# Comparative Study on Key Pest and Okra Enation Leaf Curl Virus (OELCV) Management in Okra

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***Abstract***

*The key pests of okra are whiteflies, jassids and shoot and fruit borer. The sucking pest, Sweet potato whitefly, Bemisia tabaci causes damage directly through feeding and indirectly by the transmission of viruses. The whitefly B. tabaci transmitted Okra enation leaf curl virus (OELCV) incidence has reached serious proportions in recent years. The comparative field study results revealed that, both 30 and 60 days after sowing (DAS) okra accessions Upl mona 2 and Co 1 recorded the lowest mean population of whiteflies and leaf hoppers under the IPM adopted plot and farmers practice adopted plot, whereas the highest mean population of whiteflies and leaf hoppers was recorded in AE 64 and AE 65 under both the conditions. The shoot and fruit borer damage in the IPM and farmers practice adopted plots with the lowest fruit damage being on Co1 (10 %) under IPM condition. The highest mean population of coccinellids and spiders were recorded under IPM condition. In the IPM adopted plots, both at 30 DAS and 60 DAS, the accession Upl mona 2 did not show any signs of OELCV and BYVMV infections and were immune in reaction (0% PDI) and Upl mona 2 recorded the maximum yield (6058 kg/ha). At 60 DAS, the Co 1 plants registered 20 and 40% incidence of OELCV under IPM and farmers practice, respectively.*

***Keywords :*** *Okra, Key pest, IPM, Farmer's practice*

## Introduction

India ranks first in the world in okra/bhendi/ladies' finger [Abelmoschus esculentus (L.) Moench] production with an annual yield of 5.853 mt from an area of 0.507 mha (Anonymous, 2015). Okra is an important source of vitamins, calcium, potassium, and other minerals, which are often lacking in the diet of the people in developing countries. It's medicinal value has also been

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reported to cure ulcers and to relieve hemorrhoids. Okra has been found in medical application as a plasma replacement or blood volume expander and also useful in genito-urinary disorders, spermatorrhoea and chronic dysentery (Singh et al., 2014). The crop is prone to damage by various insects, fungi, nematodes, and viruses, although there is wide variability in their degree of infestation. The production and quality of okra fruits are affected by an array of sucking and fruit boring pests from the seedling phase until harvest. The key sucking insect pests of okra are whiteflies, aphids, jassids, thrips and mites (Anitha and Nandihalli, 2008). The B. tabaci acts as a vector (De Barro et al., 2011) that transmits begomoviruses, which includes more than 200 species (Fauquet et al., 2008), and causes severe damage and yield losses to crops. The whitefly B. tabaci transmitted Okra enation leaf curl virus (OELCV) incidence has reached serious proportions in recent years both in Northern India (Sanwal et al., 2016) and Southern India as well (Sayed et al., 2014). The present study aims to develop possible integrated pest management of the disease incidence to save production and productivity of Okra.

## Materials and Methods

The field experiment was conducted during February 2019 at Attur (Latitude and Longitude: 11.598116, 78.596802), Salem district of Tamil Nadu. Different resistance response genotypes viz., resistant accession Upl mona 2, moderately resistant accession Co1 and susceptible accessions AE 64 and AE 65 were sown with a spacing of 45 X 30 cm. The crop was raised as per the recommended package of practices and was without plant protection measures. A factorial randomized block design was used to impose the treatments. The observation was recorded once at vegetative (30 days after sowing, DAS) and second at flowering (60 DAS) stages. Fruit yield was also recorded. The data were subjected to statistical analysis.

