Environment and Ecology 41 (1) : 53—57, January—March 2023
ISSN 0970-0420

Studies on Genetic Variability, Heritability and Genetic Advance in Bottle Gourd (*Lagenaria siceraria* (Mol.) Standl) Germplasms in West Garo Hills of Meghalaya, India

Susmita Chakraborty, A. K. Chaurasiya

Received 1 September 2022, Accepted 4 November 2022, Published on 27 January 2023

ABSTRACT

An experiment was carried out at Horticulture research farm, Department of Horticulture, North Eastern Hill University, Tura Campus, Meghalaya, India, to study genetic variability, heritability and genetic advance in thirty bottle gourd germplasms during 2018 and 2019. Experimental material for the study consisted of 30 genotypes. The experiment was conducted using a Randomized Block Design with three replications. The germplasm lines have been collected from places of Garo Hills Districts of Meghalaya. Observations were recorded on 32 economic traits. The highest value of genotypic and phenotypic coefficients of variation was observed for Fruit length (54.69 and 55.11) and moisture exhibited the lowest value of genotypic and phenotypic coefficients if variation (0.83 and 1.61). Total Ash had the highest heritability (99.72%) and moisture (0.27%) was the least heritable trait. Highest genetic advance as per cent of mean was observed for Fruit length (111.99%) and lowest for moisture (0.88%).

Keywords Experiment, Germplasms, Trait, Yield, Genotypic.

INTRODUCTION

Bottle gourd (*Lagenaria siceraria* (Mol.) Standl) is an important summer and rainy season crop belongs to the family Cucurbitaceae having diploid chromosome number of 2n=22, originated in Africa. It is locally known as Lau in Garo Hills region of Meghalaya. It has a good amount of vitamins and minerals. Its fruit contains 95.54% moisture, vitamin C (10.1 g), vitamin A (16 IU), thiamine (0.029 g), riboflavin (0.022 g), niacin (0.320 g), carbohydrates (3.39 g), fats (0.02 g) and potassium (150 mg)/100g (USDA 2018). Bottle gourd variability has been studied by many authors, including Heiser (1979), Marimoto and Mvere (2004), Marimoto *et al*. (2005). Studies in India demonstrated the significant regional variability (Sivaraj and Pandravada 2005). Selection may not be effective in population without variability, in terms of variability, it is the genetic fraction of the observed

Susmita Chakraborty[1]*, Dr A. K. Chaurasiya[2]
[1] Research Scholar, [2] Assistant Professor
Department of Horticulture, North Eastern Hill University, Tura Campus Chasingre, Tura, Meghalaya 794002, India
Email: jstsusmy@gmail.com
*Corresponding author

variation that provides measures of transmissibility of the variation under study and responds to selection. It is commercially grown in all the states of India in both rainy and summer seasons. Yield is a complex trait influenced by genetic factors interacting with environment. Success in any breeding program for improvement depends on existing genetic variability in the base-population and on efficiency of selection. For successful selection, it is necessary to study the nature of association of the trait of interest with other relevant traits. The relation of genotypic variability to observe variability represents heritability when the heritability of quantitative characters becomes high (Sharma and Sengupta 2013). Bottle gourd is a nutritive and popular cucurbitaceous vegetable crop grown in Garo Hills region of Meghalaya. There are number of local cultivars with wide range of variability in size, shape and color of fruits available in Garo Hills of Meghalaya but a very limited attempt has been made for genetic improvement of this crop in Garo Hills Region of Meghalaya. In the present study, the statistical analysis revealed highly significant differences for all the characters studied which indicated that the genotypes differed significantly for all the components as well as for yield and this study was undertaken with the objective to find out and determine the study on genetic diversity, heritability and morphological characterization in bottle gourd (*Lagenaria siceraria* (Mol.) Stand) in Garo Hills region of Meghalaya, India.

