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Hamsala Lakshmi Bandhavi
M.Sc. Scholar, Department of Entomology, Faculty of Agriculture, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Ashwani Kumar
Associate Professor, Department of Entomology, Faculty of Agriculture, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author
Hamsala Lakshmi Bandhavi
M.Sc. Scholar, Department of Entomology, Faculty of Agriculture, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Efficacy and economics of different insecticides against fruit borer [*Helicoverpa armigera* (Hubner)] on tomato crop

Hamsala Lakshmi Bandhavi and Ashwani Kumar

Abstract
The current study was carried out at Central Research Farm, SHUATS, Naini, Prayagraj, U.P. during *rabi* season of 2021-22. Two applications of seven insecticides were used against *Helicoverpa armigera* and the result revealed that Chlorantraniliprole 18.5% SC had the lowest fruit infestation with 1.55 and 1.24 followed by Flubendiamide 39.35% SC (1.68 and 1.33), Emamectin benzoate 5% SG (1.84 and 1.53), Indoxacarb 14.5% SC (1.95 and 1.61), Spinosad 45% SC (2.04 and 1.82), Profenofos 50% EC (2.17 and 1.93) and Imidacloprid 17.8% SL (2.24 and 2.08) respectively as compare to control (water spray) 3.19 and 4.64. Cost benefit ratio were found highest in Chlorantraniliprole with 1:12.09 followed by Flubendiamide 39.35% SC (1:11.27), Emamectin benzoate 5% SG (1:10.70), Indoxacarb 14.5% SC (1:9.84), Spinosad 45% SC (1:9.01), Profenofos 50% EC (1:9.21), Imidacloprid 17.8% SL (1:6.85) and Control (1:6.13).

Keywords: Chlorantraniliprole, cost benefit ratio, efficacy, *Helicoverpa armigera*, insecticides, tomato

Introduction

Tomato, *Lycopersicon esculentum* (Miller), is one of the second most important, popular and favorite widely grown vegetable in the world due to its immense commercial and special nutritive value, ranking second in importance next to potato (Baber *et al*., 2016) [2]. It is native of South America (Peru) (Kawde *et al.*, 2020) [7]. Tomato is universally treated as protective food. It is a very good appetizer and its soup is said to be a good remedy for parents suffering from constipation. Tomato is widely cultivated in tropical, sub-tropical and temperate climates and thus ranks third in terms of world vegetable production after potato and sweet potato. Global tomato production is currently around 130 million tons, of which 88 million are destined for the fresh market and 42 million tons are processed. The highest tomato cultivating state is Madhya Pradesh with production about 2,970 tonnes followed by Andhra Pradesh with production about 2,217 tonnes.

Tomato is more prone to insect pests attacked mainly by fruit borer, white fly, serpentine leaf miner, jassids, aphids, tobacco caterpillar, flea beetles and spider mites etc. due to their tenderness and softness as compared to other vegetables (Katroju *et al.*, 2014) [5]. Tomato fruit borer, *Helicoverpa armigera* (Hubner) is the most destructive insect pest causing losses in tomato yield to range of 51.20 per cent in Punjab (Singh *et al*., 1990) [15]; 40-50 per cent in Bangalore and 32.52 per cent in Madhya Pradesh. To control tomato fruit borer, different pesticides are being used in large quantities by farmers except in few cases. Considering the economic importance of pest and fruit, the present study was conducted to study the Efficacy of different insecticides against fruit borer on tomato crop.

Materials and Method

The present investigation was carried out during *rabi* season (October 2021 to November 2022) at Central Research Farm, SHUATS, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. The tomato seeds of variety 'Pusa Ruby' were planted at 60 cm x 60 cm spacing.

The experiment was laid down in randomized block design (RBD) with eight treatments replicated thrice comprising of Flubendiamide 39.35% SC, Spinosad 45% SC, Indoxacarb 14.5% SC, Imidacloprid 17.8% SL, Emamectin benzoate 5% SG, Chlorantraniliprole 18.50% SC, Profenofos 50% EC including untreated control. All the treatments were applied two times using hand sprayer.

