Advances in Biological Research 5 (6): 323-327, 2011
ISSN 1992-0067

Genetic Variability, Correlation and Path Co-Efficient Analysis in Bottle Gourd (*Lagenaria siceraria* L.)

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Abstract: Variability, correlation and path analysis among different characters of thirty one bottle gourd genotypes were studied. There was a great deal of significant variation for all the characters among the genotypes. High genotypic co-efficient of variation (GCV) was observed for yield per plant, fruit weight whereas low genotypic co-efficient of variation was observed fruit breadth. In all cases, phenotypic variances were higher than the genotypic variance. Differences between genotypic and phenotypic co-efficient revealed that the major portion of the phenotypic variance was genetic in nature. High heritability with low genetic advance in percent of mean was observed in leaf petiole length which indicated that non-additive gene effects were involved for the expression of this character and selection for such trait might not be rewarding. High heritability with high genetic advance in percent of mean was observed for yield per plant and days of first male flowering indicated that this trait was under additive gene control and selection for genetic improvement for this trait would be effective. Correlation studies revealed that highest significant association of yield per plant with reproductive characters no. of fruit per plant followed by fruit weight at genotypic and phenotypic level. Path co-efficient analysis revealed maximum direct contribution towards yield per plant with of no. of fruit per plant followed by fruit weight. Considering all the characters the G_4(BD-4580), G_{31} (BD-8948), G_{26}(BD-4560) and G_{28} (BD-4569) were selected for future breeding programme.

Key words: Variability · Heritability · Genetic advance · Correlation · Path co-efficient and Bottle gourd

INTRODUCTION

Bottle gourd (*Lagenaria siceraria* L.), locally known as lau is an important home garden vegetable. It is a fast growing winter seasonal climbing annual, native to Africa. Bottle gourd is a tropical and subtropical vine of the Cucurbitaceae family. It is widely grown for edible fruit. The original home of the species is not known, other than that it is a native of the tropics. It is widely grown in South and Southeast Asia, China and Africa. The herbaceous tendril-bearing vine grows to 5 m. It bears simple; alternate leaves 4-12 cm across, with 3-7 separated lobes and velvety texture because of the fine hairs. Each plant bears separate white male and female flowers [1]. Bottle gourd has relatively high nutritional value.

Bottle gourd is usually grown under kitchen garden as a winter vegetable. But at present it is also being grown as commercial crop near the urban areas. Moreover, it can also be grown in any type of soil having good drainage system. From nutritional point of view, bottle gourd can be considered as nutrition rich fruit vegetable. It contains considerable amount of water (96.1g), carbohydrates (2.5g), protein (0.2g), fat (0.1g), minerals (0.5g), fiber (0.6g) and energy (12kcal) per 100g of edible fruit [2]. Bottle gourd is a rich source of minerals and vitamins.

In Bangladesh, no comprehensive systematic research has been done in this crop. The yield potentiality of this crop needs to be improved through an effective breeding program. Studies on the variations of yield and yield contributing characters are of great importance before planning a breeding program. As the yield and its components are quantitative characters, careful assessments of the amount of variation and their association must be analyzed to gain insight into the complexity of the mechanism. The present study was, therefore, undertaken in estimating the amount of variation, the correlation coefficients and path-coefficient in the thirty one genotypes of bottle gourd.

