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Genetic Diversity and Morphological Characterization Studies in Bottle Gourd [*Lagenaria siceraria* (Mol.) Standl.]

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ABSTRACT: The current study was implemented during the kharif 2022 at Vegetable Research Farm of Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh. The experimental material comprises 30 bottle gourd genotypes. Which were planted in three replications using a randomized block strategy in order to measure genetic progress, heritability, genetic variability and genetic diversity within the genotypes. Observation for all the parameters was recorded in three selected plants of each treatment. The experiment's analysis of variance revealed incredibly substantial variations between each of the 30 genotypes for every character and also a wide range of mean values among the genotypes for different characters under study were observed. A very high magnitude of GCV and PCV was recorded for fruit length (cm), fruit width (cm) and yield per plant (Kg). Low or insignificant difference between GCV and PCV was recorded for most of the traits indicated that the investigated traits were less impacted by environment. High heritability combined with high genetic advance was recorded for days to first flowering bud, fruit length, fruit weight, number of fruits per plant, fruit width, yield per plant, total soluble solids, protein content and ascorbic acid content. Based on (D^2) statistics, thirty genotypes with comparable features were sorted into five substantially diverse clusters. Grouping of genotypes into different diverse clusters showed considerable amount of diversity among the genotypes.

Keywords: Variability, Heritability, Diversity, Genetic advance, cluster analysis.

INTRODUCTION

Cucurbits are one of the widely growing vegetable crops consisting large number of cultivatated species. One of the significant members of this family with the most genetic diversity in fruit morphological characteristics is the bottle gourd (*Lagenaria siceraria*), which has chromosomal number 2n = 22. In different regions of India, it is also known by the names Calabash, Doodhi, and Lauki (Gurcan *et al.*, 2015).

Bottle gourd is one of the earliest vegetable crop that was cultivated for human consumption. In addition to offering food and medicine, bottle gourds are also used to make a wide range of tools and instruments including bowls, bottles, containers, floats for fishing nets (Patel *et al.,* 2023). The bottle gourd is found in South Africa and India in its wild form and is said to have originated in Africa and America (Srivastava *et al.*, 2014). The critical and initial steps in any crop development programme are the collection, preservation, and evaluation of germplasm. An effective breeding programme must be created with a enhanced comprehension of the type and level of genetic diversity contained in the breeding material (Engels and Ebert 2021).

Comprehensive biological knowledge and a grasp of genetic diversity for yield and its constituent parts are required for the implementation of an intense breeding and improvement programme (Damor *et al.,* 2017). The existence of genetic variability, the way in which economic traits are passed down through the generations, heritability, the type of gene action, and the relative magnitude of additive and dominance as well as the overall genotypic and phenotypic variance of the population must all be thoroughly understood. Considering the availability of genetic variability, there is scope of yield and quality improvement and thereby develop exportpotential of bottlegourd.

Genetic diversity among germplasm is important for genetic development of any crop since it makes it allows to detect the most divergent parents on the basis of contribution of various qualitative and quantitative parameters (Sohi *et al.,* 2021).Which can be utilized in any hybridization programme. To determine which genotypes are optimal for a breeding population, genetic diversity in the germplasm must be evaluated (Goyal and Bisen 2017).

MATERIAL AND METHODS

The current study was implemented during the kharif 2022 in a Randomized Block Design (RBD) with three replications at at Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh. RLBCAU is situated in the Bundelkhand agro-climatic zone (6) of Uttar Pradesh. The experimental site is situated at 25.30° N latitude and 78.32° E longitude at an altitude of 227 m above MSL. The experimental material comprises 30 bottle gourd genotypes, which is collected from different sources and the genotypes are laid out in 3 × 3 m plot size with the spacing of 0.6 m between each 5 plants in a plot.

Three randomly chosen plants from each genotype were used to record the observations for 15 distinct features *viz.,* vine length (cm), days to first flowering bud, node number to first male flower appearance, node number to first female flower appearance, days to first fruit setting, days to first fruit picking, number of fruits per plant, fruit length (cm), fruit width (cm), average fruit weight(g), yield per plant (Kg), yield per ha(q), fruit shape, protein content(mg/100g), total soluble solid (^{o}brix) and ascorbic acid content (mg/100g). TSS content was recorded by Hand Refractometer, Protein content was calculated by Kjeldahl method and Ascorbic acid content was calculated by 2, 6-dichlorophenol indophenol titration method (Ranganna, 1986).

