International Journal of Sustainable Agriculture 1 (3): 53-57, 2009
ISSN 2079-2107

Genetic Variability and Path-Coefficient Analysis of Bitter Gourd (*Momordica charantia* L.)

[1]M.R. Islam, [1]M.S. Hossain, [1]M.S.R. Bhuiyan, [1]A. Husna and [2]M.A. Syed

[1]Department of Genetics and Plant Breeding, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh
[2]Plant Breeding Division, Bangladesh Rice Research Institute, Gazipur, Bangladesh

Abstract: Variability, correlation and path analysis among different characters of twenty bitter gourd genotypes were studied. Wide genetic variation was observed among genotypes for branches per vine, yield per plant and no. of fruit per plant. Considering genetic parameters high genotypic co-efficient of variation (GCV) was observed for branches per vine, yield per plant and no. of fruit per plant whereas low genotypic co-efficient of variation was observed days to first male and female flowering. In all cases, phenotypic variances were higher than the genotypic variance. Differences between genotypic and phenotypic coefficients 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 days to first female flowering 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 vine length indicating that this trait was under additive gene control and selection for genetic improvement for this trait would be effective. The results obtained, showed that yield per plant had high positive and high significant relation with number of nodes per vine. Path coefficient analysis revealed maximum direct contribution towards yield per plant with number of fruit per plant followed by vine length. Considering all the characters the G_1 (Shaparan), G_5, (Rampali gaj), G_9 (Nabil), G_{12} (Nandita), G_{14} (Eureca), G_{16} (Tia) and G_{19} (Maharaj) were selected for future breeding programme.

Key words: Bitter gourd (*Momordica charantia L.*) % Genetic variability % Path-coefficient % Genetic advance and Heritability

INTRODUCTION

Bitter gourd (*Momordica charantia L.)* locally known as karala/uchha is an important home garden vegetable. It is a fast growing warm seasonal climbing annual, native to South Asia. Bitter gourd is a tropical and subtropical vine of the Cucurbitaceae family. It is widely grown for edible fruit, which is among the most bitter of all vegetables. 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 deeply separated lobes. Each plant bears separate yellow male and female flowers [1]. Compared to other cucurbits, bitter gourd has relatively high nutritional value, in respect of iron and ascorbic acid contents.

Bitter gourd is usually grown under kitchen garden as a summer 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, bitter gourd can be considered as nutrition rich fruit vegetable. It contains considerable amount of water (83-92%), carbohydrates (4.0-10.5%), protein (1.5-2.0%), fat (0.2-1.0%), minerals (0.5-1.0%) and fiber (0.8-1.7 %) [2]. Ripe fruits are rich in vitamin A. Among all cucurbits vegetables bitter gourd contains the maximum amount of minerals and vitamins.

Yet no comprehensive systematic research has been done in this crop in Bangladesh. Present harvestable yield of bitter gourd is very low (3.72 t/ha,) [3] due to unavailability of high yielding varieties. Bitter gourd is monoecious and highly cross-pollinated in nature. Such pollination mechanism can be exploited for hybrid seed production commercially. Moreover, there is a great scope of development of OP varieties utilizing the existing variability. As a minor vegetable, bitter gourd did not get proper attention for its genetic improvement in the past. Considering the availability of genetic variability, its scope of yield improvement and export potential, the present investigation was undertaken with the objectives:

Corresponding Author: M.R. Islam, Department of Genetics and Plant Breeding, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh

To study the genetic variability among the genotypes and to screen out the suitable parental groups which are likely to provide superior segregates on hybridization.

