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VARIETAL SCREENING AND BIO-INTENSIVE MANAGEMENT OF MAJOR INSECT PESTS IN OKRA (*ABELMOSCHUS ESCULENTUS* L.)

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ABSTRACT

This study evaluated the resistance of six different okra (*Abelmoschus esculentus* L.) varieties (Pusa Sawani, Punjab Padmini, Arka Anamika, Red Bhindi, Pusa Padmini and Parbhani Kranti) to major insect pests, especially leafhopper (*A. biguttula biguttula*), aphids (*A. gossypii*), whitefly (*B. tabaci*) and fruit borer (*E. vittella*) in the experimental field of College of Post Graduate Studies in Agricultural Sciences, CAU (Imphal), Umiam, Meghalaya. The result revealed that Pusa Sawani was the most resilient variety (22.37%) whereas Arka Anamika the most vulnerable (44.84%). The occurrence of significant important pests was negatively non-significant with highest temperature (r= -0.26) and positively significant with lowest temperature (r= 0.52) and relative humidity (r= 0.573) during summer season 2024. The highest percent corrected mortality 49.95%, 56.81% and 61.21% was documented in T5 treatment Profen super (Profenfos 40% + Cypermethrin 4% EC) for leafhopper (*A. biguttula biguttula*), aphid (*A. gossypii*) and whitefly (*B. tabaci*) whereas the highest corrected mortality (34.59%) was found in T1 treatment (*Bacillus thuringiensis* var. *kurstaki*) for fruit borer (*E. vittella*).

Key words : *A. biguttula biguttula, A. gossypii, B. tabaci Bacillus thuringiensis* var. *kurstaki*, Okra.

Introduction

Okra (*Abelmoschus esculentus* L.) belongs to the Malvaceae family. It is a common vegetable crop cultivated extensively in India and abroad due to its high nutritional value, amenability to year-round cultivation, and export potential. Its global production is estimated to be around 10.8 million metric tons. India is the world's largest country in production as well as consumption of Okra, but its original home is in Ethiopia, Sudan and north-eastern African countries. Okra is grown on a total of 5.5 lakh ha in India, with 5.5 million metric tons yearly production and 13.09 million metric tons of productivity per hectare (IndiaStat, 2024). It is attacked by a number of insect pests right from germination to harvesting, *viz.* leafhopper, *Amrasca biguttula biguttula* (Ishida); aphid, *Aphis gossypii* (Glover); whitefly, *Bemisia tabaci* (Genn); shoot and fruit borer, *Earias insulana* (Bosid.) and *E. vittella* (Fab.); leaf roller, *Sylepta derogate* (Fab.); Red Cotton Bug (*Dysdercus koenigii*); Green Plant Bug (*Nezara viridula*); Blister Beetle (*Mylabis pustulata)*; and Green Semilooper (*Anomis flava*); Mite (*Tetranychus cinnabarinus*) (Akbar and Khan, 2015). About 69% of losses were reported in marketable yield due to attacks of different insect pests (Rawat and Sahu, 1973). Seasonal abundance of the insect pest indicates both the peak activity of the specific pest as well as when it first appeared. The development of insect pest populations is significantly influenced by both biotic and abiotic factors. Correlation studies are useful for determining if biotic or abiotic factors have a positive or negative relationship with pest populations. It shows the direct impact of a certain parameter on the growth of pest populations as well as the indirect impact of other parameters. A large number of conventional insecticides are sprayed on this crop for the management of different insect pests. Their careless usage has led to the evaluation of several problems, like environmental pollution, insecticide resistance, pest resurgence, residual toxicity, health hazards and the destruction of beneficial organisms, flora and fauna. Botanical insecticides, because of their quick biodegrading nature, may be suitable alternatives to chemical pesticides. Neem-based pesticides were additionally stated to be safe for natural enemies (Schmutterer, 1990). Keeping this in view, the present studies were undertaken to screen out some okra varieties against major insect pests, their seasonal incidence, its correlation with biotic and abiotic parameters and evaluated their bio-intensive management.

Materials and Methods

The experiment was conducted at the experimental field of College of Post Graduate Studies and Agricultural Sciences (CPGS-AS), Central Agricultural University (Imphal), Umiam, Meghalaya, India. Six varieties of okra (Pusa Sawani, Parbhani Kranti, Arka Anamika, Punjab Padmini, Red bhindi and Pusa Padmini) were sown on ridges with plant to plant and row-to-row spacing of 30cm × 30cm, respectively. The observation was recorded at weekly interval from germination till harvesting and the percent infestation was determined by the formula given by Gowrish *et al*. (2015),

Percent infestation

$$= \frac{Number\, of\ shoot/fruit/leaf\ infested}{Total\ number\, of\ shoot/fruit/leaf\ per\ plant} \times 100$$

The weekly incidence of the major insect pests associated with okra throughout the cropping season was correlated with the weekly meteorological data from the time of germination till harvesting. A total of 24 experimental plots were laid out for the application of 6 treatments in Randomized Block Design (RBD) with four replications in plot size of 2m × 2m, spacing of 30cm × 30cm. The data were statistically analyzed using ANOVA. All analyses were conducted using statistical package for the social sciences (SPSS) version 22.0.

