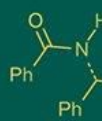


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Population dynamics and bio-rational management of key pests in okra (*Abelmoschus esculentus*) in the Bundelkhand region

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Abstract

The present investigation on "Seasonal fluctuation in population of major insect-pests of Okra in Bundelkhand region" was conducted during the *Kharif* season of 2024-25 at the Organic Research Farm Kargua Ji, Department of Entomology, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (U.P.). The study aimed to document the seasonal incidence of whitefly (*Bemisia tabaci*) and shoot and fruit borer (*Earias vittella*) was recorded. Whitefly population peaked at 8.09 individuals per leaf during the 42nd SMW (October 15-21), while shoot and fruit borer attained its maximum population of 5.40 larvae per plant during the 41st SMW. Both pest populations exhibited a declining trend towards crop maturity. Correlation analysis revealed that maximum and minimum temperatures showed a significant negative correlation with the incidence of both whitefly and fruit borer increased pest populations under cooler conditions. Relative humidity morning and evening exhibited a significant positive correlation with both pests. The findings provide crucial insights into the peak activity periods of major okra pests under the semi-arid conditions of Bundelkhand, which can aid in developing timely and effective pest management strategies. The bio-efficacy of different biopesticides was evaluated over two spray cycles, with the second spray showing improved efficacy, particularly for T₈ (Neem oil). The cost-benefit analysis showed the highest net returns and C:B ratio for *Beauveria bassiana* and Neem oil.

Keywords: Okra, population dynamics, whitefly, shoot and fruit borer, weather parameters, correlation

Introduction

Okra (*Abelmoschus esculentus* L.) Moench, belonging to the family Malvaceae, is a fruit-vegetable crop of African origin. It is highly treasured as an important summer and *Kharif* vegetable crop cultivated worldwide. Available in two colors, red and green, it is also known as red bhindi, although it turns green after cooking. While similar in taste to other fruits, it is commonly used as a vegetable in cookery. Okra is nutritionally rich, with a caloric value of 35 cal/100 g. It contains carbohydrate (6.4%), protein (1.9%), fat (0.2%), minerals (0.7%), and moisture (89.6%). Per 100 grams of edible portion, the fruit provides β -carotene (53 μ g), thiamine (0.07 mg), riboflavin (0.1 mg), vitamin C (13 mg), calcium (66 mg), magnesium (43 mg), oxalic acid (8 mg), phosphorus (56 mg), iron (0.35 mg), sodium (6.9 mg), potassium (1.09 mg), copper (0.11 mg), and sulphur (30 mg) (Singh, 2025).

The okra plant also possesses medicinal value and is used to manage ailments such as kidney stones, leucorrhoea, backache, and goitre. The mucilage extracted from the stem and root is utilized for clarifying sugarcane juice in jaggery production. Fully ripened fruits and stems, rich in crude fiber, are employed in paper manufacturing. The mucilage, a thick gelatinous substance, can bind with cholesterol during digestion and facilitate its excretion. Additionally, okra contains a protein called lectin, which may inhibit the growth of human cancer cells. It is also rich in folate (vitamin B₉), which is particularly essential for pregnant women to reduce the risk of neural tube defects affecting the brain and spinal cord of the developing fetus.

According to production statistics from the Food and Agriculture Organization of the United Nations (FAOSTAT, 2025), India ranks first in global okra production, contributing over 7.1 million tons annually, which accounts for 70% of the total world production. Peak production occurs between April and July.

The crop is cultivated on 534 thousand hectares, with an annual production of 6,371 thousand metric tonnes (Massrie, 2025) ^[26]. As a major cash crop, okra is grown extensively across India, with leading states including Gujarat, West Bengal, Bihar, Madhya Pradesh, Orissa, Chhattisgarh, Uttar Pradesh, Andhra Pradesh, Tamil Nadu, and Assam. Gujarat is the foremost producer, with an annual output of 1163.26 tonnes (Dhar *et al.*, 2025) ^[11]. Despite its high economic returns, okra is highly vulnerable to a range of insect pests and diseases, which necessitate timely and targeted management practices. Its tender and succulent nature makes it a host for nearly 72 species of insect pests that attack the crop from seedling to harvest stage. These infestations pose major challenges to commercial production (Chakraborty *et al.*, 2014) ^[3], leading to total quality and yield losses of approximately 35-40% (Bhat *et al.*, 2018) ^[2]. Significant pests affecting okra include the shoot and fruit borer (*Earias vittella*), fruit borer (*Helicoverpa armigera*), leaf roller (*Sylepta derogata*), leafhopper (*Amrasca biguttula biguttula*), whitefly (*Bemisia tabaci*), aphid (*Aphis gossypii*) and solenopsis mealybug (*Phenacoccus solenopsis*) (Aarwe *et al.*, 2016) ^[1]. Therefore, the present investigations conducted on population dynamics of major insect pests of okra in Bundelkhanad region.

