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GENETIC VARIABILITY AND PATH ANALYSIS IN ASH GOURD (*BENINCASA HISPIDA*)

M. A. Latif, N. U. Ahmed and M. M. Alam

ABSTRACT

Study on the variabilities, genetic parameters, character associations and path coefficients between yield and fourteen important characteristics of ten ash gourd genotypes were conducted to determine the critical traits that contribute to yield. The genotypes exhibited a wide range of variability for all the characters studied. Heritability (h^2_b) estimates were high for all the characters except number of female flower per plant, edible fruit length and diameter. Highest Genetic Advance in Percentage of Mean (GAPM) were observed in node order of first male and female flower anthesis followed by plant height at first male and female flower anthesis and edible fruit yield per plant and number of plant per hectare. Edible fruit yield had high negative r_p and r_g with plant height for first male and female flower anthesis, days to first male and female flower anthesis and edible fruit yield per plant. Yield had also high negative r_g with node order of first male and female flower anthesis and positive r_g with number of female flower per plant and edible fruit length. Edible fruit length and weight of individual fruit directly contributed to the yield of ash gourd. For increasing yield, selection should be based on plants bearing more fruits with higher length and weight.

Key Words: ash gourd, character association, path analysis, yield

INTRODUCTION

Ash gourd is a commonly used vegetable in Bangladesh. It is widely distributed in the countries of South East Asia. There are a large number of land races of ash gourd in Bangladesh, which are cultivated during summer season. Research on the development of this crop is limited and only a single variety (BARI Chal Komra-1) has been released by Bangladesh Agricultural Research Institute (BARI). The yield of this newly developed variety (15-30 t/ha) is lying below the level of expectation (BARI, 2006). No systematic research was made in the past to evaluate and explore the potentialities of the available germplasms. Therefore, information on its genetic architecture is essential. This would aid in formulating an efficient breeding program for improving the yield potential via its components (Dixit and Dubey, 1985). It is known that as the number of yield contributing characters increases, the indirect association becomes more complex and important. Under such circumstances, path analysis is an effective tool in assessing the direct and indirect effects of different characters on yield. A study was, therefore, conducted on the variabilities, genetic parameters, character associations and path coefficients between yield and important characters of ash gourd.

Department of Genetics & Plant Breeding, Patuakhali Science & Technology University, Dumki, Patuakhali: 8602

MATERIALS AND METHODS

The experiment was conducted on the experimental field of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur- 1703, Bangladesh during May – September, 2005. The experiment was laid out with ten genotypes of ash gourd in a RCBD with three replications, following a spacing of 1m X 1m on each bed.

The growing plants were individually supported by two meter bamboo sticks to prevent lodging. All bamboo sticks were tightened strongly by rope with long wire. Seeds of all genotypes soaked in water for 24 h and after decoating, intact or unwounded embryos were sown in trays containing vermiculite. The seeds began to germinate within 4-6 days after seeding. After 7 days of germination the seedlings were transferred to plastic pots containing a mixture of soil and well-decomposed cowdung in equal proportion. Then healthy seedlings of 20 days were transplanted in the pits of experimental field. The crop was fertilized as per the recommendation of Rashid (1993). Intercultural operations were done as and when required. Data on vine length after 30 days of sowing, days to male and female flower anthesis, node order of first male and female flower, fruit weight and number, fruit length and girth were recorded and analyzed statistically. Genotypic and phenotypic variances were calculated as per Jhonson *et al.* (1955). Broad sense heritability and genetic advance in percentage of mean (GAPM) were estimated by using the formula given by Hanson *et al.* (1965). Genotypic and phenotypic coefficients of variations were worked out following the formula given by Burton (1952). Phenotypic and genotypic correlation coefficients were done using the formula suggested by Al-Jibouri, *et al.* (1958). The path coefficients were calculated as per the formula given by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Analysis of variance revealed significant difference for all characters studied. Maximum S^2_P and S^2_G was found for plant height at first male and female flower anthesis, days to first male and female flower anthesis, node order of first male and female flower and edible fruit indicating greater scope for selection to improve these traits (Table 1). Although, the minimum genotypic and phenotypic variances were observed in individual fruit weight , the range of variation was much pronounced for most of the characters studied (Table 2). The difference between GCV and PCV was higher for the number of female flower per plant followed by edible fruit length and number of fruit set per plant compared to other traits, indicating greater environmental influence on these traits. Minimum differences between GCV and PCV for most characters demonstrated that the major portion of the Sp was genetic in nature. As GCV does not indicate the amount of heritable variation, but high heritability for most of the characters and moderate for edible fruit length and low for edible fruit diameter were revealed by the estimates of h^2_b.

