Evaluation of Okra Germplasm for Fruit Yield, Quality and Field Resistance to Yellow Vein Mosaic Virus

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Field experiments were conducted with 941 indigenous and exotic germplasm of okra [*Abelmoschus esculentus* (L.) Moench] at the Regional station of National Bureau of Plant Genetic Resources, Thrissur, Kerala from 1999-2001 to identify high yielding okra germplasm coupled with acceptable fruit quality and field resistance to yellow vein mosaic virus (*YVMV*). During the preliminary germplasm evaluation, 62 high yielding accessions were identified and were subjected to further evaluation in order to confirm the stability of desired traits for which they were selected. As regard to fruit yield per plant, indigenous accession IC 265147 collected from Thrissur district of Kerala performed better than all others did. Fruit colour, pubescence, shape, thickness, mucilage content and taste of fruits were considered together for assessing fruit quality. Based on 1 to 9 point quality score chart the accessions were grouped into four quality groups viz. low, medium, good and excellent. Accessions IC 43735, 43736, 43720, 128088, 39137A, 111500 and 265147 recorded high fruit yield per plant coupled with better fruit quality hence qualifying themselves for entry into breeding programme. Screening of these germplasm for *YVMV* field resistance under natural epiphytotic condition revealed that none of the accession was 'immune' or 'highly resistant,' 43 were 'moderately resistant', three accessions viz., IC 218887, IC 69286 and EC 305619 were 'resistant' and the rest were susceptible. The results also revealed that none of the yellow vein mosaic virus disease resistant accessions were exceptionally high yielding or *vice versa.*

Key Words: *Abelmoschus esculentus*, Field resistance, Fruit quality, Okra, Yield, *YVMV*

Among the diseases of okra [*Abelmoschus esculentus* (L.) Moench], bhendi yellow vein mosaic bigeminivirus (*YVMV*) happens to be the most devastating one. This disease considerably reduces fruit yield and fruit quality (Bhagabati *et al.*, 1998). Since cultivation of disease resistant lines is more economical and environmentally safe, screening germplasm for inbuilt resistance coupled with high yield and acceptable fruit quality becomes imperative. Many workers (Sharma and Sharma, 1984; Salehuzzaman, 1985; Bisht *et al.*, 1988; Arora *et al.*, 1992) have screened okra germplasm and have reported the presence of genotypic differences for *YVMV* field resistance. The National Bureau of Plant Genetic Resources has also screened as many as 1400 indigenous and exotic okra germplasm for field resistance to *YVMV* (Thomas *et al.*, 1990 & 1991; Bisht *et al.*, 1993). Wherever resistant source to *YVMV* have been identified, it could not be directly exploited due to their poor yield or other undesirable characters associated with resistance. It is, therefore, necessary to screen genetically divergent germplasm to identify high yielding okra lines that posses not only resistance to the virus but also bear quality fruits. The present study was planned and conducted in this direction.

The experiments were carried out in a phased manner at the Regional Station of National Bureau of Plant Genetic Resources, Thrissur, Kerala from 1999-2001. In a preliminary study on characterisation and evaluation involving 941 okra accessions raised in augmented design, 62 lines exhibiting high fruit yield (over the check, yielding 7.60 fruits/plant), fruit quality and field resistance to *YVMV* were selected. During 2001, these accessions were evaluated in a completely randomized block design in two replications, under natural epiphytotic condition, to screen them for field resistance to *YVMV* and assess their fruit yield and quality. One row of susceptible check (IC 248257) was raised at every fifth row among the lines of test genotypes to ensure generation of adequate virus inoculums and insect vector in order to promote better chance of infection. Observation on fruit yield per plant, fruit quality and field resistance to *YVMV* were recorded.

For assessing physical fruit quality, freshly harvested tender fruits from each accession were taken and based on fruit colour, pubescence, shape, thickness, mucilage and taste comparative quality score were recorded in 1 to 9 point scale. The accessions were then grouped into four classes of fruit quality namely, low (score 1 to 3), average (4 to 5), good (6 to 7) and excellent (8 to 9).

