

Original Research Article

“Efficacy of selected ~~chemical~~ insecticides against shoot and fruit borer [*Earias vittella* (Fabricius)] on okra [*Abelmoschus esculentus* (L.) Moench.]”

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ABSTRACT

A field ~~trial~~ trial was conducted at Central Research Farm (CRF), Naini, Prayagraj during *Kharif* from July to November 2021 in Randomized Block Design (RBD) with three replications. Eight treatments were evaluated against *Earias vittella* i.e., ~~Flubendiamide~~ flubendiamide @ 480% SC, ~~Indoxacarb-indoxacarb~~ @ 14.5% SC, ~~Spinosad-spinosad~~ @ 45% SC, ~~Chlorantraniliprole-chlorantraniliprole~~ 18.5% EC, Neem oil @ 2%, ~~Emamectin~~ emamectin benzoate @ 5% SG, ~~Cypermethrin-cypermethrin~~ @ 25% EC and untreated Control. Results revealed that, among the different treatments lowest per cent infestation of okra shoot and fruit borer was recorded in ~~Chlorantraniliprole-chlorantraniliprole~~ 18.5% EC (8.02%, 5.15%). Emamectin benzoate 5% SG (9.26%, 6.75%) was found to be the next best treatment followed by ~~Flubendiamide-flubendiamide~~ @ 480% SC (10.29%, 7.48%), ~~Cypermethrin-cypermethrin~~ @ 25% EC (11.41%, 9.24%), ~~Indoxacarb-indoxacarb~~ @ 14.5% SC (12.32%, 10.00%), ~~Spinosad-spinosad~~ @ 45% SC (13.13%, 11.53%) whereas Neem oil @ 2% (14.25%, 12.70) was found to be least effective against this pest. Among the treatments studied, ~~Chlorantraniliprole-chlorantraniliprole~~ 18.5% EC gave the highest marketing yield and cost benefit ratio (188 q/ha and 1:8.41) followed by ~~Emamectin-emamectin~~ benzoate 5% SG (176 q/ha and 1:8.41), ~~Flubendiamide-flubendiamide~~ @ 480% SC (152 q/ha and 1:7.18), ~~Cypermethrin-cypermethrin~~ @ 25% EC (135 q/ha and 1:6.22), ~~Indoxacarb-indoxacarb~~ @ 14.5% SC (121.2 q/ha and 1:5.74), ~~Spinosad-spinosad~~ @ 45% SC (114.6 q/ha and 1:5.29) and Neem oil @ 2% (102.4 q/ha and 1:4.80) as compared to control plot (87.2 q/ha and 1:4.2).

Keywords: *Abelmoschus* ~~esculentasesculentus~~, Cost- Benefit ratio, ~~Chlorantraniliprole-chlorantraniliprole~~, ~~Efficacy~~ efficacy, ~~Shoot-shoot~~ and ~~Fruit-fruit~~ borer, *Earias vittella*.

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is known by various local names in different parts of the world and is often known as 'Lady's Finger'. Okra is a commercial vegetable crop belongs to family Malvaceae. It originates from Ethiopia and is widely spread all over tropical, subtropical and warm temperate regions of the world (Singh *et al.*, 2014).

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The composition of okra pods per 100 g edible portion is water 88.6 g, energy 144.00 kJ (36 kcal), protein 2.10 g, carbohydrate 8.20 g, fat 0.20 g, fibre 1.70 g, Ca 84.00 mg, P 90.00 mg, Fe 1.20 mg, β carotene 185.00 μ g, riboflavin 0.08mg, thiamin 0.04 mg, niacin 0.60 mg, ascorbic acid 47.00 mg. Protein, carbohydrate and vitamin C contains of okra (Singh *et al.*, 2014). Okra seed oil is reported to contain Linoleic acid which is one of the essential fatty acid (Naidu and Kumar 2019).

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Okra is an important vegetable crop providing a good source of income to farmers. India ranked first in okra production in world (Devi *et al.*, 2015). World production of okra as fresh fruit vegetable is estimated at 6 million tones/year. 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 (Gautam *et al.*, 2015). Major okra producing Indian states are Uttar Pradesh, Bihar, Odisha, West Bengal Andhra Pradesh, Karnataka and Assam with average production of okra in India is about to 57.84 lakh tons and productivity 11.6 tons/ha during 2010-11 (Devi *et al.*, 2015). Uttar Pradesh has an area of 22.93 ha, with a production of 307.29 tonnes, and productivity of 13.40 metric tonnes/ha of okra.

