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Genetic variability, heritability and genetic advance for yield and yield attributes in bottle gourd (*Lagenaria siceraria* (mol) Standl.) germplasm

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Abstract
A field experiment was conducted at College of Horticulture, Rajendranagar, Hyderabad during *Kharif*, 2017 to study the genetic parameters for yield and yield attributes in bottle gourd germplasm. Thirty two genotypes were evaluated with three replications in Randomized Block Design. The genotypes exhibited significant differences for all the traits under study. A wide range of variability along with high estimates of PCV and GCV was observed for number of nodes per plant, internode length, node at which first female flower appearance, weight of the fruit (g), fruit length (cm), fruit diameter (cm), flesh thickness (mm), rind thickness (mm), yield per plant (kg) and total yield (t ha^{-1}), indicating high variability available among the germplasm for these characters for further improvement. High heritability coupled with high genetic advance as per cent of mean was observed for total vine length (m), number of primary branches per plant, number of nodes per plant, internode length (cm), days to first male flower appearance, node at which first female flower appears, number of fruits per plant, weight of the fruit (g), fruit length (cm), fruit diameter (cm), flesh thickness (mm), rind thickness (mm), yield per plant (kg), total yield (t ha^{-1}) and total soluble solids. The results indicated that these characters had additive gene effect and therefore, these are more reliable for effective selection for their further improvement.

Keywords: Genetic variability, heritability *Lagenaria siceraria*

Introduction
Bottle gourd [*Lagenariasiceraria* (Mol.) Standl.] is an important cucurbitaceous vegetable having wide range of uses and is largely cultivated in the tropics and subtropics for its edible fruits. It is also known as calabash gourd, trumpet gourd, white flowered gourd and zucca melon. Bottle gourd is one of the largest produced cucurbit vegetables in the world having chromosome number of 2n = 22. Bottle gourd is a monoecious and cross pollinated crop in which large amount of variation has been observed for many economically important traits. Precise information regarding the extent of genetic divergence in the breeding lines is crucial in heterosis breeding programme. The available diversity within the species for desired fruit enables a breeder in choosing the most suitable combinations to use for exploitation of hybrid vigor in a given crop.

The genetic parameters such as heritability, genetic advance, genotypic and phenotypic coefficients of variability provide an effective tool in the hands of a breeder to select a genotype having the most desirable traits for yield. Many of the quantitative traits such as number of fruits per plant and yield per plant are highly influenced by environmental conditions partitioning the overall variability into heritable and non-heritable components which will be of immense help in any planned breeding programme. Keeping the above in view, the present investigation was carried out to investigate the genetic variability parameters in bottle gourd germplasm.

Material and Methods
The field experiment was carried out at College of Horticulture, SKLTSHU, Rajendranagar, Hyderabad during *kharif*, 2017. The plot was selected on the basis of suitability of the land for cultivation of bottle gourd. A set of thirty two genotypes comprising of thirty one indigenous collections of Bottle gourd augmented from the NBPGR, New Delhi along with one Bottle gourd check variety Arka bahar were utilized for the study. Row to row and plant to plant spacing were maintained at 2m and 1m, respectively in 4m × 2m plot. Recommended cultural practices were adopted for proper growth and stand of crop. Observations on total vine length

(m), number of primary branches per plant, number of nodes per plant, internode length (cm), days to first male flower appearance, days to first female flower appearance, node at which first male flower appears, node at which first female flower appears, days to first fruit harvest, days to last fruit harvest, number of fruits per plant, weight of the fruit (g), fruit length (cm), fruit diameter (cm), flesh thickness (mm), rind thickness (mm), yield per plant (kg), total yield (t ha^{-1}), total soluble solids (^{o}Brix), and ascorbic acid (mg/100g of fruit) for each genotype were recorded from three selected plants per replication. The analysis of variance was carried out as suggested by Panse and Sukhatme (1985). Genotypic and phenotypic coefficients of variations were calculated by the formula given by Burton and Devane (1953) and heritability and genetic advance as per the formula given by Johnson *et al*., (1955) [3] and Allard (1960) respectively.

