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Research Article

Comparative Efficacy and Economics of Selected bio Pesticides with Chlorantraniliprole Against Tomato Fruit Borer [Helicoverpa Armigera (Hubner)] on Tomato [Solanum lycopersicum L

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Abstract

The field trial was conducted at Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, UP during Rabi, 2022–2023. The experiment was laid out in RBD (Randomized Block Design). Eight treatments were evaluated against Helicoverpa armigera i.e., (T1) Chlorantraniliprole 18.5% SC (T2) ½Dose Chlorantraniliprole + Nisco sixer plus 2ml/lit (T3) Spinosad 45% SC (T4) Nisco sixer plus 2ml/lit (T5) Neem seed kernel extract 5% (T6) Azadirachtin 5% (T7) Beauvaria bassiana and (T0) untreated Control Were tested to compare the efficacy against Helicoverpa armigera and their influences on yield of Tomato. The best and most economical treatment T1 Chlorantraniliprole 18.5% SC (1:10.), followed by T2 ½Dose Chlorantraniliprole + Nisco sixer plus 2ml/lit (1:10.0) T3 Spinosad 45% SC (1:8.7), T4 Nisco sixer plus 2ml/lit (1:8.1), T5 Neem seed kernel extract 5% (1:6.9), T6 Azadirachtin 5% (1:6.5), T7 Beauvaria bassiana (1:5.8), T0 untreated control (1:4.9) having lowest B:C ratio. Chlorantraniliprole 18.5% SC, ½Dose Chlorantraniliprole + Nisco sixer plus 2ml/lit, Spinosad 45% SC, Nisco sixer plus 2ml/lit recorded the minimum fruit infestation by 8.57, 9.60, 10.66, 11.35 percent respectively. The highest yield was noticed in Chlorantraniliprole 18.5% SC (240.5 q/ha), followed by ½Dose Chlorantraniliprole + Nisco sixer plus 2ml/lit (232.5 q/ha) and Spinosad (200 q/ha).

Key Words: bio pesticides; chlorantraniliprole; cost benefit ratio; helicoverpa armigera; tomato; yield

Introduction

Tomato (Lycopersicon esculentum Mill.) belonging to the family Solanaceae is the native of Peru Ecuador region and is one of the most popular and widely grown crops of commercial and dietary significance in the world as it is a very versatile vegetable. Due to its high consumption rate in developed and developing countries, it is often referred to as a luxury crop. In England, it is popularly known as Love Apple and is grown in all home gardens and by a large number of market and truck growers. It is also being grown in greenhouse in off-season. Now, it has become a good source of income to small and marginal farmers. In many countries, it is considered as poor man's orange. Tomato is also an important source of lycopene, ascorbic acid and β-carotene, which are potent antioxidants. (Kharia et al., 2022)18

Tomato is the most widely eaten vegetable, ranking first as a processing vegetable and second in terms of production after potato in the world. Nutritionally, it serves as a source of vitamins A, B, C, and D and minerals such as calcium, phosphorus, and iron. It is consumed in fresh or processed forms. However, the national average yield of tomatoes of countries such as China (59.4 tons ha− 1), India (24.6 tons ha− 1), the USA (96.8 tons ha− 1), Turkey (68.8 tons ha− 1), and Egypt (40.9 tons ha− 1) (Mengistie et al., 2022).11

In India, it ranks second among vegetables in area and production and occupies an area of 1.20 million ha. with a production of 19.4 million tons and average yield of 16.1 tons per hectare. The total cultivated area of tomato in India is about 767.32 thousand ha. With total production 16,384.98 thousand MT. India shares in the world tomato production about 11% in the year (2014-15). Madhya Pradesh is the largest tomato producing state occupying the 70.23 lakh ha. of with 2177.00 MT production (2014-15). The second largest tomato producing state in India is Karnataka having production area of 64.25 lakh ha. with a production 2034.37 MT (2014-15), Andhra Pradesh state has third rank in tomato area and production.

Respectively in the area 54.22 lakh ha. and production 1473.54 MT. (Kushwaha et al., 2018)9

The important insect pests of tomato are fruit borer Helicoverpa armigera, whitefly Bemisia tabaci, leaf hopper Amrasca devastans, leaf miner Liriomyza trifolii, potato aphid Myzus persicae and hadda beetle Epilachana dedecastigma. Among the various insect pests, tomato fruit borer, Helicoverpa armigera (Hubner) is highly destructive causing serious damage. Fruiting stage of the crop and the time of plantation govern the incidence of fruit borer. Larvae invade fruits, preventing fruit development and causing the fruit dropping. Tomato Fruit Borer damage can also be responsible for decreasing the seed viability compared to undamaged fruit. Larvae can be found only by opening the infested fruit. Severe infestation causes necrosis to the leaf chlorophillus tissue, suppresses tomato flowers to bloom and makes the mature fruit unfit to consume. It has been reported to cause serious losses throughout its range, in particular to tomato it has been found to cause a yield loss of 35–37.79% fruit. (Biswas et al., 2022)3 In India, loss in tomato yield 50 to 80 per cent. Similarly, in Northern India, 30% loss of the fruit was observed due to tomato fruit worm. 5–55% losses from this insect pest in the tomato growing areas of India. Tomato fruit worm has also caused 35% yield loss in tomato and 37.79% specifically in Karnataka, India.

