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Management of shoot and fruit borer (*Earias vittella* Fabricius) on okra (*Abelmoschus esculentus* L. Moench)

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Abstract

The present investigation entitled “To study the efficacy of chemical insecticides against okra shoot and fruit borer *Earias vittella* (Fab.)” was conducted during *Kharif* 2024 at the experimental farm, Department of Entomology, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri. The study aimed evaluate the efficacy and economic performance of selected insecticides against the pest under field conditions. Chlorantraniliprole 18.5% SC was the most effective treatment, recording the lowest fruit infestation (4.32% on number basis and 4.12% on weight basis) and was statistically at par with Flubendiamide 39.35% SC (5.35% and 5.00%) and Emamectin benzoate 5% SG @ 0.27 g/l (6.05% and 5.74%). The remaining treatments showed moderate to higher infestation levels (10.12-21.70% on number basis), while the untreated control recorded the highest infestation (37.59% on number basis and 39.25% on weight basis). Correspondingly, the highest marketable fruit yield was obtained with Chlorantraniliprole 18.5% SC (12.34 t/ha), followed by Flubendiamide 39.35% SC (11.97 t/ha) and Emamectin benzoate 5% SG (11.78 t/ha). Yield increase over the untreated control ranged from 10.61% to 48.85%, indicating a direct relationship between pest control and crop productivity. Economic analysis in terms of Incremental Cost-Benefit Ratio (ICBR) revealed that Emamectin benzoate 5% SG achieved the highest ICBR of 1:21.8, followed by Chlorantraniliprole 18.5% SC (1:18.22) and Flubendiamide 39.35% SC (1:15.30).

Keywords: Okra, shoot and fruit borer, Chlorantraniliprole 18.5% SC, Flubendiamide 39.35% SC, Emamectin benzoate 5% SG

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is an important vegetable crop cultivated widely in tropical and subtropical regions of the world. It is valued for its nutritional richness, being a good source of calcium, potassium, vitamins and minerals and for its industrial utility, particularly the use of stem mucilage in clarifying sugarcane juice during jaggery preparation (Chauvan, 1972) ^[4]. India is the largest producer of okra, with major cultivation concentrated in states such as Maharashtra, Gujarat, Uttar Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu, Punjab and Haryana. The crop is grown mainly during the kharif and summer seasons and occupies about 5.44 lakh ha with an average productivity of 11.93 t/ha (Anonymous, 2023) ^[1]. Despite its economic importance, okra production is severely constrained by insect pests throughout its growth period. Among these, the okra shoot and fruit borer (*Earias vittella* Fabricius) is recognized as the most destructive pest, causing damage from seedling to fruiting stages. The larvae bore into tender shoots and fruits, resulting in wilting, malformed produce and substantial yield losses. Several studies have reported fruit damage ranging from 22.5 to 76%, with losses in marketable yield reaching up to 69% under severe infestation (Rawat and Sahu, 1973) ^[10]. The pest is particularly severe in regions with moderate climatic conditions such as Maharashtra, Karnataka, Gujarat and Madhya Pradesh (Brar *et al.*, 2000) ^[3].

Management of *E. vittella* in okra relies predominantly on synthetic insecticides. However, continuous and indiscriminate use of conventional insecticides has resulted in the development of resistance to major chemical groups including organophosphates, carbamates and pyrethroids, along with adverse ecological consequences such as resurgence of

secondary pests and decline of natural enemies (Lal, 2001; Dhaliwal and Koul, 2010) [7, 5]. These concerns have necessitated the evaluation of newer insecticidal molecules with novel modes of action that are effective, selective and relatively safer to the environment. In this context, the present study was undertaken to evaluate the efficacy of selected new-generation chemical insecticides against the okra shoot and fruit borer (*Earias vittella*) with the objective of identifying effective and environmentally safer options for sustainable pest management in okra.

