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Studies on genetic variability of nutritional traits among YVMV tolerant okra germplasm

Rahul Kumar, R.K. Yadav*, Rakesh Bhardwaj, V.K. Baranwal*** and H. Chaudhary**

Division of Vegetable Science, ICAR-Indian Agricultural Research Institute, New Delhi 110012

ABSTRACT

Thirty diverse okra genotypes were evaluated for 19 quality traits during the rainy season 2013. It was evident from the results that the genotypes, namely, DOV-11, DOV-66, DOV-24 and DOV-12 were recorded with no incidence of *Bhendi Yellow Vein Mosaic Virus* (BYVMV) after 30 days of sowing. No incidence of BYVMV disease was recorded in genotypes DOV-12 and DOV-66 even after 90 days of sowing. The popular variety, Pusa Sawani recorded 94% BYVMV incidence after 90 days of sowing. Mucilage content was found maximum in genotype Punjab Padamini (5.73%) and least in DOV-26 (3.35%). Genotypes Arka Abhay and USDO-2546 recorded maximum dietary fibre content (0.09 g/g). Based on path-coefficient analysis protein, dietary fibre, chlorophyll a and b and carotenoids content showed high positive direct effect on yield/ plant. Genotypes USDO-2546, Punjab Padmini and Arka Abhay were found suitable for utilizing in future breeding programme for developing variety with high nutritional quality. However, DOV-12 and DOV-66, which were having dark green pods were most desirable genotypes for BYVMV resistance and higher yield.

Key words: *Abelmoschus esculentus*, correlation, genetic advance, genetic variability, heritability, quality traits, path-analysis.

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench), which belongs to Malvaceae family, is an important fruit vegetable grown throughout the tropics and warmer parts of the temperate zone. India is the largest producer of okra with 6.35 million tonnes (72.9% of total world production) from 0.53 million ha area (NHB Database, 11). Tender pods of okra are used as delicious vegetable. The pod quality traits like pod colour, pod length, pod diameter, number of ridges per pod, fibre content in pod mainly determine the acceptability of the hybrids and varieties. There is limited information available about the quality traits mainly mineral, vitamins and other antioxidant compounds present in okra. Apart from these, the okra crops heavily suffer from several biotic factors, which cause significant loss to the growers. About 19 plant viruses are reported to be responsible for causing different diseases to this crop of which *Bhendi Yellow Vein Mosaic Virus* disease is the most destructive viral disease (Jose and Usha, 9). Therefore, any variety without YVMV resistance has limited scope for its consideration. Resistance to *Bhendi* YVMV has become an integral part of okra improvement programmes. At present most of the released okra varieties at were earlier developed as YVMV resistant, are no more fully resistant, therefore, identification of new sources of resistance is the need of hour. Presently, limited information is available about the YVMV resistant genotype with desirable fruit quality traits. Keeping above points in view, the present study was carried out to estimate genetic diversity, genetic advance, characters association and direct and indirect effects on yield and quality traits of okra, which will help in its further improvement.

MATERIALS AND METHODS

The present investigation was carried out at the Research Farm of Division of Vegetable Science, ICAR-IARI, New Delhi during the *kharif* season of the year 2013. The experimental material consisted of 30 promising and diverse lines/ varieties of okra available with different institutes/ organizations in the country. The crop was raised following the standard cultivation practices with three replications in randomized complete block design. The biochemical analysis for 19 traits was conducted as per standard procedures mentioned by Ranganna (13). Mineral content in okra pod was determined by atomic absorption spectrophotometer (Model- GBC, Perkin Elmer, Inc., Shelton, CT, USA) according to Jackson (7). The texture of pod were measured using the methodology described by Bouvier *et al*. (4) using the texture analyzer (Model: *TA+HDi*, Stable Micro Systems, UK) attached with 500 kg load cell. Phenotypic and genotypic components of variance were estimated by

*Corresponding author's E-mail: rkyadavneh@gmail.com

**ICAR-NBPGR, New Delhi

***Division of Plant Pathology, ICAR-IARI, New Delhi

using the formula given by Cochran and Cox (5). The expected genetic gain or advance for each character was estimated by using the method suggested by Johnson *et al*. (8). Genotypic correlation between two characters was determined by using the variance and covariance components as suggested by Al-Jibouri *et al.* (3). Path coefficient analysis was carried out using phenotypic correlation values of yield components on yield as suggested by Wright (14) and illustrated by Dewey and Lu (6).