Analysis of variance was computed for statistical analysis using the method outlined by Panse and Sukhatme (1967). GCV and PCV were computed according to Burton and De Vane (1953), Heritability broad sense was calculated by the formula given by Lush (1949); Burton and De Vane (1953) and genetic gain was calculated utilizing the formula proposed by Johnson *et al*. (1955); Lush (1949). The D2 statistic was developed by Mahalanobis (1936) is a helpful tool for evaluating genetic divergence among crop varieties.

RESULTS AND DISCUSSION

A. Analysis of variance

The experiment's analysis of variance revealed extremely significant variations among the 30 genotypes for every trait under study (Table 2). The highly significant mean sum of squares was recorded for the traits *viz*., vine length, days to first flowering bud, node number to first male flower appearance, node number to first female flower appearance, days to first fruit setting, days to first fruit picking, number of fruits per plant, fruit length, fruit width, average fruit weight, yield per plant, yield per hectare, total soluble solid, protein content and ascorbic acid content, revealed significant difference for all the parameters, indicating sufficient amount of variation among all the germplasm for all parameters under the study. Kumar *et al.* (2021); Singh *et al.* (2021); Venkatraman (2021); Rashid *et al.* (2020); Ahmad *et al.* (2019); Chikkeri *et al.* (2018) also recorded a very high significant differences among the bottle gourd genotypes with respect to most of the parameters under their studies. The results suggested existence of adequate degree of variation between the experimental material and hence, create more scope for development of desired characters through selection in bottle gourd.

B. Genetic parameters

Higher magnitude of GCV and PCV was noted for fruit length (cm), fruit width (cm) and yield per plant (Kg), which demonstrating the existence of a broad range of genetic variability for these characterstics in the germplasm. Additionally, Studies revealed that these characteristics have a wide genetic base, little environmental effect, and are governed by additive genes, indicating that there is considerable potential for further evolution of these traits through selection. Similar results were also published by Kumar *et al.* (2021). The moderate level of PCV and GCV for days to first flowering bud, vine length (cm), node number to first male flower appearance, number of fruits per plant, node number to first female flower appearance, average fruit weight, days to first fruit picking, protein content (mg/100g), total soluble solid (°Brix) and ascorbic acid content (mg/100g) indicated moderate variation between the genotypes under study for these vegetative traits in bottle gourd, which indicated that the phenotypic-based selection will be trustworthy since the investigated traits were less impacted by environment (Table 3).

High heritability combined with high genetic advance was recorded for fruit length (cm), number of fruits per plant, fruit width (cm), average fruit weight (g) and yield per plant (kg), which suggested that picking based on these traits would be effective. High heritability combined with moderate to high genetic advance was recorded for vine length (cm), days to first flowering bud, node number to first male flower appearance and node number to first female flower appearance (Table 3). Yield per plant were resulted highly positive significant association with fruit width, number of fruits per plant, and average fruit weight at both genotypic and phenotypic level indicated that the overall fruit yield per vine would increase as a result of selection for these traits. Days to first fruit setting resulted positive significant association with days to first flowering bud, days to first fruit picking. The outcomes are consistent with the findings of Chikkeri *et al.* (2018); Ahmad *et al.* (2019) ; Rashid *et al.,* (2020) in bottle gourd.

C. Genetic divergence

Study on genetic divergence of bottle gourd with 30 genotypes were differed significantly with regards to the character under study and displayed marked divergence, when taking 14 characters together. Based on (D^2) statistics of Mahalanobis (1936) and also by the use of non-hierarchical Euclidean cluster analysis, Five divergent groups were formed from the 30 genotype data. Cluster 1 has 10 genotypes, Cluster 2 have 7 genotypes, Cluster 3 have 9 genotypes, Cluster 4 have 3 genotypes and cluster 5 have 1 genotype.