Results and Discussion

The ANOVA revealed significant differences indicating that there are enough variations among all the germplasm for all parameters under the study. The results are conveniently divided into morphological, duration, flower, yield and quality traits.

Morphological parameters: Total vine length (m) recorded phenotypic and genotypic variances (6.02 and 4.41) which were coupled with moderate PCV and GCV of 19.46 and 16.65 percents, respectively. This trait showed high heritability (73.00%) with low genetic advance (3.70) and high GA as per cent mean (29.37). Number of primary branches recorded phenotypic and genotypic variances of 3.99 and 2.89 respectively with moderate PCV (18.16) and GCV (15.46) values. The high heritability (72.00%), low genetic advance (2.98) and high GA as per cent mean (27.140) were also reported for this trait. Number of nodes per plant showed moderate phenotypic and genotypic variances (880.80 and 676.81 respectively) with high PCV (31.591) and GCV (27.693). High heritability (76.00%), high genetic advance (46.97) and high GA as per cent mean (50.00) estimates were recorded for this trait.

Internodes length (cm) showed high phenotypic and genotypic variances (9.404 and 8.02 respectively) with high PCV (21.69) and GCV (20.045). High heritability (85%), low genetic advance (5.391) and high GA as per cent mean (38.147) estimates were recorded for this trait. High Phenotypic and genotypic variance values i.e. 58.423 and 45.110 with moderate PCV and GCV of 13.573 and 11.927 values, respectively were recorded for the days to first male flower appearance. Very high heritability (77%), moderate genetic advance (12.158) and high GA as per cent mean (21.59) were also recorded for this character.

Flower characters: For days to first female flower appearance, very high phenotypic and genotypic variances of 57.501 and 46.824 respectively were recorded with very moderate PCV and GCV of 11.235 and 10.138 values. Very high heritability (81%), very moderate genetic advance (12.720) and very moderate GA as per cent mean (18.846) were recorded. High phenotypic and genotypic variances (2.539 and 0.825) along with high PCV (22.833) and GCV (13.017) were recorded for Node at first male flower appears. The character node at first male flower appears showed very high heritability (32.5%), low genetic advances (1.067) as well as moderate GA as per cent mean (15.287). Node at first female flower appears associated with high phenotypic and genotypic variances (8.602 and 6.844) in Bottle gourd genotypes with high PCV (24.795) and GCV (22.116) values. Fruit yield per hectare showed high heritability (79.6%) but low genetic advance (4.807) and high GA as per cent mean (40.637).

Duration parameters: Very low phenotypic and genotypic variances (99.736 and 76.059) were recorded for days to first fruit harvest in Bottle gourd genotypes with moderate PCV (11.962) and GCV (10.446) values. Days to first fruit harvest showed high heritability (76.3%) but moderate genetic advance (15.689) and moderate GA as per cent mean (18.792). Phenotypic and genotypic variances (116.367 and 88.194) were recorded in Bottle gourd genotypes for days to last fruit harvest with low PCV (6.818) and GCV (5.935) values. Days to last fruit harvest showed high heritability (75.8%) but very moderate genetic advance (16.842) and moderate GA as per cent mean (10.644).

