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Efficacy of certain chemicals and essential oils against okra shoot and fruit borer [*Earias vittella* (Fabricius)]

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Abstract
The experiment was conducted at the research plot of the Department of Agricultural Entomology at Central Research Field, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj during the *Kharif* season of 2021, **"**Efficacy of certain chemicals and essential oil against okra shoot and fruit borer *(Earias vittella*) Fabricius'' Seven treatments were evaluated against *Earias vittella.* The seven treatments are (T_1) Lambda cyhalothrin 5% EC, (T_2) Imidacloprid 17.8% SL, (T_3) Karanjin oil 2% EC, (T_4) Cypermethin 25% EC, (T_5) Neem oil 3%, (T_6) Emamectin benzoate 5% SG and (T_7) Spinosad 45% SC, (T_0) control were tested to the efficacy against *Earias vittella* and their influences on the yield of okra. Each insecticide was sprayed twice at 15 days interval. The shoot and fruit infestation per plant was taken day before and 3,7, and 14 days after each spray. All the insecticides tested significally reduced the pest infestation compared to control. The lowest percentage infestation of shoot and fruit borer against control was observed in cypermethin 25% EC (11.48). The mean crop yield ranged between 97.52 q/ha to 188.63 q/ha, the highest being cypermethin 25% EC (188.63 q/ha) followed by Emamectin benzoate 5% SG (175.45 q/ha). When cost benefit ratio worked out, interesting result was achieved, among the treatment studied, the best and most economical treatment T_4 Cypermethrin (1:1.49) followed by T_6 Emamectin benzoate (1:4.57).

Keywords: Chemicals, cost benefit ratio, cypermethrin, *Earias vittella*, fruit borer, insecticides, shoot borer

Introduction

Okra [*Abelmoschus esculentus* (L) Moench] is commonly known as Bhindi. It belongs to the Malvaceae family. In India, okra is grown to an extent of 0.529 m ha with 61.51 lakh metric tonne production and12.1 tonnes/ha productivity (Anon., 2017) [1]. It contributes 5.8 percent of the entire vegetable area and nearly 4 percent of the total countries vegetable production. Globally India ranks first in okra production having an area of 509 thousand hectares with an annual production of 6094.9 thousand tons and productivity of 12 million tonnes/ha. The crop is grown throughout India, Gujarat is the leading okra producing state which has production of around 921.72 thousand tons from an area of 75.27 thousand ha, with productivity of 12.25 tonnes/ha. It is followed by West Bengal (914.86 thousand tonnes from 77.5 thousand ha with 11.5 tonnes/ha productivity. Uttar Pradesh has an area of (22.93 ha), production (307.29 tonnes), and productivity (13.40 metric tonnes/ha) of okra (NHB 2018-19). Okra production is affected by many biotic and abiotic factors, which cause significant yield losses. In biotics the insect pest especially the okra fruit borer (*Earias vittella*) is a major threat that reduces almost 50–70% yield. In India *Earias insulana* and *Earias vittella* attack shoot and fruits of okra besides *Earias vittella* has been identified as the key pest in other countries (Gapud. 1993) [7]. Okra shoot and fruit borer, *Earias vittella* (Fab.) are one of the serious pests of okra, cotton, safflower, hollyhock, Indian mellow, *Hibiscus* sp., *Corchorus* sp., and *Theobroma* sp. In India, an estimated loss of 69% in marketable yield was due to an attack of this insect on okra alone (Sharma *et al.*, 2010) [27].

Materials and Methods

A field experiment was conducted during the *kharif* season of 2021 at the Crop Research farm, Department of Entomology, Naini Agriculture Institute, Sam Higginbottom university of Agriculture, Technology and sciences (SHUATS), Prayagraj, (U.P). which is located at 25^0 24' 42" N latitude, 81^0 50' 56" E longitude and 98 m altitude above the mean sea level (MSL) on sandy loam soil, having moderately basic pH (7.2), organic carbon (0.35%), available N (108.0 kg/ha), P (22.5 kg/ha), K (280.0 kg/ha), EC (0.14 dSm^{-1}), S (16.8.00 ppm), and Zn(0.51 ppm).

