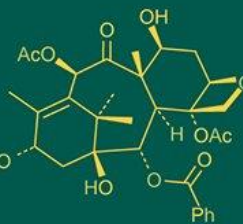
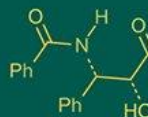
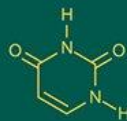
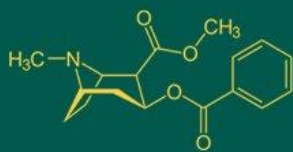


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Population dynamics of major insect pest of green gram (*Vigna radiata* L.) and bio-pesticidal management of spotted pod borer [(*Maruca vitrata*) Fabricius]

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Abstract

The present study entitled “Population Dynamics of Major Insect Pests of Green Gram (*Vigna radiata* L.) and Bio-pesticidal management of Spotted Pod Borer [(*Maruca vitrata*) Fabricius]” was conducted during the Kharif season of 2024 at the Organic Research Farm, Karguan ji, Department of Entomology, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (U.P.). The investigation aimed to study the seasonal population dynamics of major insect pests of green gram, evaluate the efficacy of different bio-pesticides against the spotted pod borer (*Maruca vitrata*), and determine the economic feasibility of bio-based pest control methods. The experiment was laid out in a Randomized Block Design (RBD) with eight treatments and one untreated control; each replicated three times. Treatments included Neem oil (5%), Garlic bulb extract (5%), *Bacillus thuringiensis* (2 kg/ha), Castor oil (5%), Panchagavya (0.01%), Neem Seed Kernel Extract (NSKE 5%), Karanj oil (2%), and *Beauveria bassiana* (2 kg/ha), while the control received only water spray. Observations were recorded on the incidence and population buildup of major pests such as *Maruca vitrata*, *Helicoverpa armigera*, and *Bemisia tabaci* in relation to meteorological factors like temperature, rainfall, and relative humidity. The results revealed that the population of major insect pests varied significantly with climatic conditions, showing peak infestation during periods of high humidity (70-90%) and moderate temperatures (30-34 °C). Among all treatments, Neem oil (5%) and *Bacillus thuringiensis* (2 kg/ha) were found most effective in minimizing larval population and pod damage of *Maruca vitrata*, followed by NSKE (5%) and *Beauveria bassiana* (2 kg/ha). These treatments also resulted in higher grain yield and better seed quality compared to the control. The untreated plots recorded the maximum pest infestation and lowest yield. Economic analysis indicated that neem-based bio-pesticides and microbial formulations were not only effective but also profitable, with the highest benefit-cost ratio (B:C) ranging from 2.6 to 2.8, demonstrating their economic viability and suitability for eco-friendly pest management. The correlation studies between pest population and weather parameters revealed that *M. vitrata* showed a positive relationship with relative humidity and moderate temperatures, while heavy rainfall had a suppressive effect on pest activity. The study concluded that integrating bio-pesticides such as neem oil, *Bacillus thuringiensis*, and *Beauveria bassiana* provides a sustainable, eco-safe, and residue-free alternative to synthetic insecticides for the effective management of spotted pod borer and other major pests of green gram. The adoption of these bio-rational practices within Integrated Pest Management (IPM) frameworks can significantly reduce chemical pesticide dependence, improve environmental safety, and enhance the economic returns of pulse growers, particularly under the dry sub-humid agro-climatic conditions of Bundelkhand region.

Keywords: Green gram, *Maruca vitrata*, spotted pod borer, bio-pesticides, neem oil, *Bacillus thuringiensis*, population dynamics, eco-friendly pest management

Introduction

Pulses are a vital group of leguminous crops cultivated mainly for their protein-rich edible seeds. Belonging to the family *Leguminosae* (Fabaceae), they play a crucial role in sustainable agriculture due to their ability to fix atmospheric nitrogen through symbiosis with *Rhizobium* bacteria. Pulses significantly contribute to food and nutritional security, particularly in vegetarian diets, as they are rich in protein, fiber, essential amino acids, vitamins, and minerals such as iron and zinc. India is the largest producer, consumer, and importer of pulses globally, with major crops including chickpea (*Cicer arietinum*), pigeon

