

# Comparative efficacy of different biopesticides against the Tobacco Caterpillar, *Spodoptera litura*(Fabricius)

## Abstract

Tobacco caterpillar, *Spodoptera litura* (Fabricius) is an economically important polyphagous pest inflicting significant economic damage to numerous field and horticultural crops. Overreliance of chemical insecticides to manage the pest has led to the development of resistance, resurgence and residue problem in the crop ecosystems, in addition to high operating costs. Biopesticides have been reported to be effective for managing this pest in ecofriendly manner. Hence, the present study was conducted to assess the efficacy of different biopesticides against *S.litura* under laboratory conditions at Bihar Agricultural College, Sabour, Bhagalpur during the *rabio* of 2022-23. It was conducted in completely randomized design (CRD) with eight treatments and three replications. Among the various biopesticides evaluated, *Steinernemacarpocapsae*- 500 IJs/Petri Plate and *Metarhizium anisopliae*  $1 \times 10^8$  spores/ml -5g/l were most effective treatments and at par each other with 93.00 and 82.50 per cent larval mortality, respectively. They had performed equally with chemical check, Emamectin benzoate 5 SG- 0.4 g/litre which recorded with 95.63 percent larval mortality. Neem oil 1500 ppm- 5 ml/litre and *Beauveria bassiana*  $1 \times 10^8 @ 5ml/l$  were the next best treatments with 78.31 and 59.38 per cent larval mortality respectively. The order of efficiency was Emamectin benzoate 5 SG (0.4g/l) > EPNs (500 IJs) > *Metarhizium anisopliae* 1% WP (5g/l) > Neem oil 1500 ppm (5 ml/litre) > *Beauveria bassiana* 1 % WP (5 g/l) > *Metarhizium anisopliae* 1 % WP ( 2.5 g/l) > *Beauveria bassiana* 1 % WP(2.5 g/l). (Correct as per abcd...in mean table).

**Keywords:** polyphagus, entomopathogenic nematodes, bio-pesticides, eco-friendly, Emamectin benzoate.

## INTRODUCTION

*Spodoptera litura* (Fabricius) is a highly polyphagous insect that a significant threat to agriculture and many other countries (Shivayogesaghwara et al., 1991). This insect has a wide range of host plants and has been reported to damage over 112 plant species from 44

different families. In India alone, it has been observed affecting about 40 plant species (Chari and Patel, 1983). Various crops are known to serve as host plants for *Spodoptera litura*, and researchers (Basu(1944), Thobbi (1961), and Patel et al. (1987) have documented its presence and damage in several agricultural crops. Some of the crops known to be affected by *Spodoptera litura* viz., maize, castor, cauliflower, tobacco and several grasses etc. *Spodoptera litura*'s ability to infest such a wide range of crops and plant species makes it an important agricultural pest that requires efficient management strategies to mitigate its impact on crop yields. Other hosts include ornamental plants, native vegetation, unwanted plants, and shade trees, such as *Leucaena leucocephala*, which serves as a shade tree in Indonesian cocoa plantations (CABI, 2019).

## MATERIAL AND METHODS

Various bio-pesticides were evaluated against the *S.litura* under controlled laboratory conditions at Department of Entomology, Bihar Agricultural College, Sabour, Bhagalpur during the rabi 2022-23. Biopesticides included were viz., *Beauveria bassiana* and *Metarhizium anisopliae* at two different doses, Neem oil 1500 ppm and *Steinernema carpocapse*. The other two were chemical check, Emamectin benzoate 5 SG and untreated control, distilled water spray. Details of treatments evaluated are given in the Table 1.

**Table 1: Treatment details**

Treatments	Biopesticide Name	Dose
T1	<i>Beauveria bassiana</i> ( $1 \times 10^8$ spores/ml)	2.5ml/l
T2	<i>Beauveria bassiana</i> ( $1 \times 10^8$ spores/ml)	5ml/l
T3	<i>Metarhizium anisopliae</i> ( $1 \times 10^8$ spores/ml)	2.5g/l
T4	<i>Metarhizium anisopliae</i> ( $1 \times 10^8$ spores/ml)	5g/l
T5	Neem oil 1500 PPM	5 ml/litre
T6	<i>Steinernema carpocapse</i>	500 IJs/10 Larvae
T7	Emamectin benzoate 5 SG	0.4g/l
T8	Untreated/Control	-

The present experiment was performed using completely randomized design (CRD) with eight treatments and three replications using leaf dip bioassay method. Leaves of tomato were properly cleaned and dipped for 30 seconds in the prepared treatment solutions. Observations were taken at 24 hrs, 48 hrs, 72 hrs, 96 hrs, 120 hrs, 144 hrs, 168 hrs, 192 hrs

after application. A total of 10 of uniformly aged 3<sup>rd</sup> instar larvae were used in each replication. Per cent mortality was calculated by using the following formula 1 (Karthi et.al. 2019) and per cent control calculated by using Abbott's (1925) formula (2)

$$\text{Percentage of mortality} = \frac{\text{Numbers of dead larvae}}{\text{Numbers of larvae introduced}} \times 100(1)$$

$$\text{Per cent control} = 100 \times \left( \frac{X-Y}{X} \right) (2)$$

Whereas X = the per cent living in the check.

