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Sanjana Kulkarni
M.Sc. Scholar, Department of Entomology, Faculty of Agriculture, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Ashwani Kumar
Associate Professor, Department of Entomology, Faculty of Agriculture, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author
Sanjana Kulkarni
M.Sc. Scholar, Department of Entomology, Faculty of Agriculture, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Efficacy and economics of some selected insecticides against shoot and fruit borer (*Earias vittella*) of okra [*Abelmoschus esculentus* (L.) Moench]

Sanjana Kulkarni and Ashwani Kumar

Abstract
The current study was carried out at Central Research Farm, SHUATS, Naini, Prayagraj, U.P during *kharif* season of 2021. Two applications of seven insecticides were used against *Earias vittella* and the results revealed that Chlorantraniliprole 18.5% SC had the lowest per cent of shoot and fruit infestation with 11.71% and 11.96% followed by Emamectin benzoate 5% SG (12.96% and 14.11%), Spinetoram 11.7% SC (13.28% and 14.70%), Imidacloprid 17.8% SL (14.71% and 16.35%), Flonicamid 50 WG (14.90% and 17.31%), Acephate 75 SP (15.74% and 17.65%) and Diafenthiuron 50 WP (16.39% and 19.61%) respectively as compared to control (water spray) with 20.75% and 24.75%. Benefit cost ratio was found highest in Chlorantraniliprole (1: 4.4) followed by Imidacloprid (1: 4.2), Emamectin benzoate (1: 4.2), Spinetoram (1: 3.4), Diafenthiuron (1: 3.3), Flonicamid (1: 3.3), Acephate (1: 3.1) and Control (1: 1.6).

Keywords: Benefit cost ratio, chlorantraniliprole, *Earias vittella*, emamectin benzoate, insecticides

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] commonly known as *Bhindi* or lady's finger (family Malvaceace) is a popular fruit vegetable crop due to its high nutritional and medicinal values. Due to their sensitive and supplemental character, as well as their growth in high moisture, okra is planted throughout the summer and *kharif* seasons. Carbohydrate (6.4%), Protein (1.9%), Fat (0.2%), Fibre (1.2%), Minerals (0.7%) and Moisture (89.6%) are all present in okra fruits. Anonymous (2013-14) [1]. Gujarat is the largest okra producing state in India, with output of roughly 921.72 thousand tones from an area of 75.27 thousand hectares and a productivity of 12.25 tonnes/ha, followed by West Bengal (914.86 thousand tones from 77.5 thousand hectares and 11.5 tonnes/ ha productivity). Uttar Pradesh has production of 307.29 tonnes from an area of 22.93 thousand ha with a productivity of 13.40 MT/ ha of okra. NHB (2018-19) [2].

One of the limiting factors is the cultivation of okra is infestation of insect pests. As many as 72 species of insects have been recorded on okra Pandey *et al*. (2019). The major insect pests are shoot and fruit borer, *Earias insulana* (Boisd.), *Earias vittella* (Boisd.); leaf hopper, *Amrasca biguttula biguttula* (Ishida.); leaf roller, *Sylepta derogate* (Fab); whitefly, *Bemisia tabaci* (Genn.); Aphid, *Aphis gossypii* (Glov.) and mite, *Tetranychus cinnabarinus* (Boisd.). Nagar *et al*. (2017) [3].

The shoot and fruit borer (E. *insulana* and E. *vittella*) is one of the most serious pests of okra. 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 consumption as well as for procurement of the seeds. The borer has been reported to cause 24.6 to 26.0 percent damage to okra shoots and 40 to 100 percent loss to fruits. Yadav *et al*. (2017) [4].

Pesticides constitute the key control tactics for management of pests and diseases and the productivity of crops depends on their effective control. Together with high yielding crop varieties and fertilizers, pesticides have helped the Indian farmers in achieving a substantial increase in agricultural productivity. Birthal *et al.* (2000) [5]. The area under plant protection has been continuously increasing in India.

Materials and Methods

During the *kharif* season of 2021, a field research was carried out at Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, U.P. The okra seeds of variety 'Abhay' were planted at 45 cm x 30 cm spacing.

