Int.J.Curr.Microbiol.App.Sci (2021) *10*(03): 516-526

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 10 Number 03 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1003.068

Screening of Okra Genotypes for Shoot and Fruit Borer, Yellow Vein Mosaic Virus Disease and Enation Leaf Curl Virus Disease Over Environments

A. A. Patel[1*], A. I. Patel[2], R. D. Vekariya[1], H. I. Damor[3], H. R. Patel[1] and N. K. Berani[4]

[1]Department of Genetics and Plant Breeding, [4]Department of Agricultural Entomology, NMCA, NAU, Navsari, India
[2]Department of Vegetable Science, ACHF, NAU, Navsari, India
[3]Department of Genetics and Plant Breeding, BACA, AAU, Anand, India

**Corresponding author*

Keywords

Okra, Shoot and fruit borer, YVMV, ELCV, Environments

Article Info

Accepted:
07 February 2021
Available Online:
10 March 2021

A B S T R A C T

Screening of okra genotypes was carried out under four different environments for shoot and fruit borer, yellow vein mosaic virus disease and enation leaf curl virus disease. The genotypes responded differently to different environments against different insect-pests and diseases. None of the genotype was found free from shoot and fruit borer infection, YVMV and ELCV incidence. However the genotypes that were found with some degree of resistance might be used for future breeding programmes.

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench], a popular vegetable crop is grown in the tropical, sub-tropical low altitude regions of Asia, Africa, America and temperate regions of the Mediterranean basin. India is a major okra producing country in the world comprising of 72 per cent of total area under okra (Anonymous, 2017). In India, okra is commercially grown in the states of Gujarat, Maharashtra, Andhra Pradesh, Uttar Pradesh, Tamil Nadu, Karnataka, Haryana and Punjab as a *kharif* as well as summer season crop. It is cultivated in the area of 511 ('000 ha) with the annual production of 62.19 lakh tonne and productivity of 12.17 MT/ha (Anonymous, 2019). Okra is an important annual fruit vegetable grown for its immature green non fibrous edible fruits. The immature green fruits of okra contain 89.6% moisture, 6.4% carbohydrates, 1.9% protein, 1.2% fiber, 66 mg/100g calcium, 103 mg/100g potassium, 88 IU/100g vitamin-A and 13 mg/100g ascorbic

acid (Abusaleha and Shanmugavelu, 1988 and Malik *et al.,* 1985). Okra can be completed within short time span due to its fast growth, short duration and photo-insensitive nature which enables farmers to raise two crops in a year. Because of high nutritive value and prolonged shelf life as compared to other vegetables, okra has captured a prominent position among export oriented vegetable crops. It is being exported to Middle East countries, Western Europe and USA. Cultivation of low yielding varieties, lack of varieties/hybrids with high degree of resistance to pests and diseases like fruit and shoot borer, okra yellow vein mosaic virus (YVMV) and enation leaf curl virus (ELCV) are the major reasons of low productivity in India. The biotic stresses like shoot and fruit borer, YVMV and ELCV are the major ones that affect fruit yield in okra. Several insect pests have so far been recorded to attack on okra crop like okra shoot and fruit borer (OSFB), jassid, aphid, whitefly and cotton leaf roller. Among these pests, OSFB (*Earias* sp.) is considered as the most important one (Aziz *et al.,* 2011) which causes both quantitative and qualitative loss of the okra crop (Butani and Jotwani, 1984). *Earias* sp. alone causes damage up to 71 % (Pareek and Bhargava, 2003). The larvae damage to the crop in two ways. Firstly larvae bore into growing shoots and move down by making tunnels inside. As a result, the shoots droop downward or dry up (Atwal and Singh 1990). Secondly, the larvae enter the fruits by making holes, rendering them unfit for human consumption.

Among the various biotic diseases yellow vein mosaic virus causes substantial yield losses. In a study, it was found that the infection rate has reached up to 100 % and field yield loss ranges between 50 % and 94 % (Ali *et al.,* 2012). The disease is characterized by a homogenous knotted, yellow veins and yellowish or creamy color of green leaf, stunted plant growth and bear very few deformed small fruits (Ali *et al.,* 2005, 2012). This YVMV disease of okra spread in the humid and heavy rainfall areas and is transmitted by a vector whitefly (*Bemisia tabaci* Gen.) belonging to genus begomovirus and family of geminivireadea (Chakraborty *et al.,* 1999). ELCV disease causes yield loss between 80 % and 90 % (Singh, 1996). The natural transmission of the disease occurs through whitefly (Venkataravanappa *et al.,* 2015). The important symptoms of this disease are curling of leaves in an adaxial direction, and mild or bold enations on the under surface of the leaves which become thick and deformed. The other characteristic symptoms are twisting of the main stem, lateral branches and leaf petiole. In case of heavy infection, the plant growth is retarded. Fruits from infected plants are small and deformed and unfit for marketing. Thus, present investigation was carried out to screen okra genotypes resistant to shoot and fruit borer, YVMV and ELCV disease.

