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Efficacy of different chemical insecticides and bio-pesticides against tomato fruit borer *Helicoverpa armigera* (Hubner) on tomato crop.

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ABSTRACT
A field study was undertaken at Student Instructional Farm of C.S.A.U.A &T., Kanpur, during Rabi season 2015-16, to evaluate efficacy of different chemical insecticides viz., Indoxacarb 14.5 SC, Fipronil 5 SC, Malathion 50 EC, and bio pesticides viz., Spinosad 45 SC, Bacillus turingiensis var. kurstaki, HaNPV, Neemarin and Metarrhizium anisopliae (Metschn.) against H. armigera. Result revealed that sequential application of insecticides i.e. Indoxacarb 14.5 SC @ 0.5 ml/lit. and Fipronil 5SC @ 1.0 ml/lit. were found to be most effective in reducing the larval population of H. armigera compared to standard checks. Among the bio-pesticides, spinosad 45 SC @ 0.20 ml/lit and B. turingiensis var. kurstaki @ 1.5gm/lit. found to be effective. Whereas lowest fruit infestation on both weight (16.40%) and number (17.50%) basis was recorded from indoxacarb14.5 SC followed by fipronil 5 SC. All the above treatments were found to be superior over untreated control which recorded highest number of larvae and fruit damage per plant.
Key words: *Helicoverpa armigera, Indoxacarb, Spinosad, Tomato.*

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INTRODUCTION

Tomato, *Lycopersicon esculentu* (Mill.) is an important vegetable crop grown all over the world. This crop is severely attacked by various insect pests *viz.,* fruit borer, *H. armigera* (Hub.); whitefly, *Bemisia tabaci* (Gennadius); aphid, *Aphis gossypii* (Glover); leaf eating caterpillar, *Spodoptera litura* (Fabricius); American serpentine leaf miner, *Liriomyza trifolii* (Burgess) and red spider mite, *Tetranychus urticae* (Koch) Ignacimuthu, S. [2]. Among these, fruit borer, *H. armigera* is an important pest responsible for major yield loss in tomato. *H. armigera* has attained the status of national pest in recent years in the form of economic damage caused to different agricultural crops throughout India. Number of synthetic organo-phosphate insecticides has been recommended for its effective control from different parts of country [3]. The safe and effective pesticides should be recommended for control of this pest. With this objective now a day's bio- pesticides have been recognized in biological approach of pest management against various insect pest infecting vegetables and fruits crops. Therefore, the use of bacteria, *B. thuringiensis* (Berliner), in its various formulations proved one of the promising for tomato pest management. Hence, a worldwide recognition has been accepted to these bacteria, *B. thuringiensis* under different trade names. Another bio-pesticide that plays an important role for controlling the *H. armigera* is the recently introduced Spinosad, one of such new chemicals which are derived from fermentation broth of soil actinomycetes, *Saccharopolyspora spinosa*, containing a naturally occurring mixture of spinosyn A and spinosyn D. Therefore, to assess the bio-efficacy and to determine the effective dose of this insecticide for the suppression of tomato fruit borer, the present work was carried out.

MATERIALS AND METHODS

The field experiment was conducted during Rabi seasons of 2015 and 2016. Seedlings of Tomato variety Azad T-5 were transplanted in 3 x 2 m^2 plots with a spacing of 60 x 40 cm along with recommended standard agronomical practices except crop protection measures.

The treatments were as follows:

T_1= Indoxacarb 14.5SC (0.50 ml/lit.), T_2=Fipronil 5SC (1.0 ml/lit.), T_3= Malathion 50EC (1.0 ml/lit.) T_4= Spinosad 45SC (0.20 ml/lit.), T_5= *B. thuringiensis var kurstaki* (1.5 gm/lit.), T_6=HaNPV (1.0 ml/lit.), T_7=Neemarin 1500ppm (4.0 ml/lit.), T_8=*Metarrhizium anisopliae* (4.0 ml/lit.) and T_9= Control. Three chemical insecticides and five biopesticides were chosen. The experiment was RBD design with three replications and nine treatments. The respective insecticides were sprayed on tomato manually by hand compression sprayer. To compare the efficacy of treatments, both recommended insecticides as well as untreated control were maintained. First spray application was made at the initiation of pest at 60 days after transplanting and second and third spraying was done at 15 and 30 days after first spray.