Table 1. Mean and standard error (SE), phenotypic (S^2_P), genotypic (S^2_G), and environmental (S^2_E) variations among different characters

Character	Mean ± SE	S^2_P	S^2_G	S^2_E
Plant height for 1st male flower anthesis (cm)	172.82±13.19	9459.03	9420.40	38.63
Plant height for 1st female flower anthesis (cm)	186.30±13.52	9943.02	9854.90	88.11
Days to 1st male flower anthesis	41.97±13.52	133.95	122.87	11.08
Days to 1st female flower anthesis	45.5±1.69	153.47	148.97	4.51
Node order of 1st male flower	15.232±1.55	130.29	127.72	2.57
Node order of 1st female flower	16.79±1.64	146.03	143.39	2.64
No. of female flower/plant	9.864±0.27	3.45	0.63	2.83
No. of fruit set/plant	6.009±0.28	4.13	3.10	1.04
Weight of individual edible fruit (kg)	1.408±0.04	0.10	0.07	0.02
Edible fruit length (cm)	23.04±0.72	26.62	13.63	12.99
Edible fruit dia (cm)	11.54±0.35	5.35	2.30	3.05
Edible fruit yield per plant (kg)	181.86±13.20	9473.463	9371.91	101.55
Number of plant per hectare (thousand)	4.87±0.32	5.46	5.36	0.094
Yield (t/ha)	49.31±2.71	397.0404	349.08	47.96

The high estimates of h^2_b indicated that the population could be subjected to mass selection procedures for exploitation based on the phenotypic performance because h^2_b includes environmental effects. Johnson *et al.* (1955) suggested that h^2_b and GAPM should always be considered jointly. The characters having high h^2_b as well as high GAPM were plant height at first male and female flower anthesis, node order of first male and female flower edible fruit yield per plant and number of plant per hectare, indicating that these characters could be improved through selection and governed to a great extent by additive genes. Such high h^2_b accompanied by a high GAPM might be due to the action of the additive genes (Panse, 1957).

The r_p (phenotypic correlation) and r_g (genotypic correlation) of the different characters were estimated in all possible combinations for determining the nature of relationship among them. r_g were higher than r_p in all cases (Table 3), indicating that the expression of such relationship among characters be suppressed to a certain extent due to the environment (Joshi *et al.*, 1982). Edible fruit yield had high negative r_p and r_g with plant height for first male and female flower anthesis, days to first male and female flower anthesis and edible fruit yield per plant.

Table 2. Estimation of the genetic parameters for different characters

Character	Range	PCV	GCV	h^2_b	GAPM
Plant height at 1st male flower anthesis (cm)	80.25-330.00	56.28	56.16	99.59	147.97
Plant height at 1st female flower anthesis (cm)	85.4-345.85	53.52	53.29	99.11	140.05
Days to 1st male flower anthesis	25-62.00	27.58	26.41	91.73	66.78
Days to 1st female flower anthesis	34-69.00	27.23	26.82	97.06	69.77
Node order of 1st male flower	4.2-36.50	74.94	74.19	98.03	193.93
Node order of 1st female flower	4.5-38.00	71.97	71.32	98.19	186.57
No. of female flower/plant	6.1-14.40	18.83	08.01	18.12	09.01
No. of fruit set/plant	1.05-9.80	33.83	29.28	74.91	66.91
Weight of individual edible fruit (kg)	0.69-1.94	22.23	19.32	75.51	44.32
Edible fruit length (cm)	8.58-32.75	22.40	16.02	51.19	30.27
Edible fruit dia (cm)	7.1-82.50	20.05	13.16	43.04	22.79
Edible fruit yield per plant (kg)	85-335.90	53.52	53.23	98.93	139.78
Number of plant per hectare (thousand)	1.3-7.00	47.93	47.51	98.28	124.35
Yield (t/ha)	12.65-82.50	40.41	37.88	87.92	93.79