Materials and Methods

Observations

Whitefly (*Bemisia tabaci*)

The number of insects (nymphs and adults) on 3 leaves per plant (upper, middle and lower) in five randomly selected plants was recorded from sowing to harvest of the okra crop at (7 days after maturity) interval by using the sudden trapping petri plate method.

Shoot and Fruit borer (*Earias vittella*)

Observations were taken at three places in each plot, and the mean was reported in number per meter row length (MRL) from sowing to harvest of the okra crop at (7 days after maturity) interval by visual method.

Observations on fruit yield

Fruit yield of okra was recorded on individual plot basis and converted in to quintal ha⁻¹. Gross a return was calculated by multiplying totally yield with market price of the produce. Cost of cultivation and cost of treatments was deducted from the gross returns, to find out returns and cost benef it of ratio by following formula.

$$BCR = \frac{\text{Net returns}}{\text{Cost of cultivation}} \times 100$$

Application of treatments

The pest population was monitored regularly and treatment was applied as and when the population of fruit borer was reached ETL per 0.5 m² respectively fruit damage.

Results and Discussion

The data on the seasonal incidence of whitefly (*Bemisia tabaci*) and shoot and fruit borer (*Earias vittella*) on okra variety Kashi Lalima during the Kharif season of 2024, along with the weekly meteorological parameters, are presented in Table 1.

The incidence of whitefly on okra was first observed during the 34th Standard Meteorological Week (SMW), corresponding to August 20-26, with a mean population of 0.99 individuals per leaf. The population showed a gradual increasing trend in the subsequent weeks. The peak whitefly population (8.09 individuals per leaf) was recorded during the 42nd SMW (October 15-21). Following this peak, the population declined to 5.23 individuals per leaf in the 43rd SMW (October 22-28). No whitefly incidence was recorded during the initial observation period of the 33rd SMW (August 13-19).

The larval population of shoot and fruit borer also commenced in the 34th SMW (August 20-26), with a mean of 0.43 larvae per plant. The infestation progressed steadily, reaching its highest level of 5.40 larvae per plant during the 41st SMW (October 8-14). Thereafter, the larval population exhibited a declining trend, with 4.33 and 4.00 larvae per plant recorded in the 42nd and 43rd SMWs, respectively. Similar to whitefly, no borer incidence was observed during the 33rd SMW.

Table 1: Seasonal incidence of whitefly and shoot and fruit borerinfesting okra during Kharif, 2024

SMW	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Sunshine (Hrs)	Mean No. of Whitefly	Mean No. of larva of fruit borer
	Max.	Min.	Morning	Evening				
33	34.3	25.2	86	66	42.2	1.2	0	0
34	35.2	24.8	92	73	88.8	4.4	0.99	0.43
35	35	24.2	91	71	33.4	4	1.67	1.99
36	35.1	25.1	88	67	14.2	0.5	3.33	3.67
37	31.2	23.7	94	74	199.8	3.3	4.67	4.99
38	31.7	23.6	94	73	59.8	6.6	4.89	5
39	33.8	25.3	91	57	26	6.7	5.67	5.05
40	35.5	23.5	87	51	0	5.6	6.33	5.33
41	33.9	22.7	89	56	0.6	6.9	7.33	5.4
42	35.5	18.8	81	40	0	5.9	8.09	4.33
43	34.7	17.3	90	42	0	8	5.23	4
Coefficient of correlation (r) for population and mean maximum temperature (°C)							-0.726*	-0.749*
Coefficient of correlation (r) for population and mean minimum temperature(°C)							-0.636*	-0.747*
Coefficient of correlation (r) for population and mean Morning RH (%)							0.589*	0.537*
Coefficient of correlation (r) for population and mean Evening RH (%)							0.622*	0.637*
Coefficient of correlation (r) for population and total rainfall (mm)							-0.132 ^{NS}	-0.125 ^{NS}
Coefficient of correlation (r) for population and sunshine (Hrs)							-0.646*	-0.675 *