Yield and yield related parameters: Number of fruits per plant recorded with very low phenotypic and genotypic variances (4.97 and 3.699) and high PCV (21.838) and GCV (18.823) values. Number of fruits per plant showed high heritability (74.3%) but low genetic advance (3.415) and high GA as per cent mean (33.424). Weight of the fruit (g) had very high phenotypic and genotypic variances (187301.60 and 181797.000) with high PCV (30.116) and GCV (29.670) values. Weight of the fruit showed high heritability (97.1%) but very high genetic advance (865.333) and high GA as per cent mean (60.215). For fruit length (cm), high phenotypic and genotypic variances (90.636 and 89.536) were recorded in Bottle gourd genotypes with high PCV (26.547) and GCV (26.385) values. Fruit length showed high heritability (98.8%) but very moderate genetic advance (19.374) and high GA as per cent mean (54.023). In case of fruit diameter (mm), very low phenotypic and genotypic variances (7.552 and 6.747) were recorded in Bottle gourd genotypes with high PCV (22.950) and GCV (21.692) values. Fruit diameter showed high heritability (89.3%) but low genetic advance (5.058) and high GA as per cent mean (42.238). Phenotypic and genotypic variances (207.566 and 191.278) were recorded in Bottle gourd genotypes for flesh thickness (mm) with high PCV (21.451) and GCV (20.592) values. Flesh thickness showed high heritability (92.2%) but high genetic advance (27.350) and high GA as per cent mean (40.721). Rind thickness (mm) was observed with very low phenotypic and genotypic variances (2.030 and 1.849) were recorded in Bottle gourd genotypes with high PCV (31.873) and GCV (30.424) values. Rind thickness showed high heritability (91.1%) but low genetic advance (2.674) and high GA as per cent mean (59.823).

The parameter yield per plant (kg) registered high phenotypic and genotypic variances (34.518 and 31.118) with high PCV (39.917) and GCV (37.900) values. Yield per plant showed high heritability (90.1%) but very moderate genetic advance (10.911) and high GA as per cent mean (74.129). Very high phenotypic and genotypic variances (870.862 and 786.713) were recorded in Bottle gourd genotypes with high PCV (40.093) and GCV (38.107) values in respect of total yield (t ha^{-1}). Total yield showed high heritability (90.3%) but high genetic advance (54.917) and high GA as per cent mean (74.612).

Quality parameters: Total soluble solids (^{0}Brix) had very low phenotypic and genotypic variances (0.473 and 0.429) were recorded in Bottle gourd genotypes with high PCV (20.330) and GCV (19.368) values. Total soluble solids showed high heritability (90.8%) but very low genetic advance (1.285) and high GA as per cent mean (38.010). Ascorbic acid (mg/100g) registered very low phenotypic and

genotypic variances (0.043 and 0.030) were recorded in Bottle gourd genotypes with low PCV (2.001) and GCV (1.684) values. Ascorbic acid showed high heritability (70.8%) but very low genetic advance (0.303) and low GA as per cent mean (2.920).

The characters which are of economic importance were quantitatively inherited and they were influenced by environment. Such type of variation is most important for choosing the superior genotypes for hybridization work. The variation occurring in a plant population is therefore attributed to three sources namely 1) additive gene effect 2) non-additive gene effect and 3) environmental effect. The first type of variation is important as it is responsible for progress resulting from selection. Since it is required to select superior genotypes from the phenotypic expression, estimation of genotype and phenotypic variances for various characters are needed as has also been stressed by Robinson *et al.*, (1951).

Similar trend of high GCV has already been reported by Rahman *et al*., (1986) [11] for fruit length, Prasad *et al.*, (1993) for fruit yield per plant, Mathew *et al*., (2000) [5] for number of fruits per plant, Singh and Rajesh Kumar, (2002) [13] for fruit yield per plant, fruit diameter, fruit length, number of nodes to first male flower, Munshi and Sirohi, (2005) [6] for number of nodes on the main axis, number of fruits per plant, fruit length, girth, weight, Singh *et al.*, (2008) [14] for yield per vine, Arvind Kumar *et al*., (2011) [1] for fruit yield per plant, Husna *et al*., (2011) [7] for yield per plant, fruit weight, Sharma and Sengupta, (2013) [12] for fruit weight, Mandal *et al*., (2015) [4] for fruit number per plant, Deepthi *et al.*, (2016) for node at which first male flower appearance, number of fruits per vine, fruit weight, fruit length, yield per vine, total yield.

