Indian Journal of Hill Farming, (2024); 37(2):62-68

doi: 10.56678/iahf-2024.37.02.10

ISSN: 0970-6429

ijhfonline.org

RESEARCH ARTICLE

# Performance of different okra cultivars and insecticides in suppressing sucking pests in Assam, India

**Chada Anu Reddy[1*], Anjumoni Devee[2], Mahesh Pathak[3], Saisri Manchikatla[4], Deepika Sorahia[5]**

## Abstract

The purpose of this study was to see the effectiveness of certain insecticides and three popular okra cultivars against sucking pests of okra. The experiment was carried out at the Experimental Farm, Dept. of Horticulture, Assam Agricultural University, Jorhat, Assam during the *Kharif*, 2020 and the *spring-summer,* 2021. It was found that the lowest aphid (2.66 and 2.00 nos./3 leaves) and whitefly (0.66 and 0.33 nos./3 leaves) population was observed in treatment V1T1 (chlorantraniliprole 18.5%SC @25 gm *a.i.*/ha + Arka Anamika) at 5 DAT in both the seasons respectively. Similarly, the treatment V3T3 (lambda-cyhalothrin 5%EC @ 15 gm *a.i.*/ha + S-51) recorded the highest aphid and whitefly populations during both *kharif* (9.33 aphids and 4.00 whiteflies/3 leaves respectively) and the *spring-summer* (7.33 aphids and 3.00 whiteflies/3 leaves respectively). Whereas, the jassid population showed a decreasing trend up to 10 DAT in both seasons. The treatment V1T1 showed the highest and V3T3 showed the lowest reduction in the jassid population during *kharif* (1.00 and 6.00/3 leaves respectively) and *spring-summer* (0.66 and 4.00 /3 leaves respectively). Hence, the insecticide chlorantraniliprole 18.5% SC proved to be the most effective insecticide for the management of sucking pests.

**Keywords:** Arka Anamika, Chlorantraniliprole, Pusa Sawani, Split plot design, and sucking pests.

## Introduction

Okra, scientifically known as *Abelmoschus esculentus*, is a versatile and nutrient-rich vegetable celebrated for its unique flavor and numerous health benefits. Believed to have originated in West Africa, okra has since spread its culinary influence worldwide, becoming a staple in various cuisines, particularly in the Southern United States, the Middle East, and South Asia. With its distinct elongated shape and vibrant green color, okra is a popular addition to dishes, lending a mild, slightly earthy taste and a delightful mucilaginous texture (Patil *et al*. 2014 Berwa *et al*., 2017). Beyond its culinary charm, okra is also a valuable source of vitamins, minerals, and dietary fiber, making it a favored choice for those seeking a nutritious diet (Subbireddy *et al*. 2018).

India, Nigeria, Sudan, and Pakistan play significant roles in the global production of okra. In terms of both land area and total output, India holds the top position as the world's leading producer, with Nigeria closely following. Based on the 2nd advance estimation data for 2020-21, India cultivated approximately 532,000 hectares of okra, resulting in a production of 6,513,000 metric tons (Anonymous 2020-21). Darrang and Nagaon are emerging as the principal okra-growing districts of Assam. During 2017-18, okra is grown on a smaller scale, covering around 12.45 thousand hectares, but still yielding a considerable 204.49 thousand metric tons (Anonymous 2018).

From germination until harvest, the okra crop is infested by a variety of insect pests and diseases causing significant yield loss. Sucking pests such as whitefly (*Bemisia tabaci*), leafhopper (*Amrasca bigutulla bigutulla*) and aphids (*Aphis gossypii*) are being found during the vegetative growth stage (Iqbal *et al*. 2015 and Rawat 2020). Farmers often turn to chemical pesticides for quick and effective insect

[1,3,5]Department of Entomology, School of Crop Protection, College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal) Umiam, Meghalaya- 793103

[2]AICRP on Biocontrol, Department of Entomology, Assam Agricultural University, Jorhat, Assam-785013

[4]Department of Entomology, College of Agriculture, Vellayani, Kerala Agricultural University, Kerala- 695522

***Corresponding Author:** Chada Anu Reddy, Department of Entomology, School of Crop Protection, College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal) Umiam, Meghalaya- 793103, E-Mail: anureddychada@gmail.com

**How to cite this article:** Reddy, C.A., Devee, A., Pathak, M., Manchikatla, S., Sorahia, D. 2024. Performance of different okra cultivars and insecticides in suppressing sucking pests in Assam, *Indian J. Hill Farm.,* **37**(2):62-68.

**Source of support:** Nil

**Conflict of interest:** None.

**Received:** 09/11/2023 **Revised:** 30/01/2025 **Accepted:** 31/01/2025

pest control, but their overuse has led to widespread insect resistance. Additionally, many conventional pesticides have been restricted due to their adverse effects on the environment and human health. Hence, there's a crucial need for next-generation pesticides to enhance insect pest management.

Chlorantraniliprole, belonging to the diamide group of insecticides, stands out as highly effective for combating various pests mainly, lepidopteran pests. It is widely recommended for a range of crops including rice, sugarcane, cabbage, tomato, okra, and more. What sets chlorantraniliprole apart from conventional insecticides is its unique mode of action, as it activates the calcium channels in the insects' muscles. Emamectin benzoate, on the other hand, is a member of the avermectins group and is derived from fermented soil microorganisms. This insecticide excels in controlling a variety of pests, including sucking pests, leaf miners, lepidopteran pests, and mites, making it a valuable asset in the cultivation of cotton, citrus fruits, grapes, various vegetables, and soybeans. Lambda-cyhalothrin, classified as a synthetic pyrethroid, acts as a sodium channel modulator in the nervous systems of insects. It has proven to be highly effective in combatting pests in crops such as cotton, paddy, soybean, and various vegetables.

