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Economics of various insecticides against shoot and fruit borer [(*Earias vittella*) Fab.] of Okra [*Abelmoschus esculentus* (L.) Moench] under field conditions

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Abstract
A field experiment was conducted during *kharif* season of 2017-18 at Central Research Field, Department of Entomology, SHUATS, Allahabad, (U.P) to study the economics of various insecticides against shoot and fruit borer [(*Earias vittella*) fab.] of okra [*Abelmoschus esculentus* (L.) Moench] under field conditions during *kharif* season of 2017 in Allahabad region. Weekly observations on shoot damage were recorded as soon as infestation started, while fruit damage was recorded at each picking till the last picking of the crop. Okra shoot and fruit borer, *E. vittella* (Fab.) were recorded infesting okra shoots and fruits during the study.

Keywords: Insecticides, *Earias vittella,* a.i, infestation

Introduction
Amongst the various vegetable grown Okra *Abelmoschus esculentus* L. (Moench) belongs to family Malvaceae, which is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. It is grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopia and the Southern United States. Globally India ranks first in okra production (72% of the total world production) having area of 533 hectares with an annual production of 6346 million tons and productivity of 11.9 million tons/ha. In Uttar Pradesh area, production and productivity of okra is 12.19 ha, 148.64 tones, 12.2 metric tons per hectare.

Nutritional value per 100 g of okra contains carbohydrates (1.5%), protein (2.0 g), total fat (0.1 g), dietary fiber (9%), folates (88 mcg), niacin (1.00 mg), pantothenic acid (0.245 mg), pyridoxine (0.215 mg), riboflavin (0.060 mg), thiamin (0.200 mg), vitamin C (21.1 mg), vitamin A (375 IU), vitamin E (0.36 mg), vitamin K (53 mcg), sodium (8 mg), potassium (303 mg), calcium (81 mg), copper (0.094 mg), iron (0.80 mg), magnesium (57 mg), phosphorus (63 mg), selenium (0.7 mcg), zinc(0.60 mg), carotene (225 mcg) and lutein and zeaxanthin (516 mcg) (source: USDA National Nutrient data base).

Biology and Lifecycle of *Earias vittella* (Fab)
It is widely distributed throughout India. Also infests cotton and other malvaceous plants. Pest is active throughout the year and prefers high temperature. During the rainy season borer damage is relatively less. The Moth is yellow green and measures about 2.5cm across the wings. It is having a narrow light longitudinal green band in the middle of forewing. The full grown caterpillars are dull-green in colour and are 2cm long having tiny stout bristles and a series of longitudinal black spots on the body.

The female moth lays 200-400 eggs at night singly on flower buds, bracts and tender leaves of Okra plants. Incubation period of eggs are 3-4 days and caterpillar pass through 6 stages, becoming full grown in 10-16 days. They pupate either on plants or on ground among fallen leaves and the moth emerge in 8-14 days in summer and 18-23 days in winter. Lifecycle is completed in 17-29 days. Several overlapping generations are completed in a year.

Materials and Methods
Benefit Cost Ratio
Cost effectiveness of each treatment was assessed based on net returns. Net return of each treatment was worked out by deducting total cost of the treatment from gross returns. Total cost of production included both cultivation as well as plant protection charges.

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

$$\text{Benefit: Cost Ratio} = \frac{\text{Net returns}}{\text{Total cost}} \times 100$$

Preparation of insecticidal spray solution

The desired concentration of insecticidal spray solution of desired concentration for each treatment was freshly prepared each time at the site of experiment, just before spraying. The quantity of spray materials required for crop was gradually increased as the crop advanced in age.

The spray solution of desired concentration was prepared by adoption the following formula:

$$V = \frac{C \times A}{\%\ a.i.}$$

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.

*Spraying was done with the help of a hand compression sprayer. Spraying was done preferably in the early morning hours when there is no wind.

Results and Discussion

Cost of cultivation of Okra

The input materials cost for cultivation Kashi Pragathi variety of okra was worked out in Rs./ha which is presented in table 3.1. It reveals that overall, input materials cost was accounted (Rs./ha 49,238). The cost of fertilizers and manures was noticed to be highest (Rs./ha 22,998) which includes Farm Yard Manure followed by the land preparation cost (Rs./ha 3000) followed by the seed material (Rs./ha 1,040).

Labour use cost for cultivation of okra

It is essential to account the total cost on labour use per hectare for cultivation of okra the total labour cost is Rs./ha 22,200. Therefore, labour use cost was worked out in Rs./ha and presented in table 1. The total labour cost was maximum on weed management (Rs./ha 9000) and harvesting (Rs./ha 9000) followed by sowing and levelling (Rs./ha 1800) followed by land preparation (Rs./ha 1500) followed by the labour used for application of manures and fertilizers (Rs./ha 900).

Table 1: Cost of agronomical practices of cultivation/ha.

