Journal of Advances in Biology & Biotechnology

Volume 27, Issue 5, Page 566-574, 2024; Article no.JABB.115746
ISSN: 2394-1081

Assessing the Impact of Weather Variables on *Maruca vitrata* (F) Population Dynamics in Green Gram and Evaluating the Efficacy of Various Insecticides

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JABB/2024/v27i5819

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/115746

Original Research Article

Received: 08/02/2024
Accepted: 12/04/2024
Published: 19/04/2024

ABSTRACT

The research was conducted during the *Kharif* 2018 season at the Central Research Farm, SHUATS, situated in Naini, Prayagraj. It encompassed two pivotal experiments aimed at understanding the population dynamics of the spotted pod borer and assessing the efficacy of various insecticides for its control. In the initial experiment, a 10×5m separate plot was designated

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to monitor the population dynamics of the spotted pod borer. Weekly observations were conducted by randomly selecting five plants and recording the larvae count per plant. Activity of the pest was observed from the 32nd to the 40th Standard Meteorological Week (SMW), peaking during the 37th SMW (9.88 larvae per five plants). Correlation analysis unveiled significant associations, including a positive correlation with rainfall (r = 0.789**) and a negative correlation with maximum and minimum temperature (r = -0.027NS and 0.260NS), as well as wind velocity (r = -0.465NS). In the subsequent experiment, the efficacy of various insecticides was evaluated using a randomized block design (RBD) with three replications and eight treatments, including an untreated plot. Two applications of all selected insecticide molecules were made against the green gram spotted pod borer, with data recorded before spraying, on the 3rd, 7th, and 14th days post-spraying. The results showcased the highest pest reduction in the chloropyriphos-treated plot (69.60%), followed by Cypermethrin (64.74%), Imidacloprid (53.04%), Quinalphos (47.26%), Monocrotophos (46.06%), Spinosad (40.96%), and Indoxacarb (34.93%) Notably, Indoxacarb (1:2.24) emerged as the most effective and economical treatment, followed by Spinosad 45SC (1:1.94), Monocrotophos (1:1.80), Chloropyriphos (1:1.75), Quinalphos (1:1.66), Imidaclopride (1:1.60), and Cypermethrin (1:1.59). This comprehensive study provides valuable insights into the management strategies for controlling the spotted pod borer in green gram cultivation, crucial for ensuring crop health and productivity.

Keywords: Benefit cost ratio; Maruca vitrata; combination; efficacy; Green gram; seasonal incidence.

1. INTRODUCTION

Pulses stand out as an economical and optimal source of protein, comprising approximately 27% of the total dietary protein in our nation. Following cereals and oilseeds, pulses emerge as the third most crucial crop group in Indian agriculture. These nutritional powerhouses are predominantly consumed in developing nations, which collectively account for around 90% of global pulse consumption. Notably, pulses play a vital role in maintaining soil fertility through the biological nitrogen fixation facilitated by bacteria such as *Rhizobium spp.*, prevalent in their root nodules. However, despite their nutritional significance, the availability of pulses has dwindled, falling from 64gm/capita/day to a mere 32gm/capita/day, a stark contrast to the WHO recommendation of 80gm/capita/day [1]. With exceptional nitrogen content (1.5%) and rapid decomposability upon incorporation into soil, pulses, particularly mungbeans, serve as excellent green manure, enriching soil fertility. Mungbeans boast a high nutritive value, containing approximately 25-28% protein, 1.0-1.5% oil, 3.5-4.5% fiber, 4.3-5.5% ash, 62-65% carbohydrates, and essential vitamins on a dry weight basis [2,3,4]. Nevertheless, their cultivation faces persistent threats from insect-pests, notably the spotted pod borer (*Maruca vitrata*), which inflicts substantial damage during various growth stages. Understanding the intricate relationship between weather parameters and the incidence of insect pests is crucial for devising effective management strategies. Research indicates that the spotted pod borer is particularly devastating to greengram, causing 20-30% pod damage and emerging as the most destructive pest during flower bud and post-flowering stages [5,6,7,8]. Due to its destructiveness at critical stages of crop growth *viz.* flowering and pod development stages especially to the economic plant parts such as flower buds, flowers and pods, it become as a significant constraint to attain the maximum productivity from grain legumes. Normally, larvae feed on anthers, filaments, styles, stigma and ovaries of flowers and larvae move from one flower to another, and each may consume 4-6 flowers before completion of larval development [9-11]. Third to fifth instar larvae are capable of boring into the pods and occasionally into peduncle and stems. Consequently, this study endeavors to elucidate the correlation between the spotted pod borer (*M. vitrata*) and weather parameters within the greengram ecosystem. A comprehensive understanding of seasonal pest incidence is imperative, considering the fluctuating weather conditions and their impact on the greengram crop [12-15]. By unraveling the intricate dynamics between pest management strategies, weather parameters, and pulse production, this research aims to contribute to the enhancement of pulses cultivation, ensuring food security and sustainable agricultural practices.