MATERIALS AND METHODS

The research work relating to determine the genetic diversity of bitter gourds was conducted at the Sher-e-Bangla Agricultural University Farm, Dhaka-1207 during April 2008 to September 2008. 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. The experimental field belongs to the Agro-ecological zone of "The Modhupur Tract", AEZ-28 [4]. Soil pHranged from 6.0- 6.6 and had organic matter 0.84%. Twenty genotypes of bitter gourd were used for the research work. The genetically pure and physically healthy seeds of these genotypes were collected from Plant Genetic Resources Centre (PGRC) of Bangladesh Agricultural Research Institute (BARI). Parar Bond of Meghna, Comilla, Siddiq Bazar, Dhaka (collected from Thailand), Agargaon local market, Agargaon, Dhaka. The experiment was laid out RCBD design with three replications. The individual plot was 3 m × 1 m in size. The twenty genotypes of the experiment were assigned at random into plots of each replication. The distance maintained spacing row to row 50 cm and plant to plant 2 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 25 days old, those were transplanted in the main field in the pit. Seeds were sown 17th. March, 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 middle week of February 2008. After final land preparation, pits of 50 cm × 50 cm × 45 cm were prepared in each plot with a spacing of a spacing of 3 m × 1.25 m. Pits were kept open in the sun for 7 days to kill harmful insect and microorganisms. 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, 150 Kg/ha, 100 kg haG^{1} and 150 kg haG^{1} respectively to the plots for bitter gourd cultivation (Anonymous, 1991). 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 12th. April, 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, colour 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 days to first male flowering, days to first female flowering, vine length (m), number of nodes per vine, branches per vine, fruit length (cm), fruit diameter (cm), number of fruit per plant, Weight per fruit (g) and yield per plant (kg). 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 [5] 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 sum of squares due to error was observed for no. of fruit per plant followed by days to first female flowering and weight per fruit. The highest grand mean was observed for weight per fruit. The highest genotypic and phenotypic variance was observed for Vine length (m) followed by weight per fruit branches per vine and days to first male flowering. The differences between GCV and PCV were high fruit diameter (cm), no. of fruit per plant and weight per fruit (g) indicating vulnerability of traits to environmental influences. High GCV and PCV was observed fruit diameter (cm), no. of fruit per plant and weight per fruit (g). The highest Environmental coefficient of variation was observed in no. of fruit per plant. High heritability estimates associates with fairly high estimates of Genetic Advance (GA) for days to first male flowering, days to first female flowering and Vine length (m) which in fact demonstrate the presence of additive genes effect.

Table 1: Estimation of genetic parameters of 20 Bitter gourd genotypes

Genetic Parameters	MSG	MSE	Grand mean	F^2g	F^2p	GCV	PCV	ECV	h^2_b	GA	GAPM	mspg	mspe	CV%
Days to first male flowering	13.26**	2.48	52.00	28.190	29.518	3.910	4.001	3.026	95.503	7.871	15.137	58.16	1.01	3.03
Days to first female flowering	21.04**	3.49	61.00	27.333	29.756	3.163	3.300	3.033	91.858	6.245	10.138	-190.04	1.48	3.03
Vine length (m)	0.54**	0.08	3.78	225.17	250.01	11.89	12.53	7.396	90.065	23.245	615.59	-6.91	0.86	7.39
No. of nodes/vine	52.67**	2.86	84.91	36.291	66.832	11.66	15.82	1.990	54.303	17.696	20.841	-44.39	2.44	1.99
Branches/vine	24.40**	2.88	40.01	30.287	58.046	17.41	24.11	4.243	52.178	25.912	64.764	-20.90	0.13	4.24
Fruit length (cm)	20.93**	0.490	18.51	5.012	7.039	8.629	10.23	3.782	71.196	14.999	81.032	-7.97	-0.47	3.78
Fruit diameter (cm)	1.27**	0.43	10.00	2.795	3.592	16.46	18.66	6.197	77.828	29.911	281.383	-4.89	-0.39	6.20
No. of fruit/plant	591.91**	25.80	34.48	2.499	3.216	16.10	18.26	14.732	77.708	29.231	80.777	-74.10	-0.20	14.73
Weight/fruit (g)	1337.81**	2.57	103.60	118.26	376.73	9.616	17.16	1.548	31.390	11.099	10.713	1.60	-0.04	1.55
Yield/plant (Kg)	3.72**	0.02	2.72	0.152	0.180	16.53	17.98	1.334	84.503	31.296	1149.32	0.04	0.02	4.66

