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Field efficacy of different chemicals against shoot and fruit borer, *Earias vittella* (Fabricius) on Okra

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Abstract
The present investigation was conducted at Kishandevpur, Prayagraj, Uttar Pradesh, during *Kharif,* 2020-21 to evaluate the field efficacy of selected chemical and botanical treatments against the shoot and fruit borer, *Earias vittella* (Fabricius) infesting okra. The experiment, entitled "Field efficacy of different chemicals against shoot and fruit borer, *Earias vittella* on okra," comprised seven insecticidal treatments along with an untreated control. The treatments included Imidacloprid 17.8% SL (T_1), Spinosad 45% SC (T_2), Emamectin benzoate 5% SG (T_3), Chlorantraniliprole 18.5% SC (T_4), Abamectin 1.9% EC (T_5), Cypermethrin 25% EC (T_6), Neem oil 1500 ppm (T_7), and an untreated control (T_0). These treatments were assessed for their effectiveness in suppressing *E. vittella* infestation and their consequent impact on okra yield. Among the evaluated treatments, Chlorantraniliprole 18.5% SC (T_4) emerged as the most effective and economically viable option, recording the highest benefit–cost ratio (1:9.3). Its performance was statistically at par with Spinosad 45% SC (T_2), which registered a benefit–cost ratio of 1:8.4. In contrast, Neem oil 1500 ppm (T_7) was the least effective treatment, with a benefit–cost ratio of 1:5.2, though it performed marginally better than the untreated control (1:4.2). In terms of pest suppression, Chlorantraniliprole 18.5% SC (T_4) provided the highest level of control over shoot and fruit borer infestation, followed in descending order by Spinosad 45% SC (T_2), Emamectin benzoate 5% SG (T_3), Abamectin 1.9% EC (T_5), Imidacloprid 17.8% SL (T_1), Cypermethrin 25% EC (T_6) and Neem oil 1500 ppm (T_7). The untreated control recorded the highest level of infestation. Yield analysis revealed that the maximum okra yield was obtained with Chlorantraniliprole 18.5% SC (195.5 q ha^{-1}), whereas the minimum yield was recorded under Neem oil 1500 ppm (92.4 q ha^{-1}). These findings indicate that Chlorantraniliprole 18.5% SC is highly effective in managing *E. vittella* while significantly enhancing okra productivity under field conditions.

Keywords: Field efficacy, *Earias vittella,* Chemical insecticides, Cost- benefit ratio

Introduction

Okra *[Abelmoschus esculentus* (L.) Moench] is an important annual vegetable crop of the family Malvaceae and is widely cultivated in tropical and subtropical regions. It is commonly referred to by various vernacular names such as lady's finger, bhindi, bamia, okro or gumbo across different parts of the world. Often described as the "Queen of Vegetables," okra is primarily grown for its tender green pods, which are consumed in diverse culinary preparations. In addition to the fruits, young leaves are used as leafy vegetables in certain regions, while mature seeds are roasted and ground as a coffee substitute in Turkey. The stems and roots are traditionally utilized in clarifying sugarcane juice during the preparation of jaggery or brown sugar. Beyond its culinary importance, okra has recognized medicinal properties, particularly in the management of ulcers and haemorrhoids (Reddy *et al*., 2018) [25]. The crop is thus valued not only for its edible fruits but also for the multiple uses of its leaves, flowers, stems, and roots as food, biofuel, and medicinal resources in different parts of the world.

Globally, okra is cultivated over an area of about 1.26 million hectares with an annual production of approximately 22.29 million tonnes. Major okra-producing countries include India, Nigeria, Sudan, Pakistan, Ghana, Egypt, Saudi Arabia, Mexico, and Cameroon. India occupies the foremost position in global okra production, contributing nearly 72% of the total output. The crop is grown on about 1.148 million hectares in the country, with an annual production of around 5.78 million tonnes and an average productivity of 11.9 t ha^{-1}. Okra is cultivated throughout India, with Andhra Pradesh emerging as the leading producing state, recording about 1,184.2 thousand tonnes from 78.9 thousand hectares at a productivity of nearly 15 t ha^{-1}. This is followed by West Bengal, which produces approximately 862.1 thousand tonnes from 74.0 thousand hectares with a productivity of 11.7 t ha^{-1}. In Uttar Pradesh, okra occupies an area of about 12.19 thousand hectares, producing nearly 148.64 thousand tonnes with an average productivity of 12.2 t ha^{-1} (National Horticulture Board, 2018–19). The major okra-growing states in India include Andhra Pradesh (20%), West Bengal (15%), Bihar (14%), Odisha (11%), Gujarat (10%), Jharkhand (7%), Maharashtra (4%), Assam (3%), and Haryana (3%) (Anonymous, 2012) [1].