The introduction of these innovative pesticides resulted in mitigating pesticide resistance and reducing residue levels. As a result, they offer promising opportunities for more effective pest control strategies (Sarkar *et al*. 2016 and Jain *et al*. 2021). Consequently, it is imperative to continue research and develop new pesticides to address the issues of insect pest management.

## Materials and methods

### *Study area and design*

This study aimed to assess the efficacy of specific insecticides in controlling the sucking pests affecting various okra cultivars. A trial was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University in Jorhat, Assam. The experiments were conducted in two crop seasons, i.e., *kharif* (August to November) during 2020 and spring-summer (February to May) during 2021. The crop was planted at recommended spacing i.e. 60 x 45 cm during *kharif* and 45 x 20 cm during the spring-summer seasons. The standard recommended agronomic package of practices as applicable for Assam was strictly adhered to (Anonymous 2019). The experiment was laid out in a split-plot design with three replications. The insecticide treatments were assigned to the sub-plots, while the okra varieties were allocated to the main plots resulting in a total of 36 sub-plots in the experiment.

### *Varieties and insecticides*

Three okra varieties viz. Arka Anamika (AA), Pusa Sawani (PS) and a local variety known as S-51 that are recommended and suitable for the region were selected and used in the experiment. The three insecticides that were tested include Chlorantraniliprole 18.5% SC @ 25 g *a.i.*/ha (C), Emamectin benzoate 5% SG @ 8.5 g *a.i.*/ha (E) and Lambda cyhalothrin 5% EC @15 g *a.i.*/ha (L). These insecticides were sprayed during the early hours of the day using a hydraulic knapsack sprayer with a hollow cone nozzle at a pressure of 3-5 kg/cm$^2$ by mixing with 500 liters of water per hectare. Different treatment combinations include V1T1- C + AA; V1T2 - E + AA; V1T3 - L + AA; V2T1 - C + PS; V2T2 - E + PS; V2T3 - L + PS; V3T1 - C + S-51; V3T2 - E + S-51; V3T3 - L +S-51 and Control.

### *Observation*

For sucking pests, pest populations on three leaves, one each from the top, middle and bottom were assessed from five selected plants in each plot (Thorat *et al* 2020). The data were collected one day before the treatment (pre-treatment count) and on 1, 3, 5, 10 and 15 Days After Treatment (DAT).

### *Statistical analysis*

The data were subjected to statistical analysis by using SPSS software. Analysis of variance was calculated to compare the results at the $p$ = 0.05 level of significance.

## Results

### *Effect of different insecticidal treatments on aphid population during Kharif, 2020 and spring-summer, 2021 (Table 1)*

The insecticidal treatments were given at 60 DAS during the fruiting stage. One day before the application of insecticides, the aphid population was recorded in all the plots and it was found that there was no significant difference among the treatments and the population of aphids ranged between 19.33 to 24.00/3 leaves in *Kharif,* 2020 and 15.33 to 18.66/3 leaves in *spring-summer*, 2021. All the treatments were found effective in reducing the aphid population at 1, 3, 5, 10, and 15 DAT compared to control. The population of the aphid was found at least at 5 DAT and later it started increasing slowly over time.

#### *One day after spraying*

At 1 DAT all the treatments showed significantly more reduction in aphid population compared to pre-treatment count in both seasons. The population in the control increased from 19.33 to 23.33/3 leaves during *Kharif* and 16.00 to 19.66 during *spring-summer*. In both seasons, the highest reduction in aphid population was observed in $V_1T_1$ (9.00 and 6.33/3 leaves respectively) which were statistically at par with $V_1T_2$ and $V_2T_2$ (10.33 and 9.33/3 leaves) during *Kharif* and only with $V_2T_2$ (7.66/3 leaves) during *spring-summer* and significantly different from others. The lowest reduction in both seasons was observed in the case of $V_3T_3$ (16.66 and 13.00/3 leaves respectively).

**Table 1:** Effect of different treatments on population of aphid, *Aphis gossypii* during *kharif*, 2020 and *spring-summer*, 2021