2. METHODS AND MATERIALS

The experimental was conducted during *Kharif* 2018 at Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, U.P. The green gram variety of GNG-1581 was sown in separate plot of 10×5m size. The distance of row to row 30cm and plant to plant was 10 cm. The observation of seasonal incidence of *M. vitrata* was recorded at weekly interval from five randomly selected plant each line and to investigate the efficacy of different insecticides against *M. vitrara.* Experiment was laid out in randomized block design (RBD) with three replications and eight treatments including untreated plot. The treatments are Chloropyriphos @ 1.5 ml/lit (T1), Quinalphos @2ml/lit (T2), Cypermethrin @ 2ml/lit (T3), Imidacloprd @ 0.5ml/lit (T4), Monocrotophos @3ml/lit (T5), Indoxacarb @ 0.2 ml/lit (T6), Spinosad @ 0.4ml/lit (T7) and Untreated Plot (T8). The incidence of spotted pod borer was observed at ETL level of insect and spraying was done and observation was recorded at day before spray, 3rd day after spray, 7th days after spray and 14th days after spray after each treatments, five plants were selected randomly from each net plot area and healthy as well damaged pods per plant were counted. Based on this percent pud damage was worked out. Grain yield were recorded from each net plot area. The analysis of variance (ANNOVA) technique was applied for calculation of the data and the calculated values for the compared the tabular values at 5% level of probability.

The following formula was used for calculating correlation coefficient:

$$\text{Correlation coefficient (r)} = \frac{\Sigma(X-\bar{X})(Y-\bar{Y})}{\sqrt{\Sigma(X-\bar{X})^2\Sigma(Y-\bar{Y})^2}}$$

$$\text{Regression coefficient (byx)} = \frac{\Sigma(X-\bar{X})(Y-\bar{Y})}{\sqrt{\Sigma(X-\bar{X})^2}}$$

Whereas,

r = Simple correlation coefficient
x = Independent variables *i.e.* Abiotic components
y = Dependent variables *i.e.* pest
N = Number of observation

The following formula was used for the calculation of percent pest reduction:

1-(post treatment pest population treated plot / Pre treatment pest population treated plot) × (pre treatmetnt pest population in control / post treatment pest population in control)

$$\text{B: C Ratio} = \frac{\text{Gross returns}}{\text{Total cost incurred}}$$

Where,

B:C Ratio = Benefit Cost Ratio

3. RESULTS AND DISCUSSION

3.1 Effect of Weather Variables on Population of *M. vitrata*

The spotted pod borer (*M. vitrata*) that attack on vegetative stage of the crop growth and observed at reproductive stage to till the maturity of the crop. The activity of spotted pod borer was appeared during 32th SMW (0.61) and remained active till the 40th SMW the peak activity was observed on 37th SMW (9.88) larvae/ five plant. The correlation of revealed that the study showed a negative correlation with maximum and minimum temperature (r = -0.027^{NS} and 0.260^{NS}) strong positive correlation with rainfall (r = 0.789**) and negative correlation with wind velocity (r = 0.465^{NS}) respectively. Present findings are also supported by the findings of [16] who studied the population dynamics of *Maruca vitrata,* and reported that the correlation of was found positive and significant with rainfall.

