International Journal of Plant & Soil Science

34(23): 299-303, 2022; Article no.IJPSS.91633
ISSN: 2320-7035

Field Efficacy of Some Insecticides and Neem Products against Tomato Fruit Borer [*Helicoverpa armigera* (Hubner)] in 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.

Article Information

DOI: 10.9734/IJPSS/2022/v34i2331593

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/91633

Original Research Article

Received 14 July 2022
Accepted 17 September 2022
Published 29 September 2022

ABSTRACT

The field trial was conducted at Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttarpradesh during *Rabi,* 2021-2022. The experiment was laid out in RBD (Randomized Block Design). Seven treatments were replicated thrice: Neem oil, NSKE (Neem Seed Kernal Extract) 2%, Flubendiamide 480 SG, Novaluron 10% EC, lndoxacarb 14.5% SC, Emamectin benzoate 5%SG, Spinosad 45% SC and untreated Control. The treatments were tested to compare their efficacy against *Helicoverpa armigera* and their influences on the yield of tomatoes. Out of all treatments lndoxacarb 14.5% SC, Spinosad 45% SC, Flubendiamide 480SG and Novaluron10% EC recorded the minimum fruit infestation by 10.24, 11.31, 12.21 and 13.21 percent respectively. The highest yield was noticed in lndoxacarb14.5% SC (212.5 q/ha), followed by Spinosad 45% SC (200 q/ha) and Flubendiamide 480 SC (187.5 q/h). The best and most economical treatment is lndoxacarb (1:8.75), followed by Spinosad (1:8.16), Flubendiamide (1:7.55), Novaluron (1:6.38), Emamectin benzoate (1:5.86), Neem oil (1:5.64), NSKE (1:4.63), as compared to control T0-control (1:4.25) having the lowest B: C ratio.

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Keywords: Helicoverpa armigera; tomato; indoxacarb; neem products; insecticides; cost-benefit ratio.

1. INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is the largest vegetable crop in the world after potato and sweet potato and it is a warm-season crop. It is the most significant vegetable, belongs to the Solanaceae family, and is widely produced for both fresh market and processing. Tomatoes are high in vitamin C, manganese, and vitamin E. Furthermore, tomato lycopene is a potent antioxidant that lowers the incidence of prostate cancer [1].

Tomatoes are grown on an area of 23,886.63 hectares with a total production of 190,000 tons, an average yield of 32.20 tons/acre. China is the largest producer of tomatoes in the world. It contributes to around 34.75 percent of total tomato production worldwide. India contributes 10% of the total world tomato production with a production of 19.01 million tons. Every year, the rate of growth is increased by 1.45%. Turkey and the United States are the third and fourth-largest tomato producers.

India is the world's second-largest producer of tomatoes. Andhra Pradesh is responsible for 20% of all tomato production in India. Madhya Pradesh is the second-largest producer of tomatoes in India, and it contributes 12% of the country's total production. Karnataka is the third-largest producer of tomatoes in India, contributing 10% of the total. Gujarat, Maharashtra, Chhattisgarh, Telangana, and Tamil Nadu are the next four largest producers.

Whitefly *(Bemisia tabaci),* leaf hopper *(Amrasca devastans),* leaf miner *(Liriomyza trifolil),* potato aphid *(Myzus persicae*), and hadda beetle *(Epilachana dodecastigma)* are the most common insect pests of tomatoes [2]. The most common and serious pest of the tomato is the fruit borer *(Helicoverpa armigera)* due to its direct attack on fruits, high mobility, voracious feeder and overlapping generations. The worldwide annual yield loss due to *H. armigera* alone is approximately 5 billion US dollars [3]. The tomato fruit borer, *He/icoverpa armigera)* is a highly polyphagous species and a pest of great economic importance for a wide variety of crops, especially cotton, soybean, tobacco, chickpea and pigeon pea.

Helicoverpa armigera is one of the most important and destructive pests in tomato farms in India, causing production losses of up to 50-80%. Fruit losses in Tamil Nadu range between 40 to 50%. Similarly, the tomato fruit worm has caused a 30 percent loss of produce in Northern India. In India's tomato-growing regions, this insect pest has caused 5-55% losses. Tomato fruit borer also caused a 35% yield loss in tomatoes and 37.79% specifically in Karnataka, India.

2. MATERIALS AND METHODS

The experiment was conducted at the Central Research Farm of the Department of Entomology, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj during the *Rabi* season of 2021-2022. The research field is situated at 25°27’ North latitude 80°50· East longitudes and an altitude of 98 meters above sea level. The climate is typically semi-arid and sub-tropical. The maximum temperature reaches up to 47°C in summer and drops down to 2.5°C in winter. The average rainfall in this area is around 1013.4 mm annually.

