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Bio-efficacy of newer insecticides against okra shoot and fruit borer, *Earias vittella* fabricius

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Abstract
Different newer chemical insecticides were evaluated for their effectiveness against okra shoot and fruit borer, *Earias vittella* during Kharif 2019. The experiment was conducted at the Instructional Farm, Department of Agricultural Entomology, Mahatma Phule Krishi Vidhyapeeth, Rahuri. Three foliar applications of each insecticide treatment were given at an interval of 10 days, initiating first application when pest reached to ETL. The result of the study revealed that the treatment of combination insecticide *viz.* flubendiamide 90 SC + deltamethrin 60 SC (36+24g a.i./ha) was proved to be the most effective with lowest larval population (0.81 larva/plant), least fruit infestation (4.5%) and highest fruit yield (9.64 t/ha) among all the treatments.

Keywords: Flubendiamide, deltamethrin, bioefficacy, okra

Introduction
Okra (*Abelmoschus esculentus*) also referred as lady's finger is an important vegetable crop of the family Malvaceae. The place of origin is Ethiopia and is mainly grown for its green tender nutritive fruits. India is the largest producer of okra in the world. In India, it is grown on an area of 5.14 lakh hectare with an annual production of 61.26 lakh tons and productivity of 12 MT per hectare. In Maharashtra, it is grown on area of 1.44 lakh hectare with an annual production of 14.80 lakh tons and productivity of 10.26 MT per hectare (Anonymous, 2018) [2]. West Bengal, Gujarat, Bihar, Odisha, Chhattisgarh, Jharkhand, Madhya Pradesh and Maharashtra are the major okra growing states in country.
In India, more than 13 species of insect pests have been reported to infest okra crop (Mandal *et al*., 2007) [7]. (Mani and Singh 2012) [8] reported 15 arthropod species in okra ecosystem. Among all, shoot and fruit borer (*Earias* sp.) is considered as the most important pest in okra (Aziz *et al*., 2011) [3] which causes both quantitative and qualitative losses of the crop (Butani and Jotwani, 1984) [4]. The larvae bore into the terminal growing shoots, floral buds, flowers and fruits of okra, resulting in cessation, withering and drying of infested shoots, tender leaves and heavy shedding of floral buds and flowers. The infested fruits become malformed and are rendered unfit for human [5] consumption as well as for procurement of the seeds. Grown up larva damages many fruits results in 54.04% yield loss and also reduces the vitality of the plant (Sivakumar *et al.*, 2003) [16]. The borer has been reported to cause 24.6 to 26.0 percent damage to okra shoots (Pareek *et al.*, 1986) [9]; Zala *et al.*, 1999) [19] and 40 to 100 per cent loss to fruits (Dhawan and Sidhu, 1984); (Kumawat, 1997) [6]; (Shah *et al.*, 200) [13]; (Pareek and Bhargava, 2003) [10]; Shinde *et al.*, 2007) [15]. Many chemical insecticides are available in the market for the management of the pest. Hence the present study was carried out to evaluate the efficacy of newer molecules with novel mode of action to find out a viable option for sustainable management of shoot and fruit borer of okra crop.

Material and Method
Present studies were conducted during Kharif-2019 at the Instructional Farm, Department of Agril. Entomology, Mahatma Phule Krishi Vidhyapeeth, Rahuri. The trial was laid out in randomized block design with seven treatments and replicated thrice with a plot size of 3 m x 3 m using the variety Phule Utkarsha.
The treatments of chemical insecticides were imposed as foliar spray against the okra shoot and fruit borer by knapsack sprayer with hallow cone nozzle. Total three sprays of each

insecticide were undertaken at an interval of 10 days by initiating the 1st spray when pest count reached ETL. The effectiveness of the treatment was assessed on the basis of larval population, fruit infestation and yield in each treatment plot. Observations on number of larvae per plant were recorded on 5 randomly selected plants per plot on one day before spraying and on 3, 5, 7 and 10 days after each spray.

Results and Discussion

Larval population

The data on larval population per plant clearly indicated that all the treatments were significantly superior over untreated control in minimizing the population of *Erias vitella*. The population ranged between 0.81 to 2.30 larvae/plant in insecticide treatment plots as against 3.54 larvae/plant in untreated control. The treatment with flubendiamide 90 SC + deltamethrin 60 SC @ 36+24g a.i./ha significantly excelled over other treatments in reducing mean larval population (0.81 larvae//plant). Flubendiamide 39.35 SC @ 48g a.i./ha was found next effective treatment which recorded 1.08 larvae/plant and was at par with chlorantraniliprole 18.5% SC @ 25g a.i./ha with the population of 1.14 larvae/plant. Mean larval population in the rest of treatments was 1.47 and 1.77 larvae/plant. Pyriproxyfen 5% EC + fenpropathrin 15% EC @ 750 g a.i./ha showed least efficacy against *Earias vittella* with population of 2.30 larvae/plant and this treatment was at par with pyridalyl 10% EC @ 70 g a.i./ha recorded 2.16 larvae/plant. Untreated control plot recorded significantly higher (3.54 larvae/plant) mean larval population.

