academicJournals

Vol. 13(12), pp. 1336-1342, 19 March, 2014
DOI: 10.5897/AJB2014.13624
ISSN 1684-5315

http://www.academicjournals.org/AJB

African Journal of Biotechnology

Full Length Research Paper

Seasonal response of okra (*Abelmoschus esculentus* L. Moench) genotypes for okra yellow vein mosaic virus incidence

S. S. Solankey, Shirin Akhtar, Randhir Kumar*, R. B. Verma and Kumar Sahajanand

Department of Horticulture (Vegetable & Floriculture), Bihar Agricultural College, Bihar Agricultural University, Sabour (Bhagalpur), Bihar – 813 210, (India).

Received 10 January, 2014; Accepted 5 March, 2014

One of the major limiting factors of okra is the incidence of okra yellow vein mosaic virus (OYVMV), its vector being whitefly. Infection of 100% plants in a field is very common and yield losses range from 50 to 94% depending on the stage of crop growth at which infection occurs. A total of 91 okra genotypes were evaluated in summer and rainy season of 2012 to 2013, out of which only 6 genotypes (IIHR123, IC90381, CI140982, IC141065, IIHR1, and Kavya) were found to have highly resistant disease reaction during both the season. The highest fruit yield in rainy and summer season was observed in the genotypes IC32855 (308 g/ plant) and IC99646 (212.3 g/plant), respectively. These genotypes could be used for further hybrid breeding programme due to their high yield and lower disease incidence for OYVMV.

Key words: Disease incidence, genotypes, okra, OYVMV, seasonal variation.

INTRODUCTION

Okra is one of the most popular vegetable crops cultivated throughout India for its tender green fruits. Okra requires a long and warm growing season for optimum growth and development. India is the largest producer of okra in the world with total area of 0.52 million hectares and production 6.26 million tones green pods, whereas productivity of the crop is 12.1 MT/ ha (Anonymous, 2012). Okra can be grown twice a year in the Indian plains (rainy season and summer season). The major limiting factor for its cultivation is the incidence of okra yellow vein mosaic virus (OYVMV) which is transmitted by whitefly (*Bemisia tabaci* Gen.) (Rana et al., 2006). This disease is caused by a complex, consisting of the monopartite begomovirus, okra yellow vein mosaic virus (family: Geminiviridae) and a small satellite DNA β component (Jose and Usha, 2003). This disease and its insect vector cause heavy losses to okra by affecting the quality and yield of the fruits. Infection of 100% plants in a field is quite common and yield losses range from 50 to 94% depending on the stage of crop growth at which infection occurs (Sastry and Singh, 1974). The initial symptom on young leaves is a diffuse, mottled appearance. Older leaves have irregular yellow interveinal areas. Clearing of the small veins starts near the leaf margins, at various points, about 15 to 20 days after infection. Thereafter, the vein clearing develops into a vein chlorosis. The newly developed leaves exhibit an interwoven network of yellow vein, which enclose the green patches of the leaf.

*Corresponding author E-mail: randhirvs@gmail.com.

Table 1. Scale for classifying disease reaction in okra to OYVMV disease.

Symptom	Severity grade	Response value	Coefficient of infection	Reaction
Symptoms absent	0	0	0 – 4	HR
Very mild symptoms up to 25% leaves	1	0.25	4.1 – 9	R
Appearance of disease between 26 to 50% leaves	2	0.50	9.1 – 19	MR
Symptom between 51 to 75% leaves	3	0.75	19.1 – 39	MS
Severe disease infection at 75% leaves	4	1.00	39.1 – 69	S
Above 75% leaves	>4	>1.00	69.1 – 100	HS

Note: HR = Highly resistant, R = Resistant, S = Susceptible, H S = Highly susceptible, MR = Moderately resistant, MS = Moderately susceptible. Correlations between variables were tested for significance (Gomez and Gomez, 1984).

