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RESEARCH ARTICLE

DUS based agro-morphological characterization and genetic variability in okra [*Abelmoschus esculentus* (L.) Moench]

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Abstract

Twenty-six okra genotypes were studied for morphological characterization, genetic variability, heritability and genetic advance at the Vegetable Research Farm, JNKVV, Jabalpur, during 2022-23. Significant differences were found among genotypes, indicating substantial morphological variation. The PCV was higher than the GCV for all traits. The highest PCV and GCV were recorded for internodal length (35.86, 33.39), fruit diameter (35.72, 33.59), fruit weight (35.67, 35.19) and number of primary branches per plant (35.61, 32.95), suggesting potential for yield improvement through genetic modification. High heritability and genetic advance for traits like fruit weight (97.31, 71.50), fruit yield per plant (91.97, 58.19), number of primary branches per plant (85.62, 62.81), fruit diameter (88.43, 65.08) and internodal length (86.68, 64.04) indicated that additive genes controlled these traits and might be improved through simple selection.

Keywords: Okra, GCV, Heritability, Genetic advance, DUS.

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Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is a vital crop in tropical and subtropical regions, originating from India (Zeven & Zhukovsky, 1975). It is a nutritious source of carbohydrates, protein, fat, minerals, vitamins and iodine (Singh et al., 2023). Morphological descriptors help characterize plant genotypes based on external traits (Joshi et al., 2020). Genetic improvement in okra depends on factors like genetic divergence, variability, heritability, genetic advance, correlation and path coefficient. The breeder's selection relies on the extent of genetic variability present. Assessing heritability and genetic advance together allows for more precise exploitation of heritable variation (Johnson et al., 1955). This study aims to identify heritable and non-heritable traits in okra genotypes to enhance breeding programs.

Materials and Methods

The investigation was conducted at the Vegetable Research Farm, JNKVV, Jabalpur (M.P.) during 2022-2023, involving 26 genotypes. The genotypes were evaluated in a randomized block design with three replications. Morphological characterization was performed based on DUS guidelines by the Protection of Plant Varieties & Farmer's Rights Authority (PPV & FRA). Phenotypic and genotypic coefficients of variation were calculated as suggested by Burton (1952). Heritability and genetic advance were estimated using Hanson et al. (1956) and Johnson et al. (1955), respectively.

Results and Discussion

Analysis of variance for 10 quantitative characters revealed significant variability among the genotypes with a wide range of variation observed among the studied traits.

Morphological Characterization as per DUS Guidelines

Among the 26 okra genotypes, 21 genotypes had a green color of the stem and five genotypes (IC117202, IC117235, IC117238, IC282294 and BO2) had red stem coloration (Table 1). Nodes on the stem at first flowering were <5 in 11 genotypes, medium (5–8) in 12 and many >8 in 3 genotypes. Among the genotypes, 5 showed medium stem diameter and 21 genotypes had large stem diameter. None genotypes were earlier in flowering, whereas medium days to flowering were observed in 21 genotypes and late in 5 genotypes. As per the DUS guidelines, the genotypes were classified into three classes for plant height as: short (5 genotypes), medium (3 genotypes) and tall (18 genotypes). Genotypes IC282294 and IC522273 had few branches, whereas 14 and 10 genotypes had medium and many number of branches, respectively. For depth of leaf blade, three genotypes had shallow lobing, while medium and deep lobing was exhibited by 5 and 18 genotypes, respectively. For the leaf blade color between veins (green or red), all the genotypes displayed green color. Among the 26 genotypes, 03 genotypes expressed a purplish tinge of vein color and the remaining 23 genotypes showed light green vein color. For the petiole length, 11 genotypes were categorized as medium, 12 as long and three genotypes as short. The flower petal color was cream in 21 and yellow in 5 genotypes with the petal base color purple on both sides in 19 genotypes and inside only in 7 genotypes. All genotypes had light green fruit. Fruit length was small in 6 genotypes, medium and long each in 10 genotypes. Fruit diameter was small in 2, medium in 22, and large in 2 genotypes. Fruit pubescence was strong in genotype IC522273, weak in 13, medium in 6 and fruits were without pubescence in 6 genotypes. Constriction of a basal part was strong in 7 genotypes, nine genotypes had weak constriction and 10 genotypes had no constriction. The fruit shape of the apex was categorized as narrow acute in 15, acute in 9 and blunt in 2 genotypes.