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pea (*Cajanus cajan*), green gram (*Vigna radiata*), black gram (*Vigna mungo*), lentil (*Lens culinaris*), and field pea (*Pisum sativum*). Among these, green gram (*Vigna radiata* L.), also known as mung bean, holds a prominent position as a short-duration pulse crop cultivated in arid and semi-arid regions. It is grown in *Kharif*, *Rabi*, and summer seasons as a catch crop and serves multiple purposes such as green manure, fodder, and cover crop. Nutritionally, mung bean is highly valued for its high protein content (about 25%), carbohydrates (49.4%), essential amino acids, vitamins A, B1, and C, and minerals like calcium (365 mg/100 g) and phosphorus (134 mg/100 g). It also possesses several health-promoting properties including anti-inflammatory, hypoglycemic, and hypolipidemic effects. Despite its immense nutritional and agronomic importance, the productivity of green gram remains low due to several abiotic and biotic stresses. Among these, insect pests are one of the major biotic factors, causing substantial yield losses ranging from 30-50% annually. The pod borer complex comprising species like *Maruca vitrata*, *Helicoverpa armigera*, and *Spodoptera litura* poses the most serious threat. Studies have shown that *Maruca vitrata* alone can cause up to 36-40% yield loss, while other pests such as flower thrips and whiteflies also contribute significantly to production decline.

Spotted Pod Borer (*Maruca vitrata* Fabricius): It is considered the most destructive pest of green gram and other legumes. The larvae web together flowers, flower buds, and young pods, feeding inside and causing severe yield loss. The pest completes its life cycle within 20-30 days under favorable warm and humid conditions, allowing several generations per season. Eggs are laid singly on flowers or pods, larvae feed internally, pupate within plant debris, and adults emerge as small brown moths with characteristic white spots. Yield losses of 30-60% have been recorded during severe infestations.

Gram Pod Borer (*Helicoverpa armigera* Hübner): A polyphagous pest infesting several crops like green gram, chickpea, pigeon pea, cotton, and tomato. The larvae bore into flowers and pods, directly feeding on developing seeds. Its population thrives under moderate temperature and high humidity.

Whitefly (*Bemisia tabaci* Gennadius): This sap-sucking pest is notorious not only for direct feeding but also for transmitting viral diseases such as *Mungbean Yellow Mosaic Virus* (MYMV). Heavy infestations cause leaf curling, chlorosis, and premature defoliation. The pest is active throughout the growing season, with peaks during warm and humid conditions. Insect infestations in green gram result in both quantitative and qualitative losses. Damaged pods lead to shriveled, discolored, and unmarketable grains. The presence of virus-transmitting pests such as whiteflies further compounds losses, with reports of yield reductions up to 80% in severe cases. Additionally, secondary infections often occur due to the wounds created by these pests, reducing seed quality and germination potential.

Material and Methods

The current investigation was carried out in *Kharif*-2024 at Organic Research Farm, Karguan ji, Department of Entomology, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, (U.P).

Experimental material

The experimental material for the present study consisted of Green gram (*Vigna radiata* L.) variety Sikha, a widely cultivated high-yielding variety suitable for the agro-climatic conditions of Uttar Pradesh. The experiment was conducted during the *Kharif* season of 2024-25 at the Organic Research Farm, Karguan ji, Department of Entomology, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, U.P.

Table 1: Treatment Details

Sr. No.	Technical name	Trade name	Formulation	Concentration (%) or rate (kg/ha)	Manufacturing agency
T ₁	Neem oil	Neema zol	5% EC	5%	M/s EID Parry Ltd.
T ₂	Garlic Bulb extract	Veg. product	Crude extract	5%	Garlic bulb extract
T ₃	<i>Bacillus thuringiensis</i> Var. Kurstaki	DiPel	5%Wp	2.0 kg/ha	M/s Wockhard India Ltd. Mumbai
T ₄	Castor oil	Plant product	Crude extract	5%	Seeds of local castor
T ₅	Pancha gavya	I agri farm	45% sc	0.01%	Indian Agri farm
T ₆	NSKE	Plant product	Crude extract	5%	Seeds of local neem
T ₇	<i>Karanj oil</i>	Plant product	Crude extract	2%	Plant product
T ₈	<i>Bavaria bassiana</i>	Bio-soft	2x10 ⁸ cfu	2.0 Kg/ha	M/s Agriland Biotech Ltd. Vadrara
T ₉	Water control	-----	-----	-----	-----

Experimental Details

The experiment was laid out in Factorial Randomized Block Design with Sixteen treatments and three replications. The

random allocation of treatments was done using statistical table prepared by Fisher and Yates (1963) ^[30].