The observations on pest incidence were recorded one day before spraying as pre- treatment count. Post treatment count were taken at 3, 7 and 14 days after each spraying. For recording the larval population counts, five plants were selected randomly and tagged in each plot. The data on larval population were recorded and statistically analyzed with mean values obtained from the conversion of per cent fruit infestation (Gomez and Gomez, 1984) [4]. The cumulative per cent fruit damage was work out using the formula. (Rahman *et al.*, 2014) [11].

$$\underset{\text{(Number basis)}}{\text{\% Fruit infestation}} = \frac{\text{Number of infested fruits}}{\text{Total no. of fruits}} \times 100$$

In order to work out cost effective treatment modules against tomato fruit borer on tomato the "Incremental Cost Benefit Ratio" were worked out based on the total tomato fruit yield in terms of rupees per hectare, cost of inputs including treatment modules and labour charges, cost of application etc. and net monetary returns were calculated at the prevailing market rates during the period of experimentation (Abbas *et al.*, 2020) [1].

$$\text{BCR} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

Where
BCR = Cost Benefit Ratio

Results and Discussion

The data on the overall larval population of tomato fruit borer on third, seventh and fourteen days after first spray revealed that T6 Chlorantraniliprole 18.5% SC (1.55) shows significantly superior over all treatments, followed by T1 Flubendiamide 39.35% SC (1.68), T5 Emamectin benzoate 5% SG (1.84), T3 Indoxacarb 14.5% SC (1.95), T2 Spinosad 45% SC (2.04), T7 Profenofos 50% EC (2.17), T4 Imidacloprid 17.8% SL (2.24) and control T0 (3.19).

Table 1: Efficacy of different insecticides against tomato fruit borer [*Helicoverpa armigera* (*Hubner*)] on different days after 1st spray during rabi season 2021-2022

Treatments	Mean larval population of *Helicoverpa armigera*/5 plants				
	1DBS	**3DAS**	**7DAS**	**14DAS**	**Mean**
Control	2.26	2.66	3.20	3.73	3.19
Flubendiamide 39.35% SC	2.73	1.86	1.40	1.80	1.68
Spinosad 45% SC	2.46	2.20	1.73	2.20	2.04
Indoxacarb 14.5%SC	2.60	2.13	1.66	2.06	1.95
Imidacloprid17.8% SL	2.46	2.40	1.93	2.40	2.24
Emamectin benzoate 5% SG	2.60	2.06	1.46	2.00	1.84
Chlorantraniliprole18.50% SC	2.86	1.73	1.20	1.73	1.55
Profenofos 50% EC	2.40	2.33	1.86	2.33	2.17
F-test	NS	S	S	S	S
C.V	8.275	6.144	13.465	9.461	10.557
C.D	-	0.234	0.426	0.378	0.386

DAS: Days after spray

The data on the overall larval population of tomato fruit borer on third, seventh and fourteen days after second spray revealed that T6 Chlorantraniliprole 18.5% SC (1.24) shows significantly superior over all treatments, followed by T1 Flubendiamide 39.35% SC (1.33), T5 Emamectin benzoate 5% SG (1.53), T3 Indoxacarb 14.5% SC (1.61), T2 Spinosad 45% SC (1.82), T7 Profenofos 50% EC (1.93), T4 Imidacloprid 17.8% SL (2.08) and control T0 (4.64).

Table 2: Efficacy of different insecticides against tomato fruit borer [*Helicoverpa armigera* (Hubner)] on different days after 2nd spray during *rabi* season 2021-2022.

Treatments	Mean larval population of *Helicoverpa armigera*/5 plants				
	1DBS	**3DAS**	**7DAS**	**14DAS**	**Mean**
Control	3.73	4.13	4.60	5.20	4.64
Flubendiamide39.35% SC	1.80	1.53	1.00	1.46	1.33
Spinosad 45% SC	2.20	2.00	1.46	2.00	1.82
Indoxacarb 14.5%SC	2.06	1.86	1.26	1.731	1.61
Imidacloprid17.8% SL	2.40	2.26	1.73	2.26	2.08
Emamectin benzoate 5% SG	2.00	1.73	1.20	1.66	1.53
Chlorantraniliprole18.50% SC	1.73	1.46	0.93	1.33	1.24
Profenofos 50% EC	2.33	2.13	1.60	2.06	1.93
F-test	S	S	S	S	S
C.V	9.461	7.925	11.843	6.567	10.981
C.D	0.378	0.297	0.360	0.255	0.389

Table 3: Efficacy of different insecticides against tomato fruit borer [*Helicoverpa armigera* (Hubner)] on different days after overall 1st and 2nd spray during *rabi* season 2021-2022

Treatments	Overall mean larval population after 1st and 2nd spray/5 plants		
	1st spray	2nd spray	1st and 2nd spray
Control	3.19	4.64	3.91
Flubendiamide39.35% SC	1.68	1.33	1.50
Spinosad 45% SC	2.04	1.82	1.93
Indoxacarb 14.5%SC	1.95	1.61	1.78
Imidacloprid17.8% SL	2.24	2.08	2.16
Emamectin benzoate 5% SG	1.84	1.53	1.68
Chlorantraniliprole18.50% SC	1.55	1.24	1.39
Profenofos 50% EC	2.17	1.93	2.05
C.D	0.386	0.389	1.026