Table 1: Morphological Characterization of 26 okra Genotypes as per DUS guidelines

Character	*Particular*	*Genotypes*	*No. of genotypes*
Stem- Color	Green	EC305616, EC550848, IC034190-A, Kashi Pragati, Parbhani Kranti, IC111478, IC117021, IC117078, IC117300, IC522273,Arka Anamika, HRB55, Pusa Sawani, Gujrat Okra-5, Arka Abhay, Punjab-8, Kashi Chaman, EMS-8-1, LAM1, Punjab Padmini, Kashi Kranti	21
	Red	IC117202, IC117235, IC117238, IC282294, BO2	5
Stem- Number of nodes at first flowering	Few (<5)	EC550848, IC034190-A, IC111478, IC117021, IC117078, IC117235, IC117238, IC117300, IC282294, Gujrat Okra-5, Kashi Chaman	11
	Medium (5-8)	EMS-8-1, LAM1, Punjab Padmini, Kashi Kranti, HRB55, EC305616, IC117202, IC522273, Pusa Sawani, Arka Abhay, Punjab-8, BO2	12
	Many (>8)	Arka Anamika, Kashi Pragati, Parbhani Kranti	3
Stem- Diameter	Small (<1cm)	None	
	Medium (1-1.5cm)	EC550848, IC117202, IC117300, IC282294, Gujrat Okra-5	5
	Large (>1.5cm)	IC034190-A, IC522273, EC305616, IC117021, IC117235, IC111478, IC117078, IC117238, Arka Anamika, Arka Abhay, Pusa Sawani, Kashi Chaman, Kashi Pragati, Parbhani Kranti, Punjab-8, LAM1, BO2, HRB55, Kashi Kranti, EMS-8-1, Punjab Padmini	21
Flowering (50% of the plants with at least one open flower)	Early (<35 days)	None	
	Medium (35-45 days)	EC305616, EC550848, IC111478, IC117021, IC117078, IC117300, IC522273, IC117202, IC117235, IC117238, IC282294, Kashi Pragati, Parbhani Kranti, Gujrat Okra-5, Arka Abhay, Punjab-8, EMS-8-1, LAM1,Punjab Padmini, HRB55, BO2	21
	Late (>45 days)	IC034190-A, Arka Anamika, Pusa Sawani, Kashi Chaman, Kashi Kranti	5
Plant height	Short (<90cm)	EC550848, IC282294, IC034190-A, IC117078, IC117300	5
	Medium (90-120cm)	IC117235, IC117202, IC117238	3
	Tall (>120cm)	EC305616, IC111478, IC117021, IC522273, Arka Anamika, Kashi Pragati, Parbhani Kranti, Pusa Sawani, Gujrat Okra-5, Arka Abhay, Punjab-8, Kashi Chaman, EMS-8-1, LAM1,Punjab Padmini, Kashi Kranti, HRB55, BO2	18

Cont.....