Yield had also high negative r_g with node order of first male and female flower anthesis and positive r_g with number of female flower per plant and edible fruit length. Similar result was found by Saha *et al.* (1991) in teasle gourd for number of fruits per plant. The relationship between yield and days to male and female flower anthesis, plant height at first male and female flower anthesis, and node order of first male and female flower were negative and significant, indicating that the less values of these traits, the more in the fruit yield. Days to first male and female flower anthesis were positively and significantly associated with node order of first male and female flowers, plant height at first male and female flower anthesis, edible fruit yield per plant and edible fruit diameter for both r_g and r_p. Number of plant per hectare was negatively and significantly associated with plant height for first male and female flower anthesis, days to first male and female flower anthesis, node order of first male and female flower and edible fruit yield per plant. Node order of male flower had a high positive significant r_g and r_p with node order of female flower, edible fruit yield per plant and negatively and significantly associated with number of plant per hectare. The total results indicated that the early flowering plants at lower height ensured more numbers of plants per hectare as well as fruit yield per hectare though it was negatively correlated with edible fruit yield per pl he path coefficient analysis involved a method of partitioning correlation coefficients into direct and indirect effects through alternate pathways. r_g were used to compute the path analysis (Table 4) . Maximum direct contribution towards yield was evident through weight of individual edible fruit (0.382) followed by edible fruit length (0.358), plant height for first male flower anthesis (0.334), node order of first female flower (0.302) and edible fruit diameter (0.224).

Table 3. r_g (G) and r_p (P) among the different characters

Characters		Plant height at 1st female flower anthesis	Days to 1st male flower anthesis	Days to 1st female flower anthesis	Node order of 1st male flower	Node order of 1st female flower	No. of female flower per plant	No. of fruit set per plant	Weight of individual edible fruit (kg)	Edible fruit length (cm)	Edible fruit dia (cm)	Edible fruit-yield per plant(kg)	Number of plant per hectare	Yield (t/ha)
Plant height for 1st male flower anthesis	G	0.972**	0.999**	0.977**	0.989**	0.994**	-0.891**	0.128	0.071	-0.186	0.938**	0.997**	-0.973**	-0.688*
	P	0.946**	0.936**	0.941**	0.961**	0.960**	-0.365	0.111	0.062	-0.129	0.609	0.969**	-0.944**	-0.631
Plant height for 1st female flower anthesis	G		0.996**	0.980**	0.983**	0.986**	-0.877**	0.082	0.051	-0.228	0.927**	0.999**	-0.963**	-0.722*
	P		0.956**	0.958**	0.971**	0.973**	-0.379	0.067	0.036	-0.190	0.609	0.995**	-0.954**	-0.682*
Days to 1st male flower anthesis	G			0.999**	0.998**	0.995**	-0.858**	0.114	0.105	-0.209	0.959**	0.996**	-0.978**	-0.684*
	P			0.942**	0.947**	0.934**	-0.304	0.075	0.108	-0.183	0.651*	0.951**	-0.927**	-0.651*
Days to 1st female flower anthesis	G				0.981**	0.962**	-0.816**	0.013	0.086	-0.321	0.952**	0.981**	-0.941**	-0.753*
	P				0.953**	0.935**	-0.321	-0.005	0.094	-0.222	0.590	0.954**	-0.920**	-0.677*
Node order of 1st male flower	G					0.994**	-0.895**	0.167	0.069	-0.142	0.946**	0.982**	-0.983**	-0.658*
	P					0.975**	-0.407	0.150	0.040	-0.105	0.624	0.965**	-0.962**	-0.606
Node order of 1st female flower	G						-0.938**	0.206	0.043	-0.081	0.919**	0.981**	-0.986**	-0.632*
	P						-0.047	0.018	0.003	-0.006	0.064	0.105	-0.104	-0.063
No. of female flower/plant	G							-0.268	0.765**	-0.372	-0.329	-0.881**	0.978**	0.651*
	P							-0.150	0.419	0.019	-0.025	-0.367	0.420	0.203
No. of fruit set/plant	G								0.370	0.935**	0.222	0.062	-0.319	0.628
	P								0.267	0.737*	0.237	0.055	-0.277	0.525
Weight of individual edible fruit (kg)	G									0.025	0.610	0.040	-0.059	0.354
	P									0.082	0.398	0.024	-0.017	0.288
Edible fruit length (cm)	G										-0.256	-0.258	-0.026	0.751*
	P										0.029	-0.198	-0.001	0.559
Edible fruit diameter (cm)	G											0.919**	-0.901**	**-0.519**
	P											0.607	-0.594	**-0.232**
Edible fruit yield per plant (kg)													-0.960**	-0.733*
													-0.950**	-0.690*
Number plant per hectare	G													0.555
	P													0.513

* Significant at 5% level, ** Significant at 1% level, r_p = phenotypic correlation, r_g = genotypic correlation