Fruits developing on infected plants have irregular yellow areas which follow a longitudinal alignment. Due to heavy infestation the fruits become malformed and reduced in size. The fruits are mostly yellow, small, tough and fibrous (Brunt et al., 1996). If plants are infected within 20 days after germination, their growth is retarded; few leaves and fruits are formed (Sastry and Singh, 1974). The extent of damage declines with delay in infection of the pathogens. Plants infected 50 and 65 days after germination suffer a loss of 84 and 49%, respectively (Sastry and Singh, 1974; Khan et al., 2005). With this severe production constraint in purview, the objectives of this study were to identify okra genotypes for resistance/ tolerance to OYVMV based on a percent disease incidence and coefficient of infection in okra under field conditions. The outcome of the study could open avenues for utilization of these genotypes in further hybrid breeding programme for OYVMV tolerance/resistance in okra.

MATERIALS AND METHODS

The present investigation was carried out using 91 diverse okra genotypes including 4 checks (Arka Anamika, Arka Abhay, VRO-6 and Pusa Sawani) collected from NBPGR, New Delhi, India and IIHR, Bengaluru, India, screened and evaluated at the research farm of the Department of Horticulture (Vegetable and Floriculture), Bihar Agricultural College, Bihar Agricultural University, Sabour, Bhagalpur (Bihar) in two different seasons, Summer and Rainy, 2012 to 2013. The recommended agronomic practices for raising a good okra crop were adopted. Observations were recorded on 12 economically important traits *viz*., days to first flowering, days to 50% flowering, first fruit picking, first flowering node, fruit length (cm), number of branch/ plant, plant height (cm), plant canopy width (cm), number of fruits/ plant, average fruit weight (g), fruit yield/ plant (g) and percent infestation of OYVMV. The soil of the plot was sandy loam in texture having good fertility, properly leveled and well drained. Scoring of OYVMV disease incidence was done on a scale of 0 to 4 (Table 1) at 15 days intervals (30, 45, 60 and 75 days) after sowing and PDI and CI value were calculated by the procedure coined by Banerjee and Kalloo (1987).

PDI (%) = (Number of infected plants / Total number of plants observed) × 100

CI (%) = PDI x RV

Where PDI = percent disease infection, RV= response value.

RESULTS AND DISCUSSION

Effect of season on growth and yield attributing traits

The effect of growing seasons (summer and rainy) was markedly observed through the mean performance of the crop itself. The summer crop was earlier than the rainy crop (the respective mean days to first flowering being 39.71 and 46.14 days after sowing, respective mean days to 50% flowering being 46.43 and 53.21 days after sowing, respective node number to first flower being 3.93 and 7.79 and respective days to first fruit picking being 49.21 and 53.36 days after sowing) (Table 2). IC33332 was the earliest genotype, whereas among checks Arka Anamika was the earliest. IC18536 was the latest genotype whereas Pusa Sawani among the checks was the most late. The effect of season was evident in yield and yield attributing characters also. In summer (Table 2) the mean yield per plant was recorded to be 154.57 g whereas in the rainy season it was massively increased to 247.85 g. Similar trends were observed in the various yield attributing traits, *viz*., number of fruits per plant, plant height, plant canopy and number of branches per plant which were lesser in summer and magnified in rainy season. However, the average fruit weight did not differ much over the seasons (12.20 g in summer and 12.21 g in rainy). During rainy season (Table 3) highest fruit yield was observed in the genotype IC32855 (308 g/ plant), whereas during summer season the same was recorded in the genotype IC99646 (212.3 g/plant). Among checks the maximum yield per plant was observed in the genotype Arka Anamika (rainy season: 253.6 g and summer season: 139.1 g) during both seasons. In summer season the highest average fruit weight was recorded in the genotype IIHR 113 (18.0 g), whereas in rainy season the same was observed in case of IC13995 (17.7 g). The number of fruits per plant was highest in IC128035 and IC31398 (19.6) in summer crop, whereas in rainy crop the highest was observed in IC18553 and IC18537A (25.4). Plant height was maximum in IC99646 in summer (110.0 cm) whereas in rainy season in the check VRO-6 (145.0 cm) closely followed by IC13995 (135.5 cm). Plant canopy in summer season was highest in IC99646 (90.0

Table 2. Mean performance of promising okra genotypes during summer season.