The correlation coefficients (r) between the pest populations and various abiotic factors were computed to understand the effect of weather on their seasonal incidence. The mean whitefly population exhibited a significant negative correlation with both maximum and minimum temperatures ($r = -0.726$ and -0.636 , respectively). Similarly, the shoot and fruit borer larval population showed a significant negative correlation with maximum ($r = -0.749$) and minimum temperature ($r = -0.747$). This indicates that as temperatures decreased during the later part of the season, the populations of both pests increased. A significant positive correlation was observed between whitefly populations and both morning ($r = 0.589$) and evening relative humidity ($r = 0.622$). Likewise, the shoot and fruit borer population showed a significant positive correlation with morning ($r = 0.537$) and evening relative humidity ($r = 0.637$). This showed that higher relative humidity favored the buildup of

both pest populations. The correlation between total rainfall and the incidence of whitefly ($r = -0.132$) and fruit borer ($r = -0.125$) was negative but non-significant. These findings are closely associated with Srinivas and Kumar (2020) conducted an experiment in two cropping systems that revealed a peak shoot and fruit borer population (3.88 and 3.27 larvae/plant) and associated fruit damage (39.56 and 35.60%) during the 20th week after germination (WAG) (i.e., 11th SMW). The adult whitefly population remained maximum (3.07 and 3.61 whiteflies per leaf) during the 11thWAG (i.e., 20th SMW) and showed a significantly positive connection with average temperature and bright sunshine in both farming systems. Similarly, Kumar and Singh (2020) [23] discovered that whitefly emergence on okra crop was initially noted during the 27th SMW (1.96 whiteflies/3 leaves) and peaked (7.59 whiteflies/3 leaves) during the 31st SMW.

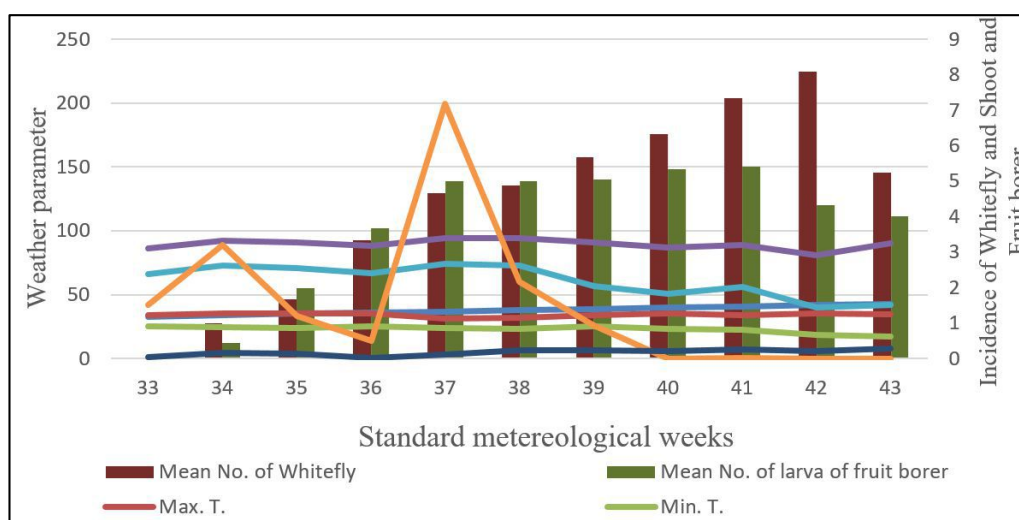


Fig 1: Seasonal incidence of whitefly and shoot and fruit borer infesting okra during Kharif, 2025

Bio-efficacy of Certain Biopesticides against Shoot and Fruit Borer (*Eariasvittella*) Infesting Okra during Kharif 2024

The efficacy of different biopesticides in reducing the larval population of *E. vittella* was evaluated over two spray cycles (first and second spray) with observations recorded at pre-treatment population (PTP), 3, 7, and 10 days after spraying

(DAS). Based on the data presented in Table 2, the percent reduction in mean population of fruit borer was recorded at 3, 7 and 10 days after first and second spray under different treatments. The mean populations of insect pest before 3, 7 and 10 Days after Transplanting were recorded 2.00, 1.67, and 1.00 larvae per plant respectively.