2. Materials and Methods

2.1 Experimental Details

A field experiment was conducted during 2024-25 to evaluate the efficacy of insecticides against the okra shoot and fruit borer, *Earias vittella* Fabricius. The study was carried out at the Instructional Farm of the Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth (MPKV),

Rahuri, Maharashtra, India, located at 19°20'56" N latitude and 74°38'45" E longitude, at an altitude of approximately 550 m above mean sea level. It was laid out in a Randomized Block Design (RBD) with three replications and 7 treatments including an untreated control, covering a total 21 plots. Each plot had a gross size of 3.6 m × 3.6 m. The experiment was conducted using okra (*Abelmoschus esculentus* L. Moench) variety Mahyco hybrid-10, planted at a spacing of 30 × 15 cm. Seed material was supplied by the Department of Entomology, MPKV, Rahuri. Six insecticides belonging to different chemical groups were evaluated for their effectiveness against *E. vittella* and details regarding their common name, formulation, trade name, source and dosage are presented in Table 1. Insecticidal applications were made using a manually operated knapsack sprayer fitted with a hollow cone nozzle to ensure uniform spray coverage.

Table 1: Details of insecticides evaluated against okra shoot and fruit borer, *E. vittella*

Sr. No.	Chemical insecticides with their formulations	Trade Name	Dose (ml or g/lit)	Source
1.	Flubendiamide 39.35% SC	Fame 39.35% SC	0.20 ml	Bayer Crop Science Ltd., Thane (West)-400607.
2.	Chlorantraniliprole 18.50% SC	Coragen 18.5% SC	0.25 ml	E.I. Dupont India Pvt. Ltd., Gujrat-391775.
3.	Emamectin Benzoate 5% SG	Proclaim	0.27 g	Syngenta India Ltd., Pune-411005
4.	Spinosad 45% SC	Tracer	0.37 ml	Agro Sciences India Pvt Ltd.
5.	Pyridalyl 10% EC	Sumi-Pleo	1 ml	Sumitomo Chemical India Ltd.
6.	NSKE 5%	-	50 g	Locally collected

2.2 Methodology

Three insecticidal sprays were administered at 10 days interval, Insecticides were sprayed by Knapsack sprayer where 500 lit/ha water is required and applications were usually carried out in the evening hours. For the efficacy of insecticides the percent fruit damage by *Earias vittella* was recorded before 1 Day Before Spraying (DBS) and on 3rd, 7th and 10th days after spraying (DAS) days after spraying. The percent fruit infestation was recorded from 5 randomly selected plants in each plot. The assessment of damage caused by *E vittella* was done by counting the number of damaged fruits and total number of healthy fruits observed from 5 randomly selected plants per plot and expressed in percentage. The weight of healthy and infested fruits okra was taken separately per plot for each treatment. Okra fruits were harvested at each observation. The extent of the damage was computed by using the formula:

$$\text{Percent fruit infestation (\%)} \text{ by number} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

$$\text{Percent fruit infestation (\%)} \text{ by weight} = \frac{\text{Weight of infested fruits}}{\text{Total weight of fruits}} \times 100$$

These obtained percentage of fruit damage were further transformed to angular values for statistical analysis. The reduction in fruit infestation over control for each treatment was also calculated by using formula:

$$\text{Reduction in fruit infestation over control (\%)} = \frac{\text{Fruit infestation in control (\%)} - \text{Fruit infestation in treatment (\%)}}{\text{Fruit infestation in control (\%)}} \times 100$$

The yield data was obtained by weighing the healthy fruits in each treatment plot separately during every picking. The yield of all pickings was computed and expressed in kg/plot from which the yield in t/ha was calculated. The yield data

of marketable fruits at different pickings in each treatment was recorded separately and subjected to statistical analysis to test the significance of mean yield in different treatments. The increase in yield over control in each treatment was calculated by using the following formula:

$$\text{Increase in yield over control} = \frac{\text{Yield in control plot} - \text{Yield in treated plot}}{\text{Yield in control plot}} \times 100$$

Incremental cost-benefit ratio (ICBR) was computed by considering the prevailing market prices of inputs, produce and labour.

3. Statistical Analysis

The experimental data on efficacy was analyzed statistically by applying Randomized Block Design (RBD). The percent shoot and fruit infestation was transformed into arc sine values and the data was subjected to the statistical analysis as per Panse and Sukhatme (1985) [8] for RBD. The significance of treatments was assessed by determining critical difference (C. D.) at 5% level of significance.