The data on effect of various treatments on reduction of okra shoot and fruit borer infestation over untreated control indicated that treatment with flubendiamide 90 SC + deltamethrin 60 SC @ 36+24 g a.i./ha was proved to be the most effective among all the treatments followed by flubendiamide 39.35 SC @ 48g a.i./ha which was at par with chlorantraniliprole 18.5% SC @ 25g a.i./ha.

Ameta and Swami (2015) [1] also reported the effectiveness of flubendiamide 90 SC + deltamethrin 60 SC @ 36+24g a.i./ha in reducing percent fruit infestation. Shimoge *et al.*, (2014) [14] found that flubendiamide at 60 g a.i./ha recorded lowest fruit borer infestation of 11.07 per cent as against 39.15 per cent in control plots on number basis. Thara *et al*. (2019) [17] reported higher effectiveness of chlorantraniliprole 18.5% SC @ 25g a.i./ha (observed mean larval population of 0.57 against control plot have mean larval population 3.62) against shoot and fruit borer of okra. These findings are in agreement with present findings.

Fruit infestation

The data on fruit infestation revealed that all the treatments were significantly superior over untreated control in minimizing the fruit infestation. The fruit infestation ranged between 4.59 to 18.02 per cent in insecticidal treated plots as against 29.79 per cent in untreated control. The treatment with flubendiamide 90 SC + deltamethrin 60 SC @ 36+24g a.i./ha was found to be the most effective which recorded the lowest percentage of fruit infestation (i.e. 4.59 per cent). Flubendiamide 39.35 SC @ 48g a.i./ha was found next effective treatment with 7.64 per cent fruit infestation and at par with chlorantraniliprole 18.5% SC @ 25g a.i./ha (8.19 per cent). Mean fruit infestation in the rest of the treatments was 10.88 and 13.87 per cent. Pyriproxyfen 5% EC + fenpropathrin 15% EC @ 750g a.i./ha showed least efficacy against *Earias vittella* with 18.02 per cent fruit infestation which was at par with pyridalyl 10% EC @ 70g a.i./ha (17.11 percent). Untreated control plot recorded significantly higher (29.79%) infestation of fruits.

The data on effect of various treatments on reduction of fruit infestation in okra indicated that treatment with flubendiamide 90 SC + deltamethrin 60 SC @ 36+24g a.i./ha recorded highest reduction (84.59%) in per cent fruit infestation over control among all the treatments and was followed by flubendiamide 39.35 SC @ 48g a.i./ha which was at par with chlorantraniliprole 18.5% SC @ 25g a.i./ha.

Superiority of flubendiamide 90 SC+ deltamethrin 60 SC @ 36+24g a.i./ha against *Earias vittella* obtained in present investigation was in agreement with Ameta and Swami (2015) [1] who recorded the flubendiamide 90 SC + deltamethrin 60 SC @ 36+24g a.i./ha as effective in reducing per cent fruit infestation. The effectiveness of flubendiamide 39.35 SC @ 48g a.i./ha as observed in present investigation is an conformity with Thiruveni and Karthik (2018) [18] who reported that flubendiamide 39.35 SC @ 48g a.i./ha (76.06 per cent reduction in fruit damage) was found to be very effective in reducing okra shoot and fruit borer infestation. Further, they reported that flubendiamide 39.35 SC @ 48 g a.i./ha registered the lowest fruit infestation (12.78%) with maximum marketable fruit yield (15.27 t/ha). The present findings in respect of chlorantraniliprole 18.5% SC @ 25g a.i./ha was in agreement with earlier report of Potai *et al*. (2019) [11] who reported that chlorantraniliprole 18.5% SC @ 25g a.i./ha was the most effective in reducing fruit damage caused by okra shoot and fruit borer, *Earias vittella*. Reddy *et al*. (2019) [12] reported the effectiveness of chlorantraniliprole 18.5% SC @ 25g a.i./ha 44.89 per cent reduction in fruit damage and 70.51 q/ha yield.

Marketable fruit yield of okra

The results pertaining to the marketable fruit yield of okra are presented in Table No. 2. The effectiveness of treatments was reflected on yield. All the insecticidal treatments were found superior over untreated control in terms of the yield. The data revealed that the treatment flubendiamide 90 SC + deltamethrin 60 SC @ 36+24g a.i./ha exhibited highest yield (9.64 t/ha) with maximum (99.58%) increase in the yield over control and found superior to all other insecticidal treatments. It was followed by flubendiamide 39.35 SC @ 48g a.i./ha (8.91 t/ha) with 84.47 per cent increase in the yield over control. Next to the order in obtaining higher yield was chlorantraniliprole 18.5% SC @ 25g a.i./ha (8.64 t/ha) with 78.88 per cent increase in the yield over control.