Preparation of spray solution: The concentration of insecticides on the basis of active ingredient the desired amount of each insecticide was measured by micro pipette and electronic balance and then mixed with required amount of water. The formulation was diluted with water just at the time of spraying was done with the help of atomizer.

$$\textbf{Amount insecticide} = \frac{\text{concentration required per cent} \times \text{volume required (lit.)}}{\text{cocentration of toxicant in insecticide formulation}}$$

Observations

Observations were recorded on the number of larvae per plant on 10 randomly selected plants per plot on one day before, 5, 10 and 15 days after each spray.

The data on percentage infestation of tomato fruits by borer was calculated at each picking by counting damage and healthy fruits in each spray application. The mean per cent fruit damage was calculated using formula:

$$\textbf{Mean fruit damage \%} = \frac{\text{number of damaged fruits}}{\text{total number of fruits}} \times 100$$

RESULT AND DISCUSSION

Efficacy of some insecticides and bio-pesticides against larval population fruit borer, *H. armigera* infesting tomato recorded at different intervals after first, second and third spray

The results showed that all the insecticidal treatments recorded significantly lowest larval population over control (Table1). Larval population of *H. armigera* was significantly lower in all the treated plots over control. From the result of first spray, Indoxacarb recorded least larvae followed by Fipronil and Malathion. Among biopesticides Spinosad showed best results, whereas HaNPV and *B. thuringiensis var. kurstaki* showed same mean larval population. Other bio-pesticides *viz.*, Neemarin and *M. anisopliae* found least effective but were superior over control. After15 days of 2ndspray, the fruit borer population was once again recorded minimum in plots treated with Indoxacarb. In case of biopesticides Spinosad followed by *B. thuringiensis var. kurstaki* was observed as best. The mean larval population remain constant after 3rd spray. These findings are agreement with Abhijit *et al.* [1]) some pesticides with novel mode of action (spinosad, rynaxypyr, indoxacarb, flubendiamide) against *H. armigera* on tomato (Var. Pathorkuchi) in field condition was observed. He recorded Indoxacarb 14.5SC @ 40g a.i. ha^{-1} was superior over other treatments against *Helicoverpa*, with 98.04 per cent reduction followed by spinosad 45 SC @ 60 g a.i. ha^{-1} (88.03%). However, Mahakalkar *et al.* [4] recorded the lowest fruit infestation from the plots treated with HaNPV (11.78%) and *B. thuringiensis* (9.64%) in alternate spraying against *H. armigera*. Sherzad and Kumar [6] observed spinosad 45 SC @ 0.40%, dichlorvos 76 EC @ 0.60% and imidacloprid 200 SL @ 4 ml/lit. were found to be most effective, with fruit damage percentage of 0.53, 1.00 and 1.04 respectively. Wajid, *et al.* [8] reported indoxacarb 75 and 60 g a.i. /ha dosage with 7.0 and 8.0 per cent fruit damage.

Table1. Effect of different insecticides against larval population of *H. armigera* after 5, 10 and 15 days of 1st, 2nd and 3rd spray (DAS: Days after spray).

Treatment	Dose 1^{-1} of Water	Mean number of larval population (*H. armigera*)/ 10 plants at								
		After 1st spray			After 2nd spray			After 3rd spray		
		5 DAS	10 DAS	15 DAS	5 DAS	10 DAS	15 DAS	5 DAS	10 DAS	15 DAS
Indoxacarb 14.5SC	0.50 ml	2.00	3.00	1.66	2.33	2.33	1.33	2.33	2.33	1.33
Fipronil 5SC	1.0 ml	2.33	3.00	2.00	3.33	2.66	1.66	3.33	3.33	1.66
Malathion 50EC	1.0 ml	2.33	3.33	2.33	3.66	3.00	2.00	3.66	3.66	2.00
Spinosad 45SC	0.20 ml	2.66	3.66	2.66	4.00	3.33	2.66	4.00	4.00	2.66
B.thuringiensis	1.5 gm	5.00	5.00	4.00	4.33	3.66	3.33	4.33	4.33	3.33
HaNPV	1.0 ml	5.33	6.00	4.66	5.00	4.00	4.00	5.00	5.00	4.00
Neemarin	4.0 ml	5.66	6.33	5.33	6.00	4.66	5.00	6.00	6.00	5.00
M. anisopliae	4.0 gm	5.66	6.66	6.33	6.66	6.00	5.33	6.66	6.66	5.33
Control	-	9.00	15.00	11.66	16.00	17.00	16.33	16.00	16.00	16.33
S.E.(D)±		0.938	1.089	1.09	1.133	1.035	0.911	1.133	1.133	0.911
CD at 5%		2.005	2.328	2.33	2.423	2.213	1.948	2.423	2.423	1.948