MATERIALS AND METHODS

The study was carried out during (2018 and 2019) at Horticulture Research farm, North Eastern Hill University, Tura Campus, Chasingre, Meghalaya. Tura is situated at 25°31' N latitude and 90° 13'E longitude having an altitude of 527 m above the mean sea level. The experiment comprised of thirty genotypes of bottle gourd collected from different Districts of Garo Hills Region of Meghalaya. The experiment comprised of thirty genotypes of bottle gourd collected from different Districts of Garo Hills Region of Meghalaya. The experiment was laid out in a Randomized Block Design with three replications at 2 × 2m row to row and plant to plant spacing. The crop was grown under rainfed condition. During first season the seeds were sown on 19th May 2018 and first harvest was taken on 22nd July 2018 while, during second season the seeds were sown on 11th May, 2019 and harvesting started from 23rd July, 2019. The crop was grown for two season and seeds for growing in second season was collected from first season. All the recommended cultural practices by ICAR were adopted for proper growth and stand of the crop during the cropping period. Bowers were constructed to support the standing crop. The observations were recorded according to NBPGR descriptor for bottle gourd. Data were recorded on nine randomly selected plants with respect to characters viz.,vine length (cm), internode length (cm), petiole length (cm), no. of primary branches, node no. at which first female flower appears, days to 50% flowering, days to first fruit harvest, number of marketable fruit harvest, days to last fruit harvest, number of leaves, fruit length (cm), peduncle length (cm), fruit width (cm), fruit weight (g), number of fruits per plant, yield of marketable fruits (kg) per plant, yield (t/ha), number of seeds per fruit, 100 seed weight (g), seed L-B ratio, TSS (◦Brix), total sugar (%), reducing sugar (%), ascorbic acid (mg/100g), total soluble protein (%), total carbohydrate (%), moisture (%), dry matter (%), total ash (%), total phenols (%), calcium (mg/100g) and crude fiber (%). The magnitude of phenotypic co-efficient of variation (PCV) and genotypic co-efficient of variation (GCV) existing in a trait was worked out by the formula given by Burton (1952). PCV and GCV were categorized as low, moderate and high by following Sivasubramanian and Madhavamenon (1973) as (0 – 10%): Low, (10 – 20%): Moderate, (Above 20%): High respectively. Heritability in broad sense was estimated as per the procedure presented by Burton and Devane (1953). Genetic advance at 5% selection intensity was worked out by using the formula given by Lush (1949) and Johnson *et al*. (1955). Statistical analysis was carried out using the mean values of genotypes for horticultural traits. The mean values of genotypes in each replication were used for analysis. The data were analyzed as per Randomized Block Design or RBD (Panse and Sukhatme 1969).

RESULTS AND DISCUSSION

In the present study, thirty genotypes of bottle gourd were evaluated to estimate the genetic variability, heritability and genetic advance (as percent of mean).

The range in the values reflect the amount of phenotypic variability, which is not very reliable since it includes genotypic, environmental and genotype × environmental interaction components and does not reveal as to which character is showing higher degree of variability. Further, the phenotype of crop is influenced by additive gene effect (heritable), dominance (non-heritable) and epistasis (no allelic interaction). Hence, it becomes necessary to split the observed variability into phenotypic coefficient of variation and genotypic coefficient of variation, which ultimately indicates the extent of variability existing for various traits (Rashid *et al*. 2020). The statistical analysis revealed highly significant differences for all the characters studied which indicated that the genotypes differed significantly for all the components as well as for yield. Information on genetic variability of yield components is of paramount importance in a crop improvement program. Estimates of phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), environmental coefficient of variation (ECV), heritability in broad sense (h^2_b) and genetic advance as percentage of mean for various characters were presented in Table 1.

Table 1. Estimates of different genetic parameters for 32 horticultural characters in bottle gourd.

Characters	PCV(%)	GCV(%)	H^2_b(%)	GA (%)
Vine length (cm)	9.19	6.19	45.41	8.61
Internode length (cm)	13.42	9.37	48.80	13.51
Petiole length (cm)	11.84	8.33	49.45	12.08
No. of primary branches	10.58	6.99	43.61	9.52
Node no. at which 1st female flower appears	9.35	7.00	56.10	10.82
Days to 50% flowering	9.46	6.96	54.14	10.57
Days to 1st fruit harvest	9.82	5.87	35.72	7.24
No. of marketable fruit harvest	24.74	21.05	72.43	36.97
Days to last fruit harvest	6.16	3.71	36.25	4.61
No. of leaves	13.60	12.18	80.27	22.51
Fruit length (cm)	55.11	54.69	98.51	111.99
Peduncle length (cm)	14.57	12.50	73.62	22.13
Fruit width (cm)	18.83	16.64	78.13	30.35
Fruit weight (g)	26.57	23.78	80.16	43.93
No. of fruits per plant	26.14	20.84	63.57	34.28
No. of seeds per fruit	19.61	19.46	98.48	39.83
100 seed weight (g)	12.33	10.24	69.06	17.56
Seed L-B ratio	11.61	7.42	40.91	9.80
TSS (◦Brix)	10.82	10.03	85.95	19.18
Total Sugar (%)	20.15	19.95	98.06	40.76
Reducing sugar (%)	27.78	27.40	97.30	55.75
Ascorbic acid (mg/100g)	8.80	7.99	82.48	14.98
Total soluble protein (%)	11.73	10.85	85.66	20.72
Total carbohydrate (%)	22.98	22.77	98.15	46.54
Moisture (%)	1.61	6.83	26.54	0.88
Dry Matter (%)	16.76	8.63	26.51	9.17
Total Ash	44.70	44.64	99.72	91.96
Total phenol	15.10	14.81	96.23	29.97
Calcium (mg/100g)	13.75	13.57	97.49	27.65
Crude fiber (%)	8.06	7.66	90.41	15.02
Yeild of marketable fruits (kg/plt)	44.71	41.19	84.86	78.28
Yield (t/ha)	44.71	41.19	36.37	78.28
Range (Max)	55.11	54.69	99.72	111.99
Range (Min)	1.61	0.83	0.27	0.88

