



Comparative Efficacy of Selected Bio-pesticides against Tomato Fruit Borer [*Helicoverpa armigera* (Hubner)] on Tomato [*Solanum lycopersicum* (L.)]

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Authors' contributions

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

Article Information

DOI: 10.9734/IJPSS/2023/v35i173186

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/102377>

Original Research Article

Received: 28/04/2023
Accepted: 30/06/2023
Published: 01/07/2023

ABSTRACT

The field trial on Comparative efficacy of selected Bio-pesticides against tomato fruit borer [*Helicoverpa armigera* (Hubner)] on tomato [*Solanum lycopersicum* (L.)] was conducted during Rabi 2022-2023, at Central Research Farm, Department of Entomology, SHUATS, Naini, Prayagraj, U.P. The experiment was laid out in RBD (Randomized Block Design) and replicated thrice with seven treatments viz., T1 Spinosad 45% SC (125ml/lit), T2 Chlorantraniliprole 18.5%SC (30g/ha), T3 Nisco sixer plus (1ml/lit), T4 Neem oil 5% (5ml/lit), T5 *Metarhizium anisopliae* (1g/lit), T6 *Beauveria bassiana* (0.3ml/lit), T7 NSKE 5% (25kg/ha). The data on incremental larval population of different treatments reported that Chlorantraniliprole 18.5% SC (1.32) was highest effective which is followed by Spinosad 45% SC (1.45) > Nisco sixer plus (1.58) > Neem oil 5% (1.65) > NSKE 5% (1.72) > *Beauveria bassiana* (1.72) > and *Metarhizium anisopliae* (1.80). The

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most economical viable treatment with the highest yield as well as C:B ratio was obtained from Chlorantraniliprole 18.5% SC 210 q/ha and (1:8.6) respectively. It was followed by Spinosad 45% SC (1:7.8), Nisco sixer plus (1:7.7), neem oil (1:7.1), NSKE (1:6.9), *Beauveria bassiana* (1:5.4), *Metarhizium anisopliae* (1:4.6) as compared to untreated control (1:3.2) having the lowest B:C ratio.

Keywords: Bio-pesticides; cost benefit ratio; *Helicoverpa armigera*; larval population; tomato.

1. INTRODUCTION

Tomato, *Lycopersicon esculentum* (Miller), is an important vegetable crop grown around the world occupying the daily food regime of a majority of people [1]. It is ranking second in importance next to potato [2]. It is native of South America (Peru) from where it is supposed to have been spread all over the world [3].

Tomato is a good source of vitamins A, C and E and minerals that are very good for body and protect the body against diseases. Tomatoes are planted by an estimated 85% of the gardens each year. If well managed, tomato is highly productive. Cropping of tomatoes during the wet and dry seasons contributes immensely to the national requirement but the bulk of production is from the dry season cropping particularly in southern states [4]. Mostly, it is commercially recognized and treated as a vegetable. The fruits are eaten raw or cooked [5]. It can be used fresh in salad, curries or bi-products like chutney, pickle, soups, ketchup, sauce, powder, purees etc, [6].

Nutritional value 100g of water (94.7g), energy (22 Kcal), nitrogen (0.11g), protein (0.7), lipid(0.42g), ash (0.31g), carbohydrates (3.84g), fiber (1g). Minerals –calcium (10mg), iron (0.1mg), magnesium(8.1mg), phosphorous(19mg), sodium(<2.5mg) zinc (0.08mg), copper (0.0032mg), manganese (0.087mg), selenium (< 2.5µg). Vitamins – vitamin c (17.8mg), thiamine (0.056mg), riboflavin (<0.1mg), niacin (0.533mg), vitamin B-6 (0.079mg), folate (10µg), vitamin-A (24µg), carotene,beta (276µg), carotene,alpha (1µg), carotene,gamma(2µg), Cryptoxanthin,beta (19µg), cryptoxanthin,alpha (10µg), lycopene (2860 µg), lutein +zeaxanthin (56µg), lutein (56µg) [7].

Tomato is one of the most popular solanaceous vegetable crops grown all over the world, ranking second in importance next to potato in many countries. Some top producers of tomato are China - 33.80, India – 10.64, USA – 6.93, Turkey – 6.67, Egypt – 3.67, Iran – 3.61, Italy – 3.19,

Spain – 2.62, Mexico – 2.50, Brazil – 2.26, making a total of 1,82,033.29 MT. (source: Food & Agriculture Organization 2018).