High heritability could be exploited through simple selection from this material and could be transmitted to the offspring to improve yield (Mohanty 2003). However, a caution has to be exercised for its direct application while making the selection. Medium to low heritability reported for other remaining characters. Low to medium heritability suggested careful selection from the material for enhancing the genetic portion of variation that can also be attained through affection of superior germplasm (Johnson *et al*, 1955) [3]. Genetic advance as a per cent over mean result were observed high values for expected genetic advance accompanied with high heritability estimate and indicative of facts that the improvement could be effectively realized through selection in these characters on a phenotypic values.

Table 1: Estimates of variability, heritability and genetic advance as percent of mean for twenty characters in thirty two genotypes of Bottle gourd

S. No.	Characters	Range		Mean	Variance		PCV (%)	GCV (%)	h^2 (%)	Genetic Advance	GA as per cent of mean
		Minimum	Maximum		Phenotypic	Genotypic					
1	Total vine length (m)	9.66	18.11	12.60	6.02	4.41	19.64	16.65	73.00	3.70	29.37
2	No. of primary branches per plant	7.22	15.00	11.00	3.99	2.89	18.16	15.46	72.00	2.98	27.14
3	Number of nodes per plant	60.62	148.65	93.94	880.80	676.81	31.59	27.69	76.00	46.97	50.00
4	Internode length (cm)	9.55	19.66	14.13	9.40	8.02	21.69	20.04	85.00	5.39	38.14
5	Days to first male flower appearance	47.33	72.66	56.31	58.42	45.11	13.57	11.92	77.00	12.15	21.59
6	Days to first female flower appearance	57.00	85.00	67.49	57.50	46.82	11.23	10.13	81.00	12.72	18.84
7	Node at which first male flower appears	5.00	10.33	6.97	2.53	0.82	22.83	13.01	32.00	1.06	15.28
8	Node at which first female flower appears	6.77	17.66	11.82	8.60	6.84	24.79	22.11	79.00	4.80	40.63
9	Days to first fruit harvest	66.00	105.88	83.48	99.73	76.05	11.96	10.44	76.00	15.68	18.79
10	Days to last fruit harvest	144.00	173.44	158.22	116.36	88.194	6.81	5.93	75.00	16.84	10.64
11	Number of fruits per plant	6.00	14.11	10.21	4.97	3.69	21.83	18.82	74.00	3.41	33.42
12	Weight of the fruit (g)	810.00	2246.67	1437.07	187301.60	181797.00	30.11	29.66	97.00	865.33	60.21
13	Fruit length (cm)	12.22	57.55	35.86	90.63	89.53	26.54	26.38	98.00	19.37	54.02
14	Fruit diameter (cm)	6.78	18.11	11.97	7.55	6.74	22.95	21.69	89.00	5.05	42.23
15	Flesh thickness (mm)	45.89	100.53	67.16	207.56	191.27	21.45	20.59	92.00	27.35	40.72
16	Rind thickness (mm)	2.44	7.44	4.46	2.03	1.84	31.87	30.42	91.00	2.66	59.82
17	Yield per plant (kg)	7.00	31.67	14.71	34.51	31.11	39.91	37.90	90.00	10.91	74.12
18	Total yield (t/ha)	34.00	158.67	73.60	870.86	789.71	40.09	38.10	90.00	54.91	74.61
19	Total soluble solids (^{0}Brix)	2.44	5.22	3.38	0.47	0.42	20.33	19.36	90.00	1.28	38.01
20	Ascorbic acid (mg/100g)	10.00	10.69	10.36	0.04	0.03	2.00	1.68	70.00	0.33	2.92

Conclusion

In the present study, the high genetic variability observed for the characters weight of the fruit, fruit length, yield per plant, yield per hectare, number of nodes per plant and node at which first female flower appears indicates the significance of these characters to be used for selecting superior genotypes.

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