YVMV disease severity was scored using 0 to 5 point scale. Based on the score, percent disease severity (PDS) and percent disease incidence (PDI) was calculated. From

PDS & PDI, coefficient of infection (CI) was arrived (Deo *et al.*, 2000). Based on CI, the accessions were categorized into six groups viz., 'highly resistant' (CI = 0 to 5),' resistant' (5 to 10), 'moderately resistant' (10 to 20), 'moderately susceptible' (20 to 40), 'susceptible' (40 to 70) and 'highly susceptible' (70 to 100).

Analysis of variance among 62 lines for fruit yield, fruit quality and coefficient of infection for *YVMV* indicated significant differences due to genotypes (Table 1), hence substantial variability in the germplasm collection for these traits exist. Fruit yield varied from 3.63 fruits/plant in IC 248257 to 17.50 fruits/plant in IC 265147. Twenty-three accessions recorded significantly higher yield as compared to check variety (Table 2). IC 265147, a collection from Thrissur district of Kerala, outperformed all others for number of fruits per plant followed by IC 39137-A, IC 43750-B and IC 43720. Fruit quality of these accessions was good. Four accessions viz., IC Nos. 128088, 140926, 43720 and EC 329422 showed better vigour with few fruit bearing branches. In homestead cultivation, with unlimited input supply, these accessions may serve as ideal genotypes.

From 941 active germplasm accessions, eleven accessions bearing more palatable and sweet fruits were identified. On further testing, most of them were found susceptible to red ant; black ant and fruit rot (*Choanephora cucurbitarum*). However, three exotic collections viz., EC 329424, EC 329361, EC 329359 remained free from fruit rot infection. Two accessions IC 140907 and IC 282252 had long fruits (> 25 cm) with less mucilage and slow fibre formation. Therefore, delay in harvest for one or two days may not affect the fruit quality drastically. However, these two accessions secured minimum fruit quality score due to their unattractive yellowish fruit colour. In North India, where short fruits are preferred IC 43736 may serve as the best choice.

Table1. ANOVA for number of fruits per plant, fruit quality scoring index (FQSI) and coefficient of infection (CI) for *YVMV* in 63 okra germplasm accessions

Source of Variation	Degrees of freedom	Mean squares		
		No. of fruits/plant	FQSI	CI
Replication	1	1.63	3.84	405414.93 *
Treatment	62	8.35 **	6.69 **	100698.31 **
Error	62	1.61	1.76	10110.98

*, ** refers to significant at P= 0.05 and 0.01 respectively.

Table 2. Merits and demerits associated with 24 (out of 63) selected high yielding okra germplasm

Sl. No.	IC / EC Nos.	Fruit No/ plant	Fruit quality score	Desirable features	Undesirable features
1	IC 33332	9.22	5.67	Early flowering	Poor keeping quality
2	IC 43720	10.26	5.33	Suitable for kitchen garden	Fruit quality and susceptible to YVMV
3	IC 43750 B	10.19	7.00	Earliness	-
4	IC 43735	9.65	8.67	Earliness and quality fruits	-
5	IC 43736	9.73	3.67	Short fruit	-
6	IC 43741	7.60	7.00	Fruit quality	-
7	IC 45799	8.63	1.33	-	Hairy fruits and susceptible to YVMV
8	IC 282236	7.69	6.00	Earliness	-
9	IC 282241	9.16	6.67	-	Susceptible to fruit rot
10	IC 128076	7.81	6.67	-	-
11	IC 128088	8.10	4.67	Branched, suitable for kitchen garden	-
12	EC 329422	9.57	5.33	Branched, suitable for kitchen garden	Susceptible to YVMV
13	IC 282268	8.11	6.00	Attractive fruits	Susceptible to fruit rot
14	EC 169331	8.32	7.33	Long slender fruits	-
15	IC 34190	9.05	7.00	-	-
16	IC 34190 A	8.32	7.00	Earliness	Twisted fruits and susceptible to fruit rot
17	IC 39137 A	10.10	6.00	Dark green fruits	-
18	IC 42485 B	8.93	6.67	Early	-
19	IC 90251	8.07	8.00	-	Susceptible to YVMV and fruit borer
20	IC 111488	8.87	5.00	-	-
21	IC 111500	9.64	5.67	Ideal plant type	Light green fruits
22	IC 265648	8.50	2.33	-	Photosensitive
23	IC 265147	17.50	8.00	-	-
24	IC 218895	8.24	7.67	Long fruits	Spiny fruits and susceptible to YVMV
Check (Pusa Sawani)		**7.60**	**6.67**		
Grand mean for 63 accessions		**7.42**	**5.87**		
CD	**2.60**	**0.37**			
CV (%)	**17.26**	**22.59**			