S. No	Particular	Requirement	Rate/unit Rs.	Cost
(A)	**Land preparation**			
I.	Ploughing	3 hours	500 Rs/hours	1500
II.	Harrowing	3 hours	500 Rs/hours	1500
III.	Layout of field	10 labours	150 Rs/labour	1500
(B)	**Manures and fertilizer**			
I.	FYM	20 tons	100 Rs/q	20000
II.	Urea	109 Kg	10 Rs/Kg	1090
III.	SSP	156 Kg	9 Rs/Kg	1404
IV.	MOP	42 Kg	12 Rs/Kg	504
V.	Labour	6 labours	150	900
(C)	**Seed sowing**			
I.	Seed material	8 kg	130 Rs/Kg	1040
II.	Sowing and levelling	12 labours	150	1800
(E)	**Weed Management**	20labour X 3 time	150 Rs/labour	9000
(F)	**Harvesting**	30labours	300 Rs/labour	9000
(G)	**Total cost of cultivation**			49238

Economics of treatments of okra

The economics of treatments is laid out in a table 2 and the cost for various treatments along with the labour cost is calculated and the total cost of chemical insecticides Rs./ha 2019 and the labour cost for the application of these insecticides is Rs./ha 6300. The highest cost among the insecticides is (T1) Chlorpyriphos Rs./ha 468 followed by (T2) Neem oil Rs./ha 420 followed by (T4) Spinosad Rs./ha 320 followed by (T5) Deltamethrin Rs./ha 315 followed by (T6) Emmamectin Benzoate Rs./ha 285 followed by (T7) Lambda cyhalothrin Rs./ha 111 followed by (T3) Cypermethrin Rs./ha 100.

Table 2: Economics of treatments

S. No	Treatment	Use of Chemical 2 time spray	Cost of Chemical	Total Cost of Chemical (Rs)	Use of 3 labours 2 time spray	Total labour cost (Rs)	Total cost of Treatment (Rs)
01	Chlorpyriphos- 20%EC	1200ml/ha	Rs 38 /100ml	468	150 Rs/labour	900	1368
02	Azadirachtin – 0.03%	1500ml/ha	Rs28/100ml	420	150 Rs/labour	900	1320
03	Cypermethrin – 10%EC	200ml/ha	Rs50/100ml	100	150 Rs/labour	900	1000
04	Spinosad 45 SC	200ml/ha	Rs 160/100ml	320	300 Rs/labour	900	1220
05	Deltamethrin 2.8 EC	700ml/ha	Rs 45/100ml	315	150 Rs/labour	900	1215
06	Emamectin Benzoate – 5% SG	150gm/ha	Rs190/100gm	285	150 Rs/labour	900	1185
07	Lambda cyhalothrin -5% EC	300ml/ha	Rs 37 /100ml	111	150 Rs/labour	900	1011
08	Control	-	-	-	-	-	-

Economics of cultivation

The economics of cultivation of okra is calculated and is given in table 3

The yields among the treatment were significant. The highest yield was recorded in T4 Spinosad (101.75 q/ha), followed by T1 Chlorpyriphos (96.90 q/ha), T5 Deltamethrin (88.25 q/ha), T3 Cypermethrin (71.57 q/ha), T7 Lambda cyhalothrin (68.00 q/ha), T6 Emmamectin Benzoate (61.50 q/ha), T2 Neem oil (55.70 q/ha) as compared to T0 Control (32.50 q/h). When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was T4 Spinosad (1:4.03), followed by T1 Chlorpyriphos (1:3.82), T5 Deltamethrin (1:3.49), T3 Cypermethrin (1:2.84), T7 Lambda cyhalothrin (1:2.70), T5 Emmamectin Benzoate (1:2.43), T2 Neem oil (1:2.20) as compared to control T0 Control (1:1.32).

Similar findings were reported that the spinosad 45 SC recorded the high yields and maximum cost benefit ratio by Patil *et al*. (1999) and Gosalwad (2006).

Similar findings were reported by observng the B: C ratio which is high in cypermethrin 20EC with (1:5.01), which is followed by spinosad (1:4.85) by Nalini and Kumar (2016) [7].

Table 3: Economics of cultivation

S. No	Treatment	Yield of q/ha	Cost of yield / Rs/q	Total cost of yield	Common cost (Rs)	Treatment cost (Rs)	Total cost (Rs)	C:B ratio
01	Chlorpyriphos- 20%EC	96.90	2000Rs/q	193800	49238	1368	50606	1:3.82
02	Azardirachtin – 0.03%	55.70	2000Rs/q	111400	49238	1320	50558	1:2.20
03	Cypermethrin – 10%EC	71.57	2000Rs/q	143340	49238	1000	50458	1:2.84
04	Spinosad 45 SC	101.75	2000Rs/q	203500	49238	1220	50453	1:4.03
05	Deltamethrin 2.8 EC	88.25	2000Rs/q	176500	49238	1215	50453	1:3.49
06	Emamectin Benzoate – 5% SG	61.50	2000Rs/q	123000	49238	1185	50423	1:2.43
07	Lambda cyhalothrin -5% EC	68.00	2000Rs/q	136000	49238	1011	50249	1:2.70
08	Control	32.50	2000Rs/q	65000	49238	0	49238	1:1.32

Conclusion

From the critical analysis of the present findings it can be concluded that infestation of shoot and fruit borer decreased with spraying of different insecticides like Spinosad and Chloropyriphos, Deltamethrin, Cypermethrin, Emamectin benzoate and Lambda cyhalothrin can suitably be incorporated in integrated pest management schedule against *Earias vittella* as an effective tool under chemical control, Neem oil can also to be incorporated in Integrated pest management in order to avoid indiscriminate use of pesticides causing pollution in the environment and not much harmful to beneficial insects and in increasing cost effectiveness.

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