Insect pests constitute one of the most important constraints in okra cultivation. Several insect species that infest cotton are also known to attack okra, causing significant economic losses. Nearly 72 insect species have been reported to infest okra, among which the shoot and fruit borer, *Earias vittella* (Fabricius) (Lepidoptera: Noctuidae), is the most destructive and widely distributed pest. Damage caused by this pest alone has been estimated to result in up to 69% reduction in marketable yield (Rawat and Sahu, 1973) [24]. Other important pests of okra include jassids, cutworms, whiteflies, and aphids, all of which adversely affect crop growth and productivity. Leafhopper infestation, for instance, has been reported to cause reductions of 49.8% in plant height and 45.1% in leaf number (Rawat and Sahu, 1973) [24].

Among the various insect pests, the okra shoot and fruit borer, *E. vittella*, is considered the most serious, causing 45–57% damage to fruits under severe infestation. Yield losses due to this pest have been reported to range from 48.97% to as high as 70.75% (Md. Abdur, 2021). The larvae damage the crop during both vegetative and reproductive stages by boring into tender shoots, flower buds, and fruits, where they feed on internal tissues. Infested flower buds often drop prematurely, while damaged fruits become malformed and unmarketable, leading to substantial economic losses.

Management of okra pests using chemical insecticides often leads to several adverse consequences, including the development of insecticide resistance, resurgence of secondary pests, phytotoxic effects, elimination of natural enemies, and accumulation of pesticide residues in edible fruits, posing health risks to consumers. These concerns are particularly serious in okra, as the crop requires frequent harvesting at short intervals, increasing the likelihood of residue contamination. Although chemical control cannot be completely avoided due to its effectiveness, its role can be minimized through the adoption of safer and more sustainable pest management approaches. These include the use of biopesticides (botanical and microbial formulations), cultivation of pest-tolerant or resistant varieties, and integration of biological control agents within an eco-friendly integrated pest management (IPM) framework.

Several insecticides have been recommended for the management of okra shoot and fruit borer; however, continuous introduction of newer pesticide molecules with improved selectivity and reduced residue persistence necessitates their systematic evaluation under field conditions. Therefore, assessing the efficacy, economic viability, and suitability of newer insecticides has become essential to identify effective and safer options for the sustainable management of *E. vittella* in okra cultivation.

Materials and Methods

The field experiment was carried out during the kharif season of 2020–2021 at Kishandevpur, Prayagraj. The experimental site is geographically located at 25.4358° N latitude and 81.8463° E longitude, with an elevation of approximately 98 m above mean sea level. The region is characterized by a semi-arid, sub-tropical climate, experiencing extreme seasonal variations, with maximum temperatures rising to about 49 °C during summer and minimum temperatures declining to nearly 1.5 °C in winter. The okra variety 'Nilima' was planted at a seed rate of 8.5 kg /ha^{-1} using the dibbling method. Sowing was carried out with a spacing of 45 cm between rows and 30 cm between plants, placing 2–3 seeds per hill at a depth of approximately 4 cm. The crop was sown on 12 August 2020. The experimental field was selected for its uniformity and suitability for cultivation, comprising well-drained sandy loam soil.

Table 1: Details of Treatments

S. No.	Treatments	Chemical insecticides	Dosage	Group	Reference
1.	T_1	Imidacloprid 17.8% SL	0.4ml/lit.	Chloro-nicotinyl	Gautam *et al.,*(2015) [9]
2.	T_2	Spinosad 45% SC	0.3-0.4ml/lit.	Spynosins	Naidu *et al.,* (2019) [17]
3.	T_3	Emamectin benzoate 5% SG	0.4g/lit.	Avermectin	Dash *et al.,* (2020) [5]
4.	T_4	Chlorantraniliprole 18.5% SC	1.5ml/lit.	Diamides	Shrivastava *et al.*, (2017) [29]
5	T_5	Abamectin 1.9% EC	1ml/lit.	Avermectin	Javed *et al.,* (2018) [11]
6.	T_6	Cypermethrin 25%EC	1ml/lit.	Syntheticpyrethroids	Wajid *et al.,* (2016) [34]
7.	T_7	Neem oil (1500 PPM)	2ml/lit.	Botanicals	Roy *et al.,* (2014) [26]
8.	T_0	Control	-	-	-

Preparation of insecticidal spray solution

For each treatment, the insecticidal spray solution at the required concentration was freshly prepared at the experimental site immediately prior to application. The volume of spray material applied to the crop was progressively increased in accordance with crop growth and developmental stage. The spray solution of the desired concentration was prepared using the following formula:

V = (C×A) ÷ % a.i

Where,

V = Volume of a formulated pesticide required

C = Concentration required

A = Volume of total solution to be prepared

% a.i = Given percentage strength of a formulated pesticide

Application of spray liquid

Spraying was carried out using a hand-operated sprayer, with due precautions taken to prevent spray drift. The sprayer was thoroughly flushed between treatments, and the volume of spray solution applied per hectare was adjusted according to the crop growth stage.