Coefficient of variation

Phenotypic coefficient of variation was the highest for fruit length (cm) (55.11) followed by yield of marketable fruits (kg/plant) (44.71), yield (t/ha) (44.71), total ash (44.70) and the lowest value of PCV was obtained for Moisture (%) (1.61).

The genotypic coefficient of variation was highest for fruit length (54.69) followed by total ash (44.64), sex ratio (41.45). Moisture (%) exhibited the lowest value of GCV (0.83) followed by days to last fruit harvest (3.71). Comparatively wide differences between the estimates of PCV and GCV were observed for the characters namely dry matter (%) (PCV 16.76 and GCV 8.63), number of fruits per plant (PCV 26.14 and GCV 20.84), Seed L-B ratio (PCV 11.61 and GCV 7.42), internode length (PCV 13.42 and GCV 9.37), days to first fruit harvest (PCV 9.82 and GCV 5.87) and number of primary branches (PCV 10.58 and GCV 6.99). The difference between the phenotypic coefficient of variation and genotypic coefficient of variation was low for the traits total ash (PCV 44.70 and GCV 44.64), calcium (Mg/100g) (PCV 13.75 and GCV 13.57), total carbohydrate (%) (PCV 22.98 and GCV 22.77), reducing sugar (%) (PCV 27.78 and GCV 27.40), number of seeds per fruit (PCV 19.61 and GCV 19.46), and TSS (◦Brix) (PCV 10.82 and GCV 10.03). Sharma and Sengupta (2013) also reported high GCV in character fruit length (47.40%) followed by no. of primary branches per vine (42.72%), fruit length and lower GCV in characters first appearance of female flower (27.25), days to first appearance of male flower (27.62%). Varalakshmi *et al*. (2018) reported GCV ranging from 9.2 (days taken for first female flower appearance) to 31.2 (fruit yield/vine). Similar findings of PCV and

GCV have been reported by Rashid *et al*. (2020) for characters fruit length (23.43 and 23.16), fruit diameter (35.65 and 34.62) and total chlorophyll (30.08 and 20.02) recorded high phenotypic and genotypic coefficients of variation respectively, indicating that genotypes had broad genetic base for these characters. Rest of the traits such as total sugars (15.62 and 13.50), dry matter (14.57 and 13.41), node number at which first female flower appeared (12.14 and 9.68), node number at which first male flower appeared (8.26 and 5.63), number of fruits plant^{-1} (6.96 and 5.46), days to anthesis of first male flower (6.62 and 6.24), days to anthesis of first female flower (5.77 and 5.11), fruit yield plant^{-1} (4.21 and 3.18), fruit yield hectare^{-1} (4.29 and 3.33), days to first fruit harvest (2.99 and 2.68) and days to last fruit harvest (2.83 and 2.57) showed moderate to low phenotypic and genotypic coefficients of variation respectively.

Heritability

Broad-sense heritability values h^2_b were generally high with a range of 26.51% to 99.72%. Dry matter % (26.51%) was the least heritable trait while yield (99.72%) was the most heritable traiti.e Total ash. All the characters had medium to high broad sense heritability estimates. Heritability reflects both additive as well as non additive gene effects, which, however, gave rough estimates. Characters showing high heritability values indicated that such characters have more number of additive factors. Hence, selection for improvement in these characters could be practiced. Sharma and Sengupta (2013) studied and reported high heritability in character vine length (99.98%) followed by fruit length and fruit width (99.97%), days to 1st appearance of male and female flowers (99.95%). Varalakshmi *et al*. (2018) studied and reported high heritability along with high genetic advance for characters vine length per vine and yield/ha. Rashid *et al*. (2020) reported high heritability estimates for almost all the characters except node number at which first male flower appeared, number of fruits plant^{-1}, fruit yield plant^{-1}, fruit yield hectare^{-1}, total chlorophyll and ranged from 44 to 97%.

