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RESEARCH ARTICLE

COMPARATIVE EFFICACY AND ECONOMICS OF DIFFERENT INSECTICIDES AND BIOPESTICIDES AGAINST TOMATO FRUIT BORER [*HELICOVERPA ARMIGERA* (HUBNER)] ON TOMATO (*SOLANUM LYCOPERSICUM* L.)

Sirasala Mahesh* and Ashwani Kumar[1]

Department of Entomology, Naini Agricultural Institute,
Sam Higginbottom University of Agriculture, Technology and Sciences,
Prayagraj – 211007, India.
Email: maheshsirasala7@gmail.com

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Abstract: The field trial was conducted at SHUATS, Prayagraj, during *Rabi*-2022-23. Experiment was laid out in RBD (Randomized Block Design) with eight treatments replicated three evaluated against *Helicoverpa armigera* i.e., T_1 Novaluran 10% EC, T_2 Emamectin benzoate 5% SG, T_3 Chlorantraniliprole 18.5% SC, T_4 *Beauveria bassiana* 1x10^8CFU, T_5 Neem oil 4%, T_6 Spinosad 45% SC, T_7 Nisco Sixer Plus and T_8 untreated Control. Were tested to compare the efficacy against *Helicoverpa armigera* and their influences on yield of Tomato. The best and most economical treatment is Chlorantraniliprole 18.5% SC (260q/ha) followed by Spinosad 45% SC (245q/ha), Emamectin benzoate 5% SG (225q/ha), Nisco Sixer Plus (200q/ha) Novaluran 10% EC (185q/ha), Neem oil 4% (163q/ha) *Beauveria basiana* 1x10^8 CFU (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 Chlorantraniliprole 18.5% SC (1:6.02) followed by Spinosad 45% SC (1:5.65), Emamectin benzoate 5%SG (1:5.30), Nisco Sixer Plus (1:4.72), Novaluran 10% EC (1:4.32), Neem oil 4% (1:3.83), *Beauveria basiana* 1x10^8CFU (1:3.53), as compared to untreated control T_8 (1:1.96) having the lowest B:C ratio.

Keywords: Biopesticides, Insecticides, *Helicoverpa armigera*, Chlorantraniliprole, Tomato, Yield

INTRODUCTION

Tomato, *Solanum lycopersicom* (Miller) is one of the most important herbaceous crop belonging to the Solanaceae family. It is popularly known as Wolf apple, Love of apple or Vilaayati baingan. It ranks third largest vegetable crop after potato and sweet potato, but it top in the list of canned vegetables. It can be used fresh in salad, curries or by by-product like chutney, pickle, soups, ketchup, sauce, powder, purees and as a whole etc. (Sharma *et al*., 2018).

Tomato fruit (*Solanum Lycopersicum* L.) is considered as one of the most effective and nutritious foods in the human diet. This fruit is rich in bioactive compounds like vitamins, carotenoids, and phenolic compounds. These compounds have high antioxidant activity and are then beneficial to human health (Panek *et al*., 2017).

India produces around 19.0 million tonnes of tomatoes annually, which is insufcient to meet the ever-increasing demand. A big gap of tomato productivity (72.14 t ha^{-1}) between India (24.66 t ha^{-1}) and the USA (96.8 t ha^{-1}) exist, which can be bridged by integrating trellis system of shoot training, shoot pruning, liquid fertilizers, farmyard manure, and mulching technologies.(Rathore *et al*., 2021).

The fruit borer, *Helicoverpa armigera* (Hubner) is the most destructive pest of tomato in India, which is commonly known as gram pod borer, American bollworm and tomato fruit borer. Young larvae feed exclusively on foliage, flower buds and flowers, while the later instars of these insects bore into fruit and render them unmarketable. Season wise avoidable losses were 36.36, 37.39 and 22.39 during January-February, March-April and October November, respectively (Meena *et al*., 2014).

MATERIALS AND METHODS

The experiment was conducted during the *Rabi* season 2022, at the Crop Research Farm(CRF), Department of Entomology, Naini Agricultural

*Corresponding Author

Institute, Sam Higginbottom University of Agriculture, Technology And Sciences (SHUATS), Prayagraj (U.P.) which is located at 25^0 39 42" N latitude, 81^0 67 "56" E longitude and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the Yamuna River by the side of Prayagraj - Rewa road about 12 km from the city.

The experiment was layed out in a randomized block design (RBD) using variety sahoo with 8 treatments including untreated control replicated thrice as depicted with individual plots of 2m x 1m with the spacing of (60cm x 45cm) and a recommended set of practices excluding plant protection during *Rabi* season 2022.

The observation on infestation of *Helicoverpa armigera* was recorded visually per plant from five randomly selected plants and tagged plants in each plot. The number of infected fruits from randomly selected plants per plot were tallied and recorded at weekly intervals on the seventh and fourteenth days after spraying observation were made on the amount of infested fruits on selected plants in each plot.

The insecticides used in this field trial are Novaluran 10% EC, Emamectin benzoate 5% SG, Chlorantraniliprole 18.5% SC, *Beauveria bassiana* $1x10^8$ CFU, Neem oil 4%, Spinosad 45% SC, Nisco Sixer Plus. The basal application of fertilizers was done manually and insecticides were applied with the help of knapsack sprayer by considering ETL level for making spray decisions.