Method of recording of observations

a. For efficacy of treatments

The incidence of borer infestation on shoots was assessed by recording the total number of damaged shoots in relation to the total number of shoots. Fruit infestation was evaluated by counting the number of damaged (infested) and healthy fruits on five randomly selected plants. Observations were taken one day prior to spraying and subsequently at 3, 7, and 14 days after treatment. The extent of damage was calculated using the following formula.

$$\text{Percent shoot infestation} = \frac{\text{Number of infested shoots}}{\text{Number of total shoots}} \times 100$$

$$\text{Percent fruit infestation} = \frac{\text{Number of infested fruits}}{\text{Number of total fruits}} \times 100$$

(Nalini and Kumar, 2016) [18]

b. For cost benefit ratio

The economic feasibility of each treatment was assessed using the benefit–cost ratio (BCR). Net returns were estimated by deducting the total plant protection costs from the additional gross income realized relative to the untreated control. The total cost of production included both the standard cultivation expenses and the treatment-specific plant protection costs. The BCR was subsequently calculated as the ratio of the additional net returns to the additional costs incurred.

$$\text{Cost benefit ratio} = \frac{\text{Gross returns}}{\text{Total cost of production}}$$

(Nalini and Kumar, 2016) [18]

Statistical analysis

Data recorded for each treatment were averaged and when required, subjected to appropriate transformations (arcsine or square-root) to satisfy the assumptions of normality and homogeneity of variance. The transformed data were subsequently analysed using analysis of variance (ANOVA) in accordance with the procedures for a Randomized Block Design as described by Gomez and Gomez (1984). Mean values were tabulated to aid interpretation of results. Treatment means were compared using the Critical Difference (CD) at the 5% level of significance ($P \leq 0.05$), and the F-test was employed to assess the significance of treatment effects.

Results and Discussion

Percent shoot infestation: 1st spray

Percent shoot infestation of *Earias vittella* on 3 DAS

The data on percentage shoot infestation by shoot and fruit borer recorded three days after spraying indicated that several treatments were significantly superior to the untreated control. Among the treatments, T4 (Chlorantraniliprole 18.5% SC) recorded the lowest infestation (4.06%), which was statistically at par with T2 (Spinosad; 10.47%). T3 (Emamectin benzoate 5% SG; 12.92%) was statistically comparable with T5 (Abamectin 1.9% EC; 16.23%). These were followed by T1 (Imidacloprid 17.8% SL; 16.44%), which was statistically at par with T6 (Cypermethrin 25% EC; 18.63%). T7 (Neem oil; 19.32%) was the least effective among the treatments; however, it still showed significantly lower infestation compared to the control (23.93%).

Percent shoot infestation of *Earias vittella* on 7 DAS

The data on percentage shoot infestation of shoot and fruit borer recorded on the seventh day after spraying indicated that several treatments were significantly superior to the untreated control. Among the treatments, T4 (Chlorantraniliprole 18.5% SC) recorded the lowest infestation (3.81%), followed by T2 (Spinosad; 11.73%), T3 (Emamectin benzoate 5% SG; 13.27%), T5 (Abamectin 1.9% EC; 16.90%), T1 (Imidacloprid 17.8% SL; 17.76%), T6 (Cypermethrin 25% EC; 19.40%) and T7 (Neem oil; 20.54%), in comparison to the untreated control (23.93%). Statistical analysis further revealed that T2, T3, T5, T1, T6, T7 and the control were statistically at par with one another, whereas T4 (Chlorantraniliprole 18.5% SC) differed significantly from the remaining treatments.

Percent shoot infestation of *Earias vittella* on 14 DAS

The data on percentage infestation of shoot and fruit borer recorded on the fourteenth day after spraying indicated that several treatments were significantly superior to the untreated control. Among all treatments, T4 (Chlorantraniliprole 18.5% SC) recorded the lowest infestation (7.79%), followed by T2 (Spinosad; 12.76%), T3 (Emamectin benzoate 5% SG; 15.39%), T5 (Abamectin 1.9% EC; 17.30%) and T1 (Imidacloprid 17.8% SL; 18.13%). T6 (Cypermethrin 25% EC; 21.02%) was statistically at par with T7 (Neem oil; 21.21%) and was less effective than the preceding treatments; however, both were significantly superior to the control (25.26%). The treatments T5 Abamectin 1.9% EC (17.30), T1 Imidacloprid 17.8% SL (18.13) and T6 Cypermethrin 25%EC (21.02), T7 Neem oil (21.21) were found statistically at par with each other.

Mean percent shoot infestation of *Earias vittella* on 3 DAS, 7 DAS and 14 DAS

The mean percent shoot infestation of shoot and fruit borer recorded at 3, 7, and 14 days after the first spray indicated that several treatments were effective compared to the untreated control. Among the treatments, T4 (Chlorantraniliprole 18.5% SC) resulted in the lowest mean infestation (5.22%), followed by T2 (Spinosad; 11.63%), T3 (Emamectin benzoate 5% SG; 13.86%), T5 (Abamectin 1.9% EC; 16.81%), T1 (Imidacloprid 17.8% SL; 17.44%), and T6 (Cypermethrin 25% EC; 19.68%). T7 (Neem oil; 20.35%) was the least effective among the treatments; however, it still exhibited significantly lower infestation than the untreated control. The treatments T1 Imidacloprid 17.8% SL (17.44), T6 Cypermethrin 25%EC (19.68) and T7 Neem oil (20.35), T0 Control (24.37) were found statistically at par with each other.

