

Original Research Article

Field efficacy and economics of different insecticides against tomato fruit borer [*Helicoverpa armigera* (Hubner)]

ABSTRACT

The field experiment on 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 incremental percent 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 affective than all other treatments. Among the treatment 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).

Key words: - Efficacy, Economics, Insecticides, *Helicoverpa armigera*, Tomato fruit borer.

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. (Patil *et al.*, 2018)^[12].

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. (Sathish *et al.*, 2018)^[16]

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 polyphagous pest of worldwide occurrence inflicting annual crop damage in India worth US \$1 billion. This pest accounts for the consumption of half of the total insecticide used in India for protection of different crops. In Tamil Nadu, losses of fruit range 40-50%. Similarly, in Northern India, 30% loss of the fruit was observed due to tomato fruit worm. reported 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. (Wajid *et al.*, 2016)^[21].

MATERIALS AND METHODS

The experiment is conducted during the *Rabi* season 2021- 2022 at SHUATS, Central Research field, Prayagraj, is situated at 25.27⁰ North latitude 80.50⁰ 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 15th Nov 2021. Seed rate 400-500 g/ha. The seedlings of the one month there 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 and MOP.

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 to meet out the irrigation requirement. Crop depends on rainy water but irrigation was practiced to meet the water requirements.

Observation were recorded 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 3rd 7th and 14th days after application in each treatment. The result obtained are converted into percent larval population and reduction percent with following formula.

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

$$\text{Percentage reduction over control} = \frac{\text{Control-Treatment}}{\text{Control}} \times 100$$

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

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.,(2021)¹⁴**, **Sushma et al. (2016)¹⁹** and **Amalendu et al.,(2010)¹²**proved their superiority over other insecticides in reducing percentage of larval population (82.6) followed by T1 Indoxacarb 14.5 %SC (75.140) these findings are in support with **Santosh et al., (2020)¹⁰⁷**,**Reguri et al.,(2021)¹⁴** proved their superiority over other insecticides in reducing percentage of larval population (85.04),(65.56)followed by T7Emamectin benzoate 5%SG (74.634) these findings are in support with **Gulam et al., (2015) ^[04]**, **Khademul et al. (2020)⁰⁵** ,**kumar et al.,(2014)⁰⁶**proved their superiority over other insecticides inreducing percentage of larval population(78)and (62.52), T2 flubendiamide 39.5%SC (68.634) these findings are in support with **Gulam et al., (2015)^[04]**, **Padhan and Raghuraman (2019)^[11]** in reducing percentage of larval population(78.10),T3 Novuluron 10% EC (65.647) these findingsare in support with **Satish et al. (2018)^[16]** and **Singh et al.,(2017)^[17]** in reducing percentage of larval population(61.85) ,T4 Fipronil 5%SC (54.225) these findings are in support with **Ghosal et al. (2016)^[3]**, **Meena et al. (2014)^[08]**and **Santosh et al., (2020)⁰⁷** proved their superiority over other insecticides in reducing percentage of larval population(81.78) and T6 Neem oil 0.03% EC (49.533) supported with **Sultana et al.,(2015)^[09]** and **Ojha et al. (2017)^[10]** in reducing percentage of larval population (49.2)was found to be least effective than all the treatments and is significantlysuperior over the control.

The yield among the treatments was significant. The highest yield was recorded in Spinosad 45% SC (250q/ha) followed by Indoxacarb 14.5% SC (220q/ha), Emamectin benzoate 5% SG (210q/ha), Novaluron 10%EC (170q/ha), Flubendiamide 39.5% SC (160q/ha), Fipronil 5% SC (130q/ha), Neem oil 0.03% EC (120q/ha) as compared to T₀ control (100q/ha). When the benefit cost ratio was worked out, interesting results was achieved. Among the treatment 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).

The present are similar with **Tejaswari and Kumar (2021)^[20]**, **Indira et al., (2014)^[06]**, **Game et al.,(2018)^[1]** and **Satish et al. (2018)^[06]** 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 Yada(2021)^[22]**, **Indira et al., (2014)^[06]** , **Satish et al. (2018)^[16]** concluded that, in terms of higher cost benefit ratio, Indoxacarb recorded (1:8.25),(1:0.85) and (1:14.73)., **Yadav and Hemasreelatha(2021)^[22]** **Sapkal et al., (2018)^[15]** observed highest C:B ratio in with Emamectin benzoate 1:6.7,1:5.04. **Reddy et al., (2021)^[14]**, **Sapkal et al., (2018)^[15]** reported that the cost benefit ratio obtained in Novaluron treated plot was (1:7.15),(1:0.95).**Tejaswari and Kumar (2021) ^[20]** ,**Ghosal et al.,(2012)^[2]**, **Meena et al.,(2014)^[08]** concluded that, in terms of higher cost benefit ratio, Flubendiamide and neem oil recorded (1:6.4) and (1:5.6).