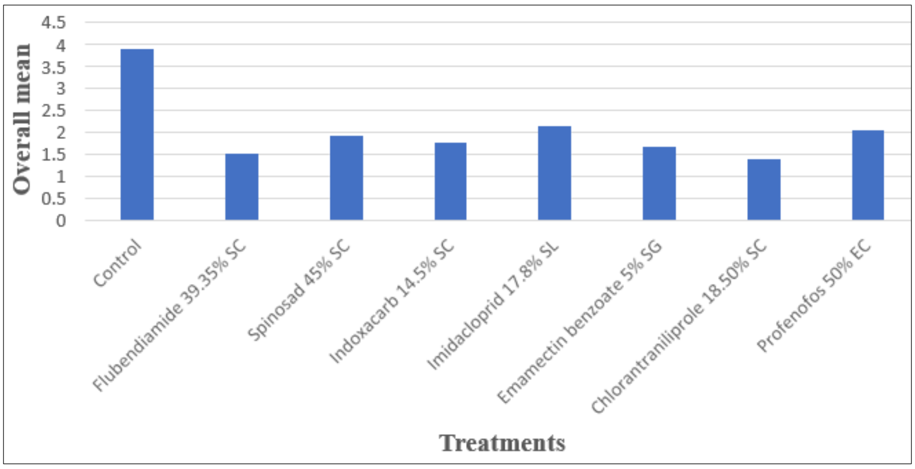

Fig 1: Graphical representation of efficacy of different insecticides against tomato fruit borer [*Helicoverpa armigera* (Hubner)] on different days after overall 1st and 2nd spray

The C:B ratio of various insecticide treatments were calculated which shows that maximum C:B ratio (1:12.09) was recorded in T6 Chlorantraniliprole 18.50% SC followed by T1 Flubendiamide 39.35% SC (1:11.27), T5 Emamectin benzoate 5% SG (1:10.70), T3 Indoxacarb 14.5% SC (1:9.84), T2 Spinosad 45% SC (1:9.01), T7 Profenofos 50% EC (1:9.21), T4 Imidacloprid17.8% SL (1:6.85) and T0 Control (1:6.13).

Table 4: Efficacy of different insecticides against fruit borer [*Helicoverpa armigera* (Hubner)] on cost benefit ratio of tomato

S. No.	Treatments	Yield (q/ha)	Total value of the yield (₹)	Common cost (₹)	Treatment cost (₹)	Total cost (₹)	B:C ratio
1.	Control	120	180000	29336	-	29336	1:6.13
2.	Flubendiamide39.35% SC	235	352500	29336	1920	31256	1:11.27
3.	Spinosad 45% SC	210	315000	29336	5618	34954	1:9.01
4.	Indoxacarb 14.5%SC	220	330000	29336	4200	33536	1:9.84
5.	Imidacloprid17.8% SL	150	225000	29336	3466	32802	1:6.84
6.	Emamectin benzoate 5% SG	225	337500	29336	2200	31536	1:10.70
7.	Chlorantraniliprole18.50% SC	260	390000	29336	2920	32256	1:12.09
8.	Profenofos 50% EC	195	292500	29336	2422	31758	1:9.21

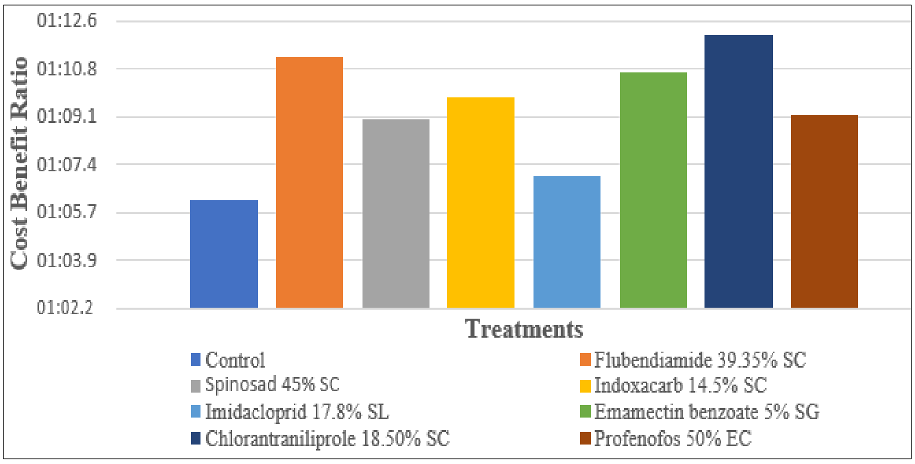

Fig 2: Graphical representation of cost benefit ratio of tomato influenced by different treatments

Discussion

The present investigation entitled, "Efficacy and economics of different insecticides against fruit borer [*Helicoverpa armigera* (Hubner)] on tomato crop", was carried out at the Trans Yamuna region of Prayagraj in field condition during *rabi* October 2021 to March 2022 at Central Research Farm at SHUATS, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P.