Y = the per cent living in the treated.

X-Y = the per cent killed by the treatment.

## RESULTS AND DISCUSSION

### After 24 hrs of application

The results of the experiment presented in Table 2, which focused on the mortality percentage of Tobacco caterpillar (*Spodopteralitura*), data revealed that, within the period of 24-hour, the larval mortality varied between 11.67 to 73.33 per cent when subjected to different treatments. The maximum per cent mortality was observed in the treatment with Emmamectin benzoate 5SG@0.4g/l (73.33) followed by the treatment, application of 500 infective juvenile units (IJs) of *Steinernema carpocapsae* (68.33). The larvae treated with Neem oil 1500ppm@5ml/litre resulted in 40.00 per cent mortality. The lowest percentage of mortality was observed in *Beauveria bassiana* @ 2.5 ml/l was 11.67 .

### After 48 hrs of application:

The data presented in Table 2 clearly indicates that the mortality percentage of Tobacco caterpillar larvae ranged from 20.00 to 91.67 per cent after 48-hour exposure to various treatments. The treatment Emmamectin benzoate 5SG @ 0.4g/l recorded the highest mortality of 91.67%, followed by the treatment, 500 IJs of *Steinernema carpocapsae* caused 80% mortality. The treatment *Metarhizium anisopliae* @ 5 g/l, caused mortality of 60.00%. The treatment, *Beauveria bassiana* @ 2.5 ml/l demonstrated lowest percentage of mortality 20.00.

### After 72 hrs of application

The data presented in Table 2 revealed range of mortality percentage, spanning from 28.33% to 100 % within 72-hour period after application of different treatments. 100 per cent

mortality was observed in the treatment Emamectin benzoate 5SG @ 0.4g/l at the exposure of 72hrs duration which was followed by the treatment of 500 infective juvenile units (IJs) of *Steinernema carpocapsae*, which resulted 95.67 percent mortality. Meanwhile, the treatment *Metarhizium anisopliae* @ 5 g/l led to 76.67 percent larval mortality. On the other hand, the treatments *Metarhizium anisopliae* @ 2.5 g/l and *Beauveria bassiana* @ 2.5 ml/l recorded lowest percentage of mortality, 35.00 and 28.33 per cent mortality, respectively.

#### **After 96 hrs of application**

The data presented in Table 2 illustrates the range of 35.00 to 100.00 percent mortality observed after applying various treatments at 96-hour duration. The treatment *Beauveria bassiana* @ 2.5 ml/l exhibited the lowest per cent mortality (35.00). The treatment with the application of 500 IJs of *Steinernema carpocapsae* resulted in 100% mortality within 96 hours which was followed by the treatment, *Metarhizium anisopliae* @ 5 g/l (85.00 percent mortality).

#### **After 120 hrs of application**

The information provided in Table 2 distinctly illustrated that the mortality percentage of Tobacco caterpillar larvae exhibited a span of 45.00 to 100.00 per cent at 120 hours exposure to diverse treatment regimens. The treatment *Metarhizium anisopliae* @ 5 g/l, recorded 100.00 per cent mortality at 120 hrs after application. *Beauveria bassiana* @ 2.5 ml/l exhibited 45.00 per cent mortality.

#### **After 144 hrs of application**

The data presented in Table 2 distinctly illustrated that the mortality percentage of Tobacco caterpillar larvae showed variance from 55.00 to 100.00 per cent following 144-hour exposure to different treatments. Neem extract 5% attained 100.00 per cent mortality at 144 hrs of application. *Beauveria bassiana* @ 5 ml/l exhibited 80.00 per cent mortality followed by the treatment, *Metarhizium anisopliae* @ 2.5 g/l and *Beauveria bassiana* @ 2.5 ml/l (55.00 per cent mortality).

#### **After 168 hrs of application**

The data presented in Table 2 makes it evident that the percentage of mortality ranged from 65.00 to 100.00 after the application of treatments over 168-hour period. The treatment *Beauveria bassiana* @ 5 ml/l led to mortality of 88.33. The lowest mortality percentage (65.00) was observed with the treatment *Beauveria bassiana* @ 2.5 ml/l followed by the treatment *Metarhizium anisopliae* @ 2.5 g/l (60%).

