J. Soils and Crops 35 (1) 87-93, June 2025

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)

EFFICACY OF BIOPESTICIDES AGAINST CUTWORM (*Agrotis ipsilon* H.) POPULATION IN PEA

Thinlay Wangmu[1], Saxena Raviprakash Narayan[2], Punam Bagang[3], Tadung Taku[4] and Yashi Umbrey[5]

ABSTRACT

A field experiment was carried out in Emchi village, Doimukh, Papum Pare district of Arunachal Pradesh, during *rabi* season of 2021-2022. The study aimed to investigate the cutworm population in pea crop and to evaluate the effectiveness of various biopesticides for its control. The presence of the larvae was recorded at 5th Standard Meteorological Week (SMW) with a population density of 0.78 larvae, at a minimum temperature of 14.4^{0}C, at a maximum temperature of 26.6^{0}C, rainfall of 0.60 mm and a relative humidity of 71 per cent. The population of the cutworm larvae gradually increased and finally reached its peak at 10th SMW (4.90) at a minimum temperature of 8.00^{0}C, at a maximum temperature of 22.90^{0}C with no rainfall and relative humidity of 62 per cent and with a slope of 0.1061X. It indicated a population growth rate of 0.1952, with R^2value of 0.049, suggesting a 4.9 per cent variation in population due to date intervals. The larval population then gradually declined to 1.29 mean larval population in the 13th SMW under the weather conditions of minimum temperature of 17.7^{0}C, maximum temperature of 25.5^{0}C, rainfall of 0.12 mm and relative humidity of 74 per cent. Further for the bio-efficacy test of biopesticides against cutworm, the pre-treatment cutworm population ranged from 2.00 to 3.00 larvae. The lowest population was recorded in the plot treated with *Bacillus thuringiensis* (1.85 larvae), followed by Nuclear Polyhedrosis Virus (1.92 larvae), *Beauveria bassiana* (2.02 larvae) and Neem oil (2.56 larvae). The untreated control plot had the highest population of cutworm of 3.45 larvae. *B. thuringiensis* exhibited the highest efficacy with 46.37 per cent reduction of cutworm population over control followed by NPV with 44.34 per cent, *B. bassiana* with 41.44 per cent and Neem oil with 27.79 per cent. The findings indicate that cutworm population in pea crop was significantly influenced by weather conditions. Considering biopesticides application, *B. thuringiensis* was found most effective treatment in managing cutworm population. So, to effectively manage cutworm population below economic threshold level (ETL), biopesticides like *B. thuringiensis*, NPV, *B. bassiana* and Neem oil can be used as an alternative to synthetic pesticides.

(Key words: Cutworm, correlation, bio-efficacy, *Bacillus thuringiensis*, *Beauveria bassiana*, NPV)

INTRODUCTION

Peas are widely consumed in diets around the world, and 100 grams of their edible portion contains 72.9% moisture, 7.2 grams of protein, 0.1 grams of fat, 4.0 grams of fiber, 15.9 grams of carbohydrates, 93 kilocalories of energy, 20 milligrams of calcium, 139 milligrams of phosphorus, 1.5 milligrams of iron, 83 micrograms of carotene, 0.25 milligrams of thiamine, 0.01 milligrams of riboflavin, 9 milligrams of vitamin C, and 0.8 milligrams of niacin (Choudhary *et al*., 2009; Kumar *et al*., 2023). They are cultivated for their tender, green seeds for consumption. They have gained popularity for their short growing period and high nutritional value. In 2022, China led global green pea production, producing 11,565,652 tons, accounting for 55.22% of the world's total output. India followed as the second-largest producer with 6,182,000 tons, contributing 29.52% of the global total (Anonymous, 2022). Peas thrive in cooler temperature, optimal growth occurring between 13^{0}C-18^{0}C (Anonymous, 2017). Temperature above 30°C is detrimental, and frost can damage the crop during flowering, high humidity and cloudy weather increase the risk of fungal diseases like damping-off and powdery mildew. Peas are vulnerable to large number of pest attack in field *viz*., *Agrotis ipsilon* H., *Etiella zinckenella* T., *Helicoverpa armigera* H., *Ophiomyia phaseoli* T., *Bruchus pisorum* L., *Acyrthosiphon pisum,*

