Research Article

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Genetic variability analysis for yield traits in sponge gourd (*Luffa cylindrica*) in arid environment

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Abstract

The genetic variability, heritability, and genetic advance for 12 yield and yield contributing traits were analyzed in 26 sponge gourd (*Luffa cylindrica* L.) genotypes at ICAR-CIAH, Bikaner during 2023. There were significant differences in all traits. A broad range of variation was observed in total marketable fruit yield, fruit weight, and days to first fruit harvesting. The phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV), indicating the substantial influence of environmental factors on trait expression. High heritability and genetic advance were observed for fruit diameter and marketable fruit yield, suggesting the predominance of additive gene action. These findings indicate that fruit yield can be enhanced through selection, while traits with lower genetic advance may benefit from hybridization and other breeding approaches.

Key words: Genetic variability, Heritability, Genetic advance, Yield

Sponge gourd (*Luffa cylindrica* L.), of cucurbitaceae family, has diploid chromosome number of 2n = 26. It exhibits significant variability, with numerous landraces identified in North India and arid regions, showcasing a broad range of traits such as leaf shape, fruit size, shape, colour, and seed colour (Choudhary *et al.*, 2016). To achieve effective breeding, it is important to analyze variability and partition the total variation into heritable and non-heritable components. This can be done using genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability percentage, and genetic advance percentage (Barma *et al.*, 1990; Singh *et al.*, 2023). Therefore, a present study was conducted to assess the genetic variability, heritability, and genetic advance in sponge gourd.

MATERIALS AND METHODS

The experiment comprised 26 diverse sponge gourd genotypes (Table 1). The study was carried out during *kharif* season of 2023 at of ICAR-Central Institute for Arid Horticulture Bikaner, Rajasthan, situated at 28°N latitude and 73°18'E longitude, with an altitude of 234.84 m above sea level. This location falls under the agroclimatic zone of Hyper Arid Partial Irrigated Zone I C. The experiment was laid out in a Randomized Block Design (RBD) with three replications maintaining 2.0 m x 0.80 m row-to-row and plant-to-plant spacing on drip system of irrigation.

Table 1: List of sponge gourd genotypes

Genotype	Source
AHSG-18, AHSG-19, AHSG-21, AHSG-23, AHSG-25, AHSG-28, AHSG-30, Thar Tapish	ICAR-CIAH, Bikaner
VRSG-3-13, VRSG-4-17, VRSG-5-17, VRSG-6, VRSG-8, VRSG-8-17, VRSG-11, VRSG-13, VRSG-18, VRSG-21-17, VRSG-40, VRSG-50, VRSG-66, VRSG-70, VRSG-73, VRSG-140 and VRSG-154	ICAR-IIVR, Varanasi
Pusa Sneha	ICAR-IARI, New Delhi

All the recommended cultural practices were adopted. Data were recorded on five randomly selected plants on days to 50% female flowering, node at which first female flower appeared, ovary length (cm), days to first fruit harvest after sowing, internodal length (cm), vine length at last harvesting (m), fruit length (cm), fruit diameter (cm), fruit weight (g), number of fruits/ vine, marketable fruit yield/ vine (kg) and total marketable fruit yield (q/ ha). The data were subjected to analysis of variance as per Panse and Sukhatme (1985). The phenotypic (PCV) and genotypic coefficient of variance (GCV) were calculated using the of Lush (1949). Heritability (h^2) in the broad sense and genetic advance (GA) as were estimated by formula given by Warner (1952). As per Johnson *et al.* (1955), heritability was categorized as low (0-30%), moderate (30-60%) and high (60% and above). The variance of genetic advance as per cent of mean was classified as advocated by Johnson

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et al. (1955), *viz.* low (<10%), moderate (10-20%) and high (>20%).

RESULTS AND DISCUSSION

The analysis of variance (Table 2) revealed significant differences among all traits. The analysis of variance indicated that the mean sum of squares for genotypes was highly significant. The significant mean sum of squares for fruit yield and related traits demonstrated substantial variability in genotypes, suggesting good potential for improvement. The mean values, range, coefficient of variation, heritability, and genetic advance for 12 traits examined are presented in Table 3. The results clearly show a substantial amount of variation among genotypes for each trait. The PCV was higher GCV, indicating that environmental factors influenced the expression of traits studied.

