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Evaluation of variability for yield in okra *Abelmoschus esculentus* (L.) Moench

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Abstract
An experiment was undertaken on eight F2 segregating population of okra derived from single crosses namely Arka Anamika×Julie, GDO-6×Akola Bahar, Akola Bahar×IC-90201, GDO-6×IC-90201, IC-90222×IC- 90201, Julie×IC-90201, GDO-6×Julie and Akola Bahar×IC-90222 at Main Garden, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in 2016 kharif season. The data was subjected to analysis of mean and variance to study the differences among eight F2 populations for quantitative traits viz., node at which first flower appeared, days required for first flower, plant height (cm), number of nodes per plant, internodal length (cm), number of branches per plant, fruit length, fruit diameter (cm), number of fruit per plant, fruit yield per plant and average fruit weight
Among the eight segregating F2 population, Akola Bahar × IC-90222 showed better mean performance for node at which first flower appeared (6.43), internodal length (4.41 cm) and fruit length (9.16cm). The F2 population GDO-6 x Akola Bahar showed higher mean performance for the trait days required for first flowering (43.21), plant height (239.80), No. of nodes per plant (25.64), No. of fruit per plant (16.54), average fruit weight (8.99 gm) and showed high variance value for node at which first flower appeared (0.79), No. of nodes per plant (11.10), No. of branches per plant (2.78), fruit length (1.03) and fruit yield per plant (655.57). F2 population Arka Anamika x Julie showed higher mean (1.70 cm), (144.14gm) respectively and higher variance for trait No. of fruit per plant and average fruit weight.
From above finding, it can be concluded that F2 population GDO-6 X Akola Bahar, Arka Anamika x Julie and Akola bahar X IC-90222 can be used for further improvement of okra crop.

Keywords: Okra, F2 Segregating population, quantitative traits

Introduction
Okra (*Abelmoschus esculentus* (L) Moench) is an economically important vegetable crop grown in tropical and sub-tropical parts of the world which belongs to the family Malvaceae, mainly grown for its tender fruits, which are cooked and consumed as vegetable and other meal. Okra, commonly known as “lady finger” is primarily suitable for cultivation as a garden crop as well as on large commercial farms. India is the largest producer of okra in the world with 67% share of the total world production (Anonymous, 2015) [1]. However, the productivity (10.6 ton/ha) is much less than the potential productivity. It is also used as a vegetable in Brazil, West Africa and many other countries. In India, major okra growing states are Uttar Pradesh, Bihar, Maharashtra, Karnataka and West Bengal.

Fresh and tender fruits contain 88 per cent moisture and a large number of chemical components including vitamin A (88 IU), vitamin B (63 IU) and vitamin (C 13 mg/100 gm) (Aykroyd, 1941) [2]. Immature100 g of okra fruits contains 3.1 K calorie energy, 1.80 g protein, 90.00 mg calcium and 1.0 mg iron (Gopalan *et al.*, 2007) [7]. Its mucilage has medicinal applications as well when used as a plasma replacement or in detoxification by binding to cholesterol and bile acid carrying toxins (Gemede *et al.*, 2015) [6]. Seeds of okra contain oil content (17.30%) it is a nutritious ingredient of cattle feed (Martin and Ruberte, 1979) [8] and contain 20 to 23 per cent crude protein. It has ayurvedic medicinal properties. Its leaves are used for preparing a medicament to reduce inflammation. It is an excellent source of iodine for control of goiter (Chadha, 2001) [4]. The stem and roots of okra are used as cane juice clarifier from which brown sugar or jaggery (gur) is prepared (Chauhan, 1972) [5] and is also used in the paper industry.

Although okra has multidirectional importance and utilization, technology development regarding variety development and crop management practices are very limited.