It was carried out in a Randomized block design (RBD) with three replications. A good tilth area was divided into three main blocks. Each main block was subdivided into 8 sub-plots of 2m×2m size. The experiment has 8 treatments comprising of Neem oil (3 ml/lit), NSKE 2% (5 ml/lit), Flubendiamide 480 SC (0.5 g/lit), Novaluron 10% EC (1.5 ml/lit), lndoxacarb 14.5% SC (1 ml/lit), *Emamectin benzoate* 5%SG (0.5 g/lit), Spinosad 45% SC (0.2 ml/lit) and untreated Control. One-month-old seedlings were transplanted @ two seedlings per hill at a spacing of 60 x 40 cm.

The observations of fruit borers were recorded by observing the damaged (infested) fruits and healthy fruits on five randomly selected plants. Observations on percent infestation were recorded one day before spray 3rd, 7th, and 14th, days after spraying. Insecticidal spray solution of desired concentration for each treatment was freshly prepared each time at the site of an experiment, just before spraying.

The extent of the damage was computed by using the formula;

2.1 Percent Fruit Infestation

$$Percent\ fruit\ damage = \frac{number\ of\ damaged\ fruits}{total\ number\ of\ fruits} x\ 100$$

2.2 Benefit Cost Ratio

Cost-effectiveness of each treatment was assessed based on net returns the net return of each treatment was worked out by deducting the total cost of the treatment from the gross return. The total cost of production included both cultivations as well as plant protection charges.

$$Benefit - cost\ ratio\ = \frac{Net\ returns}{Total\ cost}$$

3. RESULTS AND DISCUSSION

In the present study entitled, "Field efficacy of some insecticides and neem products against tomato fruit borer, *Hellicoverpa armigera* (Hubner) in tomato" 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.

The data on the percent infestation of fruit borer on mean after the first spray revealed that all treatments were significantly superior to control. With regard to all of the treatments, Indoxacarb had the lowest percentage of fruit borer infestation (11.70%), followed by Spinosad (12.52%), Flubendiamide (13.33%), Novaluron (13.69%), Emamectin benzoate (14.44%), Neem oil (15.20%), and NSKE (15.51%).

All of the treatments outperformed the control by a significant margin. The data on the percent infestation of fruit borer on mean after the second spray revealed that all treatments were significantly superior to control. With regard to all of the treatments, Indoxacarb had the lowest percentage of fruit borer infestation (8.78%), followed by Spinosad (10.11%), Flubendiamide (11.09%), Novaluron (11.61%), Emamectin benzoate (12.10%), Neem oil (12.80%) and NSKE (13.73%).

The overall data on the percent infestation of fruit borer on overall mean of first and second spray revealed that all treatments were significantly superior to control. With regard to all of the treatments, Indoxacarb had the lowest percentage of fruit borer infestation (10.24%), Spinosad (11.31%), Flubendiamide (12.21%), Novaluron (13.22%), Emamectin benzoate (12.44%), Neem oil (13.79%) and NSKE (14.42%).

All the treatments were superior to control. Among all the treatments minimum percent infestation of fruit borer was recorded in Indoxacarb (10.24%) as compared to untreated control (20.61%). These results were similar to the findings reported by Reddy et al. [4], Kumar et al. [5] Yogeeswarudu et al. [6], Gautam et al. [7], Singh et al. [8] reported that among all the treatments the lowest percentage of fruit borer infestation was recorded in Indoxacarb 14.5SC.

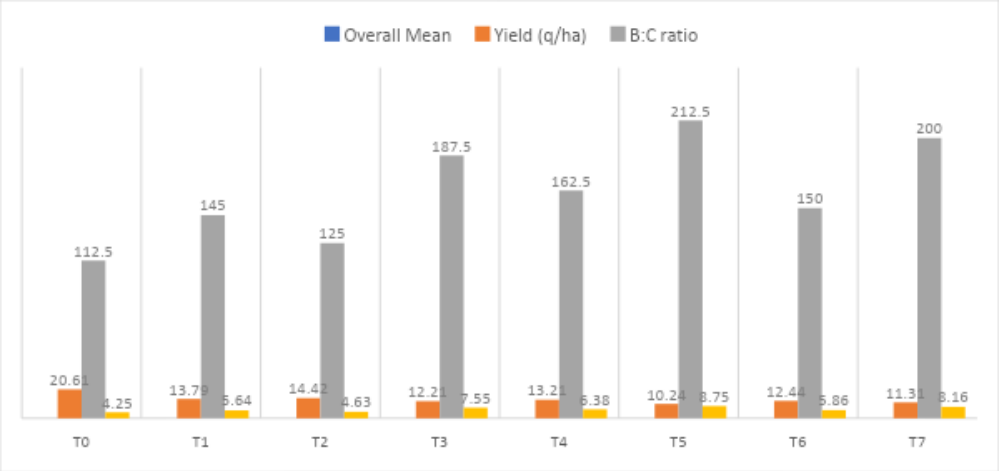

Fig. 1. Graphical representation of overall mean, yield andbenefit-cost ratio of *Helicoverpa armigera* in tomato