| Treatments | *Kharif, 2020* | | | | | | *Spring-summer, 2021* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Pre-count* | *Post treatment count* | | | | | *Pre-count* | *Post treatment count* | | | | |
| | | *1DAT* | *3DAT* | *5DAT* | *10DAT* | *15DAT* | | *1DAT* | *3DAT* | *5DAT* | *10DAT* | *15DAT* |
| $V_1T_1$ | 22.66 | $9.00^{d}$ | $4.66^{e}$ | $2.66^{e}$ | $3.33^{e}$ | $4.33^{e}$ | 15.33 | $6.33^{d}$ | $3.33^{d}$ | $2.00^{e}$ | $2.33^{e}$ | $3.00^{e}$ |
| $V_1T_2$ | 20.33 | $10.33^{d}$ | $5.00^{de}$ | $4.00^{e}$ | $5.00^{de}$ | $5.66^{de}$ | 15.66 | $8.33^{cd}$ | $4.00^{d}$ | $2.33^{de}$ | $3.33^{de}$ | $3.66^{de}$ |
| $V_1T_3$ | 21.66 | $14.00^{bc}$ | $8.66^{c}$ | $7.33^{c}$ | $8.33^{c}$ | $9.00^{cd}$ | 17.66 | $11.00^{bc}$ | $7.33^{bc}$ | $5.66^{c}$ | $6.66^{c}$ | $7.00^{c}$ |
| $V_2T_1$ | 19.33 | $12.66^{cd}$ | $5.66^{de}$ | $3.00^{e}$ | $4.00^{e}$ | $4.66^{e}$ | 16.33 | $10.33^{c}$ | $4.66^{d}$ | $3.33^{de}$ | $4.00^{de}$ | $4.33^{de}$ |
| $V_2T_2$ | 21.00 | $9.33^{d}$ | $7.33^{cd}$ | $5.66^{d}$ | $7.00^{cd}$ | $7.33^{d}$ | 17.00 | $7.66^{d}$ | $6.00^{cd}$ | $4.66^{cd}$ | $5.33^{cd}$ | $5.66^{cd}$ |
| $V_2T_3$ | 20.66 | $14.33^{bc}$ | $9.33^{bc}$ | $7.66^{c}$ | $8.66^{c}$ | $9.33^{c}$ | 18.33 | $12.66^{bc}$ | $8.33^{bc}$ | $7.00^{bc}$ | $7.66^{bc}$ | $8.00^{bc}$ |
| $V_3T_1$ | 23.66 | $13.66^{c}$ | $6.66^{d}$ | $5.33^{de}$ | $6.66^{d}$ | $7.00^{d}$ | 16.66 | $10.66^{bc}$ | $5.33^{cd}$ | $3.66^{d}$ | $4.66^{d}$ | $5.00^{d}$ |
| $V_3T_2$ | 22.33 | $12.33^{cd}$ | $8.33^{cd}$ | $6.66^{cd}$ | $7.66^{cd}$ | $8.66^{cd}$ | 17.33 | $8.66^{cd}$ | $6.66^{c}$ | $5.00^{cd}$ | $6.00^{cd}$ | $6.33^{cd}$ |
| $V_3T_3$ | 24.00 | $16.66^{b}$ | $11.00^{b}$ | $9.33^{b}$ | $11.66^{b}$ | $12.00^{b}$ | 18.66 | $13.00^{b}$ | $8.66^{b}$ | $7.33^{b}$ | $9.00^{b}$ | $9.33^{b}$ |
| Control | 19.33 | $23.33^{a}$ | $26.66^{a}$ | $28.33^{a}$ | $32.33^{a}$ | $29.66^{a}$ | 16.00 | $19.66^{a}$ | $22.33^{a}$ | $25.00^{a}$ | $28.66^{a}$ | $27.33^{a}$ |
| Var. | | | | | | | | | | | | |
| P value | 0.721 | 0.203 | 0.849 | 0.888 | 0.849 | 0.256 | 0.372 | 0.885 | 0.382 | 0.665 | 0.548 | 0.197 |
| F value | 0.355 | 2.442 | 0.171 | 4.739 | 0.170 | 1.955 | 1.281 | 0.126 | 1.238 | 0.453 | 0.702 | 2.508 |
| Treatment | | | | | | | | | | | | |
| P value | 0.681 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.001 | 0.688 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| F value | 0.509 | 23.199 | 99.808 | 115.391 | 245.502 | 8.572 | 0.498 | 12.870 | 54.506 | 110.785 | 89.766 | 117.158 |
| Var. X Treatment | | | | | | | | | | | | |
| P value | 0.794 | 0.295 | 0.010 | 0.165 | 0.005 | 0.981 | 0.965 | 0.447 | 0.069 | 0.119 | 0.399 | 0.192 |
| F value | 0.508 | 1.329 | 3.987 | 1.758 | 4.673 | 0.173 | 0.221 | 1.014 | 2.407 | 1.997 | 1.101 | 1.645 |

Data are mean of three replications

*Three and five, days after spraying*

In both seasons, the population of aphids showed a decreasing trend from 1 DAT to 5 DAT. At 3 and 5 DAT, $V_1T_1$ recorded the lowest population of 4.66, 2.66/3 leaves in *Kharif* and 3.33, 2.00/3 leaves in *spring-summer* respectively which was significantly different from other treatments at 3 DAT and statistically at par with $V_1T_2$ (4.00) and $V_2T_1$ (3.00) at 5 DAT in *kharif*. Also, treatments $V_1T_2$ (4.00/3 leaves) and $V_2T_1$ (4.66 /3 leaves) are statistically at par with $V_1T_1$ at 3 DAT and significantly different from other treatments at 5 DAT in *spring- summer*. Treatment $V_3T_3$ registered significantly lower aphids at 3 and 5 DAT (11.00, 9.33/3 leaves respectively in *Kharif* and 8.66, 7.33/3 leaves respectively in *spring-summer*) which was significantly higher than control.

*Ten and fifteen days after spraying*

From 10 to 15 DAT an increasing trend of aphid population was observed. $V_1T_1$ showed a significantly higher reduction of the aphid population at 10 (3.66 and 2.33/3 leaves) and 15 DAT (4.33 and 3.00 /3 leaves) in comparison to other treatments. The lowest population reduction was observed at $V_3T_3$ (11.66 and 12.00 /3 leaves respectively in *kharif*) (9.00 and 9.33/3 leaves respectively in *spring-summer*) which was significantly higher than the control (32.33 and 29.66/3 leaves respectively in *kharif*) (28.66 and 27.33 /3 leaves respectively in *spring-summer*). At 15 DAT natural reduction of aphid population was also observed in control which was coinciding with the maturity stage of okra.