Varietal improvement although done extensively in okra still lacks in identification of desirable parents for combining the best traits for developing good quality hybrids. The first and foremost objective for hybridization programme should be proper exploitation of the available variability among the vast array of breeding material available in the country. Okra, because of its year round cultivation, high nutritive value and export importance has captured a prominent position among the vegetables in the world. There is great genetic variation with regard to the plant height, color of fruit, internodal length, leaf area, days to first flowering, days to first harvest, number of nodes per plant, number of primary branches per plant, number of fruits per plant, number of ridges per fruits, number of leaves per plant, node at which first fruit appears, length of fruit, diameter of fruit, weight of fruit, yield per plant, yield per plot, yield per hectare and different quality trait. Plant breeding aims to improve the characteristics of plant so that they become more desirable agronomically and economically, and increase in yield is the ultimate aim. The success of any breeding programme depends upon the extent and magnitude of genetic variability existing in the germplasm and its quantitative assessment helps in successful utilization of plant characters for the developing suitable variety for yield and stability. Variability studies enable the breeder in determining most suitable genotypes for selection. Greater the variability present in the population better would be the scope of evolving desirable genotypes.

Material

The experimental materials (Genotypes of okra) were obtained from Department of Horticulture Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. In the present study, the experimental material consists of 14 genotype including six parents and eight F2 progenies derived from crosses among these six crosses. Detail is as follow.

Table 1: List of genotype and variety used as parent.

S. No	Parents	Source of obtaining genotype
1.	Akola bahar	Department of Horticulture, Dr. PDKV, Akola
2.	GDO- 6	Department of Horticulture, Dr. PDKV, Akola
3.	Julie	Department of Horticulture, Dr. PDKV, Akola
4.	IC-90222	NBPGR, New Delhi
5.	ArkaAnamika	IIHR, Bangalore
6.	IC-90201	NBPGR, New Delhi

Methodology

Hybridization among six parents genotype was carried out during summer of 2015 and F1 were evaluated during kharif 2015, few plant of F1 were self to get F2 seed. During 2016, this F2 segregating populations were sown without replications for evaluation purpose.

The following F2 populations of different cross combination were used for study.

Table 2: F2 population of different cross combination used for study.

S. No.	F2 population of crosses
1	Arka Anamika × Julie
2	GDO-6 × Akola Bahar
3	Akola Bahar × IC-90201
4	GDO-6 × IC-90201
5	IC-90222 × IC- 90201
6	Julie × IC-90201
7	GDO-6 × Julie
8	Akola Bahar × IC-90222

Character Studied

A) Growth parameter

Plant height (cm)

The length of main stem of each observational plant was measured from ground level to the growing tip. It was recorded at the time of final harvest.

Number of nodes per plant

The number of nodes on main stem was recorded at the time of last harvest.

Internodal Length (cm)

The average length of internodes of each observational plant next to first fruiting node was counted and recorded in 'cm'.

Number of branches per plant

The number of branches per plant were counted and recorded for each plant from each generation. This observation was recorded at time of final harvest.

B) Flowering parameter

Node at which first flower appeared

Node at which first flower appeared were observed and recorded for each plant.

Days required for first flowering

The dates were recorded in each treatment generation when first flower observed on plants in respective plot. Then, days required for first flower by each generation were calculated from date of sowing on plot basis.

Days required for 50% flowering

The dates were recorded in each treatment generation when 50% plants showed flowering. Then, days required for 50 per cent flowering by each generation were calculated from date of sowing on plot basis.

C) Yield parameter

Fruit Length

The length of 5 mature fruit from all the individual plants of each plot were recorded with the help of scale, and then average length of fruit was determined, making 100 reading for each genotype.

Fruit diameter (cm)

The diameter of selected observational fruits which were selected for measuring length was recorded with the help of Vernier Calliper and average was worked out for each genotype.

Number of fruit /plant

The total number of fruit of each individual plant were recorded for each genotypes.

Average Fruit weight (g)

The weight of fruits from each plant was recorded with the help of weighing balance and average was worked out for each genotype.

Fruit Yield per Plant (g)

Picking of fresh marketable okra fruits was done from the observational plant separately throughout the harvesting period at an interval of six to seven days. It was totaled and then average yield per plant per genotype was worked out.