1. P.G. Student, Dept. of Entomology, Faculty of Agricultural Sciences, Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh -791 112
2 & 3. Asst. Professors, Dept. of Entomology, Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh -791 112
4. Guest Faculty, Dept. of Animal Sciences, Faculty of Agricultural Sciences, Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh -791 112
5. Asst. Professor, Dept. of Plant Pathology, Faculty of Agricultural Sciences, Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh -791 112 (Corresponding Author)

Lyriomyza spp. etc. Amongst which, Cutworms (*Agrotis ipsilon*: Lepidoptera: Noctuidae) a larva of nocturnal moths and widespread distribution pose a significant threat (Zahiri *et al*., 2014). They are prolific and polyphagous insects that attack cultivated crops. The cutworm larvae, as the name implies, cut plant seedlings at the base of the stem and feed on the leaves generally from dusk to dawn while hiding among the crop debris or soil during the daytime (Joshi, 2020). Their cosmopolitan distribution allows them to exist in a wide range of climatic conditions. The management of cutworms through agronomic practices can be done by suppressing or escaping the extent of pest incidence by manipulating the time of sowing so that the vulnerable period of crop growth does not synchronize with period of peak activity of the pest. Prediction of possible infestation and outbreak of cutworm species is dependent partly on the monitoring of adult activity. Likewise, the pheromone bait traps have been used successfully for monitoring cutworm densities and also for suppressing the population by mass trapping. Different varieties of insecticides have been recommended for the management of cutworm in India and elsewhere. Some synthetic insecticides like neonicotinoids, organophosphates, carbamates and pyrethroids are commonly used for controlling cutworms (Joshi *et al*., 2020). Improper and rampant use of these insecticides pose health and environmental risks and have led to increase pest resistance. As a result, there is a growing interest in bio-rational approaches such as utilizing botanical biopesticides and entomopathogenic microbials as alternative measures for its eco-friendly management. Biopesticides like neem oil and entomopathogenic biopesticides have shown promising results in managing cutworms as compared to traditional insecticides like chlorpyriphos (Rameash *et al*., 2014). They possess an array of properties including toxicity to the pest, repellent, antifeedant and insect growth activities against pests of agricultural importance (Rekha *et al*., 2020). However, in the North Eastern region of India, particularly in Arunachal Pradesh, there is little research on the monitoring and sustainable management of cutworm in pea crop. Therefore, the present study was carried to explore cutworm population in the Emchi village, Doimukh, and recommend potential biopesticides for their management.

MATERIALS AND METHODS

Population dynamics

The incidence of the cutworm was studied by collecting the data of the larvae at weekly intervals in the farm at Emchi village of Doimukh at Arunachal Pradesh during *rabi* 2021-2022. The population dynamics of larvae was taken randomly from five rows of each quadrate. Larval population of cut worm was then recorded during the seedling stage as number of larvae square^{-1} meter (under the soil near cut plant). The correlation between the mean larval population and weather factors *viz*., maximum temperature, minimum temperature, relative humidity and rainfall was worked out using simple correlation analysis. The data obtained were correlated on the basis of the following formula;

$$r = \frac{n(\Sigma XY) - (\Sigma X)(\Sigma Y)}{\sqrt{[n\Sigma X^2 - (\Sigma X)^2][n\Sigma Y^2 - (\Sigma Y)^2]}}$$

where;

X is the set of values for the first variable (e.g., larval population)

Y is the set of values for the second variable (e.g., weather parameter)

n is the total number of observations

ΣXY is the sum of the products of paired scores

ΣX and ΣY are the sums of the individual X and Y values, respectively

ΣX^2 and ΣY^2 are the sums of the squares of the individual X and Y values

Bio-efficacy of biopesticides

Four biopesticides, along with a control, were evaluated for their effectiveness against cutworm larvae. The biopesticides tested included *Bacillus thuringiensis* (*B. thuringiensis*), Nuclear Polyhedrosis Virus (NPV), *Beauveria bassiana* (*B. bassiana*), and neem oil. The experiment was laid out in randomized block design with five treatments and was replicated four times. A local variety of pea was used for the experiment. The agronomic practices were adopted uniformly for all treatments. The initial pest population was recorded at the germination stage in each plot. Treatments were applied after the cutworm population reached the Economic Threshold Level (ETL) of 2-3 larvae square^{-1} meter (Anonymous, 2019). Observations of *Agrotis ipsilon* larvae were made before and after treatment. Specifically, the number of larvae found at the base of the seedlings was recorded one day before the treatment, and then at 3, 7, and 14 days after treatment application. The percentage reduction in larval population was calculated using Abbott's formula (Abbott, 1925);

$$P = \frac{C-T}{C} \times 100$$

where;