Character	*Particular*	*Genotypes*	*No. of genotypes*
Plant- Number of branches	Few (<2)	IC282294, IC522273	2
	Medium (2-4)	IC034190-A, IC111478, IC117021, IC117078, IC117300, IC117202, IC117235, IC117238, Arka Anamika, Gujrat Okra-5, Arka Abhay, Punjab-8, Kashi Chaman, Punjab Padmini	14
	Many (>4)	EC305616, EC550848, Kashi Pragati, Parbhani Kranti, Pusa Sawani, EMS-8-1, LAM1, Kashi Kranti, HRB55, BO2	10
Leaf blade-Depth of lobing	Shallow	EC550848, IC522273, Arka Abhay	3
	Medium	IC282294, Pusa Sawani, Gujrat Okra-5, LAM1, BO2	5
	Deep	EC305616, IC034190-A, IC111478, IC117021, IC117078, IC117300, IC117202, IC117235, IC117238, Kashi Pragati, Parbhani Kranti, Arka Anamika, Punjab-8, Kashi Chaman, EMS-8-1, Kashi Kranti, HRB55, Punjab Padmini	18
Leaf blade- Color between veins	Green	EC550848, IC111478,IC117021, IC117300, IC282294, Kashi Pragati, Arka Anamika, Gujrat Okra-5, EMS-8-1, HRB55, EC305616, IC117202, IC117235, IC117238, IC522273, Pusa Sawani, Parbhani Kranti, Arka Abhay, Punjab-8, Kashi Chaman, Punjab Padmini, BO2, IC034190-A, IC117078, LAM1, Kashi Kranti	26
	Red	None	0
Vein- Color	Light green	EC550848, IC111478,IC117021, IC117300, IC282294, Kashi Pragati, Arka Anamika, Gujrat Okra-5, EMS-8-1, HRB55, EC305616, IC117202, IC117235, IC117238, IC522273, Pusa Sawani, Parbhani Kranti, Arka Abhay, Punjab-8, Kashi Chaman, Punjab Padmini, BO2, IC034190-A, IC117078, LAM1, Kashi Kranti	23
	Purple	EC305616, IC117300, IC034190-A	3
Petiole - Length	Short (<12 cm)	Arka Abhay, IC117202, IC117235,	3
	Medium (12-18cm)	EC305616, EC550848, IC117078, IC117238, Gujrat Okra-5, EMS-8-1, Punjab Padmini, LAM1, Kashi Kranti, HRB55, BO2	11
	Long (>18cm)	IC034190-A, IC111478, IC117021, IC117300, IC282294, Kashi Pragati, Arka Anamika, IC522273, Pusa Sawani, Parbhani Kranti, Punjab-8, Kashi Chaman	12
Flower- Petal color	Cream	EC305616, EC550848, IC117202, IC117235, IC117078, IC117238, Gujrat Okra-5, EMS-8-1, LAM1, Kashi Kranti, HRB55, BO2, IC034190-A, IC117021, IC117300, IC282294, Kashi Pragati, Arka Anamika, Arka Abhay, Punjab-8, Kashi Chaman	21
	Yellow	IC111478, IC522273, Pusa Sawani, Parbhani Kranti, Punjab Padmini	5
	Purple	None	0
Flower- Petal base color (purple)	Inside only	EC305616, IC034190-A, IC117202, Pusa Sawani, Kashi Chaman, Punjab Padmini, HRB55	7
	Both sides	EC550848, IC117235, IC117078, IC117238, Gujrat Okra-5, EMS-8-1, LAM1, Kashi Kranti, BO2, IC117021, IC117300, IC282294, Kashi Pragati, Arka Anamika, Arka Abhay, Punjab-8, Parbhani Kranti, IC111478, IC522273	19
Flower-Diameter (at the top of flower)	Small	IC117238, IC117300, Pusa Sawani, Arka Abhay, LAM1, Kashi Kranti	6
	Medium	EC305616, Arka Anamika, Kashi Pragati, IC034190-A, EC550848, IC117021,IC117078, IC282294, Punjab-8, Kashi Chaman, HRB55	11
	Large	IC111478, IC117202, IC117235, IC522273, Parbhani Kranti, Gujrat Okra-5, EMS-8-1, Punjab Padmini, BO2	9
Fruit- Color	Light green	None	0
	Green	EC305616, IC117202, Arka Anamika, Kashi Pragati, Pusa Sawani, Kashi Kranti, EC550848, IC034190-A, IC117021, IC117078, IC117300, IC282294, Gujrat Okra-5, Arka Abhay, Punjab-8, Kashi Chaman, EMS-8-1, LAM1, HRB55,BO2, IC111478, IC117235, IC117238, IC522273, Parbhani Kranti, Punjab Padmini	26
	Light red	None	0

Cont.....