Impact of various insecticides and biopesticides treatments on infestation of fruits by *Helicoverpa armigera* (Hubner.) on tomato.

Fruit infestation on weight basis

The data demonstrated in table no-2 revealed that all the treatments were significantly superior in reducing the fruit infestation compared to the untreated control 53.40 per cent. Application of Indoxacarb 14.5 SC was found most effective followed by Fipronil 5 SC gave 16.40 and 18.60 per cent reduction in fruit damage on weight basis, respectively. The per cent fruit damage in rest of the insecticidal treatments were 20.07 per cent in Malathion 50EC, 22.80 per cent in Spinosad 45SC, 25.40 per cent in *B t var kurstaki*, 26.30 per cent in HaNPV, 28.40 per cent in Neemarin 1500ppm and 32.10 per cent in *M. anisoplea* treatments in compared to untreated check (53.40%) in bringing down the fruit infestation. Present findings are in agreement with Wajid, *et al*. [8] reveled that lowest per cent damage of fruits by *H. armigera* was observed in indoxacarb 75 and 60 g a.i. /ha dosage with 7.0 and 8.0 per cent fruit damage. Indoxacarb 50 g a.i. /ha was at par with chlorpyrifos having 14.66 and 11.83 per cent fruit damage, respectively.

Fruit infestation on number basis

The data of mean fruit infestation on number basis, indoxacarb 14.5 SC found lowest followed by fipronil 5 SC gave 17.50 and 19.70 per cent fruit damage on number basis. The per cent fruit damage in rest of the insecticidal treatments were 21.50 per cent in malathion 50EC, 23.80 per cent in spinosad 45 SC, 26.30 per cent in *Bt var kurstaki*, 27.70 per cent in HaNPV, 30.50 per cent in neemarin 1500ppm and 34.50 per cent in *M. anisoplea* treatments in compared to untreated check (56.30%) in bringing down the fruit infestation. Present findings are in agreement with Rahman, *et al.* [5] reported that two microbial insecticides HaNPV @ 0.4ml/lit. and *Bt* @ 2g/lit along with their combination against *H. armigera* gives lowest fruit infestation, both in number and weight, was obtained from treatment HaNPV and *Bt* alternate spraying (11.78%, 9.64%), followed by *Bt* (13.25%, 10.85%) and HaNPV (17.67%, 13.11%).

Table no-2. Impact of various insecticides and biopesticides treatments on infestation of fruits by *H. armigera* (Hubner.) on tomato.

Treatments	Fruit infestation on number basis (%)	Fruit infestation on weight basis (%)
Indoxacarb14.5SC	17.50	16.40
Fipronil 5SC	19.70	18.60
Malathion 50EC	21.50	20.07
Spinosad 45SC	23.80	22.80
Bacillus thuringiensis	26.30	25.40
HaNPV	27.70	26.30
Neemarin	30.50	28.40
Metarrhizium anisopliae	34.50	32.10
Control	56.30	53.40
S.E.(D)±	1.73	1.56
CD at 5%	3.54	3.25

CONCLUSION
The data on mean larval population after third spray indicated that among the all treatments, indoxacarb 45 SC @ 0.5 ml/lit. was found to be significantly superior over rest of the treatments which recorded lowest 1.33 larvae/plant after 15 days after spraying followed by fipronil 5 SC. Among the biopesticides treatments spinosad 45SC @ 0.2ml/lit. lowest 2.66 larvae/plant after 15 days after spraying followed by *B. thuringiensis* 1.5 g^{-1} . The maximum (16.33 larvae/plant) was recorded in untreated control, where as lowest fruit infestation on both weight (16.40%) and number (17.50%) basis was recorded from Indoxacarb14.5 SC followed by fipronil 5 SC.

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