P= per cent reduction over control

C= larval population in control plot

T= larval population in treated plot

RESULTS AND DISCUSSION

Population dynamics

Data regarding weekly observations of cutworm activity on pea plants revealed that the larvae began attacking the crop at the seedling stage. The cutworm started its activity during the germination stage and continued with varying intensity throughout the vegetative stage of the crop (Table 1). The larvae were first observed during the 5th Standard Meteorological Week (SMW), with an average of

0.78 larvae square^{-1} meter. This was at a minimum temperature of 14.4°C, a maximum temperature of 26.6°C, rainfall of 0.60 mm, and 71% relative humidity.

The larvae population gradually increased, peaking at the 10th SMW with an average of 4.90 larvae square^{-1} meter. This peak occurred under conditions of 8.00°C minimum temperature, 22.90°C maximum temperature, no rainfall, and 62% relative humidity. Linear regression analysis indicated that the larvae population increased at a rate of 0.1061 date^{-1} interval. However, the low R^2 value of 0.049 suggests that only 4.9% of the population variation was explained by changes in date intervals (Figure 2). After reaching the peak, the larvae population gradually declined, dropping to an average of 1.29 larvae square^{-1} meter by the 13th SMW. At this time, the conditions were a minimum temperature of 17.7°C, a maximum temperature of 25.5°C, 0.12 mm of rainfall, and 74% relative humidity (Table 1 and Figure 1).

Further, influence of weather parameters on the cutworm population was seen using simple correlation analysis. The results of the analysis have been presented in Table 2. The results revealed that larval population of cutworm had a non-significant negative correlation with maximum temperature (r=-0.143), significant negative correlation with the minimum temperature (r=-0.669) and the rainfall (r=-0.663) and non-significant negative correlation with relative humidity (r=-0.549). The results obtained were in accordance with that of Kumar *et al.* (2020), who found that larval population of cutworm had non-significant correlation with the maximum temperature and the rainfall.

Bio-efficacy of biopesticides

The results observed on the effect of different biopesticides on cutworm in pea plant are given in Table 3. The seedling mortality of pea plant due to the varied cutworm population under different treatments was recorded at 3, 7 and 14 days after the application of biopesticides. The population of *A. ipsilon* in pea prior to the application of biopesticides extended from 2.00 to 3.00 during *rabi* 2021-22.

First spray

The result showed that the efficiency of all bio-pesticidal treatments were significantly superior to untreated control in reduction of *A. ipsilon* population. Meanwhile, significant variation could be seen among the treatments. On 3rd day after first spray, the mean population of cutworm varied from the lowest of 2.10 (*B. thuringiensis*) to the highest of 2.83 (untreated control). In comparison to all other treatments, the application of *B. thuringiensis* was most effective in reducing the population of cutworm significantly in pea followed by NPV, *B. bassiana* and neem oil recorded 2.23, 2.68 and 2.82, respectively. These three treatments were found at par with each other.

Seven days after the first spray, the mean population of cutworm was recorded lowest in the plot treated with *B. thuringiensis* (1.93) followed by NPV, *B. bassiana* and neem oil (2.00, 2.27 and 2.60 respectively). These treatments were found at par with each other. The highest population was recorded in untreated control with the average larval population of 3.00.

Fourteen days after the first spray, the mean cutworm population in the treatment with *B. thuringiensis* was the lowest with 1.77 followed by NPV, *B. bassiana* and neem oil *i.e.*, 1.99, 2.20 and 2.52 respectively. These treatments were found at par with each other. The highest population was recorded in untreated control with the average larval population of 3.13.

Second spray

Three days after second spray, the mean population of cutworm in the plot treated with *B. bassiana* was lowest (2.00) followed by *B. thuringiensis,* NPV and neem oil (2.08, 2.10 and 2.85 respectively). These treatments were found at par with each other. The highest population was recorded in untreated control with the average larval population of 3.33.

