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Field Efficacy and Economics of Different Insecticides against Tomato Fruit Borer [*Helicoverpa armigera* (Hubner)]

Cheepurupalli Manisha [a*¥] and Ashwani Kumar [a#]

[a] *Department of Entomology, SHUATS, Prayagraj, India.*

Authors' contributions

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

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Original Research Article

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ABSTRACT

The experiment on Field efficacy and economics of different insecticides against tomato fruit borer [*Helicoverpa armigera* (Hubner)] was conducted during *rabi* 2021-2022, at Central Research Field, Department of Entomology, SHUATS, Naini, Prayagraj, U.P. The data on percent population reduction of different treatments revealed that the T5 Spinosad 45% SC (81.379) followed by T1 Indoxacarb 14.5% SC (75.140), T7 Emamectin benzoate 5% SG (74.634), T2 Flubendiamide 39.5% SC (68.634), T3 Novaluron 10%EC (65.647), T4 Fipronil 5% SC (54.225), T6 Neem oil 0.03% EC (49.533) found to be least efficient than all other treatments. Among the treatments studied the best and most economical treatment was Spinosad (1:6.72), Indoxacarb 14.5% SC 14.5SC (1:6.42), followed by Emamectin benzoate 5% SG (1:6.3), Novaluron 45% SC (1:5.09), Flubendiamide 20% WG (1:4.45), Fipronil 5% SC (1:7.9), (1:3.92), Neem oil 0.03% EC (1:3.45) as compared to control T0 (1:3.04).

Keywords: Efficacy; economics; insecticides; Helicoverpa armigera; tomato fruit borer.

[¥] *M.Sc. Scholar;*
[#] *Associate Professor;*
**Corresponding author: E-mail: cheepurupallimanisha@gmail.com;*

1. INTRODUCTION

Tomato, *Solanum lycopersicon* (Miller) is one of the most important herbaceous crops 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 tops in the list of canned vegetables. It can be used fresh in salad, curries or by-product like chutney, pickle, soups, ketchup, sauce, powder, purees and as a whole etc. [1].

This crop is severely attacked by various insect pests *viz.,* fruit borer, *Helicoverpa armigera* (Hubner): 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. Among these, fruit borer, *Helicoverpa armigera* is an important pest responsible for major yield loss in tomato. *Helicoverpa armigera* has attained the status of national pest in recent years in the form of economic damage caused to different agricultural crops throughout India [2].

The *Helicoverpa armigera* (Huner) (Lepidoptera: Noctuidae), a highly polyphagous species and a pest of major economic importance on a wide range of crops, particularly cotton, soybeans, tobacco, chickpea and pigeon pea. The pest is polyphagous with a wide worldwide distribution. In India alone, it causes $1 billion worth of damage annually. Half of all insecticides used in India for the protection of various crops are used for this pest. In Tamil Nadu, fruit losses range 40-50%>. Similarly, in Northern India, 30% loss of the fruit was observed due to tomato fruit worm and reported 5–55% losses from his insect pest in the tomato growing areas of India [3].

2. MATERIALS AND METHODS

The experiment is conducted during the *Rabi* season 2021- 2022 at SHUATS, Central Research field, Prayagraj, is situated at 25.27^0 North latitude 80.50^0 East longitude and at an altitude of 98mt. above sea level in a randomized block design with eight treatments replicated three times using a variety Lakshmi were bought from Prayagraj used for field trail.The sowing was done on the 15^{th}Nov 2021. Seed rate 400-500 g/ha. The seedlings are transplanted plant to plant and row to row spacing of 60 X 45 cm was maintained. Gap filling was done 10 days after to see uniform plant population in each plot.

Fertilizers were applied at the rate of half dose of nitrogen and full dose of phosphorous and potassium was given at the time of transplanting. The remaining dose of nitrogen was applied one month after transplanting. Fertilizers were applied along the furrows in the form of urea, DAP (Di-ammonium Phosphorous) and MOP (Muriate of potash).

The crop was sown in *Rabi* season 2021-2022, one main irrigation channel of 1m width prepared in the experimental field and two sub irrigation channels of 0.5 m each were made tomeet out the irrigation requirement. Crop depends on rainy water but irrigation was practiced to meet the water requirements.