In India, Total Horticulture production in 2021-22 is estimated to be 341.63 million tons, an increase of about 7.03 million tons (increase of 2.10%) over 2020-21. The production of vegetables is estimated to be 204.61 million tons, compared to 200.45 million tonne in 2020-21. Tomato production is expected to be 20.34 million tons, compared to 21.18 million tons in 2020-21. In 2021-22 the total production area of tomato is 841 Ha and the production is 20336 million tons and productivity is 24.3 kg/ha (Source: National Board of Horticulture). In India, Madhya Pradesh contributed maximum production (2970.31 metric tons) but highest productivity is occupied by Andhra Pradesh (36kg/ha) while Tamil nadu, Karnataka, Gujarat, Orissa, west Bengal, Telangana, Chhattisgarh, Maharashtra, Bihar, are the top producers of tomato [8].

Tomato is more prone to insect pests and diseases mainly due to its tenderness and softness as compared to other crops [9]. All parts of plant including leaves, stems, flowers and fruits are subjected to attack [10]. It has been reported on 181 cultivated and wild plant species belonging to 45 families in India. It is basically a polyphagous pest [11]. The defoliators (*Spodoptera litura*, *Monolepta andrawesi*, *Poekilocerus pictus* and *Atractomorpha crenulata*), leaf miner (*Liriomyza trifolii*), sucking insect-pests (*Bemisia tabaci*, *Aphis gossypii*, *Myzus persicae* and *Nezara viridula*), stem feeders, *Euzophera perticella* and *Leucinodes orbonalis* and fruit borers, *Helicoverpa armigera* and *Othreis fullonica* (*Eudocima fullonica*) [12]. The sucking pests white flies, thrips and aphids not only feed on foliage, stem and fruits in deteriorating the quality, but also act as the vector for disseminating tomato virus.

The fruit borer, *Helicoverpa armigera* (Hubner) is the versatile and widely distributed polyphagous pest and most destructive pest of tomato, which is commonly known as Gram pod borer,

American bollworm, Tomato fruit borer belonging to the family Noctuidae of the order Lepidoptera and causes 40-50 percent damage to the tomato crop. They bore circular holes and thrust only a part of their body inside the fruit and eat the contents. If the fruit is bigger in size, it is only partly damaged by the caterpillar but later it invariably invaded by fungi bacteria and spoiled completely. This is a key pest as it attacks fruits and makes fruits unfit for human consumption causing considerable crop loss.

Regular use of chemical pesticides create problem in the natural ecosystem like environmental pollution, pest resistance and health hazard etc. due to these reasons by studying the insecticidal properties and their results and plant products were used against tomato fruit borer (*Helicoverpa armigera*). A number of previous studies on the sustainable management of insect pests on tomato ecosystem through IPM technologies based on the use of bio pesticides and other environmentally safer botanicals considerable success in mitigating the insect pests damage.

(CRF), SHUATS, Prayagraj (U.P). The study was set up in a Randomized Block Design (RBD) which was replicated thrice. Each main block was divided into 8 sub-plots of 2m x 1m size with maintaining 25cm borders as bunds and treatments were assigned randomly. The spraying of botanical and conventional insecticides were applied at the initial incidence of tomato fruit borer and two sprays were given. All the spraying was done by using a knapsack sprayer at 15 days intervals. The insecticide and bio pesticides include, T1- Spinosad 45% SC, T2- Chlorantraniliprole 18.5SC, T3- Nisco sixer plus, T4- Neem oil, T5- *Beauveria bassiana* T6- *Metarhizium anisopliae*, T7- NSKE and T8- untreated control.

2.1 Observations

Observation was 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 1 day before spraying (DBS) and 3rd, 7th and 14th days after spraying (DAS) in each treatment. The result obtained was with following formula.

$$\text{Larval population} = \frac{\text{No. of larvae}}{\text{Total no. of plants}}$$

2. MATERIALS AND METHODS

The experiment was conducted during Rabi season 2022 -2023 at Central Research Farm

Table 1. Comparative efficacy of selected Bio-pesticides against tomato fruit borer [*Helicoverpa armigera* (Hubner)] on tomato [*Solanum lycopersicum* (L.)]

