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Management of tomato fruit borer *Helicoverpa armigera* (Hub.) (Lepidoptera, Noctuidae) in Punjab, India

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ABSTRACT: Spinosad, novaluron, neem oil, rynaxypyr, *Ha*NPV and *Bt* were evaluated to reduce the fruit damage in tomato due to fruit borer (*Helicoverpa armigera*). Novaluron recorded the maximum benefit cost ratio (29.06) and hihest improved yield (65.22 q ha^{-1}). Bt had a cost benefit ratio of 17.98, due to the lesser cost of plant protection. © 2024 Association for Advancement of Entomology

KEY WORDS: Better productivity, less toxicity, residue, benefit cost ratio

INTRODUCTION

Due to its unique nutritional content and broad production, the tomato (*Lycopersicon esculentum*) is the second most significant vegetable crop in the world and is referred to as a protective food. With a production area of 5.4 lakh ha, India ranks second globally in terms of the number of tomatoes it produces each year, producing close to 7.1 million tonnes, ranking it fifth globally (Arora *et al.,* 2012). In addition to other factors contributing to low productivity, fruit borer infestations cause significant harm by directly reducing the yield of marketable fruits by 22–38per cent (Dhandapani *et al.,* 2003). The fleshy structure of tomato fruit makes it vulnerable to a variety of insect pests and diseases (Pandey *et al.,* 2015). As a result, enormous volumes of pesticides are consumed, leaving hazardous residues (Kumari *et al.,* 2010). Because it is a crop with a short growing season and a high yield, it is significant economically. India has a climate that is ideal for growing tomatoes all year round. It is grown both outside in open fields and indoors in polyhouses so that the crop can be harvested all year long. Among the pests that attack tomato, the fruit borer (*Helicoverpa armigera*) is important. In Punjab, it is crucial for an effective eco-friendly management approach combined with other management techniques against tomato fruit borer. So, eco-friendly management against tomato fruit borer in reducing fruit damage was undertaken, in order to estimate yield losses from tomato fruit borer damage and propose biorational management measures.

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MATERIALS AND METHODS

Spinosad (45% SC @ 0.3 ml per liter), novaluron (10% EC @ 2.6 ml per liter), neem oil (1000 ppm @ 4 ml per liter), rynaxypyr (20% SC @ 0.4 ml per liter), *Ha*NPV (@ 1ml per liter), *Bacillus thuringiensis* (*Bt* @ 2ml per liter) were evaluated along with a control, on the management of fruit borer. The experiment was conducted at Entomological farm of Lovely Professional University, Phagwara, Punjab, in the Zaid season of 2022.

Estimation of infested fruit percentage: The amount of *H. armigera* in the fruits damage was recorded at each harvest. The healthy and damaged fruits were separated, and the damage fruit infestation was counted to calculate the percentage of damage percentage was worked out with the help of following formula given by Abott, 1925.

$$Percent\ of\ fruit\ damage = \frac{Number\ of\ damage\ fruit}{\begin{array}{c}Total\ number\ of\ fruit\\ (damaged + healthy\ )\end{array}} \times 100$$

Management of Tomato fruit borer (Helicoverpa armigera): The number of larvae per plant was counted on five randomly selected plants in each treatment plot a day before, 3DAS, 7DAS, 10DAS, and 14DAS after each spray. Three sprays of each insecticide at a predetermined concentration were administered. The pest infestation was recorded for each plot and compared to the untreated plots after two consecutive applications of insecticides at 15-day intervals. At each picking, the total number of fruit and those damaged were recorded. The first spray was applied 12 weeks after seedling transplantation, and the second 15 days later, for a total of two sprays. The numbers of tomato fruit borers were counted at 3DAS, 5DAS, 10DAS and 14DAS. To assess the economics of the various treatments against tomato fruit borer, the benefit: cost ratio was calculated.