3.2 Effect of Insecticides Molecules on Percent Pod Damage

All insecticides molecules were significant and superior over control (Table 2). The mean data of 3rd days 7th days and 14th days larval population after first spray revealed that thetreatments expected control are effective and at par. Among the all treatments highest percent pest reduction of greengramspoted pod borer was recorded in Chloropyriphos @ 1.5 ml/li (T1) (70.10) treated plot followed by Cypermethrin @ 2ml/lit (T3) (67.03), Imidacloprd @ 0.5ml/lit (T4) (50.77), Quinalphos @2ml/lit (T2) (47.73), Monocrotophos @3ml/lit (T5) (47.43), Spinosad @ 0.4ml/lit (T7) (37.13), and Indoxacarb @ 0.2 ml/lit (T6) (36.97) respectively. The data of larval population of greengramspoted pod borer over the control after second spray revealed that all the treatments were significantly superior over control. Among all the treatments mean data of percent pest reduction were found Chloropyriphos @ 1.5 ml/lit (T1) (69.10) treated plot followed by Cypermethrin @ 2ml/lit (T3) (55.80), Imidacloprd @ 0.5ml/lit (T4) (55.33), Quinalphos @2ml/lit (T2) (46.77), Monocrotophos @3ml/lit (T5) (44.74), Spinosad @ 0.4ml/lit (T7) (44.47), and Indoxacarb @ 0.2 ml/lit (T6) (32.90) respectively.

Table 1. Population dynamics of insect pest of *M. vitrata* in green gram during *Kharif season* 2018

S. N.	SMW	Date of Observation	*M. vitrata*	Temperature		RH	RF	WV
				Max.	Min.			
1	31	10.08.2818	0	32.2	25.8	86	0	2.3
2	32	17.08.2018	0.61	36.4	26.7	78	0	3.2
3	33	24.08.2018	1.42	33.4	24.3	87	11.4	2.1
4	34	31.08.2018	2.67	32.5	25.2	82	14.2	4.1
5	35	07.09.2018	4.89	31.9	26.4	75	34.7	3.4
6	36	14.09.2018	7.14	34.2	25.6	83	36	2.5
7	37	21.09.2018	9.88	31.4	24.9	88	21.3	1.3
8	38	28.09.2018	6.23	31.2	26.2	81	18.1	1.5
9	39	05.10.2018	2.15	30.7	23.4	88	9.3	1.8
10	40	12.10.2018	1.1	30.2	23.6	78	0	2.3
11	41	19.10.2018	0	30.1	23.9	79	1.2	4.1

SMW- Standard Meteorological Week, Max.- Maximum Temperature ºC, Min.- Minimum Temperature ºC, RH-Relative Humidity, RF- Rainfall (mm) and WV- Wind Velocity(km/hr.)