Character	*Particular*	*Genotypes*	*No. of genotypes*
Fruit- Length	Small	EC550848,IC034190-A,IC117021, IC111478, Arka Anamika, Gujrat Okra-5	6
	Medium	EC305616, IC117078, IC117202, IC117300, IC282294, IC522273, Parbhani Kranti, Kashi Pragati, Arka Abhay, , Kashi Chaman	10
	Long	Pusa Sawani, Kashi Kranti, Punjab-8, EMS-8-1, LAM1, HRB55, BO2, Punjab Padmini, IC117235, IC117238	10
Fruit Diameter (at mid length)	Small (<1.5 cm)	IC117078, HRB55	2
	Medium (1.5-2.5 cm)	IC117238, Punjab-8, Kashi Chaman, EMS-8-1, Punjab Padmini, Kashi Kranti, IC117202, IC117300, EC550848, IC034190-A, LAM1, IC282294, Arka Abhay, Parbhani Kranti, EC305616, IC111478, IC117021, IC117235, Pusa Sawani, Arka Anamika, Gujrat Okra-5, BO2	22
	Large (>2.5 cm)	Kashi Pragati, IC522273	2
Fruit-Pubescence	Absent	EC550848, IC117078, IC117202, IC117300, Kashi Pragati, EMS-8-1	6
	Weak	EC305616, IC034190-A, IC117021, IC282294, Parbhani Kranti, Pusa Sawani, Arka Abhay, Punjab-8, Kashi Chaman, LAM1,Punjab Padmini, Kashi Kranti, BO2	13
	Medium	IC111478,IC117235,IC117238,Arka Anamika, Gujrat Okra-5, HRB55	6
	Strong	IC522273	1
Fruit- Constriction of basal part	Absent	EC305616, IC034190-A, IC117021, IC117235, IC117300, Parbhani Kranti, Punjab-8, LAM1, BO2, HRB55	10
	Weak	EC550848, IC111478, IC117078,IC117202, IC117238, Arka Anamika, Gujrat Okra-5, Arka Abhay, Kashi Kranti	9
	Strong	IC282294, IC522273, Kashi Pragati, Pusa Sawani, Kashi Chaman, EMS-8-1, Punjab Padmini	7
Fruit- Shape of apex	Narrow acute	EC305616, EC550848, IC117021, IC117235, IC117078,IC117202, IC117300, Kashi Pragati, Parbhani Kranti, Gujrat Okra-5, Arka Abhay, Punjab-8, Punjab Padmini, BO2, HRB55	15
	Acute	IC034190-A, IC117238, Arka Anamika, IC522273, Pusa Sawani, Kashi Chaman, EMS-8-1, LAM1, Kashi Kranti	9
	Blunt	IC111478, IC282294	2
Fruit- Number of locules	<6	EC305616, EC550848, IC117021, IC117202, IC117300, Kashi Pragati, Parbhani Kranti, Gujrat Okra-5, Arka Abhay, Punjab-8, Punjab Padmini, BO2, HRB55, IC034190-A, IC117238, Arka Anamika, IC522273, Pusa Sawani, Kashi Chaman, EMS-8-1, LAM1, Kashi Kranti, IC111478, IC282294	24
	6 to 7	IC117078, IC117235	2
	>8	None	0
Fruit-Length of physiologically mature fruit	Short (<10cm)	None	0
	Medium (10-15cm)	EC305616, IC117021, IC117300, IC111478, IC117078, IC117202, Gujrat Okra-5, Arka Abhay, Pusa Sawani, Kashi Pragati, LAM-1, EC550848, IC034190-A, IC282294, EMS-8-1	15
	Long (>15cm)	BO2, HRB55, Kashi Kranti, Punjab Padmini, IC117235, IC117238, IC522273, Arka Anamika, Parbhani Kranti, Punjab-8, Kashi Chaman,	11
Seed- Color	Green	EC550848, IC034190-A, EC305616, IC117235, IC117300, IC117078, IC117202, Arka Anamika, Gujrat Okra-5, Kashi Chaman, Kashi Pragati, Parbhani Kranti, LAM1, BO2, HRB55, Kashi Kranti, IC282294, EMS-8-1, Punjab Padmini	19
	Brown	IC117021, IC111478, IC117238, IC522273, Pusa Sawani, Arka Abhay, Punjab-8	7
Seed- Hairiness	Absent	EC550848, IC034190-A, EC305616, IC117235, IC117300, IC117078,IC117202, Arka Anamika, Gujrat Okra-5, Kashi Chaman, LAM1, BO2, Kashi Kranti, IC282294, Punjab Padmini, IC111478, IC117238, Pusa Sawani, Arka Abhay, Punjab-8	20
	Present	IC117021, IC522273, Kashi Pragati, EMS-8-1, HRB55, Parbhani Kranti	6

Among the 26 genotypes, only two genotypes (IC117078 and IC117235) had more than six locules. Physiologically mature fruit length was medium in 15 genotypes and long in 11 genotypes. Seed color was green in 19 and brown in 11 genotypes, with hairiness in 6 genotypes and none in 20 genotypes. These distinct genotypes might be used in breeding programs to enhance fruit yield and related traits. These results align with findings by Binalfew and Alemu (2016), Joshi et al. (2020) and Pallakki et al. (2022).