From the interaction study, it was observed that variety had no significant effect on the aphid population. The combined effect of variety and treatment had a significant effect on the population reduction of aphids. The insecticidal treatment has shown a significant effect on the population of aphids in *kharif* (P = 0.001). Individual effect of variety and combination effect of variety x treatments were not significant in reducing aphid population in *spring-summer* but the treatments had significant effect on population reduction of aphid.

### *Effect of different insecticidal treatments on the jassid population (Table 2)*

*One day after spraying during Kharif and spring-summer*

Among the treatments, $V_1T_1$ showed the highest reduction in the jassid population (4.66 and 2.33/3 leaves respectively) which was statistically at par with treatment $V_1T_2$ (6.00/3 leaves) and significantly different from $V_2T_1$ (6.66/3 leaves), $V_3T_1$ (7.33/3 leaves), $V_2T_2$ (8.00/3 leaves) $V_3T_2$ (8.66/3 leaves), $V_1T_3$ (9.00/3 leaves) and $V_2T_3$ (9.66/3 leaves) during *Kharif*. Whereas in spring-summer it was significantly different for all the other treatments. The treatment $V_3T_3$ showed the least reduction of the jassid population (10.33 and 6.33/3 leaves) which was significantly different from other insecticidal treatments in both seasons at 1 DAT.

*Three, five, ten, and fifteen days after spraying during kharif*

All the treatments showed a reduction in the number of jassid up to 10 DAT. At 3, 5 and 10 DAT, $V_1T_1$ showed a lesser population of jassid (4.00, 2.33 and 1.00/3 leaves respectively) which was statistically at par with $V_1T_2$ (5.00 /3 leaves), $V_2T_1$ (5.33/3 leaves) at 3 DAT, followed by $V_3T_1$ (6.33/3 leaves), $V_2T_2$ (6.66/3 leaves), $V_3T_2$ (7.66/3 leaves), $V_1T_3$ (8.33/3 leaves) and $V_2T_3$ (8.66 /3 leaves). Among the treatments, the highest jassid population was seen in $V_3T_3$ (9.66 /3 leaves), which was significantly different from the other treatments.

At 5 DAT significant reduction of the jassid population was observed in $V_1T_1$ (2.33/3 leaves) which was significantly different from other treatments. The $V_1T_2$ (3.33/3 leaves) and $V_2T_1$ (4.00/3 leaves) are not significantly different and statistically at par with $V_1T_3$ (6.33/3 leaves). The lowest population reduction was observed in $V_2T_3$ (6.66/3 leaves) followed by $V_3T_3$ (7.00/3 leaves) which were statistically similar to each other and significantly different from $V_3T_1$ (4.33/3 leaves) and $V_2T_2$ (4.66/3 leaves).

A similar trend of population reduction of jassid was also observed at 10 DAT and 15 DAT. The highest reduction of jassid was observed in $V_1T_1$ (1.00 and 2.00/3 leaves) followed by $V_1T_2$ (2.00 and 3.00/3 leaves), $V_2T_1$ (3.00 and 3.66/3 leaves), V3T1 (3.66 and 4.00/3 leaves), $V_2T_2$ (4.00 and 4.33/3 leaves), $V_3T_2$ (4.66 and 5.00/3 leaves) and $V_1T_3$ (5.00 and 6.00/3 leaves) at 10 and 15 DAT respectively. Treatment $V_2T_3$ (5.66 and 6.33/3 leaves) recorded the lowest jassid population at 10 and 15 DAT which was statistically at par with $V_3T_3$ (6.00 and 6.66 /3 leaves respectively). Natural reduction of the jassid population was observed at 15 DAT.

*Three, five, ten and fifteen days after spraying during spring-summer*

At 3, 5, 10, and 15 DAT, $V_1T_1$ registered the highest reduction in the jassid population (2.00, 1.33, 0.66 and

**Table 2:** Effect of different treatments on population of jassid, *Amrasca biguttula biguttula* during *kharif*, 2020 and *spring-summer*, 2021