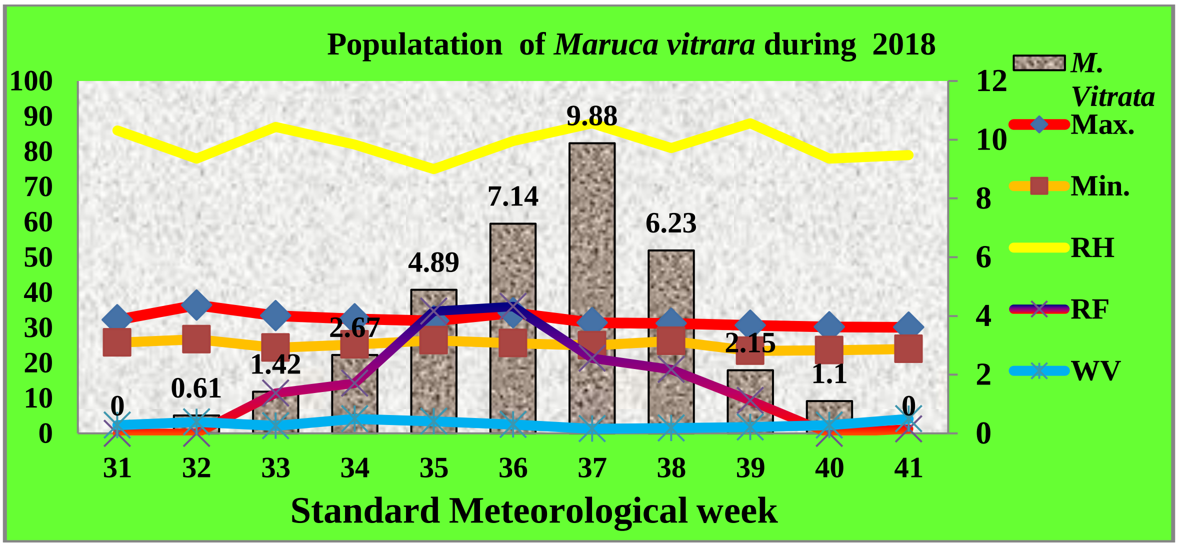

Fig. 1. Spotted pod borer (*M. vitrara*) *vs.* weather variables

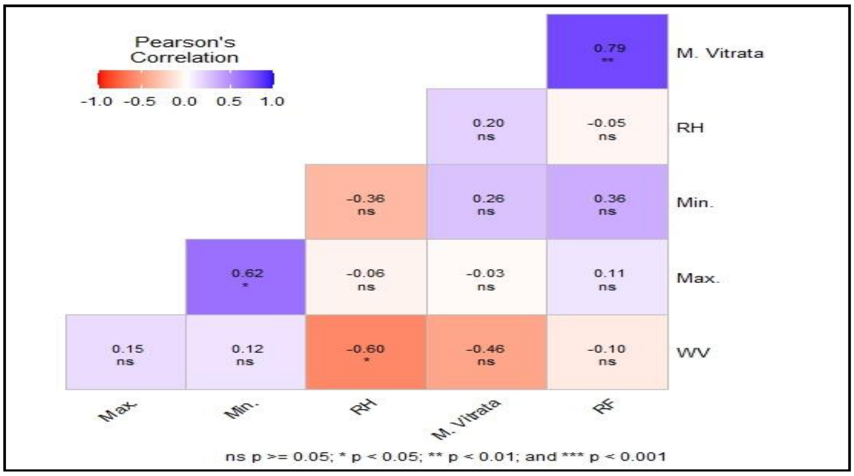

Fig. 2. Pearson's correlation of *M. vitrata vs.* weather variables

Table 2. Bio-efficacy of insecticides molecules against pod borer in greengram after first spray

Treatments		No. of larvae/plant before spray	Percent pest reduction indicated day after first spray			
			3 DAS	7 DAS	14 DAS	Mean
T1	Chloropyriphos @ 1.5 ml/lit	3.20	49.60	73.70	87.00	70.10
T2	Quinalphos @2ml/lit	3.40	34.30	49.90	59.00	47.73
T3	Cypermethrin @ 2ml/lit	3.42	51.40	69.40	80.30	67.03
T4	Imidacloprd @ 0.5ml/lit	3.00	37.00	53.30	62.00	50.77
T5	Monocrotophos @3ml/lit	4.02	35.20	48.20	59.80	47.43
T6	Indoxacarb @ 0.2 ml/lit	3.80	25.30	38.80	46.80	36.97
T7	Spinosad @ 0.4ml/lit	3.60	23.50	38.00	49.90	37.13
T8	Control	3.86	0.00	0.00	0.00	0.00
	F- Test		S	S	S	S
	S. Ed.		1.10	1.91	2.58	2.32
	C.D.(P=0.05)		2.36	4.09	5.53	4.97