RESULTS AND DISCUSSION

Fruit damage:

During the initial picking the infestation (on number basis) ranged 19.04 to 29.60 percent, with spinosad recording 20.06 percent, followed by novaluron (19.04%), neem oil (25%), rynaxypyr (23.69%), *Ha*NPV (24.04%), *Bt* (24.31%) and control (29.60 %). Damaged fruit ranged from 17.34 to 29.78 per cent in the second picking, with spinosad recording 19.27 per cent, followed by novaluron (17.34%), neem oil (24.44%), rynaxypyr (21.98%), *Ha*NPV (23.45%) and control (29.78%). In the third plucking fruit damage was in the range of 25.41 to 34.19 per cent, with spinosad recording 26.31 per cent, followed by novaluron (25.41%), neem oil (33.61%), rynaxypyr (30.93%), *Ha*NPV (33.63%), *Bt* (34.19%) and control (34.19%). During the fourth plucking fruit damage was from 21.37 to 36.43 per cent in the treatments. Spinosad recorded 23.09 per cent, followed by novaluron (21.37%), neem oil (36.43%), rynaxypyr (26.90%), *Ha*NPV (28.72%), *Bt* (28.72%) and control (43.81%). In fifth picking, the fruit damage range recorded a minimum of 18.19 and a maximum of 31.06 per cent. Spinosad recorded 19.30 per cent, followed by novaluron (18.19%), neem oil (31.06%), rynaxypyr (23.94%), *Ha*NPV (26.33%), *Bt* (29.11%) and control (46.42%). In sixth picking, the fruit damage was in the range of 15.88 to 29.81 per cent. Spinosad recorded 17.23 per cent, followed by novaluron (15.88%), neem oil (29.81%), rynaxypyr (21.11%), *Ha*NPV (24.34 %), *Bt* (27.17%) and control (39.01%). The average mean of fruit damage on a number basis among various management schedules revealed that novaluron had the significantly least fruit damage (19.54%), closely followed by spinosad (20.88%). Followed by rynaxypyr (24.35%), *Ha*NPV (26.06%), *Bt* (28.37%) and control (30.06%). Statistically all the management schedules performed better than control (Table 1). Novaluron was found to be best when compared with other treatments in terms of fruit damage. This was followed by spinosad and rynaxypyr. Pooran mal kharia (2015) recorded similar pattern.

Population of tomato fruit borer in treatments:

In the first spray, during the 3DAS, larval population per plant in spinosad was found to lowl (4.73), followed by rynaxypyr (4.80), *Ha*NPV (4.93), *Bt*

(5.07), neem oil (5.13) and control (6.00). At 7DAS results were recorded best in spinosad (4.20) followed by rynaxypyr (4.27), *Ha*NPV (4.53), *Bt* (4.60), neem oil (4.67) and control (6.20). At 10DAS larval population in spinosad was 4.07, followed by rynaxypyr (4.33), *Ha*NPV (4.67), *Bt* (4.73), neem oil (4.80), and control (6.33). At 14DAS larval population slowly showed increase in all the treatments viz; spinosad (4.13) followed by rynaxypyr (4.47), *Ha*NPV (4.87), *Bt* (5.07), neem oil (5.20) and control (6.40). It was found that the population in the treatments differed significantly from each other at 3 days after first spray. The significantly lower population (4.67 larvae/plant) was recorded in novaluron, with the highest reduction, which differed significantly from the remaining six treatments at 3 days after spray. Based on these observations, novaluron was found as the most effective insecticide against tomato fruit borer at 3 days after spraying. The effectiveness of the treatments was further compared at 7 days after spray, and it was found that all the treatments were superior to control in controlling tomato fruit borer. A significantly lower population (3.93 larvae /plant) was observed in novaluron with a significant reduction as compared with other treatments. The effectiveness of the treatments was further compared at 10 days after spray, and it was found that spinosad and novaluron treatments were superior to control in controlling tomato fruit borer. A significantly lower population (3.47 larvae /plant) was observed in novaluron with a significant reduction as compared with other treatments. The population of tomato fruit borer was further recorded at 14 days after spray, which showed an almost similar trend in the effectiveness of treatments against tomato fruit borer. Based on post-treatment observations at 3, 7, 10, and 14 days after spray, it was found that all the insecticides were effective against tomato fruit borer. However,