Based on mean performance (Table 2), among the 26 genotypes, Pusa Sawani (204.46 cm) had the maximum plant height, while IC 034190-A (151.18 cm) had the shortest. Genotype EC 550848 had the most primary branches per plant (6.06), while IC 522273 had the least (1.74). For the internodal length, genotype IC 522273 registered the longest length (9.39 cm) and Punjab Padmini had the shortest (2.26 cm). The earliest node at first flowering appeared at 2.66 nodes in genotype IC 034190-A and BO-2, while Parbhani Kranti exhibited the latest (6.10 nodes). Genotype IC 117202 took 40.54 days for days to 50% flowering, which was the earliest among the genotypes, while EC 550848 (44.57 days) was the latest. The maximum length of fruit was showed by the genotype HRB-55 (14.32 cm) and EC 550848 had the shortest (8.53 cm). IC 522273 had the largest fruit diameter (4.30 cm) and IC 117078 was the smallest (1.38 cm). The results were in line with the previous findings of Ola et al. (2021) for fruit length and diameter. Among the studied genotypes, genotype IC 522273 exhibited the heaviest fruit (27.77 g), whereas IC 117021 was the lightest (8.53 g). Genotype IC 282294 produced the most fruits per plant (20.13) and IC 522273 the fewest (8.66). HRB-55 had the highest fruit yield per plant (279.49 g), followed by LAM-1 (254.53 g) and IC 522273 (235.82 g), while EC 550848 was the lowest (96.59 g). These results align with the findings of Pallakki et al. (2022), Koundinya et al. (2013), Reddy et al. (2022) and Verma et al. (2018).

Genetic Variability

The higher magnitude of PCV compared to GCV across all characters suggests environmental influence on their expression. The close relationship between PCV and GCV indicates minimal environmental impact (Table 3). PCV was highest (>30%) for internodal length (35.86%), fruit diameter (35.72%), fruit weight (35.67%), number of primary branches per plant (35.61%) and fruit yield per plant (30.71%). Moderate PCV (20-30%) was noted for a node at first flower appears (25.39%) and the number of fruits per plant (22.08%). PCV was low (<20%) for days to 50% flowering (4.05%), plant

Table 2: Mean performance of okra genotypes

Genotypes	PH (cm)	PB/P	IL (cm)	NFF	DF50	FL (cm)	FD (cm)	FW (g)	F/P	FY/Plant(g)
EC- 305616	165.14	2.43	5.02	3.56	41.15	10.76	1.73	10.20	10.50	96.71
EC- 550848	166.36	6.06	3.79	2.76	44.57	8.53	1.63	9.19	10.56	96.59
IC 034190-A	151.18	2.90	3.88	2.66	42.37	9.20	1.68	9.71	13.13	127.13
IC 111478	184.36	4.60	6.92	3.60	41.96	8.92	1.87	9.86	16.13	156.08
IC 117021	185.63	1.86	6.28	3.53	40.95	9.80	1.84	8.53	15.73	132.17
IC 117078	160.54	4.24	4.32	2.93	41.52	10.15	1.38	12.18	16.40	187.16
IC 117202	178.11	5.13	4.92	4.80	40.54	9.74	1.61	9.04	13.26	116.78
IC 117235	167.20	3.90	4.44	3.63	43.15	11.76	1.83	15.08	14.40	203.10
IC 117238	162.03	4.76	3.14	4.60	41.19	11.12	1.83	16.28	9.86	155.91
IC 117300	153.22	3.13	4.76	3.33	41.85	9.79	1.65	9.17	12.20	106.56
IC 282294	167.25	5.76	7.54	4.53	40.60	9.85	2.34	9.27	20.13	165.80
IC 522273	184.77	1.74	9.39	5.70	42.98	11.10	4.30	27.77	8.66	235.82
Parbhani Kranti	188.68	3.43	5.31	6.10	41.91	10.38	1.72	9.16	12.06	121.52
Pusa Sawani	204.46	3.58	6.67	5.43	43.69	11.21	1.76	16.66	12.23	193.46
Gujrat Okra-5	188.35	1.76	4.95	4.63	40.79	10.18	1.84	9.15	14.06	116.27
Arka Abhay	188.67	3.20	5.46	4.96	42.39	10.70	2.29	10.46	15.80	155.24
Punjab-8	192.17	5.13	6.32	4.40	43.71	12.20	1.59	13.23	16.80	213.78
Kashi Chaman	177.45	3.13	3.39	3.83	43.98	12.51	1.50	12.92	16.66	206.43
EMS-8-1	180.27	4.26	3.49	4.33	42.35	9.33	1.64	15.48	16.26	225.29
LAM-1	185.77	2.76	3.69	5.36	43.05	9.95	1.60	21.41	12.46	254.23

