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# Evaluation of the efficacy of insecticides and bio-pesticides against *Helicoverpa armigera* (Hubner) on tomato

**Santosh Kumar, Ram Singh Umrao, Alok Kumar, Vivek Kumar Patel, Rakesh Debnath and Abhay Kumar**

## Abstract
Field studies were carried out for the control of Tomato fruit borer (*Helicoverpa armigera*) during in Rabi season 2018-19 at Student Instructional Farm-"Insectary", Department of Entomology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The present investigation to evaluate the efficacy of some insecticides and biopesticides on tomato Azad Type-6 variety was taken and treated against Tomato fruit borer. The climate of Kanpur Nagar is sub-tropical with hot dry summer and severe cool in winter season, we applied chemical insecticide viz. Indoxacarb 14.5SC, Fipronil 5SC, Malathion 50EC, Imidacloprid 17.8SL and bio-pesticide viz. Spinosad 45SC & Neemarin 1500PPM at their recommended doses. The data on larval counts were taken from 10 randomly selected plants of each plot treated with pesticides, separately. It was observed that Indoxacarb 14.5SC @ 1.0 ml $lit^{-1}$ was found to be very effective against *Helicoverpa armigera* followed by Fipronil 5SC @ 1.0 ml $lit^{-1}$ in reducing the larval population and showed highest percent reduction in fruit infestation to 85.04% and 81.78% over control. Among the bio-pesticides, spinosad 45SC @ 0.20 ml/lit found to be effective as it showed 72.51% fruit infestation reduction over untreated plot. All the above treatments were found to be superior over untreated control which recorded highest number of larvae and fruit damage per plant.

**Keywords:** Tomato, bio-pesticides, insecticides, larval population, *Helicoverpa armigera*

## Introduction
Tomato (*Lycopersicon esculentum* Mill.) belongs to family Solanaceae. It is one of the most important and remunerative vegetable crops due to its immense commercial and nutritive value and wide range of climatic adoptability, grown in tropical and subtropical regions, round the year in the world. It can be used both in fresh or processed form. It is world's largest vegetable crop after potato and sweet potato**.** The leading tomato growing countries, in the world are China, India, United States, Turkey, Egypt, Iran, and Italy. Highest production of tomato in world is from China (56.80 million tonnes) followed by India (19.60 million tonnes) (2017-18). India is second largest producer of vegetables in the world next to china. In India tomato is cultivated on 808.54thousand-hectare area with annual production and average productivity of 19696.92 thousand tonnes and 24.36 tonnes $ha^{-1}$, respectively. Andhra Pradesh, Bihar, Karnataka, Uttar Pradesh, Odisha, Maharashtra, Madhya Pradesh and Assam are the largest producer of tomato in our country [2]. Whereas, in Uttar Pradesh, the annual production of tomato is 826.32 thousand tonnes from 20.88thousand-hectare area [2]. Among vegetables, tomato is known as "poor man's apple" because it is good source of carbohydrates, proteins, fats, vitamins and minerals along with roughages, which are essential constituents of balanced diet. Tomato is also popular because of its high content of vitamin A, B and C.

However, in the background of increasing population, the daily need of tomato is increasing day by day. Land is a limiting resource of agriculture, there is no option except to produce more food and other agriculture commodities from less per capita available land. Therefore, increase in production must come through increased yield from available land. Besides, this should be achieved in an eco- friendly, cost effective and sustainable manner.

The tomato yield in India is considerably lower because of several factors of which the damage caused by insect pest is most important. It is devastated by an array of pests like tobacco caterpillar, whitefly, pinworms, serpentine leaf minor, aphids, spider mites and fruit borer. Mandal (2012) reported that the fruit borer (*Helicoverpa armigera* Hub.), aphid

(*Aphis gossypi* Glov.) and whitefly (*Bemisia tabaci* Gennadins) had been major insect pests of tomato [7]. Oda *et al.* (2012) reported that the prevalence of various insect pests such as aphid, thrips, whitefly, leaf miner, insects belonging to the Coccidae and Miridae families, and cotton bollworm. However, the major economic damage is caused by the fruit borer [8]. Yield losses due to this pest is estimated around 24 to 73% in India [3].