Table 1. Fruit damage (number basis) due to fruit borer, *Helicoverpa armigera* on tomato at each picking

Treat	Fruit damage (%) on various picking (number basis)						Mean
	1st	2nd	3rd	4th	5th	6th	
T_1	20.06 (26.61)^{cd}	19.27 (26.04)^{cd}	26.31 (30.86)^{bc}	23.09 (28.72)^{ef}	19.30 (26.06)^{e}	17.23 (24.52)^{e}	20.88 (27.19)^{de}
T_2	19.04 (25.87)^{d}	17.34 (24.61)^{d}	25.41 (30.27)^{c}	21.37 (27.54)^{f}	18.19 (25.24)^{e}	15.88 (23.49)^{e}	19.54 (26.23)^{e}
T_3	25.00 (30.00)^{b}	24.44 (29.63)^{b}	33.61 (.43)^{a}	36.43 (37.13)^{b}	31.06 (33.87)^{b}	29.81 (33.09)^{b}	30.06 (33.25)^{b}
T_4	23.69 (29.13)^{bc}	20.69 (27.06)^{abc}	29.78 (33.07)^{abc}	26.90 (31.24)^{de}	23.94 (29.29)^{d}	21.11 (27.35)^{d}	24.35 (29.57)^{cd}
T_5	24.04 (29.36)^{b}	21.98 (27.96)^{bc}	30.93 (33.79)^{ab}	28.72 (32.40)^{cd}	26.33 (30.87)^{d}	24.34 (29.56)^{cd}	26.06 (30.69)^{bc}
T_6	24.31 (29.54)^{b}	23.45 (28.97)^{b}	33.63 (35.44)^{a}	32.54 (34.78)^{bc}	29.11 (32.65)^{bc}	27.17 (31.41)^{bc}	28.37 (32.18)^{bc}
T_7	29.60 (32.96)^{a}	29.78 (33.07)^{a}	34.19 (35.78)^{a}	43.81 (41.44)^{a}	46.42 (42.95)^{a}	39.01 (38.65)^{a}	37.13 (37.54)^{a}
SE(m)	0.76	0.30	0.32	0.25	0.32	0.49	1.19
C.D.	2.38	0.93	1.00	0.79	0.99	1.53	3.47

Note: T_1= Spinosad (45% SC @ 0.3 ml per liter), T_2= Novaluron (10% EC @ 2.6 ml per liter), T_3= Neem oil (1000 ppm @ 4 ml per liter), T_4= Rynaxypyr (20% SC @ 0.4 ml per liter), T_5= *Ha*NPV (@ 1ml per liter), T_6 = *Bacillus thuringiensis* (Bt @ 2ml per liter), T_7 = Control. Figures in parentheses are angular transformation (asin(sqrt (x/100))) values

Table 2. Efficacy of different treatments against larval population of tomato fruit borer (*H. armigera*) during Zaid season, 2022

