Current Horticulture 11(2): 39–43, May–August 2023 DOI: 10.48165/chr.2023.11.2.19

Genetic variability and divergence in okra (*Abelmoschus esculentus*)

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Received: 15 July 2021; **Accepted:** 18 January 2023

ABSTRACT

An experiment comprising 19 genotypes of okra {*Abelmoschus esculentus* (L.) Moench} sown in RBD with three replications was conducted during rainy season of 2019 and 2020 at Vegetable Research Farm, BUAT Banda. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were highest for days to 50% germination and lowest for first flower, days to 50% flower, days to maturity, fruit length, fruit diameter, number of seeds/fruit, fruit yield/plant, fruit yield/plot and fruit yield. The heritability estimates were high for days to 50% germination, average fruit weight, number of fruits/plant, fruit yield/ plant and fruit yield, indicating that selection based on phenotypic performance would be more operative. The high heritability coupled with high GAM was observed for days to 50% germination, average fruit weight and number of fruits/plant, indicating that additive gene effect was more important. Based on D^2 analysis, 19 genotypes were grouped into six clusters. The cluster I had seven genotypes followed by cluster II and III with six and three genotypes respectively, while the remaining clusters were monogenotypic. The cluster II recorded maximum intra cluster distance, followed by cluster I and clusters III. Maximum inter-cluster distance was observed between cluster III and VI, followed by that between cluster III and IV and between cluster I and III, suggesting that genotypes belonging to cluster III and VI, III and IV and I and III are more divergent than the rest of the clusters.

Key Words: GCV, PCV, Heritability, Genetic Divergence

Okra [*Abelmoschus esculentus* (L.) Moench] is widely consumed species of Malvaceae family. The major problems in okra cultivation in India is lack of location-specific and high-yielding varieties. (Jethaya *et al*., 2016). Flower opening is a long process in which tubular corolla starts spreading gradually after day break. However, ready-to-open buds could be identified in all taxa. Anther dehiscence coincides with full opening of the corolla. (Joseph *et al*., 2013). Since genetic variability and heritability are very important because phenotypic selection depends upon the range of genetic diversity, the study was undertaken to determine the extent of genetic variability, heritability, genetic advance and genetic divergence to identifying high-yielding genotypes.

MATERIALS AND METHODS

The study was carried at Department of Vegetable Science, College of Horticulture, Banda University of Agriculture and Technology, Banda, with 19 genotypes sown in randomized block design with three replications during rainy season 2019 and 2020. Each variety was planted in three rows replicated thrice with a spacing 60 cm × 30cm.

Observations were recorded from five randomly selected plants from the middle row of each variety in each replication for days to 50% germination, days to first flower, days to 50% flowering, days to maturity, plant height (cm) at 60 DAS, number of nodes at 60 DAS, number of primary branches, node to first flower appear, fruit length (cm), fruit diameter (cm), number of seeds/fruit, average fruit weight, number of fruits/plant, fruit yield/plant, fruit yield/plot and fruit yield. Mean values of five plants were used for statistical analysis.

Phenotypic and Genotypic coefficients of variability, heritability (h^2) broad sense and expected genetic advance were estimated as suggested by Burton (1952), Hanson *et al.* (1956) and Johnson *et al.* (1955) respectively. The genetic divergence among genotypes was estimated by using D2 statistics (Mahalanobis 1936). All the genotypes used were clustered into different groups by following Tocher's method (Rao 1952). The average intra and inter cluster distances were calculated by the formulae suggested by (Singh and Chaudhary 1985).

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RESULTS AND DISCUSSION

All the 16 characters showed high wide range of variation (Table 1). Days to 50% germination varied from 3.93 (P-8) to 8.19 (Pusa A-4) with mean value of 6.05 days. Days to first flower were minimum in genotype NDO-10 (41.32) and Pusa A-4 (48.79) took maximum days to first flower with mean value of 44.45 days. Days to 50% flowering was minimum in Varsha Uphar (44.71) and maximum in Kashi Vardan (54.63) with mean value of 49.59 days. Arka Nikita took minimum days to mature (49.02), whereas maximum days to maturity were taken by Kashi Vardan with mean value of 54.54 days. Genotype Varsha Uphar having maximum plant at 60 DAS (92.42 cm) whereas Hisar Unnat had minimum plant height at 60 DAS (71.31 cm) with mean value of 81.70 cm.