Materials and Methods

The evaluation of 35 genotypes of okra comprising six lines *viz*., GAO-5, GO-6, AOL-16-04, NOL 17-05, NOL 17-06, NOL 17-09 and four testers *viz*., Arka Anamika, Arka Abhay, Kashi Kranti and Parbhani Kranti), their 24 hybrids and one commercial check 'OH-102' was carried out at College farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari. The experimental material was laid out in a complete randomized lock design (RBD) with three replications over four environments created by four dates of sowing *viz.*, E_1: summer (14/2/2019), E_2: late summer (14/03/2019), E_3: *kharif* (20/06/2019) and E_4: late *kharif* (22/07/2019). Each entry was presented by a single-row plot of ten plants, spaced at 45 x 30 cm during summer and 60 x 30 cm during *kharif*.

For shoot borer, total number of shoots damaged from total number of plants in each treatment was counted and expressed in percentage after 45 days of sowing using following formula:

$$\text{Shoot borer infestation (\%)} = \frac{\text{Number of plants infected by shoot borer}}{\text{Total number of plants}} \times 100$$

For fruit borer, number of fruits damaged from total number of fruits in each treatment was counted and expressed in percentage after 45 days of sowing using the following formula:

$$\text{Fruit borer infestation (\%)} = \frac{\text{Number of fruits infected by fruit borer}}{\text{Total number of fruits}} \times 100$$

For YVMV, at final harvest stage, number of plants affected in each treatment was counted and expressed in percentage by using the following formula.

$$\text{YVMV incidence (\%)} = \frac{\text{Number of plants infected by YVMV}}{\text{Total number of plants}} \times 100$$

For ELCV, at final harvest stage, number of plants affected in each plot was counted and expressed in percentage by using the following formula:

$$\text{ELCV incidence (\%)} = \frac{\text{Number of plants infected by ELCV}}{\text{Total number of plants}} \times 100$$

Results and Discussion

Among the parents, shoot borer incidence intensity was ranged between 23.33 % (Kashi Kranti) to 36.67 % (Parbhani Kanti) in E_1, 0.00 % (NOL 17-06 and NOL 17-09) to 20.00 % (GO-6) in E_2, 20.00 % (GAO-5) to 40.00 % (Kashi Kranti) in E_3 and 23.33 % (AOL-16-04) to 43.33 % (GO-6) in E_4. In hybrids, it ranged between 16.67 % (GO-6 x Arka Anamika) to 40.00 % (GO-6 x Arka Abhay and GO-6 x Parbhani Kranti) in E_1, 3.33 % (NOL 17-09 x Parbhani Kranti) to 40.00 % (NOL 17-09 x Arka Anamika) in E_2, 10.00 % (GAO-5 x Arka Anamika and GO-6 x Kashi Kranti) to 43.33 % (NOL 17-06 x Arka Anamika) in E_3 and 23.33 % (NOL 17-05 x Kashi Kranti and NOL 17-09 x Kashi Kranti) to 50.00 % (GO-6 x Arka Abhay and NOL 17-06 x Parbhani Kranti) in E_4. Shoot borer intensity for standard check was 40.00 % in E_1, 13.33 % in E_2, 13.33 % in E_3 and 36.67 % in E_4.

Among the parents, fruit borer incidence intensity was ranged between 15.33 % (Kashi Kranti) to 26.95 % (AOL-16-04) in E_1, 19.40 % (Arka Anamika) to 32.40 % (NOL 17-06) in E_2, 16.40 % (Kashi Kranti) to 24.50 % (NOL 17-06) in E_3 and 21.60 % (GAO-5) to 35.40 % (Parbhani Kranti) in E_4. In hybrids, it ranged between 11.77 % (GO-6 x Parbhani Kranti) to 32.59 % (NOL 17-06 x Arka Abhay) in E_1, 10.40 % (NOL 17-09 x Parbhani Kranti) to 33.90 % (GAO-5 x Parbhani Kranti) in E_2, 11.70 % (GAO-5 x Arka Abhay) to 23.60 % (NOL 17-06 x Arka Abhay) in E_3 and 16.50 % (NOL 17-09 x Parbhani Kranti) to 28.10 % (GAO-5 x Parbhani Kranti) in E_4. Fruit borer intensity for standard check was 18.95 % in E_1, 23.70 % in E_2, 13.70 % in E_3 and 29.20 % in E_4.

Many hybrids showed lesser damage in per cent against okra shoot and fruit borer. Lesser incidence of okra shoot and fruit borer was also observed in okra by Afzal *et al.*, (2015), Patel (2015), Dave and Pandya (2017), Khan *et al.*, (2017), Nagesh and Mulge (2017), Kumar and Tayde (2018a), Vinayak *et al.*, (2018) and Vekariya (2019).