#### **After 192 hrs of application**

Results obtained from the experiment (Table 2) showed that 100 percent mortality with the treatment *Beauveria bassiana* @ 5ml/l was achieved during 192 hrs. However, Emamectin benzoate 5SG @ 0.4 g/l, EPN (500IJs), *Metarhizium anisopliae* @ 5g/l, Neem extract 5% attained 100 percent mortality within 168 hrs. The treatment *Metarhizium anisopliae* @ 2.5 g/l and *Beauveria bassiana* @ 2.5ml/l showed 80.00 and 70.00 per cent mortality, respectively. Only 6.66 percent mortality was recorded in untreated control during the entire period of investigation.

### Discussion

The comparative effectiveness of various biopesticides and EPNs were studied. Per cent mortality of *S. litura* was recorded after 24 hours, 48 hours, 72 hours, 96 hours, 120 hours, 144 hours, 168 hours, and 192 hours of application, it was revealed from the provided table 3 related mortality of *S. litura*. The treatment Emamectin benzoate @ 0.4 g/l achieved the highest mortality 73.33, 91.67 and 100 per cent after 24 hrs, 48 hrs and 72 hrs, respectively. Emamectin benzoate is a semi-synthetic biopesticide derived from avermectins, which are natural products produced by the bacterium *Streptomyces avermitilis*. The next most effective treatment was observed, using EPNs @ 500 IJs per petri plate, resulted 100 % mortality of *S. litura* within 96 hrs of application. Among fungal biopesticides, *Metarhizium anisopliae* @ 5 g/l, recorded 100.00 per cent mortality at 120 hrs after application. Neem extract 5 % attained 100.00 per cent mortality at 144 hrs of application. In case of *Beauveria bassiana* @ 5 ml/l, 100 percent mortality was achieved after 192 hrs. While *Metarhizium anisopliae* @ 2.5 g/l and *Beauveria bassiana* @ 2.5 ml/l showed 80.00 and 70.00 per cent mortality, respectively. Only 6.66 per cent mortality was recorded in untreated control during the period of investigation. Hence it was concluded that larval mortality enhanced with increase in doses and time interval. Emamectin benzoate inhibits signal transmission at junction and act as (GABA) gamma aminobutyric acid antagonist in insects. *Beauveria bassiana* (White muscardine diseases) and *Metarhizium anisopliae* (Green muscardine diseases) produces endotoxin, causes death of insect larvae. The present findings are in relevant with Pragma and Das (2022) who found that the fungal mycotoxin of *Beauveria bassiana* and *Metarhizium anisopliae* showed the reduced development of lepidopteran pests. Patel et al. (2020) tested the effectiveness of various native strains of entomopathogenic fungi, including *Beauveria bassiana*, *Metarhizium anisopliae*, and *Nomuraea rileyi*, as well as entomopathogenic bacteria such as *Bacillus thuringiensis*, was evaluated in comparison to

non-native strains. Yadav et al. (2017) conducted an experiment on bio-efficacy of *Steinernema carpocapsae* and found that *S. carpocapsae* caused 100 per cent larval mortality.

**Table 2 :Comparative bio-efficacy of *Steinernema carpocapsae* against *S.litura***

Treatment	Mortality percentage of <i>S.litura</i>								
	24 hrs	48 hrs	72 hrs	96 hrs	120hrs	144hrs	168hrs	192hrs	Mean
T <sub>1</sub> - <i>Beauveria bassiana</i> 1×10 <sup>8</sup> @ 2.5ml/l	11.67 <sup>g</sup>	20.00 <sup>g</sup>	28.33 <sup>f</sup>	35.00 <sup>e</sup>	45.00 <sup>d</sup>	55.00 <sup>c</sup>	65.00 <sup>c</sup>	70.00 <sup>c</sup>	41.25 <sup>c</sup>
T <sub>2</sub> - <i>Beauveria bassiana</i> 1×10 <sup>8</sup> @5ml/l	25.00 <sup>e</sup>	30.00 <sup>e</sup>	35.00 <sup>e</sup>	51.67 <sup>c</sup>	65.00 <sup>c</sup>	80.00 <sup>b</sup>	88.33 <sup>b</sup>	100.00 <sup>a</sup>	59.38 <sup>b</sup> <sub>c</sub>
T <sub>3</sub> - <i>Metarhizium anisopliae</i> 1×10 <sup>8</sup> @2.5g/l	20.00 <sup>f</sup>	26.67 <sup>f</sup>	35.00 <sup>e</sup>	40.00 <sup>d</sup>	45.00 <sup>d</sup>	55.00 <sup>c</sup>	60.00 <sup>d</sup>	80.00 <sup>b</sup>	45.21 <sup>c</sup>
T <sub>4</sub> - <i>Metarhizium anisopliae</i> 1×10 <sup>8</sup> @5 g/l	38.33 <sup>d</sup>	60.00 <sup>c</sup>	76.67 <sup>c</sup>	85.00 <sup>b</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	82.50 <sup>a</sup>
T <sub>5</sub> -Neem oil 1500 ppm@ 5 ml/litre	40.00 <sup>c</sup>	50.00 <sup>d</sup>	60.00 <sup>d</sup>	85.00 <sup>b</sup>	90.00 <sup>b</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	78.31 <sup>a</sup> <sub>b</sub>
T <sub>6</sub> - <i>Steinernema carpocapsae</i> 500 IJs/Petri Plate	68.33 <sup>b</sup>	80.00 <sup>b</sup>	95.67 <sup>b</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	93.00 <sup>a</sup>
T <sub>7</sub> -Emamectin benzoate <b>5SG@0.4g/l</b>	73.33 <sup>a</sup>	91.67 <sup>a</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	100.00 <sup>a</sup>	95.63 <sup>a</sup>
T <sub>8</sub> -Untreated/Control (dipped in water)	0 <sup>h</sup>	0 <sup>h</sup>	0 <sup>g</sup>	0 <sup>f</sup>	0 <sup>e</sup>	0 <sup>d</sup>	0 <sup>e</sup>	6.66 <sup>d</sup>	0.83 <sup>d</sup>
SEm (±)	1.01	1.14	1.12	1.16	0.82	0.57	0.90	1.23	17.97
CD(p=0.05)	0.10	0.12	0.10	0.15	0.15	0.16	0.19	0.23	
CV	1.10	1.15	0.85	1.21	1.15	1.16	1.35	1.53	