The mean sum of squares revealed significant differences for all the traits, indicating substantial variability among the genotypes. A wide range of variation was observed for total marketable fruit yield (104.17-213.75 q/ha), fruit weight (88.77-124.05 g), days to first fruit harvesting after sowing (52.4-69.27 days), and days to 50% female flowering (41-55 days). The data on mean performance of 26 genotypes revealed significant variation for all 12 traits studied. Days to 50% female flowering was found to be earliest in Pusa Sneha (41 days), whereas, AHSG-30 was found late (55 days). Node at which first female flower appeared was observed on lowest node number in genotype VRSG-50 (9.63), while VRSG-5-17 produced first female flower on node number 12.80. Ovary length was found to be maximum in genotype VRSG-50 (6.64 cm) followed by AHSG-18 (6.58 cm), while minimum length was observed in VRSG-6 (3.8 cm).

Table 2: Analysis of variance for fruit yield and its component traits

Character	Mean sums of square		
	Replication (df=2)	Genotypes (df=25)	Error (df=50)
Days to 50% female flowering	25.78	32.50**	9.86
Node at which first female flower appeared	0.71	1.84**	0.36
Ovary length (cm)	0.03	1.96**	0.08
Internodal length (cm)	2.05	1.70**	0.66
Days to first fruit harvesting after sowing	20.66	60.25**	10.21
Fruit length (cm)	3.89	23.49**	1.90
Fruit diameter (cm)	0.02	0.75**	0.03
Fruit weight (g)	13.25	153.99**	29.56
Number of marketable fruits/ vine	4.16	19.80**	1.40
Vine length at last harvest (m)	0.09	0.27**	0.03
Marketable fruit yield/ vine (kg)	0.04	0.62**	0.05
Total marketable fruit yield (q/ha)	147.97	2403.87**	183.51

**Significant at 1% probability level

The internodal length was maximum in Pusa Sneha (12.53 cm), followed by VRSG-5-17 (11.73 cm), while it was minimum in VRSG-6 (9.36 cm). The variety Pusa Sneha took 49.80 days to first fruit harvesting whereas VRSG-4-17 was found to be late (69.26 days) for first fruit harvesting after sowing. Fruit length was maximum in AHSG-23 (31.40 cm), followed by AHSG-28 (26.88 cm) and Thar Tapish (25.92 cm) which are at par to each other. The shortest fruit length was observed in VRSG-6 (17.80 cm). Fruit diameter was maximum in VRSG-3-13 (4.67 cm), followed by AHSG-25 (4.32). Whereas, minimum diameter was observed in VRSG-70 (2.55 cm). Fruit weight was maximum in AHSG-23 (124.05 g), followed by AHSG-28 (114 g), Pusa Sneha (108.0 g), while minimum fruit weight was observed in VRSG-6 (88.77 g). Number of marketable fruits/ vine was maximum in AHSG-23 (28.73), followed by Pusa Sneha (26.00), AHSG-28 (24.60), while it was minimum in VRSG-6 (17.73).

Vine length at last harvesting was maximum in Pusa Sneha (3.83 m), whereas shortest vine length was observed in VRSG-70 (2.60 m). Marketable fruit yield/ vine was highest in AHSG-23 (3.42 kg), followed by Pusa Sneha (3.41 kg), while lowest or minimum marketable fruit yield was observed in VRSG-6 (1.67 kg). Among genotypes, AHSG-23, Pusa Sneha and Thar Tapish were found to be better yield performer in arid environment. These findings align with the those of Abhijeet *et al.* (2018), Singh *et al.* (2019), Vijaykumar *et al.* (2020), Yadav *et al.* (2023) and Okusanya *et al.* (1981).

The PCV was moderate for total marketable fruit yield (19.62%), followed by ovary length (16.52%), fruit diameter (16.21%), fruit length (13.66%), and number of marketable fruits/ vine (13.08%). Similar findings were reported by Singh *et al.* (2019), Thulasiram *et al.* (2023) and Yadav *et al.* (2023). In contrast, lowest PCV was recorded for internodal length (9.38%), followed by days to first fruit harvest after sowing (8.69%), days to 50% female flowering (8.67%), fruit weight (8.44%), and node at which first female flower appeared (8.41%). Singh *et al.* (2009) and Vijaykumar *et al.* (2020) also reported such findings.