Treatments	First Spray				Second Spray			Overall mean	Yield (q/ha)	C:B Ratio
	1	3	7	14	3	7	14			
	DBS	DAS	DAS	DAS	DAS	DAS	DAS			
T1 Spinosad 45% SC	2.86 (9.74)	1.86 (7.83)	1.46 (6.93)	1.67 (7.39)	1.26 (5.53)	1.06 (5.88)	1.40 (6.74)	2.47 (6.89)	190	1:7.85
T2 Chlorantraniliprole 18.5 SC	2.53 (9.62)	1.73 (7.56)	1.33 (6.62)	1.53 (7.11)	1.13 (5.92)	0.93 (5.53)	1.26 (6.45)	2.41 (6.57)	210	1:8.67
T3 Nisco sixer plus	2.80 (9.62)	2.00 (8.12)	1.60 (7.25)	1.80 (7.70)	1.40 (6.62)	1.20 (6.27)	1.53 (7.10)	2.54 (7.21)	170	1:7.78
T4 Neem oil 5%	2.73 (9.51)	2.06 (8.25)	1.66 (7.39)	1.86 (7.83)	1.46 (6.27)	1.26 (6.43)	1.60 (7.22)	2.61 (7.36)	160	1:7.11
T5 Beauveria bassiana	2.86 (9.73)	2.13 (8.38)	1.73 (7.54)	1.93 (7.97)	1.53 (6.43)	1.33 (6.60)	1.66 (7.54)	2.72 (7.52)	120	1:5.46
T6 Metarhizium anisopliae	2.67 (9.39)	2.20 (8.52)	1.80 (7.70)	2.00 (8.12)	1.60 (7.11)	2.6 (6.78)	1.80 (7.71)	2.94 (7.69)	100	1:4.64
T7 NSKE 5%	2.86 (9.74)	2.13 (8.39)	1.73 (7.56)	1.93 (7.99)	1.53 (6.95)	1.40 (6.62)	1.66 (7.37)	2.67 (7.52)	150	1:6.95
T8 Control	2.60 (9.27)	3.20 (10.30)	3.67 (11.03)	3.93 (11.43)	4.33 (12.29)	4.53 (12.29)	4.93 (12.83)	4.67 (11.66)	70	1:3.24
F-test	NS	S	S	S	S	S	S	S	--	--
C.D. at 5%		0.421	0.408	0.402	0.402	0.402	0.495	0.890	--	--
C.V	9.023	11.102	6.697	11.011	12.863	14.044	14.261	13.059	--	--

*Figures in parentheses are arc sin transformed values while those outside are original value

2.2 Cost benefit Ratio of Treatments

Gross returns was calculated by multiplying total yield with market price of the produce. Cost of cultivation and cost of treatments was deducted from the gross returns, to find out returns and cost benefit of ratio by following formula,

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

Where,

BCR = Benefit Cost Ratio.

3. RESULTS AND DISCUSSION

The data on larval population of *Helicoverpa armigera* over control at (3rd, 7th and 14th DAS) days after first spraying revealed that all the treatments were significantly superior over control among all the treatments used, T2-Chlorantraniliprole 18.5 SC proved to be the most effective against *Helicoverpa armigera* with (1.53%) larval population as compared to the untreated control (T8 -Water spray (3.60%) followed by next effective treatments T2-Spinosad 45 SC with (1.66%), T3 - Nisco sixer plus with (1.80%), T4 - Neem Oil (1.86%), T7-NSKE (1.93%), T5 -*Beauveria bassiana* (1.93%) and T6- *Metarhizium anisopliae* (2.00%) which was the least effective among all the treatments.

The data on larval population of *Helicoverpa armigera* over control at (3rd, 7th and 14th DAS) days after second spraying revealed that all the treatments were significantly superior over control among all the treatments used, T2-Chlorantraniliprole 18.5 SC proved to be the most effective against *Helicoverpa armigera* with (1.111%) larval population as compared to the untreated control (T8 -Water spray (4.60%) followed by next effective treatments T2-Spinosad 45 SC with(1.24%), T3 - Nisco sixer plus with (1.378%), T4 - Neem Oil(1.44%), T7 - NSKE (1.51%), T5 *Beauveria bassiana* (1.51%) and T6- *Metarhizium anisopliae* (1.60%) which was the least effective among all the treatments.