Punjab Padmini	181.17	4.06	2.26	5.53	42.63	11.20	1.71	13.20	14.33	183.86
Kashi Kranti	190.06	1.90	3.80	5.60	44.38	12.83	1.65	18.22	11.06	196.88
HRB-55	184.33	2.97	7.59	5.30	42.07	14.32	1.44	18.36	12.36	279.49
BO-2	180.53	4.69	2.64	2.66	41.19	13.92	1.76	13.60	10.53	146.48
Arka Anamika	198.76	4.63	7.46	4.10	43.43	9.96	1.72	11.14	11.23	138.16
Kashi Pragati	182.60	2.76	5.62	5.16	42.20	10.06	3.70	10.48	13.46	130.09
Mean	178.81	3.64	5.12	4.35	42.33	10.75	1.91	13.06	13.47	166.96
S.E(m±)	4.96	0.28	0.38	0.29	0.88	0.34	0.13	0.44	0.88	8.38
C.D@5%	14.09	0.80	1.09	0.82	2.52	0.96	0.38	1.25	2.52	23.83

PH - Plant height (cm), PB/P-Number of primary branches per plant, IL- Internodal length (cm), NFF- Node at first flower appears , DF50- Days to 50% flowering, FL- Fruit length (cm), FD- Fruit diameter (cm), FW- Fruit weight (g), F/P- Number of fruits per plant, FY/Plant- Fruit yield per plant (g)

Table 3: Estimates of genetic variability parameters in okra genotypes

Characters	*Range*		*Coefficient of Variation*		*Heritability bs (%)*	*GA as % of mean*
	Min	*Max*	*GCV*	*PCV*		
Plant height (cm)	151.18	204.46	6.97	8.47	67.84	11.84
Primary branches/plant	1.74	6.06	32.95	35.61	85.62	62.81
Internodal length (cm)	2.26	9.39	33.39	35.86	86.68	64.04
Node at 1st flower appears	2.66	6.10	22.60	25.39	79.29	41.47
Days to 50% flowering	40.54	44.57	1.80	4.05	19.87	1.66
Fruit length (cm)	8.53	14.32	13.15	14.25	85.16	24.99
Fruit diameter (cm)	1.38	4.30	33.59	35.72	88.43	65.08
Fruit weight (g)	8.53	27.7	35.19	35.67	97.31	71.50
No. of fruits/plant	8.66	20.13	18.90	22.08	73.23	33.31
Fruit yield/ plant (g)	96.59	279.49	29.45	30.71	91.97	58.19

DAS- days after sowing, Min.- minimum, Max.- maximum, GCV- genotypic coefficient of variation, PCV- phenotypic coefficient of variation, BS- broad sense, GA- genetic advance

height (8.47%) and fruit length (14.25%). Low PCV indicated inept selection for these traits due to a narrow genetic base. Studies by Sravanthi et al. (2021), Koundinya et al. (2013) and Verma et al. (2018) support these findings, particularly for fruit yield per plant, fruit weight, internodal length and number of primary branches per plant, suggesting their suitability for further breeding programs.

High GCV (>30%) was observed for fruit weight (35.19%), fruit diameter (33.59%), internodal length (33.39%) and a number of primary branches per plant (32.95%). These findings aligned closely with Sravanthi et al. (2021) for fruit weight and number of primary branches per plant. Low GCV (<20%) was noted for days to 50% flowering (1.80%), plant height (6.97%), fruit length (13.15%) and number of fruits per plant (18.90%). These results closely match those of Verma et al. (2018) and Kumari et al. (2017) for days to 50% flowering, number of fruits per plant and fruit length, as well as those of Verma et al. (2018) for plant height. Moderate GCV (20-30%) was exhibited for fruit yield per plant (29.45%) and node at first flower appears (22.60%). A similar resemblance for a node at first flower appears was reported by Ranga and Darvhankar (2022).