Table 2: Experimental Details

Sr. No.	Particulars	Details
1.	Season	: <i>Kharif</i> , 2024-25
2.	Variety	: Sikha
3.	Seed Rate	: 14 Kg ha ⁻¹
4.	Experimental Design	: RBD (Randomised Block Design)
5.	Number of Treatments	: 09
6.	Number of Replications	: 03
7.	Total Number of Plots	: 27
8.	Spacing	: 30 × 10 cm
9.	Gross Plot Size	: 2.30 × 2.70 m ² = 6.21 m ²
10.	Net Plot Size	: 2.10 × 2.50 m ² = 5.75 m ²

Results and Discussion

Physical attributes of different genotypes

The data presented in Table No. 3 clearly that the study was carried out to investigate the population trends of key insect pests of greengram crop during the *kharif* season of 2024. It was noted that the major insect pest Spotted Pod Borer (*Maruca vitrata*) (principal insect pests, namely Aphid

(*Aphis craccivora* Koch), Jassid (*Empoasca kerri* Pruthi), Whitefly (*Bemisia tabaci* Gennadius), and Pod borer (*Helicoverpa armigera* Hubner), were monitored along with the influence of meteorological factors on their occurrence throughout the crop development stage using appropriate methods.

Table 3: To Study about bio-pesticide in the of the management of spotted pod borer (*Maruca vitrata* F.) in insect pest of green gram.

S.M.W	Abiotic factors								Mean Population Per Five Plant			
	Temp.			R.H.			Rainfall (In mm)	Sunshine' (Hrs.)	Pod Borer	White Fly	Spotted Pod borer	
	Min. temp. (°C)	Max. temp. (°C)	Mean temp. (°C)	Morning RH (%)	Evening RH (%)	Avg. RH (%)					Larval population	Pod damage (%)
31	21.8	33.1	27.45	84.5	61.8	73.15	38.2	5.2	0.3	13.4	0	0
32	22.6	32.9	27.75	87.1	66.3	76.70	61.3	4.2	3.1	15.2	0	0
33	20.8	30.9	25.85	88.7	76.4	82.55	149.0	0.8	8.9	20.2	1.6	4.5
34	20.2	30.4	25.30	89.6	73.1	81.35	80.3	2.5	20.3	25.6	2.45	7.9
35	19.7	31.7	25.70	83.5	59.8	71.35	29.5	7.2	23.4	21.3	6.1	13.9
36	21.4	34.2	27.80	79.9	51.3	65.60	33.56	6.9	19.2	9.9	7.93	17.2
37	22.0	32.0	27.00	81.2	56.5	68.85	15.4	5.4	13.8	10.5	2.1	3.9
38	19.2	31.8	25.50	75.4	50.8	63.10	7.8	1.2	8.2	5.8	0.9	1.8
39	18.9	30.2	24.55	73.0	52.1	62.55	10.0	1.5	4.6	4.5	0.7	1.5
40	19.5	31.0	25.25	76.0	53.2	64.60	12.0	2.0	3.9	3.8	0.6	1.2
41	20.1	32.3	26.20	78.5	55.7	67.10	8.0	2.5	2.8	3.2	0.5	1.0
42	20.6	33.0	26.80	80.0	58.2	69.10	5.0	3.1	2.1	2.8	0.4	0.8
43	21.0	33.5	27.25	82.0	60.0	71.00	2.0	3.4	1.8	2.2	0.3	0.6
Coefficient of correlation (r1) for population and Min. temp.									-0.10	0.21	0.35	-0.39
Coefficient of correlation (r2) for population and Max. temp.									-0.18	-0.31	0.22	0.12
Coefficient of correlation (r3) for population and Morning R.H.									0.28	0.81	0.18	0.10
Coefficient of correlation (r4) for population and Evening R.H.									0.13	0.75	0.31	0.22
Coefficient of correlation (r5) for population and Total rainfall									0.25	0.76	0.33	0.28
Coefficient of correlation (r7) for population and Sunshine hours									0.48	0.24	0.61	0.55