Fruit Yield per Plot (kg)
The yield from net plot was recorded immediately after harvest of green fruits. The data of all harvests were consolidated generation was made out.

Fruit Yield per Hectare
The fruits after picking from each plot were weighed separately at each picking. Total yield per hectare was calculated from yield per plot.

Statistical analysis
Statistical analysis of the data recorded was done using procedure given by Singh and Choudhary (1977) [10], Burton and Devane (1953) [3] and Robinson, H. F (1949) [9].

Analysis of Variance

1. Mean = $\frac{1}{n}\sum_{i=1}^{n} Yi$

2. Variance = $\frac{1}{n-1}\sum_{i=1}^{n}(Yi - Y)$
Where,
Yi =Individual value
Y = Population mean

Standard Error (SE) = $\frac{S.D}{\sqrt{N}}$
Where,
S.D = Standard Deviation
N = Number of observations

Results and Discussion
The data was subjected to analysis of mean and variance to study the differences among eight F2 populations for quantitative traits viz., node at which first flower appeared, days required for first flower, plant height (cm), number of nodes per plant, internodal length (cm), number of branches per plant, fruit length, fruit diameter (cm), number of fruit per plant, fruit yield per plant and average fruit weight and the results of this analysis are presented in Table 3.

Table 3: Mean and Variance values for character in F2 population of okra

Population	Node at which first flower appeared			Days required for first flowering		
	Mean ± SE	Range	Variance	Mean ± SE	Range	Variance
Arka Anamika x Julie	6.54±0.08	5-8	0.71	43.82±0.18	41-47	3.32
GDO-6×Akola Bahar	6.50±0.09	5-8	0.79	43.21±0.19	41-48	3.50
Akola Bahar ×IC-90201	6.66±0.08	5-8	0.57	43.48±0.16	41-48	2.51
GDO-6 × IC-90201	6.77±0.08	5-9	0.56	44.00±0.15	42-47	2.20
IC-90222 x IC-90201	6.81±0.08	5-9	0.59	43.96±0.15	41-46	2.24
Julie x IC-90201	6.65±0.07	5-8	0.49	48.06±0.17	41-48	2.96
GDO-6 x Julie	6.66±0.07	5-9	0.69	44.5±0.19	41-49	3.74
Akola Bahar x IC-90222	6.43±0.07	5-9	0.53	44.32±0.17	41-47	2.82
IC-90201	6.2			42.8		
Arka Anamika	6.6			45		
IC-90222	7.4			44		
Julie	7.2			43		
GDO-6	6.6			43.6		
Akola Bahar	7.2			43		

Table 4: Mean and Variance of plant height and number of nodes per plants.

Population	Plant height (cm)			Number of nodes per plant		
	Mean ±SE	Range	Variance	Mean ± SE	Range	Variance
Arka Anamika x Julie	222.72±0.82	200-235	66.47	24.48±0.31	17-34	9.89
GDO-6×Akola Bahar	239.80 ±0.55	227-249	30.79	25.64±0.33	17-34	11.10
Akola Bahar ×IC-90201	230.12 ±0.55	220-347	30.30	22.77±0.23	17-27	5.35
GDO-6 × IC-90201	223.00 ±0.38	214-231	14.37	21.6 ±0.23	16-26	5.25
IC-90222 x IC-90201	231.65 ±0.77	222-253	58.66	24.64±0.29	19-34	8.69
Julie x IC-90201	233.09±.45	220-245	20.20	23.2±0.24	17-30	8.58
GDO-6 x Julie	224.26±0.53	216-236	27.57	24.24±0.20	18-31	4.04
Akola Bahar x IC-90222	224.60 ±0.65	195-235	45.33	24.27±0.20	19-29	3.83
IC-90201	219.80			24.2		
Arka Anamika	221.00			28.6		
IC-90222	224.20			24.6		
Julie	196.40			25.8		
GDO-6	221.00			24.4		
Akola Bahar	196.40			24.2		

Table 5: Mean and variance of intermodal length and number of branches per plant.