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MATERIALS AND METHODS

The genetically pure and physically healthy seeds of these genotypes were collected from Plant Genetic Resources Centre (PGRC) of Bangladesh Agricultural Research Institute (BARI). The crop was grown at the experimental field of Sher-e-Bangla Agricultural University, Dhaka-1207 during October 2008 to March 2009. The experimental area was situated at 23°77'N latitude and 90°33'E longitude at an altitude of 8.6 meter above the sea level [3]. The experimental field belongs to the Agro-ecological zone of "The Modhupur Tract", AEZ-28 [4]. Soil pH ranged from 6.0- 6.6 and had organic matter 0.84%. Thirty one genotypes of bottle gourd were used for the research work. The experiment was laid out RCBD design with three replications. The genotypes were distributed into the pit of each block of the prepared layout of the experiment. The thirty one genotypes of the experiment were assigned at random into pits of each replication. The distance maintained spacing pit to pit 3 m. The distance maintained between two blocks was 1 m. Due to uncertain rainfall during the period of the study, the seeds were dibbled in poly bag for higher germination percentage and to get healthy seedlings and when the seedlings the seedlings become 20 days old, those were transplanted in the main field in the pit. Seeds were sown 15th October, 2008. The experiment plot was prepared by several ploughing and cross ploughing followed by laddering and harrowing with tractor and power tiller to bring about good tilth in the first week of October 2008. After final land preparation, pits of 55 cm × 55 cm × 45 cm were prepared in each plot with a spacing of a spacing of 3 m × 1 m. To control field cricket 5 mg Furadan was also mixed with the soils of each pit before making it ready for dibbling. The doses of manure and fertilizers such as Cowdung, Urea, TSP and MOP applied @ 10 ton/ha, 125 Kg/ha, 125 Kg/ha and 150 Kg/ha respectively to the plots for bottle gourd cultivation [5]. Total cowdung, half of TSP and one third MOP were applied in the field during final land preparation. Remaining TSP and one third MOP and whole gypsum and zinc oxide and one third of urea were applied in pit one week prior to transplantation. Remaining urea and MOP were applied as top dressing in four installments at 20, 40, 60 and 75 days after transplanting. Germination of seeds was completed within 12 days and the seedlings of different accessions were planted in the pit on 5th November, 2008. The standard agronomic intercultural operations were done from time to time throughout the cropping season for proper growth and development of the plants. In mature stage fruit fly caused severe damage to the fruit. For protection from fruit fly, MSGT (Mashed Sweet Gourd Trap) and Pheromone bait was used along with ripcord, sevin powder. Fruits were picked on the basis of horticultural maturity, size, color and age being determined for the purpose of consumption as the fruit. Fruits were picked with sharp knife and care was taken to avoid injury of the vine. Data were recorded on the parameters from the studied plants during the experiment such as number of male flowers, number of female flowers, ratio of male and female flowers, fruit length (inch), fruit breadth (inch), number of fruit per plant, Weight per fruit (kg) and yield per plant (kg). The data were analyzed to estimate genotypic and phenotypic co-efficient of variation using the formula of Burton [6], heritability in broad sense and genetic advance was estimated [7] by the following formula, suggested by Johnson *et al.* [8] and correlation co-efficient by Miller *et al.* [9]. Mean data of the characters were subjected to multivariate analysis. Univariate analysis of the individual character was done for all characters under study using the mean values [10] and was estimated using MSTAT-C computer programme. Mean, range and co-efficient of variation (CV %) were also estimated using MSTAT-C.

RESULTS AND DISCUSSION

The analysis of variance indicated the existence of highly significant variability for all the characters studied (Table 1). The mean sum of squares due to genotypes were high for most of the characters. The highest mean was observed for number of male flower. In order to obtain a clear understanding of the pattern of variations, the phenotypic variance has been partitioned into genotypic and environmental variance. Considerable genotypic, environmental and phenotypic variances were found in yield per plant (kg) followed by fruit weight (kg). The differences between GCV and PCV were high no. of fruit per plant indicating vulnerability of traits to environmental influences. High GCV and PCV was observed yield per plant (kg), weight per fruit (kg), no. of female flowers and no. of fruit per plant. The highest Environmental co-efficient of variation was observed in no. of fruit per plant. High heritability estimates associates with fairly high estimates of Genetic Advance in percent of mean (GAPM) for yield per plant and fruit weight (kg) which in fact demonstrate the presence of additive genes effect and selection for genetic improvement for this trait would be effective. Such high GA may be due to the action of additive genes [11].

Table 1: Estimates of genetic parameters of nine characters in thirty one bottle gourd genotypes

Characters	Number of male flowers	Number of female flowers	Ratio of male & female flowers	Number of fruit /plant	Fruit weight (kg)	Fruit length (inch)	Fruit breadth (inch)	Fruit peduncle length (inch)	Yield/ plant (kg)
MSG	1002.91**	121.93**	1.07**	42.56**	0.65**	14.56**	42.47**	3.85**	388.28**
%CV	12.5	10.58	16.57	14.68	7.86	1.1	1.26	2.74	15.75
Mean	37.65	19.52	1.94	10.42	1.99	12.29	16.61	4.94	21.54
SE	1.92	0.68	0.07	0.41	0.05	0.23	0.39	0.12	1.2
$ó^2g$	3.24	13.41	0.21	0.32	18.93	9.5	13.29	10.83	125.55
$ó^2e$	0.02	2.34	0.02	0.1	2.59	1.21	2.74	1.09	11.51
$ó^2p$	3.26	15.74	0.23	0.42	21.52	10.71	16.02	11.92	137.06
h^2_b	99.4	85.15	89.39	75.6	87.97	88.71	82.93	90.82	91.6
GCV	31.86	35.14	22.82	29.16	38.61	16.49	15.84	27.42	52.02
PCV	31.95	38.08	24.13	33.54	41.17	17.5	17.39	28.77	54.35
ECV	2.47	14.68	7.86	16.57	14.28	5.88	7.19	8.72	15.75
GA	4.74	8.92	1.14	1.3	10.77	7.67	8.76	8.28	28.31
GAPM	83.86	85.6	56.95	66.93	95.61	40.99	38.08	68.98	131.43