Source: Indian Grassland and Fodder Research Institute, Jhansi, (U.P)

Table 4: To study the Bio-efficacy of bio-pesticides against major insects of greengram

Treatment Code	Biopesticide	Spotted Pod Borer			Whitefly Population	Pod Borer Population	Economics				
		Mean Larval Population (larvae/plant)	Pod Damage (%)	% Reduction Over Control			Yield (q/ha)	Gross Return (₹)	Total Cost (₹)	Net Return (₹)	C:B Ratio
T ₁	Neem oil 5% EC	2.1	10.4	60.8	2.90	2.65	10.8	70,200	26,200	44,000	1:2.68
T ₂	Garlic bulb extract 5%	3.2	13.6	50.0	3.55	3.40	9.8	63,700	25,800	37,900	1:2.47
T ₃	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	1.8	8.3	72.2	2.05	1.58	11.6	75,400	26,500	48,900	1:2.84
T ₄	Castor oil 5%	3.4	14.2	46.9	4.60	4.35	9.5	61,750	25,900	35,850	1:2.38
T ₅	Panchagavya 0.01%	4.3	17.9	32.8	5.52	5.05	8.9	57,850	25,700	32,150	1:2.25
T ₆	NSKE 5%	2.4	11.2	63.4	2.55	2.08	10.5	68,250	26,000	42,250	1:2.63
T ₇	Karanj oil 2%	4.1	16.8	35.9	3.80	3.60	9.2	59,800	25,950	33,850	1:2.30
T ₈	<i>Beauveria bassiana</i> 2x10 ⁸ cfu	3.0	12.7	52.9	3.20	2.75	10.2	66,300	26,400	39,900	1:2.51
T ₉	Control (Water spray)	6.4	26.5	0.0	12.33	7.73	7.6	49,400	25,000	24,400	1:1.98
S. Em±		0.031	0.180	0.520	0.084	0.032	N/A	N/A	N/A	N/A	N/A
CD at 5%		0.094	0.545	1.572	0.254	0.097	N/A	N/A	N/A	N/A	N/A

