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Evaluation of promising interspecific hybrid derivatives of okra (*Abelmoschus esculentus* (L.) Moench)

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Okra [*Abelmoschus esculentus* (L.) Moench] is one of the important warm season vegetables grown in the tropical and sub tropical parts of the world. The main limiting factor in the cultivation of this crop is yellow vein mosaic virus (YVMV). The loss due to YVMV is in the range of 50 to 95 per cent depending on the stage of the crop growth at which infection occurs (Sastry and Singh, 1974). The resistant varieties developed by various research organizations by interspecific hybridization have started showing the signs of susceptibility. So it is imperative to find diverse sources of resistance to YVMV and transfer the same to the cultivated species.

In this regard to transfer YVMV resistance from 'Susthira' (*A. caillei*) to 'Salkeerthi' (*A. esculentus*) interspecific hybridization was done between them and the generations were advanced up to F_8 in previous research works. In the present study F_9 generation was evaluated for YVMV resistance and other desirable traits.

The experiment was carried out in the Department of Olericulture, College of Horticulture, Kerala Agricultural University, Vellanikkara during June to October 2011. The experiment was laid out in Randomized Completely Block Design with 2 replications. Fifteen treatments involving twelve F_9 generation selections along with their parents and Arka Anamika were evaluated in plot size of 4.5x1.8 m with a spacing of 60 x 45 cm. Observations were recorded for twenty quantitative and seven qualitative traits. The mean values were used for statistical analysis. The genotypic and phenotypic coefficients of variation, heritability, genetic advance, genotypic and phenotypic correlation coefficients were worked out according to Jain (1982).

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The screening for YVMV resistance was done by field evaluation creating artificial epiphytotic conditions by planting highly susceptible YVMV lines all around the field. Based on per cent disease incidence and severity, coefficient of infection (CI) was worked out as suggested by Datar and Mayee (1981). Artificial inoculation of YVMV through grafting and whitefly inoculation techniques suggested by Kapoor and Varma (1950) were followed to confirm the level of resistance.

Table 1: Genetic parameters for different quantitative characters

Characters	PCV	GCV	Herita-bility	Genetic advance
Plant height (cm)	5.01	4.97	98.2	14.89
Internodal length (cm)	10.76	10.59	96.9	2.11
Number of primary branches	5.76	5.61	94.9	0.35
Length of epicalyx segment (cm)	14.59	14.18	94.5	0.58
Width of epicalyx segment (cm)	25.64	25.58	99.5	0.37
Petiole length (cm)	4.60	4.06	77.8	2.60
Days to flower	7.83	7.70	96.9	8.02
Days to first harvest	7.5	7.34	95.7	8.43
Number of harvests	11.10	10.70	92.9	2.44
First fruiting node	8.59	8.36	94.7	0.95
Length of fruit (cm)	23	22.97	99.7	8.56
Girth of fruit (cm)	3.42	3.37	97.3	0.54
Locules per pod	4.45	4.27	91.9	0.5
Number of fruits per plant	11.93	11.78	97.5	2.83
Number of ridges per pod	4.25	4.16	95.7	0.5
Crop duration (days)	1.39	1.31	88.9	4.22
Yield per plant (g)	3.26	3.21	96.7	11.58
Pollen sterility (%)	63.16	63.16	99.9	3.01
Mucilage content (g/100g)	48.29	47.85	98.2	0.45
Coefficient of infection (CI)	135.93	135.92	99.9	34.17

Table 2: Details of the quantitative and qualitative characters expressed by the promising selections in the F_9 generation in comparison with parents and Arka Anamika

Character	(F_9-5-5)	(F_9-6-8)	(F_9-8-14)	(F_9-9-23)	*A.c**(P1)	*A.e** (P2)	*Arka Anamika*
Qutantitative characters							
Plant Height (cm)	100.23	120	97	105	143.7	123	140
Internodal length (cm)	4	8	6	8	7.8	12.2	10
No. of primary branches	3	4	3	3	3	3	3.3
Length of epicalyx segment (cm)	1.7	2.1	2.2	2.0	1.3	2.2	2.0
Width of epicalyx segment (cm)	0.5	0.6	0.8	0.5	1.1	0.5	0.6
Petiole length (cm)	31	25	29	27	34	30.2	34
Days to flower	42	47	52	46	47	39.2	47
Days to first harvest	48	52	58	51	52.6	44.2	52
No. of harvests	8	9	8	6	11	14	11
First fruiting node	4	5	5	4	4.6	4	5
Length of fruit (cm)	18	22	19	22	16.8	27.9	18
Girth of fruit (cm)	6.4	5.9	6.5	5.8	8.4	7.4	7.5
Locules per pod	5	5	5	5	6	5	6
No. of fruits per plant	25	24	17	20	12	15	15
No.of ridges per pod	5	5	5	5	6	5	5
Crop duration (days)	149	154	153	155	171.6	167.3	145
Yield per plant (g)	278	285	192	210	177.3	191.4	178.01
Pollen fertility (%)	98.54	97.89	97.52	98.45	99.9	99.5	96.57
Mucilage content (g/100g)	0.27	0.59	0.49	0.53	1.12	0.25	0.33
YVMV reaction	HR	HR	HR	HR	HR	HS	MS
Qualitative characters							
Pod pubescence	NP	NP	NP	NP	NP	NP	NP
Leaf margin	DF	NF	DF	NF	NF	DF	DF
Flower colour	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Flower size	Medium	Large	Large	Large	Medium	Medium	Medium
Purple throat at base of corolla	Present	Present	Present	Present	Present	Present	Present
Colour of leaf vein	GWPT	GWPT	GWPT	GWPT	GWPT	GWPT	GWPT
Colour of leaf base	RWGT	RWGT	RWGT	RWGT	RWGT	RWGT	RWGT
Colour of fruit	DG	G	G	DG	G	LG	G