4. Results and Discussion

To study the efficacy of chemical insecticides against okra shoot and fruit borer *Earias vittella*

A field evaluation was conducted to assess the efficacy of six insecticidal treatments Flubendiamide 39.35% SC, Chlorantraniliprole 18.5% SC, Emamectin benzoate 5% SG, Spinosad 45% SC, Pyridalyl 10% EC, and Neem Seed Kernel Extract (NSKE) 5% against the shoot and fruit borer, *Earias vittella*, infesting okra

Fruit infestation (number and weight basis)

The effect of insecticidal treatments after each spray was evaluated based on the number of infested fruits as well as

the weight of infested fruits. Observations were recorded on the 3rd, 7th and 10th days following each spray application. The data pertaining to the mean percentage of fruit infestation, calculated both on a number basis and a weight basis, corresponding to the 3rd, 7th and 10th day after each spray, along with the cumulative results obtained after all three sprays, are presented in the table 5.

4.1 First spray

The data on percent fruit infestation on number as well as weight basis due to *E. vittella* after first spray is presented in Table 2

Number basis

Prior to the first spray, fruit infestation by *Earias vittella* ranged from 28.48 to 32.00%, with no significant differences among treatments. Based on the mean fruit infestation at 3rd, 7th and 10th DAS, Chlorantraniliprole 18.5% SC @ 0.25 ml/lit recorded the lowest infestation on number basis (7.34%) and was statistically at par with Flubendiamide 39.35% SC @ 0.20 ml/lit (8.47%) and Emamectin benzoate 5% SG @ 0.27 g/lit (9.32%). Pyridalyl 10% EC @ 1 ml/lit, Spinosad 45% SC @ 0.37 ml/lit and NSKE 5% @ 50 g/lit were comparatively less effective, recording 13.63, 18.99 and 25.36% infestation, respectively. The untreated control registered the highest fruit infestation (32.67%).

Weight basis

The weight-based fruit infestation by *E. vittella* is presented in Table 2. All pesticide treatments significantly reduced infestation at 3rd, 7th and 10th DAS, while pre-treatment infestation was non-significant among treatments, ranging from 29.81 to 31.72%. Based on the mean infestation at 3rd, 7th and 10th DAS, Chlorantraniliprole 18.5% SC @ 0.25 ml/lit recorded the lowest fruit damage on weight basis (7.01%) and was the most effective treatment, statistically at par with Flubendiamide 39.35% SC @ 0.20 ml/lit (8.10%) and Emamectin benzoate 5% SG @ 0.27 g/lit (8.93%). Pyridalyl 10% EC @ 1 ml/lit (13.50%), Spinosad 45% SC @ 0.37 ml/lit (18.81%) and NSKE 5% @ 50 g/lit (25.04%) were comparatively less effective, while the untreated control recorded the highest fruit damage (32.87%).

4.2 Second spray

The data on percent fruit infestation on number as well as weight basis due to *E. vittella* after second spray is presented in Table 3.

Number basis

Based on the mean fruit infestation recorded at 3rd, 7th and 10th DAS after the second spray on number basis, Chlorantraniliprole 18.5% SC @ 0.25 ml/lit registered the lowest mean fruit infestation (4.21%) and proved to be the most effective treatment. It was statistically at par with Flubendiamide 39.35% SC @ 0.20 ml/lit (5.34%) and Emamectin benzoate 5% SG @ 0.27 g/lit (6.26%). The subsequent treatments in order of efficacy were Pyridalyl 10% EC @ 1 ml/lit (10.01%), Spinosad 45% SC @ 0.37 ml/lit (15.42%) and NSKE 5% @ 50 g/lit (21.68%). The untreated control recorded the highest mean fruit infestation (37.22%).

Weight basis

On weight basis, Chlorantraniliprole 18.5% SC @ 0.25 ml/lit recorded the minimum mean fruit damage (3.89%)

and remained statistically at par with Flubendiamide 39.35% SC @ 0.20 ml/lit (4.90%) and Emamectin benzoate 5% SG @ 0.27 g/lit (5.74%). Pyridalyl 10% EC @ 1 ml/lit (9.97%), Spinosad 45% SC @ 0.37 ml/lit (15.28%) and NSKE 5% @ 50 g/lit (21.60%) were comparatively less effective, while the untreated control exhibited the highest mean fruit damage (40.46%).