	1st spray					2nd spray				
Treatment	DBS	3DAS	7DAS	10DAS	14DAS	DBS	3DAS	7DAS	10DAS	14DAS
Spinosad	5.20	4.73^{bc} (2.39)	4.20^{bc} (2.28)	4.07^{d} (2.25)	4.13^{de} (2.26)	4.13	3.67^{d} (2.16)	3.00^{d} (2.00)	2.87^{e} (1.97)	3.07^{d} (2.02)
Novaluron	5.40	4.67^{c} (2.38)	3.93^{c} (2.22)	3.47^{e} (2.11)	3.93^{e} (2.22)	3.93	3.20^{e} (2.05)	2.47^{e} (1.86)	1.93^{f} (1.71)	2.13^{e} (1.77)
Neem oil	5.60	5.13^{b} (2.48)	4.67^{b} (2.38)	4.80^{b} (2.41)	5.20^{b} (2.49)	5.20	4.93^{b} (2.44)	4.40^{b} (2.32)	4.33^{b} (2.31)	4.60^{b} (2.37)
Rynaxypyr	5.33	4.80^{bc} (2.41)	4.27^{bc} (2.29)	4.33^{cd} (2.31)	4.47^{cd} (2.34)	4.47	3.93^{d} (2.22)	3.40^{d} (2.10)	3.27^{d} (2.07)	3.40^{c} (2.10)
*Ha*NPV	5.47	4.93^{bc} (2.44)	4.53^{b} (2.35)	4.67^{bc} (2.38)	4.87^{bc} (2.42)	4.87	4.33^{c} (2.31)	3.87^{c} (2.21)	3.93^{c} (2.22)	4.27^{b} (2.30)
Bt	5.27	5.07^{bc} 2.46)	4.60^{b} (2.37)	4.73^{b} (2.39)	5.07^{b} (2.46)	5.07	4.60^{bc} (2.37)	4.13^{bc} (2.26)	4.20^{bc} (2.28)	4.47^{b} (2.34)
Control	5.73	6.00^{a} (2.65)	6.20^{a} (2.68)	6.33^{a} (2.71)	6.40^{a} (2.72)	6.40	6.47^{a} (2.73)	6.47^{a} (2.73)	6.53^{a} (2.74)	6.60^{a} (2.76)
SE(m)		0.137	0.150	0.128	0.162		0.133	0.149	0.116	0.118
C.D. 5%		0.428	0.469	0.400	0.504		0.413	0.464	0.363	0.368

DBS = Day before spraying, DAS = Day after spraying, Figures in parentheses are square root transformation ($\sqrt{x+1}$)values.

Table 3. Economics of different treatments (per ha) against *Helicoverpa armigera* on tomato

Treatment	treatment cost (Rs)	Yield (q)	Increase yield (q)	Increased value (Rs)	Net profit (Rs)	BCR
Spinosad	6300	213.89	52.06	78090	71790	11.40
Novaluron	3255	227.05	65.22	97830	94575	29.06
Neem oil	2550	186.77	24.94	37410	34860	13.67
Rynaxypyr	6000	206.65	44.82	67230	61230	10.21
*Ha*NPV	5250	197.79	35.96	53940	48690	9.27
Bt	2355	191.63	29.8	44700	42345	17.98
Control	-	161.83				

Cost of insecticides: Spinosad 45% SC – Rs1600/ 75 ml; Novaluron 10% EC- Rs 900/1000 ml; Neem oil 10000 ppm - Rs 350/ 1000 ml; Rynaxypyr 20% SC - Rs 900/ 60 ml; *Ha*NPV 1x10^{9} POB Rs 500/ 100 ml; *Bacillus thuringiensis* - Rs 536/ 1000 ml. Rate of tomato fruits – Rs 15/kg novaluron and spinosad were more effective (Table 2).

During the second spray, the number of fruit borers recorded three days after second spray revealed that the treatments differed significantly. Novaluron recorded, the significantly low population (3.20 larvae/plant) 3 days after spray, followed by spinosad (3.67), rynaxypyr (3.93), *Ha*NPV (4.33) and *Bt* (4.60). The effectiveness of the treatments was further compared 7 days after spray, and it was discovered that all the treatments outperformed the control in suppressing fruit borer. Fruit borer populations were much lower (2.47 larvae/plant) with novaluron, followed by spinosad (3.00), rynaxypyr (3.40), *Ha*NPV (3.87) and *Bt* (4.13), and were found to be more effective than neem oil (4.40) and control (6.47) after 7 days of spray. When the effectiveness of the treatments was assessed at 10 days after spraying, it was found that spinosad and novaluron treatments outperformed the control in suppressing fruit borer. Novaluron treatment recorded low population (1.93 larvae/plant), followed by spinosad (2.87), rynaxypyr (3.27), *Ha*NPV (3.93) and *Bt* (4.20), and were found to be effective than neem oil (4.33). The population of fruit borer was also recorded 14 days after spray, which revealed almost similar trend in the effectiveness of treatments against fruit borer. Based on post-treatment observations at 3, 7, 10, and 14 days after spray, it was found that all treatments were efficient against tomato fruit borer when compared to the control. Kolarath *et al.* (2015) found similar results in the efficacy of novaluron against tomato fruit borer as superior to other insecticide followed by spinosad and rynaxypyr. Bhanuprakash *et al.* (2019) reported similar result for the efficacy of insecticide among all the treatments.