The experiment was laid down in randomized block design (RBD) with eight treatments replicated thrice with each plot size of 2m x 2m and proper irrigation was provided. The treatments comprising of Spinetoram 11.7% SC, Emamectin benzoate 5% SG, Chlorantraniliprole 18.5% SC, Flonicamid 50% WG, Acephate 75% SP, Imidacloprid 17.8% SL and Diafenthiuron 50% WP were applied two times using knapsack sprayer. The shoot damage (due to *Earias vittella*) was recorded at weekly interval while fruit damage at each picking from randomly selected five plants. The observations recorded one day before spray followed by 3, 7 and 14 days after spraying. After the last picking, total of all pickings of individual plots produce were calculated to work out the yield of the treatments. Yield of healthy fruits was converted into quintal per hectare. The extent of damage was computed by using the formula:

Percent shoot infestation

$$\text{Percent shoot damage} = \frac{\text{Number of infested shoots}}{\text{Total number of shoots}} \times 100$$

Percent fruit infestation

$$\text{Percent fruit damage} = \frac{\text{Number of damaged fruits}}{\text{Total number of fruits}} \times 100$$

$$\text{Benefit Cost Ratio} = \frac{\text{Gross returns}}{\text{Total cost}}$$

Result and Discussion

Efficacy of treatments

The data so obtained through observation were subjected to statistical analysis wherever necessary. From the data on mean of shoot infestation of first spray revealed that the treatment Chlorantraniliprole 18.5 per cent SC (11.71 per cent) caused the least shoot damage, followed by Emamectin benzoate 5 per cent SG (12.96 per cent), Spinetoram 11.7 per cent SC (13.28 per cent), Imidacloprid 17.8 per cent SL (14.17 per cent), Flonicamid 50 per cent WG (14.90 per cent), Acephate 75 per cent SP (15.74 per cent), and Diafenthiuron 50 per cent WP (16.39 per cent) was the least effective treatment. (See Table 1) (Fig 1)

These results are in support with Shirale *et al.* (2012) [6] Naidu and Kumar (2019) [7] who reported that Chlorantraniliprole proved superior over other insecticides in reducing infestation of L. *orbonalis.* Reshma and Behera (2018) [8] reported Emamectin benzoate as effective treatment. Muthukrishnan *et al.* (2013) [9] reported Spinetoram as effective treatment.

The data on mean of fruit infestation of second spray revealed that the treatment Chlorantraniliprole 18.5 per cent SC (11.96 per cent) caused the least fruit damage of the seven insecticides tested against the shoot and fruit borer, followed by Emamectin benzoate 5 per cent SG (14.11 per cent), Spinetoram 11.7 per cent SC (14.70 per cent), Imidacloprid 17.8 per cent SL (16.35 per cent), Flonicamid 50 per cent WG (17.31 per cent), Acepahte 75 per cent SP (17.65 per cent) and Diafenthiuron (19.61 per cent) was the least effective treatment. (See Table 2) (Fig 2)

These results are in support with Tripura *et al.* (2017) [10] and Kumar *et al.* (2017) [11] reported that Chlorantraniliprole recorded lowest fruit damage. Parthiban *et al.* (2014) [12] recorded that Emamectin benzoate on fruit yield was the most effective. Bade *et al.* (2017) [13] found Spinetoramas the most effective in reducing the incidence of shoot and fruit borer of brinjal.

Cost benefit ratio

There was a considerable difference in yield between the treatments. In comparison to control (1: 1.6), Chlorantraniliprole (1: 4.4) produced the best yield, followed by Imidacloprid (1: 4.2), Emamectin benzoate (1: 4.2), Spinetoram (1: 3.4), Diafenthiuron (1: 3.3), Flonicamid (1: 3.3), and Acephate (1: 3.1). (See Table 3)

The present results are similar with Kumar *et al.* (2017) [14] and Kushwaha and Painkra (2016) [15] recorded highest B: C ratio in Chlorantraniliprole. Nemade *et al.* (2015) [16] concluded that in terms of higher incremental cost benefit ratio, Imidacloprid was found superior. Devi *et al.* (2014) [17] and Singh *et al.* (2018) [18] observed higher B: C ratio in Emamectin benzoate. Ghosal *et al.* (2013) [19] observed highest yield and B: C ratio in Spinetoram.