Among the parents, YVMV intensity was ranged between 13.33 % (NOL 17-05, NOL 17-06, NOL 17-09 and Parbhani Kranti) to 23.33 % (AOL-16-04) in E_1, 0.00 % (Kashi Kranti) to 26.67 % (AOL-16-04) in E_2, 10.00 % (Kashi Kranti) to 33.33 % (AOL-16-04) in

E_3 and 6.67 % (Arka Abhay) to 33.33 % (NOL 17-05) in E_4. In hybrids, it ranged between 10.00 % (AOL-16-04 x Parbhani Kranti, NOL 17-06 x Kashi Kranti, NOL 17-09 x Arka Abhay and NOL 17-09 x Kashi Kranti) to 23.33 % (GO-6 x Arka Abhay, AOL-16-04 x Arka Anamika and AOL-16-04 x Arka Abhay) in E_1, 3.33 % (NOL 17-09 x Kashi Kranti) to 33.33 % (NOL 17-05 x Kashi Kranti) in E_2, 3.33 % (GO-6 x Arka Anamika) to 30.00 % (NOL 17-05 x Arka Abhay and NOL 17-09 x Parbhani Kranti) in E_3 and 6.67 % (GAO-5 x Kashi Kranti and GO-6 x Kashi Kranti) to 30.00 % (GAO-5 x Parbhani Kranti, AOL-16-04 x Arka Abhay and NOL 17-09 x Parbhani Kranti) in E_4. YVMV intensity for standard check was 20.00 % in E_1, 10.00 % in E_2, 10.00 % in E_3 and 26.67 % in E_4. In the present investigation, many hybrids showed lesser damage in per cent against YVMV. Lesser incidence of YVMV was also observed in okra by Kumar and Reddy (2015), Nirosha *et al.*, (2015), Patel (2015), More (2015), Kumar and Tayde (2018b), Rynjah *et al.*, (2018), Vekariya (2019) and Jamir *et al.*, (2020) (Table 1–7).

Table.1 Scale for shoot and fruit borer resistance (Rai and Satpathy, 1998)

Grade	Fruit infestation	Category
1	0	Immune (I)
2	0.1- 10%	Highly resistant (HR)
3	10.1-20 %	Fairly resistant (FR)
4	20.1-30 %	Tolerant (T)
5	30.1-40 %	Susceptible (S)
6	40.1 and above	Highly susceptible (HS)

Table.2 Scale for yellow vein mosaic virus resistance (Ali *et al*., 2005)

Sr. No.	Rating Scale	Severity Range (%)
1	Immune	0%
2	Highly resistant	1% - 10%
3	Moderately resistant	11% - 25%
4	Tolerant	26% - 50%
5	Moderately susceptible	51% - 60%
6	Susceptible	61% - 70%
7	Highly susceptible	71% - 100%

Table.3 Disease rating scale of ELCV disease (Nazeer *et al*. 2014)

Disease Index (%)	Severity Grade	Symptoms	Remarks
0	0	No symptoms	Resistant
1-20	1	Thickening of only secondary and tertiary veins	Highly tolerant
21-30	2	Thickening of only secondary and primary (mid-rib) veins	Tolerant
31-50	3	Vein thickening, leaf curling or enation or both	Susceptible
>50	4	Stunting along with vein thickening, leaf curling or enation	Highly susceptible

Table.4 Field evaluation of different genotypes of okra for shoot damage by shoot and fruit borer and reaction in individual environment