Genetic advance

The highest value of genetic advance as percent of mean was obtained for Fruit length (111.99) followed by Total ash (91.96). Moisture % showed the least value (0.88) followed by Days to last fruit harvest (4.61). Sharma and Sengupta (2013) studied and reported high genetic advance in characters fruit length (96.68%) and fruit weight (95.82%). Ara *et al*. (2014) also reported similar findings in bottle gourd. Rashid *et al*. (2020) studied and reported the characters viz., fruit length, fruit diameter, total sugars and dry matter content.

CONCLUSION

Information on genetic variability of yield components is of paramount importance in a crop development program. The extent of genotypic variability indicates the amenability of a given character for its improvement. The understanding of the heritability along with genetic advance helps in drawing valuable conclusions for effective selection based on phenotypic performance. A broad sense heritability estimate from a test provides information on relative extent of genetic and environmental variation in germplasm pool. Knowledge of heritability coupled with expected genetic advance of a trait is necessary for assessing the scope of improvement of a character through selection. The analysis of variance revealed highly significant differences among the genotypes for all the attributes under study which clearly indicated sufficient variability for each trait among the genotypes included in this investigation. By this investigation it can be observed that there was a lot of variability among the different germplasm lines of bottle gourd and between the bottle gourd genotypes for various traits like yield, fruit weight, number of fruits per plant and genetic diversity analyzed by ANOVA. Results showed high estimates of heritability coupled with high genetic advance (as per cent of mean), indicating the preponderance of additive gene action for control of these traits and selection for these traits would be effective. This suggests that real progress in improvement through selection could be made for yield. It is clear from the result and discussion that tremendous potential exists for converging the elite allelic resources present in these bottle gourd genotypes through a efficient breeding and selection approach so as to get better high yielding recombinants, with good quality characteristics.

REFERENCES

Ara ZG, Zakaria M, Uddin MZ, Rahman MM, Rasul MG, Kabir AFMR (2014) Correlation matrix among different parameters of bottle gourd genotypes. *Int J Nat Soc Sci* 1: 48-51.

Deore SL, Khadabadi SS, Patel QR (2009) *In vitro* antioxidant activity and quantitative estimation of phenolic content of *Lagenaria siceraria*. *Rasayan J Chem* 2(1): 129-132.

Hemeda HM, Ibrahim HS, Khattab HAH (2008) Bakery fortification and biological evaluation of bottle gourd seeds (*Lagenaria siceraria*). *Egypt J Food Sci* 36(1): 93-113.

Kandasamy R, Arivazhagan E, Bharati S (2019) Evaluation of growth and yield characters in bottle gourd (*Lagenaria siceraria* (Mol.) Standl). *Int J Pharmacog Phytochem* 8(3): 4653-4655.

Marimoto Y, Mvere B (2004) *Lagenaria siceraria* (Molina) Standley. In: Plant resources of Tropical Africa 2. Vegetables, (eds Grubben GJH and Denton OA), pp 353-358.

Marimoto Y, Maundu P, Fujimaki H, Morishima H (2005) Diversity of landraces of the white-flowered gourd (*Lagenaria siceraria*) and its wild relatives in Kenya: Fruit and seed morphology. *Genet Resour Crop Evol* 52: 737-747.

Panse VG (1957) Genetics of quantitatives characters in relation plant breeding. *Ind J Genet Pl Breed* 17: 318-328.

Rashid M, Wani KP, Hussain K, Dar ZA, Singh PK, Khalil A, Ali G, Farwah S, Hussain SM, Rizvi S (2020) Studies on genetic variability, heritability and genetic advance in bottle gourd (*Lagenaria siceraria* (Mol.) Standl). *Int J Chem Stud* 8(3): 455-458.

Sharma A, Sengupta SK (2013) Genetic diversity, heritability and morphological characterization in bottle gourd (*Lagenaria siceraria* (Mol.) Standl). *The Bioscan* 8(4): 1461-1465.

Singh DK, Kumar R (2002) Studies on the genetic variability in bottle gourd. *Prog Hort* 34(1): 99-101.

Sivasubramanian J, Madhavamenon P (1973) Genotypic and phenotypic variability in rice. *Madras Agric J* 12: 15-16.

USDA (2018) National Nutrient Database for Standard Reference, release 1. The national agricultural library,. https://ndb.nal.usda.gov/ndb/.

Varalakshmi B, Pitchaimuthu M, Rao S (2018) Genetic variability, correlation and path analysis in bottle gourd (*Lagenaria siceraria* (Mol.) Standl) germplasm. *J Hort Sci* 13(2): 131-133.