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Evaluation and Economics of Selected Insecticides and Bio-pesticides against Fruit Infestation of *Helicoverpa armigera* (Hubner) on Tomato

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The field trial was conducted in Central Research Farm (CRF) at SHUATS, Prayagraj, during *Kharif*-2021-22. The experiment was laid out in RBD (Randomized Block Design) and replicated thrice with seven treatments. Viz., T_1 Indoxacarb 14.5%EC, T_2 Flubendiamide 39.5%SC, T_3 Emamectin benzoate 5%SG, T_4 *Bacillus thuringiensis* 5% WP, T_5 Spinosad 45% SC, T_6 Neem oil 4%, T_7 Chlorantraniliprole 18.5%SC, (T_8) untreated Control was tested to compare the percent fruit infestation against *Helicoverpa armigera* and their influences on yield of Tomato. The lowest fruit infestation and best economical treatment were recorded in Spinosad 45 SC followed by Indoxacarb 14.5% SC, Chlorantraniliprole 18.5% SC, Emamectin benzoate 5% SG, Flubendiamide 39.5% SC, *Bacillus thuringenesis* 5% WP Neem oil 4% and as compared to control $T_{8.}$ The highest yield was obtained in Spinosad 45SC (260q/ha) followed by Indoxacarb 14.5%SC (245q/ha), Chlorantraniliprole 18.5% SC (225q/ha), Emamectin benzoate 5%SG (200q/ha) Flubendiamide 39.5% SC (185q/ha), *Bacillus thuringenesis* 5% WP (163q/ha) Neem oil 4% (149q/ha) and as compared to control T_8 (80q/ha). After calculating the benefit-cost ratio of different treatments highest B: C ratio of different treatments was observed for Spinosad 45SC (1:8.8) followed by Indoxacarb 14.5% SC (1:8.3), Chlorantraniliprole18.5% SC (1:7.6), Neem oil (1:7.2), Emamectin benzoate 5% SG (1:6.8), Flubendiamide 39.5% SC (1:6.3), *Bacillus thuringenesis* (1:5.6), as compared to control T_8 (1:2.8) having the lowest B: C ratio.

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1. INTRODUCTION

Tomato (*Solanum Lycopersicum* Mill.), a member of the Solanaceae family, is the most important vegetable grown for both fresh market and processing. It is thought to be a tropical American native. Tomatoes are the world's third-largest vegetable crop, following potato and sweet potato, and are a warm-season crop. It is grown as an off-season vegetable in India's hills, and farmers earn a good living by shipping their produce to the plains from June to September. Tomatoes provide vitamin C as well as a variety of colours and flavours to foods. "The area under vegetable cultivation in the country is about 9,542 in thousand ha and the production is about 169478 in thousand million tons. Tomato is being cultivated in 808.54 thousand ha producing 19696.92 thousand MT" [1].

The major producing states of tomato in India are Madhya Pradesh, Karnataka, Odisha, West Bengal, Chhattisgarh, Andhra Pradesh, Uttar Pradesh, and Bihar. The highest tomato cultivating state in Madhya Pradesh the area is about 100.2 thousand ha and production is about 3102 thousand MT but the highest productivity was occupied by Himachal Pradesh with 41.663 t ha.

"The tomato crop is being damaged by a total of 41 insect- pests species belonging to 21 families which includes the defoliators (*Spodoptera litura, Monolepta and rawest,* and *Atractomorpha crenulate*), leaf miner (*Liriomyza trifolii*) sucking insect-pests (*Bemisia tabaci, Aphis gossypii, Myzus persicae and Nezara viridula*) stem feeders, *Euzophera perticella* and *Leucinodes orbonalis* and fruit borers, *Helicoverpa armigera* and *Othreis Fullonica* (*Eudocima fullonic*)" [2].

"The tomato fruit borer (*Helicoverpa armigera*, Hubner) is key pest as it attacks the cashable part of the plant i.e., fruits. Yield losses in tomato due to tomato fruit borer is estimated at around 22 to 38% in India" [3].