Table 2: Field efficacy of different chemicals to control shoot and fruit borer (*Earias vitella*) in okra (1st spray): Percent shoot infestation

Treatment		Percent shoot infestation				
		DBS	**3 DAS**	**7 DAS**	**14 DAS**	**Mean**
T_1	Imidacloprid 17.8% SL	17.75	16.44	17.76	18.13	17.44
T_2	Spinosad 45% SC	16.51	10.47	11.73	12.76	11.63
T_3	Emamectin benzoate 5% SG	17.56	12.92	13.27	15.39	13.86
T_4	Chlorantraniliprole 18.5% SC	16.51	4.06	3.81	7.79	5.22
T_5	Abamectin 1.9% EC	19.48	16.23	16.9	17.3	16.81
T_6	Cypermethrin 25%EC	20.24	18.63	19.4	21.02	19.68
T_7	Neem oil 1500% PPM	20.58	19.32	20.54	21.21	20.35
T_0	Control	23.9	23.93	23.93	25.26	24.37
	F-test	NS	S	S	S	S
	C.D.at 0.5%	7.41	2.04	1.93	1.77	1.12
	S.Ed. (±)	3.45	0.95	0.9	0.84	1.52

DBS: Day before spraying; DAS: Days after spraying

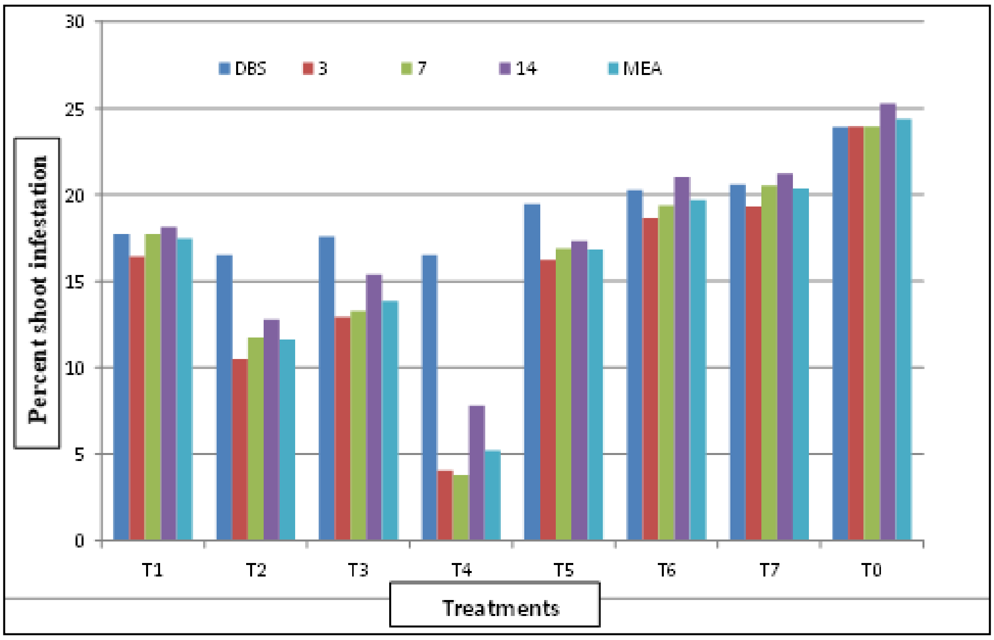

Fig.1: Graphical representation of field efficacy of different chemicals to control shoot and fruit borer (*Earias vitella*) in okra (1st spray): Percent shoot infestation

Percent fruit infestation: 2nd spray

Percent fruit infestation of *Earias vittella* on 3 DAS

The percent fruit infestation of shoot and fruit borer recorded on the third day after the second spray indicated that several treatments were significantly more effective than the untreated control. Among the treatments, T4 (Chlorantraniliprole 18.5% SC) recorded the lowest infestation (5.39%), followed by T2 (Spinosad; 11.47%), T3 (Emamectin benzoate 5% SG; 13.48%), T5 (Abamectin; 14.33%), T1 (Imidacloprid 17.8% SL; 14.95%), T6 (Cypermethrin 25% EC; 16.47%) and T7 (Neem oil; 17.97%). T7 (Neem oil) was the least effective among the treatments but still significantly reduced infestation compared to the control (24.45%). The treatments T2 Spinosad (11.47), T3 Emamectin benzoate 5% SG (13.48), T5 Abamectin (14.33) and T5 Abamectin (14.33), T1 Imidacloprid 17.8% SL (14.95), T6 Cypermethrin 25%EC (16.47), T7 Neem oil (17.97) and T3 Emamectin benzoate 5% SG (13.48), T5 Abamectin (14.33), T6 Cypermethrin 25%EC (16.47) were found statistically at par with each other.