Genotype	Days to first flowering	Days to 50% flowering	First fruit picking	First flowering node	Fruit length (cm)	Number of branch/ plant	Plant height (cm)	Plant canopy width (cm)	Number of fruits/ plant	Average Fruit weight (g)	Fruit yield/ plant (g)	OYVMV coefficient of infection (%)
IC99646	46	52	57	6	14.0	3.0	110.0	90.0	12.9	16.5	212.3	75.0
IC90219	38	43	47	2	15.0	3.0	50.0	60.0	18.8	10.8	204.1	75.0
IC33206A	36	42	46	2	15.0	2.0	50.0	55.0	15.1	13.4	202.5	5.0
IC111515	34	40	43	2	18.0	4.0	45.0	60.0	12.7	15.4	196.3	5.0
IC128035	39	46	52	4	15.0	2.0	40.0	50.0	19.6	9.6	188.4	16.7
IC31398	40	48	51	2	12.0	1.0	50.0	45.0	19.6	9.6	188.4	16.7
IC43741	32	38	44	3	11.0	3.0	60.0	68.0	12.9	12.8	165.7	16.7
IC43750	34	38	42	2	17.0	5.0	60.0	70.0	15.5	10.1	155.9	21.4
IIHR113	58	63	64	9	10.0	3.0	60.0	52.0	8.6	18.0	155.0	0.0
IC111321	37	41	46	3	14.0	1.0	45.0	55.0	17.5	8.7	151.8	0.0
Arka Anamika (c)	41	53	49	6	12.0	2.0	40.0	41.0	7.2	9.6	139.1	0.0
VRO-6 (c)	39	45	49	4	13.0	1.0	35.0	40.0	2.5	15.0	137.7	0.0
Arka Abhay (c)	38	48	44	4	10.0	3.0	60.0	90.0	10.3	11.1	118.4	5.0
Pusa Sawani (c)	44	53	55	6	9.9	4.0	78.0	67.0	12.0	10.2	115.4	75.0
General Mean	39.71	46.43	49.21	3.93	13.28	2.64	55.93	60.21	13.24	12.20	154.57	22.25
C.D. at 5%	13.92	15.10	13.23	4.57	5.58	2.62	41.08	33.72	10.68	6.41	112.68	63.28

Table 3. Mean performance of promising okra genotypes during rainy season.

Genotype	Days to first flowering	Days to 50% flowering	First fruit picking	First flowering node	Fruit length (cm)	Number of branch/ plant	Plant height (cm)	Plant canopy width (cm)	Number of fruits/ plant	Average Fruit weight (g)	Fruit yield/ plant (g)	OYVMV coefficient of infection (%)
IC32855	48	54	55	10	11.3	4.0	95.0	87.0	24.5	12.6	308.0	45.0
IC18530	47	52	55	9	9.7	4.0	105.0	100.0	21.8	13.0	283.0	45.0
IC33332	40	44	49	7	10.7	4.0	125.3	99.0	23.8	10.9	259.0	80.0
IC13995	46	57	55	8	8.7	4.0	135.5	105.0	14.6	17.7	259.0	52.5
IC18536	52	58	56	8	7.4	4.0	119.0	90.0	24.3	10.6	256.3	25.0
IC18553	48	55	53	7	10.6	2.0	128.9	105.0	25.4	10.0	254.0	80.0
IC18542	46	52	55	9	9.9	3.0	132.0	80.0	18.5	13.6	251.8	25.0
IC15036	46	53	52	7	10.4	4.0	126.0	106.0	22.5	11.1	250.0	80.0
IC14845B	48	55	55	9	8.5	3.0	75.0	78.0	17.5	14.3	249.5	25.0
IC18537A	44	52	52	8	9.4	4.0	117.5	99.0	25.4	9.7	247.6	80.0
Arka Anamika (c)	40	52	46	6	8.6	5.0	100.6	80.0	18.0	14.1	253.6	20.0

Table 3. Contd.

VRO-6 (c)	43	46	52	8	8.0	3.0	145.0	105.0	20.8	11.7	243.0	45.0
Arka Abhay (c)	46	58	57	6	11.0	4.0	113.0	95.0	21.8	10.8	235.3	25.0
Pusa Sawani (c)	52	57	55	7	10.2	4.0	110.0	75.0	11.0	10.9	120.0	100.0
General Mean	46.14	53.21	53.36	7.79	9.59	3.71	116.27	93.14	20.70	12.21	247.85	51.96
C.D. at 5%	7.74	8.90	6.39	2.55	2.57	1.57	39.32	24.22	9.22	4.68	87.82	58.07

Table 4. Genotypic character association in okra during rainy and summer season.