## TNAU IPM Module (Factor 1)

- Application of neem cake @ 250 kg/ha before sowing
- Trichoderma viridae @ 4g or Pseudomonas fluorescens @ 10g/kg of seeds
- Correct spacing and paired row system
- Removal of Abutilon indicum and Hibiscus ficulensus for whitefly, Bemisia tabaci
- Hand picking and destruction of lepidopteran eggs and larvae
- Erecting bird perches
- Conservation of coccinellids and spiders

- ☞ Spraying of botanicals like neem seed kernel extract (NSKE) @ 5%, 30 and 60 DAS
- ☞ Yellow sticky traps @ 50/ha
- ☞ Application of chemical insecticide whenever the pest reaches alarming stage and insecticidal spray was given

## Farmer's practice (Factor 2)

- ☞ Phosalone 35 EC @ 2.5 l/ha
- ☞ Quinalphos 25 EC @ 2.0 l/ha
- ☞ Triazophos 40 EC @ 2.0 l/ha
- ☞ Dimethoate 30 % EC @ 1.0 ml/lit
- ☞ Malathion 50 % EC @ 1.5 ml/ lit
- ☞ Oxydemeton –Methyl 25 % EC @ 1.0 ml/ lit
- ☞ Thiamethoxam 25 % WG @ 4.0 ml/10 lit

## Statistical analysis

Data from field experiments were analyzed by using a one-way analysis of variance (ANOVA) (SAS Institute, 1985). The data on percentages were transformed with arcsine values and the population numbers into x + 0.5 before statistical analysis. The Means in a column followed by the same letter are not significantly different (a = 0.05) by Tukey's HSD test.

## Results and Discussion

The results of the field trial conducted at Attur, Salem district of Tamil Nadu to assess the interaction of plant resistance and IPM strategies to contain OELCV incidence vectored by *B. tabaci* are discussed here:

## Whitefly population

Both at 30 and 60 days after sowing (DAS) okra accessions Upl mona 2 and Co 1 recorded the lowest mean population of whiteflies under the IPM adopted plot and farmers practice adopted plot, whereas the highest mean population of whiteflies was recorded in AE 64 and AE 65 under both the conditions (Table 1).

Hilje et al. (2001) reported that cultural practices could play a significant role in IPM systems targeting whiteflies, because of their preventative nature and practices such as crop-free periods, altering planting dates, crop rotation, and weed and crop residue disposal had performed well. Mohankumar et al. (2016) reported that "okra IPM package" had recorded significantly less quantum of pests such as aphids, whiteflies, etc., and incidence of fruit borer and occurrence of BYVMV and powdery mildew, while there was an enormous increase in shoot and root growth, increased populations of natural enemies when compared to the farmer's practice that used only conventional pesticides. The reported yield increase in IPM experimental plots was 12.43-45.54% over and above the farmers practice that had offered the benefit cost ratio of 2.53-3.23:1 in the IPM plots when compared to 1.23-1.52 in t farmer's practices plots.

## Leafhopper population

In the IPM adopted plot, okra accessions Co1 (2.11, 1.67) and Upl mona 2 (4.22, 3.22) recorded the lowest mean population of leafhopper both at 30 and 60 DAS observations. Whereas AE 64 (4.22, 3.55) and AE 65 (5.67, 4.22) recorded the highest mean population of leafhopper both 30 and 60 days observation and a similar trend was noticed with the farmers practice adopted plot (Table 1). Bhutto et al. (2017) evaluated the different IPM treatments on okra. The pest population of jassid, aphid and whitefly decreased gradually after each spray except control treatment in the different IPM intervention plots.

## Shoot and fruit borer infestation

There was a varying degree of infestation of shoot and fruit borer damage in the IPM, and farmers practice adopted plots with the lowest fruit damage being on Co1 under IPM condition (Table 2).

Javed et al. (2019) reported the minimum shoot and fruit infestations in IPM module while in farmers' routine module it was greater during 2016. Similarly, in 2017, mean shoot and fruit infestations in IPM module, farmers' routine module and control module were 7.62, 14.19 and 19.52%, and 4.58, 11.07 and 18.16%, respectively. Likewise, 1.33- and 2.75-fold higher yields of marketable okra fruits were recorded for IPM module respectively than farmer's routine module and control module.