Population	Internodal length			Number of branches per plant		
	Mean±SE	Range	Variance	Mean ± SE	Range	Variance
Arka Anamika x Julie	5.08 ±0.09	3.2-6.8	0.73	3.66±0.10	2- 6	9.28
GDO-6×Akola Bahar	5.00 ±0.10	3.1-7.5	0.99	3.10±0.17	0 -8	2.78
Akola Bahar ×IC-90201	4.96± 0.11	2.8-7.5	1.18	4.00±0.12	2 -7	1.50
GDO-6 × IC-90201	4.42±0.13	2-6.1	1.74	3.86±0.11	2- 6	1.25
IC-90222 x IC-90201	5.15±0.12	3-8.3	1.50	3.58±0.15	1- 8	2.27
Julie x IC-90201	5.23±0.10	3.5-7.8	1.06	2.29±0.11	0- 4	1.29
GDO-6 x Julie	5.44±0.11	3.5-7.5	1.19	3.73±0.15	0- 7	2.19

Akola Bahar x IC-90222	4.41±0.09	3.2-7.5	0.89	3.57±0.14	0 -6	2.04
IC-90201	4.86			3.2		
Arka Anamika	4.80			2.4		
IC-90222	4.86			3.6		
Julie	4.85			3		
GDO-6	5.50			5.6		
Akola Bahar	4.65			4.8		

Table 6: Mean and Variance of fruit length and fruit diameter.

Population	Fruit length (cm)			Fruit diameter (cm)		
	Mean± SE	Range	Variance	Mean±SE	Range	Variance
Arka Anamika x Julie	7.31±0.09	5.6-8.9	0.76	1.70±0.01	1.4-1.89	0.02
GDO-6×Akola Bahar	8.53±0.10	6.7-11.1	1.03	1.54±0.01	1.3-1.89	0.01
Akola Bahar ×IC-90201	8.39±0.09	6.2-10.6	0.90	1.67±0.02	1.45-1.89	0.02
GDO-6 × IC-90201	8.37±0.07	7-9.6	0.52	1.55±0.01	1.45-1.79	0.01
IC-90222 x IC-90201	7.73±0.10	6.4-9.5	0.91	1.65±0.01	1.45-1.89	0.01
Julie x IC-90201	7.21±09	6-8.4	0.81	1.60±0.01	1.45-1.89	0.01
GDO-6 x Julie	8.10±0.09	6.5-9.7	0.76	1.64±0.01	1.34-1.89	1.83
Akola Bahar x IC-90222	9.16±0.09	7-10.9	0.77	1.54±0.01	1.34-1.89	0.01
IC-90201	7.74			1.51		
Arka Anamika	8.34			1.53		
IC-90222	8.87			1.46		
Julie	8.28			1.709		
GDO-6	7.66			1.55		
Akola Bahar	8.38			1.53		

Table 7: Mean and Variance of number of fruit per plant and average fruit weight

Population	Number of fruit per plant			Average fruit weight (gm)		
	Mea+SE	Range	Variance	Mean± SE	Range	Variance
Arka Anamika x Julie	15.85±0.27	10-21	7.09	8.95±0.11	7.3-12	1.27
GDO-6×Akola Bahar	16.54±0.26	11-20	6.53	8.99 ±0.10	8-13	0.97
Akola Bahar ×IC-90201	15.01±0.23	11-21	5.44	8.34±0.10	6.8-11	0.67
GDO-6 × IC-90201	12.91±0.25	10-23	6.22	8.18±0.08	7-9.6	0.57
IC-90222 x IC-90201	14.35±0.25	11-21	6.27	8.10±0.08	6.5-9.6	0.79
Julie x IC-90201	14.72±0.24	11-19	5.62	7.39±0.08	6.4-9	0.71
GDO-6 x Julie	15.77±0.27	10-23	7.13	7.65±0.08	6.4-9	0.65
Akola Bahar x IC-90222	14.65±0.23	11-19	5.41	8.57±0.08	6.7-10.9	0.71
IC-90201	13			8.24		
Arka Anamika	16.8			10.58		
IC-90222	15.2			8.04		
Julie	16.2			8.74		
GDO-6	18.4			10.12		
Akola Baher	17.8			8.60		

Table 8: Mean and Variance of fruit yield per plant.

