

“Comparative efficacy of selected insecticides, *Bacillus thuringensis* and Neem oil against tomato fruit borer, *Helicoverpa armigera* (Hubner) on tomato”

Comment [RM1]: Rewrite title, use word “tomato” just one word on title

ABSTRACT

The field trial was conducted in Central Research Farm (CRF) at SHUATS, Prayagraj, during *Kharif*-2021-

22. Experiment was laid out in RBD (Randomized Block Design) replicated thrice with seven treatments. Viz., T₁ Indoxacarb 14.5% EC, T₂ Flubendiamide 39.5% SC, T₃ Emamectin benzoate 5% SG, T₄ *Bacillus thuringiensis* 5% WP, T₅ Spinosad 45% SC, T₆ Neem oil 4%, T₇ Chlorantraniliprole 18.5% SC, (T₈) 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 was recorded in Spinosad 45 SC followed by Indoxacarb 14.5% SC, Chlorantraniliprole 18.5% SC, Emamectin benzoate 5% SG, Flubendiamide 39.5% SC, *Bacillus thuringiensis* 5% WP, Neem oil 4% and as compared to control T₈. The highest yield was obtained in Spinosad 45 SC (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 thuringiensis* 5% WP (163q/ha), Neem oil 4% (149q/ha) and as compared to control T₈ (80q/ha). After calculating the benefit cost ratio of different treatments highest B:C ratio of different treatments was observed Spinosad 45 SC (1:8.8) followed by Indoxacarb 14.5% SC (1:8.3), Chlorantraniliprole 18.5% SC (1:7.6), Neem oil (1:7.2), Emamectin benzoate 5% SG (1:6.8), Flubendiamide 39.5% SC (1:6.3), *Bacillus thuringiensis* (1:5.6), as compared to control T₈ (1:2.8) having the lowest B:C ratio.

Keywords: Botanicals, Chemical insecticide, Cost-benefit ratio, *Helicoverpa armigera*, Spinosad, Tomato.

INTRODUCTION

Tomato (*Solanum lycopersicum* Mill.), belonging to family Solanaceae is the most important vegetable grown widely both for fresh market and processing. It is said to be a native of tropical America. Tomato is the world's largest vegetable crop after potato and sweet potato and it is a warm season crop. It is grown as an off-season vegetable in the hills of India and farmers fetch good income after sending their produce in the plains from June to September. Tomato supplies vitamin C and adds variety of colours and flavours to the foods.

The area under vegetable cultivation in the country is about 9,542 thousand ha and the production is about 169,478 thousand million tons. Tomato is being cultivated in 808,54 thousand ha producing 19,696.92 thousand MT (**Horticultural Statistics at a Glance 2020**).

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 is Madhya Pradesh in area 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.

Tomato crop is being damaged by a total of 41 insect-pest species belonging to 21 families which include the defoliators (*Spodoptera litura*, *Monolepta andrewesi*, and *Atractomorpha renulata*), leaf miner (*Liriomyza trifolii*) sucking insect-pests (*Bemisia tabaci*, *Aphis gossypii*, *Myzus persicae* and *Nezaraviridula*) stem feeders, *Euzophera perticella* and *Leucinodes orbonalis* and fruit borers, *Helicoverpa armigera* and *Othreis Fullonica* (*Eudocima fullonica*) (**Reddy and Kumar 2004**).

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 around 22 to 38% in India (**Dhandapani et al., 2003**).

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 least health hazards in keeping harmony with the nature. Many indigenous plant extracts have been tried and recommended for insect-pest management in different field crops (**Kumar et al., 2012; Shah et al., 2013**), which is safer to environment, natural enemies, humans and other animals along with low to moderate mammalian toxicity.

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 were 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 T₁ Indoxacarb 14.5% EC, T₂ Flubendiamide 39.5% SC, T₃ Emamectin benzoate 5% SG, T₄ *Bacillus thuringiensis* 5% WP, T₅ Spinosad 45% SC, T₆ Neem oil 4%, T₇ Chlorantraniliprole 18.5% SC and T₈ untreated Control.

Observations:

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

$$\text{Larval population} = \frac{\text{No. of larvae}}{5 \text{ plants}}$$

$$\% \text{ Fruit infestation} = \frac{\text{No. of infested fruits}}{\text{Total no. of fruits}} \times 100$$

Benefit Cost Ratio

Cost effectiveness of each treatment was assessed based on net returns. Net return of each treatment 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.

$$\text{Gross return} = \text{Marketable yield} \times \text{Market price}$$

$$\text{Net return} = \text{Gross return} - \text{Total cost}$$

$$\text{Benefit Cost Ratio} = \frac{\text{Gross Returns}}{\text{Total Cost}} \times 100$$

RESULTS AND DISCUSSION

The data on the per cent fruit infestation of fruit borer on mean 3rd, 7th and 14th day after first spray revealed that all treatments were significantly superior over control. Among all the treatments lowest per cent fruit infestation of fruit borer was recorded in Indoxacarb 14.5% SC (25.85) followed by, Spinosad 45% SC (26.43), Chlorantranilprole 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 per cent fruit infestation of fruit borer on mean 3rd, 7th and 14th day after second spray revealed that all treatments were significantly superior over control. Among all the treatments lowest per cent fruit infestation of fruit borer was recorded in Spinosad 45% SC (18.76), followed by Indoxacarb 14.5% SC (19.89), Chlorantranilprole 18.5% SC (20.37), Emamectin benzoate 5% SG (22.52), Flubendiamide 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 45% SC. These results were similar to the findings reported by Ghosh *et al.*, (2010), Roopa and Kumar (2014), Kumar and Sarada (2015), Indoxacarb found to be next effective treatment and its results were supported by Reddy *et al.*, (2021), Singh *et al.*, (2017), Chlorantranilprole 18.5% SC found to be next effective treatment and its results were supported by Deshmukhet *et al.*, (2010), Ambuleet *et al.*, (2015), Regmiet *et al.*, (2018). Emamectin benzoate found to be next best effective treatments. This results were similar finding of Khademulet *et al.*, (2020) Flubendiamide found to be next effective treatments and its results are supported by Kubendran *et al.*, (2008).

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

S.No.	Treatments	Percent of fruit infestation <i>H. armigera</i>									Overall Mean	Yield (q/ha)	B:C ratio
		First spray					Second spray						
		1DAS	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	<i>Bacillus thuringiensis</i> 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	Cloranthraniliprole 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			

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), Chlorantraniliprole 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 treatments 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).

Highest yield (260q/ha) and Cost: Benefit Ratio (1:8.8) was obtained from the Spinosad treated plots and lowest (80q/ha) in untreated control plot. Similar findings were made by **Nitharwalet *et al.*, (2017)** 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 (2015)** 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).

CONCLUSION:

It was concluded that among all the treatments in Spinosad 45% SC proved to be the best treatment which is followed by Emamectin benzoate 5% SG, Indoxacarb 14.5% SC, Flubendiamide 39.5% SC, Chlorantraniliprole 18.5% SC, Neem oil, and *Bacillus thuringiensis*. Untreated control in managing *Helicoverpa armigera* reduction. Recommended dose of chemicals may be useful in devising proper integrated pest management strategy against fruit borer of Tomato.

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