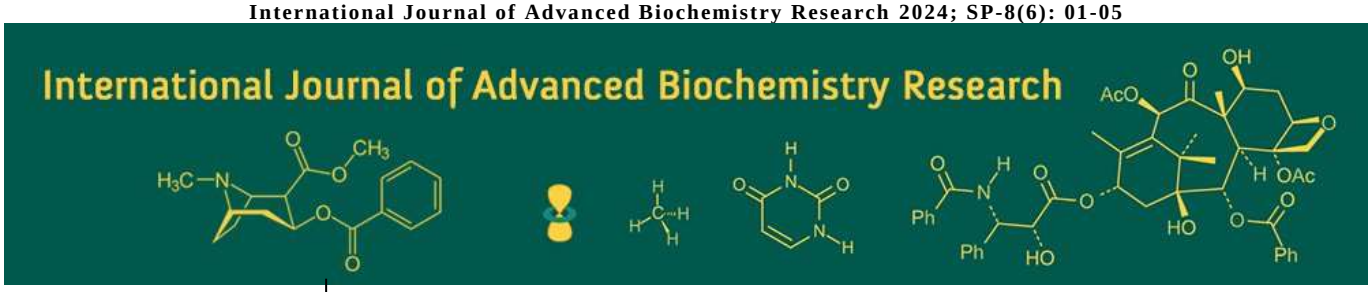

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Comparative efficacy of biopesticides and certain chemicals against shoot and fruit borer (*Earias vittella*) on okra [*Abelmoschus esculentus* (L.)]

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Abstract
A field trail was conducted at the Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj during *Kharif* season 2023. The trail was laid out in Randomized Block Desion with three replications, Eight treatments were evaluated against *Earias vittella viz.*, T_1 NSKE 5% + Spinosad 45% SC @ 5 ml/lit + 0.4 ml/lit, T_2 Azadirachtin 1500 PPM @ 5 ml/lit, T_3 *Metarhizium anisopliae* 1×10^8 (CFU/gm) @ 4 gm/lit, T_4 *Beauveria bassiana* 2×10^9 (CFU/gm) @ 2 ml/ lit, T_5 Emamactin benzoate 5% SG@ 0.3 ml/lit, T_6 Chlorantraniliprole 18.5% SC @ 0.5 ml/lit, T_7 Imidacloprid 17.80SL @ 0.3 ml/lit, T_8 Untreated control. Result revealed that, among the all treatments (T_6) Chlorantraniliprole 18.5% SC (12.52), proved to be the most effective treatment and least effective (T_4) *Beauveria bassiana* 2×10^9 (CFU/gm) (18.85). Among all the treatments, the cost benefit ratio has been analyzed, in which the highest was Chlorantraniliprole 18.5% SC (1:5.7) and marketable yield (155 q/ha) followed by Emamectin benzoate 5% SC (1:5.5 and 143 q/ha), NSKE 5% + Spinosad 45% SC (1:3.6 and 128 q/ha), Imidacloprid 17.80% SL (1:4.5 and 118 q/ha), *Metarhizium anisopliae* 1×10^8 (CFU/gm) (1:3.9 and 103 q/ha), Azadiractin 1500 PPM (1:3 and 80 q/ha) and *Beauveria bassiana* 2×10^9 (CFU/gm) (1:2.7 and 72 q/ha) as compared to Untreated control (1:1.4).

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

Introduction
Okra [*Abelmoschus esculentus* (L.) Moench] is an annual vegetable belonging to *Malvaceae* family; it is also known by different names *viz*., ladies' finger, bhindi, bamia, okro or gumbo in different parts of the world. Okra is known as "Queen of vegetables". Okra is valued for its tender green fruits. 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, biofuel and as a medicine in different parts of the world. (Chincholkar *et al.*, 2023) [4]

It is a short duration crop propagated through seeds, cherished for its tender and scrumptious green fruits used in curries, soups or in canned, dehydrated, or frozen forms for off-season consumption Okra is more remunerative than the leafy vegetables. The roots and stems are useful for clearing cane juice from which gur or jaggery is prepared.