Population	Fruit Yield Per Plant(g)		
	Mean± SE	Range	Variance
Arka Anamika x Julie	144.16+2.09	98-187.9	526.03
GDO-6×Akola Bahar	125.62±2.56	84.37-188	655.57
Akola Bahar ×IC-90201	125.18±1.95	91-175	378.68
GDO-6 × IC-90201	113.76±2.22	82-189	492.00
IC-90222 x IC-90201	116.38±2.03	97-170.3	412.40
Julie x IC-90201	109.07±1.76	81-148.7	308.46
GDO-6 x Julie	120.95±2.05	76.7-176	419.35
Akola Bahar x IC-90222	127.01±2.02	86.76.-182	407.54
IC-90201	118.96		
Arka Anamika	177.74		
IC-90222	129.904		
Julie	146.28		
GDO-6	141.58		
Akola Baher	153.08		

Among the eight segregating F2 population and six parental line, genotype IC-90201 showed flowering at lower node (6.2) followed by Akola Bahar × IC-90222 (6.43) Akola Bahar × IC-90222, whereas highest node number was eight at which first flower appeared in the line IC-90222,Julie,and Akola Bahar. The highest variance value was observed in F2 population of the cross GDO-6 x Akola Bahar (0.79) and lowest for Julie x IC-90201(0.49).

Among the eight segregating F2 population the F2 population and six line IC-90201 (42.8) shown early effect on days

required for first flowering followed by GDO-6 x Akola Bahar (43.21), Arka Anamika x Julie (43.82), Akola Bahar x IC-90201 (43.48) and GDO-6 x IC-90201 (44.00) respectively as compared to other crosses whereas the line Julie,IC-90222 and Arka Anamika required more days to first flower (7.4), (7.2), and (6.6) respectively. The F2 population GDO-6 x Akola Bahar showed maximum variance for the trait.

For the character plant height, all the F2 population showed increase in performance over the parent with F2 population GDO-6 x Akola Bahar showing highest performance, and F2 population Arka Anamika x Julie showed maximum variance for plant height.

For the character number of nodes per plant, F2 population GDO-6 x Akola Bahar (25.64) showed increase in performance over parents. None of the other cross showed increase in performance over parent, whereas highest mean was exhibited by genotype Arka Anamika (28.6). The F2 population GDO-6 x Akola Bahar showed maximum variance for the trait.

For the character internodal length, F2 population Akola Bahar x IC-90222 showed decrease in performance over parents which is desired and F2 population GDO-6 x IC-90201 showed maximum variance for the trait.

For the character number of branches per plant, F2 population Arka Anamika x Julie (3.66) showed increase in performance over parents, whereas highest mean value were exhibited by line GDO-6 (5.6) and Akola Bahar (4.8). The F2 population GDO-6 x Akola Bahar (2.78) showed maximum variance for the trait.

For the character fruit length,among the eight F2 population and six lines highest mean was exhibited by Akola Bahar x IC-90222 (9.162) followed by line IC-90222 (8.87). F2 population Akola Bahar x IC-90222(9.12) showed increase in performance over parents. Other crosses GDO-6×Akola Bahar (8.52) showed increase in performance over parent. The F2 population GDO-6 x Akola Bahar showed maximum variance for the trait.

For the fruit diameter, cross IC-90222 x IC-90201(1.65) showed increase in performance over parent. The F2 population GDO-6 x Julie showed maximum variance for the trait.

For the character, number of fruits per plant, F2 population IC-90222 x IC-90201 (14.35) showed increase in performance over parents. The F2 population GDO-6 x Julie showed maximum variance for the trait.

For the character average fruits weight, F2 population Akola Bahar x IC-90222 (8.57) showed increase in performance over parents, whereas highest mean was showed by line Arka Anamika (10.58) and F2 population Arka Anamika x Julie showed maximum variance for the trait.

