Comparative efficacy of insecticides and their combinations against okra shoot and fruit borer, *Earias vitella* (Fabricius)

ABSTRACT: The research was conducted on okra crop to check the efficacy of some insecticides and their combinations against okra shoot and fruit borer, *Earias vittella* (Fab.). The study was carried out during *kharif* season 2023 at Central Research Farm of Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (U.P.) with eight treatments including untreated check which were replicated thrice. All the treatments were found to be superior over untreated control, neem oil 3%, spinosad 45 SC, cypermethrin 25 EC, profenophos 50 EC, spinosad 45SC + neem oil 3%, cypermethrin 25EC + neem oil 3%, profenofos 50 EC + cypermethrin 25 EC were tested to compare the efficacy against *Earias vitella* and their influences on yield of okra. Here the best and the most economic treatment was profenofos 50 EC + cypermethrin 25 EC followed by cypermethrin 25EC + neem oil 3%, spinosad 45SC + neem oil 3%, spinosad 45 SC, cypermethrin 25 EC, profenophos 50 EC and the least effective treatment was neem oil 3%. The highest yield among the treatments was noticed in profenofos 50 EC + cypermethrin 25 EC (140quintal/hac.) and the lowest in neem oil 3% (75quintal/hac.) with cost benefit ratio 1:4.7 and 1:2.0, respectively.

Keywords: Okra shoot and fruit borer, *Earias vitella*, insecticides, chemicals, combinations, management.

1. INTRODUCTION: An important vegetable crop, okra (*Abelmoschus esculentus* L.) is a member of the Malvaceae family. **(Singh *et al.*, 2008)** cultivated in tropical, subtropical and mild temperate parts of the world. Okra locally known as Bhendi and Lady's finger worldwide. It is generally a self-pollinating crop belonging to the Malvaceae **(Sekyere *et al.*, 2011)**. Okra is referred to as the "Vegetable's Queen." It is prized for the soft green fruits it bears. It can be prepared in a number of ways and is a key ingredient in a variety of recipes **(Janu and Kumar 2022).** The root and stems are used for clarification of sugarcane juice before it is converted into jiggery and brown sugar. Okra is good source of vitamin A, B and C also rich in calcium, phosphorus, potassium, protein, carbohydrates, fats, minerals, iron and iodine **(Baloch *et al.*, 1990)**. It has good nutritional value particularly the high content of vitamin C (13mg/100g), fat (0.2g/100g), carbohydrate (6 4g/100g), iron (1.5mg/100g), moisture (89.6g/100g), protein (1.9g/100g), fibre (1.2g/100g), calories 35 (kcal/100g), and other minerals **(Fageria *et al*., 2012)**. The total area and production under okra in the world is reported to be 1.26 million ha and 22.29 million tonnes, respectively. With an area of 1148 thousand hectares, an annual production of 6346 million tonnes, and a productivity of 11.9 million tonnes/ha, India leads the world in okra production, accounting for 5784 thousand tonnes (72% of total global production). Gujarat is the state that produces the most okra, with an estimated 1019.42 thousand tons produced annually. **(National Horticulture Board, 2021-22).** The several insect pests of okra, some are serious pests that frequently arise; for example, the borer has been recorded to inflict damage to okra shoots of 24.6 to 26.0 percent and losses to fruits of 40 to 100 percent. (**Pareek *et al.*, 2003 and Shinde *et al.*, 2005)**. The fruit borer, *Earias vittella*, which feeds on okra shoots, lays light greenish blue eggs with longitudinal ridges. The completely developed larvae (caterpillar) had a length of 1.64 cm and was orange, black, and green in color. The larvae have a pale-yellow ventral side and a brownish dorsal side with white stripes. Its pupa is a rough, bluntly rounded, gray, inverted boat-shaped cocoon that forms on the stem or fruits and is chocolate brown in color. Its adults have tiny forewings that measure 1.25 cm wide. The adult borer's head and thorax are ochreous white, while its forewings are pale white with a green spot in the middle that resembles a wedge, and its hind wings are a silvery, creamy white color. The middle of the forewing of *Earias vittella* moths has a slender, light green longitudinal band. The main distinction between a male and a female is that the male has thick hair at the anal end of the body, while the female is larger than the male and has a V-shaped anal region. (**Aman *et al.*, 2022).** During the night, the female moth deposits 200–400 eggs by herself on the delicate leaves, bracts, and flower buds of okra plants. Incubation period of eggs are 3-4 days and the caterpillar passes through 6 stages, becoming full grown in 10-16 days. The moth emerges about 8–14 days during the summer and 18–23 days during the winter after pupating on plants or on the ground among fallen leaves. It takes 17–29 days to complete the lifecycle. In a year, multiple overlapping generations are completed. **(Kaveri and Kumar 2020).** OSFB bore into tender shoots flower buds and fruits. As a result, the attacked shoots thy up while tile flower buds and developing fruits dropped prematurely Affected fruit remain on the plants become unfit for human consumption **(Mohan et al., 1983) and Atwal 1976).** It bore into the shoots and feed inside and damage seeds **(Karim 1992).** The first symptoms of' attack were visible when the crop was 3 weeks old and the larvae bored into the shoots. Under severe attack, the top leaves wilted and the whole apex of the plant dropped down. As soon as fruiting began, the larvae moved to the flower buds, small fruits and even iliature pods, causing reduction of yield. **(Singh and Bichoo 1989)**