"Pesticides produced from natural products have been recently attracting the attention of many scientists to avoid the problems caused by synthetic compounds. They are highly interested in their chemical constituents and biological properties. Organic production of perishable foods seems to be the best alternative with the least health hazards in keeping harmony with nature. Many indigenous plant extracts have been tried and recommended for insect-pests management in different field crops, which are safer for the environment, natural enemies, humans, and other animals along with low to moderate mammalian toxicity" [4,5].

2. MATERIALS AND METHODS

The experiment was conducted during *Kharif* season 2021 at Central Research Farm (CRF), SHUATS, Prayagraj (U.P). The study was laid out in a Randomized Block Design (RBD) which was replicated thrice. Each main block was divided into 8 sub-plots of 2m x 2m size with maintaining 25cm borders as bunds and treatments were assigned randomly The spraying of botanical and conventional insecticides was applied at the initial incidence of fruit borer with two consecutive sprays. All the spraying was done by using a hand sprayer at 15 days intervals. The insecticides and biopesticides include T_1 Indoxacarb 14.5%EC, T_2 Flubendiamide 39.5%SC, T_3 Emamectin benzoate 5%SG, T_4 *Bacillus thuringiensis* 5% WP, T_5 Spinosad 45% SC, T_6 Neem oil 4%, T_7 Chlorantraniliprole 18.5% SC and T_8 untreated Control.

Observations: The observation was recorded on the number of larvae per 5 plants in 2m length at different locations of all treatments were randomly selected and a total number of larvae was recorded one day before application and 14^{th} days after application in each treatment. The result obtained was converted into percent larval population and reduction percent with the following formula:

Larval population = No. of larvae / 5 plants

$$Fruit\ infestation = \frac{No. of\ infested\ fruits}{Total\ no. of\ fruits} x100$$

Benefit Cost Ratio: The cost-effectiveness of each treatment was assessed based on net returns. A net return of each treatment is worked out by deducting the total cost of the treatment from gross returns. The total cost of production

Table 1. Effect of selected insecticides, *Bacillus thermogenesis* and neem oil against tomato fruit borer, *Helicoverpa armigera* (Hubner) on tomato during *Kharif* 2021

Sl. No.	Treatments	Per cent of fruit infestation *H.armigera*									Overall Mean	Yield (q/ha)	B: C ratio
		First spray					Second spray						
		1DBS	3DAS	7DAS	14DAS	MEAN	3DAS	7DAS	14DAS	MEAN			
T1	Indoxacarb 14.5%EC	3.14	27.44	20.36	29.79	25.86	22.15	14.18	23.35	19.81	22.83	245	1:8.3
T2	Flubendiamide 39.5%SC	3.34	30.19	23.19	32.91	28.76	30.03	21.61	28.94	26.86	27.81	185	1:6.3
T3	Emamectin benzoate 5%SG	3.54	33.47	25.92	36.44	32.10	25.47	17.16	24.94	22.40	27.25	200	1:6.8
T4	*Bacillus thuringiensis* 5% WP	3.64	38.47	27.77	39.91	35.38	32.36	23.74	31.67	29.25	32.31	163	1:5.6
T5	Spinosad 45% SC	3.04	26.69	21.61	30.99	26.43	21.15	14.44	20.70	18.81	22.62	260	1:8.8
T6	Neem oil 4%	3.71	38.44	30.89	43.03	37.45	34.50	24.91	32.42	30.61	34.03	149	1:7.2
T7	Clorantraniliprole 18.5%SC	3.26	29.30	20.47	29.72	26.49	23.27	15.87	22.86	20.66	23.57	225	1:7.6
T8	Control	4.53	73.55	75.35	77.83	75.57	83.13	85.89	90.89	86.63	81.10	80	1:2.83
	F- test	NS	S	S	S	S	S	S	S	S	S	-----	-----
	S. Ed. (±)	0.243	21.72	26.05	22.64	23.44	28.88	34.03	13.30	31.89			
	C.D (P = 0.05)	NS	5.66	6.76	7.85	3.58	6.18	6.31	6.18	3.68			

included both cultivations as well as plant protection charges.

