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Efficacy and economics of selected insecticides against okra shoot and fruit borer [*Earias vittella* (Fabricius)]

Vishal Anna Ingle and Ashwani Kumar

Abstract
The field trial was conducted at Naini Agricultural Institute, Prayagraj during the *kharif* season of 2022 at Central Research Farm, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (U.P). Eight treatments including control were evaluated against *Earias vittella* (F) i.e.,(T_1) Chlorantraniliprole 18.5% SC @0.5ml/lit, (T_5) Spinosad 45% SC @0.4ml/lit, (T_2) Fipronil 5% SC @1ml/lit, (T_3) Imidacloprid 17.8% SL @0.3ml/lit, (T_7) *Metarhizium anisopliae* (CFU 1×10^8) @4gm/lit, (T_4) Nisco sixer plus @2ml/lit, (T_6) Neem oil 1500 ppm @2ml/lit, (T_0) untreated control. Each insecticide was sprayed twice at 15 days interval. All the insecticide tested significally reduced the pest infestation compared to untreated control. The lowest percent of shoot and fruit borer infestation were observed Chlorantraniliprole (9.37% and 6.45%) after first and second insecticidal application respectively, which is followed by Spinosad (10.54% and 6.96%), Fipronil (11.12% and 7.85%), Imidacloprid (11.94% and 9.07%), *Metarhizium anisopliae* (12.71% and 9.31%), Nisco sixer plus (13.19% and 9.57%), Neem oil (14.10% and 10.34) and Untreated control (19.81% and 25.11%). Among all the treatment cost benefit ratio were reported best and most economical in Chlorantraniliprole 18.5% SC (1:4.89), followed by Spinosad 45% SC (1:4.45), Fipronil 5% SC (1:4.44), Imidacloprid 17.8% SL (1:3.97), *Metarhizium anisopliae* CFU 1×10^8 (1:3.41), Nisco Sixer plus (1:2.89), Neem oil 1500 ppm (1:2.76), untreated control (1:1.93).

Keywords: Chlorantraniliprole, *Earias vittella*, economics, efficacy, insecticides

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is an annual vegetable belonging to Malvaceae family; it is also known by different names *viz*., ladies finger, bhendi, bamia, okra or gumbo in different parts of the world. Okra is known as "Queen of vegetables" okra is a very useful plant. It is mainly cultivated for edible fruits but its other parts like leaves, flower petals, stems and roots are also being used as a food, bio-fuel and as a medicine in different parts of the world. (Rani and Kumar 2022) [14].

Okra has good nutritional value particularly the high content of vitamin C (13mg/100g), fat (0.2g/100g), carbohydrate (6.4g/100g), iron (1.5mg/100g), moisture (89.6g/100g), protein (1.9g/100g), fibre (1.2g/100g), calories 35 (kcal/100g), and other minerals. (Chandravanshi *et al.*, 2019) [1].

The total area and production under okra in the world is reported to be 1.26 million ha and 22.29 million tonnes, respectively. It is mainly grown in India, Nigeria, Sudan, Pakistan, Ghana, Egypt, Saudi Arabia, Mexico and Cameroon. India ranks first in okra production 5784.0 thousand tonnes (72% of total world production) having area of 1148.0 thousand hectares with an annual production of 6346 million tonnes and productivity of 11.9 million tonnes/ha. The crop is grown throughout India, Andhra Pradesh is the leading okra producing state which has production of around 1184.2 thousand tons from an area of 78.90 thousand ha, with a productivity of 15 tons / ha. It is followed by west Bengal (862.1 thousand tonnes from 74.00 thousand with 11.70 tonnes/ ha productivity. In Uttar Pradesh area, production and productivity of okra is 12.19 ha, 148.64 tonnes, 12.2 metric tons per hectare. (Janu and Kumar, 2022) [5].

Okra crop suffers damage by a number of insect pest *viz*., the jassids, *Amrasca biguttula bigutula*, Ishida; the aphid, *Aphis gossypii* Glover; the fruit borers, *Earias insulana Boisduval* and *Earias vittella* Fab.; *Helicoverpa armigera* Hub.; whitefly, *Bemisia tabaci* Genn.; and red spider mite, *Tetranychus cinnabarinus* that appears occasionally. Among all pests, shoot and fruit borer, *Earias vittella* (Fabricius) is the most damaging pest of okra as young larva borers into tender shoots in early vegetative growth of plants.