Percent fruit infestation of *Earias vittella* on 7 DAS

The percent fruit infestation of shoot and fruit borer recorded on the seventh day after the second spray indicated that several treatments were significantly more effective than the untreated control. Among the treatments, T4 (Chlorantraniliprole 18.5% SC) recorded the lowest infestation (4.45%), followed by T2 (Spinosad; 12.50%), T3 (Emamectin benzoate 5% SG; 14.10%), T5 (Abamectin; 15.55%), T1 (Imidacloprid 17.8% SL; 15.89%), T6 (Cypermethrin 25% EC; 17.47%) and T7 (Neem oil; 18.87%). T7 (Neem oil) was the least effective among the treatments but still significantly reduced infestation compared to the control (24.01%). The treatments T2 Spinosad (12.50), T3 Emamectin benzoate 5% SG (14.10) and T5 Abamectin (15.55), T1 Imidacloprid 17.8% SL (15.89), T6 Cypermethrin 25%EC (17.47) and T7 Neem oil (18.87), T0 Control (24.01) were found statistically at par with each other.

Percent fruit infestation of *Earias vittella* on 14 DAS

The percentage infestation of shoot and fruit borer recorded on the fourteenth day after the second spray showed that several treatments were significantly more effective than the untreated control. Among all treatments, T4 (Chlorantraniliprole 18.5% SC) recorded the lowest infestation (7.76%), followed by T2 (Spinosad; 13.04%), T3 (Emamectin benzoate 5% SG; 14.83%), T5 (Abamectin; 16.67%), T1 (Imidacloprid 17.8% SL; 17.34%), T6 (Cypermethrin 25% EC; 18.42%) and T7 (Neem oil; 19.43%). Although T7 (Neem oil) was the least effective among the treatments, it still resulted in significantly lower infestation than the control (24.60%). The treatments T5 Abamectin (16.67), T1 Imidacloprid 17.8% SL (17.34), T6 Cypermethrin 25%EC (18.42) and T6 Cypermethrin 25%EC (18.42) and T7 Neem oil (19.43) were found statistically at par with each other.

Mean percent fruit infestation of *Earias vittella* on 3 DAS, 7 DAS and 14 DAS

The mean percentage infestation of shoot and fruit borer recorded at 3, 7, and 14 days after the second spray indicated that several treatments were effective compared to the untreated control. Among the treatments, T4 (Chlorantraniliprole 18.5% SC) exhibited the lowest mean infestation (5.86%), followed by T2 (Spinosad; 12.33%), T3 (Emamectin benzoate 5% SG; 14.13%), T5 (Abamectin; 15.51%), T1 (Imidacloprid 17.8% SL; 16.06%), T6 (Cypermethrin 25% EC; 17.45%) and T7 (Neem oil; 18.75%). While T7 (Neem oil) was the least effective among the treatments, it still demonstrated significantly lower infestation than the control. The treatments T5 Abamectin (15.51) and T1 Imidacloprid 17.8% SL (16.06) were found statistically at par with each other.

Table 3: Field efficacy of different chemicals to control shoot and fruit borer (*Earias vitella*) in okra (2nd spray): Percent fruit infestation

Treatment		DBS	Percent fruit infestation			
			3 DAS	7 DAS	14 DAS	Mean
T_1	Imidacloprid 17.8% SL	19.07	14.95	15.89	17.34	16.06
T_2	Spinosad 45% SC	17.22	11.47	12.5	13.04	12.33
T_3	Emamectin benzoate 5% SG	16.51	13.48	14.1	14.83	14.13
T_4	Chlorantraniliprole 18.5% SC	15.52	5.39	4.45	7.76	5.86
T_5	Abamectin 1.9% EC	17.26	14.33	15.55	16.67	15.51
T_6	Cypermethrin 25%EC	19.48	16.47	17.47	18.42	17.45
T_7	Neem oil 1500% PPM	20.24	17.79	18.87	19.43	18.75
T_0	Control	23.86	24.45	24.01	24.6	24.35
	F-test	NS	S	S	S	S
	C.D.at 0.5%	5.32	3.26	2.24	1.8	1.02
	S.Ed. (±)	2.48	1.52	1.05	0.87	1.22

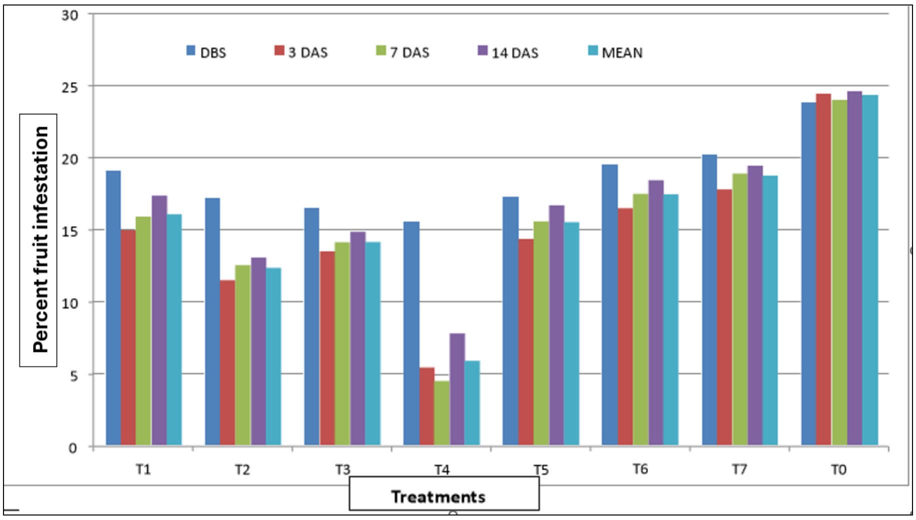

Fig. 2: Graphical representation of field efficacy of different chemicals to control shoot and fruit borer (*Earias vitella*) in okra (2nd spray): Percent fruit infestation