Seven days after second spray, the mean population of cutworm in plot treated with *B. bassiana* was the lowest with 1.95, followed by *B. thuringiensis,* NPV and neem oil which recorded larval population of 2.00, 2.05 and 2.77 respectively and these treatments were found at par with each other. The untreated control plot recorded the highest mean larval population of 3.40.

Fourteen days after the second spray, the mean population of cutworm in plot treated with *B. thuringiensis* was the lowest with 1.67, followed by *B. bassiana,* NPV and neem oil where larval population recorded was 1.78, 1.78 and 2.70 respectively. Application of *B. bassiana* and NPV were found at par with each other. The highest population was recorded in untreated control with the average larval population of 3.86.

Third spray

Three days after the third spray, the mean population of cutworm in plot treated with NPV was the lowest with 1.78 followed by *B. bassiana*, *B. thuringiensis* and neem oil (1.85, 1.86 and 2.27 respectively). The untreated control plot had shown the highest larval population of 4.00.

Seven days after the third spray, the cutworm population in plot treated with *B. bassiana* was the least with 1.52 followed by *B. thuringiensis,* NPV and neem oil which recorded 1.80, 1.81 and 2.17 respectively. The untreated control plot had recorded that the highest mean larval population of 4.20.

Fourteen days after the third spray, the cutworm population in plot treated with *B. bassiana* was the lowest with 1.17 followed by *B. thuringiensis,* NPV and Neem oil where population noted was 1.47, 1.59 and 1.97 respectively and these treatments were found at par with each other. The untreated control plot had shown the highest mean larval population of 4.30.

It can be observed from the Table 3 that the application of *B. thuringiensis* resulted in the lowest cutworm population and thus showing the highest efficacy with 46.37 per cent reduction followed by NPV with 44.34 per cent, *B. bassiana* with 41.44 per cent reduction and neem oil with 27.79 per cent reduction over control. Abou-Taleb *et al*. (2010) revealed that the effectiveness of *Bacillus thuringiensis* var. *kurstaki* was generally higher than conventional insecticides. Alshehrei *et al*. (2021) suggested that the Vip3A protein produced by *B. thuringiensis* is effective against cutworm, providing a potential biopesticide solution for managing this agricultural pest. The findings of Yan *et al*. (2020) indicated that *Bt* maize is effective in reducing the damage caused by black cutworm larvae, thereby enhancing seedling survival and potentially improving crop yields. However, Amitava *et al*. (2003) found that *Metarhizium anisopliae* was the most effective biopesticide in controlling cutworm significantly followed by Nuclear Polyhydrosis Virus (NPV).

Table 1. Details of weather parameters during the incidence of cutworm larvae in pea during *rabi* 2021-2022

SMW	Month and Date	Temperature (^{0}C) Maximum	Temperature (^{0}C) Minimum	Rainfall (mm)	Relative Humidity (%)	Mean larval population sq m^{-1}
4	**Jan 24-Jan 30**	25.00	18.60	0.18	68	0.00
5	**Jan 31-Feb 06**	26.60	14.40	0.60	71	0.78
6	**Feb 07-Feb 13**	26.80	13.00	0.20	68	1.85
7	**Feb 14-Feb 20**	21.60	12.10	0.00	75	1.99
8	**Feb 21-Feb 27**	22.70	12.00	0.20	64	3.09
9	**Feb 28-Mar 06**	19.80	8.40	0.07	63	2.89
10	**Mar 07-Mar 13**	22.90	8.00	0.00	62	4.90
11	**Mar 14- Mar 20**	26.45	11.24	0.00	67	3.86
12	**Mar 21- Mar 27**	26.50	17.50	0.20	68	3.21
13	**Mar 28-Apr 03**	25.50	17.70	0.12	74	1.29
14	**Apr 04-Apr 10**	22.80	14.70	0.70	68	0.00

Table 2. Correlation between weather parameters and cutworm incidence in pea during *rabi* 2021-2022

Season	Weather parameters	Correlation coefficient 'r'
rabi 2021-2022	Max. Temp. (^{0}C)	-0.143
	Min. Temp. (^{0}C)	-0.669*
	Rainfall (mm)	-0.663*
	Relative Humidity (%)	-0.549