This is an oligophagous pest of malvaceous crops like okra and cotton. It is widely distributed throughout India. In initial stage caterpillars bore into tender shoots and tunnel downwards. Affected shoots wilted and drooped down. During reproductive stage, they bore the fruits and feed inside it. The infested fruits become unsuitable for consumption and marketing. (Dash *et al.,* 2020) [3].

Okra shoot and fruit borer *Earias vittella* (Fab.), (Noctuidae: Lepidoptera) is the most noxious and destructive pest. Initially caterpillar gain entry into growing shoot tip then bud, flower and developing fruits and feed there. Consequently, there is dropping and drying of growing tips. The infested shoot die, the buds, flowers, fruits drop prematurely and affected fruits become unfit for human consumption, fetching less price in the market. This pest may cause 40-50% damage of fruit in some areas of south-east Asian countries. In India the damage due to *Earias vittella* is upto 35% of the total harvested yield. Chemical control measures for controlling insect pests in the field is the most common approach. (Panbude *et al*., 2019) [12].

Materials and Methods

The experiment was conducted at the Central Research Farm (CRF), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India during the *kharif* season 2022 in Randomized Block Design (RBD) with three replications. A good tilth area was divided into three main blocks. Each main block was sub-divided into 8 sub-plots each of which was of 2 m × 1 m with maintaining 30 cm borders as bunds and the treatments was assigned randomly.

The seed of variety Arka Anamika at the seed rate of 8 kg ha^{-1} were sown in the plots with spacing 45×30 cm (Row × Plant).

Observations were recorded on the number of infested shoots and healthy shoots in each plot a day before spray, 7th and 14th days after spraying on selected plants in each plot. The cumulative percent shoot damage was work out using the formula:

$$\% \text{ Shoot infestation} = \frac{\text{Number of infested shoots}}{\text{Number of total shoots}} \times 100$$

(Choudhury *et al*., 2021) [2].

Observations were also recorded on the number of infested fruits and number of marketable fruits on selected plants in a plot picking wise. The percent fruit damage was work out by using the formula:

$$\% \text{ Fruit infestation} = \frac{\text{Number of infested fruits}}{\text{Number of total fruits}} \times 100$$

(Choudhury *et al*., 2021) [2].

The Cost Benefit Ratio was calculated by following formula:

$$\text{BCR} = \frac{\text{Gross return}}{\text{Total cost of production}}$$ (Nalini and Kumar, 2016) [10].

Where,

BCR = Benefit Cost Ratio

Results and Discussion

The data on the percent infestation of shoot and fruit borer on okra 7th and 14th day after first spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments lowest percent shoot, infestation was recorded in T_1 Chlorantraniliprole 18.5% SC (9.37), followed by T_5 Spinosad 45% SC (10.54), T_2 Fipronil 5% SC (11.12), T_3 Imidacloprid 17.8% SL (11.94) and T_7 *Metarhizium anisopliae* CFU 1×10^8 (12.71) and T_4 Nisco sixer plus (13.19). In this T_6 Neem oil 1500 PPM (14.10) is found to be least effective than all the treatments and is significantly superior over the untreated control plot T_0 (19.81) infestation.

The data on the percent infestation of shoot and fruit borer on okra 7th and 14th day after second spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments lowest percent shoot, infestation was recorded in T_1 Chlorantraniliprole 18.5% SC (6.45), followed by T_5 Spinosad 45% SC (6.96), T_2 Fipronil 5% SC (7.85), T_3 Imidacloprid 17.8% SL (9.07) and T_7 *Metarhizium anisopliae* CFU 1×10^8 (9.31) and T_4 Nisco sixer plus (9.57). In this T_6 Neem oil 1500 PPM (10.34) is found to be least effective than all the treatments and is significantly superior over the untreated control plot T_0 (25.11) infestation.