Tomato fruit borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is the most destructive, polyphagous insect pest causing average percent damage of fruit is about 41.44%, reducing market value and quality of the fruit (Sapkal *et al*., 2018), and found to cause a yield loss up to 35% in general and up to 36% in Uttar Pradesh**.** The problem of pest is magnified due to its direct attack on fruiting structure, voracious feeding habits, high mobility, fecundity and multivoltine overlapping generations. Losses solely due to this pest up to Rs. 10,000 million have been reported in various crops like chickpea, cotton, pigeonpea, groundnut, tomato and other crops of economic importance. Tomato being a commercial vegetable crop, farmers have a tendency to overuse and even abuse insecticide in an over ambitious approach to knock down this destructive pest. As a result, it has caused turbulence in the Agri-ecosystem. It has led to many problems like buildup of insecticide resistance, pest resurgence, reduction or killing of natural enemies and insecticide residue in the tomato fruit. In such situation, newer group of insecticide and biological insecticide offer great scope as they maintain higher toxicity to insects at lower doses and are not persistent like conventional group of insecticides**.** Several new group of insecticides like Indoxacarb, Fipronil, Imidaclopridand Spinosad belonging to a novel class of insecticide have been introduced which have unique chemical structure and have been reported effective against insect pest of many crops [6].These are also reported safe to natural enemies and environment. In order to avoid the adverse consequences of traditional insecticides on non-target organism, environmental pollution, health hazard and development of resistance, it become necessary to evaluate the new insecticides which not only safe to natural enemies and environment but also effective at very low doses.

## Materials and Methods

Field experiment was conducted during Rabi season of 2018-19 at Student Instructional Farm- "Insectary", Department of Entomology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The experiment was laid out in randomized block design (RBD) with Seven treatments (including untreated control), each replicated thrice. The transplanting was done on 16th October, 2018. The soil type of experimental field was sandy loam with average fertility. Also, the field was well leveled having good drainage and adequate irrigation facility. Seedling of Tomato variety Azad T-6 were transplanted in 3×2.70 $m^2$ plots with spacing of 60 x 40 cm along with recommended standard agronomical practices except crop protection measures. The respective insecticides were sprayed on tomato manually by hand compression sprayer. To compare the efficacy of treatments, both recommended insecticides as well as untreated control were maintained. First spray application was made at the initiation of pest at 60 days after transplanting and second and third spraying was done at 15 and 30 days after first spray.

## Observations

Observations were recorded on the number of larvae per plant over 10 randomly selected plants per ploton5th, 10th and 15thdays respectively after each spray. The data on percentage infestation of tomato fruits by borer was calculated at each picking by counting damage and healthy fruits.

## Selection of Insecticides and Bio-pesticides

The registered formulations of insecticides and bio-pesticides used in this study are listed below which were obtained from departmental store.

## Preparation of spray solution

The concentration of insecticides on the basis of active ingredient the desired amount of each insecticide was measured by micro pipette and electronic balance and then mixed with required amount of water. The formulation was diluted with water just at the time of spraying was done with the help of atomizer.

$$\text{Amount of insecticide} = \frac{\text{Concentration requirement percentage} \times \text{volume required(lit.)}}{\text{concentration of toxicant in insecticide}}$$

## Statistical Analysis

The experiment for evaluation of insecticides was laid out in Randomized Block Design with 3 replications for finding out infestation percentage of *H. armigera*. Pest count were transformed using angular transformation, there as the data having pest population at zero level in any treatment were transformed to $\sqrt{x + 0.5}$ values (where x = observed insect population per plot). The statistical analysis was made to determine the standard error and critical difference at 5% level of significance. Standard error and critical difference were calculated by following formula.

$$\text{Standard error} = \frac{\sqrt{2MES}}{R}$$

MES: error mean sum of square, error variance
R = Replication

Critical difference (C.D.) @ 5% = SE (d) $\times$ t5%

All the observation was analysed statistically to compare the treatment effect. The percentage reduction over control was calculated by following formula (Abbot's, 1925).

## Percentage reduction

The percentage reduction in population over untreated check was calculated with the following formula.

$$\text{Percentage reduction over control} = \frac{C-T}{C} \times 100$$

C = % Total number of larvae in untreated or control plot.
T = % Total number of larvae in treated plot by different insecticides and bio-pesticides.