Characters		Days to first flowering	Days to 50% flowering	First fruit picking	First flowering node	Fruit length (cm)	Number of branch/ plant	Plant height (cm)	Plant canopy width (cm)	Number of fruits/ plant	Average Fruit weight (g)	Fruit yield/ plant (g)
Days to first flowering	Rainy	0.746*	0.789*	0.312	-0.030	-0.247	-0.210	-0.270	-0.185	-0.130	-0.329	
	Summer	0.945*	0.948*	0.884*	-0.500	-0.033	0.357	-0.055	-0.297	0.465	-0.074	
Days to 50% flowering	Rainy		0.640*	-0.037	-0.032	0.047	-0.305	-0.273	-0.271	0.135	-0.237	
	Summer		0.891*	0.906*	-0.625*	-0.071	0.314	-0.063	-0.376	0.330	-0.217	
First fruit picking	Rainy			0.436	0.086	-0.305	-0.086	-0.073	-0.107	0.040	-0.088	
	Summer			0.839*	-0.474	-0.112	0.407	-0.102	-0.184	0.430	0.023	
First flowering node	Rainy				-0.085	-0.255	-0.235	-0.135	0.101	0.295	0.448	
	Summer				-0.612*	0.049	0.372	0.030	-0.532	0.414	-0.326	
Fruit length (cm)	Rainy					-0.060	-0.068	0.062	0.198	-0.308	-0.006	
	Summer					0.201	-0.202	-0.067	0.384	-0.008	0.440	
Number of branch/ plant	Rainy						-0.255	-0.192	-0.168	0.165	-0.019	
	Summer						0.438	0.572*	0.008	0.161	0.226	
Plant height (cm)	Rainy							0.625*	0.107	-0.121	-0.065	
	Summer							0.765*	0.020	0.330	0.334	
Plant canopy width (cm)	Rainy								0.503	-0.150	0.371	
	Summer								0.086	0.148	0.307	
Number of fruits/ plant	Rainy									-0.568*	0.652*	
	Summer									-0.500	0.783*	
Average Fruit weight (g)	Rainy										0.235	
	Summer										0.109	

* Significant at 5% probability levels.

cm), whereas in rainy season IC15036 had the greatest canopy width (106.0 cm). The number of branches per plant was highest in IC43750 (5.0) in summer, whereas in rainy season the highest number of branches per plant was recorded in the check Arka Anamika (5.0). On the basis of correlation analysis during both the seasons (Table 4), days to first flowering, days to 50% flowering, plant height and number of fruits per plant are significantly correlated. However, number of fruits per plant has significant negative correlation during rainy season. It was found that days to first