RESULTS AND DISCUSSION

The combined mean performance of 30 okra genotypes for quality traits indicated that there were significant differences among them with respect to different characters under study. Four genotypes, namely, DOV-11, DOV-66, DOV-24 and DOV-12 recorded no incidence of BYVMV after 30 days of sowing (Table 1). However, genotypes, namely, Arka Abhay and Arka Anamika recorded 14.82 and 37.26% BYVMV infestation after 30 days of sowing,

Table 1. Per cent incidence of *Bhendi Yellow Vein Mosaic Virus* disease and pod yield in 30 okra genotypes.

Genotype	Disease incidence (%)			Pod yield	
	(30 DAS)	(60 DAS)	(90 DAS)	Yield/ plant (g)	Yield (q/ha)
Arka Abhay	14.82	56.48	85.18	91.33	53.33
Arka Anamika	37.26	56.86	85.29	91.33	48.00
DOV- 11	0.00	6.09	6.89	157.67	137.25
DOV-2	1.15	5.75	17.78	148.00	125.26
DOV-4	8.60	16.13	33.33	119.25	81.25
DOV-62	11.76	37.25	41.18	105.45	77.61
DOV-64	10.18	21.29	25.93	155.67	115.61
DOV-66	0.00	0.00	0.00	163.67	141.52
Hissar Unnat	30.43	39.13	42.03	115.25	75.01
DOV-152	11.11	23.61	27.78	147.33	98.67
DOV-26	11.59	20.94	28.97	133.00	99.67
DOV-29	4.55	8.64	11.21	137.67	105.00
IC-09491	35.42	48.13	52.05	88.00	74.25
USDO-2546	1.96	4.90	12.75	110.50	94.25
USDO-2730	2.78	12.04	15.07	125.42	115.42
P-7	8.33	23.33	30.00	108.00	118.25
P-8	2.61	5.76	15.76	114.00	83.33
Parbhani Kranti	6.94	7.72	29.17	140.00	125.61
Punjab Padmini	6.41	27.69	33.33	125.00	91.74
Pusa A4	9.68	45.16	53.76	69.52	65.15
DOV-24	0.00	0.74	3.85	149.00	121.51
DOV-23	23.19	30.44	36.23	149.67	116.25
DOV-12	0.00	0.00	0.00	142.33	110.20
DOV-27	22.22	27.16	33.33	153.00	125.41
Varsha Uphar	26.67	46.67	50.67	139.33	88.00
VRO-21	20.83	40.63	45.84	148.33	87.67
VRO-5	20.84	35.42	36.46	149.00	114.15
VRO-6	18.28	44.09	46.24	144.00	79.52
DOV-22	23.33	27.78	32.22	143.00	101.00
Pusa Sawani (C)	22.00	73.67	94.00	66.00	48.67
$CD_{0.05}$	5.35	6.19	6.73	9.71	8.49

DAS = days after sowing

respectively. Even after 90 days of sowing no disease incidence was recorded in genotypes DOV-12 and DOV-66, while Pusa Sawani recorded 94% BYVMV incidence during same period. It was also noticed that previously bred resistant genotype, Pusa Sawani recorded the maximum YVMV incidence and was found highly susceptible. Two popular varieties, namely, Arka Abhay and Arka Anamika also recorded 85.18 and 85.29% BYVMV incidence respectively after 90 days of sowing (Table 2). Therefore, it was concluded that the genotypes, namely, DOV-12 and DOV-66 can be grown in virus prone areas during *kharif* season (July-October).

Mean, range, PCV, GCV, heritability (h^2), and genetic advance as per cent over mean of quality traits in 30 genotypes is presented in Table 3. Sugar content ranged from 1.30 to 6.55% (USDO-2546) and mean value of ascorbic acid content was found maximum in genotype P-7 (13.33 µg/g) and minimum in DOV-24 (7.06 µg/g). Genotype VRO-21 (9.66) was found better in fruit texture followed by DOV-22 (8.91). Ash content (%) ranged from 0.60 (VRO-6) to 2.00 (Punjab Padamini). Mucilage content, which is important from nutrition viewpoint, was also found maximum in genotype Punjab Padmini (6.10%), while least was in genotype DOV-26 (3.35%). There was significant variation in mucilage content in different okra genotypes. Genotypes with high mucilage also recorded high value of sugars. Mucilage yield from the various accessions of okra were also significantly variable in the study conducted by Ahiakpa *et al*. (1). Protein content, another important trait from nutrition viewpoint, was found maximum in USDO-2546 (2.75%) and minimum in DOV-26 (1.37%) with mean value of 1.78%. Quite high genotypic differences were recorded in phenol content, which ranged from 5.74 (DOV-2) to 25.05 mg/g (Varsha Uphar). Among minerals, maximum content of calcium was recorded in Arka Abhay (6.75 ppm), iron in DOV-27(1.6 ppm), magnesium in DOV-29 (2.84 ppm) and copper in P-8 (0.69 ppm). Flavonoids were recorded maximum in Parbhani Kranti (4.15 mg/ g) followed by Punjab Padmini (3.86 mg/g). Dietary fibre content, a desirable nutritional trait was recorded maximum (0.09 g/g) in genotype Arka Abhay and USDO-2546, while it was low in DOV-26, DOV-29, P-7 Varsha Uphar and VRO-6 (0.03 g/g). Total leaf carotenoid content ranged from 0.14 to 2.10 mg/g (Table 2). Genotypes USDO-2546, Punjab Padmini and Arka Abhay can be utilized in future breeding programme