The experiment was laid down in randomized block design (RBD) with 3 replications and 8 treatments using variety KASTURI in a plot size of (2m × 2m) at a spacing of (60 × 45cm). The infestation and population of shoot and fruit borer were recorded from five randomly selected plants from every plot. Two insecticidal sprays were applied at 15 days' interval starting from 45 days after sowing. The chemicals and essential oil treatments include Lambda cyhalothrin 5% EC @ 0.6ml/lt, Imidacloprid 17.8 SL @ 0.4ml/lt, Karanjin oil 2% EC @ 2ml/lt, Cypermethrin 25% EC @ 2ml/lt, Neem oil @ 3%, Emamectin benzoate 5% SG @0.3ml/lt and Spinosad 45% SC, along with untreated control. The spraying was done after the population level reaching ltd ETL. The observations a was recorded one day before spray, 3rd, 7th, and 14th days after spraying. The assessment of the shoot damage was done by calculating the number of damaged shoots and total number of healthy shoots observed from five randomly selected plants per plot and expressed in percentage. The percent of fruit damage was assessed at each picking by counting the total number of affected fruits from each plot. The damage was calculated by using the formulae;

Percent shoot infestation

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

Percent fruit infestation

$$\text{Per cent fruit damage} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

(Nalini and Kumar 2016) [16]

Cost Benefit Ratio
Gross return = Marketable Yield x Market price
Net return = Gross return – Total cost

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

(Nalini and Kumar 2016) [16]

Results and Discussion
The results of the experiment entitled "Efficacy of certain chemicals and essential oil against shoot and fruit borer, *[Earias vittella (*Fabricius)] on okra [*Abelmoschus esculentus* (L.) Moench]" to study cost benefit ratio during the *kharif* season of 2021. The data so obtained through observation on various aspects were subjected to statistical analysis wherever necessary and the complied mean data are tabulated in the following pages. Results obtained are presented aspect wise hereunder. It is evident from the overall shoot infestation (first spray) 3, 7, & DAS mean (Table 1) (Fig 1) that Cypermethrin 25% EC was found most effective insecticide treatment against shoot and fruit borer (*Earias vittella),* as it was recorded as lowest shoot damage (10.71). The second best treatment was Spinosad 45% SC (12.11) followed by Emamectin benzoate 5% SG (12.23), Imidacloprid 17.8 SL (12.91), Lambda cyhalothrin 5% EC (13.83), Karanjin oil 2% EC (14.26). Neem oil 3% was observed least effective treatment as compared to all treatments and is Significally superior over the control (22.57).