## Results and Discussion

**Efficacy of some insecticides and bio-pesticides against larval population fruit borer, *H. armigera* infesting tomato recorded at different intervals after first, second and third spray**

The results showed that all the insecticidal treatments recorded significantly lowest larval population over control on 10 randomly selected plants/plot (Table No.- 2& 3).

From the result of 1st spray, Indoxacarb14.5SC recorded least larvae followed by Fipronil 5SC and Malathion 50EC. Among biopesticides Spinosad 45SC showed best results, whereas other bio-pesticides *viz.*, Neemarin 1500ppm found least effective but were superior over control.The observation recorded after 5th day of first spraying have shown maximum reduction of mean larval population of *H. armigera*i.e. 1.23, 1.40, 1.73, 2.06, 2.16 and 2.56, respectively. In case of per cent reduction of larval population over control showed that Indoxacarb l4.5SC was most effective having minimum fruit infestation with 78.90% reduction over control followed by Fipronil 5SC, Malathion 50EC, Imidacloprid 17.8SL, Spinosad 45SC and Neemarin 1500ppm i.e. 75.98%, 70.32%, 64.66%, 62.95% and 56.08%, respectively. After 10th day of first spraying Indoxacarb 14.5SC, Fipronil 5SC, Malathion 50EC, Imidacloprid 17.8SL, Spinosad 45SC and Neemarin 1500ppm minimized the mean larval population effectively to1.80, 1.90, 1.96, 2.70, 2.86 & 3.10. In case of per cent reduction of larval population over control showed i.e. 80.91%, 79.85%, 79.21%, 71.36%, 69.67% and 67.12%, respectively. Observation were recorded after 15th day of first spraying which shown maximum reduction of larval population with the application of Indoxacarb 14.5SC followed by Fipronil 5SC, Malathion 50EC, Imidacloprid 17.8SL, Spinosad 45SC and Neemarin 1500ppmi.e. 1.13, 1.43, 1.56, 1.86, 2.20&2.27. Whereas in case of reduction in fruit infestation over controli.e. 85.32%, 81.42%, 79.44%, 75.84%, 71.42% and 70.51%, respectively.

After2ndspray, the fruit borer population was once again recorded minimum in plots which were treated with Indoxacarb 14.5SC followed by Fipronil 5SC, Malathion 50EC and Imidacloprid 17.8SL. In case of bio pesticides, Spinosadwas observed as best followed by Neemarin 1500ppm. The mean larval population recorded after 5th, 10th& 15th day after 2ndspraying i.e. 2.00, 2.70, 3.00, 3.26, 3.63 & 3.96 (after 5th day), 1.76, 2.20, 2.86, 3.10, 3.46 & 4.43 (after 10th day) and 1.26, 1.70, 2.10, 2.36, 2.96 & 3.53(after 15th day), respectively. In case of reduction in fruit infestation over control after 5th, 10th& 15th dayof2nd sprayingi.e. 83.27%, 77.42%, 74.91%, 72.74%, 69.64% &66.88% (after 5th day),87.02%, 83.77%, 78.90%,77.13%, 74.48% & 67.33% (after 10th day), and 89.96%, 86.46%, 83.28%, 81.21%, 76.43% and 71.89% (after 15th day),respectively on 10 randomly selected plants/plot.

After 3rd spray, result showed that all insecticides again effectively minimized the larval population of *H. armigera* when compared with control after 5th, 10th& 15th day. Plot treated with Indoxacarb 14.5SC found most effective followed by Fipronil 5SC, Malathion 50EC and Imidacloprid 17.8SL. In case of biopesticides, Spinosadwas observed as best followed by Neemarin 1500ppmi.e. 1.90, 2.30, 2.66, 3.10, 3.30 & 3.86 (mean larval population after 5th day), 1.66, 1.90, 2.10, 2.40, 2.90 & 3.60 (mean larval population after 10th day), 1.33, 1.76, 1.90, 2.10, 2.60 & 3.23 (mean larval population after 15th days). In case of reduction in fruit infestation over control after 5th, 10th& 15th day after 3rd spraying i.e. 83.47%, 80.00%, 76.86%, 73.04%, 71.30% & 66.43% (after 5th day), 87.75%, 85.98%, 84.51%, 82.30%, 78.61 & 73.45% (after 10th day), 88.78%, 85.16%, 83.97%, 82.29%, 78.07% & 72.16% (after 15th day), respectively on 10 randomly selected plants/plot.