Table 2. Mean, range, PCV, GCV, heritability (h^2), genetic advance (GA) and genetic advance as per cent over mean of quality traits of 30 okra genotypes.

Trait	Mean	Range		PCV	GCV	Heritability	GA	GA as % mean
		Min.	Max.					
Total sugars (%)	3.59	1.30	6.55	37.25	36.31	95.00	2.61	72.78
Ascorbic acid (µg/g)	9.82	7.06	13.33	19.41	18.13	87.20	3.42	34.83
Fruit texture	7.25	3.60	9.70	20.71	20.17	94.90	2.93	40.43
Ash (%)	1.10	0.60	2.00	31.54	31.42	99.30	0.71	64.26
Moisture (%)	89.41	84.80	93.70	2.87	2.59	81.40	4.31	4.82
Mucilage (%)	4.23	3.35	6.10	22.41	12.48	31.00	0.61	14.43
Protein (%)	1.78	1.30	2.75	24.41	19.59	64.40	0.58	32.50
Mg (ppm)	2.28	1.64	2.84	16.26	13.18	65.80	0.50	21.89
Fe (ppm)	1.08	0.49	1.60	31.29	25.50	66.40	0.46	42.43
Ca(ppm)	4.06	2.84	6.75	20.67	19.60	89.90	1.55	38.22
CU (ppm)	0.44	0.26	0.70	27.33	9.65	12.50	0.03	6.80
Mn (ppm)	0.27	0.19	0.32	16.46	10.63	41.70	0.04	15.04
Phenols (mg/g)	15.90	5.74	25.05	31.66	31.23	97.30	10.09	63.45
Flavanoids (mg/g)	2.29	0.46	4.15	42.68	42.36	98.50	1.98	86.44
Dietary fibre (g/g)	0.05	0.03	0.09	42.35	30.19	50.80	0.02	37.32
Chlorophyll a (mg/g)	0.79	0.18	1.99	49.86	49.76	99.60	0.80	101.89
Chlorophyll b (mg/g)	0.64	0.18	1.37	47.47	43.85	85.40	0.54	83.80
Total chlorophyll (mg/g)	1.43	0.37	3.35	44.78	44.09	96.90	1.28	89.54
Carotenoids (mg/g)	1.12	0.14	2.10	61.76	61.76	99.50	1.42	126.85

Table 3. Genotypic correlations among quality traits in 30 okra genotypes.