4.3 Third spray

The data on percent fruit infestation on number as well as weight basis due to *E. vittella* after third spray is presented in Table 4

Number basis

The pooled mean fruit infestation by *Earias vittella* (3rd, 7th and 10th DAS) after the third spray showed significant variation among treatments. Chlorantraniliprole 18.5% SC @ 0.25 ml/lit proved most effective, registering the lowest infestation (1.39%) and remained statistically on par with Flubendiamide 39.35% SC @ 0.20 ml/lit (2.23%) and Emamectin benzoate 5% SG @ 0.27 g/lit (2.56%). Pyridalyl 10% EC @ 1 ml/lit (6.70%), Spinosad 45% SC @ 0.37 ml/lit (11.87%) and NSKE 5% @ 50 g/lit (18.07%) were moderately effective. The untreated control recorded the highest fruit infestation (42.89%).

Weight basis

On weight basis, a comparable pattern of efficacy was observed. Chlorantraniliprole 18.5% SC @ 0.25 ml/lit resulted in the minimum fruit damage (1.47%) and was statistically at par with Flubendiamide 39.35% SC @ 0.20 ml/lit (2.01%) and Emamectin benzoate 5% SG @ 0.27 g/lit (2.55%). Pyridalyl 10% EC @ 1 ml/lit (6.48%), Spinosad 45% SC @ 0.37 ml/lit (11.74%) and NSKE 5% @ 50 g/lit (18.18%) showed comparatively higher damage levels. The untreated control exhibited the maximum fruit damage (44.42%).

Cumulative effect of three sprays

The cumulative percent fruit infestation recorded at 3rd, 7th and 10th DAS after each spray on number and weight basis is presented in Table 5

Number basis

All insecticidal treatments were significantly superior to the untreated control. Mean fruit infestation in treated plots ranged from 4.32 to 21.70%, as against 37.59% in an untreated control. Chlorantraniliprole 18.5% SC @ 0.25 ml/lit recorded the lowest infestation (4.32%) and was statistically at par with Flubendiamide 39.35% SC @ 0.20 ml/lit (5.35%) and Emamectin benzoate 5% SG @ 0.27 g/lit (6.05%). The remaining treatments recorded infestation levels between 10.12 and 21.70%, while the untreated control showed the highest infestation (37.59%).

Weight basis

A similar trend was observed on weight basis, where fruit damage in treated plots ranged from 4.12 to 21.61%, compared to 39.25% in an untreated control. Chlorantraniliprole 18.5% SC @ 0.25 ml/lit was the most effective (4.12%) and remained statistically at par with Flubendiamide 39.35% SC @ 0.20 ml/lit (5.00%) and Emamectin benzoate 5% SG @ 0.27 g/lit (5.74%). The remaining treatments recorded fruit infestation between 9.98

and 21.61%, whereas the untreated control registered the maximum damage (39.25%).

Overall, the pooled results on both number and weight basis indicated that Chlorantraniliprole 18.5% SC @ 0.25 ml/lit was the most promising treatment, followed by Flubendiamide 39.35% SC @ 0.20 ml/lit and Emamectin benzoate 5% SG @ 0.27 g/lit.

The percent reduction in fruit infestation over untreated control ranged from 42.27 to 88.50% on number basis and 44.94 to 89.50% on weight basis, with Chlorantraniliprole 18.5% SC recording the highest reduction (88.50% and 89.50%, number and weight basis respectively). The present findings are in conformity with Saini and Tayde (2023) ^[11], who evaluated seven insecticides against *Earias vittella* on okra, viz., Fipronil 5% SC @ 1 ml/lit, Spinosad 45% SC @ 1 ml/lit, Azadiractin 1% EC @ 3 ml/lit, Chlorantraniliprole 18.5% SC @ 0.3 ml/lit, Imidacloprid 17.8% SL @ 0.4 ml/lit, Emamectin benzoate 5% SG @ 0.3 ml/lit, NSKE 5% @ 50 ml/lit, along with an untreated control. The lowest shoot and fruit borer infestation was recorded with Chlorantraniliprole 18.5% SC (8.96%, 9.29%) and Spinosad 45% SC (9.74%, 10.42%), followed by Imidacloprid 17.8% SL (10.58%, 11.04%), Emamectin benzoate 5% SG (11.89%, 12.27%), Fipronil 5% SC (12.46%, 13.09%), Azadiractin 1% EC (12.77%, 14.16%) and NSKE 5% (13.42%, 14.63%). The mean crop yield ranged from 30 to 160 q/ha, with the highest yield recorded in Chlorantraniliprole 18.5% SC (160 q/ha), followed by Spinosad 45% SC (154 q/ha). Also superiority of Chlorantraniliprole 18.5% SC @ 25 g. a.i./ha against *E. vittella* as obtained in present investigation is in agreement with Shrivastava *et al.*, (2017) ^[12] who found that the Chlorantraniliprole 18.5% SC @ 30 g a.i./ha was effective in reducing percent fruit infestation both on number and weight basis.