Okra has good nutritional value particularly the high content of vitamin C (13 mg/100 g), fat (0.2 g/100 g), carbohydrate (6.4 g/100 g), iron (1.5 mg/100 g), moisture (89.6 g/100 g), protein (1.9 g/100 g), fibre (1.2 g/100 g), calories 35 (kcal/100 g) and other minerals. (Chandravanshi *et al.*, 2018) [5]

It is grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopia, Cyprus and the Southern United States. (Rawat *et al.*, 2020) [22]

The major okra growing states in India includes Andhra Pradesh (20%), West Bengal (15%), Bihar (14%), Orissa (11%), Gujarat (10%), Jharkhand (7%), Maharashtra (4%), Assam (3%) and Haryana (3%) (Chincholkar *et al.*, 2023) [4]

Among this okra shoot and fruit borer (OSFB), *Earias vittella* is the most serious pest, which cause direct damage to tender shoots and fruits. It is reported that about 69% losses in marketable yield due to attack of this insect pest. The damage due to fruit borer accounts for nearly 22.5% in Uttar Pradesh, 25.93% to 40.91%in Madhya Pradesh 45% in Karnataka which affects the nutritional quality and makes it unsuitable for human consumption.

Objectives

1. To evaluate the efficacy of few selected biopesticides and certain chemicals against okra shoot and fruit borer [*Earias vittella* (Fabricius)].
2. To calculate the cost benefit ratio of different treatments.

Materials and Methods

Field trails were conducted to study the "Comparative efficacy of biopesticides and certain chemicals against shoot and fruit borer (*Earias vittella*) on Okra [*Abelmoschus esculentus* (L.)]" at central research field, SHUATS, Prayagraj, U.P. during *Kharif* 2023-2024. The survey was laid out in RBD having seven treatments and control in three replications with the plot size 2 m^2. The Research was fulfilled on Okra variety Arka Anamika. Two spraying intervals were given at fifteen days interval using a hand sprayer during dawn or dusk hours to avoid photo oxidation of insecticedes. The treatments details are: T_1 NSKE 5% + Spinosad 45% SC @ 5 ml/lit + 0.4 ml/lit, T_2 Azadirachtin 1500 PPM @ 5 ml/lit, T_3 *Metarhizium anisopliae* 1×10^8 (CFU/gm) @ 4 gm/lit, T_4 *Beauveria bassiana* 2×10^9 (CFU/gm) @ 2 ml/ lit, T_5 Emamactin benzoate 5% SG@ 0.3 ml/lit, T_6 Chlorantraniliprole 18.5% SC @ 0.5 ml/lit, T_7 Imidacloprid 17.80SL @ 0.3 ml/lit, T_8 Untreated control.

Percent shoot Infestation

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 per cent 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) [6]

Percent fruit Infestation

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

$$\% \text{ Fruits infestation} = \frac{\text{Number of infected fruits}}{\text{Number of total fruits}} \times 100$$

(Choudhury *et al.*, 2021) [6]

Cost Benefit Ratio

Gross return was calculated by multiplying total yield with the market price of the produce. Cost of cultivation and cost of treatment imposition was deducted from the gross returns, to find out net returns and cost benefit ratio by following formula The B:C ratio was calculated by formula.

$$\text{B:C} = \frac{\text{Gross return}}{\text{Total cost of production}}$$

(Nalini and Kumar, 2016) [16]

Results and Discussion

The present study entitled, "Comparative efficacy of biopesticides and certain chemicals against shoot and fruit borer (*Earias vittella*) on Okra [*Abelmoschus esculentus* L.]" was undertaken at the Central Research Farm, SHUATS, Prayagraj. The data so obtained through observation on various aspects were subjected to statistical analysis wherever necessary and the compiled mean data are tabulated in the following pages. Results, thus obtained are presented aspect wise here under.

Shoot Infestation

Among all the treatments lowest per cent shoot infestation was recorded in (T_6) Chlorantraniliprole 18.5% SC (13.85), followed by (T_5) Emamectin benzoate 5% SC (14.19), (T1) NSKE 5% + Spinosad (15.10), (T_7) Imidacloprid 17.80% SL (15.36), (T_3) *Metarhizium anisopliae* 1×10^8 (CFU/gm) (16.65), (T_2) Azadiractin 1500 PPM (17.40), In this (T_4) *Beauveria bassiana* 2×10^9 (CFU/gm) (18.10). The treatment (T_6) Chlorantraniliprole 20% SC (12.49) was most effective among all the treatments, and is significantly superior over the untreated plot (T_8) (24.05) infestation.