Among the treatments evaluated, Chlorantraniliprole 18.5% SC was the most effective in controlling the shoot and fruit borer population on okra and can be recommended for its management, with infestation levels of 5.22% and 5.86% recorded after the first and second sprays, respectively. These results are consistent with the findings of Shrivastava *et al.* (2007), who also reported Chlorantraniliprole 18.5% SC as the most effective treatment. The next most effective treatment was Spinosad 45% SC, which recorded infestation levels of 11.63% and 12.33% after the first and second sprays, respectively, supporting observations by Pachole *et al.* (2007), Rajput and Tayde (2017) [22], and Sarkar *et al.* (2015) [27]. Emamectin benzoate was also effective, with infestation levels of 13.86% and 14.13% for the first and second sprays, respectively, in agreement with the studies of Bangar and Patel (2012) [2], Gadhiya *et al.* (2014) [8], and Dash *et al.* (2020) [5]. Abamectin was the next most effective treatment, with values of 16.81% and 15.55% for the first and second sprays, corroborating the findings of Gosalwad and Kawathekar (2009) [10]. This was followed by Imidacloprid 17.8% SL, which recorded efficacy of 17.44% and 16.6%, consistent with Gautam *et al.* (2013) and Pankaj *et al.* (2016) [21]. Finally, Cypermethrin 25% EC and Neem oil were comparatively less effective, but still significantly reduced infestation compared to the control, in line with the reports of Singh *et al.* (2015) [30] and Kumar and Thakur (2017) [14, 15].

Fruit yield and cost benefit ratio

The yield (table 4) differences among the treatments were found to be significant. The highest yield was obtained with T4 (Chlorantraniliprole 18.5% SC; 195.5 q/ha), followed by T2 (Spinosad; 149.2 q/ha), T3 (Emamectin benzoate 5% SG; 140.2 q/ha), T5 (Abamectin; 136.3 q/ha), T1 (Imidacloprid 17.8% SL; 133.2 q/ha), T6 (Cypermethrin 25% EC; 96.3 q/ha) and T7 (Neem oil; 92.4 q/ha), compared to the untreated control (T0; 72.2 q/ha). Analysis of the benefit–cost ratio (BCR) revealed that T4 (Chlorantraniliprole 18.5% SC) was the most economical treatment (1:9.3), followed by T2 (Spinosad; 1:8.4), T3 (Emamectin benzoate 5% SG; 1:8.11), T5 (Abamectin; 1:7.8), T1 (Imidacloprid 17.8% SL; 1:7.6), T6 (Cypermethrin 25% EC; 1:5.5) and T7 (Neem oil; 1:5.2), whereas the control (T0) recorded the lowest BCR (1:4.2). Among the treatments evaluated (table 4), highest cost–benefit ratio (1:9.3) was achieved with Chlorantraniliprole, consistent with the findings of Shirale *et al.* (2012) [28] and Mainali *et al.* (2014) [16], who reported that this treatment resulted in the highest yield. Spinosad recorded a BCR of 1:8.4, supporting observations by Kumar *et al.* (2017) [14, 15] and Pachole *et al.* (2017) [19]. The treatment with Emamectin benzoate produced a BCR of 1:8.1, in agreement with Roy *et al.* (2014) [26] and Dash *et al.* (2020) [5]. Abamectin and Imidacloprid yielded BCRs of 1:7.8 and 1:7.6, respectively, consistent with reports by Gosalwad and Kawathekar (2009) [10] and Pachole *et al.* (2017) [19]. Finally, Cypermethrin and Neem oil resulted in BCR of 1:5.5 and 1:5.2, respectively, which aligns with the findings of Kumar and Thakur (2017) [14, 15].