Genotype Kashi Vibhuti had minimum fruit diameter (1.39 cm), whereas Phule Vimukta (1.81 cm) had maximum fruit diameter with general mean of 1.67 cm. Fruit length was maximum in Varsh Uphar (12.09 cm), whereas minimum in P-8 (9.91 cm) with mean performance of 11.15 cm. Number of seeds/fruit was maximum in P-8 (57.50), whereas was minimum in Hisar Unnat (43.83) with general mean of 51.66. Average fruit weight was observed maximum in Hisar Unnat (12.61 g) and was minimum in Kashi Pragati (9.73 g) with mean performance of 11.59 g. Genotype P-8 had maximum number of fruits/plant (23.04) and Punjab Suhavani (14.73) had minimum number of fruits/plant with general mean of 18.81. Kashi Kranti, Hisar Naveen and P-8 had maximum yield per plant (0.23 kg) whereas, Azad Bhindi-1 and Punjab Suhavani had minimum yield/plant (0.19 kg) with mean value of 0.21 kg. Fruit yield was observed maximum in Hisar Naveen (129.49 q/ha) and minimum in Punjab Suhavani (106.71 q/ha) with average yield of 116.94 q/ha.

The PCV estimates were more than that of GCV for all characters, revealing the role of environment in phenotypic expression of these traits. Pooled analysis revealed that days to 50% germination exhibited higher PCV and GCV estimates than rest characters. Koundinya *et al.* (2013) reported similar of observation for number of fruits/plant and number of branches/ plant; low for days to first flower, days to 50% flower, days to maturity, fruit length, fruit diameter, number of seeds/fruit, fruit yield/ plant, fruit yield/plot and fruit yield, indicating that there is limited scope for improvement. Similar observations have been reported by Akotkar*et al.* (2010) for fruit diameter; koundinya *et al.* (2013) days to first flower, days to 50% flowering, days to maturity and fruit diameter.

The heritability estimates were high for days to 50% germination, average fruit weight, number of fruits/plant, fruit yield/plant and fruit yield, indicating that the selection based on phenotypic performance of these characters would be more operative and these were witnessed by Koundinya *et al.* (2013) for number of fruits/plant and fruit yield/plant; Vani *et al.* (2012) for yield (q/ha) and yield/plant; Mehta *et al.* (2006) for average fruit weight. Moderate for days to maturity, plant height at 60 DAS, number of nodes at 60 DAS, node to first flower appear, number of seeds/fruit and fruit yield/plot. These findings are related to those Thulasiram *et al.* (2017) for days to maturity. Low for days to first flower, days to 50% flowering, number of primary branches, fruit length and fruit diameter. These findings are in close harmony with Kumar *et al.* (2012) for fruit diameter. Similar findings with high heritability coupled with high GAM was reported by Badiger *et al.* (2017) for average fruit weight; Ramanjinappa *et al.* (2011) for number of fruits/plant. It indicated that additive gene effect was more important for these traits.

Koundinya *et al.* (2013) supported report for days to 50% flowering and days to maturity; Thulasiram *et al.* (2017) for days to first flower, fruit length and fruit yield.

All the 19 genotypes were grouped into six clusters. The cluster I was the largest with seven genotypes, followed by cluster II and III with six and three genotypes respectively. While, clusters IV, V and VI had one genotypes each.

The intra and inter-cluster D represent the index of genetic diversity among clusters as given in. The cluster II (13.38) recorded maximum intra cluster distance, followed by cluster I (13.11) and cluster III (11.52). Maximum inter-cluster distance was observed between cluster III and VI (188.84), followed by that between cluster III and IV (108.81) and between cluster I and III (108.47), suggesting thereby that genotypes belonging to cluster III and VI, III and IV and I and III are more divergent than the rest of the clusters. The inter-cluster distance was least between cluster IV and VI (17.10) followed by I and IV (21.21) and between II and V (21.73) suggesting close relationship among genotypes.