2. MATERIALS AND METHODS: The experiment was conducted in Randomized Complete Block design with three replications. The spraying was done after the population level reaches to ETL. The ETL level of the pest is 5% of shoot damage and 10% fruit damage **(Shirale *et al.*, 2012).** The observations were recorded one day before spraying, 7^{th} and 14^{th} days after spraying. The assessment of the shoot damage was done by calculating the number of damaged shoots and total numbers of healthy shoots observe 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 affect fruits from each plot.

Shoot Infestation

The total number of shoots, as well as the number of infested shoots, was observed and recorded at weekly intervals from five selected plants in each plot. Shoot infestation was determined by percent using the following formula-

%Shoot infestation =

$$\frac{Number\ of\ infested\ shoots}{Number\ of\ total\ shoots} X100$$

Fruit Infestation

The percentage of fruit infestation determined using the following formula:

%Fruit infestation =

$$\frac{Number\ of\ infested\ fruit}{Number\ of\ total\ fruits} X100$$

Choudhury *et al.* (2021)

The healthy marketable yield from different treatments were collected separately and weighed. There were two sprays throughout the research period and the treatment cost and common cost of cultivation per hectare was calculated. Total income was realized by multiplying the total yield per hectare by the prevailing market price; while the net benefit was obtained by subtracting the total cost of plant protection from total income. The C: B was calculated by following formula -

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

(**Nalini and Kumar, 2016)**

3. RESULTS AND DISUSSION

3.1 Effect of insecticides and their combinations against Okra shoot and fruit borer, *Earias vitella* during *kharif* season (2023) (First spray).

The data of overall mean (7DAS and 14 DAS) resulted that all the treatments were found to reduce the shoot infestation significantly over control and lowest shoot damage was recorded in Profenofos 50 EC + Cypermethrin 25 EC (4.63%) followed by Cypermethrin 25EC + Neem oil 3% (7.22%), Spinosad 45SC + Neem Oil 3% (8.11%), Spinosad 45 SC (9.40%), cypermethrin 25 EC (12.24%), profenophos 50 EC (15.21%). The least effective treatment was Neem oil 3% (17.43%) compared to all the treatments and maximum damage of shoot is found in untreated plot (27.66%).

3.2 Effect of insecticides and their combinations against Okra shoot and fruit borer, *Earias vitella* during *kharif* season (2023) (second spray).

The data of overall mean (7DAS and 14 DAS) of second spray indicated that among all the treatments lowest fruit damage was recorded in Profenofos 50 EC + Cypermethrin 25 EC (3.05%) followed by Cypermethrin 25EC + Neem oil 3% (4.29%), Spinosad 45SC + Neem Oil 3% (5.54%), Spinosad 45 SC (5.95%), cypermethrin 25 EC (7.70%), profenophos 50 EC (8.56%). The least effective treatment was Neem oil 3% (9.38%) compared to all the treatments and maximum damage of fruit is found in untreated plot (22.04%).