Table 4: Economics of cultivation (Cost-benefit ratio)

Treatment		Yield (q/ ha^{-1})	Selling price (Rs./q)	Gross returns (Rs.)	Total cost of cultivation (Rs.)	Net returns (Rs.)	C:B ratio
T_1	Imidacloprid 17.8% SL	133.2	2500	332500	43280	289220	01:07.6
T_2	Spinosad 45% SC	149.2	2500	372500	43908	328592	01:08.4
T_3	Emamectin benzoate 5% SG	140.2	2500	350000	43128	306872	01:08.1
T_4	Chlorantraniliprole 18.5% SC	195.5	2500	487500	52228	435272	01:09.3
T_5	Abamectin 1.9% EC	136.3	2500	340000	43128	296872	01:07.8
T_6	Cypermethrin 25%EC	96.3	2500	24000	43328	19328	01:05.5
T_7	Neem oil 1500% PPM	92.4	2500	230000	43643	186375	01:05.2
T_0	Control (Untreated)	72.2	2500	180500	42728	137772	01:04.2

Conclusion

The present study concluded that insecticidal sprays significantly reduced shoot and fruit borer, *Earias vitella* infestation in okra. The results indicate that new-generation insecticides, including T1 Imidacloprid 17.8% SL (0.4 ml/l), T2 Spinosad (0.3–0.4 ml/l), T3 Emamectin benzoate 5% SG (0.4 g/l), T4 Chlorantraniliprole 18.5% SC (1.5 ml/l), T5 Abamectin (1 ml/l), T6 Cypermethrin 25% EC (1 ml/l) and T7 Neem oil 0.03% EC (2 ml/l) were effective against the shoot and fruit borer *Earias vittella*, compared to the untreated control (T0). Furthermore, the highest cost–benefit ratio were observed with T4 (Chlorantraniliprole 18.5% SC) and T2 (Spinosad 45% SC), highlighting their economic viability. Based on these findings, it is recommended that these effective insecticides be rotated within existing Integrated Pest Management (IPM) programs to minimize the risks of insecticide resistance, pest resurgence, and other related challenges.

References

1. Anonymous. Ministry of Agriculture, Government of India. National Horticulture Board, 2012.
2. Bangar N, Patel JJ. Evaluation of various synthetic insecticides against *Earias vitella* Fabricius infesting okra. AGRES- An International e-Journal,2012:1(3):367-375.
3. Bansode AG, Patil CS, Jadhav SS. Efficacy of insecticides against shoot and fruit borer, *Earias vittella* F. infesting okra. Pest Management in Horticultural Ecosystems,2015:21(1):106-109.
4. Choudhury MdAR, Mondal MdF, Khan AU, Hossain MdS, Azad MdOKA, Prodhan MDH, *et al*. Evaluation of Biological Approaches for Controlling Shoot and Fruit Borer (*Earias vittella* F.) of okra grown in Peri-Urban area in Bangladesh. Horticulturae,2021:7.
5. Dash L, Ramalakshmi V, Padhy D. Bio-efficacy of emamectin benzoate 5% SG against shoot and fruit borer *Earias vitella* (Fabricius) on okra. The Pharma Innovation Journal,2020:9(12):144-146.
6. Devi LL, Tushar MG, Senapati AK, Chatterjee ML. Comparative efficacy of Some Bio-rational Insecticides for Management of Shoot and Fruit Borer (*Earias Vittella* Fab.) on Okra. Indian Journal of Applied Research,2014:4:7-10.
7. Dhar T, Bhattacharya S. Efficacy of imidacloprid and Spinosad against pest complex of okra and tomato. International Journal of Bio Resource, Management and Agricultural sciences (IJBEAS),2015:1(3):126-131.
8. Gadhiya HB, Borad PK, Bhut JB. Effectiveness of synthetic insecticides against *Helicoverp armigera* (Hubner) Hardwick and *Spodoptera litura* (Fabricius) infesting groundnut. The Bioscan,2014:9(1):23-26.
9. Gautam HK, Singh NN, Rai AB. Effect of some plant extract and an insecticide on the incidence of *Earias vittella* in okra. Indian Journal of Agriculture Research,2015:49(2):175-179.
10. Gosalwad SS, Kawathekar BR. Efficacy of insecticides against okra fruit borer (*Earias vittella* Fabricius). Journal of Plant Protection Research,2009:6(2):59-63.
11. Javed M, Majeed MZ, Sufyan M, Ali S, Afzal M. Field Efficacy of Selected Synthetic and Botanical Insecticides against Lepidopterous Borers, *Earias vittella* and *Helicoverpa armigera* (Lepidoptera: Noctuidae), on Okra (*Abelmoschus esculentus* (L.) Moench). Pakistan Journal of Zoology,2018:50(6):2019-2028.
12. Kumar S, Dagnoko S, Haougui A, Ratnadass A, Pasternak D, Kouame C. Okra (*Abelmoschus* spp.) in West and Central Africa: Potential and progress on its improvement. African Journal of Agricultural Research,2010:5(25):3590-3598.
13. Kalawate A, Dethe MD. Bioefficacy study of bio-rational insecticides on brinjal. Journal of Bio-pesticides,2012:5(1):75.
14. Kumar A, Thakur S. Comparative efficacy of essential oils, neem products and *Beauveria bassiana* against brinjal shoot and fruit borer (*Leucinodes orbonalis*) of Brinjal (*Solanum Melongena* L.). *Earias vitella* (Fabricius) in okra crop. Horticulture Flora Research Spectrum,2017:2(3):251-254.
15. Kumar S, Singh VK, Kumar A, Chandra N. Bioefficacy of Coragen against Shoot and Fruit Borer, *Earias vittella* (Fab.) in Okra. International Journal of Current Microbiology and Applied Sciences,2017:6(10):1021-1027.
16. Mainali RP, Thapa RB, Tiwari S, Pokhrel P. Biology and management of Eggplant fruit and shoot borer, *Leucinodes orbonalis* Guenee. International Journal of Applied Sciences and Biotechnology,2014:2(1):18-28.
17. Naidu G, Kumar A. Field efficacy of certain insecticides against shoot and fruit borer (*Earias vittella* Fab.) on rainy season okra in Prayagraj (U.P.). Journal of Entomology and Zoology Studies,2019:7(6):1211-1213.
18. Nalini C, Kumar A. Population dynamics and comparative efficacy of certain chemicals and biopesticides against okra shoot and fruit borer (*Earias vittella*). Int Q J Life Sci.,2016:11(3):1589-1592.
19. Pachole SH, Thakur S, Simon S. Comparative bio-efficacy of selected chemical insecticides and bio-rationals against shoot and fruit borer [*Earias vittella* (Fabricius)] on okra [*Abelmoschus esculentus* (L.)