Table 1. Efficacy of some insecticides and neem products on tomato fruit borer [*Helicoverpa armigera* (Hubner)] in tomato

S. No.	Treatments	Percent age of fruit infestation of tomato fruit borer								Yield (q/h a)	B:C ratio
		First spray				Second spray			Overall mean		
		1DBS	3DAS	7DAS	14DAS	3DAS	7DAS	14DAS			
T_0	Control	18.99	20.80^{a}	23.26^{a}	24.80^{a}	18.77^{a}	19.21^{a}	19.74^{a}	20.61	112.5	1:4.25
T_1	Neem oil	18.81	13.86^{bc}	12.09^{bc}	16.04^{b}	13.90^{bc}	11.60^{b}	12.91^{b}	13.79	145	1:5.64
T_2	NSKE @2%	18.19	14.43^{b}	12.69^{b}	16.75^{bcd}	15.17^{b}	12.33^{b}	13.68^{b}	14.42	125	1:4.63
T_3	Flubendiamide @480SG	16.86	12.00^{c}	10.91^{e}	13.58^{de}	12.07^{d}	10.37^{d}	10.83^{c}	12.21	187.5	1:7.55
T_4	Novaluron @10% EC	15.62	12.73^{c}	11.50^{de}	14.91^{cd}	12.45^{c}	11.00^{d}	11.37^{c}	13.21	162.5	1:6.38
T_5	Indoxacarb @14.5% SC	17.18	10.19^{d}	7.61^{f}	11.85 f	8.18^{e}	8.58^{f}	9.59^{c}	10.24	212. 5	1:8. 75
T_6	Emamectin benzoate @5% SG	17.15	13.46^{bc}	11.70^{cd}	15.46^{bc}	12.77^{c}	11.39^{c}	12.13^{b}	12.44	150	1:5.86
T_7	Spinosad @45% SC	17.80	10.68^{d}	8.75^{e}	12.88^{ef}	10.54^{de}	9.31^{e}	12.59^{c}	11.31	200	1:8.16
	F- test	NS	S	S	S	S	S	S	S	------	------
	S. Ed. (±)	1.95	0.42	0.59	1.19	0.43	0.52	0.74	0.58	------	------
	C. D. (P = 0.05)	-	0.91	1.28	2.55	0.93	1.12	1.59	1.39	------	------

The yields among the treatment were significant. The highest yield was recorded in Indoxacarb (212.5 q/ha), followed by Spinosad (200 q/ha), Flubendiamide (187.5 q/ha), Novaluron (162.5 q/ha), Emamectin benzoate (150 q/ha), Neem oil (145 q/ha), NSKE (125 q/ha), as compared to control T0-control (112.5 q/ha).

When the cost-benefit ratio was worked out, an interesting result was achieved. Among the treatment studied, the best and most economical treatment was Indoxacarb (1:8.75), followed by Spinosad (1:8.16), Flubendiamide (1:7.55), Novaluron (1:6.38), Emamectin benzoate (1:5.86), Neem oil (1:5.64), NSKE (1:4.63), as compared to control (1:4.25).

Higher yield (212.5 q/ha) and Higher Cost: Benefit Ratio (1:8.75) was obtained from the Indoxacarb treated plots and the lowest (112.5 q/ha) in the untreated control plot. Similar findings were made by Singh et al. [8] who reported that the Indoxacarb 14.5 SC is the best and most economical treatment.

4. CONCLUSION

It can be concluded that among all the treatments, the lowest percent infestation of fruit borer was recorded in Indoxacarb 14.5%SC (10.24%) and proved to be the best treatment followed by Spinosad 45% SC (11.31%), Flubendiamide 480 SG (12.21%), Novaluron 10% EC (13.21%), Emamectin benzoate 5%SG (12.44%), Neem oil (13.79%), NSKE 2% (14.42%) and Untreated control in managing *Helicoverpa armigera* infestation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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The peer review history for this paper can be accessed here:
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