Trait	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Total sugars (%)	1.00	-0.06	-0.41*	0.41*	-0.55**	0.65**	0.52**	0.10	0.20	0.23	0.42*	-0.01	-0.13	-0.10	0.48**	0.13	-0.01	0.07	0.09	-0.19
Ascorbic acid (µg/g)		1.00	-0.19	-0.26	0.22	-0.29	0.03	-0.12	0.01	0.08	-0.63**	0.56**	-0.08	-0.25	0.04	-0.12	-0.09	-0.12	-0.20	0.19
Fruit texture			1.00	-0.23	0.07	-0.71**	-0.10	0.07	-0.25	-0.44**	0.16	0.24	0.11	0.14	-0.21	-0.04	-0.01	-0.03	-0.01	0.26
Ash (%)				1.00	-0.83**	0.58**	0.78**	-0.11	-0.03	0.35*	0.01	-0.46**	-0.09	-0.01	0.75**	0.15	-0.07	0.06	0.13	-0.39*
Moisture (%)					1.00	-0.36*	-0.89**	-0.04	0.04	-0.48**	0.06	0.22	0.11	0.15	-0.72**	-0.11	0.27	0.05	-0.05	0.19
Mucilage (%)						1.00	0.28	0.13	0.04	0.11	0.65**	-0.30	-0.02	0.13	0.64**	0.37*	0.36*	0.39*	0.43*	-0.31
Protein (%)							1.00	-0.08	0.06	0.34	0.10	0.20	-0.19	-0.16	0.73**	0.05	-0.27	-0.09	-0.03	-0.21
Mg (ppm)								1.00	-0.09	-0.11	0.35*	-0.36*	0.36*	0.08	-0.24	0.10	0.20	0.15	0.11	0.20
Fe (ppm)									1.00	0.02	0.09	0.15	-0.31	-0.24	0.15	-0.18	-0.33	-0.26	-0.21	0.22
Ca (ppm)										1.00	-0.47*	-0.32	-0.33	-0.49**	0.43*	-0.04	-0.25	-0.14	-0.13	-0.35*
Cu (ppm)											1.00	0.07	0.21	0.27	0.02	-0.18	0.17	-0.03	-0.10	-0.31
Mn (ppm)												1.00	-0.14	0.01	-0.16	-0.28	-0.27	-0.29	-0.33	0.67**
Phenols (mg/g)													1.00	0.78**	-0.31	0.35*	0.32	0.36*	0.38*	0.17
Flavanoids (mg/g)														1.00	-0.25	0.20	0.3*	0.29	0.29	0.08
Dietary fibre (g/g)															1.00	0.27	-0.08	0.14	0.21	-0.29
Chlorophyll a (mg/g)																1.00	0.75**	0.95**	0.98**	0.05
Chlorophyll b (mg/g)																	1.00	0.91**	0.82**	-0.08
Total chlorophyll (mg/ g)																		1.00	0.98**	-0.01
Carotenoids (mg/ g)																			1.00	0.04
Yield /plant																				1.00

**,*Significant at 1 and 5% levels

for developing varieties/lines with better nutritional quality.

Phenotypic coefficient of variations (PCV) was higher than the corresponding genotypic coefficient of variations (GCV) in all the traits under study (Table 2). There was narrow gap between PCV and GCV for almost all the traits except, mucilage (22.41 and 12.48), Cu content (27.33 and 9.65), dietary fibre (42.35 and 30.19), protein (24.41 and 19.59), Fe contents (31.29 and 25.50) and Mn (16.46 and 10.63) contents, showing that for these traits environment also played important role in total variation rather than genotype itself. High GCV was also recorded for leaf carotenoids content (61.76) followed by chlorophyll content (49.76).

Heritability (h^2) in broad sense was high in most of the quality traits except, mucilage (31.00%), Cu content (12.50%), Mn content (41.70%) and dietary fibre (50.80%). High heritability coupled with high genetic advance as per cent over mean was recorded in leaf carotenoid content (99.50 and 126.85, respectively) and chlorophyll a content (99.60 and 101.89, respectively). It demonstrated the pre-ponderance of additive genes in controlling the expression of these traits and thus, providing better opportunity for effective and reliable selection for these traits. These findings were also corroborated with the findings of Prakash and Pithaimuthu (12) and Akotkar *et al.* (2). Similarly, Mogili *et al*. (10) observed high GCV and heritability for yield/ plant and YVMV incidence in okra.

Genotypic correlation coefficients presented in Table 3 showed that sugar percentage had highly significant and positive correlation with mucilage (0.65), protein (0.52) and dietary fibre (0.48), while highly significant and negative correlation with moisture % (-0.55). It also showed positive and significant correlation with Cu (0.42). Ascorbic acid, an important trait showed highly significant and positive correlation with Mn (0.56), while it showed highly significant and negative correlation with Ca (-0.63). Ash content showed highly significant correlation in positive direction with mucilage (0.58), protein (0.78) and dietary fibre (0.75). Okra mucilage was highly significant and positively correlated with Cu (0.65) and dietary fibre (0.64), while it was significantly and positively correlated with chlorophyll a, b, total chlorophyll and carotenoid content (0.37, 0.36, 0.39 and 0.43, respectively). Protein content showed positive and highly significant correlation with dietary fibre (0.73). Most of the mineral showed non-significant correlation with yield/ plant, except Ca (-0.35), which had negative and significant correlation with yield per plant. In contrast to this, Mn content (0.67) was highly significantly and positively correlated with yield per plant. Phenol content showed highly significant and positive correlation with flavonoid (0.78), while its correlation with total chlorophyll (0.36) and carotenoid content (0.38) was positive and significant. Path-coefficient at genotypic level for quality traits showed that total sugars, ascorbic acid, moisture, protein, flavonoids, dietary fibre, chlorophyll a and b and carotenoids content had high direct and positive effects on yield.

On overall basis, it was concluded that, for improving the nutritional traits, high ascorbic acid, low mucilage, high minerals, phenol, and dietary fibre content should be given greater importance in okra improvement.

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