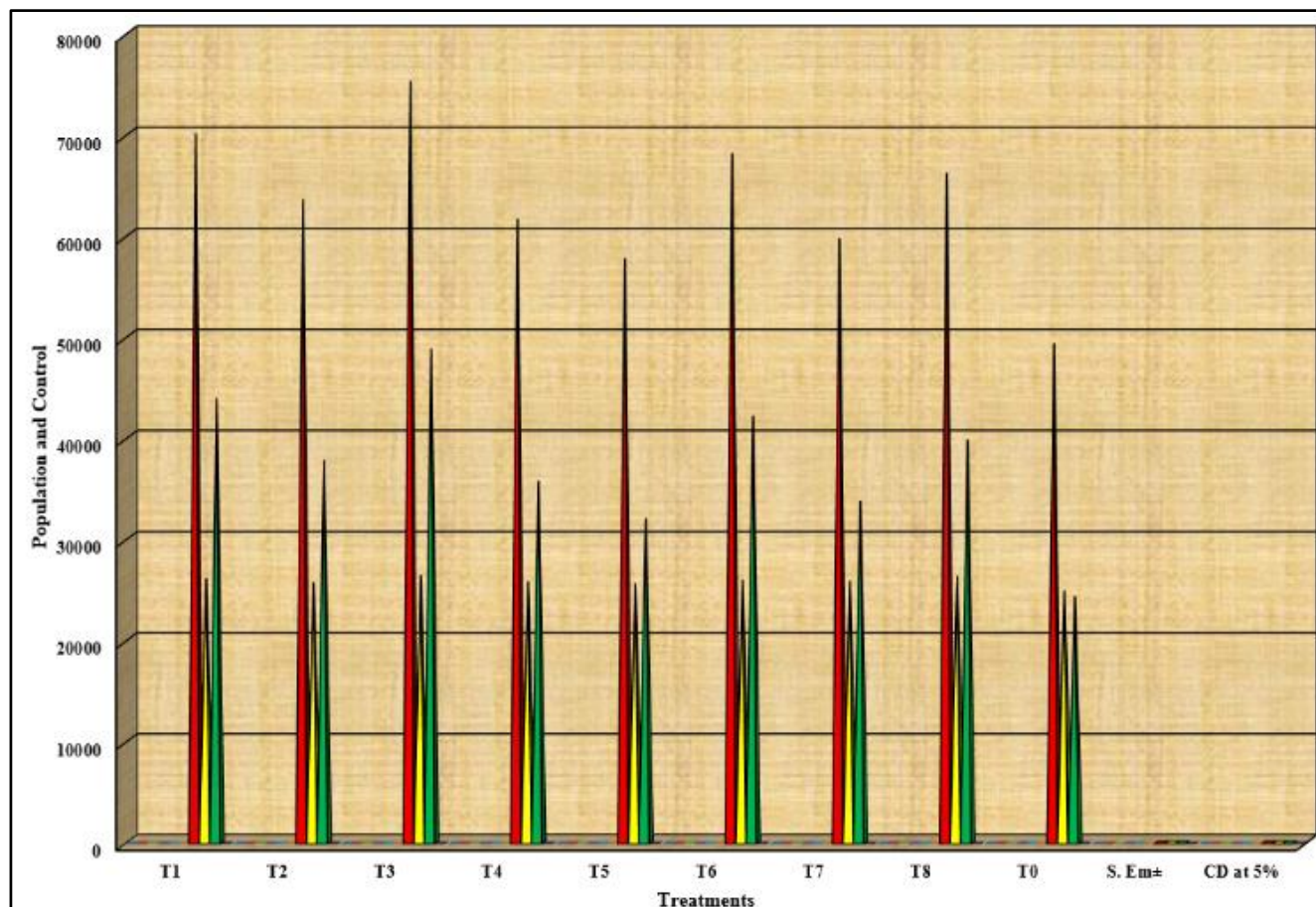


Fig 1: To study the Bio-efficacy of bio-pesticides against major insects of greengram

The data presented in Table 3 depict the seasonal fluctuation of major insect pests of green gram in relation to various abiotic factors during the *Kharif* season of 2024 at Jhansi. The population of pod borer (*Helicoverpa armigera*), whitefly (*Bemisia tabaci*), and spotted pod borer (*Maruca vitrata*) exhibited significant variation with changing meteorological conditions across the crop growth period. The initial pest activity of pod borers and whiteflies was noticed during the 32nd standard meteorological week (SMW), corresponding with mean temperature of 27.7 °C and relative humidity of 76.7%. The incidence of *Maruca vitrata* was first recorded in the 33rd SMW, with a larval population of 1.6 larvae per five plants and 4.5% pod damage. Pest population gradually increased with the progression of the crop growth, attaining peak infestation during the 36th SMW, where the mean temperature was 27.8 °C and the average relative humidity was 65.6%. During this period, the maximum population of *Helicoverpa armigera* (6.9/5 plants) and *Bemisia tabaci* (19.2/5 plants) was recorded, while *Maruca vitrata* reached its highest larval count (7.93/5 plants) and maximum pod damage (17.2%). Thereafter, a steady decline in pest population was observed with a fall in temperature and humidity toward the crop maturity stage. The correlation analysis revealed that the population of *Maruca vitrata* showed a positive correlation with sunshine hours ($r = 0.55$), rainfall ($r = 0.28$), and relative humidity ($r = 0.22$), indicating that moderate humidity coupled with bright sunshine favored the pest multiplication. In contrast, pod borer population exhibited a moderate positive association with sunshine hours ($r = 0.48$) but a weak negative correlation with maximum temperature ($r = -0.18$). Whitefly population showed a strong positive