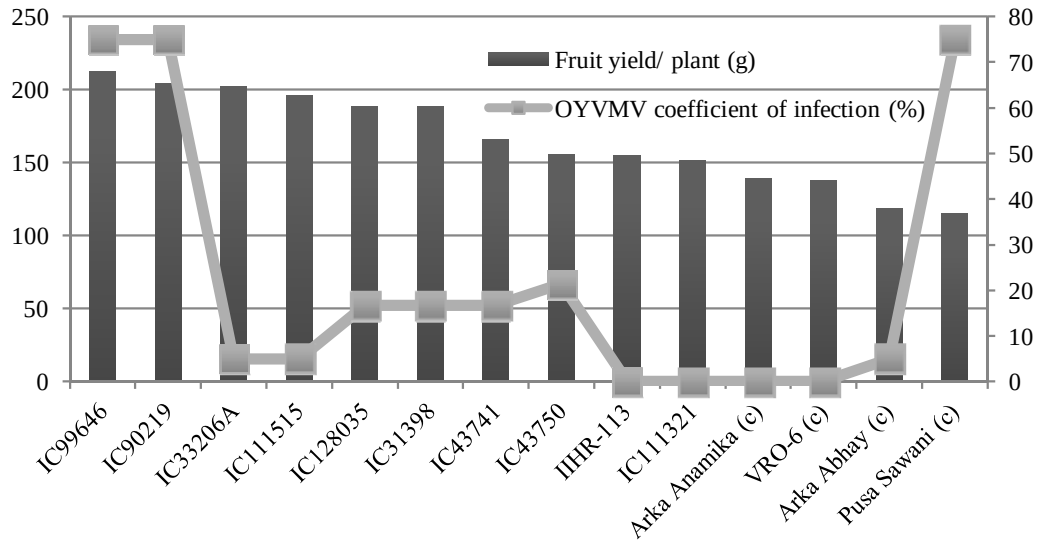

Figure 1. Performance of promising okra genotypes for yield and OYVMV infection during summer season.

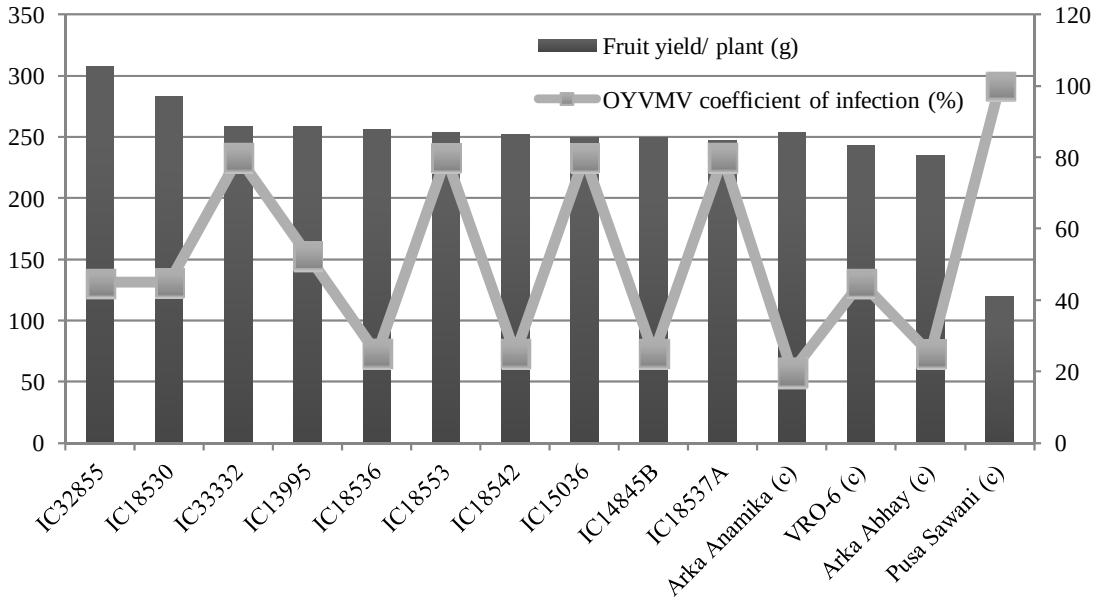

Figure 2. Performance of promising okra genotypes for yield and OYVMV infection during rainy season.

flowering, days to 50% flowering, days to first fruit picking via first flowering node; number of branches per plant via plant canopy width have positive significant correlation during summer season. Similar pattern of correlation was also accounted by (Dhankar and Dhankar, 2002; Das et al., 2013; Solankey et al., 2013).

Effect of season on OYVMV attributing traits

In the rainy season crop the intensity of OYVMV was very high due to the favourable environmental condition for the vector, that is, whitefly and the virus (Das et al., 2013). The mean incidence of OYVMV in summer season (Figures 1 and 2) was low (22.25%) compared to the high incidence in rainy season (51.96%). Out of 91 okra genotypes, 45 genotypes were found to be highly resistant, 17 resistant, 10 moderately resistant, 08 moderately susceptible, 06 susceptible and rest 05 showed highly susceptible reactions during summer season (Table 5). However, only 6 genotypes were found to be highly resistant (IIHR123, IC90381, CI140982, IC141065, IIHR1, Kavya), 6 resistant, 5 moderately resistant, 14 moderately sus-

Table 5. Reaction of okra genotypes against OYVMV during both seasons (summer and rainy).