Table 2: Bio-efficacy of Certain Biopesticides against Shoot and Fruit Borer (*Eariasvittella*) Infesting Okra during Kharif 2024

Treatment	Percent reduction in mean population fruit borer							
	First Spray				After Second spray			
	PTP	3 DAS	7 DAS	10 DAS	PTP	3 DAS	7 DAS	10 DAS
T ₁ - <i>Beauveria bassiana</i>	2.00	50.33	53.28	51.03	2.33	51.82	52.76	50.25
T ₂ -Castor oil	1.99	44.00	42.32	40.87	2.00	45.78	47.65	44.68
T ₃ - <i>Bacillus thuringiensis</i> Var. <i>Kurstaki</i>	2.00	52.67	55.99	54.05	2.33	53.48	58.29	52.41
T ₄ - <i>Metarrhiziumanisople</i>	1.99	51.82	52.76	50.25	2.00	52.82	54.24	53.87
T ₅ -Garlic extract 10%	1.99	44.57	47.69	45.31	2.33	46.99	51.22	46.05
T ₆ -NSKE	2.00	47.99	51.35	48.78	2.00	48.98	53.39	48
T ₇ -Karanj oil	1.99	44	47.15	44.87	2.33	46.76	50.97	45.82
T ₈ -Neem oil	2.00	51.67	55.29	52.52	2.33	58.12	55.63	53.03
T ₀ -Water Spray	2.00	-	-	-	2.33	-	-	-
SEm ±		0.21	1.09	1.59	-	0.32	1.34	1.53
CD (P = 0.05)		NS	3.27	4.79	-	NS	4.04	4.62

After First Spray Cumulative mean

The cumulative mean percent reduction after first spray ranged from 42.40 to 54.24 percent. The highest cumulative

mean reduction was recorded in *Bacillus thuringiensis* Var. *Kurstaki* (54.24 percent) which was at par with Neem oil (53.16 percent), *Metarrhizium anisopliae* (51.61 percent)

and *Beauveria bassiana* (51.55 percent). The lowest cumulative mean reduction was recorded in Castor oil (42.40 percent) which was at par with Karanj oil (45.34 percent), Garlic-extract 10% (45.86 percent) and NSKE (49.37 percent). The pre-treatment population was non-significant among all the treatments.

After Second Spray Cumulative mean

The cumulative mean percent reduction after second spray ranged from 46.04 to 55.59 percent. The highest cumulative mean reduction was recorded in Neem oil (55.59 percent) which was at par with *Bacillus thuringiensis* Var. *Kurstaki* (54.73 percent) and *Metarrhizium anisopliae* (53.64 percent). The lowest cumulative mean reduction was recorded in Castor oil (46.04 percent) which was at par with Karanj oil (47.85 percent), Garlic-extract 10% (48.09 percent) and NSKE (50.12 percent). The pre-treatment population was non-significant among all the treatments.

Yield and C: B ratio: The application of biopesticides significantly influenced the marketable yield of okra compared to the untreated control. The highest yield was recorded in the treatment with *Beauveria bassiana*, which produced 88.65 Q/ha. This was statistically at par with neem oil, which resulted in a yield of 88.49 Q/ha. These were followed by *Bacillus thuringiensis* var. *kurstaki* (86.25 Q/ha) and *Metarrhizium anisopliae* (85.43 Q/ha), both of which also demonstrated high efficacy in reducing pest infestation and subsequently increasing yield. The treatment with NSKE (83.66 Q/ha) also showed a considerable yield advantage. *Bacillus thuringiensis* var. *kurstaki* (1:3.64) and *Metarrhizium anisopliae* (1:3.59) also proved to be highly economical, with favorable returns on the invested capital.

Conclusion

Present study showed whitefly (*Bemisia tabaci*) and shoot and fruit borer (*Earias vittella*) infestation on okra commenced during the 34th SMW (August 20-26). Peak populations of whitefly (8.09/leaf) and fruit borer (5.40/plant) occurred during the 42nd SMW (October 15-21) and 41st SMW (October 8-14), respectively, declining thereafter. Correlation analysis revealed that both pests exhibited significant negative correlation with temperature and sunshine hours, but significant positive correlation with relative humidity. Rainfall had no significant impact on pest populations. The bio-efficacy of different bio pesticides was evaluated over two spray cycles, with the second spray showing improved efficacy, particularly for T₈ (Neem oil). The cost-benefit analysis showed the highest net returns and C:B ratio for *Beauveria bassiana* and Neem oil.

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