Considerable yield advantage (9.64 t/ha) due to effective control of *Earias vittella* in okra particularly through use of flubendiamide 90 SC + deltamethrin 60 SC @ 36+24g a.i./ha as observed in present investigation was in agreement with Ameta and Swami (2015) 1 who found that the flubendiamide 90 SC + deltamethrin 60 SC @ 36+24g a.i./ha was effective in reducing per cent fruit infestation.

Table 1: Cumulative effect of selected insecticides on larval population due to *Earias vittella* on okra

Tr. No.	Treatments	Dose (g a.i./ha)	Number of larva per plant					
			Precount	I spray	II spray	III spray	Mean	Reduction (%)
T_1	Chlorantraniliprole 18.5% SC	25	2.66	1.17 (1.08)	1.14 (1.07)	1.11 (1.05)	1.14 (1.07)	67.80
T_2	Pyridalyl 10% EC	50-70	2.72	2.01 (1.42)	2.26 (1.50)	2.21 (1.48)	2.16 (1.47)	38.98

T_3	Deltamethrin 2.8% EC	10-15	2.68	1.70 (1.30)	1.78 (1.33)	1.82 (1.35)	1.77 (1.33)	50.00
T_4	Emamectin benzoate 5% SG	6.75-8.5	2.71	1.47 (1.21)	1.45 (1.20)	1.48 (1.22)	1.47 (1.21)	58.47
T_5	Flubendiamide 39.35 SC	48	2.62	1.14 (1.07)	1.11 (1.05)	0.98 (0.99)	1.08 (1.04)	66.95
T_6	Flubendiamide 90 SC + Deltamethrin 60 SC	36+24	2.69	0.91 (0.95)	0.79 (0.88)	0.73 (0.85)	0.81 (0.90)	77.12
T_7	Pyriproxyfen 5% EC + Fenpropathrin 15% EC	500-750	2.76	2.40 (1.55)	2.15 (1.46)	2.36 (1.54)	2.30 (1.52)	35.02
T_8	Untreated control	--	2.70	2.94 (1.71)	3.68 (1.92)	4.01 (2.00)	3.54 (1.88)	-
	S.Em+		0.02	0.01	0.02	0.02	0.02	-
	CD @ 5%		-	0.06	0.07	0.09	0.07	-

(Figure in the parenthesis are √X+0.5 are transform values)

Table 2: Cumulative effect of selected insecticides on fruit infestation due to *Earias vittella* on okra

Tr. No.	Treatments	Dose (g a.i./ha)	Percent fruit infestation						Marketable fruit yield (T/ha)	Increase over control (%)
			Precount	I spray	II spray	III spray	Mean	Reduction (%)		
T_1	Chlorantraniliprole 18.5% SC	25	18.42	10.51 (18.34)	8.05 (16.05)	6.01 (13.87)	8.19 (16.19)	72.51	8.64	78.88
T_2	Pyridalyl 10% EC	50-70	18.49	18.78 (24.52)	17.81 (23.88)	14.75 (21.73)	17.11 (23.41)	42.56	5.67	17.39
T_3	Deltamethrin 2.8% EC	10-15	18.57	16.11 (22.71)	14.01 (21.18)	11.49 (19.18)	13.87 (21.07)	53.44	6.48	34.16
T_4	Emamectin benzoate 5% SG	6.75-8.5	18.53	12.94 (20.35)	10.92 (18.70)	8.78 (16.76)	10.88 (18.66)	63.48	7.12	47.41
T_5	Flubendiamide 39.35 SC	48	18.69	9.83 (17.74)	7.62 (15.62)	5.46 (13.22)	7.64 (15.64)	74.35	8.91	84.47
T_6	Flubendiamide 90 SC + Deltamethrin 60 SC	36+24	18.57	6.30 (14.20)	4.74 (12.31)	2.73 (9.35)	4.59 (12.12)	84.59	9.64	99.58
T_7	Pyriproxyfen 5% EC + Fenpropathrin 15% EC	500-750	18.53	19.72 (25.13)	18.60 (24.40)	15.73 (22.44)	18.02 (24.02)	39.51	5.34	10.55
T_8	Untreated control	--	18.59	24.14 (27.81)	30.76 (31.39)	34.47 (33.23)	29.79 (30.89)	-	4.83	-
	S.Em+		0.41	0.23	0.38	0.34	0.31	-		
	CD @ 5%		-	0.69	1.14	1.02	0.95	-		

(Figure in the parenthesis are angular transform values)

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