3.3 Effect of insecticides and their combinations against okra shoot and fruit borer, *Earias vitella* during *kharif* season (2023) (Overall mean of first and second spray).

The results of Profenofos 50 EC + Cypermethrin 25 EC percent mean infestation of first and second spray (3.84%) are closely confirming with the finding of **Pardeshi *et al*. (2010)** (6.47%) was superior against *E. vittella*. Whereas **Padwal *et al.* (2013)** (6.8%) and **Nalini and Kumar (2016)** (8.91%) found Cypermethrin 25EC + Neem oil 3% (5.75%) next superior, followed by Spinosad 45SC + Neem Oil 3% (6.82%), **Rawat *et al.* (2020)** (6.70%).

Spinosad 45 SC (7.67%), were next superior treatment supported by **Janu and Kumar (2022)** (12.02%) and **Rajput and Tayde (2017)** (10.46%). Cypermethrin 25 EC (9.97%) were closely related to **Neelima *et al.* (2021)** (10.29%) and **Manikanta and Kumar (2022)** (11.48%) followed by Profenophos 50 EC (11.88%) supported by **Patta et al. (2019)** (24.03%), **Madhuri and Kumar (2022)** (18.33%), **Kumar and Singh (2022)** (13.78%) and Neem oil 3% (13.40%) was least effective among all the treatments supported by **Naik *et al*. (2022**) (13.45%) and **Pachole *et al.* (2017)** (11.85%).