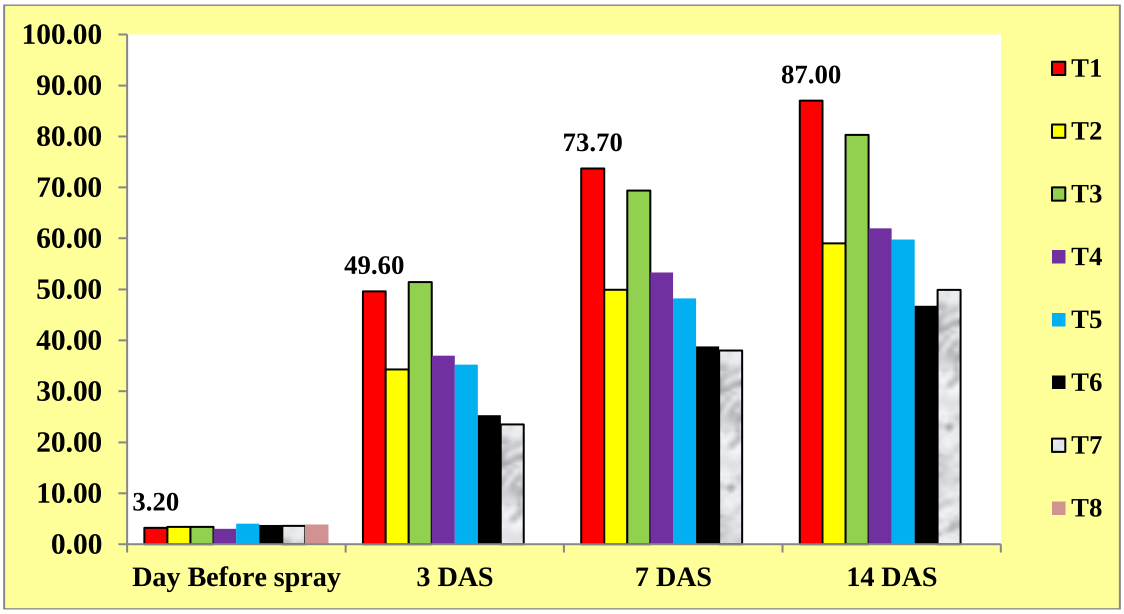

Fig. 3. Effect of different insecticides molecules on percent pest reduction after first spray

Table 3. Bio-efficacy of insecticides molecules against pod borer in greengram after second spray

Treatments		No. of larvae/plant before spray	Percent pest reduction indicated day after second spray			
			3 DAS	7 DAS	14 DAS	Mean
T1	Chloropyriphos @ 1.5 ml/lit	3.06	45.50	73.80	88.00	69.10
T2	Quinalphos @2ml/lit	3.20	30.90	49.11	60.30	46.77
T3	Cypermethrin @ 2ml/lit	3.26	38.20	47.20	82.00	55.80
T4	Imidacloprd @ 0.5ml/lit	4.20	37.30	55.80	72.90	55.33
T5	Monocrotophos @3ml/lit	3.70	30.00	46.70	56.50	44.74
T6	Indoxacarb @ 0.2 ml/lit	3.20	19.10	33.60	46.00	32.90
T7	Spinosad @ 0.4ml/lit	4.00	23.60	62.32	48.30	44.40
T8	Control	3.92	0.00	0.00	0.00	0.00
	F- Test		S	S	S	S
	S. Ed.		0.87	1.15	2.75	3.17
	C.D.(P=0.05)		1.86	2.47	5.90	6.8

Table 4. Economics of insecticides evaluated against spotted pod borer in greengram

Name of Treatments	Cost of Insecticides	Common Cost	Total cost	Yield q/ha	Gross return	Net return over control	C:B Ratio
T1 Chloropyriphos	1620	43036	44656	11.04	78384	14839	1:1.75
T2 Quinalphos	1600	43036	44636	10.48	74408	10863	1:1.66
T3 Cypermethrin	1840	43036	44876	10.05	71355	7810	1:1.59
T4 Imidacloprd	1100	43036	44136	10.00	71000	7455	1:1.60
T5 Monocrotophos	1950	43036	44986	11.44	81224	17679	1:1.80
T6 Indoxacarb	1090	43036	44126	13.98	99258	35713	1:2.24
T7 Spinosad	1256	43036	44292	12.12	86052	22507	1:1.94
T8 Control	0	43036	43036	8.95	63545	0	1:1.47