correlation with both morning ($r = 0.81$) and evening relative humidity ($r = 0.75$) as well as with rainfall ($r = 0.76$), suggesting that humid and warm conditions were highly conducive for their proliferation. The results confirm that *Maruca vitrata* and *Bemisia tabaci* thrive under moderate temperature and high relative humidity, typical of the *Kharif* season, while heavy rainfall caused a temporary decline in their numbers. These findings align with those of Patel and Borad (2016) [31], who also reported similar relationships between pest buildup and weather parameters. The data in Table 4 summarize the efficacy of different bio-pesticides against spotted pod borer and associated insect pests, along with yield and economic performance. All bio-pesticidal treatments significantly reduced the larval population and pod damage over control. The lowest *Maruca vitrata* larval population (1.8 larvae/plant) and pod damage (8.3%) were recorded in plots treated with *Bacillus thuringiensis* var. *kurstaki* (2 kg/ha), which also resulted in the highest reduction of 72.2% over control. It was followed by Neem oil 5% EC (2.1 larvae/plant and 10.4% pod damage) and NSKE 5% (2.4 larvae/plant and 11.2% pod damage) with reduction of 60.8% and 63.4%, respectively. Moderate effectiveness was observed in *Beauveria bassiana* (3.0 larvae/plant, 12.7% damage) and Garlic bulb extract (3.2 larvae/plant, 13.6% damage), while the least reduction was seen in Panchagavya (4.3 larvae/plant, 17.9% damage). Regarding associated pests, whitefly and pod borer populations were minimum in *Bt*- and neem-treated plots (1.58 and 2.65 per five plants, respectively), while maximum infestation persisted in the untreated control (7.73 and 12.33 per five plants, respectively). The results clearly demonstrate that microbial and neem-based formulations not

only suppress *Maruca vitrata* effectively but also have a broad-spectrum effect on other pests. The effect of bio-pesticide treatments on yield and economics revealed remarkable variations. The highest grain yield (11.6 q/ha) was recorded with *Bacillus thuringiensis* application, followed by Neem oil (10.8 q/ha) and NSKE (10.5 q/ha). The untreated control produced the lowest yield (7.6 q/ha). The corresponding gross return was highest under *B. thuringiensis* (₹75,400/ha) and net return of ₹48,900/ha with a benefit-cost ratio of 1:2.84, establishing its superiority among all treatments. Neem oil ranked second with a B:C ratio of 1:2.68, while Panchagavya recorded the lowest profitability (1:2.25). The economic advantage of biopesticides over control and other botanicals indicates that they are cost-effective, eco-friendly, and residue-free alternatives to synthetic chemicals. The results confirm that *B. thuringiensis* and neem-based formulations are not only biologically effective but also economically viable for small-scale farmers. These findings corroborate the observations of Thakur *et al.*, (2021) [26], who reported that microbial and botanical pesticides offer high benefit-cost ratios and sustainable pest management outcomes in pulse crops.

Overall, the study demonstrated that the population dynamics of major pests of green gram are strongly influenced by weather factors, and timely application of effective bio-pesticides such as *Bacillus thuringiensis* and neem oil during peak pest periods (34th-36th SMW) can successfully manage *Maruca vitrata* infestation, improve yield, and enhance profitability. The integration of these bioagents into Integrated Pest Management (IPM) modules holds promise for sustainable and eco-friendly pest control under the dry sub-humid conditions of Bundelkhand region.

Conclusion

The study revealed that the population of major insect pests of green gram, especially *Maruca vitrata*, was strongly influenced by temperature, humidity, and rainfall, with peak activity during the 34th-36th SMW. Among all treatments, *Bacillus thuringiensis* var. kurstaki (2 kg/ha) and Neem oil (5%) were most effective in reducing larval population and pod damage while improving yield. Biopesticides significantly enhanced productivity and profitability over control, with *B. thuringiensis* showing the highest B:C ratio (1:2.84). The use of bio-based pest management proved eco-friendly, economical, and sustainable. Hence, integrating such biopesticides into IPM programs is highly recommended for effective and safe control of *M. vitrata* in green gram.

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