Bansode *et al.* (2015) ^[2] reported that Flubendiamide @ 60 g a.i./ha was the most effective treatment, recording the lowest fruit infestation (13.42%) with the highest yield

(15.27 t/ha). It was statistically at par with Emamectin benzoate @ 9.5 g a.i./ha (13.61%), followed by Indoxacarb @ 75 g a.i./ha, Acephate @ 560 g a.i./ha and Profenophos @ 500 g a.i./ha. Dhanalaxmi and Mallapur (2010) ^[6] reported that Emamectin benzoate 5% SG @ 0.2 g/l was the most effective treatment against okra fruit borers, recording the lowest fruit damage (7.82%) and highest yield (47.02 q/ha), followed by Spinosad 45% SC @ 0.1 ml/l (9.19%, 45.94 q/ha) and Indoxacarb 14.5 SC @ 0.3 ml/l (10.74%, 43.03 q/ha).

Marketable fruit yield of okra

All insecticidal treatments significantly increased marketable okra yield over the untreated control (Table 6). Chlorantraniliprole 18.5% SC @ 0.25 ml/lit recorded the highest yield (12.34 t/ha; 48.85% increase over control) and was statistically at par with Flubendiamide 39.35% SC @ 0.20 ml/lit (11.97 t/ha; 44.39%) and Emamectin benzoate 5% SG @ 0.27 g/lit (11.78 t/ha; 42.10%). The remaining treatments yielded 10.91, 10.03 and 9.17 t/ha with Pyridalyl 10% EC, Spinosad 45% SC and NSKE 5%, respectively. Yield followed the order: Chlorantraniliprole > Flubendiamide > Emamectin benzoate > Pyridalyl > Spinosad > NSKE. The superior performance of Chlorantraniliprole concurs with earlier reports by Saini and Tayde (2023) ^[11], Shrivastava *et al.*, (2017) ^[12] and Raju and Kumari (2017) ^[9], who also documented maximum okra yields following its application.

ICBR analysis

ICBR analysis (Table 7) showed that all treatments were economically superior to the untreated control. The highest ICBR was recorded with Emamectin benzoate 5% SG (21.8), followed by Chlorantraniliprole 18.5% SC (18.22) and Flubendiamide 39.35% SC (15.30). Despite a comparatively lower ICBR, Chlorantraniliprole 18.5% SC provided the highest net return due to its superior efficacy against *Earias vittella*.

Table 2: Effect of different insecticides on fruit infestation by *Earias vittella* in okra after the first spray.