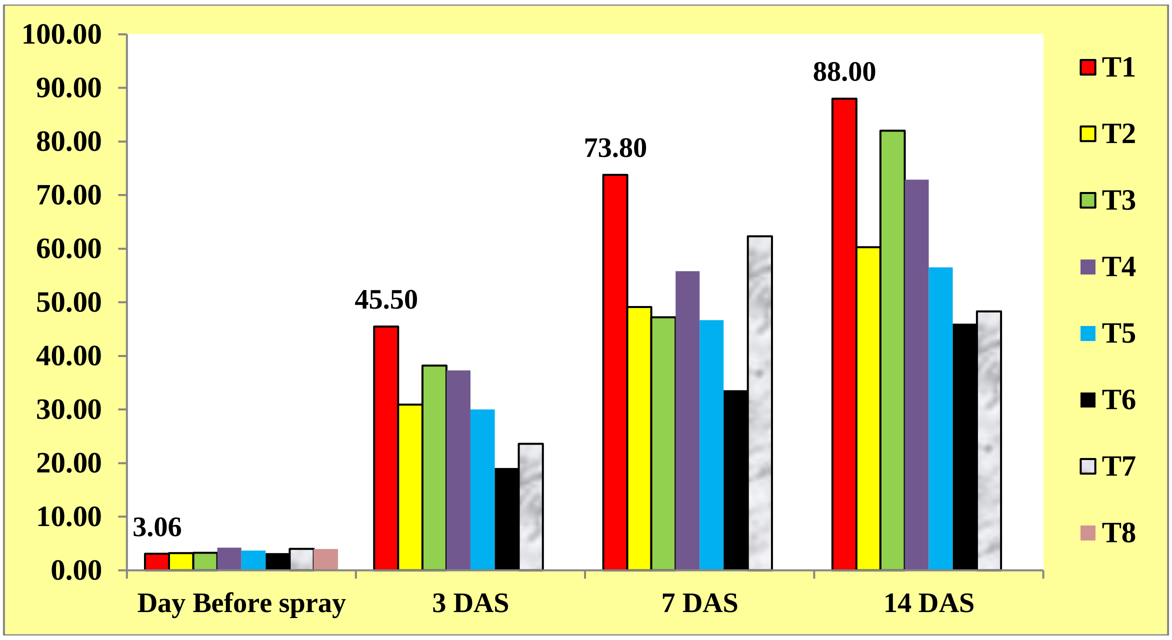

Fig. 4. Effect of different insecticides molecules on percent pest reduction after second spray

According to overall mean of percent pest reduction after first spray and second spray revealed all the treatments highest percent pest reduction was found in Chloropyriphos @ 1.5 ml/lit (T_1) treated plot (69.60 %) similar finding were reported by Reddy and Prasad [17] followed by Cypermethrin @ 2ml/lit (T_3) (47.26 %) similar finding by [18], Imidacloprd @ 0.5ml/lit (T_4) (53.04) larval reduction and also similar were reported by [19] mean larval reduction by Spinosad @ 0.4ml/lit (T_7) (40.96 %) similarly reported by Kumar [20] noticed (44.68 %) reduction of *M. vitrata* Spinosad treated plot. The mean percent reduction of Quinalphos treated plot is (47.26 %). similar finding also [21] and Indoxacarb treated plot (34.93 %) similar findings were also [16] reported that indoxacarb treated plot shown (36.66) percent pest reduction of *M. vitrata* respectively.

3.3 Benefit Cost Ratio (BCR)

The highest yield was recorded in T6- Indoxacarb (13.98 q/ha), T7- Spinosad (12.12q/ha), T5- Monocrotophos (11.44 q/ha), T1- Chloropyriphos (11.04 q/ha), T2- Quinalphos (10.48 q/ha), T4- Imidacloprid ((10.00q/ha), T3- Cypermethrin (10.05 q/ha) and Control (8.95 q/ha). The treatments Indoxacarb (13.98) was highest effective among all treatments. Similar yield was reported Yadav and Singh [22] that the maximum yields was recorded in treatment Indoxacarb (11.8 q/ha) Followed by Spinosad (11.08 q/ha).

The benefit cost ratio worked out, interesting result was achieved, among the treatments studied, the best treatment T6- Indoxacarb (1:2.24) followed by T7-Spinosad (1:1.94), T5- Monocrotophos (1:1.80), T1- Chloropyriphos (1:1.75), T2- Quinalphos (1:1.66), T4- Imidacloprid (1:1.60) and T3 Cypermethrin (1:1.59). The highest benefit ratio was found in Indoxacarb treatment (1:2.24) similar finding Mandal et al. [19].

4. CONCLUSION

The result obtained from this study demonstrates that the activity of spotted pod borer was appeared during 32^{th} SMW (0.61) and remained active till the 40^{th} SMW the peak activity was observed on 37^{th} SMW (9.88) larvae/ five plant . The correlation of revealed that the study showed a negative correlation with maximum and minimum temperature (r = -0.027^{NS} and 0.260^{NS}) strong positive correlation with rainfall (r = 0.789**) and negative correlation with wind velocity (r = 0.465^{NS}) respectively. The Chloropyriphos was the most effective in managing *M. vitrata* in greengram through reducing larval population, pod damage and the higher incremental cost benefit ratio was observed from Indoxacarb 1:2.24 respectively.

ACKNOWLEDGMENTS

The authors are sincere gratitude to Head of Department Entomology, Naini agricultural institute, SHUATS Prayagraj, UP, for provided all facilities which required for conducting this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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