The reason for the superiority of chemical insecticide in reducing larval population compared to different sequential application of *Beauveria bassiana*, *Metarhizium anisopliae*, neemoil, NSKE, nisco sixer plus and spinosad is probably due to its quicker action against target pest. Chitralkha et al. [13] and Sapkal et al.

(2018) who detailed that chlorantraniliprole 18.5SC was unrivaled in lessening the larval population of tomato Fruit borer. Spinosad 45 SC is viewed as the following best treatment which is in accordance with the discoveries of Jamir and Kumar [5] and Ambulkar et al. [14] they detailed that Spinosad 45 SC was seen as best in diminishing larval population of tomato Fruit borer as well as expanding the yield.

Nisco sixer in addition to is viewed as the following best treatment which is in accordance with the findings of Lalhuzuala and Kumar [15] and Barwa and Kumar [16]. In accordance with the findings of Mustafiz et al. [10] as well as Bhati et al. [17] the next effective treatment neem oil. NSKE is viewed as the following powerful treatment which is in accordance with the findings of Tejeswari and Kumar [18] and Gupta et al. [19]. *Beauveria bassiana* viewed as the following powerful treatment which is in accordance with the findings of Deepthi and Yadav (2021), as well as Patil et al. [20]. Swathi et al. [21] and Sathish et al. [22] *Metarhizium anisopliae* found that was the least effective of the treatments.

The yield among the treatments was significant. The highest yield was recorded in Chlorantraniliprole 18.5SC (210q/ha) followed by Spinosad 45SC (190q/ha), Nisco sixer plus (170q/ha), Neem oil 5% (160q/ha), NSKE (150/ha), *Beauveria bassiana* (120q/ha), *Metarhizium anisopliae* (100q/ha) as compared to T8 control (70q/ha). When the benefit cost ratio was worked out, interesting results were achieved. Among the treatment studied the best and most economical treatment was Chlorantraniliprole 18.5SC (1:8.67), followed by Spinosad 45SC (1:7.85), Nisco sixer plus (1:7.78), Neem oil 5% (1:7.11), NSKE (1:6.95), *Beauveria bassiana* (1:5.46), *Metarhizium anisopliae* (1:4.64), as compared to control T8 (1:3.24).

The Yield and Benefit ratio of green gram shows the highest efficiency in Chlorantraniliprole18.5SC was supported by Patel et al. [23] followed by Spinosad 45SC was supported by Ghimire et al. (2022) and Choudhary et al. [24]. Nisco sixer plus was supported by Reddy et al. [25]. Neem oil 5% and NSKE were supported by Faqiri and kumar [26] and *Beauveria bassiana* and *Metarhizium anisopliae* the results of were supported by Devi et al. [27] and Anil and Kumar [28] respectively [29,30].

4. CONCLUSION

From the critical analysis of the present findings it was observed that the current insecticides like Chlorantraniliprole 18.5SC, Spinosad 45SC, Nisco sixer furthermore, neem oil, NSKE, *Beauveria bassiana*, *Metarhizium anisopliae*, were seen as successful against *Helicoverpa armigera* alongside an unexpected yield level in tomato. Chlorantraniliprole 18.5SC (1:8.6) had high cost benefit ratio and followed by Spinosad 45SC (1:7.8). Subsequently, this recommendation might be suitable with the current Integrated pest management programs to stay away from aimless utilization of pesticides for eco friendly and to adjust vegetation from eco framework which causes contamination in the climate.

ACKNOWLEDGEMENT

The authors are grateful to Prof. (Dr.) Rajendra B. Lal Hon'ble Vice Chancellor SHUATS, Prof. (Dr.) Shailesh Marker, Director of Research, Dr. Deepak Lal, Dean of PG studies, Prof. (Dr.) Biswarup Mehra, Dean, Naini Agricultural Institute, and (Dr.) Ashwani Kumar, Associate Prof, and Head, Department of Entomology, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj for taking their keen interest and encouragement to carry out this research work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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