In the experiment eight different treatments were applied, consisting of T1 Flubendiamide 39.35% SC, T2 Spinosad 45% SC, T3 Indoxacarb 14.5%SC, T4 Imidacloprid 17.8% SL, T5 Emamectin benzoate 5% SG, T6 Chlorantraniliprole 18.50% SC, T7 Profenofos 50% EC, T0 Control were used against tomato fruit borer.

The lowest first spray mean larval population of fruit borer was recorded in T6 Chlorantraniliprole 18.5% SC (1.55) followed by T1 Flubendiamide 39.35% SC (1.68), T5 Emamectin benzoate 5% SG (1.84)**,** T3 Indoxacarb 14.5% SC (1.95), T2 Spinosad 45% SC (2.04), T7 Profenofos 50% EC (2.17), T4 Imidacloprid 17.8% SL (2.24) and control T0 (3.19).

The lowest second spray mean larval population infestation of fruit borer was recorded in T6 Chlorantraniliprole 18.5% SC (1.24) followed by T1 Flubendiamide 39.35% SC (1.33), T5 Emamectin benzoate 5% SG (1.53), T3 Indoxacarb 14.5% SC (1.61), T2 Spinosad 45% SC (1.82), T7 Profenofos 50% EC (1.93), T4 Imidacloprid 17.8% SL (2.08) and control T0 (4.64).

The overall mean larval population of tomato fruit borer was found superior in Chlorantraniliprole 18.5% SC (1.39) which is similar with Patel *et al.,* 2016 [9] resulting (1.41) followed by Flubendiamide 39.35% SC (1.50), Emamectin benzoate 5% SG (1.68) which is similar with Patil *et al.,* 2018 [10] resulting (0.90), Indoxacarb 14.5% SC (1.78) which is similar with the findings of Sathish *et al.,* 2018 [14] resulting (2.10), Spinosad 45% SC (1.93) which is similar with Sapkal *et al.,* 2018 [13] resulting (1.04). Among the treatments the least effective are Profenofos 50% EC (2.05), Imidacloprid 17.8% SL (2.16) and control (3.91).

The yields of different treatments were found significant with each other. The highest fruit yield was registered in T6 Chlorantraniliprole 18.50% SC (260 q/ha) which is similar with Patel *et al.*, 2016 [9] resulting (267 q/ha) followed by T1 Flubendiamide 39.35% SC (235 q/ha) which is similar with Tejeswari and Kumar, 2021 [16] resulting (196 q/ha), T5 Emamectin benzoate 5% SG (225 q/ha), T3 Indoxacarb 14.5% SC (220 q/ha) which is similar with Reddy *et al.*, 2021 [12] resulting (225q/ha), T2 Spinosad 45% SC (210 q/ha) which is found similar with Choudhary *et al.,* 2017 [3] resulting (200 q/ha), T7 Profenofos 50% EC (195 q/ha) which is similar with Kaur and Singh, 2014 [6] resulting (188 q/ha), T4 Imidacloprid17.8% SL (150 q/ha) which is similar with Kuhar *et al*., 2005 [8] resulting (153 q/ha), T0 Control (120 q/ha).

The C:B ratio of various insecticide treatments were calculated and presented in which shows that maximum C:B ratio (1:12.09) was recorded in T6 Chlorantraniliprole18.50% SC which was found similar with Reddy *et al.,* 2021 [12] resulting (1:8.5) followed by T1 Flubendiamide 39.35% SC (1:11.27) which is similar with Reddy *et al.,* 2021 [12] resulting (1:7.8), T5 Emamectin benzoate 5% SG (1:10.70), T3 Indoxacarb 14.5%SC (1:9.84) which is similar with Reddy *et al.,* 2021 [12] resulting (1:10.8), T2 Spinosad 45% SC (1:9.01) which was found similar with Reddy *et al.,* 2021 [12] resulting (1:9.6), T7 Profenofos 50% EC (1:9.21), T4 Imidacloprid17.8% SL (1:6.85), T0 Control (1:6.13).

Conclusion

The outcome of total experimentation efficacy of different insecticides against tomato fruit borer clearly suggested that Chlorantraniliprole 18.50% SC followed by Flubendiamide 39.35% SC, Emamectin benzoate 5% SG proved to be effective in suppressing the fruit borer. While Indoxacarb 14.5% SC, T2 Spinosad 45% SC ranked middle in order of their efficacy, then Profenofos 50% EC and Imidacloprid 17.8% SL found to be least effective in controlling *Helicoverpa armigera.* Among the treatments studied chlorantraniliprole 18.5SC gave the highest cost benefit ratio (1:12.09) and marketing yield (260 q/ha) under Prayagraj Agroclimatic conditions.

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