after fourteen days of treatment revealed that no fruit infestation was recorded from T_1 and T_6 and an increase in the fruit infestation was noticed in T_8 (91.16 per cent). Reduction in the fruit infestation was observed in T_5 (3.04 per cent), T_2 (8.38 per cent), T_4 (27.45 per cent) and T_3 (48.72 per cent). Only a slight decrease was noticed in T_7 (67.49 per cent) (Table 2).

Okra fruit damage during summer season:

Seven days after treatment T_1 and T_6 showed non-significant difference with no fruit infestation. Second lowest infestation was observed in T_2 having 13.70 per cent fruit infestation. It was found on par with T_5 (15.35 per cent). T_8 (85.47 per cent) showed maximum per cent fruit infestation followed by T_7 (63.81 per cent) and T_3 (52.88 per cent). Fourteen days after spraying, all treatments reduced fruit infestation except T_8 (87.41 per cent) and T_3 (39.09 per cent). No fruit infestation was recorded in T_1 and T_6. T_5 recorded less fruit damage (8.86 per cent) which was found on par with T_2 having 9.34 percent fruit damage. Fruit infestation was also reduced in T_4 (21.10 per cent) and T_7 (58.53 per cent) (Table 2).

Table 2. Percentage of fruits damaged by *Earias vitella* in okra treated with different insecticides during rabi season (September to December 2018) and summer season (January to April 2019)

Treatments	Percentage of fruits damaged (mean of 18 plants)					
	Rabi season			Summer season		
	1 DBT	7 DAT	14 DAT	1 DBT	7 DAT	14 DAT
T_1 - Chlorantraniliprole 8.8% + Thiamethoxam 17.5% SC	70.87	0.00 (0.59)	0.00 (0.59)	73.02	0.00 (0.59)	0.00 (0.59)
T_2 -Lambda cyhalothrin 4.6% + Chlorantraniliprole 9.3% ZC	65.27	13.79 (21.73)	8.38 (16.78)	75.28	13.70 (21.70)	9.34 (17.78)
T_3 - Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% ZC	60.21	51.49 (45.86)	48.72 (44.27)	67.18	39.75 (39.02)	39.09 (38.70)
T_4 -Flubendiamide 19.92% w/w + Thiacloprid 19.92% w/w	74.56	30.98 (33.82)	27.45 (31.54)	63.09	31.52 (33.98)	21.10 (26.96)
T_5 - Novaluron 10 EC	69.42	7.91 (16.30)	3.04 (10.01)	74.52	15.35 (23.00)	8.86 (17.29)
T_6 - Chlorantraniliprole 18.5 SC (check)	65.97	0.00 (0.59)	0.00 (0.59)	71.66	0.00 (0.59)	0.00 (0.59)
T_7 - Thiamethoxam 25 WG (check)	68.80	67.98 (55.56)	67.49 (55.26)	68.72	59.18 (50.32)	58.53 (49.91)
T_8 - Absolute control	75.89	89.03 (70.78)	91.16 (72.87)	79.5	85.47 (67.63)	87.41 (69.29)
C.D.(0.05%)		2.99	3.49		4.99	4.65

Figures in parentheses are arc sine transformed values. DAT- Days after treatment, DBT- Day before treatment

Chlorantraniliprole 8.8 per cent + Thiamethoxam 17.5 per cent SC treated plots recorded high net returns during both rabi (Rs.192330.54/ha) and summer season (Rs. 28788592/ha). It was followed by Chlorantraniliprole 18.5 SC (16408705 and 56758322 Rs./ha during rabi and summer season respectively). Similar findings were reported by Anjabapu (2018). In the present study the highest benefit-cost ratio was obtained from Chlorantraniliprole 8.8 per cent + Thiamethoxam 17.5 per cent SC treated plots and it was 2.42 and 3.12 during rabi and summer season respectively. The report of Rambhau (2018) showed that Chlorantraniliprole 8.8 per cent + Thiamethoxam 17.5 per cent SC recorded highest benefit-cost ratio of 3.72, which supports the present study (Table 3).

Results obtained from the study concluded that Chlorantraniliprole 8.8 per cent + Thiamethoxam 17.5 per cent SC @ 0.7 ml/l of water was very effective against okra shoot and fruit borer larvae during both rabi and summer. The efficacy of the same in tomato was reported by Kuhar *et al.* (2011) in which Chlorantraniliprole 8.8 per cent + Thiamethoxam17.5 per cent SC @ 7 oz/acre significantly reduced fruit damage in tomato. The present study was in line with Hossain (2015) who reported that pod borer infestation was lowest in plots treated with Voliam flexi 300 SC @ 0.5 ml/l. In the present investigation next best treatments were Novaluron 10 EC and Lamdacyhalothrin 4.6 per cent + Chlorantraniliprole 9.3 per cent ZC (Ampligo).

Reddy *et al.* (2018) evaluated the persistence and dissipation of combination insecticides in cowpea, concluded that in the combination of Chlorantraniliprole 8.8 per cent + Thiamethoxam 17.5 per cent SC, single insecticides were dissipated

Table 3. Economics of different insecticides during rabi season and summer season

Treatments	Rabi season			Summer season		
	Gross income (Rs./ha)	Net income (Rs./ha)	B : C ratio	Gross income (Rs./ha)	Net income (Rs./ha)	B : C ratio
T1 - Chlorantraniliprole 8.8% + Thiamethoxam 17.5% SC	328051.52	192330.54	2.42	423606.9	287885.92	3.12
T2 - Lambda cyhalothrin 4.6%+ Chlorantraniliprole 9.3% ZC	273740.00	137844.02	2.01	341658.9	205762.92	2.51
T3 - Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% ZC	140548.00	5970.77	1.04	175970.2	41392.97	1.31
T4 - Flubendiamide 19.92% w/w + Thiacloprid 19.92% w/w	194636.80	58320.82	1.43	246236.8	109920.82	1.81
T5 - Novaluron 10 EC	278044.20	139748.22	2.01	333999.7	195703.72	2.41
T6 - Chlorantraniliprole 18.5 SC (check)	300733.03	164087.05	2.20	404229.2	267583.22	2.90
T7 - Thiamethoxam 25 WG (check)	153533.20	18897.22	1.14	215229.4	80593.42	1.59
T8 - Absolute control	78985.10	-54810.88	0.59	103081.4	-30714.58	0.77

to Below Quantification Level (BQL) on 10th day. As a single insecticide Chlorantraniliprole dissipated at 7th and Thiamethoxam at 5th day. They also conducted the risk assessment revealed that Theortical Maximum Residual Concentration (TMRC) of the mixtures on cowpea pods were below Maximum Permissible Intake (MPI) at 2hrs after spraying.

In this mixture Chlorantraniliprole is a ryanodine receptor modulator, which interrupts the calcium ion balance and disrupts proper muscle function in insects. It is highly specific to insect ryanodine receptors. Thus it is safe to natural enemies and mammals. Voliam flexi is a combination insecticide (Chlorantraniliprole 8.8 per cent + Thiamethoxam 17.5 per cent SC) which is effective against borers and sucking pest. So it eliminates the cost of other insecticides and also reduces the cost of spraying. This compensates the high cost of Chlorantraniliprole 8.8 per cent + Thiamethoxam 17.5 per cent SC. This is also supported by findings of Sangamithra *et al.,* (2018) that the combination insecticides with different modes of action and target group is effective against pest infestation and also reduces the number of insecticide spraying and they fit very well in the IPM strategies.

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