** indicates significant at 1% level of significance, MSG = Mean sum of squares due to genotypes, MSE = Mean sum of squares due to error, F^2e = Environmental variance, F^2g = Genotypic variance, F^2p = Phenotypic variance, GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation, h^2_b = Heritability, GA = Genetic advance, mspg = Mean sum of product due to genotype, mspe = Mean sum of product due to error, Probt. in ANCOV = Probability of genotype in covariance analysis, Probt. in ANOVA = Probability of treatment in variance analysis

Table 2: Genotypic and phenotypic correlation co-efficient among ten characters

Parameters		Days to first female flowering	Vine length (m)	No. of nodes/vine	Branches /vine	Fruit length (cm)	Fruit diameter (cm)	No. of fruit/plant	Weight /fruit (g)	Yield /plant (kg)
Days to first male flowering	G_v	0.686**	-0.801**	-0.081	0.534**	-0.590**	-0.282	-0.179	-0.427**	0.264
	P_v	0.677**	-0.726**	-0.039	-0.318	-0.477**	-0.288	-0.194	-0.235	0.220
Days to first female flowering	G_v		-0.181	0.219**	0.526**	-0.613**	-0.230	-0.164	-0.805**	0.006
	P_v		-0.158	0.134	-0.344*	-0.472**	-0.203	-0.153	-0.475**	-0.019
Vine length (m)	G_v			0.603**	0.015	0.401**	0.027	-0.093	-0.182	-0.084
	P_v			0.364*	0.114	0.333	0.029	-0.041	-0.044	-0.111
No. of nodes per vine	G_v				-0.559**	0.503**	-0.848**	-0.875**	-0.017	0.854**
	P_v				-0.251	0.367*	-0.640**	-0.692**	0.091	0.588**
Branches per vine	G_v					0.225	0.224	0.208	0.724**	-0.293
	P_v					0.343*	0.213	0.236	0.463**	-0.251
Fruit length (cm)	G_v						-0.258	-0.292	0.660**	0.496**
	P_v						-0.157	-0.162	0.597**	0.495**
Fruit diameter(cm)	G_v							0.987**	-0.540**	0.930**
	P_v							0.968**	-0.172	-0.764**
No. of fruit per plant	G_v								-0.620**	0.877**
	P_v								-0.162	-0.713**
Weight/fruit (g)	I_G									0.374*
	P_v									0.383

* indicates significant at 5% level of significance, ** indicates significant at 1% level of significance, I_G = genotypic variance, P_v = phenotypic variance

Such high GA may be due to the action of additive genes [6]. The genetic advance in percentage of mean was observed high for yield per plant, vine length (m) and fruit diameter (cm). The mean sum of product due to genotype and mean sum of product due to error was observed high for days to first male flowering.

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, vine length (m) has positive but non significant influence on yield per plant. Days to first male flowering were highly significant and positively correlated with the no. of nodes per vine and weight per fruit (g). Positively significant correlations were also noticed for vine length (m), vine length (m), branches per vine, fruit diameter (cm) and weight per fruit (g) both at phenotypic and genotypic level. Highly positively significant correlation was noticed for no. nodes per vine at genotypic level and positively significant at phenotypic level. Highly positively significant correlation was noticed for fruit length (cm) both at genotypic and phenotypic level with positively