The healthy marketable yield that was achieved from the various treatments was gathered and weighed separately. Insecticide costs for this experiment were calculated for the 2022 *Rabi* season. The price of the used botanicals was acquired from a neighbouring market. The cost of treatments, rent for burrowing the sprayer, and manpower costs for the spraying made up the entire cost of plant protection. During the research period, there were two sprays, and the total cost of plant protection was estimated. The net benefit is calculated by deducting the total cost of plant protection from total income, which was calculated by multiplying the total yield per hectare by the going market rate. The benefit over the control for each sprayed treatment was derived by deducting the income of the control treatment from that of each sprayed treatment.

Formulae Used

Percent fruit infestation:

Per cent fruit damage

$$= \frac{Number\ of\ damaged\ fruits}{Total\ number\ of\ fruits} X100$$

Benefit Cost Ratio:

Benefit Cost Ratio = Gross Returns /Total cost incurred

RESULTS AND DISCUSSION

The effectiveness of various insecticides on the percent infestation of the tomato fruit borer revealed that all treatments were significantly more effective than controls at reducing the infestation of the shoot and fruit borer and, as a result, significantly increased yield. On 7th and 14th day of first spray lowest percentage infestation was recorded in Chlorantraniliprole 18.5% SC (9.21 and 9.30) followed by Spinosad 45% SC (9.37 and 10.29) and Emamectin benzoate 5% SG (10.75 and 11.03) treated plots respectively that differed significantly with other treatment plots but statistically at par with each other.

The lowest percent infestation was seen in plots treated with Chlorantraniliprole 18.5% on the seventh and fourteenth days after the second spray (5.73 and 9.27), followed by Spinosad 45% SC (6.21 and 9.37) and Emamectin benzoate 5% SG (7.05 and 9.51). These findings are corroborated by Devi *et al*. (2014) and Wade *et al*. (2020), who found that Chlorantraniliprole 18.5% outperformed other insecticides in lowering the percentage of tomato fruit borer infection. Chlorantraniliprole 18.5% was discovered to be the most effective therapy by Patel *et al*. (2016) and Ghosh *et al*. (2010).

The yields for the various treatments were substantial. Compared to the control plot (80 q/ha), Chlorantraniliprole 18.5% (260 q/ha) produced the highest yield, followed by Spinosad 45% SC (245 q/ha), Emamectin benzoate 5% SG (225 q/ha), Nisco Sixer Plus (200 q/ha), Novaluran 10% EC (185 q/ha), Neem oil 4% (163 q/ha) and *Beauveria bassiana* $1x10^8$CFU (149 q/ha). Jamir and Kumar (2022) also confirm these findings.

Chlorantraniliprole 18.5% (1:6.02), Spinosad 45% SC (1:5.65), Emamectin benzoate 5% SG (1:5.30), Nisco Sixer Plus (1:4.72), Novaluran 10% EC (1:4.32), Neem oil 4% (1:3.83) and *Beauveria bassiana* $1x10^8$CFU (1:3.53).were the most effective and cost-effective treatments out of those investigated, when compared to control plot (1:1.96). Ravi *et al*. (2008) validate these findings.

Table 1. Yield and benefit cost ratios, effectiveness of chosen pesticides against tomato fruit borer during first and second sprays.

No.	Names of the Treatments	Dosage	Tomato fruit borer infestation percentage/ Five plants				Yield (q/ha)	B:C Ratio
			First spray		Second spray			
			7DAS	14DAS	7DAS	14DAS		
T_1	Novaluran 10% EC	1.5 ml/l	11.51	12.59	8.74	10.57	185 q/ha	1:4.32
T_2	Emamectin benzoate 5% SG	0.4 gm/lit	10.75	11.03	7.05	9.51	225 q/ha	1:5.30
T_3	Chlorantraniliprole 18.5%	0.4 ml/l	9.21	9.30	5.73	9.29	260 q/ha	1:6.02
T_4	*Beauveria bassiana* $1x10^8$CFU	40 ml/l	12.22	13.61	10.56	11.14	149 q/ha	1:3.53
T_5	Neem oil 4%	2.5 ml/l	12.08	13.08	9.49	10.86	163 q/ha	1:3.83
T_6	Spinosad 45% SC	0.3 ml/l	9.37	10.29	6.21	9.37	245 q/ha	1:5.65
T_7	Nisco Sixer Plus	2 ml/l	10.91	11.88	7.86	10.07	200 q/ha	1:4.72
T_0	Control	-	19.21	21.14	22.22	24.26	80 q/ha	1:1.96
	F- test		S	S	S	S	-	-
	S. Ed. (±)		0.95	0.12	0.25	0.44	-	-
	C. D. (P = 0.05)		2.87	1.32	0.73	0.37	-	-

DAS – Day after Spray

CONCLUSION

It was concluded that among all the treatments Chlorantraniliprole 18.5% SC proved to be the best treatment which is followed by Spinosad 45% SC , Emamectin benzoate 5% SG, Nisco Sixer Plus, Novaluran 10% EC , Neem oil 4%, and *Beauveria bassiana* $1x10^8$CFU 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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