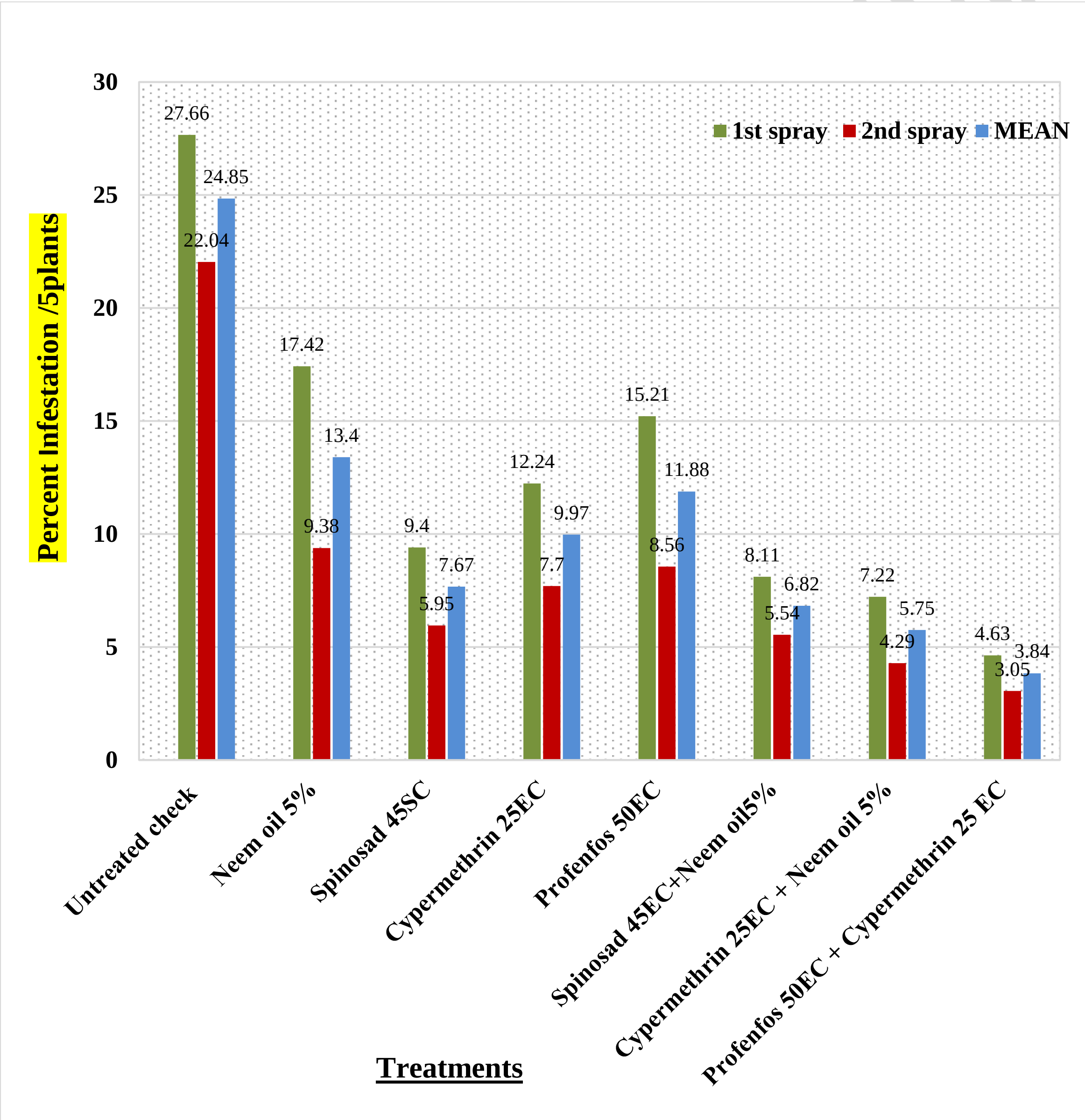

Figure. Effect of insecticides and their combinations against okra shoot and fruit borer, *Earias vitella* during *kharif* season (2023) (Overall mean of first and second spray).

3.4 Effect of insecticides and their combinations against Okra shoot and fruit borer, *Earias vitella* during *kharif* season (2023) on okra yield and cost benefit ratio.

Effect on yield –The data revealed that T_7 Profenofos 50 EC + Cypermethrin 25 EC, T_6 Cypermethrin 25EC + Neem oil 3%, T_5 Spinosad 45SC + Neem Oil 3% and T_2 Spinosad 45 SC were found significantly superior over rest of the treatments and recorded 140 quintal/hac.,137quintal/hac.,132quintal/hac and 105quintal/hac yield of healthy fruits respectively. The remaining treatments viz., T_3 cypermethrin 25 EC, T_4 profenophos 50 +EC, T_1 Neem oil 3%were found least effective with low yield 95quintal/hac., 86quintal/hac., 70quintal/hac. respectively.

Cost benefit ratio-When cost benefit ratio worked out among the treatments studied, the best and most economic treatment was found to be (T_7) Profenofos 50 EC + Cypermethrin 25 EC with C:B ratio (1:4.7) which was highest among all the treatments, the result is in closely agreement with **Pardeshi *et al*. (2010)**. (T_6) Cypermethrin 25EC + Neem oil 3% also reported profitable yield and cost benefit ratio (1:3.6) these findings are supported by **Padwal *et al.* (2013)** and **Nalini and Kumar (2016).** The cost benefit ratio of (T_5) Spinosad 45SC + Neem Oil 3% (1:3.4) these results were to the findings reported by **Rawat *et al.* (2020)** and, the next best cost benefit ratio obtained in the treatment (T_2) Spinosad 45 SC (1:3.3) was supported by **Devi *et al*. (2023)** and **Janu and Kumar (2022)**. The results of cost benefit ratio obtained in the treatment (T_3) Cypermethrin 25 EC was (1:3.2) similar to **Naik et al. (2022)** and **Sureshsing and Tayde (2017)**. Treatments (T_4) Profenophos 50 EC and (T_1) Neem oil 3% showed least cost benefit ratio (1:2.9) and (1:2.0) respectively, the result is in closely agreement with **Madhuri and Kumar (2022)**, **Kumar and Singh (2022)** and **Rani and Kumar (2022), Naik *et al*. (2022**).