Data findings showed that cluster 1 included maximum number of the genotypes which were encouraging, with the majority of the yield attributable traits like fruit length, protein content, fruit width, average fruit weight, days to first flowering bud, number of fruits per plant and these genotypes can be used as donors in

breeding high yielding varieties (Table 4) and (Fig. 1). Similar results were also published by Ahmad *et al.* (2021); Rambabu *et al.* (2020); Rehan *et al.* (2020); Damor *et al.* (2017) in bottle gourd.

Table 1: Fruit quality parameters of bottle gourd.

Sr. No.	Genotypes	Fruit shape	Fruit colour	Fruit surface
1.	Sharada	Cylindrical	light green	smooth
2.	Pusa Santushti	Pear	light green	fine hairy
3.	Amrit F_1	Cylindrical	light green	smooth
4.	Narendra Shishir	Round	light green	smooth
5.	Surag	Cylindrical	light green	smooth
6	Madhu Sree	Round	light green	fine hairy
7.	Pusa Samrudhi	Cylindrical	light green	smooth
8.	IC-594545	Round	whitish green	smooth
9.	RBG-1	Cylindrical	dark patchy green	smooth
10.	RBG-2	Cylindrical	whitish green	smooth
11.	RBG-3	Bottle	light patchy green	smooth
12.	RBG-4	Round	light green	smooth
13.	RBG-5	Cylindrical	whitish green	smooth
14.	RBG-6	Pear	whitish green	fine hairy
15.	RBG-7	Bottle	light patchy green	fine hairy
16.	Pusa Naveen	Bottle	light green	fine hairy
17.	Hybrid Green Gold	Cylindrical	light green	smooth
18.	MAHY8	Cylindrical	light green	fine hairy
19.	Muskan	Cylindrical	light green	fine hairy
20.	Mahi	Cylindrical	light green	smooth
21.	Narendra Madhuri	Flat round	light green	fine hairy
22.	Arka Bahar	Cylindrical	light green	fine hairy
23.	RBG-8	Crooked	dark patchy green	smooth
24.	RBG-9	Bottle	dark patchy green	smooth
25.	RBG-10	Crooked	dark patchy green	smooth
26.	RBG-11	Crooked	dark patchy green	smooth
27.	RBG-12	Bottle	light green	fine hairy
28.	RBG-13	Crooked	whitish green	smooth
29.	RBG-14	Crooked	light patchy green	smooth
30.	RBG-16	cylindical	whitish green	smooth

Table 2: ANOVA analysis of bottle gourd genotypes for different characters.

Sr. No.	Characters	Source of variation		
		Replications Mean sum of squares	Treatments Mean sum of squares	Error
1.	d.f	2	29	58
2.	Vine length	567.8	17813.2**	1286.2
3.	Days to first flowering bud	4.011	39.815**	1.448
4.	Node number to first male flower appearance	0.433	5.848**	0.881
5.	Node number to first female flower appearance	0.300	5.572**	1.334
6.	Days to first fruit setting	6.933	62.974**	2.807
7.	Days to first fruit picking	5.633	66.460**	3.955
8.	Number of fruits per plant	0.344	4.470**	0.298
9.	Fruit length	4.633	281.641**	5.116
10.	Fruit width	0.446	20.031**	0.732
11.	Average fruit weight	0.004	0.082**	0.009
12.	Yield per plant	0.505	8.688**	0.656
13.	Yield per ha	1559.2	26816.3**	2025.2
14.	Total Soluble Solid	0.007	0.908**	0.009
15.	Protein Content	210.6	3949.1**	77.4
16.	Ascorbic acid content	0.040	9.287**	0.136

*Significant at 5% level of probability, ** Significant at 1% level of probability

Table 3: Mean, Range, Coefficient of variations (GCV and PCV), Genetic Advance, Genetic Advance as Per cent of mean and Heritability, for 21 Characters of bottle gourd genotypes.