In tomato the total life cycle was completed in 35 to 75 days depending on climate. Female lays eggs in groups of 4 to 10, sometimes they were scattered. The incubation period varied from 4 to 6 days. The larva moults six times to become adult (Singh. S 2017)17. The average corresponding days for each instars are 2 to 8 days. Pupa stage last for 10 to 14 days. The male moth emerged within 9 days and female moth takes 11 days to complete development. (Ali et al., 2009)1.

Materials and Methods

The experiment was conducted under field conditions at Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, UP during the rabi season 2022–2023 in Randomized block design with three replications. A good tilth area was divided into three main blocks. Each main block was sub-divided into 8 sub-plots of 2m × 1m size with maintaining 30 cm borders as a bunds and treatments was assigned randomly. The research field is situated at the right side of Rewa road at 25◦ 22' 15.888" North Latitude and 81◦51' 31.4712" East Longitude and is about 98m above mean sea level. The climate at Prayagraj is typical subtropical which prevails in the eastern part of UP. The extremes of both summer and winter are experienced here. The maximum temperature recorded during summer up to 47◦C and the minimum temperature was recorded during winter up to 1.5◦C. All necessary facilities for cultivation of crop were available at research farm. The spray solution of desired concentration was prepared by adoption the following formula:

$$V = \frac{C \times A}{\%\ a.\ i.}$$

Where,

V = Volume of a formulated pesticide required.

C = Concentration required.

A = Volume of total solution to be prepared.

% a.i. = Given Percentage strength of a formulated pesticide.

Percent Fruit Infestation:

$$\text{Per cent fruit damage} = \frac{\text{Number of damaged fruits}}{\text{Total number of fruits}} \times 100$$

Cost Benefit

Ratio:

Gross return = Marketable Yield x Market price

$$\text{Benefit Cost Ratio} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

(Singh et al., 2017)16

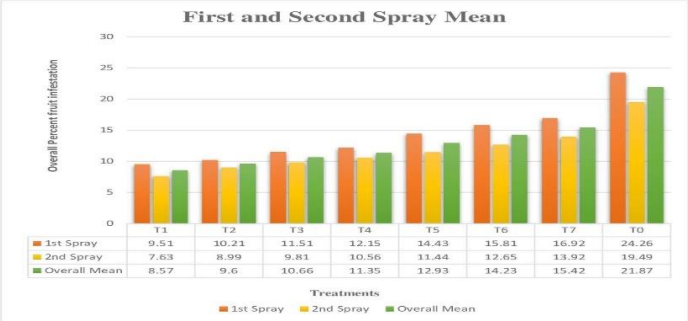
Results and Discussions:

S.No.	Treatments	Percent fruit infestation of 5 plants								Overall Mean	Yield (q/ha)	C:B ratio
		Dosage	First Spray				Second Spray					
			DBS	7DAS	14DAS	Mean	DBS	7DAS	14DAS	Mean		
T1	Chlorantraniliprole18.5%SC	1ml/L	21.67	8.44	10.59	9.515	11.85	6.64	8.62	7.63	8.57	240.5	1:10.4
T2	½Dose chlorantraniliprole + Nisco sixer plus 2ml/lit	0.5ml/L+ 2ml/L	19.48	9.06	11.37	10.216	13.43	8.9	9.08	8.99	9.60	232.5	1:10.0
T3	Spinosad 45% SC	0.4ml/L	18.69	10.25	12.05	11.15	14.43	9.63	10.0	9.81	10.66	200	1:8.7
T4	Nisco sixer plus 2ml/lit	2ml/L	18.91	11.23	13.07	12.15	14.87	10.52	10.59	10.56	11.35	187.5	1:8.1
T5	Neem seed kernel extract 5%	50ml/L	18.31	15.00	13.86	14.43	15.32	11.29	11.60	11.44	12.93	160	1:6.9
T6	Azadirachtin 5%	5ml/L	18.02	16.31	15.31	15.81	16.86	12.80	12.50	12.65	14.23	150.5	1:6.5
T7	Beauvaria bassiana	2gm/L	20.36	17.66	16.17	16.92	17.51	14.39	13.46	13.92	15.42	135.5	1:5.8
T0	Control		21.53	23.19	25.33	24.26	23.14	18.86	19.49	19.17	21.87	110.5	1:4.9
	F-test		NS	S	S	S	S	S	S	S	S	-	-

S.No.	Treatments	Percent fruit infestation of 5 plants								Overall Mean	Yield (q/ha)	C:B ratio
		Dosage	First Spray				Second Spray					
			DBS	7DAS	14DAS	Mean	DBS	7DAS	14DAS	Mean		
	S. Ed. (±)		1.38	0.35	0.32	0.85	0.39	0.31	0.15	0.42	0.58	-	-
	C.D. (P = 0.05)		-	1.047	0.995	2.842	1.175	0.941	0.463	1.396	1.954	-	-

Figure 1: Percentage infestation of tomato fruit borer [Helicoverp aarmigera (Hubner)] in Tomato during 1st and 2nd spray.