Table 1: Evaluation of different insecticides on per cent reduction of larval population of tomato fruit borer, *H.armigera* during rabi 2021-2022 (1st spray)

Treatment		Per cent Population reduction of <i>Helicoverpa armigera</i> / Five plants				
		1DBS(No. of.larva/ five plants)	3 DAS	7 DAS	14DAS	Mean
T ₁	Indoxacarb 14.5% S	2.33	60.910	76.613	69.343	68.955
T ₂	Flubendaimide 39.5% SC	2.067	52.793	68.390	61.010	60.731
T ₃	Novaluron 10% EC	2.467	41.643	56.437	60.713	52.931
T ₄	Fipronil 5% SC	2.000	28.403	48.317	49.700	42.140
T ₅	Spinosad 45% SC	2.333	72.100	82.657	76.190	76.982
T ₆	Neem oil 0.03%	2.000	33.020	45.937	43.450	40.802
T ₇	Emamectin benzoate 5% SG	2.267	58.347	72.070	65.473	65.297
T ₀	Control	2.200	---	---	---	---
	F-test	NS	S	S	S	S
	C.D. at 5%		11.355	10.590	9.718	6.591
	S.Ed. (+)	0.040	5.211	4.860	4.459	2.66

Table 2: Evaluation of different insecticides on per cent reduction of larval population of tomato fruit borer, *H.armigera* during rabi 2021-2022 (2nd spray)

Treatment		Per cent Population reduction of <i>Helicoverpa armigera</i> / 5 plants			
		3 rd DAS	7 th DAS	14 th DAS	Mean
T₁	Indoxacarb 14.5% SC	75.422	84.470	84.080	81.324
T₂	Flubendaimide 39.5% SC	67.840	81.013	80.757	76.537
T₃	Novaluron 10% EC	73.460	80.783	80.847	78.363
T₄	Fipronil 5% SC	61.173	71.063	66.690	66.309
T₅	Spinosad 45% SC	83.773	92.357	91.203	85.776
T₆	Neem oil 0.03%	53.060	63.653	58.087	58.263
T₇	Emamectin benzoate 5% SG	77.647	88.420	85.847	83.971
T₀	Control	---	---	---	---
	F-test	S	S	S	S
	C.D. at 5%	9.416	6.760	7.702	4.464
	S.Ed. (+)	4.320	3.102	3.534	2.048

Figure:1 YIELD OF DIFFERENT TREATMENTS(q/ha)

Table : 3 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

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 new generation insecticides like Spinosad, Indoxacarb, Navuluron, emamectin benzoate and Flubendiamide, Fipronil, neem oil were found effective against lepidopteran caterpillar *Helicoverpa 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 Integrated pest management programmes in order to avoid the problems associated with insecticidal resistance, pest resurgence etc.

REFERENCES

1. **Game, L. , Nagar ,S. and Simon ,S. (2018)** Comparative efficacy of selected chemical insecticides and neem products against tomato fruit borer [*Helicoverpa armigera* (Hubner)] in Allahabad. *Journal of Pharmacognosy and Phytochemistry*. **7**(4): 2215-2218.
2. **Ghosal, A., Chatterjee, M. L. and Manna, D. (2012)**. Studies on some insecticides with novel mode of action for the management of tomato fruit borer (*Helicoverpa armigera* Hub.). *Journal of Crop and Weed*. **8** (2):126-129.
3. **Ghosh, A. , Chatterjee, M. and Roy, A. (2010)** Bio-efficacy of spinosad against tomato fruit borer (*Helicoverpa armigera* Hub.) (Lepidoptera: Noctuidae) and its natural enemies. *Journal of Horticulture and Forestry*. **2**(5): 108-111.
4. **Ghulam, A., Najamul, H., Muhammad, F., Ikramul, H. and Haider, K. (2015)**. Effect of selected insecticides on *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae) on tomato (*Lycopersicon esculentum* Miller) and their successful management. *Advances in Entomology*. **3**:16-23.
5. **Khademul, MD.I., Howlader, M.T.H. and Ahmed, K.S. (2020)**. Management of

Helicoverpa armigera (Hubner) infesting tomato using bio-pesticides under field condition and its effect on tomato yield. *Journal of Bangladesh Agriculture University*. **18(1):**1-5.