**Conclusion:**

The most effective treatment was Emamectin benzoate @ 0.4g/l with larval mortality of 100 percent within 72 hrs which was followed by EPNs @ 500 IJs caused 100 per cent larval mortality within 96 hrs. The treatment Emamectin benzoate @ 0.4g/l achieved the highest larval mortality and appeared as the most effective insecticide to manage the pest. Emamectin benzoate is a semi-synthetic bio pesticide, which are natural products produced by the bacterium *Streptomyces avermitilis*. It is also promising bio pesticides effective Lepidopteran insect pests. It is eco-friendly and no harmful effect on natural enemies biodegradable and can be more effective than chemical pesticides in the long term. Thus this semi-bio pesticide may be incorporated in Integrated Pest management.

## REFERENCES

- Abbott W(1987) A method of computing the effectiveness of an insecticide. J. Econ. Entomol, 18: 265–267.
- Basu AC (1944) Effect of different food on larval and post larval development of moths of *Prodenialitura* Fabricius (Lepidoptera: Noctuidae). Bombay natural history society, 44: 275-88.
- CABI (2019) Invasive Species Compendium: Datasheets, maps, images, abstracts and full text on invasive species of the world. Available: <http://www.cabi.org/isc/datasheet/44520>. Accessed 18 November 2019.
- Chari MS and Patel NG (1983) Cotton leaf worm *Spodoptera litura*, its biology and integrated control measures. Journal of Cotton Research & Development, 13: 7-8.
- Karthi S, Senthil-Nathan S, Kalaivani K, Vasantha-Srinivasan P, Chellappandian M, Thanigaivel A, Ponsankar A, Sivanesh H, Stanley-Raja V, Chanthini KM, Shyam-Sundar N. (2019) Comparative efficacy of two mycotoxins against *Spodoptera litura* Fab. and their non-target activity against *Eudriluseugeniae* Kinb. Ecotoxicology and Environmental Safety. 183:109474.
- Patel CC, Chari MS (1987) Bio-ecological studies on Tobacco leaf eating caterpillar *Spodoptera litura* Tob Res, 13, 1-8.
- Patel PH, Sisodiya DB, Raghunandan BL, Patel NB, Gohel VR, Chavada KM (2020) Bioefficacy of Entomopathogenic fungi and bacteria against invasive pest *Spodoptera frugiperda* (JE Smith) under laboratory condition. Journal of Entomology and Zoology Studies, 8(6): 716-720.
- Pragya K, Das SB (2022) Potential of Entomopathogenic fungi for biocontrol of *Spodoptera litura* Fab. (Lepidoptera: Noctuidae), The Pharma Innovation Journal, 11(6):249-254.
- Shivayogeshwara B, Mallikarjunaiah H, Krishnaprasad NK and Shetty MVN (1991) Integrated management of *Spodoptera litura* Fabricius (Noctuidae: Lepidoptera) in FCV tobacco crop. Tobacco Research, 17: 59-61.
- Thobbi VV (1961) Growth potential of *Prodenialitura* Fabricius in relation to certain food plants in Surat, Indian Journal Entomology 22: 262-64.
- Yadav S, Patil J, Sharma HK (2017) Bio-efficacy of *Steinernema carpocapsae* against *Spodoptera litura* under laboratory condition. International Journal of Pure and Applied Biosciences, 5: 165-172.