Observation was made on the number of larvae per 5 plants in 2m row length at 5 different locations of all treatments were randomly selected and total number of larvae were recorded 1day before application and 3^{rd} 7^{th} and 14^{th} days after application in each treatment. The result obtained are converted into per cent larval population reduction with following formula shown below:

Larval population = No. of larvae/ 5 plants in 2m

Per cent reduction over control = ((Control-Treatment) / Control) ×100

2.1 Benfit Cost Ratio

Benefit Cost Ratio Cost effectiveness of each treatment was assessed based on net returns. Net return of each treatment was worked out by deducting total cost of the treatment from gross returns. Total cost of production included both cultivation as well as plant protection charges.

Gross return = Marketable Yield x Market price

Net return = Gross return – Total cost

Benefit: Cost Ratio = (Gross return / Total cost)

3. RESULTS AND DISCUSSION

Among all the treatments highest percent population reduction of fruit borer was recorded in T5 Spinosad 45% SC (81.379) these findings are in support with Reguri et al.[4], Sushma et al. [5] and Amalendu et al. [6] followed by T1 Indoxacarb 14.5% SC (75.140) these findings are in support with Santosh et al. [7], Reguri et al. [4] shown this insecticide in reducing percentage of larval population (85.04), (65.56) followed by T7 Emamectin benzoate 5% SG (74.634) these findings are in support with Gulam et al. [8], Khademul et al. [9], kumar et al. [10] (78) and (62.52) followed by T2 flubendiamide 39.5% SC (68.634) these findings are in support with Gulam et al., [8], Padhan and Raghuraman [11] in reducing percentage of larval population (78.10), T3 Novuluron 10% EC (65.647) these findings are in support with Satish et al. [2] and Singh et al., [12] in reducing percentage of larval population(61.85) ,T4 Fipronil 5% SC (54.225) these findings are in support with Ghosal et al. [13], Meena et al. [14] and Santosh et al., (2020) (81.78) and T6 Neem oil 0.03% EC (49.533) supported with Sultana et al., [15] and Ojha et al*.* [16] in reducing percentage of larval population (49.2)was found to be least effective than all the treatments and is significantly superior over the control. These results are shown in Table 1.

The highest yield was recorded in Spinosad 45% SC (250 q/ha) followed by Indoxacarb 14.5% SC (220 q/ha), Emamectin benzoate 5% SG (210 q/ha), Novaluron 10%EC (170 q/ha), Flubendiamide 39.5% SC (160 q/ha), Fipronil 5% SC (130 q/ha), Neem oil 0.03% EC (120 q/ha) as compared to T0 control (100q/ha).These results are shown in Fig. 1.

When the benefit cost ratio was worked out, interesting results was achieved. The best and most economical treatment was Spinosad (1:6.72), Indoxacarb 14.5% SC 14.5SC (1:6.42), followed by Emamectin benzoate 5% SG (1:6.3), Novaluron 45% SC (1:5.09), Flubendiamide 20% WG (1:4.45), Fipronil 5% SC (1:7.9), (1:3.92), Neem oil 0.03% EC (1:3.45) as compared to control T0 (1:3.04). These results are shown in Table 2.

Table 1. Efficacy of different insecticides against tomato fruit borer, *H. armigera* during *rabi* 2021-2022 (Over all mean)

Treatments		Per cent population reduction of *H. armigera*l five plants		
		1st Spray (Mean)	2nd Spray (Mean)	Overall Mean
T_1	Indoxacarb 14.5% SC	68.955	81.324	75.140
T_2	Flubendaimide 39.5% SC	60.731	76.537	68.634
T_3	Novaluron 10% EC	52.931	78.363	65.647
T_4	Fipronil 5% SC	42.140	66.309	54.225
T_5	Spinosad 45% SC	76.982	85.776	81.379
T_6	Neem oil 0.03%	40.802	58.263	49.533
T_7	Emamectin benzoate 5% SG	65.297	83.971	74.634
T_0	control	---	-----	------

Table 2. Economics and benefit cost ratio

Treatment Symbols	Yield (q/ha)	Selling price (Rs/q)	Gross return (Rs)	Total cost of cultivation (Rs)	Net return (Rs)	B: C Ratio
Indoxacarb 14.5% SC	220	1200	264000	41176	222824	1:6.42
Neem oil 0.03%	120	1200	144000	41701	102299	1:3.45
Fipronil 5% SC	130	1200	156000	39783	116217	1:3.92
Emamectin benzoate 5% SG	210	1200	252000	39951	212049	1:6.3
Novaluron 10% EC	170	1200	204000	40051	163949	1:5.09
Spinosad 45% SC	250	1200	300000	44641	255359	1:6.72
Flubendiamide 39.5% SC	160	1200	192000	43051	148949	1:4.45
Control	100	1200	120000	39451	80549z	1:3.04