Disease Reaction	Summer Season, 2013		Rainy Season, 2013	
	Number of Genotypes	Name of Genotypes	Number of Genotypes	Name of Genotypes
Highly resistant	45	IC90381 (*A. tuberculatus*), IC140982 (*A. tetraphyllus*), IC141065 (*A. moschatus*), IIHR1 (*A. tetraphyllus*), IC15027, IC18537, IC13999A, IC14018, IC111321, IC90210, IC23628, IC18073A, IC18540, IC18530, IC90212, IIHR123, IIHR110, IIHR113, IC43742, IC23594, IC32298, IC117116, IC32855, IC18541A, IC27875, IC32850, IC33323A, Arka Anamika, IIHR112, IIHR129, IIHR53, IIHR115, IC14909, IC16566, IC45727, IC26375, IC18532, IC18975, IC18537A, IC15036, VRO-6, Kavya, RBH-18, IC15435, IIHR120.	06	IIHR123, IC90381 (*A. tuberculatus*), IC140982 (*A. tetraphyllus*), IC141065 (*A. moschatus*), IIHR1 (*A. tetraphyllus*), Kavya
Resistant	17	IC18960, IC13995, IC22237, IC18542, IC128065, IC111515, IC33206A, Arka Abhay, IC18536, IC43745, IC18960B, IC18553, IC90170, IC99709, IIHR43, IC111520, IC16262A	06	IC15435, IIHR113, IIHR120, IIHR53, IIHR129, RBH-18
Moderately resistant	10	IC45723, IC14845B, IC90298, IC31398, IC43743, IC14600, IC43741, IC31037A, IC22283, IC43149	05	IC111520, IC16566, IC33206B, IIHR128, IC99646
Moderately susceptible	08	IC43751, IC43750, IC128037, IC43746D, IC90219, IC128035, IC11537, IC128071	14	Arka Abhay, Arka Anamika, IC128049, IC14845B, IC16262A, IC18532, IC18536, IC18541A, IC18542, IC22283, IC32850, IC43149, IIHR112, VRO-6
Susceptible	06	IC33332, IC22282, IC33332, IC43741, IC44526, IIHR116	29	IC11537, IC111515, IC128035, IC13999A, IC18073A, IC18530, IC31037A, IC32855, IC33206A, IC43741, IC90219, IIHR 43, IIHR110, IC 43750, IC 90212, IC128071, IC13995, IC14018, IC14026, IC22282, IC26375, IC43742, IC43743, IC43745, IC45723, IC90170, IC90210, IC99709, IC18960B
Highly susceptible	05	IC14026, IC128049, IC99646, IC33206B, Pusa Sawani	31	IC128037, IC117116, IC14600, IC15036, IC18537A, IC18540, IC18553, IC18975, IC22237, IC23594, IC27875, IC32298, IC33323A, IC33332, IC43741, IC44526, IC45727, IC128065, IC15027, IC18960, IC43746D, IC43751, IC111321, IC14909, IC18537, IC23628, IC31398, IC90298, IIHR115, IIHR116, Pusa Sawani

ceptible, 29 susceptible and rest 31 showed highly susceptible reaction during rainy seasons. Only six genotypes were found to have common highly resistant response against OYVMV during both the season, that is, IIHR123, IC90381, CI140982, IC141065, IIHR1 and Kavya. However, the check variety Pusa Sawani was found to have 100% disease incidence during rainy season and 75% incidence in summer season. Among the six highly resistant genotypes four (IC90381: *Amaranthus tuberculatus*; IC140982: *Amaranthus tetraphyllus*; IC141065: *Amaranthus moschatus*; IIHR1: *A. tetraphyllus*), are from wild back ground.

On the basis of two season research work, it was observed that the okra crop has more yield potential during rainy season but this season was not only favours growth and development of crop but also OYVMYV infestation. None of the genotypes showed higher yield potential coupled with high resistance to OYVMV during rainy season (Figures 1 and 2). The check varieties were also more prone to OYVMV during the rainy season than in summer. The incidence of the disease in a particular genotype also varied from season

to season, probably due to the influence of the environmental conditions. It is worth mentioning that Singh (1990) reported that hot weather with little rainfall was favourable for development of OYVMV and also for multiplication of the vector *Bemisia tabaci*. Earlier, other reports indicated that the incidence of OYVMV disease was higher during the rainy season when relative humidity was very high which support our findings (Sangar, 1997; Bhagat et al*.,* 2001; Chattopadhyay et al., 2011; Das et al., 2013).