These findings are in agreement with Abhijit *et al.*(2012) who observe the efficacy of some pesticides with novel mode of action (spinosad, indoxacarb, flubendiamide) for the management of *Helicoverpa armigera* on tomato (Var. Pathorkuchi) in field condition [1]. Insecticides applied thrice at 15 days interval after borer population build up showed that Indoxacarb 14.5SC@ 40 g a.i. ha-l was superior over other treatments against *Helicoverpa armigera*, with 98.04% reduction, closely followed by spinosad 45SC @ 60 g a.i. ha-l (88.03%). Sherad and Kumar (2014) observed spinosad 45 SC @ 0.40%, dichlorvos 76 EC @ 0.60% and imidacloprid 200 SL @ 4 ml/lit [10]. Were found to be most effective, with fruit damage percentage of 0.53, 1.00 and 1.04 respectively. Wajid hasan, *et al*. (2016) evaluated the effect of Indoxacarb against *H. armigera* in tomato [11]. The lowest percent damage of fruits by *H. armigera* was observed in Indoxacarb 75 and 60 g a.i. ha-1 dosage with 7.0 and 8.0 per cent fruit damage. Chavan, *et a1*. (2015) reported that Spraying of Bacillus thuringiensis @ l kg/ha and azadirachtin 3000 ppm @ 2.5 lit/ha at 45 and 65 days after transplanting showed maximum efficacy against *Helicoverpa armigera* [4]. Dhar and Bhattacharya. (2015) tested seven insecticidal treatments with different spray schedules against fruit borer infesting Tomato [5]. Among the seven insecticidal treatments single application of imidacloprid 17.8SL followed by twice applications of spinosad 45SC gave Maximum reduction in infestation of fruit borer in tomato.

**Table 1:** Details of Insecticides & Bio pesticides used

| Sl. No. | Common name& Formulation | Trade Name | Dose/lit. of water | Source of availability |
|---|---|---|---|---|
| 1. | Imidacloprid 17.8 SL | ULTIMO | 0.50 ml | M/S Biostadt India Ltd Mumbai, 400018 |
| 2. | Fipronil 5 SC | AgadiSC | 1.0 ml | ADAMA India P.Ltd., Hyderabad, 500078 |
| 3. | Nemarin (Neem Oil) 1500 ppm | Achook | 3.0 ml | Biotech international Ltd. New Delhi |
| 4. | Indoxacarb 14.5 SC | ISACARB | 1.0 ml | Isagro (Asia) Agro-chemical PVT Ltd., Mumbai |
| 5. | Malathion 50 EC | Himmala | 1.0 ml | Hindustan insecticides Ltd. New Delhi |
| 6. | Spinosad 45 SC | TAFFIN | 0.20 ml | TATA Insecticides Ltd. |
| 7. | Untreated (Control) | - | - | - |

**Table 2:** Evaluation of different Insecticides and Biopesticides against larval population of *H. armigera*after 5th, 10th and 15th day of 1st, 2nd and 3rdspray (DAS: Days after spray).