Results and Discussion

Leafhopper (*A. biguttula biguttula*)

The study revealed that Arka Anamika exhibited the highest infestation (36.67%) of leafhopper (*Amrasca biguttula biguttula*), classifying it as highly susceptible, whereas Pusa Sawani (23.42%) demonstrated resistance to the pest as presented in Table 1. However, these findings contrast with Priyanka *et al*. (2020), who reported Arka Anamika as moderately susceptible and Parbhani Kranti as highly susceptible. Supporting this, Kekan *et al.* (2022) identified Parbhani Kranti (7.20) and Arka Anamika (6.84) as the most susceptible varieties among the 40 genotypes screened. The infestation of leafhopper first appeared in the 14th Standard Meteorological Week (SMW), during the first week of April, with an initial count of 2.40 hoppers per plant. Similarly, Mohapatra *et al.* (2022) also recorded the onset of leafhopper infestation in early April. The highest population density was observed in the 4th week of May (20th SMW), whereas Sapkal *et al.* (2022) reported the peak at the 16th SMW, after which the population gradually declined.

The correlation analysis revealed that maximum temperature had a strong positive association with leafhopper infestation (r = 0.607), while minimum temperature (r = 0.215) showed an insignificant positive relationship. Morning relative humidity (r = -0.329), evening relative humidity (r = -0.349) and rainfall (r = -0.362) were negatively correlated with infestation (Table 2). In a related study, Dhandge *et al.* (2018) also found a significant positive correlation with maximum temperature (r = 0.545), while minimum temperature (r = 0.370) and day relative humidity (r = 0.277) were positively but non-significantly correlated. However, evening relative humidity (r = -0.219) showed a negative correlation. Similarly, Rawat *et al.* (2020) reported a non-significant positive correlation of leafhopper population with maximum temperature (r = 0.513) and morning relative humidity (r = 0.513), while rainfall (r = -0.602) exhibited a statistically significant negative correlation. Minimum temperature and evening relative humidity were also found to be negatively, but non-significantly correlated.

In terms of pest management as represented in Table 3, the highest corrected mortality (49.95%) was achieved using Profenfos 40% + Cypermethrin 4% EC. Among the biopesticide combination *of Beauveria bassiana*, *Metarhizium robertsii*, *Trichoderma harzianum*, *Lecanicillium lecanii* and *Pseudomonas fluorescens* achieved the highest mortality (37.41%). These results were supported by Narwade *et al.* (2023) identified *Lecanicillium lecanii* as the most effective biopesticide, followed by *Azadirachtin* and *Metarhizium anisopliae*. Meanwhile, Kekan *et al.* (2022) reported *Azadirachtin* as the top-performing treatment, followed by *L. lecanii*, *Pongamia pinnata* 2% EC, *Beauveria bassiana* and *M. anisopliae*.

Aphid (*A. gossypii*)

The data presented in Table 1 indicates that none of the evaluated varieties were completely resistant to aphid infestation. Among the tested varieties, the highest infestation was observed in Arka Anamika (96.87%), while Red Bhindi recorded the lowest infestation (51.16%). Aphid infestation peaked during the 20th Standard Meteorological Week (2nd week of May),

Table 1 : Percent Infestation of Major Insect Pests on Screened Okra varieties during *Kharif* season, 2023.

Varieties	Leafhopper (*A. biguttula biguttula*) (%)	Aphids (*A. gossypii*) (%)	Whitefly (*B. tabaci*) (%)	Fruit borer (*E. vittella*) (%)	Mean Infestation (%)
Pusa Sawani	23.42	51.57	2.56	20.63	22.37
Panjab Padmini	25.41	51.69	2.90	27.74	25.09
Arka Anamika	36.67	96.87	12.18	40.84	44.84
Red Bhindi	23.81	51.16	3.67	31.45	25.93
Pusa Padmini	24.98	52.33	3.60	31.19	25.78
Parbhani Kranti	27.77	56.53	2.43	31.44	27.79
SE(m)	2.75	1.42	0.94	3.77	
CD@5%	6.13	3.15	2.1	8.4	

Table 2 : Correlation of Meteorological parameters with incidence of major pests of Okra during Summer season, 2024.