Table 4. Direct and indirect effects of different characters on yield

Character	Plant height for 1st male flower anthesis	Plant height at 1st female flower anthesis	Days to 1st male flower anthesis	Days to 1st female flower anthesis	Node order of 1st male flower	Node order of 1st female flower	No. of female flower per plant	No. of fruit set per plant	Weight of individual edible fruit (kg)	Edible fruit length (cm)	Edible fruit dia (cm)	Edible fruit yield per plant (kg)	Number of plant per hectare	Yield (t/ha)
Plant height for 1st male flower anthesis	0.334	0.207	-0.386	-0.617	-0.835	0.300	0.021	-0.030	0.027	-0.067	0.210	-1.320	1.468	-0.688
Plant height for 1st female flower anthesis	0.325	0.213	-0.385	-0.619	-0.830	0.298	0.021	-0.019	0.020	-0.082	0.207	-1.323	1.452	-0.722
Days to 1st male flower anthesis	0.334	0.212	-0.387	-0.631	-0.842	0.300	0.020	-0.026	0.040	-0.075	0.215	-1.319	1.475	-0.684
Days to 1st female flower anthesis	0.326	0.208	-0.386	-0.631	-0.828	0.290	0.019	-0.003	0.033	-0.115	0.213	-1.299	1.419	-0.753
Node order of 1st male flower	0.330	0.209	-0.386	-0.619	-0.844	0.300	0.021	-0.039	0.026	-0.051	0.212	-1.301	1.483	-0.658
Node order of 1st female flower	0.332	0.210	-0.385	-0.607	-0.839	0.302	0.022	-0.048	0.016	-0.029	0.206	-1.299	1.487	-0.632
No. of female flower/plant	-0.298	-0.187	0.332	0.515	0.755	-0.283	-0.024	0.062	0.293	-0.133	-0.074	1.167	-1.475	0.651
No. of fruit set/plant	0.043	0.017	-0.044	-0.008	-0.141	0.062	0.006	-0.232	0.141	0.335	0.050	-0.082	0.481	0.628
Weight of individual edible fruit (kg)	0.024	0.011	-0.041	-0.054	-0.058	0.013	-0.018	-0.086	0.382	0.009	0.136	-0.053	0.089	0.354
Edible fruit length (cm)	-0.062	-0.048	0.081	0.203	0.120	-0.024	0.009	-0.217	0.010	0.358	-0.057	0.342	0.039	0.751
Edible fruit diameter (cm)	0.313	0.197	-0.371	-0.601	-0.798	0.277	0.008	-0.052	0.233	-0.092	0.224	-1.217	1.359	-0.519
Edible fruit yield per plant (kg)	0.333	0.212	-0.385	-0.619	-0.829	0.296	0.021	-0.014	0.015	-0.092	0.206	-1.324	1.448	-0.733
Number plant per hectare	-0.325	-0.205	0.378	0.594	0.830	-0.298	-0.023	0.074	-0.023	-0.009	-0.202	1.271	-1.508	0.555

Maximum and high negative direct effect were observed through number of plant per hectare (-1.508) followed by edible fruit yield per plant (-1.324), node order of first male flower (-0.844), days to first female flower anthesis (-0.631) and days to first male flower anthesis (-0.387). Edible fruit length which gave a significant positive correlation coefficient with yield, also produced the strongest direct positive effect. This influence to some extent was counterbalanced by the negative direct values via some other variables. Similar high direct effect by weight of individual fruit was reported by Rahman *et al.* (1986) in bottle gourd, Mondal *et al.* (1989) in water melon and Islam *et al.* (1993) in Cucumber. Weight of individual edible fruit showed a positive direct effect (0.382) but the correlation of this character with yield was insignificant probably because of high negative indirect effect through some other characters. Plant height for first male flower anthesis had a positive direct effect (0.334) but the correlation of this character with yield was negatively significant probably because of high positive indirect effect through number of plant per hectare. The number of fruit set per plant had positive higher indirect contribution to yield through edible fruit length and weight of individual fruit but lower indirect contribution to yield through plant height for first male flower anthesis. Edible fruit length had the highest indirect effect on yield through fruit yield per plant (0.342) while fruit yield per plant had the highest indirect effect on yield through number of plants per hectare.

It might thus be concluded from the results that edible fruit length and weight of individual fruit had high GCV, h^2b and GAPM as well as high positive direct effects on yield. Therefore, maximum weightage should be given to these characters for the improvement of yield in ash gourd.

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