The highest cost benefit ratio was recorded in the treatment, the best and most economical treatment T_1 Chlorantraniliprole (1:4.89) followed by T_5 Spinosad (1:4.45), T_2 Fipronil (1:4.44),T3 Imidacloprid (1:3.97), T_7 *Metarhizium anisopliae* (1:3.41), T_4 Nisco sixer plus (1:2.89), T_6 Neem oil (1:2.76) and T_0 Control (1:1.93).

Among all the first and second spray shoot and fruit borer treatments Chlorantraniliprole 18.5% SC 9.37% and 6.45%. These results are supported by Patil *et al.*, (2022) [13], Kulkarni and Kumar (2022) [6]. Spinosad 45% SC recorded the lowest percentage of shoot and fruit damage of first and second spray are 10.54% and 6.96% infestation over control. This result are similar to the finding by Kumar and singh (2022) [7], Gundavarapu and Kumar (2020) [4] and Janu and Kumar (2022) [5].The efficacy of Fipronil 5% SC in first and second spray are 11.12% and 7.85% respectively. These results are similar to the findings of Naidu and kumar (2019) [9]. The next best treatment which is Imidacloprid 17.8 SL in which the efficacy values of first and second spray are 11.94% and 9.07% respectively which was similar to Pachole *et al*., (2017) [11] and Manikanta and Kumar (2022) [8].

The next best treatment which is *Metarhizium anisopliae* (CFU 1×10^8) in which the efficacy values of first and second spray are 12.71% and 9.31% respectively this results are supported by Panbude *et al.*, (2019) [12] and Nalini and kumar (2016) [10]. This is followed by the next treatments Nisco sixer plus and Neem oil 1500 ppm in which efficacy values of first and second spray are (13.19), (9.57) and (14.10), (10.34) respectively these results are supported by Sreeja and Kumar (2022) [15] and Rani and Kumar (2022) [14] respectively.

Highest yield Benefit Cost Ratio (1:4.89) was obtained in Chlorantraniliprole which was supported by Kulkarni and Kumar (2022) [6] and Rani and Kumar (2022) [14]. Who reported that the chlorantraniliprole recorded the high yield. Spinosad which also reported a profitable yield and cost benefit ratio (1:4.45) these findings are supported by Pachole *et al*., (2017) [11] and Janu and Kumar (2022) [5]. The cost benefit ratio of Fipronil (1:4.44) these results were to the findings reported by Rani and Kumar (2022) [14] and Naidu and Kumar (2019) [9]. The cost benefit ratio obtained in the treatment Imidacloprid (1:3.97) was supported by Manikanta and Kumar (2022) [8]. The cost benefit ratio of *Metarhizium anisopliae* (1:3.41) was supported by Nalini and Kumar

(2016) [10]. The cost benefit ratio of Nisco sixer plus (1:2.89) Sreeja and Kumar (2022) [15]. The Benefit Cost Ratio of the Neem oil (1:2.76) which were supported by Nalini and Kumar (2016) [10] and Rani and Kumar (2022) [14].

Table 1: Efficacy of selected insecticides against okra shoot and fruit borer [*Earias vittella* (Fabricius)]. (First spray)

Treatments		% Shoot Infestation (First Spray)			
		1 DBS	**7 DAS**	**14 DAS**	**Mean**
T_0	Untreated control	17.08 (24.37)*	19.59 (26.26)*	20.03 (26.58)*	19.81 (26.42)*
T_1	Chlorantraniliprole 18.5 SC	16.43 (23.88)*	8.65 (17.02)*	10.09 (18.47)*	9.37 (17.81)*
T_2	Fipronil 5 SC	16.33 (23.79)*	10.13 (18.42)*	12.11 (20.32)*	11.12 (19.46)*
T_3	Imidacloprid 17.8 SL	16.65 (24.05)*	11.19 (19.49)*	12.69 (20.85)*	11.94 (20.20)*
T_4	Nisco sixer plus	17.05 (24.38)*	12.56 (20.74)*	13.82 (21.82)*	13.19 (21.29)*
T_5	Spinosad 45 SC	17.31 (24.56)*	9.37 (17.74)*	11.72 (20.01)*	10.54 (18.92)*
T_6	Neem oil (1500 ppm)	18.48 (25.43)*	13.43 (21.48)*	14.78 (22.60)*	14.10 (22.05)*
T_7	*Metarhizium anisopliae* (CFU 1×10^8)	16.87 (24.22)*	11.75 (20.03)*	13.68 (21.69)*	12.71 (20.87)*
Overall mean		17.02	12.08	13.61	12.84
F- test		NS	S	S	S
S. Ed. (±)		0.676	3.428	2.968	3.193
C. D. (P = 0.05%)		-	3.25	2.35	1.43