| Treatment | Dose lit⁻¹ of Water | Mean number of larval population (*H. armigera*)/ 10 plants at | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | After 1st spray | | | After 2nd spray | | | After 3rd spray | | |
| | | 5 DAS | 10 DAS | 15 DAS | 5 DAS | 10 DAS | 15 DAS | 5 DAS | 10 DAS | 15 DAS |
| Indoxacarb 14.5 SC | 1.0 ml | 1.23 (1.315) | 1.80 (1.516) | 1.13 (1.276) | 2.00 (1.581) | 1.76 (1.503) | 1.26 (1.326) | 1.90 (1.549) | 1.66 (1.469) | 1.33 (1.352) |
| Fipronil 5 SC | 1.0 ml | 1.40 (1.378) | 1.90 (1.549) | 1.43 (1.389) | 2.70 (1.788) | 2.20 (1.643) | 1.70 (1.483) | 2.30 (1.673) | 1.90 (1.549) | 1.76 (1.503) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Malathion 50 EC | 1.0 ml | 1.73 (1.493) | 1.96 (1.568 | 1.56 (1.435) | 3.00 (1.870) | 2.86 (1.833) | 2.10 (1.612) | 2.66 (1.777) | 2.10 (1.612) | 1.90 (1.549) |
| Imidacloprid 17.8 SL | 0.50 ml | 2.06 (1.600) | 2.70 (1.788) | 1.86 (1.536) | 3.26 (1.939) | 3.10 (1.897) | 2.36 (1.691) | 3.10 (1.897) | 2.40 (1.702) | 2.10 (1.612) |
| Spinosad 45 SC | 0.20 ml | 2.16 (1.630) | 2.86 (1.833) | 2.20 (1.643) | 3.63 (2.032) | 3.46 (1.989) | 2.96 (1.860) | 3.30 (1.949) | 2.90 (1.843) | 2.60 (1.760) |
| Neemarin 1500 ppm | 3.00 ml | 2.56 (1.749) | 3.10 (1.897) | 2.27 (1.664) | 3.96 (2.111) | 4.43 (2.220) | 3.53 (2.007) | 3.86 (2.088) | 3.60 (2.024) | 3.23 (1.931) |
| Control | 0 | 5.83 (2.515) | 9.43 (3.151) | 7.70 (2.863) | 11.96 (3.529) | 13.56 (3.749) | 12.56 (3.613) | 11.50 (3.464) | 13.56 (3.749) | 11.86 (3.515) |
| S.E.(D)± | | 0.35 | 0.54 | 0.58 | 0.88 | 0.89 | 0.69 | 0.53 | 0.55 | 0.30 |
| CD at 5% | | 0.77 | 1.19 | 1.29 | 1.95 | 1.96 | 1.52 | 1.18 | 1.21 | 0.67 |

$\sqrt{x+0.5}$ transformed values are given in parenthesis.

**Table 3:** Efficacy of different Insecticides & Bio pesticides against larval population of *H. armigera* after 5th, 10th and 15th day of 1st, 2nd and 3rd spray over control (DAS: Days after spray).

| Treatment | Dose lit⁻¹ of Water | % reduction of larval population(*H. armigera*) over control/ 10 plants at | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | After 1st spray | | | After 2nd spray | | | After 3rd spray | | | Overall Mean |
| | | 5 DAS | 10 DAS | 15 DAS | 5 DAS | 10 DAS | 15 DAS | 5 DAS | 10 DAS | 15 DAS | |
| Indoxacarb 14.5SC | 1.0 ml | 78.90 | 80.91 | 85.32 | 83.27 | 87.02 | 89.96 | 83.47 | 87.75 | 88.78 | 85.04 |
| Fipronil 5SC | 1.0 ml | 75.98 | 79.85 | 81.42 | 77.42 | 83.77 | 86.46 | 80.00 | 85.98 | 85.16 | 81.78 |
| Malathion 50EC | 1.0 ml | 70.32 | 79.21 | 79.44 | 74.91 | 78.90 | 83.28 | 76.86 | 84.51 | 83.97 | 79.04 |
| Imidacloprid 17.8SL | 0.50 ml | 64.66 | 71.36 | 75.84 | 72.74 | 77.13 | 81.21 | 73.04 | 82.30 | 82.29 | 75.62 |
| Spinosad 45SC | 0.20 ml | 62.95 | 69.67 | 71.42 | 69.64 | 74.48 | 76.43 | 71.30 | 78.61 | 78.07 | 72.51 |
| Neemarin 1500ppm | 3.00 ml | 56.08 | 67.12 | 70.51 | 66.88 | 67.33 | 71.89 | 66.43 | 73.45 | 72.76 | 68.05 |
| Control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Conclusion
The experiment on bio-efficacy of different insecticides and bio-pesticides treatments revealed that Indoxacarb 14.5SCwas found most effective also showed highest percent of fruit infestation reduction caused by *H. armigera* i.e. (85.04%) followed by Fipronil 5SC (81.78%), Malathion 50EC (79.04%), Imidacloprid 17.8SL (75.62%), Spinosad 45SC(72.51%) and Neemarin 1500ppm (68.05%) over control respectively.


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