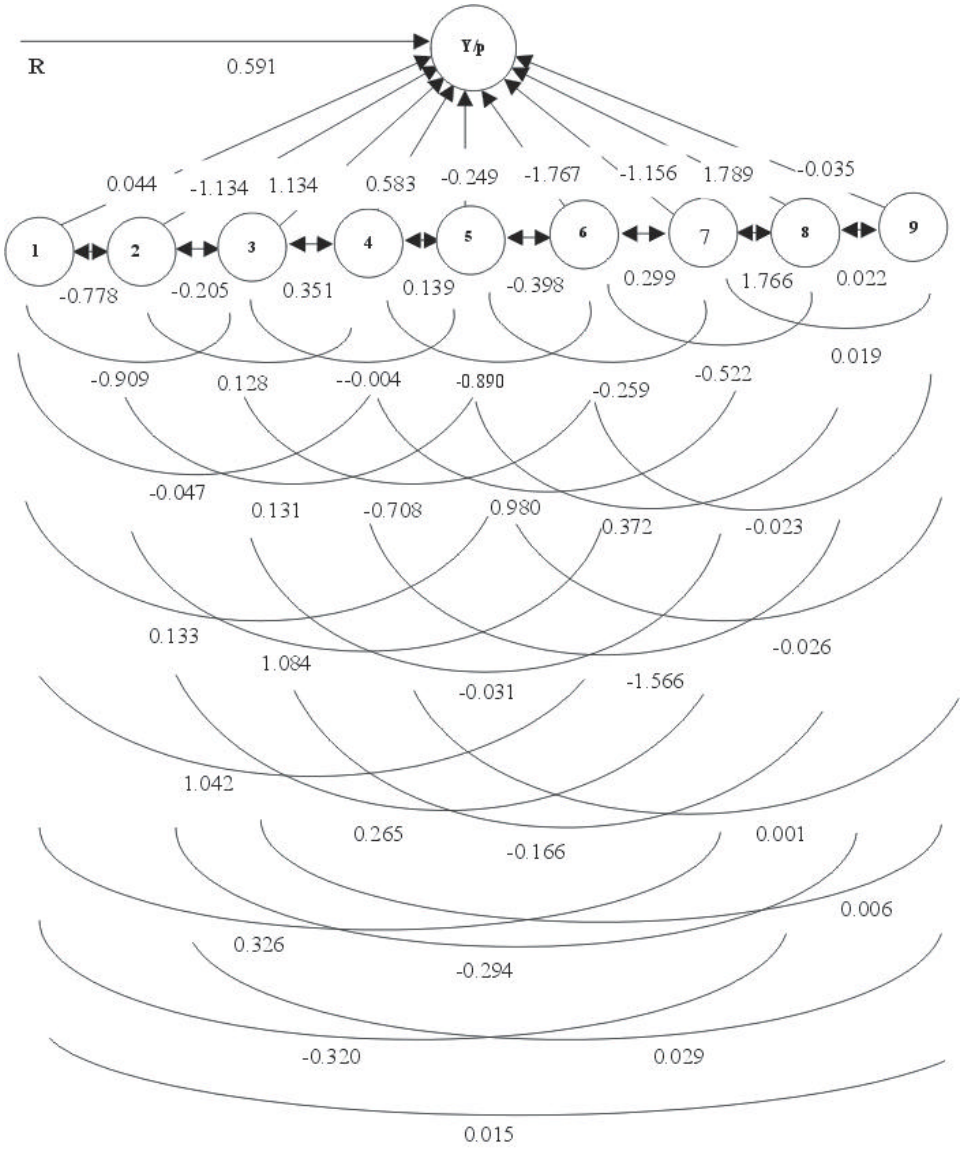

Fig. 1: Path diagram of yield and yield contributing characters in different genotypes of Bitter gourd 1= Days to first male flowering, 2 = Days to first female flowering, 3 = Vine length, 4 = No. of nodes per vine, 5 = Branches per vine, 6 = Fruit length, 7 = Fruit diameter, 8 = No. of fruit per plant, 9 = Weight per fruit, Y/p = Yield per plant. R = Residual effect=0.591.