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The adult female of okra shoot and fruit borer, *Earias vittella* lays eggs individually on leaves, floral buds and on tender fruits. Small brown caterpillars bore into the top shoot and feeds inside the shoot before fruit formation. The shoot wilt and dry as a result the damaged plant developed branches. Later on caterpillars bore into the fruits and feed inside as a result the infested plant bears smaller and deformed pods. A larva attacks a number of stems and pods one after another. Damaged plant tissues serve as entrance for disease causing microorganisms such as fungi. (Rahman *et al.*, 2013).

Comment [PS5]: Okra is attacked by a number of insect-pests viz., ----- among which okra shoot and fruit borer, *Earias vittella* is an important pest.

It is reported that about 69% losses in marketable yield are 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 (Pachole *et al.*, 2017).

MATERIALS AND METHODS

The experiment was conducted at Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P) during the *Kharif* season of 2021 with a recommended package of practices excluding plant protection. The ~~Okra-okra~~ variety 'Arka anamika' was sown at 45 cm x 30 cm spacing. The experiment was laid down in Randomized Block Design (RBD) with eight treatments replicated thrice with each plot size of 2m X 2m and proper irrigation was provided. The treatments comprising of flubendiamide 480% SC, indoxacarb 14.5% SC, spinosad 45% SC, chlorantraniliprole 18.5% SC, Neem oil 2%, emamectin benzoate 5 SG and cypermethrin 25% EC were applied two times using knapsack sprayer at 15 days interval. From each plot five plants were randomly selected and labeled for recording observations.

The infestation of pest on shoot was initiated, the observations on total number of shoots and number of infested shoots and fruit infestation of five observational plants from each treatment replication wise were recorded at 3rd, 7th and 14th days after imposing treatments. The data recorded in the different treatments were subjected to statistical analysis after suitable transformation by following standard procedures of RBD experiment. After the last picking, total of all pickings of individual plots produce were calculated to work out the yield of the treatments. Yield of healthy fruits was converted into quintal per hectare.

The observations on the per cent infestation were recorded visually per plant from five randomly selected and tagged plants in each plot. The insecticides were sprayed at recommended doses when larval population reaches its ETL level, which was further converted into per plant population and subsequent observation was recorded at 3rd, 7th and 14th days after spraying on same plants.

The desired concentration of insecticidal spray solution for each treatment was freshly prepared each and every time at the site of experiment, just before the start of spraying operations. The quantity of spray materials required for crop was gradually increased with the advancement of crop stage.

The healthy marketable yield obtained from different treatments was collected separately and weighted. The cost of insecticides used in this experiment was recorded during *Kharif* season. The cost of botanicals used was obtained from nearby market. The total cost of plant protection consisted of cost of treatment, sprayer, rent and labour charges for the spray. There were two sprays throughout the research period and the overall plant protection expenses were calculated. Total income was realized by multiplying the total yield per hectare by the prevailing market price,

Comment [PS6]: Which were the formulations used in the experiment? Indicate the different trade names of formulations used.

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while the net benefit is obtained by subtracting the total cost of plant protection from the total income. Benefit over the control for each sprayed treatment was obtained by subtracting the income of the control treatment from that of each sprayed treatment.

Cost benefits of treatment

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 includes both cultivation as well as plant protection charges.

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RESULTS AND DISCUSSION

Okra (*Abelmoschus esculentus* L.) is known by various local names in different parts of the world and is often known as 'Lady's Finger'. Okra is a commercial vegetable crop belongs to family Malvaceae. Okra crop suffers heavy damage by a number of insect pest viz., the jassid, *Amresca biguttulla biguttulla* (Ishida), aphid, *Aphis gossypii* (Glover), Okra fruit borers, *Earias spp.*, whitefly, *Bemisia tabaci* (Genn.). Among these pests shoot and fruit borer *Earias vittella* (Fab.) is the most destructive pest of okra as the larva bores in to young shoots and fruits.

The adult female of okra shoot and fruit borer, *Earias vittella* lays eggs individually on leaves, floral buds and on tender fruits. Small brown caterpillars bore into the top shoot and feeds inside the shoot before fruit formation. The shoot wilt and dry as a result the damaged plant developed branches. Later caterpillars bore into the fruits and feed inside as a result the infested plant bears smaller and deformed pods. A larva attacks a number of stems and pods one after another. Damaged plant tissues serve as entrance for disease causing microorganismssuch as fungi. It is reported that about 69% losses in marketable yield due to attack of this insect pest. A number of chemical insecticides have been found effective against this pest in different parts of the country.