## Natural enemies' population

## Coccinellids

The mean population of coccinellids differed significantly among the okra accessions under IPM and farmers practice conditions. At thirty days after sowing, IPM adopted plot okra accessions Co 1 (2.00), Upl mona 2 (1.33) AE 64 (1.22) and AE 65 (1.00) recorded the greater mean population of coccinellids. Whereas, farmers practice adopted plot okra accessions Co 1

(1.22), Upl mona 2 (0.89), AE 64 (0.78) and AE 65 (0.56) recorded the lowest mean population of coccinellids (Table 3). Aziz and Khoso, (2019) studied the genotypes of okra sown separately and sprayed with Neem Seed Extract against whitefly, jassid, aphid, and borer and found that the predator population was comparatively higher 2.26, 1.64 and 1.76/plant on Rama Krishna, Rani and Anamika okra varieties. The population of predators was not affected significantly by application of 2 per cent of neem seed extract because predators are not phytophagous like other pests.

## Spiders

The mean population of spiders differed significantly among the okra accessions and treatment plot conditions. A similar trend as that of the coccinellid population was noticed in spider population also (Table 3).

## OELCV incidence

In the IPM adopted plots, both at 30 DAS and 60 DAS, the accession Upl mona 2 did not show any signs of OELCV and BYVMV infections and were immune in reaction (0% PDI). At 60 DAS, the Co 1 plants registered 20 and 40% incidence of OELCV under IPM and farmers practice, respectively. The highest OELCV PDI was recorded on AE 64 (80) and AE 65 (90). Whereas, in the farmers practice adopted plot Upl mona 2, Co1, AE 64 and AE 65 recorded the PDI of 0, 40, 100 and 100 respectively at 60 days interval. But, in contradiction to their reaction for OELCV incidence, the test accessions did not show any signs of BYVMV infections and were immune in reaction (0% PDI) (Table 4).

## Fruit yield

Results obtained from the IPM adopted plot yield of okra during 2019 clearly indicated that there was a decrease in the yield as the increase of pest population, OELCV incidence and decrease in natural enemies. Significantly the highest yield was recorded by the immune accession Upl Mona 2 (6058 Kg/ha) and was followed by Co 1 (5718 Kg/ha). The highly susceptible accessions, AE 65 (2261 Kg/ha) and AE 64 (2569 Kg/ha) Significantly recorded the lowest yield. Whereas, farmers practice adopted plot the okra accession Upl mona 2 exhibited immune reaction to OELCV, the accessions Co 1 showed moderately resistant reaction and AE 64 and AE 65 showed highly susceptible reaction and the recorded yield was 4475, 4324, 1677 and 1733 kg/ha respectively (Table 4).

Praveen and Dhandapani (2001) evaluated the effectiveness of different biocontrol agents against the major pests of okra in Coimbatore, Tamil Nadu, India and found that release of Chrysoperla carnea (25,000 larvae/ha/release) + Econeem 0.3% (0.5 l/ha) spray for three times at an interval of 15d starting from 45d after sowing to be effective in reducing the sucking pests and fruit borer populations. The fruit yield reported (10,326 kg/ha) and the cost benefit ratio (CBR) (1:2.60) arrived were higher in C. cornea and Econeem 0.3% treated plots when compared to either C. carnea alone or Econeem 0.3% alone were used. Altieri (1990) opinioned that a diversified agroecosystem should support different types of natural enemies and thereby naturally reduce the pest population. The ladybird beetles *Coccinella septempunctata and Menochilus sexmaculata* were present on okra crops (Meena et al., 2010 and Vasconcelos et al., 2008). The *Cheilomenes sexmaculatus and Chrysoperla carneafeed* on leafhoppers on okra ecosystem (Yadav et al., 2009). Wagan and Wagan, (2015) recorded natural enemies such as spider, lady bird beetle, ant, and Crysopa spp. that were associated with the jassids population on okra crop. These agents would suppress the pest population when a favourable niche is found for their perpetuation.