Characters	Range	Mean	V_p	V_g	PCV (%)	GCV (%)	Genetic Advance	Genetic Advance as % of mean	Broad sense heritability (%)
DFFB	39.3-26.0	32.21	14.23	12.78	11.70	11.09	6.98	21.65	89.83
FMFEN	13.0-8.67	10.90	2.53	1.65	14.56	11.76	2.14	19.58	65.25
FFFEN	15.3-10.6	12.93	2.74	1.41	12.81	9.18	1.75	13.57	51.42
FFS	57.3-37.3	46.92	22.86	20.05	10.16	9.52	8.64	18.37	87.72
FFP	66.3-46.0	55.62	24.79	20.83	8.99	8.24	8.62	15.57	84.05
FL	46.6-10.0	30.76	97.29	92.17	32.09	31.23	19.25	62.63	94.74
FW	12.6-4.30	6.99	7.16	6.43	38.29	36.28	4.95	70.82	89.78
F Wt	0.87-0.63	0.75	0.03	0.02	22.01	18.62	0.27	32.45	71.55
NFPP	8.0-4.6	6.42	1.68	1.39	19.46	17.66	2.20	33.00	82.33
YPP	6.6-3.4	4.82	3.33	2.67	32.29	28.94	3.02	53.42	80.32
VL	800.0-570.0	697.44	6795.17	5509.0	11.50	10.36	137.67	19.22	81.07
TSS	2.93-1.67	2.29	0.30	0.29	22.05	21.72	1.11	44.07	97.02
PC	219.6-138.1	182.04	1367.97	1290.5	18.30	17.78	71.88	35.57	94.34
ACC	16.9-11.2	14.61	3.18	3.05	12.41	12.14	3.52	24.47	95.72

V_p- phenotypic variance, V_g - genotypic variance, PCV- phenotypic coefficient of variance (%), GCV- genotypic coefficient of variance(%), DFFB- days to first flowering bud, FMFEN- first male flower at early node, FFFEN- first female flower at early node, FFS- days to first fruit setting, FFP- days to first fruit picking, FL- fruit length(cm), FW- fruit width(cm), F Wt- average fruit weight(g), NFPP- number of fruits per plant, YPP- yield per plant (Kg), YPH- yield per ha(q), VL- vine length (cm), T.S.S- total Soluble Solid (°Brix), PC- protein Content (mg/100g), ACC- ascorbic acid content (mg/100g)

Table 4: Clustering pattern of 30 bottle gourd genotypes by Tocher's method.

Group	Number of genotypes	Genotypes
Cluster 1	10	RBG-8, RBG-9, Pusa Samrudhi, Mahi, Amrit F_1, MAHY8, Surag RBG-13, RBG-7, Sharada
Cluster 2	7	RBG-11, RBG-14, RBG-10, Hybrid Green Gold, RBG-12, RBG-3, Pusa Santushti
Cluster 3	9	Madhu Sree, RBG-4, RBG-16, RBG-5, RBG-6, RBG-1, Narendra Madhuri, IC-594545, Narendra Shishir
Cluster 4	3	Muskan, Arka Bahar, RBG-2
Cluster 5	1	Pusa Naveen

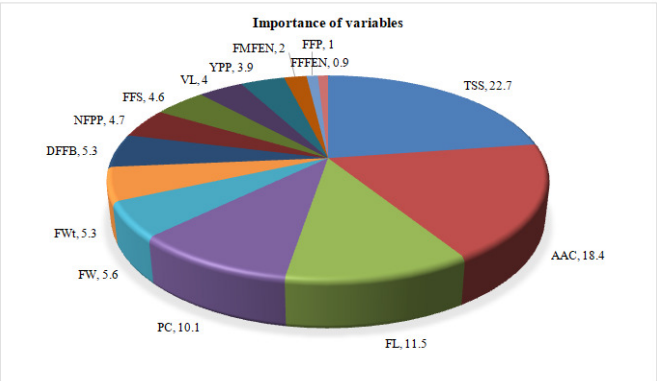

Fig. 1. Percentage contribution of different characters towards diversity in bottle gourd genotypes.

CONCLUSIONS

It is possible to draw the very convenient conclusion that there is a great deal of scope for improvement in the desired attributes of this seemingly highly valuable vegetable crop, which has not received the attention it deserves given its potential. This conclusion is based on data on various important economic traits, including phenotypic and genotypic coefficients of variability, heritability, genetic advance in percent of mean and genetic divergence analysis.

FUTURE SCOPE

Genotypes Hybrid Green Gold followed by MAHY 8 and Pusa Samrudhi, may be used for higher fruit yield per plant and also, these possess earlier to days to first flowering bud, earliest node number to first female flower appearance, highest fruit weight and more protein content.

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