The data on the mean of fruit infestation of second spray (3rd, 7th &14th) mean (Table 2) (Fig 2) percent infestation of second spray revealed that few treatments are effective against control. Among the treatments lowest percent infestation of fruit borer was recorded in T_4 Cypermethrin 25% EC (12.24) followed by T_7 Spinosad 45% SC (13.15), T_6 Emamectin benzoate 5% SC (13.66), T_2 Imidacloprid 17.8 SL (14.54), T_1 Lambda cyhalothrin 5% EC (15.44), T_5 Neem oil 3% (15.38). In this T_3 Karanjin oil 2% EC (17.42), is found to be least effective than all the treatments and is significantly superior over the control T_0 (30.36).
The yields among the treatment were significant. The highest yield in (Table3) (Fig 3) was recorded in T_4 Cypermethrin (188.63 q/ha) followed by T_6 Emamectin benzoate (175.45 q/ha), T_7 Spinosad 14.5 SC (163.25 q/ha), T_2 Imidacloprid (153.25 q/ha), T_1 Lambda-cyhalothrin (136.75 q/ha), T_5 Neem oil 2% (120.63 q/ha), and T_3 Karanjin oil (115.68 q/ha). The treatments T_3 Karanjin oil (115.68 q/ha) was least effective among all the treatments. Control plot T_0 (97.52 q/ha) yield. When cost benefit ratio worked out in (Table 4) interesting result was achieved, among the treatment studied, the best and most economical treatment T_4 Cypermethrin (1:4.71) followed by T_6 Emamectin benzoate (1:4.38), T_7 Spinosad (1:3.90), T_2 Imidacloprid (1:3.84), T_1 Lambda cyhalothrin (1:3.42), T_5 Neem oil (1:3.01), T_3 Karanjin oil (1:2.89) and T_0 Control (1:2.51).
Among all the treatments Cypermethrin 25%EC was found and it is most effective in managing the shoot and fruit borer infestation on okra. The values obtained in the first and second spray are 10.71% and 12.23%. These results are supported by Singh. *et al.*, (2015) [28], Uddin *et al.*, (2016) [30] and Deen *et al.*, (2009) [5]. Spinosad 45% SC was found to be very effective in reducing the infestation of shoot and fruit borer. Same trend was observed by Rajput and Tayde (2017) [23] and Sarkar *et al.*, (2015) [26], who reported that application of spinosad reduced the borer infestation and recorded the lowest percentage of shoot and fruit damage of first and second spray are 12.11% and 13.15% infestation over control. Similarly finding by Bajad. *et al.*, (2014*)* [2], Panbude., *et al.*, (2019) [19]. The efficacy of Emamectin benzoate 5% SG in first and second spray are 12.24% and 13.67% respectively. These results are similar to the findings of Bangar and Patel (2012) [3], Gadhiya *et al.*, (2014) [6] and Dash *et al.*, (2020) [4]. Next best treatment which is Imidacloprid 17.8 SL in which the efficacy values of first and second spray are 12.91% and 14.55% respectively which was similar to Gautam *et al.*, (2013) [8] and Pankaj *et al.*, (2016) [20], and the treatment which is lambda cyhalothrin 5% EC in which the efficacy values of first and second spray are 12.91% and 14.55% respectively these results are supported by Javeed *et al.*, (2018) [11]. This is followed by the next treatments karanjin oil 2% EC and neem oil 3% in which efficacy values of first and second spray are (14.26), (17.42) and (14.44), (17.42) respectively these results are supported by Chetan *et al.*, (2019), Lakhamapura *et al.*, (2018) [14], and Padwal and Kumar (2013) [18].
Maximum cost benefit ratio (1:4.71) was obtained in cypermethrin which was supported by Panse, R. and Shukla, A. (2012) [21], Singh *et al.*, (2006) [29], Pardeshi *et al.*, (2011) [22] who reported that the cypermethrin recorded the high yield. Emamectin benzoate which also reported a profitable yield of 175.45 q/ha and cost benefit ratio (1:4.57) these findings are supported by (Jat and Ameta 2013) [10], (Sarkar *et*

al., 2015) [26] and Roy *et al.*, (2014) [24] and Dash *et al.*, (2020) [4]. The cost benefit ratio of Spinosad (1:3.9) these results were to the findings reported by Kumar *et al.*, (2017) [12] and Pachole *et al.*, (2017) [17], and the next cost benefit ratio obtained in the treatment Imidacloprid (1:4.02) was supported by Gosalwad and Kawathekar (2009) [9] and Pachole *et al.*, (2017) [17]. The results of the cost benefit ratio obtained in the treatment Lambdacyhalothrin 5% EC was (1;3.42) similar to Mitali *et al.*, (2008) [15]. The cost benefit ratio of Neem oil (1:3.01) and Karanjin oil (1:2.89) which were supported by Kumar and Thakur (2017) [13] and Sahak and Lyall (2013) [25].

Table 1: Efficacy of certain chemicals and essential oil on percent infestation of shoot and fruit borer, *[Earias vittella (*Fabricius)] on okra (first spray) shoot infestation

Treatments		Percent infestation in number				
		DBS	**3rd DAS**	**7th DAS**	**14TH DAS**	**Mean**
T0	Control	18.28	19.35	21.5	26.88	22.57
T1	Lambda cyhalothrin5% EC	16.09	13.43	12.07	16	13.83
T2	Imidacloprid 17.8 SL	16.13	12.64	11.11	14.99	12.91
T3	Karanjin oil 2%EC	15.56	13.88	12.78	16.12	14.26
T4	Cypermethrin 25% EC	15.48	10.71	8.33	13.09	10.71
T5	Neem oil 3%	14.44	13.88	12.22	17.24	14.44
T6	Emamectin benzoate5% SG	16.67	12.63	10.75	13.33	12.24
T_7	Spinosad 45% SC	17.24	11.64	10.33	14.36	12.11
Over all mean		16.24	13.53	12.39	16.50	14.13
F – test		NS	S	S	S	S
C.D.at 0.5%		-----	2.65	.89	3.12	1.85
S.Ed. A (+)		1.42	1.23	1.35	1.45	0.86