## Conclusion

The accessions Upl mona 2 and Co 1 recorded an improved performance against key pest and with less reaction to OELCV incidence under IPM condition. For effective management of okra pest, further research on management strategies may be identified involving more importance to alternate methods in pest management. Host plant resistance is a major, often preventative measure for managing pest (Chu et al., 2001; Thomas et al., 2014; Khan et al., 2015). Therefore, a comprehensive, integrated pest management and insecticide resistance management strategies, rotation of conventional insecticides with novel molecules including insect growth regulator (IGR) compounds, use of sticky traps and exploitation of native biological control agents shall sustain the management of okra pest.

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**Table 1. Performance of different accessions of okra under IPM and farmers practice against whitefly and leafhopper under field condition - Season I (February, 2019)**

| **Factor 1: IPM Plot** | | | | |
|---|---|---|---|---|
| Accession | Pest (No./Leaf) | | | |
| | Whitefly | | Leafhopper | |
| | 30 DAS | 60 DAS | 30 DAS | 60 DAS |
| Co 1 | 4.20 (2.05)b | 2.89 (1.65)ab | 2.11 (1.45)a | 1.67 (1.29)a |
| Upl mona 2 | 2.27 (1.51)a | 1.11 (1.10)a | 4.22 (2.05)b | 3.22 (1.79)b |
| AE 64 | 7.04 (2.64)c | 7.11 (2.38)b | 4.22 (2.05)b | 3.55 (1.88)bc |
| AE 65 | 8.18 (2.84)c | 7.33 (2.45)b | 5.67 (2.38)c | 4.22 (2.05)c |
| SEd | 0.1914 | 0.3830 | 0.0958 | 0.0726 |
| CD(.05) | 0.4683 | 0.9373 | 0.2345 | 0.1777 |
| **Factor 2: Non-IPM Plot** | | | | |
| Co 1 | 7.27 (2.68)ab | 7.11 (2.66)b | 3.89 (1.97)a | 3.22 (1.79)a |
| Upl mona 2 | 4.02 (2.00)a | 3.78 (1.94)a | 5.67 (2.38)b | 4.56 (2.13)b |
| AE 64 | 7.42 (2.70)ab | 7.00 (2.64)b | 6.00 (2.45)b | 4.89 (2.21)bc |
| AE 65 | 11.93 (3.44)b | 9.22 (3.03)c | 7.33 (2.71)c | 5.67 (2.38)c |
| SEd | 0.3119 | 0.1080 | 0.0769 | 0.0848 |
| CD(.05) | 0.7632 | 0.2643 | 0.1881 | 0.2076 |

* Mean of five replications

* Values in parentheses are square root transformed

**Table 2. Performance of different accessions of okra under IPM and farmers practice against shoot and fruit borer under field condition at 60 Days After Sowing - Season I (February 2019)**

| **Factor 1: IPM Plot** | |
|---|---|
| Accessions | Damage percentage of shoot and fruit borer |
| Co 1 | 10.00 (18.43)[a] |
| Upl mona 2 | 33.33 (35.00)[b] |
| AE 64 | 16.67 (23.85)[a] |
| AE 65 | 13.33 (21.14)[a] |
| SEd | 4.3251 |
| CD(.05) | 10.5837 |
| **Factor 2: Non-IPM Plot** | |
| Co 1 | 23.33 (28.77)[a] |
| Upl mona 2 | 43.33 (41.15)[b] |
| AE 64 | 40.00 (39.14)[b] |
| AE 65 | 36.67 (37.14)[b] |
| SEd | 3.2959 |
| CD(.05) | 8.0650 |