Significant at 5%

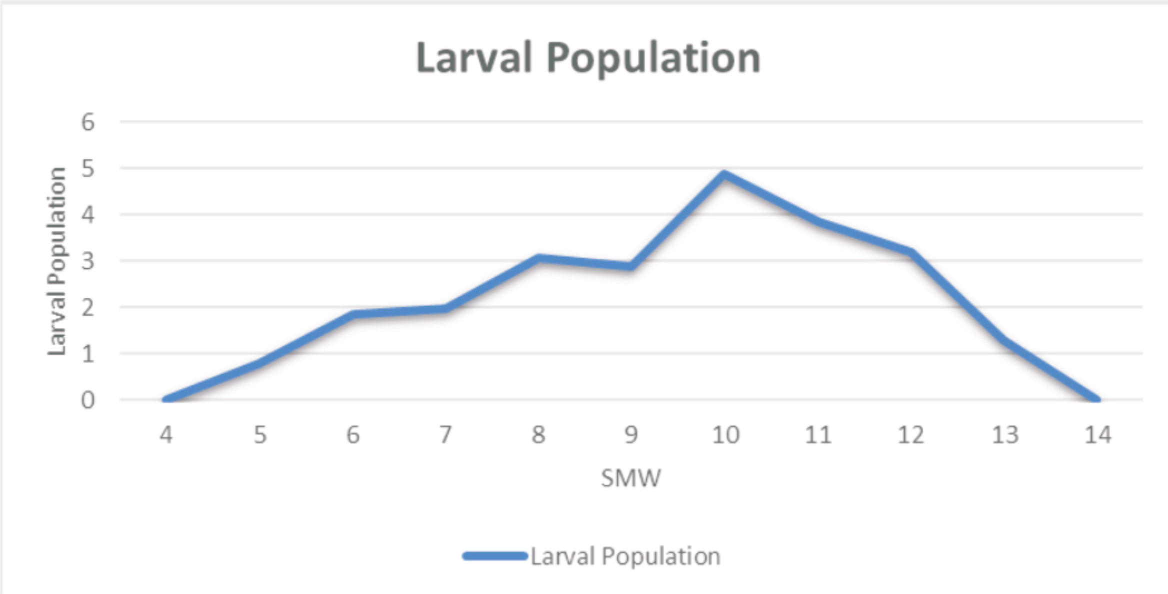

Figure 1. Incidence of cutworm larvae on pea

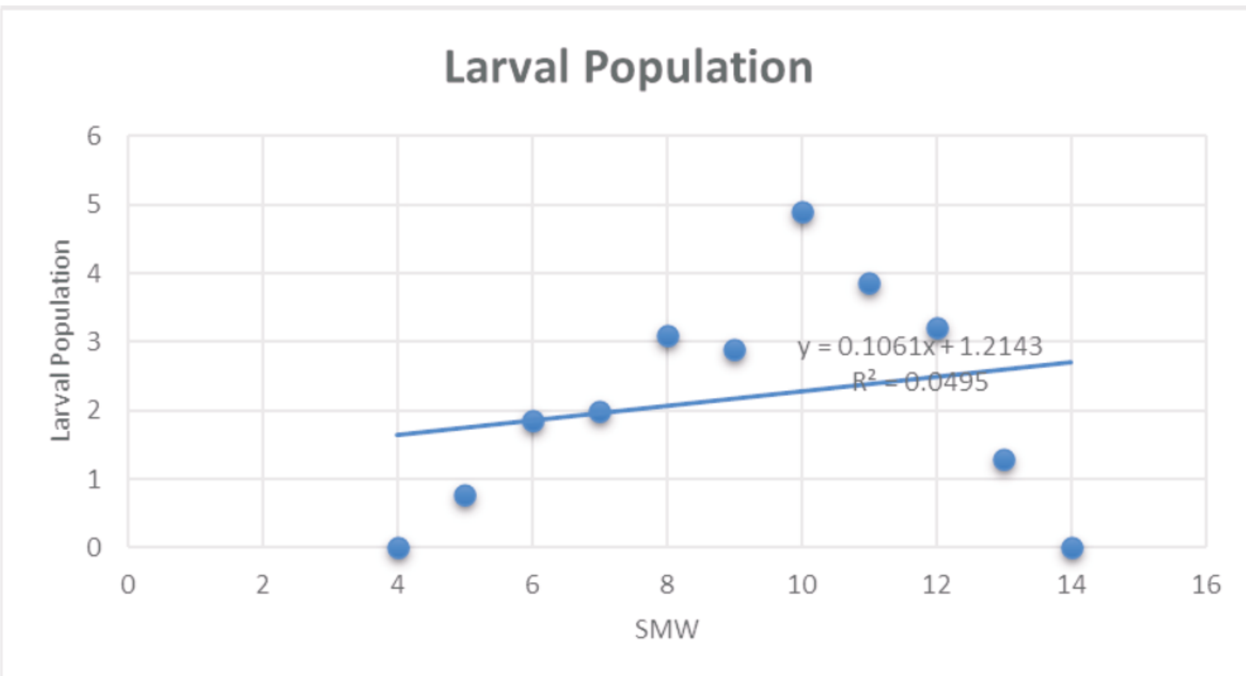

Figure 2. Graph representing the slope and R-Square

Table 3. Effect of biopesticides on the mean larval population of cutworm

Tr. No.	Treatments	1st Spray (Mean population)				2nd Spray (Mean population)			3rd spray (Mean population)			Pooled mean	Per cent reduction over control (%)
		pre-count	3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS		
T_1	***Bacillus thuringiensis***	2.67	2.10	1.93	1.77	2.08	2.00	1.67	1.86	1.80	1.47	1.85	46.37
		(1.63)	(1.44)	(1.38)	(1.33)	(1.44)	(1.41)	(1.29)	(1.36)	(1.34)	(1.21)		
T_2	***Beuveria bassiana***	2.83	2.68	2.27	2.20	2.00	1.95	1.78	1.85	1.52	1.17	2.02	41.44
		(1.68)	(1.63)	(1.50)	(1.48)	(1.41)	(1.39)	(1.33)	(1.36)	(1.23)	(1.08)		
T_3	**Neem oil**	3.00	2.82	2.60	2.52	2.85	2.77	2.70	2.27	2.17	1.97	2.56	27.79
		(1.73)	(1.67)	(1.61)	(1.58)	(1.68)	(1.66)	(1.64)	(1.50)	(1.47)	(1.40)		
T_4	***Nuclear Polyhedrosis***	2.33	2.23	2.00	1.99	2.10	2.05	1.78	1.78	1.81	1.59	1.92	44.34
	***Virus* (NPV)**	(1.52)	(1.49)	(1.41)	(1.41)	(1.44)	(1.43)	(1.33)	(1.33)	(1.34)	(1.26)		
T_5	**Control**	2.50	2.83	3.00	3.13	3.33	3.40	3.86	4.00	4.20	4.30	3.45	-
		(1.58)	(1.68)	(1.73)	(1.76)	(1.82)	(1.84)	(1.96)	(2.00)	(2.04)	(2.07)		
	SE(m)±	0.34	0.33	0.24	0.27	0.29	0.26	0.34	0.31	0.34	0.31	-	-
	CD at 5%	1.02	1.01	0.72	0.81	0.87	0.78	1.02	0.93	1.02	0.93	-	-

Note: Figure in the parenthesis indicate square root transform values

The results of the field experiment provided valuable insights into the dynamics of cutworm larvae in pea crops, highlighting several key observations. For the first time, cutworm larvae was detected during a specific meteorological week, with their population reaching a peak at a later period. The study revealed that the variation in cutworm numbers could be somewhat attributed to the time intervals, though this relationship was weak. The correlation analysis showed that the cutworm population exhibited a non-significant negative relationship with maximum temperature, suggesting that changes in temperature may not have a strong influenced on larval numbers. In contrast, there was a significant negative correlation with minimum temperature and rainfall, indicating that cooler and wetter conditions likely play a role in reducing cutworm population. The relative humidity also had a non-significant negative correlation with larval numbers, suggesting that it may not be a major factor in population fluctuations. The study evaluated the effectiveness of various biopesticides in controlling cutworm population and found that they were significantly more effective than untreated controls. *B. thuringiensis* emerged as the most effective biopesticide for reducing cutworm population. Nuclear Polyhedrosis Virus (NPV) and *B. bassiana* also showed substantial efficacy, though to a slightly lesser extent, while Neem oil, though beneficial, had a comparatively lower impact. These results underscore the potential of biopesticides as viable alternatives to synthetic pesticides for managing cutworm infestations in pea crops.