Table 1 Effect of insecticides and their combination against okra shoot and fruit borer, *Earias vitella* after first and second spray

S.No.	**Treatments**	**Dosage**	**Percent infestation of shoot and fruit borer**								**Overall mean**	**Yield (q/hac.)**	**C: B**
			1st spray (shoot infestation)				**2nd spray (fruit infestation)**						
			1DBS	7DAS	14DAS	Mean	1DBS	7DAS	14DAS	Mean			
T_1	Neem oil 3 %	30 ml lit^{-1}	20.84	16.77^{b}	18.09^{b}	17.43^{b}	17.50^{ab}	8.40^{b}	10.37^{b}	9.33^{b}	13.40^{b}	75	1:2.0
T_2	Spinosad 45 SC	0.5 ml lit^{-1}	19.59	8.47^{de}	10.34^{de}	9.40^{e}	13.22^{d}	4.56^{d}	7.24^{de}	5.95^{e}	7.67^{cd}	105	1:3.3
T_3	Cypermethrin 25 EC	0.5 ml lit^{-1}	18.84	11.36^{cd}	13.12^{cd}	12.24^{d}	15.04^{c}	6.74^{c}	8.66^{cd}	7.70^{d}	9.97^{bc}	95	1:3.2
T_4	Profenofos 50 EC	1.5 ml lit^{-1}	19.38	14.21^{bc}	16.22^{bc}	15.21^{c}	16.24^{bc}	7.56^{bc}	9.57^{bc}	8.56^{c}	11.88^{b}	86	1:2.9
T_5	Spinosad 45 SC +Neem oil 3 %	0.25 ml lit^{-1} + 30 ml lit^{-1}	19.06	7.01^{e}	9.21^{ef}	8.11^{f}	12.73^{d}	4.60^{d}	6.48^{ef}	5.54^{e}	6.82^{cde}	132	1:3.4
T_6	Cypermethrin 25 EC +Neem oil 3%	0.25 ml lit^{-1} + 30 ml lit^{-1}	18.39	6.59^{ef}	7.85^{ef}	7.22^{g}	11.96^{d}	3.32^{e}	5.26^{fg}	4.29^{f}	5.75^{de}	137	1:3.6
T_7	Profenophos50 EC + Cypermethrin 25 EC	1.5 ml lit^{-1}	14.33	3.34^{f}	5.92^{f}	4.63^{h}	9.76^{e}	2.05^{f}	4.05^{g}	3.05^{g}	3.84^{e}	140	1:4.7
T_0	Untreated check	-	15.89	26.30^{a}	29.02^{a}	27.66^{a}	18.76^{a}	21.51^{a}	22.58^{a}	22.04^{a}	24.85^{a}	42	1:1.5
F-Test			NS	S	S	S	S	S	S	S	S		
S. Ed (±)			-----	3.58	3.65	0.88	1.61	1.21	1.53	0.68	3.69		
C.D.			3.15	1.61	1.70	3.48	0.75	0.57	0.70	2.81	3.24		

DBS- Day before Spraying, DAS- Day after Spraying, NS- Non significant, S- Significant.

4. CONCLUSION: *Earias vittella* is a major pest of okra with high damage potential which makes its control indispensable, so research was conducted to manage *E. vittella* using various chemical insecticides, botanicals and their combinations belonging to different groups is in vague for suppression of this pest but only partial control of pest could be achieved by using chemicals and botanicals alone. So results of this study had indicated that all the treatments are significantly superior over the untreated control, but the combinations of the insecticides had shown the highest efficacy against *E. vittella* in case of infestation as well as yield. However, among different tested insecticides combination of profenofos + cypermethrin shows best result 3.84 percent infestation reduction with 140q/hac yield and 1:4.7 cost benefit ratio followed by Cypermethrin 25EC + Neem oil 3% (5.75%) whereas the least effective treatment was Neem oil 3%(13.40%).The sequence of treatment according to their reduction in mean percent infestation found T_7 profenofos + cypermethrin $<T_6$ Cypermethrin 25EC + Neem oil 3% $<T_5$ Spinosad 45SC + Neem Oil 3% $<T_2$ Spinosad 45 SC $<T_3$ cypermethrin 25 EC $<T_4$ profenophos 50 EC $<T_1$ Neem oil 3% $<T_0$ untreated check. The combinations of Botanicals and Chemical insecticides are also showing good results in suppressing pest population and can be a part of integrated pest management as an effective tool under chemical control. 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.

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