The genotypes of cluster V took maximum days for 50% germination (X = 8.19). The genotypes of cluster IV took minimum days for 50% germination (X = 4.32). Days to first flower was maximum in genotypes of cluster V (X = 48.79), while genotypes

Table 1: Range and mean performance of okra genotypes (pooled data) (2019-20)

Genotype	Days to 50% germination	Days to first flower	Days to 50% flowering	Days to maturity	Plant height(cm) [60 DAS]	Number of nodes (60 DAS)	Number of primary branches	Node to first flower appear	Fruit length (cm)	Fruit diameter (cm)	Number of seeds/ fruit	Number of fruits/ plant	Fruit yield (q/ha)
Kashi Vibhuti	6.73	44.82	51.00	56.43	77.36	15.69	2.94	5.68	10.91	1.39	48.50	18.81	110.39
Arka Anamika	6.65	43.62	49.44	54.13	84.19	15.06	3.10	6.40	10.83	1.85	57.33	21.45	114.49
Arka Abhay	5.91	46.66	52.13	57.27	76.83	13.49	3.69	5.57	11.34	1.56	55.67	18.75	112.29
Arka Nikita	6.76	40.69	45.06	49.02	75.34	16.68	3.09	6.36	10.66	1.69	54.83	19.57	120.41
Hisar Unnat	5.59	43.03	46.67	52.05	71.31	13.72	4.03	5.59	11.13	1.64	43.83	16.80	117.39
Kashi Pragati	7.57	44.43	49.34	53.88	84.27	16.59	3.47	4.44	12.00	1.59	47.83	21.36	113.02
Pusa A-4	8.19	48.79	53.86	59.23	81.80	16.86	3.51	6.58	10.06	1.63	53.17	16.57	117.47
NDO-10	8.07	41.32	47.69	52.31	78.08	12.77	2.53	6.02	11.83	1.73	52.33	20.10	108.87
Azad Bhindi-1	7.65	44.17	50.08	55.28	77.98	13.67	2.36	6.72	11.30	1.61	54.00	18.39	107.27
Punjab Suhavani	4.26	43.25	48.13	53.30	71.37	13.23	2.96	6.24	10.52	1.77	48.17	14.73	106.71
Pusa Sawani	6.16	47.32	51.84	57.34	88.09	18.25	3.73	4.65	11.36	1.67	45.83	16.19	123.38
Kashi Vardan	4.70	48.29	54.63	59.76	83.57	18.45	3.21	6.74	10.52	1.68	50.83	18.97	112.91
Kashi Kranti	7.10	44.32	50.51	54.70	80.39	17.04	3.37	5.52	11.49	1.54	47.50	21.47	125.95
Hisar Naveen	7.11	41.60	47.31	52.58	88.28	18.11	3.29	5.98	12.00	1.76	52.00	22.32	129.49
P-8	3.93	47.52	53.71	57.58	87.39	17.77	4.05	6.45	9.91	1.52	57.50	23.04	127.22
Phule Vimukta	4.03	43.55	47.48	52.98	88.65	18.51	3.42	6.21	11.85	1.81	57.17	15.69	121.67
Akola Bahar	4.32	45.51	48.53	53.16	85.12	17.35	3.83	5.08	10.70	1.80	49.33	16.91	111.94
Prabhani Kranti	5.13	44.38	50.12	55.68	79.92	17.26	3.65	5.98	11.31	1.75	52.83	17.42	120.48
Varsha Uphar	5.14	41.35	44.71	49.65	92.42	18.75	4.05	6.18	12.09	1.69	52.83	18.96	120.49

(Table continued)

(Table continued)

Genotype	Days to 50% germination	Days to first flower	Days to 50% flowering	Days to maturity	Plant height(cm) [60 DAS]	Number of nodes (60 DAS)	Number of primary branches	Node to first flower appear	Fruit length (cm)	Fruit diameter (cm)	Number of seeds/ fruit	Number of fruits/ plant	Fruit yield (q/ha)
Mean	6.05	44.45	49.59	54.54	81.70	16.27	3.38	5.91	11.15	1.67	51.66	18.81	116.94
CV	9.43	5.16	4.60	4.06	4.08	7.57	12.68	8.19	4.88	11.01	4.28	5.79	0.63
SE	0.23	0.94	0.93	0.90	1.36	0.50	0.18	0.20	0.22	0.07	0.90	0.45	0.30
CD (5%)	0.65	2.63	2.62	2.54	3.82	1.41	0.49	0.56	0.62	0.21	2.53	1.25	0.85
CD (1%)	0.87	3.48	3.46	3.37	5.06	1.87	0.65	0.74	0.83	0.28	3.36	1.66	1.12

Table 2: Genotypic and phenotypic coefficients of variability (GCV and PCV), heritability, genetic advance as per cent of mean for different characters in okra (pooled data) (2019-20).