Table 1: Efficacy of some insecticides against shoot and fruit borer of okra [*Abelmoschus esculentus* (L.) Moench] (First spray)

Treatments		% Shoot infestation				
		Before spraying	3 DAS	7 DAS	14 DAS	Mean
T_1	Spinetoram 11.7% SC	18.968 (25.768)*	12.768 (20.936)*	11.771 (20.064)*	15.312 (23.022)*	13.283 (21.346)*
T_2	Emamectin benzoate 5% SG	20.021 (26.577)*	12.277 (20.505)*	11.553 (19.868)*	15.078 (22.836)*	12.969 (21.077)*
T_3	Chlorantraniliprole 18.5% SC	20.158 (26.672)*	11.349 (19.653)*	10.007 (18.440)*	13.776 (21.785)*	11.710 (19.972)*
T_4	Flonicamid 50% WG	18.968 (25.768)*	14.107 (22.057)*	12.824 (20.969)*	17.788 (24.940)*	14.906 (22.664)*
T_5	Acephate 75% SP	20.021 (26.577)*	14.713 (22.554)*	14.611 (22.393)*	17.919 (25.033)*	15.747 (23.357)*
T_6	Imidacloprid 17.8 SL	20.158 (26.672)*	13.082 (21.179)*	12.920 (21.028)*	16.532 (23.988)*	14.178 (22.087)*
T_7	Diafenthiuron 50% WP	20.021 (26.577)*	15.020 (22.799)*	14.888 (22.690)*	19.288 (26.049)*	16.398 (23.850)*
T_0	Control	18.801 (25.683)*	19.182 (25.974)*	20.258 (26.732)*	22.811 (28.516)*	20.750 (27.084)*
F – test		NS	S	S	S	S
S. Ed. (±)		1.109	0.714	1.431	1.004	0.412
C. D (P = 0.05)		-----	1.539	3.073	2.157	0.892

*Figures in parenthesis are arc sin transformed values
DAS: Days after spray

Table 2: Efficacy of some selected insecticides against shoot and fruit borer of okra [*Abelmoschus esculentus* (L.) Moench] (Second spray)

Treatments		% Fruit infestation				
		Before spraying	3 DAS	7 DAS	14 DAS	Mean
T_1	Spinetoram 11.7% SC	24.309 (29.536)*	14.011 (21.980)*	12.515 (20.715)*	17.584 (24.791)*	14.703 (22.497)*
T_2	Emamectin benzoate 5% SG	24.309 (29.536)*	13.776 (21.785)*	11.847 (20.117)*	16.709 (24.121)*	14.110 (22.016)*
T_3	Chlorantraniliprole 18.5% SC	23.596 (29.057)*	11.275 (19.616)*	10.307 (18.716)*	14.312 (22.217)*	11.964 (20.192)*
T_4	Flonicamid 50% WG	24.033 (29.349)*	16.944 (24.296)*	15.661 (23.311)*	19.337 (26.075)*	17.314 (24.569)*
T_5	Acephate 75% SP	24.309 (29.536)*	18.653 (25.575)*	15.961 (23.536)*	18.340 (23.345)*	17.651 (24.831)*
T_6	Imidacloprid 17.8 SL	23.596 (29.057)*	15.195 (22.931)*	15.473 (23.142)*	18.389 (25.386)*	16.352 (23.833)*
T_7	Diafenthiuron 50% WP	23.809 (29.197)*	20.490 (26.900)*	17.725 (24.895)*	20.623 (27.005)*	19.612 (26.274)*
T_0	Control	23.596 (29.057)*	24.084 (29.381)*	23.358 (29.566)*	25.833 (30.543)*	24.758 (29.837)*
F – test		NS	S	S	S	S
S. Ed. (±)		0.836	1.048	1.723	1.029	0.741
C. D (P = 0.05)		-----	2.256	3.701	2.214	1.599