The GCV among genotypes showed a moderate range, with highest values (17.57%) observed for total marketable fruit yield followed by marketable fruit yield/

Table 3: Genetic parameter of variability for fruit yield and its component traits

Character	Mean	Range	PCV (%)	GCV (%)	h² in broad sense (%)	GA	GA as % of mean
Days to 50% female flowering	48.10	41-55	8.67	5.71	43.35	3.73	7.75
Node at which first female flower appeared	10.97	9.63-12.8	8.41	6.39	57.85	1.10	10.03
Ovary length (cm)	5.08	3.8-6.64	16.52	15.59	89.01	1.54	30.29
Internodal length (cm)	10.68	9.37-12.53	9.38	5.51	34.45	0.71	6.66
Days to first fruit harvesting after sowing	59.64	52.4-69.27	8.69	6.85	62.02	6.63	11.10
Fruit length (cm)	22.07	17.80-26.88	13.66	12.14	79.01	4.91	22.24
Fruit diameter (cm)	3.19	2.55-4.67	16.21	15.31	89.10	0.95	29.76
Fruit weight (g)	99.85	88.77-124.05	8.44	6.44	58.39	10.14	10.15
Number of marketable fruits/ vine	20.97	17.73-28.73	13.08	11.81	81.45	4.60	21.95
Vine length (m)	3.14	2.6-3.83	10.44	8.93	72.81	0.49	15.74
Marketable fruit yield/ vine (kg)	2.47	1.67-3.42	19.62	17.56	80.09	0.80	32.37
Total marketable fruit yield (q/ha)	154.87	104.17-213.75	19.62	17.57	80.13	50.17	32.39

vine (17.56%), ovary length (15.59%), fruit diameter (15.31%), and fruit length (12.14%). These findings are in consistent with those of Abhijeet *et al.* (2018), Kumar *et al.* (2019) and Vijaykumar *et al.* (2020). In contrast, lowest GCV values were recorded for vine length (8.93%), followed by days to first fruit harvesting after sowing (6.85%), fruit weight (6.44%), node at which first female flower appeared (6.39%), and days to 50% female flowering (5.71%). Similar estimates were reported by Kumar *et al.* (2013), Jethava *et al.* (2016), Abhijeet *et al.* (2018), Kumar *et al.* (2019) and Vijaykumar *et al.* (2020).

The highest heritability values were recorded for fruit diameter (89.10%), followed by ovary length (89.01%), number of marketable fruits/ vine (81.45%), total marketable fruit yield (80.13%), marketable fruit yield/ vine (80.09%), and fruit length (79.01%). High heritability was observed for various characters are according to the findings of Vijaykumar *et al.* (2020), Thulasiram *et al.* (2023) and Yadav *et al.* (2023). Moderate heritability was observed for fruit weight (58.39%), node at which first female flower appeared (57.85%), days to 50% female flowering (43.35%), and internodal length (34.45%). Similar findings were also reported by Choudhary *et al.* (2014), Abhijeet *et al.* (2018), Kumar *et al.* (2019), and Vijaykumar *et al.* (2020).

The highest genetic advance was observed for total marketable fruit yield (50.17). Moderate genetic advance was recorded for fruit weight (10.14), while the lowest values were noted for days to first fruit harvesting after sowing (6.63), followed by fruit length (4.91), number of marketable fruits/ vine (4.60), and days to 50% female flowering (3.73). The highest genetic advance as a percentage of the mean was recorded for total marketable fruit yield (32.39%), followed closely by marketable fruit yield/ vine (32.37%), ovary length (30.29%), fruit diameter (29.78%), fruit length (22.24%), and number of marketable fruits/ vine (21.95%). Moderate genetic advance as a percentage of the mean was observed for vine length (15.74%), followed by days to first fruit harvesting after sowing (11.10%), fruit weight (10.15%), and node at which first female flower appeared (10.03%). The lowest genetic advance as a percentage of the mean was recorded for internodal length (6.66%), followed by days to 50% female flowering (7.75%).

The high genetic advance observed for these traits suggests that they are controlled by additive genes, making selection effective for their further improvement. Moderate genetic advance indicates the involvement of both additive and non-additive variance in these traits, while traits with low genetic advance highlight the significance of non-additive gene effects. Heritability estimates, when considered alongside genetic advance, provide more valuable information than heritability values alone, as they offer a better basis for selecting the best individuals. High heritability and high genetic advance were observed for traits like total marketable fruit yield and fruit length, indicating the dominance of additive gene action, which can be effectively improved through selection. On the other hand, moderate heritability combined with low genetic advance suggested the influence of non-additive gene action for traits such as internodal length and days to first fruit harvest, which may be improved through hybridization and combination breeding methods. Similar estimates were reported by Abhijeet *et al.* (2018), Kumar *et al.* (2019), Vijaykumar *et al.* (2020), Myla *et al.* (2022) and Kousthubha *et al.* (2023), Singh *et al.* (2023).

CONCLUSION

Thus, it is concluded that total marketable fruit yield, fruit weight, and days to first fruit harvesting showed considerable potential for improvement. The AHSG-23, Pusa Sneha and Thar Tapish gave more yield.

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