For the character fruits yield per plant, genotype Arka Anamika (177.74) has highest mean performance followed by Julie (146.27) and F2 population GDO-6 x Julie showed maximum variance for the trait. Sood *et al*., (1993) [11] also reported maximum range of variation for fruit yield per plant and plant height in okra.

Summary and Conclusions

Among the eight segregating F2 population, Akola Bahar × IC-90222 showed better mean performance for node at which first flower appeared (6.43), internodal length (4.41 cm) and fruit length (9.16cm), whereas highest mean performance was showed by genotype IC-90201 flower at lower node (6.2).

The F2 population GDO-6 x Akola Bahar showed higher mean performance for the trait days required for first flowering (43.21), plant height (239.80), No. of nodes per plant (25.64), No. of fruit per plant (16.54), average fruit weight (8.99 gm) and showed high variance value for node at which first flower appeared (0.79), No. of nodes per plant (11.10), No. of branches per plant (2.78), fruit length (1.03) and fruit yield per plant (655.57), whereas IC-90201 (42.8) showed early effect on days required for first flowering and the highest population mean for the number of nodes per plant is recorded by parental line Arka Anamika (28.6) followed by Julie (25.8) and the genotype GDO-6 (5.6) showed with highest number of branches per plant followed by Akola Bahar (4.8), and again the highest mean for number of fruit per plant was recorded by line GDO-6 (18.4), and highest mean for average fruit weight was recorded for line Arka Anamika (10.58) followed by line GDO-6 (10.12).

For No. of branches per plant, F2 population Akola Bahar x IC-90201 showed highest mean performance (4.00) and for fruit diameter and fruit yield per plant, F2 population Arka Anamika x Julie showed higher mean (1.70 cm), (144.14gm) respectively and higher variance for trait No. of fruit per plant and average fruit weight, whereas highest population mean for fruit yield per plant was recorded by line Arka Anamika (177.74g) followed by line Julie (146.21g).

Hence, it may be concluded that in okra, the increase in mean values as a results of hybridization indicate scope for further improvement in traits like plant height, number of fruits per plant and fruit weight in subsequent generation. From above finding, it can be concluded that F2 population GDO-6 X Akola Bahar, Arka Anamika x Julie and Akola bahar X IC-90222 can be used for further improvement of okra crop.

References

1. Anonymous. Horticultural Statistics at a Glance. National Horticulture Board, October. 2015; 11:73.
2. Aykroyd, 1941, Health bulletin, Nutritional research Lab, 2015, 21-26.
3. Burton GE, EH Devane, Estimating heritability in tall fesque (*Festuca arundinacea*) from replicated clonal material. Agron. J. 1953; 45:478-481.
4. Chadha KL, Hand book of Horticulture, ICAR publication, 2001, 422.
5. Chauhan VS. Vegetable production in India. 3rd Edition, Textbook publishers Ramprasad and sons, 1972, 239.
6. Gemede HF, Ratta N, Haki GD, Woldegiorgis AZ, Beyene F. Nutritional quality and health benefits of Okra [*Abelmoschus Esculentus*]: A Review. Global J. Medical Res.: K Interdisciplinary. 2015; 14(5):29-37.
7. Gopalan C, Rama Sastri BV, Balasubramanian S. Nutritive value of Indian Foods, National Institute of Nutrition (NIN), ICMR, 2007, 1-2.
8. Martin FW, Ruberte R. Milling and use of okra seed meal at the household level. J of Agric. 1979; 62:1-7.
9. Robinson HF, Cornstockm RE, Harvey PH. Estimates of heritability and degree of dominance in corn. Agronomy Journal. 1949; 41:353-359.
10. Singh RK, Chaudhary BD. Biometrical methods in quantitative genetic analysis, Kalyani Publishers, New Delhi, 1977, 57-58.
11. Sood Sonia, PS Arya, SK Sharma. Correlation and path coefficient analysis in bhindi (*Abelmoschus esculentus (L.)* Moench). Him. J agric. Res. 1993; 19(1-2):37-42.