Table 2: Efficacy of certain chemicals and essential oil on Percent Fruit Infestation shoot and fruit borer, [*Earias vittella* (Fabricius)] on okra (Second spray) (Fruit infestation)

Treatments		Percent infestation in number				
		DBS	**3rd DAS**	**7th DAS**	**14th DAS**	**Mean**
T0	Control	25.18	27.40	29.63	34.07	30.37
T1	Lambda cyhalothrin5% EC	25.20	18.69	11.38	16.25	15.44
T2	Imidacloprid 17.8 SL	21.37	17.66	10.60	15.38	14.55
T3	Karanjin oil 2%EC	23.57	20.32	14.52	17.42	17.42
T4	Cypermethrin 25% EC	22.22	15.38	7.69	13.67	12.23
T5	Neem oil	25.20	18.69	12.19	17.07	15.98
T6	Emamectin benzoate5% SG	21.37	16.23	10.14	14.63	13.67
T_7	Spinosad 45% SC	22.22	15.94	9.75	13.76	13.15
Over all mean		23.29	18.79	13.24	17.78	16.60
F – test		NS	S	S	S	S
C.D.at 0.5%		-----	2.52	2.61	3.12	3.27
S.Ed. A (+)		1.53	1.17	1.22	1.46	1.52

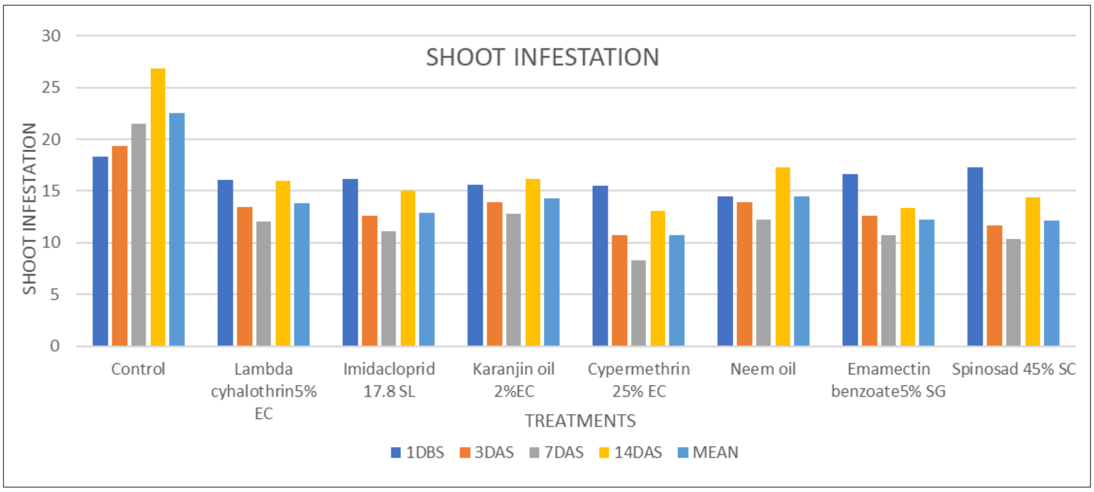

Fig 1: Efficacy of certain chemicals and essential oil on Percent infestation of okra shoot and fruit borer[*Earias vittella* (Fabricius)] (First Spray)

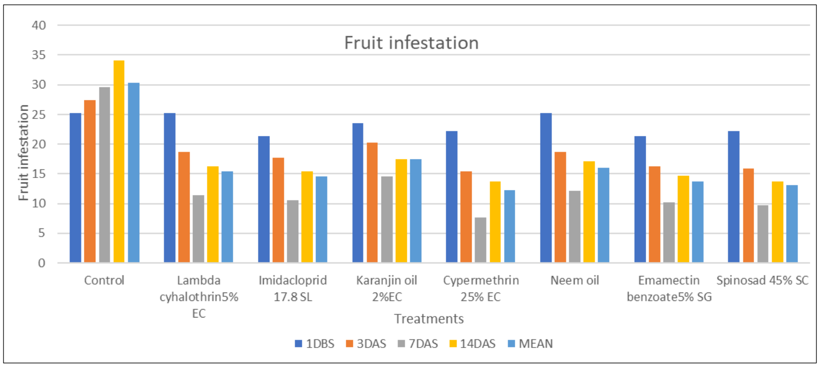

Fig 2: Efficacy of certain chemicals and essential oil on Percent infestation of okra shoot and fruit borer [*Earias vittella* (Fabricius)] (Second Spray)