Weather parameters	Leafhopper (*A. biguttula biguttula*)	Aphids (*A. gossypii*)	Whitefly (*Bemisia tabaci*)	Fruit borer (*E. vittella*)
Maximum temperature (%)	0.607**	-0.262	-0.368*	-0.375*
Minimum temperature (%)	0.215	0.521**	0.353*	0.442**
Maximum relative humidity (%)	-0.329*	0.573**	0.580**	0.742**
Minimum relative humidity (%)	-0.349*	0.690**	0.762**	0.746**
Rainfall (mm)	-0.362*	0.354*	0.541**	0.716**

Table 3 : Effect of different biopesticides on overall mean percent corrected mortality of major insect pests of Okra during Summer season, 2024.

Treatment	*A. biguttula biguttula*	*A. gossypii*	*B. tabaci*	*E. vittella*
T_1	19.06	15.73	32.01	34.59
T_2	21.21	27.24	37.94	24.14
T_3	37.41	44.96	49.78	20.45
T_4	15.02	38.72	35.01	20.33
T_5	49.95	62.95	61.21	8.57
T_6	0.00	0.00	0.00	0.00

T_1 (*Bacillus thuringiensis* var. *kurstaki*), T_2 (*Lecanicillium lecanii*), T_3 (*Beauveria bassiana* +*Metarhizium robertsii* (*M. aniospliae*) +*Trichoderma harzianum* + *Lecanicillium lecanii* + *Pseudomonas fluorescens*), T_4 (Neem oil, 0.03%), T_5 (Profenfos 40% + Cypermethrin 4% EC), T_6 (Control).

showing a negative correlation with maximum temperature (r = -0.262) and minimum temperature (r = 0.521). Additionally, morning relative humidity (r = 0.573), evening temperature (r = 0.690) and rainfall (r = 0.354) exhibited a positively significant correlation with aphid infestation as shown in Table 2. These findings align with the observations of Sapkal *et al.* (2022), who reported a significant positive correlation with minimum temperature (r = 0.651) and morning relative humidity (r = 0.635). In contrast, Dhandge *et al.* (2018) found a positive correlation between pest population and both maximum temperature (r = 0.343) and minimum temperature (r = 0.058), whereas morning and evening relative humidity were negatively correlated (r = -0.026 and r = -0.475).

Regarding pest control measures (Table 3), Profen Super demonstrated the highest corrected mortality rate of 62.95%. Among the tested biopesticides, the combination *of Beauveria bassiana*, *Metarhizium robertsii*, *Trichoderma harzianum*, *Lecanicillium lecanii* and *Pseudomonas fluorescens* achieved the highest mortality (44.96%), while *Bacillus thuringiensis* recorded the lowest efficacy (15.73%), as illustrated in Table 3. These results are supported by Narwade *et al.* (2023), who identified *L. lecanii* as the most effective treatment, followed by *Azadirachtin* and *Metarhizium anisopliae*. Similarly, Kekan *et al.* (2022) concluded that *L. lecanii* was highly effective, reducing the aphid population to a mean of 6.28 per three leaves, closely followed by *Azadirachtin* (6.65). Meanwhile, *B. bassiana* recorded a mean aphid population of 7.85.

Whitefly (*B. tabaci*)

The findings presented in Table 1 highlight that Arka Anamika (12.18%) was the most susceptible variety to whitefly (*Bemisia tabaci*) infestation compared to other varieties. The infestation began in the 16th Standard Meteorological Week (SMW), corresponding to the third week of April, with an initial count of 1.3 whiteflies. These observations align with the findings of Mohapatra *et al.* (2022), who reported the onset of whitefly infestation in the first week of April (14th SMW). The whitefly population reached its peak during the 19th SMW (2nd week of May), which corroborates the study by Dhandge *et al*. (2018), who found that the whitefly population peaked in the 16th SMW, followed by a gradual decline in the subsequent weeks.

Correlation analysis with meteorological parameters (Table 2) indicated a significant negative correlation with maximum temperature (r = -0.368). On the other hand, minimum temperature (r = 0.353), morning relative humidity (r = 0.580), evening relative humidity (r = 0.762), and rainfall (r = 0.541) exhibited significant positive correlations with whitefly infestation. These results are partially supported by Dhandge *et al*. (2018), who reported a positive correlation with minimum temperature (r = 0.252) and maximum relative humidity (r = 0.025). However, their findings differed concerning maximum temperature, which showed a high correlation (r = 0.523), and minimum relative humidity, which exhibited a negative correlation (r = -0.378).