Sr. No.	Genotypes	Shoot borer damage (%)				Shoot borer reaction			
		E_1	E_2	E_3	E_4	E_1	E_2	E_3	E_4
	PARENTS								
	FEMALES (LINES)								
1	GAO-5	30.00	6.67	20.00	30.00	T	HR	FR	T
2	GO-6	26.67	20.00	30.00	43.33	T	FR	T	HS
3	AOL-16-04	26.67	16.67	13.33	23.33	T	FR	FR	T
4	NOL 17-05	33.33	6.67	23.33	33.33	S	HR	T	S
5	NOL 17-06	26.67	0.00	13.33	36.67	T	I	FR	S
6	NOL 17-09	30.00	0.00	13.33	23.33	T	I	FR	T
	MALES (TESTERS)								
7	Arka Anamika	33.33	13.33	23.33	30.00	S	FR	T	T
8	Arka Abhay	26.67	13.33	30.00	23.33	T	FR	T	T
9	Kashi Kranti	23.33	13.33	40.00	30.00	T	FR	HS	T
10	Parbhani Kranti	36.67	13.33	26.67	26.67	S	FR	T	T
	HYBRIDS								
11	GAO-5 x Arka Anamika	30.00	23.33	10.00	30.00	T	T	FR	T
12	GAO-5 x Arka Abhay	23.33	13.33	30.00	30.00	T	FR	T	T
13	GAO-5 x Kashi Kranti	26.67	23.33	20.00	30.00	T	T	FR	T
14	GAO-5 x Parbhani Kranti	36.67	10.00	16.67	26.67	S	HR	FR	T
15	GO-6 x Arka Anamika	16.67	26.67	20.00	30.00	FR	T	FR	T
16	GO-6 x Arka Abhay	40.00	20.00	33.33	50.00	S	FR	S	HS
17	GO-6 x Kashi Kranti	23.33	20.00	10.00	30.00	T	FR	HR	T
18	GO-6 x Parbhani Kranti	40.00	20.00	23.33	36.67	S	FR	T	S
19	AOL-16-04 x Arka Anamika	23.33	16.67	26.67	30.00	T	FR	T	T
20	AOL-16-04 x Arka Abhay	36.67	6.67	20.00	33.33	S	HR	FR	S
21	AOL-16-04 x Kashi Kranti	33.33	16.67	20.00	40.00	S	FR	FR	S
22	AOL-16-04 x Parbhani Kranti	36.67	23.33	16.67	33.33	S	T	FR	S
23	NOL 17-05 x Arka Anamika	33.33	6.67	20.00	40.00	S	HR	FR	S
24	NOL 17-05 x Arka Abhay	33.33	6.67	13.33	43.33	S	HR	FR	HS
25	NOL 17-05 x Kashi Kranti	30.00	16.67	26.67	23.33	T	FR	T	T
26	NOL 17-05 x Parbhani Kranti	36.67	13.33	16.67	40.00	S	FR	FR	S
27	NOL 17-06 x Arka Anamika	26.67	3.33	43.33	40.00	T	HR	HS	S
28	NOL 17-06 x Arka Abhay	33.33	13.33	20.00	40.00	S	FR	FR	S
29	NOL 17-06 x Kashi Kranti	30.00	6.67	20.00	26.67	T	HR	FR	T
30	NOL 17-06 x Parbhani Kranti	26.67	13.33	23.33	50.00	T	FR	T	HS
31	NOL 17-09 x Arka Anamika	23.33	40.00	33.33	40.00	T	S	S	S
32	NOL 17-09 x Arka Abhay	26.67	3.33	26.67	30.00	T	HR	T	T
33	NOL 17-09 x Kashi Kranti	33.33	6.67	23.33	23.33	S	HR	T	T
34	NOL 17-09 x Parbhani Kranti	26.67	3.33	23.33	43.33	T	HR	T	HS
35	**Standard check OH-102**	40.00	13.33	13.33	36.67	S	FR	FR	S

Table.5 Field evaluation of different genotypes of okra for fruit damage by shoot and fruit borer and reaction in individual environment

Sr. No.	Genotypes	Fruit borer damage (%)				Fruit borer reaction			
		E_1	E_2	E_3	E_4	E_1	E_2	E_3	E_4
	PARENTS								
	FEMALES (LINES)								
1	GAO-5	16.95	22.60	17.50	21.60	FR	T	FR	T
2	GO-6	23.40	26.60	21.60	28.80	T	T	T	T
3	AOL-16-04	26.95	26.80	18.00	34.30	T	T	FR	S
4	NOL 17-05	19.27	31.80	16.80	29.70	FR	S	FR	T
5	NOL 17-06	29.33	32.40	24.50	30.70	T	S	T	S
6	NOL 17-09	19.62	27.50	18.40	26.10	FR	T	FR	T
	MALES (TESTERS)								
7	Arka Anamika	18.88	19.40	17.00	25.10	FR	FR	FR	T
8	Arka Abhay	20.22	22.40	18.00	29.70	T	T	FR	T
9	Kashi Kranti	15.33	25.30	16.40	28.60	FR	T	FR	T
10	Parbhani Kranti	14.04	29.70	13.60	35.40	FR	T	FR	S
	HYBRIDS								
11	GAO-5 x Arka Anamika	18.94	15.60	15.50	19.10	FR	FR	FR	FR
12	GAO-5 x Arka Abhay	11.83	20.60	11.70	21.30	FR	T	FR	T
13	GAO-5 x Kashi Kranti	25.82	16.90	21.50	20.80	T	FR	T	T
14	GAO-5 x Parbhani Kranti	17.20	33.90	16.70	28.10	FR	S	FR	T
15	GO-6 x Arka Anamika	23.26	22.70	19.70	27.30	T	T	FR	T
16	GO-6 x Arka Abhay	21.21	19.40	20.40	21.40	T	FR	T	T
17	GO-6 x Kashi Kranti	19.55	20.90	18.20	27.50	FR	T	FR	T
18	GO-6 x Parbhani Kranti	11.77	19.60	12.20	22.60	FR	FR	FR	T
19	AOL-16-04 x Arka Anamika	16.90	17.20	16.40	20.10	FR	FR	FR	T
20	AOL-16-04 x Arka Abhay	14.27	17.70	13.20	21.70	FR	FR	FR	T
21	AOL-16-04 x Kashi Kranti	19.45	13.60	16.60	17.60	FR	FR	FR	FR
22	AOL-16-04 x Parbhani Kranti	12.75	16.40	14.40	22.40	FR	FR	FR	T
23	NOL 17-05 x Arka Anamika	13.66	15.60	14.10	20.00	FR	FR	FR	FR
24	NOL 17-05 x Arka Abhay	18.09	19.90	16.50	23.80	FR	FR	FR	T
25	NOL 17-05 x Kashi Kranti	19.89	18.70	15.60	24.00	FR	FR	FR	T
26	NOL 17-05 x Parbhani Kranti	14.56	19.90	12.30	25.50	FR	FR	FR	T
27	NOL 17-06 x Arka Anamika	14.09	26.50	12.90	25.90	FR	T	FR	T
28	NOL 17-06 x Arka Abhay	32.59	18.00	23.60	19.90	S	FR	T	FR
29	NOL 17-06 x Kashi Kranti	19.35	27.10	13.80	24.60	FR	T	FR	T
30	NOL 17-06 x Parbhani Kranti	15.23	14.10	12.50	18.80	FR	FR	FR	FR
31	NOL 17-09 x Arka Anamika	15.39	16.80	12.70	20.90	FR	FR	FR	T
32	NOL 17-09 x Arka Abhay	21.84	14.20	18.00	18.20	T	FR	FR	FR
33	NOL 17-09 x Kashi Kranti	17.66	22.60	14.80	23.30	FR	T	FR	T
34	NOL 17-09 x Parbhani Kranti	25.18	10.40	20.40	16.50	T	FR	T	FR
35	**Standard check OH-102**	18.95	23.70	13.70	29.20	FR	T	FR	T