| *Treatments* | *Kharif, 2020* | | | | | | *Spring-summer, 2021* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Pre-count* | *Post treatment count* | | | | | *Pre-count* | *Post treatment count* | | | | |
| | | *1DAT* | *3DAT* | *5DAT* | *10DAT* | *15DAT* | | *1DAT* | *3DAT* | *5DAT* | *10DAT* | *15DAT* |
| $V_1T_1$ | 13.33 | $4.66^{d}$ | $4.00^{d}$ | $2.33^{d}$ | $1.00^{cd}$ | $2.00^{e}$ | 8.00 | $2.33^{d}$ | $2.00^{d}$ | $1.33^{d}$ | $0.66^{d}$ | $1.00^{d}$ |
| $V_1T_2$ | 13.66 | $6.00^{d}$ | $5.00^{d}$ | $3.33^{cd}$ | $2.00^{cd}$ | $3.00^{de}$ | 8.33 | $3.33^{cd}$ | $2.66^{d}$ | $1.66^{d}$ | $1.00^{d}$ | $1.33^{d}$ |
| $V_1T_3$ | 15.66 | $9.00^{bc}$ | $8.33^{bc}$ | $6.33^{bc}$ | $5.00^{bc}$ | $6.00^{bc}$ | 8.66 | $5.33^{bc}$ | $5.00^{bc}$ | $4.00^{bc}$ | $3.33^{bc}$ | $3.66^{bc}$ |
| $V_2T_1$ | 14.00 | $6.66^{cd}$ | $5.33^{d}$ | $4.00^{cd}$ | $3.00^{cd}$ | $3.66^{d}$ | 8.00 | $3.66^{cd}$ | $3.00^{cd}$ | $2.33^{cd}$ | $1.66^{cd}$ | $2.00^{cd}$ |
| $V_2T_2$ | 14.66 | $8.00^{c}$ | $6.66^{cd}$ | $4.66^{c}$ | $4.00^{c}$ | $4.33^{cd}$ | 8.33 | $4.66^{c}$ | $4.00^{c}$ | $3.33^{c}$ | $2.66^{c}$ | $3.00^{c}$ |
| $V_2T_3$ | 16.33 | $9.66^{bc}$ | $8.66^{bc}$ | $6.66^{b}$ | $5.66^{b}$ | $6.33^{b}$ | 8.66 | $5.66^{bc}$ | $5.33^{b}$ | $4.33^{bc}$ | $3.66^{bc}$ | $4.00^{bc}$ |
| $V_3T_1$ | 14.33 | $7.33^{cd}$ | $6.33^{cd}$ | $4.33^{c}$ | $3.66^{cd}$ | $4.00^{cd}$ | 8.33 | $4.33^{c}$ | $3.66^{cd}$ | $3.00^{c}$ | $2.33^{c}$ | $2.66^{c}$ |
| $V_3T_2$ | 15.33 | $8.66^{bc}$ | $7.66^{c}$ | $5.33^{bc}$ | $4.66^{bc}$ | $5.00^{c}$ | 8.66 | $5.00^{bc}$ | $4.66^{bc}$ | $3.66^{bc}$ | $3.00^{bc}$ | $3.33^{bc}$ |
| $V_3T_3$ | 16.66 | $10.33^{b}$ | $9.66^{b}$ | $7.00^{b}$ | $6.00^{b}$ | $6.66^{b}$ | 9.00 | $6.33^{b}$ | $5.66^{b}$ | $4.66^{b}$ | $4.00^{b}$ | $4.33^{b}$ |
| Control | 16.00 | $17.33^{a}$ | $18.66^{a}$ | $19.33^{a}$ | $20.66^{a}$ | $19.66^{a}$ | 7.66 | $8.33^{a}$ | $9.66^{a}$ | $10.66^{a}$ | $11.33^{a}$ | $11.00^{a}$ |
| Var. | | | | | | | | | | | | |
| P value | 0.592 | 0.254 | 0.653 | 0.693 | 0.777 | 0.814 | 0.103 | 0.065 | 0.023 | 0.183 | 0.803 | 0.716 |
| F value | 0.599 | 1.965 | 0.476 | 0.402 | 0.269 | 0.216 | 4.235 | 5.83 | 11.27 | 2.66 | 0.23 | 0.364 |
| Treatment | | | | | | | | | | | | |
| P value | 0.442 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.083 | 0.001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| F value | 0.941 | 22.830 | 48.864 | 71.050 | 98.195 | 87.122 | 2.607 | 9.05 | 21.09 | 32.63 | 37.99 | 53.401 |
| Var. X Treatment | | | | | | | | | | | | |
| P value | 0.839 | 0.671 | 0.377 | 0.056 | 0.016 | 0.137 | 0.144 | 0.85 | 0.97 | 0.97 | 0.80 | 0.162 |
| F value | 0.446 | 0.675 | 1.145 | 2.579 | 3.590 | 1.896 | 1.857 | 0.41 | 0.192 | 0.191 | 0.232 | 1.771 |

Data are mean of three replications

**Table 3:** Effect of different treatments on population of whitefly, *Bemisia tabaci* during *kharif*, 2020 and *spring-summer*, 2021