(Figures in the parenthesis arc sin transformed value)*
DBS- Days before Spray
DAS- Days after Spray

Table 2: Efficacy of selected insecticides against okra shoot and fruit borer [*Earias vittella* (Fabricius)]. (Second spray)

Treatments		% Fruit Infestation (Second Spray)			
		1 DBS	**7 DAS**	**14 DAS**	**Mean**
T_0	Untreated control	20.48 (26.90)*	24.07 (29.37)*	26.16 (30.76)*	25.11 (30.10)*
T_1	Chlorantraniliprole 18.5 SC	12.61 (20.77)*	5.96 (14.04)*	6.94 (15.24)*	6.45 (14.70)*
T_2	Fipronil 5 SC	14.53 (22.29)*	7.68 (16.05)*	8.03 (16.43)*	7.85 (16.27)*
T_3	Imidacloprid 17.8 SL	15.41 (23.08)*	8.53 (16.94)*	9.62 (18.06)*	9.07 (17.52)*
T_4	Nisco sixer plus	17.03 (24.36)*	9.29 (17.72)*	9.86 (18.26)*	9.57 (18.02)*
T_5	Spinosad 45 SC	13.83 (21.78)*	6.56 (14.78)*	7.36 (15.72)*	6.96 (15.29)*
T_6	Neem oil (1500 ppm)	18.63 (25.54)*	10.07 (18.44)*	10.62 (18.93)*	10.34 (18.76)*
T_7	*Metarhizium anisopliae* (CFU 1×10^8)	16.63 (24.01)*	8.83 (17.27)*	9.79 (18.23)*	9.31 (17.76)*
Overall mean		16.14	10.12	11.04	10.58
F- test		S	S	S	S
S. Ed. (±)		2.590	5.801	6.246	6.020
C. D. (P = 0.05%)		4.33	2.78	2.50	0.894

(Figures in the parenthesis arc sin transformed value)*
DBS- Days before Spray
DAS- Days after Spray

Table 3: Economics of Cultivation

Sr.no.	Treatments	Yield q/ha	Total cost of yield (₹)	Common cost (₹)	Treatment cost (₹)	Total cost (₹)	B:C Ratio
T_0	Untreated control	48.50	87300	45010	-	45010	1:1.93
T_1	Chlorantraniliprole 18.5 SC	153.00	275400	45010	11210	56220	1:4.89
T_2	Fipronil 5 SC	118.00	212400	45010	2810	47820	1:4.44
T_3	Imidacloprid 17.8 SL	105.00	189000	45010	2560	47570	1:3.97
T_4	Nisco sixer plus	82.66	148680	45010	6360	51370	1:2.89
T_5	Spinosad 45 SC	143.00	257400	45010	12788	57798	1:4.45
T_6	Neem oil (1500 ppm)	73.00	131400	45010	2560	47570	1:2.76
T_7	*Metarhizium anisopliae* (CFU 1×10^8)	90.00	162000	45010	2480	47490	1:3.41

Cost of yield per quintal=1800.

Conclusion

From the present study, the results showed that Chlorantraniliprole 18.5% SC was found to be the most effective treatment against okra shoot and fruit borer. It also gave the highest cost benefit ratio compared to other treatments. While Spinosad 45% SC, Fipronil 5% SC, Imidacloprid 17.8% SL, *Metarhizium anisopliae* CFU 1×10^8 have shown average results. Nisco sixer plus and Neem oil 1500 ppm found to be least effective for controlling shoot and fruit borer.

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