Heritability and Genetic Advance

Broad-sense heritability was estimated for each character to determine the relative magnitude of genotypic and phenotypic variation, providing insights into the heritable aspect of variability crucial for plant breeding. Heritability estimates ranged from 19.87% (days to 50% flowering) to 97.31% (fruit weight), indicating the proportion of overall variances attributed to genetic influence. The heritability estimations were categorized as high (>85%), moderate (60–85%) and low (<60%). Results showed high heritability (>85%) for fruit weight (97.31%), fruit yield per plant (91.97%), fruit diameter (88.43%), internodal length (86.68%), number of primary branches per plant (85.62%) and fruit length (85.16%). Low heritability (<60%) was observed for days to 50% flowering (19.87%). Moderate heritability (60-85%) was noted for the traits viz., a node at first flower appears (79.29%), fruits per plant (73.23%) and plant height (67.84%).

Genetic advance, along with heritability, serves as a crucial selection parameter for identifying superior genotypes for future breeding programs. High heritability coupled with high genetic advance as a percentage of mean was observed for fruit weight, fruit yield per plant, number of primary branches per plant, fruit diameter and internodal length (Table 3), indicating the potential for direct selection-based improvement due to additive gene action. These findings were consistent with previous studies, particularly for fruit weight by Singh (2015) and fruit yield per plant by Kumari et al. (2017) and Sravanthi et al. (2021). Moderate genetic advance with high heritability, as seen in a node at the first flower, appears and a number of fruits per plant suggests a merged effect of additive and non-additive gene action. Conversely, high heritability coupled with low genetic advance was observed for fruit length, indicating the relevance of both additive and non-additive gene action. Low heritability alongside low genetic advance was noted for days to 50% flowering. These results emphasize the impact of non-additive gene action and underscore the importance of evaluating materials across multiple sites and generations for improving overall fruit yield.

Conclusion

The study based on morphological characterization and genetic parameters suggested that genotypes like IC522273 (184.77 cm plant height and 235.82 g yield per plant), Arka Anamika (198.76 cm height and 138.16 g yield/ plant), BO2 (red stem color, 180.53 cm height and 146.48 g yield/plant), IC117235 (red stem color, 167.20 cm height and 203.10 g yield/plant), HRB55 (184.33 cm height and 279.49 g maximum yield/plant), LAM1 (21.41 g fruit weight and 254.23 g yield/plant) and IC282294 (20.13 maximum number of fruits per plant) could be selected as best genotypes and these genotypes might be exploited in the breeding program to develop superior hybrids that can maximize the yield of okra.

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सारांश

भिंडी के रूपात्मक लक्षण वर्णन, आनुवंशिक परिवर्तनशीलता, आनुवंशिकता और आनुवंशिक उन्नति का अध्ययन करने के लिए भिंडी के छब्बीस जीनोटाइप पर सब्जी अनुसंधान प्रक्षेत्र, जवाहरलाल नेहरू कृषि विश्वविद्यालय, जबलपुर में २०२२-२३ के दौरान कार्य किया गया। भिंडी में रूपात्मक लक्षण वर्णन प्रजनन कार्यक्रम का एक अनिवार्य हिस्सा है क्योंकि अध्ययन के तहत जीनोटाइप अच्छी मात्रा में भिन्नता देखी गई है। अध्ययन किए गए सभी लक्षणों के लिए भिन्नता का फेनोटाइपिक गुणांक, भिन्नता के जीनोटाइपिक गुणांक से अधिक दर्ज किया गया। इंटरनोडल लंबाई (35.86, 33.39), फल का व्यास (35.72, 33.59), फल का वजन (35.67, 35.19) और प्रति पौधे प्राथमिक शाखाओं (35.61, 32.95) की संख्या के लिए अधिकतम फेनोटाइपिक व जीनोटाइपिक भिन्नता गुणांक दर्ज किया गया, जिससे यह ज्ञात हुआ की भिंडी की आनुवंशिक संरचना में बदलाव के कारण उपज में सुधार की पर्याप्त गुंजाइश है। फल का वजन (97.31, 71.50), प्रति पौधे फल की उपज (91.97, 58.19), फल का व्यास (88.43, 65.08), इंटरनोडल लंबाई (86.68, 64.04) और प्रति पौधे प्राथमिक शाखाओं की संख्या (85.62, 62.81) जैसे लक्षणों के लिए देखे गए माध्य के प्रतिशत के रूप में उच्च आनुवंशिक प्रगति से जुड़ी उच्च आनुवंशिकताएं दर्शाती हैं कि वे योगात्मक जीन की क्रिया के कारण है और सरल चयन के माध्यम से इन लक्षणों को सरलतापूर्वक मजबूत व उत्पादन में वृद्धि की जा सकती है।