In terms of control measures, Table 3 reveals that Profen Super was the most effective treatment, achieving the highest corrected mortality of 61.21%. Among the biopesticides, a combination of *Beauveria bassiana*, *Metarhizium robertsii*, *Trichoderma harzianum*, *Lecanicillium lecanii*, and *Pseudomonas fluorescens* recorded the highest mortality rate of 49.78%. These findings are in partial agreement with the study conducted by Narwade *et al*. (2023), who found *L. lecanii* to be the most effective biopesticide, followed by *Azadirachtin* and *Metarhizium anisopliae*. They concluded that *L. lecanii* achieved the highest mortality with the lowest whitefly population, followed by *Azadirachtin*, *B. bassiana*, and *M. anisopliae*.

Fruit borer (*E. vittella*)

An evaluation of six different okra varieties revealed (Table 1) that Arka Anamika experienced the highest infestation rate (40.84%), indicating a significant susceptibility to fruit borer (*Earias vittella*). However, these findings contradict those of Sakriya *et al*. (2022), who reported Arka Anamika as highly resistant to fruit borer infestation. The infestation was first observed during the 17th Standard Meteorological Week (SMW) with an initial count of 0.61 larvae per plant, which gradually increased and peaked at the 22nd SMW with 3.22 larvae per plant. In contrast, Dhandge *et al*. (2018) recorded the initial incidence earlier, at the 11th SMW (0.7 larvae per plant), closely aligning with the present study. Similarly, Jalgaonkar *et al*. (2020) reported a peak fruit borer population at the 9th Week After Sowing (WAS), followed by a steady decline until the final harvest, which closely aligns with the current study's peak at the 10th WAS.

The correlation analysis between fruit borer infestation and weather parameters (Table 2) showed a significant negative correlation with maximum temperature (r = -0.375), while minimum temperature (r = 0.442), morning relative humidity (r = 0.742), evening relative humidity (r = 0.746), and rainfall (r = 0.716) exhibited a significant positive correlation (Table 2). These findings are consistent with those of Dabhi *et al*. (2013), who also reported a negative correlation with maximum temperature and a significant positive correlation with morning and evening relative humidity. Mohammad *et al*. (2019) further supported this by documenting a strong positive correlation with relative humidity (r = 0.91).

In terms of pest control (Table 3), *Bacillus thuringiensis* emerged as the most effective treatment, achieving the highest mortality rate of 34.56%, whereas Profen Super exhibited the lowest efficacy with only 8.57% mortality. Choudhury *et al*. (2021) evaluated various control measures, including *Bacillus thuringiensis*, *Azadirachtin*, Spinosad and Abamectin, and reported the highest mortality with Spinosad (80.69%), followed by *B. thuringiensis* (60.14%), *Azadirachtin* (56.45%), and Abamectin (55.58%), findings that partially support the present study. However, Sharma and Kumar (2024) presented contradictory results, stating that Profenfos 50EC + Cypermethrin 25EC was the most effective treatment, achieving the lowest fruit damage (3.05%), followed by Cypermethrin 25EC + Neem oil 3% (4.29%), Spinosad 45SC + Neem Oil 3% (5.54%), Spinosad 45SC (5.95%), Cypermethrin 25EC (7.70%), and Profenfos 50EC (8.56%).

Conclusion

The present study concludes Pusa Sawani as the most resistant variety against the major insect pests of okra ecosystem. Leafhopper (*A. biguttula biguttula*), Aphid (*A. gossypii*), Whitefly (*B. tabaci*) and Fruit borer (*E. vittella*) are major pests of Okra which are active throughout the cropping season with highest population in the month May and June during Summer season. Profen super was found most effective but at par with consortium of *Beauveria bassiana* + *Metarhizium robertsii* + *Trichoderma harzianum* + *Leacnicillium lecanii* + *Pseudomonas fluorescens* for management of sucking pests {Leafhopper (*A. biguttula biguttula*), Aphid (*A. gossypii*), Whitefly (*B. tabaci*)} whereas *Bacillus thuringiensis* var. *kurustaki* gave best result against Lepidopteran pest (Fruit borer, *E. vittella*). These biopesticides can safely be used for management of

Leafhopper (*A. biguttula biguttula*), Aphid (*A. gossypii*), Whitefly (*B. tabaci*) and Fruit borer (*E. vittella*) in Okra ecosystem and can be incorporated in development IPM module against Okra insect pests.

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Author contribution statement

Karishma Kalita and Mahesh Pathak conceived and designed the research. Karishma Kalita conducted the complete experiment whereas Mahesh Pathak, Kennedy Ningthoujam, R.K Patidar and T. Rajesh and Jyotim Gogoi provided the data analysis tools. Karishma Kalita and Jyotim Gogoi analysed the data. Karishma Kalita and Mahesh Pathak wrote the manuscript. All authors read and approved the manuscript.

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