Table 3: Efficacy of certain chemicals and essential oil on yield of Okra

S. No	Treatments	Yield (q/ha)
T_0	Control	97.52
T_1	Lambda cyhalothrin 5% EC	136.75
T_2	Imidacloprid 17.8 SL	153.25
T_3	Karanjin oil 2% EC	115.68
T_4	Cypermethrin 25% EC	188.63
T_5	Neem oil 3%	120.63
T_6	Emamectin benzoate5% SG	175.45
T_7	Spinosad 45% SC	163.25

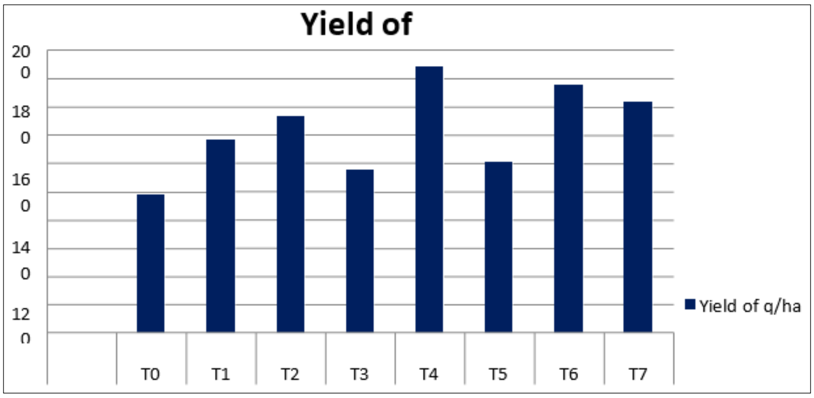

Fig 3: Graphical representation of yield of Okra

Table 4: Benefit Cost Ratio (BCR)

S No.	Treatment	Yield of q/ha	Cost of yield (₹)	Gross return (₹)	Common cost (₹)	Treatment cost (₹)	Total cost (₹)	B:C ratio
T_0	Control	97.52	1800	175536	69689	-	69689	1:2.51
T_1	Lambda- cyhalothrin 5% EC	136.75	1800	246150	69689	2120	71809	1:3.42
T_2	Imidacloprid 17.8% EC	153.25	1800	275850	69689	2072	71761	1:3.84
T_3	Karanjin oil 2% EC	115.68	1800	208224	69689	2200	71889	1:2.89
T_4	Cypermethrin 25% EC	188.63	1800	339534	69689	2320	72009	1:4.71
T_5	Neem oil 3%	120.63	1800	217134	69689	2300	71989	1:3.01
T_6	Emamectin benzoate 5% SG	175.45	1800	315810	69689	2250	71939	1:4.38
T_7	Spinosad 45% SC	163.25	1800	293850	69689	5500	75189	1:3.90

Conclusion

From the present study, the results showed that Cypermethrin 25% EC (T_4), is the most effective treatment against okra fruit and shoot infestation and produces maximum yield, and recorded the highest Cost-Benefit ratio compared to other treatments. While Emamectin benzoate 5% SG (T6), Spinosad 45% SC (T_7), Imidacloprid 17.8 SL, and Lambda-cyhalothrin 5% EC have shown average results. Botanical neem oil 3% and Karanjin oil 2% were found to be the least effective in managing *Earias vittella*. Hence, it is suggested that the effective insecticides may be alternated in harmony with the existing Integrated pest management programs in order to avoid the problems associated with insecticidal resistance, pest resurgence etc., Botanicals are the part of integrated pest management in order to avoid indiscriminate use of pesticides causing pollution in the environment and not much harmful to beneficial insects.

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