Tr. No	Treatments	Per cent fruit infestation									
		Number basis					Weight basis				
		Pre count	3 DAS**	7 DAS	10 DAS	Mean	Pre count	3 DAS	7 DAS	10 DAS	Mean
1	Flubendiamide 39.35% SC	30.93 (33.75)*	8.64 (17.09)	8.24 (16.68)	8.51 (16.95)	8.47 (16.91)	30.22 (33.30)	8.44 (16.89)	7.74 (16.14)	8.11 (16.53)	8.10 (16.52)
2	Chlorantraniliprole 18.50% SC	30.74 (33.67)	7.53 (15.68)	7.12 (15.28)	7.37 (15.48)	7.34 (15.48)	31.26 (33.97)	7.33 (15.49)	6.65 (14.79)	7.04 (15.30)	7.01 (15.19)
3	Emamectin benzoate 5% SG	28.48 (32.22)	9.51 (17.96)	9.09 (17.55)	9.35 (17.80)	9.32 (17.77)	31.72 (34.26)	9.26 (17.71)	8.58 (17.01)	8.96 (17.41)	8.93 (17.38)
4	Spinosad 45% SC	31.06 (33.84)	19.48 (26.13)	18.35 (25.31)	19.13 (25.91)	18.99 (25.79)	30.84 (33.69)	19.30 (26.00)	18.17 (25.18)	18.96 (25.70)	18.81 (25.63)
5	Pyridalyl 10% EC	30.29 (33.35)	14.14 (21.93)	13.02 (21.04)	13.75 (21.68)	13.63 (21.55)	29.81 (33.06)	14.01 (21.83)	12.84 (20.83)	13.67 (21.62)	13.50 (21.43)
6	NSKE 5%	30.49 (33.46)	25.84 (30.55)	24.72 (29.81)	25.51 (30.34)	25.36 (30.23)	30.90 (33.73)	25.37 (30.25)	24.47 (29.65)	25.28 (30.18)	25.04 (30.02)
7	Untreated control	32.00 (34.43)	32.11 (34.52)	32.51 (34.76)	33.38 (35.29)	32.67 (34.86)	31.14 (33.86)	31.91 (34.40)	32.51 (34.76)	34.18 (35.76)	32.87 (34.97)
	SE (±)	1.45	1.28	1.12	1.13	1.18	1.50	1.22	1.04	1.11	1.12
	CD @ 5%	NS	3.93	3.46	3.50	3.63	NS	3.77	3.20	3.42	3.46
	CV (%)	7.50	9.45	8.48	8.41	8.78	7.72	9.12	7.96	8.29	8.46

*(Figures in the parenthesis are arc sine transformed values); DAS**: Days after spray

Table 3: Effect of different insecticides on fruit infestation by *Earias vittella* in okra after the second spray.

Tr. No	Treatments	Per cent fruit infestation							
		Number basis				Weight basis			
		3 DAS**	7 DAS	10 DAS	Mean	3 DAS	7 DAS	10 DAS	Mean
1	Flubendiamide 39.35% SC	5.52 (13.52) *	5.11 (13.01)	5.39 (13.38)	5.34 (13.30)	5.22 (13.17)	4.55 (12.31)	4.94 (12.83)	4.90 (12.77)
2	Chlorantraniliprole 18.50% SC	4.39 (12.04)	3.99 (11.46)	4.26 (11.86)	4.21 (11.79)	4.18 (11.72)	3.51 (10.73)	3.99 (11.48)	3.89 (11.31)
3	Emamectin benzoate 5% SG	6.43 (14.64)	6.04 (14.16)	6.31 (14.47)	6.26 (14.42)	6.07 (14.24)	5.40 (13.40)	5.74 (13.81)	5.74 (13.82)
4	Spinosad 45% SC	15.92 (23.47)	14.80 (22.58)	15.55 (23.19)	15.42 (23.08)	15.77 (23.33)	14.65 (22.45)	15.41 (23.03)	15.28 (22.94)
5	Pyridalyl 10% EC	10.43 (18.74)	9.26 (17.67)	10.34 (18.74)	10.01 (18.39)	10.42 (18.81)	9.33 (17.77)	10.16 (18.55)	9.97 (18.37)
6	NSKE 5%	22.15 (28.06)	21.06 (27.28)	21.81 (27.82)	21.68 (27.72)	21.98 (27.94)	21.01 (27.26)	21.82 (27.83)	21.60 (27.68)
7	Untreated control	34.86 (36.19)	36.93 (37.41)	39.86 (39.15)	37.22 (37.58)	38.97 (38.62)	40.52 (39.53)	41.89 (40.33)	40.46 (39.49)
	SE (±)	0.93	0.91	0.98	0.94	0.91	0.87	0.94	0.91
	CD @ 5%	2.87	2.81	3.03	2.90	2.80	2.69	2.89	2.79
	CV (%)	7.70	7.69	8.02	7.80	7.45	7.39	7.70	7.51

*(Figures in the parenthesis are arc sine transformed values); DAS**: Days after spray

Table 4: Effect of different insecticides on fruit infestation by *Earias vittella* in okra after the Third Spray