Another indigenous collection IC 218887 exhibited deep purple fruit with high quality score. However, it remained poor yielder throughout the study period. Pubescence on fruits varied from downy to prickly. Introgressed hybrid derivative (naturalized) between *Abelmoschus manihot* ssp. *tetraphyllus* (L.) and *A. esculentus*, namely IC 43745, IC 45799 and EC 305745 had spiny fruits which were difficult to harvest and not consumable.

The study also indicates that more than 50 per cent of the accessions identified for high yield were associated with undesirable traits like poor fruit quality, susceptibility to *YVMV*, fruit rot, etc. Only few accessions *viz.*, IC Nos. 43735, 43736, 43720, 128088, 39137A, 111500 and 265147 possessed good quality fruits with high yield hence, recommended for inclusion in okra improvement programme.

Reaction of 62 germplasm accessions and check variety Pusa Sawani to *YVMV* is presented in Table 3. The result showed that the virus infected all accessions under study. However, the degree of severity varied from accession to accession. None of the germplasm accession was 'immune' or 'highly resistant' to this disease. Nath *et al.* (1999) also reported that no cultivated variety is immune to this disease. Based on coefficient of infection, three accessions viz., IC 218887, IC 69286 and EC 305619 were grouped under 'resistant' category, 43 under 'moderately resistant', five as 'moderately susceptible' and 12 as 'highly susceptible' categories. Of the three accessions under field resistance category, one (IC 218887) was a poor yielder and the other two (IC 69286 and EC 305619) had poor fruit quality.

To sum up, none of the indigenous and exotic germplasm of *A. esculentus* was 'immune' or 'highly resistant' to *YVMV* under field condition. Even germplasm exhibiting moderate degree of field resistance to *YVMV* did not record high yield or bear quality fruits. Under such circumstances, screening of lines showing field resistance to *YVMV* with high yield and quality in the cultivated species may not yield the desired results whereas that for lines having any one of these quality appears to be a rational approach in order to introgress the desired genes. Perhaps, transfer of gene(s) for resistance available from related wild species to the high yielding cultivars with better fruit qualities may be rewarding as reported by Nerkar and Jambhale (1985).

Table 3. Grouping of okra genotypes based on their field resistance to YVMV

S.No.	IC / EC Nos.	CI	Resistant category
1	IC 69286	5.6	Resistant
2	IC 218887	7.2	Resistant
3	EC 305619	7.2	Resistant
1	IC 43720	70	Highly susceptible
2	IC 45799	74	Highly susceptible
3	IC 218894	72	Highly susceptible
4	IC 282240	70	Highly susceptible
5	EC 329359	88	Highly susceptible
6	EC 329422	76	Highly susceptible
7	IC 90234	100	Highly susceptible
8	IC 90251	73	Highly susceptible
9	IC 93777	73	Highly susceptible
10	IC 282270	71	Highly susceptible
11	IC 248257	100	Highly susceptible
12	IC 265626	71	Highly susceptible
1	IC 282252	21.60	Moderately susceptible
2	IC 90230	22.40	Moderately susceptible
3	IC 265648	23.00	Moderately susceptible
4	IC 140906	22.40	Moderately susceptible
5	IC 18540	23.50	Moderately susceptible
1-43	IC Nos.-33340, 128076, 45803, 113904, 282241, 218889, 882272, 128072, 128088, 282268, 169331, 34190, 39137-A, 52322, 90295, 99724, 111488, 111500, 111507, 117221-A, 117308, 256154, 265147, 43741, 43744, 43750, 33332, 43733, 43735, 43736, 782236, 15435, 34190-A, 42485-B, 429424, 329361, 282285, 218870, 140926, 140907, 182232, and Pusa Sawani	10-19.5	Moderately resistant

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