Table.6 Field evaluation of different genotypes of okra for YVMV disease incidence and reaction in individual environment

Sr. No.	Genotypes	YVMV incidence (%)				Disease reaction			
		E_1	E_2	E_3	E_4	E_1	E_2	E_3	E_4
	PARENTS								
	FEMALES (LINES)								
1	GAO-5	16.67	20.00	23.33	20.00	MR	MR	MR	MR
2	GO-6	20.00	13.33	20.00	30.00	MR	MR	MR	T
3	AOL-16-04	23.33	26.67	33.33	30.00	MR	T	T	T
4	NOL 17-05	13.33	13.33	16.67	33.33	MR	MR	MR	T
5	NOL 17-06	13.33	3.33	20.00	26.67	MR	HR	MR	T
6	NOL 17-09	13.33	6.66	20.00	33.33	MR	HR	MR	T
	MALES (TESTERS)								
7	Arka Anamika	16.67	6.66	20.00	20.00	MR	HR	MR	MR
8	Arka Abhay	16.67	16.67	26.67	6.67	MR	MR	T	HR
9	Kashi Kranti	20.00	0.00	10.00	20.00	MR	I	HR	MR
10	Parbhani Kranti	13.33	16.67	13.33	23.33	MR	MR	MR	MR
	HYBRIDS								
11	GAO-5 x Arka Anamika	20.00	23.33	10.00	16.67	MR	MR	HR	MR
12	GAO-5 x Arka Abhay	13.33	10.00	6.67	23.33	MR	HR	HR	MR
13	GAO-5 x Kashi Kranti	16.67	13.33	10.00	6.67	MR	MR	HR	HR
14	GAO-5 x Parbhani Kranti	20.00	10.00	10.00	30.00	MR	HR	HR	T
15	GO-6 x Arka Anamika	13.33	26.67	3.33	23.33	MR	T	HR	MR
16	GO-6 x Arka Abhay	23.33	10.00	20.00	26.67	MR	HR	MR	T
17	GO-6 x Kashi Kranti	13.33	10.00	23.33	6.67	MR	HR	MR	HR
18	GO-6 x Parbhani Kranti	20.00	20.00	20.00	16.67	MR	MR	MR	MR
19	AOL-16-04 x Arka Anamika	23.33	30.00	13.33	23.33	MR	T	MR	MR
20	AOL-16-04 x Arka Abhay	23.33	33.33	23.33	30.00	MR	T	MR	T
21	AOL-16-04 x Kashi Kranti	16.67	16.67	20.00	26.67	MR	MR	MR	T
22	AOL-16-04 x Parbhani Kranti	10.00	20.00	10.00	20.00	HR	MR	HR	MR
23	NOL 17-05 x Arka Anamika	16.67	20.00	13.33	23.33	MR	MR	MR	MR
24	NOL 17-05 x Arka Abhay	16.67	16.67	30.00	20.00	MR	MR	T	MR
25	NOL 17-05 x Kashi Kranti	16.67	33.33	10.00	23.33	MR	T	HR	MR
26	NOL 17-05 x Parbhani Kranti	16.67	23.33	13.33	20.00	MR	MR	MR	MR
27	NOL 17-06 x Arka Anamika	20.00	13.33	16.67	23.33	MR	MR	MR	MR
28	NOL 17-06 x Arka Abhay	20.00	16.67	20.00	13.33	MR	MR	MR	MR
29	NOL 17-06 x Kashi Kranti	10.00	6.66	10.00	16.67	HR	HR	HR	MR
30	NOL 17-06 x Parbhani Kranti	13.33	16.67	13.33	23.33	MR	MR	MR	MR
31	NOL 17-09 x Arka Anamika	13.33	10.00	23.33	23.33	MR	HR	MR	MR
32	NOL 17-09 x Arka Abhay	10.00	10.00	30.00	23.33	HR	HR	T	MR
33	NOL 17-09 x Kashi Kranti	10.00	3.33	6.67	20.00	HR	HR	HR	MR
34	NOL 17-09 x Parbhani Kranti	13.33	20.00	30.00	30.00	MR	MR	T	T
35	**Standard check OH-102**	20.00	10.00	10.00	26.67	MR	HR	HR	T