Moench]. Journal of Pharmacognosy and Phytochemistry,2017:6(5):1493-1495.
20. Padwal KG, Kumar A. Efficacy of plant products and combinations with cypermethrin in management of *Earias vittella* of Okra. Annuals of Plant Protection sciences,2014:22(1):73-75.
21. Pankaj K, Singh DV, Dabas JPS, Sachan K, Kumar M. Assessment the efficacy and economic of insecticides and bio-pesticides against major insect pests of okra (*Abelmoschus esculentus*). International Journal of Agriculture Sciences,2016:8:2050-2052.
22. Rajput GS, Tayde AR. Population dynamics and comparative efficacy of certain novel insecticides, botanicals and bio-agents against shoot and fruit borer *Earias vittella* (Fabricius) of okra crop [*Abelmoschus esculentus* (L.) (Moench). Journal of Entomology and Zoology Studies,2017:5(4):1667-1670.
23. Rakshith KA, Kumar A. Field efficacy of selected insecticides and neem products against shoot and fruit borer *Earias vittella* (Fabricius.) on okra *Abelmoschus esculentus* L. (Moench). International Journal of Current Microbiology and Applied Science,2017:6(8):122-128.
24. Rawat RR, Sahu HR. Estimation of losses in growth and yield of okra due to *Empoasca devastans* Distant and *Earias* species (India). Indian Journal of Entomology,1973:3(5):252-254.
25. Reddy SKB, Patel HP, Bharpoda TM. Utilization of Plant Extracts for Managing Fruit Borers in Okra, [*Abelmoschus esculentus* (L.) Moench]. International Journal of Current Microbiology and Applied Sciences,2018:7(5):2786-2793.
26. Roy A, Shrivastava SK, Mandal SM. Functional properties of okra *Abelmoschus esculentus* L. (Moench): traditional claims and scientific evidences. Plant Science Toda,2014:1(3):121-130.
27. Sarkar S, Patra S, Samanta A. Evaluation of bio-pesticides against red cotton bug and fruit borer of okra. The Bioscan,2015:10(2):601-604.
28. Shirale D, Patil M, Zehr U, Parimi S. Newer insecticides for the management of brinjal shoot and fruit borer, *Leucinodes orbonalis*. Indian Journal of Plant Protection,2012:40(4):273-275.
29. Shrivastava PK, Kumar A, Dhingra MR. Evaluation of insecticides for the management of shoot and fruit borer *Earis vitttella* (Fabricius.) infesting okra. Journal of Entomology and Zoology Studies,2017:5(5):1052-1056.
30. Singh HP, Vijaya VB, chamroy T. Seasonal incidence and field efficacy of insecticides against shoot and fruit borer, *Earias vitella* (Fabricius.) on okra (*Abelmoschus esculentus* L.). Plant Archives,2015:15(1):389-392.
31. Srivastava KP, Dhaliwal GS. A Text book of Applied Entomology.
32. Umrao RS, Singh S, Kumar J, Singh DR, Singh DK. Efficacy of novel insecticides against shoot and fruit borer *Earias Vitella* (Fabricius) in okra crop. Horticulture Flora Research Spectrum,2013:2(3):251-254.
33. USDA National Nutrient data base, 2019.
34. Wajid H, Chhibber RC, Singh CP. Effect of indoxacarb against tomato fruit borer (*Helicoverpa armigera* Hubner.) and phytotoxicity to tomato plants. Advances in Plants and Agriculture Research,2016:3(2):51-54.
35. Yadav R, Kumar S, Sanp RK. Efficacy of certain botanical insecticides against shoot and fruit borer, *Leucinodes orbonalis* (Guenee) on brinjal (*solanum melongena* L.). The Bioscan,2015:10(3):987-990.
36. Yadav S, Ramkewal GP, Singh RS, Vikrant. Effect of certain eco-friendly insecticides on *Earias vitella* (major insectcidies) of okra crop in central region of Uttar Pradesh, India. Plant Archives,2017:17(1):135-140.