| *Treatments* | *Kharif, 2020* | | | | | | *Spring-summer, 2021* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Pre-count* | *Post treatment count* | | | | | *Pre-count* | *Post treatment count* | | | | |
| | | *1DAT* | *3DAT* | *5DAT* | *10DAT* | *15DAT* | | *1DAT* | *3DAT* | *5DAT* | *10DAT* | *15DAT* |
| $V_1T_1$ | 6.33 | $2.66^{d}$ | $1.66^{d}$ | $0.66^{d}$ | $1.00^{d}$ | $1.33^{d}$ | 4.66 | $2.00^{c}$ | $1.33^{d}$ | $0.33^{d}$ | $0.66^{d}$ | $1.00^{d}$ |
| $V_1T_2$ | 7.33 | $3.66^{d}$ | $2.66^{cd}$ | $1.66^{cd}$ | $2.00^{cd}$ | $2.33^{cd}$ | 5.33 | $2.66^{c}$ | $2.00^{cd}$ | $1.00^{d}$ | $1.33^{d}$ | $1.66^{d}$ |
| $V_1T_3$ | 9.33 | $5.66^{bc}$ | $4.66^{bc}$ | $3.00^{bc}$ | $3.33^{bc}$ | $3.66^{bc}$ | 7.00 | $4.33^{bc}$ | $3.33^{bc}$ | $2.33^{bc}$ | $2.66^{bc}$ | $3.00^{bc}$ |
| $V_2T_1$ | 6.66 | $3.33^{d}$ | $2.33^{d}$ | $1.00^{d}$ | $1.33^{d}$ | $1.66^{d}$ | 5.00 | $2.33^{c}$ | $1.66^{cd}$ | $0.66^{d}$ | $1.00^{d}$ | $1.33^{d}$ |
| $V_2T_2$ | 8.33 | $4.66^{cd}$ | $3.66^{c}$ | $2.33^{c}$ | $2.66^{c}$ | $3.00^{c}$ | 6.33 | $3.66^{bc}$ | $2.66^{c}$ | $1.66^{cd}$ | $2.00^{cd}$ | $2.33^{cd}$ |
| $V_2T_3$ | 9.66 | $6.33^{b}$ | $4.66^{bc}$ | $3.66^{bc}$ | $4.00^{bc}$ | $4.33^{bc}$ | 7.33 | $5.00^{b}$ | $3.66^{bc}$ | $2.66^{bc}$ | $3.00^{bc}$ | $3.33^{bc}$ |
| $V_3T_1$ | 8.00 | $4.33^{cd}$ | $3.33^{cd}$ | $2.00^{cd}$ | $2.33^{cd}$ | $2.66^{cd}$ | 5.66 | $3.00^{c}$ | $2.33^{cd}$ | $1.33^{cd}$ | $1.66^{cd}$ | $2.00^{cd}$ |
| $V_3T_2$ | 8.66 | $5.00^{c}$ | $4.33^{bc}$ | $2.66^{c}$ | $3.00^{c}$ | $3.33^{c}$ | 6.66 | $4.00^{bc}$ | $3.00^{bc}$ | $2.00^{c}$ | $2.33^{c}$ | $2.66^{c}$ |
| $V_3T_3$ | 10.00 | $6.66^{b}$ | $5.00^{b}$ | $4.00^{b}$ | $4.33^{b}$ | $4.66^{b}$ | 7.66 | $5.33^{b}$ | $4.00^{b}$ | $3.00^{b}$ | $3.33^{b}$ | $3.66^{b}$ |
| Control | 7.66 | $9.33^{a}$ | $10.66^{a}$ | $12.33^{a}$ | $13.33^{a}$ | $11.66^{a}$ | 6.00 | $7.66^{a}$ | $9.33^{a}$ | $11.00^{a}$ | $12.33^{a}$ | $11.66^{a}$ |
| Var. | | | | | | | | | | | | |
| P value | 0.473 | 0.684 | 0.619 | 0.771 | 0.459 | 0.282 | 0.315 | 0.104 | 0.536 | 0.099 | 0.403 | 0.963 |
| F value | 0.908 | 0.419 | 0.542 | 0.278 | 0.953 | 0.764 | 1.565 | 4.200 | 0.731 | 4.348 | 1.151 | 0.038 |
| Treatment | | | | | | | | | | | | |
| P value | 0.269 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.250 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| F value | 1.421 | 9.956 | 22.165 | 56.730 | 75.492 | 31.900 | 1.494 | 17.520 | 22.278 | 43.331 | 53.168 | 46.380 |
| Var. X Treatment | | | | | | | | | | | | |
| P value | 0.806 | 0.558 | 0.261 | 0.651 | 0.348 | 0.610 | 0.785 | 0.009 | 0.493 | 0.870 | 0.942 | 0.671 |
| F value | 0.492 | 0.836 | 1.420 | 0.703 | 1.206 | 0.760 | 0.521 | 4.604 | 0.937 | 0.398 | 0.275 | 0.070 |

Data are mean of three replications

1.00/3 leaves respectively) which was statistically on par with the treatment $V_1T_2$ (2.66, 1.66, 1.00 and 1.33/3 leaves respectively) and was significantly different from $V_2T_1$ (3.00, 2.33, 1.66 and 2.00/3 leaves respectively), $V_3T_1$ (3.66, 3.00, 2.33 and 2.66/3 leaves respectively), $V_2T_2$ (4.00, 3.33, 2.66 and 3.00/3 leaves respectively), $V_3T_2$ (4.66, 3.66, 3.00 and 3.33/3 leaves respectively), $V_1T_3$ (5.00, 4.00, 3.33 and 3.66/3 leaves respectively) and $V_2T_3$ (5.33, 4.33, 3.66 and 4.00 /3 leaves respectively). No significant variation was found among the $V_1T_3$, $V_2T_1$ and $V_3T_2$ at 3,5,10 and 15 DAT. The $V_3T_3$ recorded a minimal reduction in the jassid population (5.66, 4.66, 4.00 and 4.33/3 leaves respectively). It was observed that in all treatments, there was a slight increase in the jassid population at 15 DAT. In the control, the population gradually increased from 1 to 10 DAT, followed by a slight natural reduction at 15 DAT.

The interaction effect of both variety and treatment has a significant effect at 10 DAT. The insecticidal treatments play a major role in the reduction of the jassid population during *kharif*. The combined effect of variety and treatment was not significant but individually the insecticidal treatments had a significant effect on the population reduction of jassid during *spring-summer*.

### *Effect of different insecticidal treatments on whitefly population during Kharif, 2020 and spring-summer, 2021 (Table 3)*

The incidence of whiteflies prior to the treatment did not vary significantly in both seasons. The whitefly population ranged from 6.33 to 10.00 /3 leaves during *Kharif* and 4.66 to 7.66 /3 leaves during *spring-summer*. All the treatments were found effective over control in reducing the whitefly population at 1, 3, 5, 10, and 15 DAT. The population of the whitefly was recorded at least on 5 DAT and later it started increasing slowly with time.