Table.7 Field evaluation of different genotypes of okra for ELCV disease incidence and reaction in individual environment

Sr. No.	Genotypes	ELCV incidence (%)				Disease reaction			
		E_1	E_2	E_3	E_4	E_1	E_2	E_3	E_4
	PARENTS								
	FEMALES (LINES)								
1	GAO-5	0.00	43.33	3.33	0.00	R	S	HT	R
2	GO-6	3.33	20.00	0.00	3.33	HT	HT	HT	R
3	AOL-16-04	6.66	40.00	10.00	6.67	HT	S	HT	HT
4	NOL 17-05	3.33	20.00	0.00	0.00	HT	HT	R	R
5	NOL 17-06	0.00	36.67	0.00	0.00	R	S	R	R
6	NOL 17-09	0.00	53.33	10.00	3.33	R	HS	HT	HT
	MALES (TESTERS)								
7	Arka Anamika	0.00	40.00	0.00	0.00	R	S	R	R
8	Arka Abhay	0.00	53.33	10.00	13.33	R	HS	HT	HT
9	Kashi Kranti	0.00	43.33	0.00	3.33	R	S	R	HT
10	Parbhani Kranti	6.66	40.00	13.33	10.00	HT	S	HT	HT
	HYBRIDS								
11	GAO-5 x Arka Anamika	6.66	50.00	0.00	0.00	HT	S	R	R
12	GAO-5 x Arka Abhay	13.33	50.00	10.00	0.00	HT	S	HT	R
13	GAO-5 x Kashi Kranti	0.00	46.67	0.00	0.00	R	S	R	R
14	GAO-5 x Parbhani Kranti	0.00	40.00	0.00	0.00	R	S	R	R
15	GO-6 x Arka Anamika	3.33	50.00	0.00	0.00	HT	S	R	R
16	GO-6 x Arka Abhay	10.00	63.33	13.33	16.67	HT	HS	HT	HT
17	GO-6 x Kashi Kranti	3.33	50.00	0.00	0.00	S	S	R	R
18	GO-6 x Parbhani Kranti	0.00	50.00	0.00	0.00	R	S	R	R
19	AOL-16-04 x Arka Anamika	0.00	53.33	0.00	0.00	R	HS	R	R
20	AOL-16-04 x Arka Abhay	3.33	60.00	10.00	0.00	HT	HS	HT	R
21	AOL-16-04 x Kashi Kranti	0.00	53.33	0.00	0.00	R	HS	R	R
22	AOL-16-04 x Parbhani Kranti	3.33	50.00	0.00	0.00	HT	S	R	R
23	NOL 17-05 x Arka Anamika	0.00	56.67	0.00	0.00	R	HS	R	R
24	NOL 17-05 x Arka Abhay	0.00	40.00	0.00	0.00	R	S	R	R
25	NOL 17-05 x Kashi Kranti	0.00	63.33	0.00	3.33	R	HS	R	HT
26	NOL 17-05 x Parbhani Kranti	6.66	53.33	0.00	13.33	HT	HS	R	HT
27	NOL 17-06 x Arka Anamika	3.33	53.33	0.00	0.00	HT	HS	R	R
28	NOL 17-06 x Arka Abhay	0.00	53.33	0.00	0.00	R	HS	R	R
29	NOL 17-06 x Kashi Kranti	3.33	40.00	0.00	0.00	HT	S	R	R
30	NOL 17-06 x Parbhani Kranti	6.66	40.00	0.00	0.00	HT	S	R	R
31	NOL 17-09 x Arka Anamika	3.33	30.00	0.00	0.00	HT	T	R	R
32	NOL 17-09 x Arka Abhay	0.00	33.33	0.00	0.00	R	S	R	R
33	NOL 17-09 x Kashi Kranti	0.00	40.00	0.00	0.00	R	S	R	R
34	NOL 17-09 x Parbhani Kranti	3.33	33.33	0.00	0.00	HT	S	R	R
35	**Standard check OH-102**	0.00	20.00	0.00	0.00	R	HT	R	R

Among the parents, ELCV intensity was ranged between 0.00 % (GAO-5, NOL 17-06, NOL 17-09, Arka Anamika, Arka Abhay and Kashi Kranti) to 6.66 % (AOL 16-04 and Parbhani Kranti) in E_1, 20.00 % (GO-6 and NOL 17-05) to 53.33 % (NOL 17-09 and Arka Abhay) in E_2, 0.00 % (GO-6, NOL 17-05, NOL 17-06, Arka Anamika and Kashi Kranti) to 13.33 % (Parbhani Kranti) in E_3 and 0.00 % (GAO-5, NOL 17-05, NOL 17-06 and Arka Anamika) in E_4. In hybrids, it ranged between 0.00 % to 13.33 % (GAO-5 x Arka Abhay) in E_1, 30.00 % (NOL 17-09 x Arka Anamika) to 63.33 % (GO-6 x Arka Abhay and NOL 17-05 x Kashi Kranti) in E_2, 0.00 % to 13.33 % (GO-6 x Arka Abhay) in E_3 and 0.00 % to 16.67 % (GO-6 x Arka Abhay) in E_4. ELCV intensity for standard check was 0.00 % in E_1, 20.00 % in E_2, 0.00 % in E_3 and 0.00 % in E_4. Many hybrids showed lesser damage in per cent against ELCV. Lesser incidence of ELCV was also observed in okra by Patel (2015), More (2015), Yadav *et al.*, (2018), Devi *et al.*, (2019) and Jamir *et al.*, (2020).