Benefit-cost ratio:

The treatments were designed to generate a financial return by enhancing productivity and reducing pest damage. All treatments were deemed to be lucrative over control. Novaluron treatment had the maximum benefit cost ratio (29.06) and the highest improved yield over control (65.22 q ha^{-1}), followed by, treatment *Bt* (17.980, neem oil (13.67) and Spinosad (11.40). Rynaxypyr recorded (10.21) low cost benefit ratio due to highest cost of plant protection. Sundar Pal *et a.,* (2018) also found similar results, where the maximum return was recorded in Novaluron followed by Spinosad and Rynaxypyr as compared to others over control (Table 3).

REFERENCES

Abbott W.S. (1925) A method of computing the effectiveness of an insecticide. Journal of Economic Entomology 18(2): 265–267.

Arora S., Kanojia A.K., Kumar A., Mogha N. and Sahu V. (2012) Biopesticide formulation to control tomato lepidopteran pest menace. Current science 102(7): 1051–1057.

Bhanuprakash S.V., Sharanappa and Kumar A. (2019) Seasonal incidence of tomato fruit borer and efficacy of chemical, Bio insecticides and HaNPV against *Helicoverpa armigera* in Tomato. Journal of Pharmacognosy and Phytochemistry 8(1): 2366–2369.

Dhandapani K.M., Hadman M., De Sevilla L., Wade M.F., Mahesh V.B. and Brann D.W. (2003) Astrocyte protection of neurons: Role of transforming growth factor-â signaling via a c-Jun-AP-1 protective pathway. Journal of Biological Chemistry 278(44): 43329–43339.

Ghosh A., Chatterjee M. and Roy A. (2010) Bio-efficacy of spinosad against tomato fruit borer (*Helicoverpa armigera* Hub.) (Lepidoptera: Noctuidae) and its natural enemies. Journal of Horticulture and Forestry 2(5): 108–111.

Kharia P.M. (2015) Population Dynamics and Evaluation of Management Schedules for Fruit Borer, *Helicoverpa Armigera* (Hubner) and Whitefly, *Bemisia tabaci* (Gennadius) on Tomato [With CD Copy]. Doctoral dissertation, Department of Entomology, CCSHAU, Hisar, Hariyana.

Kumari P., Singh A.K., Chattopadhyay B. and Chakraborty S. (2010) Molecular characterization of a new species of Begomovirus and betasatellite causing leaf curl disease of tomato in India. Virus Research 152(1-2): 19–29.

Pal S., Singh D.K., Umrao R.S. and Sharma O. (2018) Eco-Friendly Management of Tomato Fruit Borer, *Helicoverpa armigera* under Hill Condition, Uttarakhand, India. International Journal of

Current Microbiology and Applied Sciences 7(10): 3008–3013.

Pandey R., Gupta,A., Chowdhary A., Pal R K. and Rajam M.V. (2015) Over-expression of mouse ornithine decarboxylase gene under the control of fruit-specific promoter enhances fruit quality in tomato. Plant molecular biology 87: 249–260.

Remya K., Balikai R.A., Nandihalli B.S. and Havaldar Y.N. (2015) Evaluation of newer insecticides for the management of pod borers of field bean, *Lablab purpureus* (L.) Sweet. Karnataka Journal of Agricultural Sciences 28(1): 107-109.

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