Tr. No	Treatments	Per cent fruit infestation							
		Number basis				Weight basis			
		3 DAS**	7 DAS	10 DAS	Mean	3 DAS	7 DAS	10 DAS	Mean
1	Flubendiamide 39.35% SC	2.42 (8.94) *	2.01 (8.15)	2.27 (8.65)	2.23 (8.58)	2.29 (8.70)	1.67 (7.36)	2.06 (8.26)	2.01 (8.11)
2	Chlorantraniliprole 18.50% SC	1.54 (7.09)	1.18 (6.22)	1.46 (6.89)	1.39 (6.73)	1.68 (7.37)	1.21 (6.31)	1.53 (7.07)	1.47 (6.91)
3	Emamectin benzoate 5% SG	2.75 (9.53)	2.37 (8.79)	2.57 (9.17)	2.56 (9.16)	2.90 (9.72)	2.18 (8.49)	2.57 (9.19)	2.55 (9.13)
4	Spinosad 45% SC	12.32 (20.49)	11.24 (19.55)	12.05 (20.27)	11.87 (20.10)	12.18 (20.37)	11.10 (19.44)	11.94 (20.17)	11.74 (19.99)
5	Pyridalyl 10% EC	7.15 (15.48)	6.07 (14.26)	6.88 (15.13)	6.70 (14.96)	6.98 (15.25)	5.80 (13.89)	6.65 (14.91)	6.48 (14.68)
6	NSKE 5%	18.52 (25.46)	17.43 (24.67)	18.25 (25.27)	18.07 (25.13)	18.52 (25.47)	17.61 (24.81)	18.40 (25.38)	18.18 (25.22)
7	Untreated control	41.82 (40.29)	42.95 (40.94)	43.91 (41.50)	42.89 (40.91)	42.97 (40.95)	44.42 (41.79)	45.87 (42.63)	44.42 (41.79)
	SE (±)	0.80	0.77	0.75	0.77	0.77	0.76	0.81	0.78
	CD @ 5%	2.45	2.37	2.30	2.37	2.36	2.34	2.50	2.40
	CV (%)	7.58	7.61	7.13	7.44	7.28	7.55	7.70	7.51

*(Figures in the parenthesis are arc sine transformed values); DAS**: Days after spray

Table 5: Cumulative effect of different insecticides on fruit infestation due to *E. vittella* on okra

Sr. No.	Treatments	Per cent fruit infestation									
		Number basis					Weight basis				
		I spray	II spray	III spray	Mean	Reduction over control (%)	I spray	II spray	III spray	Mean	Reduction over control (%)
1	Flubendiamide 39.35% SC	8.47 (16.91)	5.34 (13.30)	2.23 (8.58)	5.35 (12.93)	85.76	8.10 (16.52)	4.90 (12.77)	2.01 (8.11)	5.00 (12.46)	87.26
2	Chlorantraniliprole 18.50% SC	7.34 (15.48)	4.21 (11.79)	1.39 (6.73)	4.32 (11.33)	88.50	7.01 (15.19)	3.89 (11.31)	1.47 (6.91)	4.12 (11.14)	89.50
3	Emamectin benzoate 5% SG	9.32 (17.77)	6.26 (14.42)	2.56 (9.16)	6.05 (13.79)	83.90	8.93 (17.38)	5.74 (13.82)	2.55 (9.13)	5.74 (13.44)	85.38
4	Spinosad 45% SC	18.99 (25.79)	15.42 (23.08)	11.87 (20.10)	15.43 (22.99)	58.95	18.81 (25.63)	15.28 (22.94)	11.74 (19.99)	15.28 (22.85)	61.07
5	Pyridalyl 10% EC	13.63 (21.55)	10.01 (18.39)	6.70 (14.96)	10.12 (18.30)	73.08	13.50 (21.43)	9.97 (18.37)	6.48 (14.68)	9.98 (18.16)	74.57
6	NSKE 5%	25.36 (30.23)	21.68 (27.72)	18.07 (25.13)	21.70 (27.70)	42.27	25.04 (30.02)	21.60 (27.68)	18.18 (25.22)	21.61 (27.64)	44.94
7	Untreated control	32.67 (34.86)	37.22 (37.58)	42.89 (40.91)	37.59 (37.78)	--	32.87 (34.97)	40.46 (39.49)	44.42 (41.79)	39.25 (38.75)	--
	SE (±)	1.18	0.94	0.77	0.96	--	1.12	0.91	0.78	0.94	--
	CD @ 5%	3.63	2.90	2.37	2.97	--	3.46	2.79	2.40	2.88	--
	CV (%)	8.78	7.80	7.44	8.01	--	8.46	7.51	7.51	7.83	--