* Mean of three replications; * Values in parentheses are arcsine transformed

**Table 3. Performance of different accessions of okra under IPM and farmers practice against predators under field condition - Season I (February 2019)**

| Factor 1: IPM Plot | | | | |
|---|---|---|---|---|
| Okra accession | Predators | | | |
| | Lady bird beetle | | Spiders | |
| | 30 DAS | 60 DAS | 30 DAS | 60 DAS |
| Co 1 | 2.00 (1.41) [a] | 1.33 (1.15) [a] | 1.11 (1.05) [a] | 1.22 (1.10) [a] |
| Upl mona 2 | 1.33 (1.15) [b] | 1.11 (1.05) [a] | 1.00 (0.99) [a] | 1.00 (1.00) [a] |
| AE 64 | 1.22 (1.10) [bc] | 1.00 (1.00) [a] | 0.67 (0.82) [b] | 0.89 (0.94) [a] |
| AE 65 | 1.00 (1.00) [c] | 0.56 (0.74) [b] | 0.56 (0.74) [b] | 0.56 (0.74) [b] |
| SEd | 0.0508 | 0.0795 | 0.0699 | 0.0771 |
| CD(.05) | 0.1243 | 0.1946 | 0.1710 | 0.1886 |
| **Factor 2: Non-IPM Plot** | | | | |
| Co 1 | 1.22 | 1.33 | 1.22 | 1.22 |
| | (1.10) [a] | (1.15) [a] | (1.10) [a] | (1.10) [a] |
| Upl mona 2 | 0.89 | 1.11 | 1.00 | 0.89 |
| | (0.94) [ab] | (1.05) [a] | (1.00) [a] | (0.94) [ab] |
| AE 64 | 0.78 | 1.00 | 0.89 | 0.33 |
| | (0.88) [ab] | (1.00) [a] | (0.94) [a] | (0.57) [c] |
| AE 65 | 0.56 | 0.67 | 0.56 | 0.78 |
| | (0.74) [b] | (0.82) [b] | (0.74) [b] | (0.88) [b] |
| SEd | 0.0494 | 0.0695 | 0.0800 | 0.0786 |
| CD(.05) | 0.1210 | 0.1700 | 0.1957 | 0.1924 |

* Mean of three replications

* Values in parentheses are square root transformed

## Table 4. Yield performance of different accessions of okra under IPM and farmers practice against OELCV under field condition - Season I (February 2019)

| Factor 1: IPM Plot | | | | | | | |
|---|---|---|---|---|---|---|---|
| Okra accession | 30 DAS | | | 60 DAS | | | Marketa-ble Yield (Kg /ha) |
| | Percent Disease Incidence | Disease Severity Range (%) | Reaction | Percent Disease Incidence | Disease Severity Range (%) | Reaction | |
| Co 1 | 10 | 1-10 | Highly resistant | 20 | 11-25 | MR | 5718 [b] |
| Upl mona 2 | 0 | 0 | Immune | 0 | 0 | Immune | 6058 [a] |
| AE 64 | 60 | 51-60 | MS | 80 | 71-100 | HS | 2569 [c] |
| AE 65 | 70 | 61-70 | S | 90 | 71-100 | HS | 2261 [d] |
| SEd | | | | | | | 19.63 |
| CD(.05) | | | | | | | 42.77 |
| | **Factor 2 : Non - IPM Plot** | | | | | | |
| Co 1 | 20 | 11-25 | MR | 40 | 26-50 | Tolerant | 4324 [b] |
| Upl mona 2 | 0 | 0 | Immune | 0 | 0 | Immune | 4475 [a] |
| AE 64 | 90 | 71-100 | HS | 100 | 71-100 | HS | 1677 [d] |
| AE 65 | 100 | 71-100 | HS | 100 | 71-100 | HS | 1733 [c] |
| SEd | | | | | | | 15.11 |
| CD(.05) | | | | | | | 32.94 |

* MR- Moderately Resistant; MS- Moderately Susceptible; S- Susceptible; HS- Highly Susceptible