Conclusion

It may be concluded that there was significant effect of season on yield and yield attributing traits as well as incidence of OYVMV in okra. While summer crop is early, higher values for yield attributing traits and yield were recorded in rainy crop. Rainy season favours incidence of OYVMV. However, this season also favours the morphological and reproductive phase of okra. Moreover, rainy season crop has more yield potential than summer season crop. From the large number of genotypes evaluated under this study, the genotypes IIHR123, IC90381, CI140982, IC141065, IIHR1, Kavya, IC32855 and IC99646 and check variety Arka Anamika had high potential and lower incidence for OYVMV. Hence, these genotypes could be utilized for further breeding programmes.

ACKNOWLEDGEMENTS

We thank NBPGR, New Delhi and IIHR, Bengaluru for providing okra germplasm and AICRP (Vegetable Crops) and BAU, Sabour for providing research facilities for the research work.

Conflict of Interests

The author(s) have not declared any conflict of interests.

REFERENCES

Anonymous (2012). Indian Horticulture Database. National Horticulture Board, OKRA, Ministry of Agriculture, Govt. of India, p.157.

Banerjee MK, Kalloo G (1987). Sources and inheritance of resistance to leaf curl virus in Lycopersicon spp. Theor. Appl. Genet. 73: 707-710.http://dx.doi.org/10.1007/BF00260780;PMid:24241195

Bhagat AP, Yadav BP, Prasad Y (2001). Rate of dissemination of okra yellow vein mosaic virus disease in three cultivars of okra. Indian Phytopathol. 54: 488-489.

Brunt AA, Crabtree K, Dallwitz MJ, Gibbs AJ, Watson L, Zurcher EJ (1996). Plant viruses online: descriptions and lists from the VIDE Database. Version: 20th August, 1996, http://biology.anu.edu.au/Groups/MES/vide/.

Chattopadhyay A, Dutta S, Chatterjee S (2011). Seed yield and quality of okra as influenced by sowing dates. Afr. J. Biotechnol. 10(28): 5461-5467.

Das S, Chattopadhyay A, Dutta S, Chattopadhyay SB, Hazra P (2013). Breeding Okra for Higher Productivity and Yellow Vein Mosaic Tolerance. Int. J. Veg. Sci. 19: 58–77. http://dx.doi.org/10.1080/19315260.2012.675024.

Dhankar BS, Dhankar SK (2002). Genetic variability, correlation and path analysis in okra (Abelmoschus esculentus L. Moench). Veg. Sci. 29(1): 63-68.

Gomez KA, Gomez AA (1984). Statistical Procedures for Agricultural Research (2nd Ed.). John Wiley and Sons. New York. p. 680.

Jose J, Usha R (2003). Bhendi yellow vein mosaic disease in India is caused by association of a DNA b satellite with a begomovirus. Virology 305: 2310-2317. http://dx.doi.org/10.1006/viro.2002.1768.

Khan Safdar Ali, Ma Habib A, Rasheed S, Iftikhar Y (2005). Management of Yellow Vein Mosaic Disease of Okra Through Pesticide/Bio-pesticide and Suitable Cultivars. Int. J. Agric. Biol. 7(1): 145-147.

Rana SC, Singh PB, Pandita VK, Sinha SN (2006). Evaluation of insecticides as seed treatment for control of early sucking pests in seed crop of okra. Ann. Plant Prot. Sci. 14: 364-367.

Sangar RBS (1997). Field reaction of bhindi varieties to yellow vein mosaic virus. Indian J. Virol. 13: 131-134.

Sastry KSM, Singh SJ (1974). Effect of yellow vein mosaic virus infection on growth and yield of okra crop. Indian Phytopath. 27: 294-297.

Solankey SS, Singh AK, Singh RK (2013). Genetic expression of heterosis for yield and quality traits during different growing seasons in okra (Abelmoschus esculentus). Indian J. Agric. Sci. 83(8): 17-21.