None of the hybrid gave immune/resistant reaction for shoot and fruit borer, YVMV and ELCV in all the environments. Among parents, AOL-16-04 and NOL 17-09 for shoot borer, GAO-5 and Arka Anamika for fruit borer, Arka Anamika and Kashi Kranti for YVMV and GO-6 and NOL 17-05 for ELCV performed better. Among 55 hybrids, one in E_1, 10 in E_2 and 13 in E_3 registered fairly resistant reaction for shoot borer, 19 in E_1, 17 in E_2, 21 in E_3 and seven in E_4 registered fairly resistant reaction for fruit borer, four in E_1, eight in E_2, 11 in E_3 and three in E_4 registered highly resistant reaction for YVMV and 11 in E_1, 21 each in E_3 and E_4 registered resistant reaction for ELCV.

Parents and hybrids which showed moderately resistant or tolerance reaction can be used in further breeding programmes to develop varieties/hybrids resistant or tolerant to YVMV, ELCV and shoot and fruit borer along with good agronomic traits.

Acknowledgement

The authors acknowledge the support given by Department of Genetics and Plant Breeding, N. M. College of Agriculture Navsari Agricultural University, Navsari, Gujarat. We are also grateful to the group of vegetable scientists of Department of Vegetable Science, Navsari Agricultural University, Navsari, Gujarat, India.

References

Abusaleha and Shanmugavelu, K.G. (1988). Studies on the effect of organic *vs* inorganic source of nitrogen on growth, yield and quality of okra. *Indian J. Hort.*, 45: 312.

Afzal, M.; Mukhtar, M. K.; Tahir, H. M.; Ibrar-ul-haq; Babar, M. H. and Sherawat. S. M. (2015). Screening of different okra genotypes against fruit borer (*Earias* spp.) (Lepidoptera: Noctuidae) on okra crop. *Pak. J. Zool.*, 47 (6): 1631-1635.

Ali, M. I.; Khan, M. A.; Rashid, A.; Ehetisham-ul-haq, M.; Javed, M. T. and Sajid, M. (2012). Epidemology of okra yellow vein mosaic virus (OYVMV) and its management through tracer. *American J. Plant Sci.*, 3 (1): 741-5.

Ali, S. K.; Habib, A.; Rasheed, S. and Iftikhar, Y. (2005). Correlation of environmental conditions with okra yellow vein mosaic virus and *B. tabaci* population density. *Int. J. Agric. Biol.*, 7: 142-144.

Anonymous (2017). FAOSTAT http://faostat.fao.org/.

Anonymous (2019). https://www.indiastat.com/table/agriculturedata/2/la-dys-finger-

okra/23059/14905/data.aspx.

Atwal, A. S. and Singh, B. (1990). Pest population and assessment of crop losses, New Delhi; Indian Agriculture Research Institute.

Aziz, M. A.; Hasan, M. and Ali, A. (2011). Impact of abiotic factors on incidence of fruit and shoot damage of spotted bollworms, *Earias* spp. on okra (*Abelmoschus esculentus* L.). *Pak. J. Zool.*, 43: 863-868

Butani, D. K. and Jotwani, M. G. (1984). Insects in vegetables. Periodical Expert Book Agency. Vivek-Vihar, Delhi (India), pp. 45-66.

Chakraborty, S.; Pandey, P. K. and Singh, B. (1999). Okra leaf curl disease: A threat to okra [*Abelmoschus esculentus* (L.) Moench]. *Veg. Sci.*, 24 (1): 52-4.

Dave, P. P. and Pandya, H. V. (2017). Screening of okra genotypes against *Earias vittella* (Fabricius) in Gujarat. *J. Ento. Zoo. Studi.*, 5 (6): 2160-2166.

Devi, A. P.; Bhattacharjee, T.; Banerjee, S.; Maurya, P. K.; Chatterjee, S. and Chattopadhyay, A. (2019). Heterotic expression of okra hybrids for tolerance to enation leaf curl virus. *Int. J. Veg. Sci.*, 26 (2): 163-189.

Jamir, I.; Mandal, A. K.; Devi, A. P.; Bhattacharjee, T.; Maurya, P. K.; Dutta, S. and Banik, S. (2020). Screening of genotypes against viral diseases and assessment of yield loss due to yellow vein mosaic virus in okra grown in the eastern part of India. *Indian Phytopatho*., 12 (4): 1-9.