REFERENCES

Abbot, W. S. 1925. A method for computing the effectiveness of an insecticide. J. Econ. Entomol. **18**: 265-267.

Abou-Taleb, H. K., M. A. Attia and S. M. Abdel Rahman, 2010. Field performance and laboratory toxicity of five insecticides against black cutworm, *Agrotis ipsilon* (Lepidoptera: Noctuidae). Alex. Sci. Exch. J. 223-229.

Alshehrei, F., D. K. El-Ghareeb, A. El Baz, S. Qari, H. Hamza, H.H. Abulreesh, H. A. Malak, R. Elmougy and G. E. Osman, 2021. Optimization of growth media for maximal production of insecticidal vegetative protein (vip3A) from *Bacillus thuringiensis* and its activity against black cutworm (*Agrotis ipsilon*). Afr. J. Biotechnol. **20**(5): 216-229.

Amitava, K., P. Santanu, A. Basu, M. Chettri, A. Konar, S. Paul, S. Pandey and B. Singh, 2003. Field evaluation of bio-pesticides and insecticides against cutworm in Plains of West Bengal. J. Indian Potato Assoc. **30**(1-2): 155-156

Anonymous, 2017. Ministry of Agriculture and Farmer's Welfare. http://dpd.gov.in/Annual%20Report%202017-18 Accessed on 30 March, 2022.

Anonymous, 2019. Cutworms in Field Crops. www.gov.mb.ca Accessed on 30 March, 2022.

Anonymous, 2022. Food and Agriculture Organization (FAO) Statistics. https://www.fao.org/faostat/en/#data Accessed on 30 March, 2022.

Choudhary, B. R., M. S. Fageria and R. S. Dhaka, 2009. A text book on production technology of vegetables. Kalyani Publishers, New Delhi. pp.318.

Joshi, M. J. 2020. Feeding inhibition with bioformulations in cutworms, *Agrotis ipsilon* (Hufnagel). Indian J. Entomol. **82**(1): 134-138.

Joshi, M. J., A. Rana, V. Prithiv Raj, S. Kaushal, A. G. Inamdar, K. S. Verma and R. S. Chandel, 2020. The potency of chemical insecticides in management of cutworm, *Agrotis ipsilon* Hufnagel (Noctuidae: Lepidoptera): A review. J. Entomol. Zool. Stud. **8**(3): 307-311.

Kumar, A. S., R. Aarwe, A. K. Bhowmick, A. S. Thakur and R. Sharma, 2020. Population dynamics of major phototactic insect pests of chickpea ecosystem through light trap. Legume Res. **43**(2), 289-293.

Kumar, A., M. Kumari and S. Sepehya, 2023. Integrated nutrient management studies in pea (*Pisum sativum* L.) under sub-montane and low hills subtropical zone of Himachal Pradesh. J. Soils and Crops. **33**(1): 73-77.

Rameash, K., A. Kumar, H. Kalita and R. K. Avasthe, 2014. Eco-friendly management of cutworm, *Agrotis ipsilon* and cabbage butterfly, *Pieris brassicae* in cabbage. Indian J. Plant Prot. **42**(2): 349-353.

Rekha, M. S., B.N. Chaudhari, G. R. Shamkuwar, P.S. Neharkar and H. R. Sawai, 2020. Evalauation of biopesticide, botanicals and plant extracts against rice stem borer, *Scripophaga incertulas* (Walker). J. Soils and Crops. **30**(1): 124-128.

Yan, X., J. Lu, M. Ren, Y. He, Y. Wang, Z. Wang and K. He, 2020. Insecticidal activity of 11 *Bt* toxins and 3 transgenic maize events expressing Vip3Aa19 to Black Cutworm, *Agrotis ipsilon* (Hufnagel). Insects, **11**(4): 208.

Zahiri, R., J. D. Lafontaine, Schmidt and P. D. Hebert, 2014. A transcontinental challenge- A test of DNA Barcode performance for 1,541 species of Canadian Noctuidae. Plos one. **9**(3): 12.

Rec. on14.08.2024 & Acc. on 28.08.2024