*One, three, five, ten and fifteen days after treatment during Kharif, 2020*

At 1, 3 and 5 DAT, $V_1T_1$ showed the highest reduction in whitefly population (2.66, 1.66 and 0.66/3 leaves respectively) which was at par with treatments $V_1T_2$ and $V_2T_1$ (3.66 and 3.33/3 leaves respectively) at 1 DAT and in $V_2T_1$ at 3 and 5 DAT (2.33 and 1.00/3 leaves respectively). Among the remaining treatments lowest whitefly population was recorded at $V_1T_2$ (3.66, 2.66 and 1.66/3 leaves respectively) followed by $V_3T_1$ (4.33, 3.33 and 2.00/3 leaves respectively), $V_2T_2$ (4.66, 3.66 and 2.33/3 leaves respectively), $V_3T_2$ (5.00, 4.33

and 2.00/3 leaves respectively), $V_1T_3$ (5.66, 4.66 and 3.00/3 leaves respectively) and $V_2T_3$ (6.33, 4.66 and 3.66/3 leaves respectively) at 1, 3 and 5 DAT. The minimum reduction in the number of whiteflies was observed with treatment $V_3T_3$ (6.66, 5.00 and 4.00/3 leaves respectively) which was statistically at par with treatment $V_2T_3$ (6.33/3 leaves) at 1 DAT and significantly different from other treatments on 3 and 5 DAT. The population of whiteflies increased in control and reached 12.33/3 leaves at 5DAT.

The population of whiteflies started increasing from 10 DAT onwards. At 10 and 15 DAT, $V_1T_1$ registered the highest reduction in whitefly population (1.00 and 1.33/3 leaves respectively) which was statistically similar to $V_2T_1$ (1.33 and 1.66/3 leaves respectively) followed by $V_1T_2$ (2.00 and 2.33/3 leaves respectively), $V_3T_1$ (2.33 and 2.66/3 leaves respectively), $V_2T_2$ (2.66 and 3.00/3 leaves respectively), $V_3T_2$ (3.00 and 3.33/3 leaves respectively), $V_1T_3$ (3.33 and 3.66/3 leaves respectively) and $V_2T_3$(4.00 and 4.33/3 leaves respectively).

The minimum reduction in the population of whiteflies was observed in treatment $V_3T_3$ (4.33 and 4.66/3 leaves respectively) which are significantly higher than the control (13.33 and 11.66/3 leaves respectively). The natural reduction of whitefly number in control plots might be due to a decrease in temperature.

The variety and interaction of variety and treatment had no significant effect on the population of whiteflies but individually the insecticidal treatments had a significant effect on the reduction of the number of whiteflies.

*One, three, five, ten and fifteen days after treatment during spring-summer, 2021*

Similar results were also observed during *spring-summer*, 2021. At 1 and 3 DAT, the population of whitefly was found lowest in $V_1T_1$ (2.00 and 1.33/3 leaves respectively) which was not significantly different from $V_3T_1$, $V_1T_2$, and $V_2T_1$ (3.00, 2.66, and 2.33/3 leaves respectively) at 1 DAT. The $V_1T_1$ (1.33 nos./3 leaves) also resulted in the highest reduction of whitefly at 3 DAT which was significantly different from other treatments. There was no statistical difference among the treatments $V_1T_3$ (4.33/3 leaves), $V_3T_2$ (4.00/3 leaves) and $V_2T_2$ (3.66/3 leaves) in respect of the whitefly population at 1 DAT.

At 3 DAT the maximum whitefly population reduction was observed in $V_1T_1$, which was followed by $V_2T_1$ (1.66/3 leaves) and was statistically at par with $V_1T_2$, $V_3T_1$ (2.00 and 2.33/3 leaves respectively). Similarly, there was no significant difference among the treatments $V_2T_3$, $V_1T_3$ and $V_3T_2$ (3.66, 3.33 and 3.00/3 leaves respectively).

The treatment $V_1T_1$ (0.33, 0.66 and 1.00/3 leaves respectively) also registered the lowest whitefly population at 5, 10 and 15 DAT which were statistically not different from $V_2T_1$ (0.66, 1.00 and 1.33 respectively) and $V_1T_2$ (1.00, 1.33 and 1.66/3 leaves respectively) at 5, 10 and 15 DAT. There was no statistical difference among the treatments $V_1T_3$ (2.33, 2.66 and 3.00/3 leaves respectively), $V_2T_3$ (2.66, 3.00 and 3.33/3 leaves respectively) and were statistically at par with $V_3T_1$ (1.33, 1.66 and 2.00/3 leaves respectively) and $V_2T_2$ (1.66, 2.00 and 2.33/3leaves respectively) at 5, 10 and 15 DAT. The treatment $V_3T_2$, recorded 2.00, 2.33 and 2.66 numbers of whitefly per three leaves at 5, 10 and 15 DAT and was significantly higher than $V_3T_3$ (3.00, 3.33 and 3.66/3 leaves respectively) and control (12.33 and 11.66/3 leaves respectively) and significantly lower than the other treatments.

At 1, 3, 5, 10 and 15 DAT, $V_3T_3$ (5.33, 4.00, 3.00, 3.33 and 3.66/3 leaves respectively) registered the lowest reduction of whitefly population in comparison with other treatments and significantly higher than control (7.66, 9.33, 11.00, 12.33 and 11.66/3 leaves respectively).