Here, ** indicates significant at 1% level of significance, MSG = Mean sum of squares due to genotypes, CV = Co-efficient of Variation, SE = Standard Error, σ^2e = Environmental variance, σ^2g = Genotypic variance, σ^2p = Phenotypic variance, GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation, ECV= Environmental coefficient of variation, h^2_b= Heritability, GA = Genetic advance, GAPM= Genetic advance in percent of mean

Table 2: Genotypic and phenotypic correlation of eight yield contributing characters on yield of thirty one bottle gourd genotypes

Character		No. of male flowers	No of female flowers	Ratio of male and female flowers	No. of fruit/ plant	Fruit weight (kg)	Fruit length (inch)	Fruit breadth (inch)	Fruit peduncle length (inch)
No. of female flowers	G	0.741**	-						
	P	0.693**	-						
Ratio of male & female flowers	G	-0.335*	-0.211	-					
	P	-0.326*	-0.299	-					
No. of fruit /plant	G	0.092	0.052	0.194	-				
	P	0.086	0.071	0.178	-				
Fruit weight (kg)	G	0.102	0.108	-0.067	0.474**	-			
	P	0.085	0.099	-0.064	0.388*	-			
Fruit length (inch)	G	-0.439**	-0.205	0.202	0.052	0.080	-		
	P	-0.427**	-0.192	0.202	0.044	0.077	-		
Fruit breadth (inch)	G	0.073	-0.126	0.069	0.290	0.375*	-0.385*	-	
	P	0.074	-0.120	0.069	0.267	0.357*	-0.384*	-	
Fruit peduncle length (inch)	G	-0.117	-0.013	-0.100	0.137	0.063	0.330*	-0.200	-
	P	-0.110	-0.004	-0.012	0.116	0.066	0.325*	-0.199	-
Yield per plant (kg)	G	0.056	0.192	0.167	0.900**	0.781**	0.136	0.374*	0.064
	P	0.051	0.172	0.160	0.887**	0.737**	0.127	0.359*	0.059

* indicates significant at 5% level of significance, ** indicates significant at 1% level of significance, G = Genotypic correlation, P = Phenotypic correlation

Phenotypic and genotypic correlation co-efficient among different pairs of characters of bottle gourd are presented in Table 2. Correlation studies showed that genotypic correlation appeared to be higher than the corresponding phenotypic correlation (Table 2). These observations indicated that in majority of the cases, the environment had not appreciable influenced the expressions of characters associations. In the present finding, no. of fruit per plant and fruit weight (kg) has positively and highly significant influence on yield per plant. No. of male flowers were highly significant and positively correlated with the no. of female flowers. But no. of male flowers produced significant and negative correlation with ratio of male & female flower and fruit length at both genotypic and phenotypic level indicated that if the number of male flower are increased, then ratio of male and female flower and fruit length are decreased. Fruit breadth was positively significant correlations with fruit weight and negatively significant correlations with fruit length both at phenotypic and genotypic level. Fig. 1 showing path diagram of eight yield and yield contributing characters of thirty one genotypes of bottle gourd.

Weight (-0.030) which were contributed to result insignificant insignificant positive genotypic correlation with yield per plant (0.167).