The first spray was given 30 days of transplanting. The percent infestation of shoot and fruit borer in okra after first spray (shoot) revealed that all the chemical treatments were significantly superior over control. Among all the treatments lowest population of okra shoot and fruit borer was recorded in chlorantraniliprole 18.5% EC (6.58%). Emamectin benzoate 5% SG (8.00%) was found to be the next best treatment followed by flubendiamide @ 480% SC (8.88%), cypermethrin @ 25% EC (10.32%), indoxacarb @ 14.5% SC (11.16%), spinosad @ 45% SC (12.33%) andNeem oil @ 2% (13.47%) was found to be least effective against this pest (Table 1).

The second spray was applied after 15 days of first spray and data on percent fruit damage was recorded. The pooled data for second spray showed minimum percent fruit damage in

Comment [PS9]: This is not a part of Results and Discussion.

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chlorantraniliprole 18.5% EC (5.15%), emamectin benzoate 5% SG (6.75%) and flubendiamide @ 480% SC (7.48%) recorded lowest population of *Earias vittella* which was significantly superior over control followed by cypermethrin @ 25% EC (9.24%), indoxacarb @ 14.5% SC (10%), spinosad @ 45% SC (11.53%) and Neem oil @ 2% (12.70%) showed the least effectiveness among all treatments. (Table 1)

Between the various treatments, there were notable yields. Chlorantraniliprole 18.5% EC (188 q/ha) produced the maximum yield. Reddy *et al.*, (2019) first supported these findings, and then Dash *et al.*, (2019) supported them for emamectin benzoate 5% SG (176 q/ha). After cypermethrin @ 25% EC (135 q/ha), which is consistent with the same results of Padwal and Kumar (2013), the next-best therapy was Flubendiamide @ 480% SC (152 q/ha). These findings were corroborated by Deepak *et al.*, (2017). According to studies by Patra *et al.*, (2007) was similar finding to the Indoxacarb @ 14.5% SC (121.2 q/ha). Pachole *et al.*, (2017) validated the comparable conclusion that Spinosad @ 45% SC (114.6 q/ha) was effective, and the lowest yield was Neem oil @ 2% (102.4 q/ha), which is in line with findings by Archunan and Pazhanisamy (2020) and the control plot (92.6 q/ha). (Table 1)

An intriguing outcome was obtained after calculating the cost-benefit ratio. The most effective and affordable treatment of all those examined was chlorantraniliprole 18.5% EC (1:8.59). Shrivastava *et al.*, (2017) followed by Emamectin benzoate 5% SG (1:8.41), which are in agreement with Birah and Raghuraman's (2011) findings, made comparable findings Following Flubendiamide @ 480% SC (1:7.18), which was obtained in a manner similar to that of Deepak *et al.*, (2017), Cypermethrin @ 25% EC (1:6.22), which was obtained in a manner similar to that of Javed *et al.*, (2018). The following treatment, Indoxacarb @ 14.5% SC (1:5.74), was similar to the results of Bajad *et al.*, (2014). Spinosad @ 45% SC (1:5.29) was the following course of treatment, which is consistent with Sarkar *et al.*, (2015) Additionally, Neem oil at 2% showed the lowest benefit-cost ratio (1:4.80), which is similar to the findings from Subbireddy *et al.*, (2018) and the control plot (1:4.2). (Table 1)

Comment [PS11]: These findings are supported by the results of Reddy *et al.* .

Comment [PS12]: The next treatment in efficacy was emamectin benzoate giving fruit yield of 176 q/ha, which is corroborated by the findings of Das *et al.* 2019.

Comment [PS13]: The results on the efficacy of cypermethrin are consistent with those of Padwal and Kumar (2013). The next treatment was flubendiamide 480 SC which is supported by Deepak *et al.* (2017).

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Comment [PS15]: The sense is not clear. Reframe the sentences to get a better inference.

Comment [PS16]: Discussion part is not appropriate.