Khan, A. K.; Javed, H.; Naeem, M. and Mukhtar, T. (2017). Screening of selected genotypes of okra against American bollworm on the basis of shoot infestation. *J. of Ento. Zoo. Studies*, 5 (4): 850-852.

Kumar, K. I. and Tayde, A. R. (2018b). Screening of okra genotypes against yellow vein mosaic virus disease (OYVMV) under Field conditions in Allahabad. *J. Pharma. and Phyto.*, 7 (1): 660-662.

Kumar, S. and Reddy, M. T. (2015). Morphological characterization and agronomic evaluation of yellow vein mosaic virus resistant single cross hybrids for yield and quality traits in okra. Open Access Library Journal 2: 1-17

Malik, C. P.; Pohalla, P. L.; Singh, M. B. and Singh, H. (1985). The biology of okra. A review, in *Widening Horizons of Plant Sciences* (C. P. Malik, ed.) *Cosmo. Publ*., New Delhi. pp. 355.

More, S. J. (2015). Line x Tester analysis over environments in okra [*Abelmoschus esculentus* L. Moench]. *Ph.D. Thesis*, submitted to Navsari Agricultural University, Navsari.

Nagesh, G. C. and Mulge, R. (2017). Screening of okra genotypes against fruit borer (*Earias* spp.) infestation. *Int. J. Curr. Microbiol. App. Sci*., 6 (11): 1559-1565.

Nazeer, W.; Tipu, A. L.; Ahmad, S.; Mahmood, K.; Mahmood, A. and Zhoumail, B. Z. (2014). Evaluation of Cotton Leaf Curl Virus Resistance in BC_1, BC_2, and BC_3 Progenies from an Interspecific Cross between *Gossypium arboreum* and *Gossypium hirsutum*. *Plos one*, 9 (11): 111861.

Nirosha, K.; Vethamoni, P. I. and Sathiyamurthy, V. A. (2015). Yellow vein mosaic virus resistant hybrids in okra (*Abelmoschus esculentus* L.) Moench. *Elec. J. Pl. Br.*, 6 (1): 312-314.

Pareek, P. L. and Bhargava, M. C. (2003). Estimation of avoidable losses in vegetables caused by borers under semi-arid condition of Rajasthan. *Ins. Environ.*, 9: 59-60.

Patel, B. H. (2015). Genetic analysis of yield and its quality parameters in okra [*Abelmoschus esculentus* (L.) Moench],

M.Sc. Thesis, submitted to Navsari Agricultural University, Navsari.

Rai, S. and Satpathy, S. (1998). Recent advances in screening for insect resistance in vegetables. Summer school on advanced technologies in improvement of vegetable crops including cole crops. May 4-24, IARI, New Delhi. pp. 67-74.

Rynjah, S.; Sathiyamurthy, V. A.; Saraswathi, T. and Harish, S. (2018). Field screening of okra [*Abelmoschus esculentus* L. Moench] genotypes against okra yellow vein mosaic virus disease. *J. Pharma. and Phyto.*, 7 (5): 1852-1854.

Singh, S. J. (1996). Assessment of losses in okra due to enation leaf curl virus. *Indian J. Virology*, 12 (1): 51-52.

Vekariya, R. D. (2019). Genetic study and stability analysis over environments in okra [*Abelmoschus esculentus* (L.) Moench]. *Ph. D. (Agri.) Thesis*, submitted to Navsari Agricultural University, Navsari. pp. 232-235.

Venkataravanappa V.; Reddy, C. N. L.; Jalali, S.; Briddon, R. W. and Reddy, M. K. (2015). Molecular identification and biological characterisation of a begomovirus associated with okra enation leaf curl disease in India. *European J. Pl. Patholology*, 141 (2): 217-235.

Vinayak, N.; Jalgaonkar, M. M.; Kumud, N.; Anil, V. and Golvankar, G. (2018). Varietal preference of okra shoot and fruit borer, *Earias vittella* (fab.) in summer season under field condition in konkan region of Maharashtra. *Int. J. Curr. Microbiol. App. Sci.*, 7 (11): 2397-2402.

Yadav, Y.; Maurya, P. K.; Bhattacharjee, T.; Banerjee, S.; Jamir, I.; Mandal, A. K.; Dutta, S. and Chattopadhyay, A. (2018). First evidence on heterotic affinity and combining ability of cultivated okra [*Abelmoschus esculentus* (L.) Moench] inbred lines for tolerance to enation leaf curl virus disease. *Agric. Res. & Tech.*, 18 (5): 3795-3802.

How to cite this article:

Patel, A. A., A. I. Patel, R. D. Vekariya, H. I. Damor, H. R. Patel and Berani, N. K. 2021. Screening of Okra Genotypes for Shoot and Fruit Borer, Yellow Vein Mosaic Virus Disease and Enation Leaf Curl Virus Disease Over Environments. *Int.J.Curr.Microbiol.App.Sci.* 10(03): 516-526. doi: https://doi.org/10.20546/ijcmas.2021.1003.068