DBS** - Day Before Spray**, DAS*** - Day After Spray***



Discussion:

In present investigations, efforts have been made to evolve an effective and economically viable pest management strategy against tomato fruit borer. From these view point, the present investigation "Comparative efficacy of selected bio pesticides with Chlorantraniliprole 18.5% SC against Tomato fruit borer [Helicoverpa armigera (Hubner)] on Tomato [Solanum lycopersicum L.]". The results obtained on per cent fruit infestation and benefit cost ratio on tomato for evaluating each treatment, for tomato fruit borer management have been described thoroughly here

In this experiment, eight different treatments, consisting of applications (T1) Chlorantraniliprole 18.5 SC (T2) ½Dose chlorantraniliprole + Nisco sixer plus 2ml/lit (T3) Spinosad 45% SC (T4) Nisco sixer plus 2ml/lit (T5) Neem seed kernel extract 5% (T6) Azadirachtin 5% (T7) Beauvaria bassiana and (T0) untreated Control were tested to compare the efficacy against Helicoverpa armigera and their influence on yield of Tomato. The results obtained are discussed from available and relevant literature in this chapters before. All the treatments were significantly superior over control. Among all the treatments minimum percent infestation of fruit borer was recorded in T1 Chlorantraniliprole 18.5 SC (8.57%) as compared to T0 – untreated control (21.87%). These results were similar to the findings reported by Jamir et al., (2022)7, Hivare et al., (2019)6, Patil et al., (2018)12, reported that among all the treatments lowest number of fruit borer was recorded in Chlorantraniliprole 18.5% SC. Next most effective treatment was recorded in T_2 ½Dose Chlorantraniliprole + Nisco sixer plus 2ml/lit (9.604%) and these results were similar to the findings reported by Lalhluzuala et al., (2022)10, Reddy et al., (2020)14, Gayathri et al., (2021)4. Next effective treatment was recorded in T3 Spinosad 45% SC (10.66%), and the similar reports were given by Harshita et al. (2018)5. It is followed by T4 Nisco Sixer Plus 2ml/lit (11.35%) and the similar report was recorded by Tejeswari et al. (2021)18. T5 Neem Seed Kernal Extract (12.939%) and the similar report was recorded by Rahman et al. (2014)13. T6 Azadirachtin 5% (14.234%) and the similar was reported by Hivare et al. (2019)6. and the least effective and maximum percent incidence was showed by T7 Beauvaria bassiana (15.423%) and the similar reported by Rijal et al. (2008)15. Higher yield (240.5 q/ha) and Higher Cost: Benefit Ratio (1:10.4) was obtained from Chlorantraniliprole 18.5% SC treated plots and lowest (110 q/ha) in untreated control plot. Similar findings made by Jamir et al., (2022)7 who reported that the Chlorantraniliprole 18.5% SC is the best and most economical treatment recorded yield (222.54q/ha) and cost benefit ratio (1:9.14).

Next highest yield and benefit cost ratio was recorded in T_2 –½Dose Chlorantraniliprole + Nisco sixer plus 2ml/lit (232.5 q/ha and 1:10.0). Similar findings made by Lalhluzuala et al., (2022)10. Bandhavi et al. (2022)2 who reported that the T3 Spinosad 45SC is the best and most economical treatment which is similar to yield (200 q/ha) and cost benefit ratio (1:8.7). Jamir et al. (2022)7 reported that the cost effective of T4 Nisco sixer Plus was high with the yield of (187.5 q/ha) and cost benefit ratio (1:8.1). Next effective treatment was T5 – Neem seed Kernal Extract (160 q/ha and 1:6.9 respectively), this was supported by Rahman et al. (2014)13.

Conclusion

It was concluded that among all the treatments in Chlorantraniliprole% SC with minimum mean 8.57% and maximum yield of 240.5q/ha proved to be the best treatment which is followed by ½ Chlorantranilirpole + Nisco Sixer Plus 2ml/lit mean of 9.6% and yield with 232.5 q/hac, Spinosad 45% SC with mean 10.66% and yield 200 q/ha, Nisco Sixer plus 2ml/lit with mean of 11.35% and yield 187.5 q/hac, Neem Seed Kernal Extract 5% mean 12.93% and yield is 160 q/hac, Azadirachtin 5% mean is 14.23% and yield is 150.5 q/hac, Beauveria bassiana with mean of 15.42% and yield is 135.5 q/hac and at last Untreated control with mean of 21.87% and yield is 110.5q/hac in managing Helicoverpa armigera reduction. Recommended dose of chemicals may be useful in devising proper integrated pest management strategy against fruit borer of tomato.

Declarations:

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Data availability statements:

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

Declaration Statements:

I hereby declare that all the information given above is true and correct to the best of my knowledge.

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Conflicts of Interest:

We have no conflicts of interest to disclose. All authors declare that they have no conflicts of interest.

Code availability:

No Software application or custom code.

Authors Contributions:

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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