*Figures in parenthesis are arc sin transformed values
DAS: Days after spray

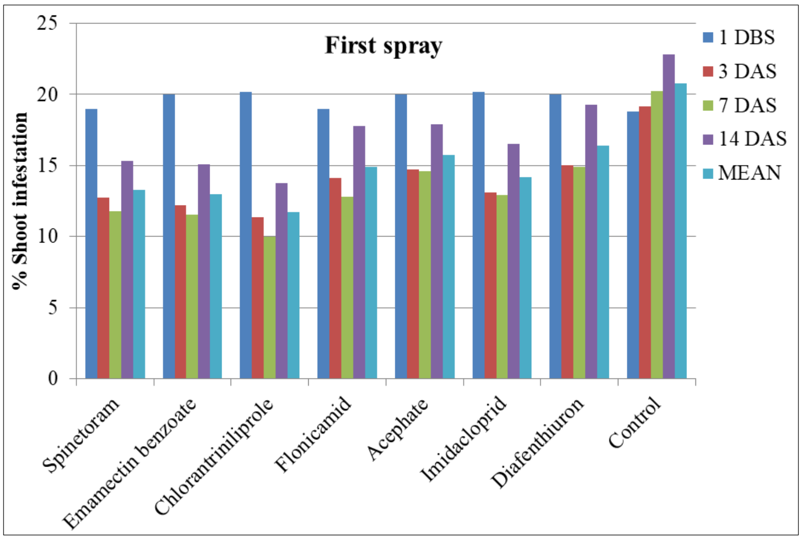

Fig 1: Efficacy of some selected insecticides against shoot and fruit borer of okra. (first spray)

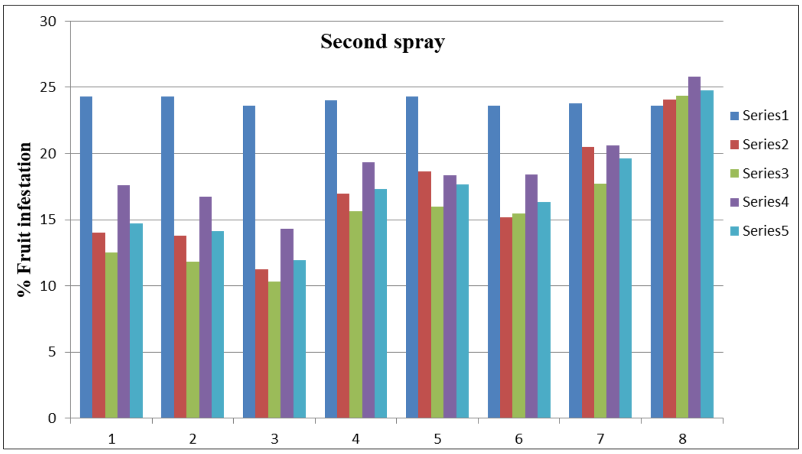

Fig 2: Efficacy of some selected insecticides against shoot and fruit borer of okra. (second spray)

Table 3: Economics of treatments for management of shoot and fruit borer

Treatments	Yield (q/ha)	Cost of yield	Total cost of yield (Rs.)	Common cost (Rs.)	Treatment cost (Rs.)	Total cost (Rs.)	Cost: Benefit ratio
Spinetoram 11.7% SC	137.9	1500	206850	47278	12050	59328	1: 3.4
Emamectin benzoate 5% SG	140.5	1500	210750	47278	2480	49758	1: 4.2
Chlorantraniliprole 18.5% SC	162.4	1500	243600	47278	8000	55278	1: 4.4
Flonicamid 50% WG	107.2	1500	160800	47278	1280	48558	1: 3.3
Acephate 75% SP	103.3	1500	154950	47278	1454	48732	1: 3.1
Imidacloprid 17.8% SL	151.8	1500	227700	47278	5800	53078	1: 4.2
Diafenthiuron 50% WP	110.6	1500	165900	47278	2480	49758	1: 3.3
Control	52	1500	78000	47278	-	47278	1: 1.6

Conclusion

From the experiment discussed above, the results revealed that the most efficient pesticide against shoot and fruit borer was found to be Chlorantraniliprole, followed by Emamectin benzoate and Spinetoram with Diafenthiuron being the least effective. Chlorantraniliprole had the best cost-benefit ratio followed by Imidacloprid, Emamectin benzoate and Spinetoram.

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