Fruit Infestation

Among all the treatments lowest per cent fruit infestation was recorded in (T_6) Chlorantraniliprole 18.5% SC (12.52), followed by (T_5) Emamectin benzoate 5% SC (13.37), (T_1) NSKE 5% + Spinosad (14.50), (T_7) Imidacloprid 17.80% SL (15.46), (T_3) *Metarhizium anisopliae* 1×10^8 (CFU/gm) (15.91), (T_2) Azadiractin 1500 PPM (18.05), In this (T_4) *Beauveria bassiana* 2×10^9 (CFU/gm) (18.85). The treatment (T_6) Chlorantraniliprole 20% SC (13.85) was most effective among all the treatments, and is significantly superior over the untreated plot (T_8) (24.67) infestation.

Table 1: To study the efficacy of selected biopesticides and certain chemicals against okra shoot and fruit borer [*Earias vittella* (Fabricius)] (After First spray)

Treatment		Percent infestation of Shoot borer/5 plants				
		1st DBS	3rd DAS	7th DAS	14th DAS	Mean
T_1	NSKE 5% + Spinosad 45% SC	20.40	16.68	13.41	15.21	15.10
T_2	Azadirachtin 1500 PPM	21.46	17.93	16.68	17.60	17.40
T_3	*Metarhizium anisopliae* 1×10^8 (CFU/gm)	19.21	18.10	15.44	16.44	16.65
T_4	*Beauveria bassiana* 2×10^9 (CFU/gm)	21.84	19.54	16.76	18.1	18.10
T_5	Emamactin benzoate 5% SG	18.27	15.77	12.62	14.20	14.19
T_6	Chlorantraniliprole 18.5% SC	19.67	15.55	12.34	13.68	13.85
T_7	Imidacloprid 17.80SL	18.52	16.51	14.27	15.30	15.36
T_8	Untreated	21.05	22.89	24.13	25.13	24.05
F - test		NS	S	S	S	S
C.V.		9.22	9.01	8.73	8.30	8.43
C.D. at (0.05%)		---	2.82	2.40	2.46	2.48
S.Ed. A (±)		1.07	0.93	0.79	0.81	0.82

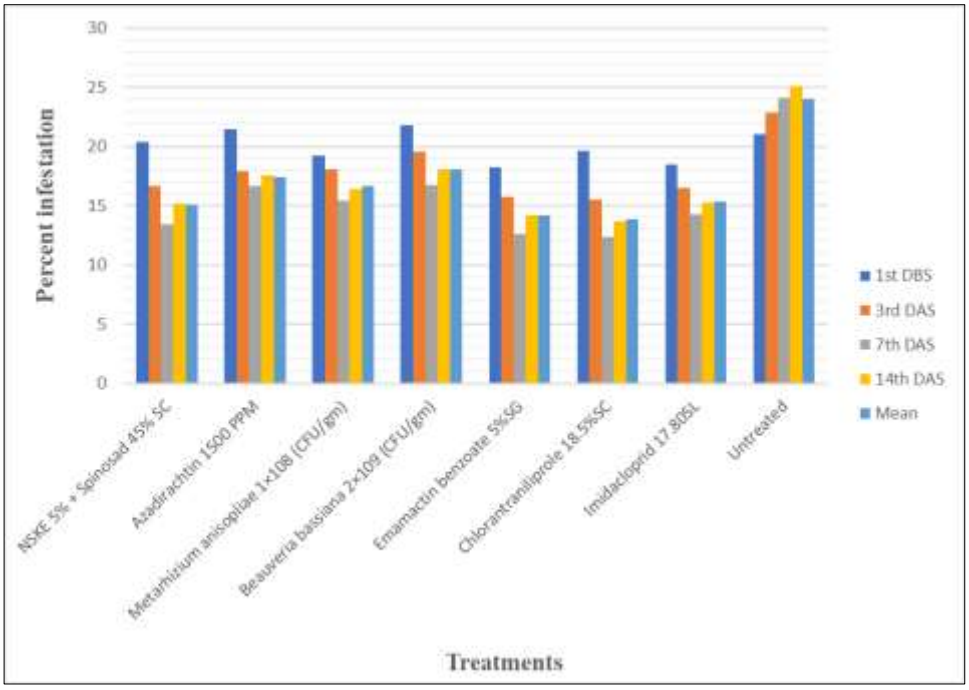

Fig 1: Graphical representation of shoot borer on percent infestation. (After First spray) On Shoot

Table 2: To study the efficacy of selected biopesticides and certain chemicals against okra shoot and fruit borer [*Earias vittella* (Fabricius)]. (After Second spray)