- 6. Kumar, K.I and Devi, M. (2014)** Field Efficacy, Net Profit and Cost Benefit Ratio of Certain Insecticides against Fruit Borer, *Helicoverpa armigera* (Hubner) in Tomato. *International Journal of Agriculture, Environment & Biotechnology*. **7(2):** 343-346.
- 7. Kumar, S. , Umrao, R.S. , Kumar, A. , Patel V.K. , Debnath, R. and Kumar, A. (2020)** Evaluation of the efficacy of insecticides and biopesticides against *Helicoverpa armigera* (Hubner) on tomato. *Journal of Entomology and Zoology Studies*. **8(3):** 555-558.
- 8. Meena, L.K., Raju, S.V.S. (2014).** Bio efficacy of newer insecticides against tomato fruit borer, *Helicoverpa armigera* (Hubner) on tomato, *Lycopersicon esculentum* mill under field conditions. *International Quarter Journal of Life Science*. **347-350**.
- 9. Mustafiz, S.S.B. , Chowdhury, M.T.I., and Akter, A. (2015)** Efficacy of Some Botanicals in Controlling Fruit Borer (*Heliothis armigera*) in Tomato. *Academic Journal of Entomology*. **8(3):** 140-149.
- 10. Ojha, P.K., Kumari, R. and Chaudhary R.S. (2017)** Field evaluation of certain bio-pesticides against *Helicoverpa armigera* Hubner (Noctuidae: Lepidoptera) and its impact on pod damage and per plant yield of chickpea. *Journal of Entomology and Zoology Studies*. **5 (2):** 1092-1099.
- 11. Padhan, S. and Raghuraman, M. (2019)** Bio-efficacy of some contemporary insecticides against Tomato fruit borer *Helicoverpa armigera* Hubner in Varanasi region. *The PharmaInnovation Journal* .**8(6):** 1113-1116.
- 12. Patil, P.V. , Pawar, S.A. , Kadu, R.V. , and Pawar, D.B. (2018)** Bio-efficacy of newer insecticides, botanicals and microbial against tomato fruit borer *Helicoverpa armigera* (Hubner) infesting tomato. *Journal of Entomology and Zoology Studies*. **6(5):** 2006-

2011.

- 13. Ravi,k.k., Rao,S.C. , Vemuri,S.B. and Reddy,K.N.(2014)** Bio-efficacy of insecticides against fruit borer (*helicoverpa armigera*) in tomato (*lycopersicom esculentum*).*International journal Applied Biology and Pharmaceutical technology*.**5**(1):239-243
- 14. Reddy, D.R. , Kumar,A. and Sai ,P.K. (2021)** Field efficacy of some insecticides against tomato fruit borer, *Helicoverpa armigera* (Hubner).*Journal of Etomology and Zoological Studies* **9**(1): 1434-1436.
- 15. Sapkal,S.D. , Sonkamble,M.M. and Gaikwad, B.B (2018)** Bioefficacy of newer insecticides against tomato fruit borer, *Helicoverpa armigera* (Hubner) on tomato, *Lycopersicon esculentum* (mill) under protected cultivation. *International Journal of Chemical Studies*.**6**(4): 3326-3330.

16. **Sathish, B. N. , Singh, V.V. , Kumar, S. and Kumar, S. (2018)** Efficacy of different chemical insecticides and bio-pesticides against tomato fruit borer *Helicoverpa armigera* (Hubner) on tomato crop. *Bulletin of Environment, Pharmacology and Life Sciences*. 7(12):107-110.
17. **Singh, N. , Dotasara, S.K. , Kherwa , B. and Singh, S. (2017)** Management of tomato fruit borer by incorporating newer and biorational insecticides. *Journal of Entomology and Zoology Studies*. 5(2): 1403-1408.
18. **Solange, M. , França, J. V. , Oliveira, Badji, C.A. , Guedes, C.A. , Barbara, L. R. , Duarte and Breda, M.O. (2015)** “ Research Integrated management of tomato fruit borer (*Neoleucinodes elegantalis*)”. *African Journal of Agriculture*. 10(10) :4561-4569.
19. **Sushma, D. and Bharpoda (2016)** Field evaluation of biopesticides against *Helicoverpa armigera* (Hubner) in tomato, *Lycopersicon esculentum* Mill. Under middle Gujarat condition. *International Journal of Applied Agriculture and Horticulture Sciences*. 8(1):1266-1518.
20. **Tejeswari, K. and Kumar, A. (2021)** Comparative efficacy of chemicals with biopesticides against tomato fruit borer, *Journal of Entomology and Zoology Studies* .9(5):425-429
21. **Wajid, H., Chhibber, R.C. and Singh, C.P. (2016)**. Effect of indoxacarb against tomato fruit borer *Helicoverpa armigera* (Hub.) and phytotoxicity to tomato plants. *Advances in Plants and Agriculture Research*. 3(2):51-54.
22. **Yadav, U. and latha, T.H.S. (2021)** Field efficacy of selected insecticides against tomato fruit borer [*Helicoverpa armigera* (Hubner)] on tomato. *The Pharma Innovation Journal* .10(10): 841-843