Gross return = Marketable yield X Market price

Net return = Gross return – Total cost

$$Benefit\ Cost\ Ratio\ = \frac{Gross\ Returns}{Total\ Cost} x100$$

3. RESULTS AND DISCUSSION

The data on the percent fruit infestation of fruit borer on the mean 3rd, 7th, and 14th day after the first spray revealed that all treatments were significantly superior to control. Among all the treatments lowest percent fruit infestation of fruit borer was recorded in Indoxacarb 14.5% SC (25.85) followed by, Spinosad 45% SC (26.43), Chlorantraniliprole 18.5% SC (26.49), Flubendiamide 39.5% SC (28.75), Emamectin benzoate 5%SG (32.10) *Bacillus thuringiensis* 5% WP (35.38) and Neem oil 4% EC (37.45) was found to be least effective than all the treatments and is significantly superior over the control.

The data on the percent fruit infestation of fruit borer on the mean 3rd, 7th, and 14th day after the second spray revealed that all treatments were significantly superior to control. Among all the treatments lowest percent fruit infestation of fruit borer was recorded in Spinosad 45% SC (18.76), followed by Indoxacarb 14.5% SC (19.89), Chlorantraniliprole 18.5%SC (20.37), Emamectin benzoate 5% SG (22.52), Flubendamide 39.5% SC (26.86), *Bacillus thuringiensis* 5% WP (29.25), and Neem oil 4% (30.61) was found to be least effective than all the treatments and is significantly superior over the control.

All the treatments were found to be significantly superior to control in reducing fruit infestation. The minimum larval population was recorded in Spinosad 45SC. These results were similar to the findings reported by Ghosh et al. [6], Roopa and Kumar [7] and Kumar and Sarada [4], Indoxacarb was found to be the next effective treatment and its results were supported by Reddy et al. [8], Singh et al. [9], Chlorantraniliprole 18.5SC found to be next effective treatment and its results were supported by Deshmukh et al. [10], Ambule et al. [11], Regmi et al. [12]. Emamectin benzoate was found to be the next best effective treatment. These results were similar findings of Khademul et al. [13] Flubendiamide was found to be the next most effective treatment and its results are supported by Kubendran et al. [14].

The yield among the treatments was significant. The highest yield was recorded in Spinosad 45% SC (260q/ha) followed by Indoxacarb 14.5% SC (245q/ha), Clorantraniliprole 18.5% SC (225q/ha), Emamectin benzoate 5% SG (200q/ha), Flubendiamide 39.5% SC (185q/ha), *Bacillus thuringiensis* 5% WP (163q/ha), Neem oil 4% EC (149q/ha) as compared to T_0 control (80q/ha). When the benefit-cost ratio was worked out, interesting results were achieved. Among the treatment studied the best and most economical treatment was Spinosad 45% SC (1:8.8), Indoxacarb 14.5% SC (1:8.3), followed by Chlorantraniliprole 18.5% SC (1:7.6), Neem oil 4% EC (1:7.2) Emamectin benzoate 5% SG (1:6.8), Flubendiamide 39.5% SC (1:6.3), *Bacillus thuringiensis* 5% WP (1:5.6) as compared to control T_0 (1:2.83).

The highest yield (260q/ha) and Cost Benefit Ratio (1:8.8) were obtained from the Spinosad treated plots and the lowest (80q/ha) in the untreated control plot. Similar findings were made by Nitharwal et al. [15] who reported that the Spinosad 45% SC is the best and most economical treatment. Recorded yield (260q/ha) and cost-benefit ratio (1:1.88). Kumar and Sarada [4] reported that the cost- effectiveness of flubendiamide 39.5% SC was high with the cost-benefit ratio. Recorded yield (185q/ha) and cost-benefit ratio (1:6.3) [16,17].

4. CONCLUSION

It was concluded that among all the treatments in Spinosad 45%SC proved to be the best treatment which is followed by Emamectin benzoate5%SG, Indoxacarb 14.5%SC Flubendiamide 480SC, Chlorantraniliprole 18.5%SC, Neem oil, and *Bacillus thuringenesis* Untreated control in managing *Helicoverpa armigera* reduction dose of chemicals may be useful in devising a proper integrated pest management strategy against fruit borer of Tomato.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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