Treatment		Percent fruit infestation/5 plants				
		1st DBS	3rd DAS	7th DAS	14th DAS	Mean
T_1	NSKE 5% + Spinosad 45% SC	15.21	16.11	13.36	14.40	14.50
T_2	Azadirachtin 1500 PPM	17.60	19.51	17.05	17.83	18.05
T_3	*Metarhizium anisopliae* 1×10^8 (CFU/gm)	16.44	17.28	14.79	16.13	15.91
T_4	*Beauveria bassiana* 2×10^9 (CFU/gm)	18.1	19.66	18.40	18.48	18.85
T_5	Emamactin benzoate 5% SG	14.20	15.18	11.79	13.45	13.37
T_6	Chlorantraniliprole 18.5% SC	13.68	14.91	10.79	12.18	12.52
T_7	Imidacloprid 17.80SL	15.30	16.78	14.16	15.95	15.46
T_8	Untreated	25.13	22.90	25.11	26.31	24.67
F - test		S	S	S	S	S
C.V.		6.59	8.30	6.32	5.48	5.58
C.D. at (0.05%)		2.25	2.46	1.73	1.61	1.63
S.Ed. A (±)		0.74	0.81	0.57	0.49	0.54

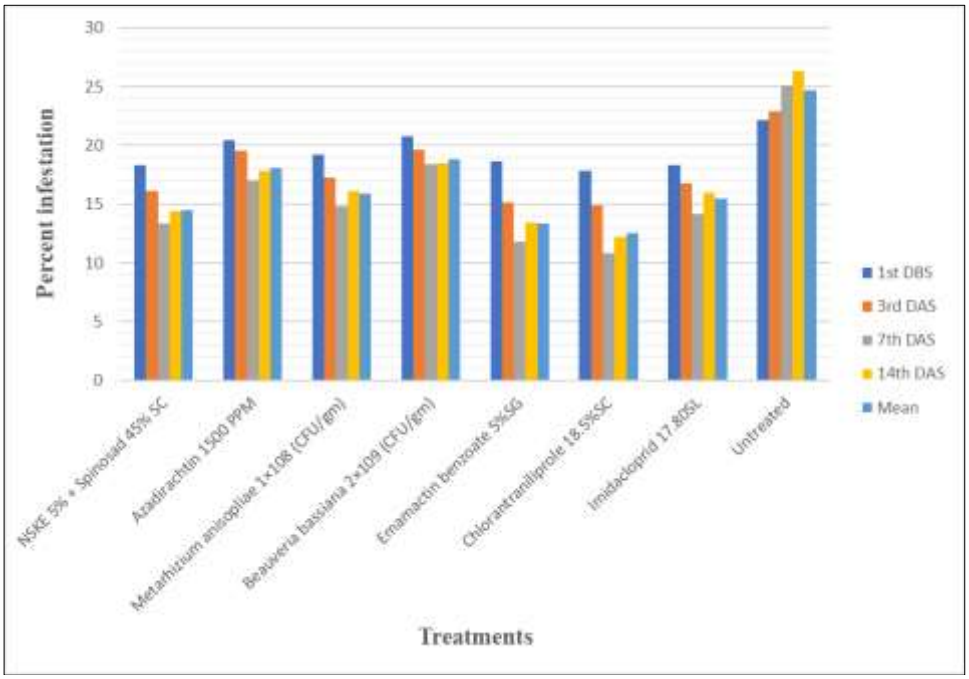

Fig 2: Graphical representation of fruit borer on percent infestation. (After Second spray) On Fruit

Conclusion

The results showed that (T_6) Chlorantraniliprole 18.5% SC was found to be the most effective treatment against okra shoot and fruit borer *(Earias vittella*). It also gave the highest cost benefit ratio compared to other treatments. While (T_5) Emamectin benzoate 5% SC, (T_1) NSKE 5% + Spinosad 45% SC, (T_7) Imidacloprid 17.80% SL, (T_3) *Metarhizium anisopliae* 1×10^8 (CFU/gm) have shown average results. (T_2) Azadiractin 1500 PPM, and biopesticides (T_4) *Beauveria bassiana* 2×10^9 (CFU/gm) found to be least effective for controlling shoot and fruit borer *(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. Botanical 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. From above we can conclude that the treatments Chlorantraniliprole, Emamectin benzoate and NSKE + Spinosad are the best treatments for control of okra shoot and fruit borer.

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