Table no. 1 To evaluate the selected chemical insecticides and neem oil on per cent infestation of shoot and fruit borer, *E. vittella* of okra

S.No.	Treatments	% Infestation of okra shoot and fruit borer							Yield (q/ha)	C:B ratio
		First spray				Second spray				
		1DBS	3DAS	7DAS	14DAS	3DAS	7DAS	14DAS		
T ₁	Flubendiamide @ 480% SC	14.63	10.58 ^a	06.75 ^a	09.16 ^a	07.070 ^a	04.29 ^a	09.38 ^a	152	1:7.18
T ₂	Indoxacarb @ 14.5% SC	15.25	12.31 ^b	09.48 ^b	12.34 ^b	09.24 ^b	07.40 ^b	11.01 ^b	121.2	1:5.74
T ₃	Spinosad @ 45% SC	15.39	13.24 ^c	10.39 ^{bc}	13.50 ^{bc}	10.82 ^{bs}	08.96 ^{bc}	12.82 ^{bc}	114.6	1:5.29
T ₄	Chlorantraniliprole 18.5% EC	13.23	08.13 ^d	03.37 ^c	07.33 ^{bc}	04.35 ^{bcd}	02.68 ^{bcd}	06.25 ^{bcd}	188	1:8.59
T ₅	Neem oil @ 2%	15.58	14.07 ^e	12.63 ^{cd}	14.69 ^{cd}	11.49 ^{cd}	09.90 ^{bcd}	14.69 ^{bcd}	102.4	1:4.80
T ₆	Emamectin benzoate @ 5% SG	14.47	09.09 ^d	05.18 ^{de}	08.30 ^{de}	06.67 ^{de}	03.57 ^{cd}	08.46 ^{cde}	176	1:8.41
T ₇	Cypermethrin @ 25% EC	14.86	11.25 ^f	08.37 ^{ef}	11.15 ^{de}	08.05 ^{de}	06.84 ^d	10.89 ^{de}	135	1:6.22
T ₈	Control	15.84	17.03 ^g	19.77 ^l	20.97 ^e	22.89 ^e	24.12 ^d	26.96 ^e	87.2	1:4.2
	F-test	NS	S	S	S	S	S	S		

Comment [PS17]: This is not the proper way to give the table heading. It should be : Effect of selected insecticides and neem oil on per cent infestation of *Earias vittellaa* on okra

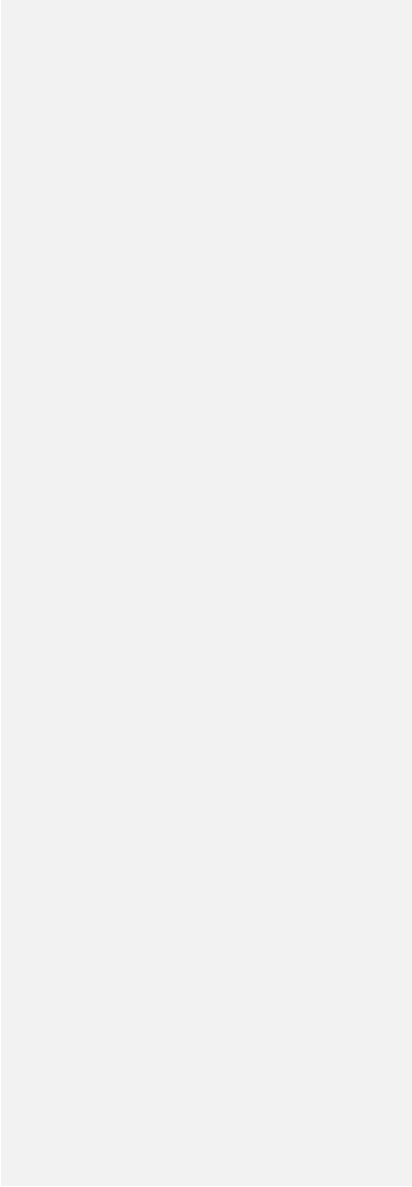
Comment [PS18]: Give the concentration of each insecticide used for field application

Comment [PS19]: These are not rates, these are active ingredients in the formulations.

Comment [PS20]: What do these letters indicate? Is there any transformation of data required? There is not uniformity in table figures.

	S. Ed (\pm)	00.91	00.33	01.13	01.42	01.55	02.43	01.84		
	C.D. (P = 0.5)	-	00.72	02.42	03.05	03.32	05.21	03.45		

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CONCLUSOION Spelling

From the present findings, it can be concluded that chlorantraniliprole 18.5% EC is more effective in controlling population of okra shoot and fruit borer and also give the highest cost benefit ratio and marketable yield i.e. (135 q/ha and 1:6.22), followed by emamectin benzoate 5% SG was found to be the next best treatment followed flubendiamide @ 480% SC, Cypermethrin @ 25% EC, Indoxacarb @ 14.5% SC, Spinosad @ 45% SC. Neem oil @ 2% was found to be least effective against this pest. Future study may be conducted to validate the findings.

Comment [PS21]: Figures do not match with those given in Table?

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