The population of whiteflies was influenced only by the individual effect of treatments whereas, the individual effect of variety and combined effect of variety X treatment had no significant impact on reduction of the whitefly population.

## Discussion

The insect pest population was found increasing in control plots. Chlorantraniliprole 18.5%SC @ 25gm *a.i.*/ha was found to be the most effective and the best insecticide in pest management and variety Arka among all the varieties. All the insect pest population except jassid was found to decrease up to 5 DAT during both seasons and were later found to be increasing slowly in all the insecticidal treatments. The jassid population showed a decreasing trend up to 10 DAT and then started increasing slowly. The insecticides emamectin benzoate 5% SG @ 8.5gm *a.i.*/ha and lambda-cyhalothrin 5% EC @ 15gm *a.i.*/ha were also found significantly effective in comparison to control.

The notable decline in population can be attributed to the application of chlorantraniliprole 18.5% SC @ 25gm *a.i.*/ha and this may be because of the specific mode of action associated with this insecticide. These findings are in line with Rahman *et al*. 2015 and Saini and Yadav 2022 where the Arka Anamika variety demonstrated superiority among the varieties tested. Arka Anamika exhibited fewer issues with insect pests and gave higher fruit yield. Further, the research conducted by Yadav *et al*. 2020 substantiates the current study, indicating that Chlorantraniliprole 18.5% SC at a rate of 25 gm *a.i.*/ha is the most effective method for whitefly management.

Potai *et al*. 2018 also identified Chlorantraniliprole 18.5% SC @ 25 gm *a.i.*/ha as an effective treatment for managing sucking pests which also corroborates the present findings. A study conducted by Rohit *et al*. 2020 also concluded that Chlorantraniliprole 18.5% SC is the most effective method for controlling sucking pests after Thiamethoxam 25% WG. These multiple instances of confluence between the present findings and prior research demonstrate the consistent efficacy of Chlorantraniliprole 18.5% SC in pest management across different studies.

## Acknowledgments

The author was not funded by any organization to disclose.

## Statements and Declarations

No potential conflict of interest was reported by the authors. No specific grant was given to this research work by any funding organizations in the public, private, or not-for-profit sectors.

## Reference

Anonymous. 2018. Horticultural statistics at a glance. National Horticulture Board, Ministry of Agriculture and Farmers Welfare, Government of India, pp. 1-514.

Anonymous. 2019. Package of practices for horticultural crops of Assam. Assam Agricultural University, Jorhat, pp. 49.

Anonymous. 2020-2021. Press Information Bureau, Ministry of Agriculture and Farmers Welfare, Government of India.

Berwa R., Sharma A.K., Pachori R., Shukla A., Aarwe R. and Bhowmik P. 2017. Efficacy of chemical and botanical insecticides against sucking insect pest complex on okra (*Abelmoschus esculentus* L. Moench). *J. Entomol. Zool. Stud.*, **5**: 693-1697.

Jain D., Kumar H., Chouhan B.S., Singh B. and Sumeriya H. 2021. Comparative efficacy of different bio and synthetic insecticides against sucking pests of okra (*Abelmoschus esculentus* L. Moench). *Pharma Innov. J.*, **10**: 719-727.

Patil S.R., Lande G.K., Awasthi N.S. and Barkhade U.P. 2014. Effect of different doses of newer insecticides against sucking pests of okra. *The Bioscan*, **9**: 1597-1600.

Potai A., Chandrakar G. and Bhuarya N.S. 2018. Effect of different doses of newer insecticides against sucking pests of okra. *J. Pharmacogn. Phytochem.*, **7**: 1177-1179.

Rahman M.A., Uddin M.M., Haque M.A. and Rahman M.M. 2015. Varietal preference of okra shoot and fruit borer, Earias vittella (Fab.) under field condition in Bangladesh. *Acad. Res. J. Agric. Sci. Res.*, **3**: 8-12.

Rohit S.K., Painkra K.L., Painkra G.P. and Bhagat P.K. 2020. Evaluation of new promising pesticides for the management of sucking pests in winter okra crop. *J. Entomol. Zool. Stud.*, 8: 1176-1180.

Saini D. and Yadav S.K. 2022. Screening of different okra [*Abelmoschus esculentus* (L.) Moench] varieties against major sucking pests. *Int. J. Agric. Sci.*, **7**: 211-221.

Sarkar S., Patra S. and Samanta A. 2016. Efficacy of different bio-pesticides against sucking pests of okra (*Abelmoschus esculentus* L. Moench). *J. Appl. Nat. Sci.*, **8**: 333-339.

Subbireddy K.B., Patel H.P., Patel N.B. and Bharpoda T.M. 2018. Utilization of ready-mix insecticides for managing fruit borers in okra [*Abelmoschus esculentus* (L.) Moench]. *J. Entomol. Zool. Stud.*, **6**: 1808-1811.

Thorat S.S., Kumar S. and Patel J.D. 2020. Bio efficacy of different pesticides against whitefly (*Bemisia tabaci* Gennadius) in tomato. *J. Entomol. Zool. Stud.*, **8**: 1428-1431.

Yadav N., Uchware V. and Jain P. 2020. Bio-efficacy of insecticides against okra whitefly (*Bemisia tabaci*) in Malwa region of Madhya Pradesh. *J. Entomol. Zool. Stud.*, **8**: 481-483.