*(Figures in the parenthesis are arc sine transformed values); DAS**: Days after spray

Table 6: Effect of insecticides on marketable fruit yield of okra

Sr. No	Treatments	Dose g or ml/liter of water	Marketable fruit yield		Per cent increase over control
			kg/plot	t/ha	
1	Flubendiamide 39.35% SC	0.20 ml	15.51	11.97	44.39
2	Chlorantraniliprole 18.50% SC	0.25 ml	15.98	12.34	48.85
3	Emamectin benzoate 5% SG	0.27 g	15.27	11.78	42.10
4	Spinosad 45% SC	0.37 ml	13.00	10.03	20.99
5	Pyridalyl 10% EC	1 ml	14.13	10.91	31.60
6	NSKE 5%	50 g	11.88	9.17	10.61
7	Untreated control	-	10.75	8.29	0.00
SE ($\pm$)			0.35	0.27	-
CD @ 5%			1.10	0.81	-

Table 7: Economics of insecticidal treatments against *E. vittella* on okra

Tr. No.	Treatments	Dose g or ml/liter of water	Quantity of insecticide (g or ml/ha) for 3 sprays	Yield (t/ha)	Increase in yield over control (t/ha) (A)	Incremental Benefit over control (Rs/ha) (B)	Treatment cost for 3 applications (Rs/ha) (C)	Additional Net profit (Rs/ha) (D) = B-C	ICBR E = (D/C)
1	Flubendiamide 39.35% SC	0.20 ml	300 ml	11.97	3.68	1,28,800	7,900	1,20,900	1:15.30
2	Chlorantraniliprole 18.50% SC	0.25 ml	375 ml	12.34	4.05	1,41,750	7,372	1,34,378	1:18.22
3	Emamectin benzoate 5% SG	0.27 g	405 gm	11.78	3.49	1,22,150	5,337	1,16,813	1:21.8
4	Spinosad 45% SC	0.37 ml	555 ml	10.03	1.74	60,900	13,653	47,247	1:3.46
5	Pyridalyl 10% EC	1 ml	500 ml	10.91	2.62	91,000	12,543	78,457	1:6.26
6	NSKE 5%	50 g	75,000 gm	9.17	0.88	30,800	4,500	26,300	1:5.85
7	Untreated control	-	-	8.29	-	0.00	0.00	-	-

Treatment cost = Cost of insecticide + Charges of insecticide application (Labour charges)

Flubendiamide 39.35% SC	:	Rs. 490/30 ml	NSKE 5%	:	Rs. 60/kg
Chlorantraniliprole 18.50% SC	:	Rs. 1399/120 ml	Average market price of okra	:	Rs. 35,000/t
Emamectin benzoate 5% SG	:	Rs. 2885/500 gm	Labour charges	:	Rs. 1000/ha/application
Spinosad 45% SC	:	Rs. 1130/50 ml	No. of applications	:	Three
Pyridalyl 10% EC	:	Rs. 300/100 ml			

Conclusion

The treatment with Chlorantraniliprole 18.5% SC @ 0.25 ml/lit recorded the lowest fruit infestation on both number and weight basis and was at par with treatments Flubendiamide 39.35% SC @ 0.20 ml/lit and Emamectin benzoate 5% SG @ 0.27 g/lit. Next treatments in order of effectiveness were Pyridalyl 10% EC @ 1 ml/lit, Spinosad @ 0.37 ml/lit and NSKE 5% @ 50 g/lit. An untreated control exhibited the highest level of fruit infestation. The highest marketable yield was obtained with Chlorantraniliprole 18.5% SC (12.34 t/ha), followed by Flubendiamide 39.35% SC (11.97 t/ha) and Emamectin benzoate 5% SG (11.78 t/ha), with yield increases over control ranging from 10.61 to 48.85%. The highest ICBR was recorded with Emamectin benzoate 5% SG (21.8), followed by Chlorantraniliprole 18.5% SC (18.22) and Flubendiamide 39.35% SC (15.30).

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