G-Green
DG- Dark Green
LG- Light Green
HR- Highly Resistant
GWPT- Green with purple tinge
DF-Deeply fid
NP- Not pubescent
LP- Less pubescent
NF- Narrowly fid
HS-Highly susceptible
A.c * - *A. caillei*
A.e * - *A. esculentus*

The pollen fertility per cent was also assessed by calculating the mean stained and unstained pollen grains. One per cent acetocarmine was used to know the pollen fertility.

Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) are better indices for comparison of characters with different units of measurements. High GCV and PCV values were exhibited by incidence of YVMV (Table 1). Duration of the crop and girth of fruit exhibited low phenotypic and genotypic coefficient of variation. The low variability noticed for these characters indicate the difficulty in improving these characters by selection.

High heritability together with high genetic advance is an important requirement for selection programme. High heritability was observed for all the 20 characters under study which indicates that the environment plays a little role on inheriting these traits to progenies. High heritability coupled with high genetic advance was shown by incidence of YVMV (Table 2). This indicates the presence of additive genes and shows that these characters can be improved by selection. Chaukhande *et al*. (2011) reported high genetic advance for above character.

Significant positive phenotypic and genotypic correlation with yield was shown by fruit length, crop duration

and fruits per plant indicating that an improvement of these characters will produce a simultaneous improvement in yield.

Mucilage content in the parental species *A. esculentus* variety Salkeerthi was as low as 0.25 g/100g and *A. caillei* variety Susthira recorded 1.12 g/100g which is very high among all the genotypes under study. Similar results were obtained by Ravisankar (2002). In the F_9 generation lines, it ranged from 0.27-0.62 g/100g. Variety Arka Anamika recorded 0.33 g/100g.

The pollen fertility in *A. esculentus* and *A. caillei* were 99.9 and 99.5 per cent respectively due to their regular chromosome behavior during meiosis. Similar results were reported by Jaseena *et al*. (2008). Pollen stainability in the F_9 lines varied from 94.18 to 98.75 per cent while it was 96.57 per cent in Arka Anamika.

In the field screening trials the *A. esculentus* var. Salkeerthi was highly susceptible to YVMV (CI=69.21) whereas *A. caillei* var. Susthira was highly resistant (CI=0). In F_9 lines, six were highly resistant (F_9-4 F_9-5, F_9-6, F_9-8, F_9-9, F_9-10) and remaining were moderately susceptible (CI=28.37) to YVMV. The check variety Arka Anamika was also moderatey susceptible (CI=24.96)

For the confirmation of disease resistance, whitefly transmission studies were carried out. Six genotypes (F_9-4, F_9-5, F_9-6, F_9-8, F_9-9, F_9-10) which found as highly resistant in the field screening were inoculated by viruliferous whiteflies carrying YVMV. Variety Salkeerthi served as control. All six genotypes remained resistant and did not show any disease symptoms even after 40 days of inoculation whereas, *A. esculentus* var. Salkeerthi showed typical symptoms of YVMV within 30 days of inoculation. Kousalya (2005) have adopted whitefly transmission for artificial screening of okra genotypes against YVMV.

Out of the six selections tested, only two selections showed symptoms and other four selections (F_9-5, F_9-6, F_9-8 and F_9-9) were completely free of YVMV in graft transmission confirming the true resistance of these genotypes. The present study also showed that graft transmission technique is more effective method for screening of YVMV in okra.

Promising lines from F_9 generation

Out of the F_9 generation, four individual plant selections viz., F_9-5-5, F_9-6-8, F_9-8-14 and F_9-9-23 were made. The prominent features of these F_9 selections were that they expressed high level of resistance to YVMV (CI=0), earliness, yield per plant, high pollen fertility (97.52 to 98.54 per cent), less mucilage content (0.27-0.59 g/100g) and prominent morphological characters of *A. esculentus* (Table 2) This clearly shows that breeding programme of developing YVMV resistant okra genotypes with desirable qualitative and quantitative traits had proceeded in the right direction. Further advancing these lines made from the F_9 generation will be able to develop high yielding and YVMV resistant okra varieties in the near future as reported by Sureshbabu and Dutta (1990).

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