Original Research Article

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

ABSTRACT

The field experiment on Comparitive efficacy of selected Bio-pesticides against tomato fruit borer [*Helicoverpa armigera* (Hubner)] on tomato [*Solanum lycopersicum* (L.)] was conducted during *Rabi* 2022, at Central Research Farm, Department of Entomology, SHUATS, Naini, Prayagraj, U.P. The relative efficacy of different insecticides *viz*., T_1 Spinosad 45% SC (125ml/lit), T_2 Chlorantraniliprole 18.5%SC (30g/ha), T_3 Nisco sixer plus (1ml/lit), T_4 Neem oil 5% (5ml/lit), T_5 *Metarhizium anisopliae* (1g/lit), T_6 *Beauveria bassiana*(0.3ml/lit), T_7 NSKE 5% (25kg/ha). The data on incremental larval population of different treatments revealed that the Chlorantraniliprole 18.5% SC (1.32) > Spinosad 45% SC (1.45) > Nisco sixer plus (1.58) > Neem oil 5% (1.65) > NSKE 5% (1.72) > *Beauveria bassiana* (1.72) > *Metarhizium anisopliae* (1.80). Found to be the most economical viable treatments the highest yield was obtained from Chlorantraniliprole 18.5% SC 210 q/ha and as well as C:B ratio (1:8.6). 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).

Key words*: - Bio-pesticides, Cost benefit ratio, Helicoverpa armigera, Larval population,Tomato.*

INTRODUCTION

Tomato, *Lycopersicon esculentum* (Miller), is an important vegetable crop grown around the world occupying the daily food regime of a majority of people **(Hussain and Bilal, 2007**). It is ranking second in importance next to potato **(Babar *et al*., 2016)**. It is native of South America (Peru) from where it is supposed to have been spread all over the world **(Ruksana and Kumar, 2022)**.

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 productionis from the dry season cropping particularly in southern states **(Olaniyi *et al.*, 2009)**. Mostly, it is commercially recognized and treated as a vegetable.The fruits are eaten raw or cooked **(Jamir and Kumar, 2022)**. It can be used fresh in salad, curries or bi-products like chutney, pickle, soups, ketchup, sauce, powder, purees etc, **(Deepthi and Yadav, 2022**).

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). **(Source :- USDA National Nutrient data base, 2020).**

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 tomatoare 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 productionof 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 21.18million 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 highestproductivity 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 **(Source: Agriculture Statistics at a Glance 2021-22).**

Tomato is susceptible to insect attack from seedling to fruiting stage. All parts of plant including leaves, stems, flowers and fruits are subjected to attack **(Mustafiz *et al.*, 2015).** Tomato crop is being damaged by a total of 41 insect-pests species belonging to 21 families which included 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)* **(Reddy and Kumar, 2004).** 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 isinvariably 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 basedon the use of bio pesticides and other environmentally safer botanicals considerable success in mitigating the insect pests damage.

MATERIALS AND METHODS

The experiment was conducted during *Rabi* season 2022 at Central Research Farm (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, T_1- Spinosad 45% SC, T_2- Chlorantraniliprole 18.5SC, T_3- Nisco sixer plus, T_4- Neem oil, T_5- *Beauveria bassiana* T_6- *Metarhizium anisopliae,* T_7- NSKE and T_8- untreated control.

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 1day before application and 3rd 7th and 14th days after application in each treatment. The result obtained was with following formula.

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

3.6.2. 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,

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

Where,

BCR = Benefit Cost Ratio.

Table 1: Comparitive 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 DBS	3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 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 anisopilae***	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 (1283)	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**	**0402**	**0.495**	**0.890**	--	
	C.V	**9.023**	**11.102**	**6.697**	**11.011**	**12.863**	**14.044**	**14.261**	**13.059**	--	

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 controlamong all the treatments used, T_2-Chlorantraniliprole 18.5 SC proved to be the most effective against *Helicoverpa armigera* with (1.53%) larval population as compared to the untreated control (T_8 -Water spray (3.60%) followed by next effective treatments T_2- Spinosad 45 SC with (1.66%), T_3 - Nisco sixer plus with (1.80%), T_4 - Neem Oil (1.86%), T_7 -NSKE (1.93%), T_5 -*Beauveria bassiana* (1.93%) and T_6- *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, T_2-Chlorantraniliprole 18.5 SC proved to be the most effective against *Helicoverpa armigera* with (1.111%) larval population as compared to the untreated control (T_8 -Water spray (4.60%) followed by next effective treatments T_2- Spinosad 45 SC with(1.24%), T_3 - Nisco sixer plus with (1.378%), T_4 - Neem Oil(1.44%), T_7 -NSKE (1.51%), T_5 *Beauveria bassiana* (1.51%) and T_6- *Metarhizium anisopliae* (1.60%) which was the least effective among all the treatments.

Chitralekha *et al.* (2018) who detailed that chlorantraniliprole18.5SC was unrivaled in lessening the larval population of tomato Fruit borer. Spinosad 45 SCis viewed as the following best treatment which is in accordance with the discoveries of **Jamir and Kumar (2022)** 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 discoveries of **Barwa and Kumar(2022).** In accordance with the findings of **Mustafiz *et al.* (2015)** the next effective treatment neem oil. NSKE is viewed as the following powerful treatment which is in accordance with the discoveries of **Gupta *et al.* (2018).** *Beauveria bassiana* viewed as the following powerful treatment which is in accordance with the discoveries of **Deepthi and Yadav (2021)**. **Sathish *et al.* (2018)** *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 T_8 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 anisopl*iae (1:4.64), as compared to control T_8 (1:3.24).

The Yield and Benefit ratio of green gram shows the highest efficiency in Chloratriniliprole18.5SC was supported by **Patel *et al.* (2016)** followed by Spinosad 45SC was supported by **Ghimire *et al.* (2022)**. Nisco sixer plus was supported by **Reddy *et al.* (2020).** Neem oil 5% and NSKE were supported by **Faqiri and kumar (2016)** and *Beauveria bassiana* and *Metarhizium anisopliae* the results of were supported by **Devi *et al.* (2013)** and **Anil and Kumar (2022)** respectively.

Conclusion

From the critical analysis of the present findings it was observed that spraying insecticides significantly reduced the population of tomato fruit borer pest. The current discoveries presume that the new age sprays like Chlorantraniliprole 18.5SC, Spinosad 45SC, Nisco sixer furthermore, neem oil, NSKE, *Beauveria bassiana*, *Metarhizium anisopliae*, were seen as successful against *Helicoverpa armigera* along side an unexpected yield level in tomato. Additionally, Chlorantraniliprole 18.5SC (1:8.6) and Spinosad 45SC (1:7.8) had high cost benefit ratio. Subsequently, it is recommended might be substituted with the current Integrated pest management programs to stay away from aimless utilization of pesticides for ecofriendly the executives and to adjust vegetation from eco framework which causes contamination in the climate.

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