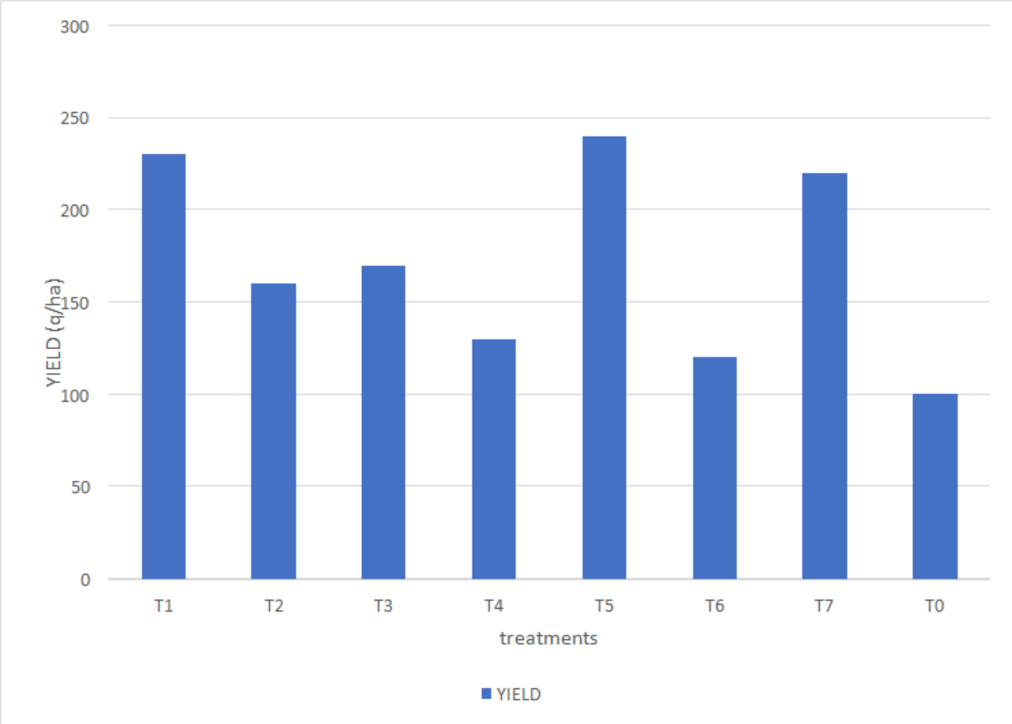

Fig. 1. Yield of different treatments (q/ha)

The present results of benefit cost ratio findings are similar with Tejaswari and Kumar [17], Indira et al. [10], Game et al. [18] and Satish et al. [2] reported that the cost benefit ratio obtained in Spinosad treated plot was (1:7.07), (1:0.86), (1:0.78) and (1:11.42). Hemasreelatha and Yadav [19], Indira et al. [6], Satish et al. [2] concluded that, in terms of higher cost benefit ratio, Indoxacarb recorded (1:8.25),(1:0.85) and (1:14.73)., Yadav and Hemasreelatha [19], Sapkal et al. [20] observed C:B ratio in with Emamectin benzoate 1:6.7,1:5.04. Reddy et al. [4], Sapkal et al. [20] reported that the cost benefit ratio obtained in Novaluron treated plot was (1:7.15),(1:0.95). Tejaswari and Kumar (2021) [17], Ghosal et al. [6], Meena et al. [14] concluded that, in terms of higher cost benefit ratio, Flubendiamide and neem oil recorded (1:6.4) and (1:5.6) [21,22].

4. CONCLUSION

From the above discussion it was found that, spraying of insecticides significantly reduced the fruit borer population in tomato. The present findings conclude that the most effective insecticide was Spinosad among these newer generation insecticides like Spinosad, Indoxacarb, Navuluron, emamectin benzoate, Flubendiamide, Fipronil and neem oil and the least effective was neem oil against lepidopteran caterpillar *Helicovera armigera* along with an additional yield level in tomato. Further, it was observed that the cost benefit ratio was also high with Spinosad and Indoxacarb. Hence, it is suggested that the effective insecticides may be alternated in harmony with the existing Intergrated pest management programes in order to avoid the problems associated with insecticidal resistance, pest resurgence etc.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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