Table 3: Direct (bold) and indirect effect of Twenty Bitter gourd genotypes

Parameters	Days to first male flowering	Days to first female flowering	Vine length (m)	No. of nodes /vine	Branches per vine	Fruit length (cm)	Fruit diameter (cm)	No. of fruit per plant	Weight per fruit (g)	Yield per plant (Kg)
Days to first flowering male	**0.044**	-0.778	-0.909	-0.047	0.133	1.042	0.326	-0.320	0.015	0.264
Days to first flowering female	0.030	**-1.134**	-0.205	0.128	0.131	1.084	0.265	-0.294	0.029	0.006
Vine length (m)	-0.035	0.205	**1.134**	0.351	-0.004	-0.708	-0.031	-0.166	0.006	-0.084
No. of nodes/vine	-0.004	-0.248	0.683	**0.583**	0.139	-0.890	0.980	-1.566	0.001	0.854**
Branches/vine	-0.024	0.597	0.017	-0.326	**-0.249**	-0.398	-0.259	0.372	-0.026	-0.293
Fruit length (cm)	-0.026	0.695	0.455	0.294	-0.056	**-1.767**	0.299	-0.522	-0.023	0.496**
Fruit diameter (cm)	-0.012	0.260	0.030	-0.494	-0.056	0.457	**-1.156**	1.766	0.019	-0.930**
No. of fruit/plant	-0.008	0.186	-0.105	-0.510	-0.052	0.516	-1.141	**1.789**	0.022	-0.877**
Weight/fruit (gm)	-0.019	0.912	-0.206	-0.010	-0.180	-1.166	0.624	-1.109	**-0.035**	0.374*

* indicates significant at 5% level of significance, ** indicates significant at 1% level of significance, Residual effect, R = 0.5952

correlated on yield per plant. Strong significant positive correlations were noted for vine length (m) at genotypic level weight per fruit (g) both at genotypic and phenotypic level. Fig. 1 showing path diagram of yield and yield contributing characters in different genotypes of bitter gourd.

The results of the path analysis revealed that no. of fruit per plant had the maximum direct (1.789) followed by vine length (m) (1.134), no. of nodes per vine (0.583) and days to first flowering male (0.044) (Table 3). The contribution of yield components like fruit length (cm), no. of nodes per vine and days to first male flowering were higher in the present study. The direct effect of no. of fruit per plant on yield was diluted mainly due to negative indirect effect via days to first male flowering (-0.008), Vine length (m) (-0.105), No. of nodes per vine (-0.510), branches per vine (-0.052) and fruit diameter (cm) (-1.141). Positive direct effect was exhibited by yield per plant in building up the correlation with yield. Direct positive effect no. of nodes per vine seemed to be the third and last important contribution to yield. Yield per plant has significant positive genotype correlation with days to first male flowering, days to first female flowering and weight per fruit (g) had the positive non significant genotypic correlation on yield. Yield per plant has significant positive genotype correlation with no. of nodes per vine and fruit length (cm) had the positive highly significant genotypic correlation on yield. The contributions of negative and positive indirect effects via different parameters were responsible for exhibiting the negative total genotypic correlation with yield. The estimated residual effect was 0.5952 indicating that 90% of the variability in Bitter gourd yield was contributed by the characters studied in the path analysis.

REFERENCES

1. Rashid, M., 2004. Sabji Biggan. University Press, Dhaka, pp: 99.
2. Gopalan, C., B.V. Rama and S.C. Balasubramanian, 1982. Nutritive value of Indian food. Indian Council of Medical Research, National Institute of Nutrition, Hyderabad.
3. Bangladesh Bureau of Statistics, 2000. Yearbook of Agricultural Statistics of Bangladesh, 2000. Ministry of Planning, Govt. of the People's Republic of Bangladesh, pp: 40.
4. Anonymous, 1988. Review of vegetable crop programme Mennonite Central Committee (MCC), Bangladesh, pp: 26-35.
5. Singh, R.K. and B.D. Chaudhury, 1985. Biometrical methods of quantitative genetic analysis. Haryana J. Hort. Sci., 12(2): 151-156.
6. Panse, V.G., 1957. Genetics of Quantitatives characters in relation plant breeding. Indian J. Genet. Pl. Breed., 17: 318-328.