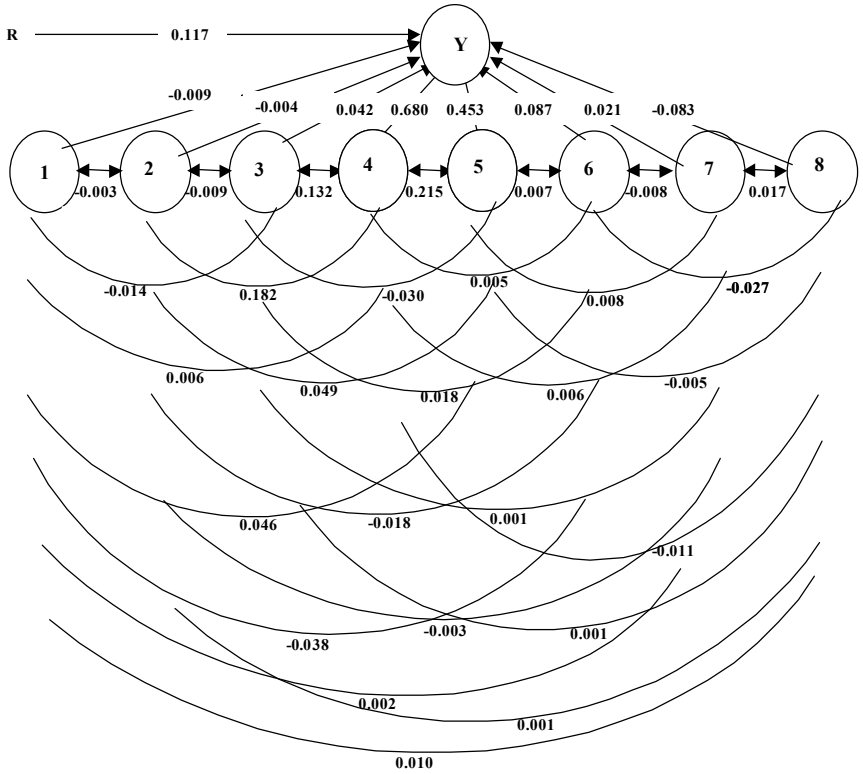

Fig. 1: Path diagram of eight yield and yield contributing characters of thirty one bottle gourd genotypes
1= No. of male flower, 2 = No. of female flower, 3 = Ratio of male & female flower, 4 = No. of fruit /plant, 5 = Fruit weight, 6 = Fruit length, 7 = Fruit breadth, 8 = Fruit Peduncle length, Y = Yield and R=Residual effect

Table 3: Path analysis of eight yield contributing characters on yield of thirty one bottle gourd genotypes

Character	No. of male flowers	No. of female flowers	Ratio of male and female flowers	No. of fruit per plant	Fruit weight (kg)	Fruit length (inch)	Fruit breadth (inch)	Fruit peduncle length (inch)	Genetic correlation with yield
No. of male flowers	-0.009	-0.003	-0.014	0.063	0.046	-0.038	0.002	0.010	0.056
No. of female flowers	-0.007	-0.004	-0.009	0.182	0.049	-0.018	-0.003	0.001	0.192
Ratio of male & female flowers	0.003	0.001	0.042	0.132	-0.030	0.018	0.001	0.001	0.167
No. of fruit /plant	-0.001	-0.001	0.008	0.680	0.215	0.005	0.006	-0.011	0.900**
Fruit weight (kg)	-0.001	0.000	-0.003	0.322	0.453	0.007	0.008	-0.005	0.781**
Fruit length (inch)	0.004	0.001	0.008	0.035	0.036	0.087	-0.008	-0.027	0.136
Fruit breadth (inch)	-0.001	0.001	0.003	0.197	0.170	-0.033	0.021	0.017	0.374*
Fruit Peduncle length (inch)	0.001	0.000	0.000	0.093	0.028	0.029	-0.004	-0.083	0.064
Residual effect									0.117

* indicates significant at 5% level of significance, ** indicates significant at 1% level of significance, Residual effect, R = 0.117

The results of the path analysis revealed that no. of fruit per plant had the maximum direct effect (0.680) followed by weight per fruit (kg) (0.453), fruit length (0.087) and ratio of male and female flower (0.042) (Table 3). No. of male flowers (0.009), no. of female flowers (0.004) and fruit peduncle length (0.083) represented negative direct effects. The contributions of yield components like no. of fruit per plant and fruit weight (kg) were higher in the present study. Positive direct effect was exhibited by yield per plant in building up the correlation with yield. No. of fruit per plant, fruit weight and fruit breadth had the positive highly significant genotypic correlation on yield. No. of male flowers, no. of female flowers, ratio of male and female flowers, fruit length and fruit peduncle length had the positive insignificant genotypic correlation on yield. The

contributions of negative and positive indirect effects via different parameters were responsible for exhibiting the positive total genotypic correlation with yield. The estimated residual effect was 0.117 indicating that 90% of the variability in Bottle gourd yield was contributed by the characters studied in the path analysis.

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