Character	Mean	Range	GCV (%)	PCV (%)	h2b (%)	GA(5%)	GA as % of mean (5%)
Days to 50% germination	6.05	3.93-8.19	22.885	24.75	85.5	2.638	43.591
Days to first flower	44.45	41.32-48.79	4.981	7.171	48.3	3.169	7.128
Days to 50% flowering	49.59	44.71-54.63	5.405	7.097	58.0	4.206	8.481
Days to maturity	54.54	49.02-59.76	5.119	6.535	61.4	4.506	8.262
Plant height [(cm)60 DAS]	81.70	71.31-92.42	7.089	8.178	75.1	10.343	12.659
Number of nodes (60 DAS)	16.27	12.77-18.75	11.992	14.18	71.5	3.400	20.892
Number of primary branches	3.38	2.36-4.05	13.238	18.329	52.2	0.666	19.697
Node to first flower appear	5.91	4.44-6.74	10.537	13.346	62.3	1.013	17.136
Fruit length (cm)	11.15	9.91-12.09	5.502	7.357	55.9	0.945	8.476
Fruit diameter (cm)	1.67	1.39-1.81	5.286	12.214	18.7	0.079	4.713
No of seeds/fruit	51.66	43.83-57.50	7.561	8.686	75.8	7.004	13.559
Average fruit weight (g)	11.59	9.73-12.61	10.360	10.988	88.9	2.332	20.121
Number of fruits/plant	18.81	14.73-23.04	12.371	13.661	82.0	4.342	23.080
Fruit yield/plant (kg)	0.21	0.19-0.23	5.916	6.010	96.9	0.025	11.995
Fruit yield/ plot (kg)	8.33	7.50-9.18	5.170	6.448	64.3	0.711	8.540
Fruit yield (q/ha)	116.94	106.71-129.49	5.823	5.857	98.8	13.947	11.927

GCV: Genotypic coefficient of variation; PCV: phenotypic coefficient of variation; H^2b: Heritability in broad sense; GA: Genetic Advance

of cluster VI (X = 43.25) took minimum days to first flower. The genotypes of cluster V (X = 53.86) took maximum days to 50% flowering. The genotypes with early days to 50% flowering were concentrated in cluster II (X = 47.64).

The genotypes of cluster V showed highest mean for days to maturity (X = 59.23). The genotypes with early days to maturity appeared in cluster II (52.79). The highest cluster mean for plant height was observed in cluster III (X = 85.35). Lowest mean value of plant height was found in cluster VI (X = 71.37). Cluster III (X = 17.64) showed highest cluster mean for number of nodes/plant. However, lowest value was recorded in cluster VI (X = 13.23). Cluster IV (X= 3.83) showed highest cluster means for number of primary branches. However, lowest value was recorded in cluster VI (X = 2.96).

Maximum node to first flower was observed in genotypes of cluster V (X = 6.58). However, minimum node to first flower was observed in cluster IV (X = 5.08). The highest cluster means for fruit length and diameter was observed in clusters II (X = 11.40) and IV (X = 1.80) respectively. However, lowest value was recorded in clusters V (X = 10.06) and II (X = 1.61). The highest cluster means for number of seeds/fruit was recorded maximum in genotypes of cluster V (X = 53.17). However, it was minimum in genotypes of cluster VI (X = 48.17). The genotypes of cluster VI possessed maximum average fruit weight (X = 13.28). Minimum average fruit weight was recorded in genotypes of cluster VI (X = 10.55). The genotypes of cluster III possessed maximum number of fruits/plant (X = 22.28), fruit yield/plant (X = 0.23), fruit yield/plot (X = 9.06) and fruit yield (X = 127.55). However, genotypes of cluster VI recorded means of number of fruits/plant (X = 14.73), fruit yield/plant (X = 0.19), fruit yield/plot (X = 7.80) and fruit/yield (X = 106.71).

CONCLUSION

Thus, it can be concluded that selection and hybridization of genotypes from high divergent clusters are expected to yield potential F_{1s} and transgressive for further exploitation.

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