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COMBINING ABILITY AND HETEROSIS IN SNAKEGOURD (*Tricosanthes cucurminata* L)

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ABSTRACT

A half diallel set of five parents and their 10 F_1's were studied to determine the combining ability and magnitude of heterosis for eight important characters in snakegourd at the experimental field of Bangabandhu Sheikh Mujibur Rahman Agricultural University during April to July, 2004. Combining ability analysis revealed that both general and specific combining ability variances were significant for all the characters except fruit diameter and fruit yield per plant. Predominance of additive gene action was noted for all the characters except days to first female flower where non-additive gene action was predominant. Parent P_1 was the best general combiner for fruit yield and some yield contributing characters. Among the crosses $P_2 \times P_3$, $P_1 \times P_2$ and $P_1 \times P_4$ were the best specific combiner for fruit yield and some of yield contributing characters. Both positive and negative heterosis was obtained of which few hybrids showed desirable and significant values. $P_2 \times P_5$ showed the highest significant mid parental heterotic value for earliness and high yield whereas, $P_1 \times P_2$, $P_2 \times P_3$, $P_2 \times P_5$ and $P_3 \times P_4$ showed the highest significant better parent heterotic effect for earliness and high yield.

Key words: Snakegourd (*Trichosanthes cucurminata* L.), combining ability, heterosis, fruit yield

INTRODUCTION

Snakegourd is an annual, climbing type day neutral herbaceous vegetable crop and belongs to the family cucurbitaceae. It is cultivated all over the Bangladesh and an important summer vegetable in this country. There are lean period at the end of winter and beginning of summer seasons when there is always a scarcity of vegetables in this country. Vegetable scarcity during that gap period can be ameliorated to same extent through improvement of cucurbitaceous crops like snakegourd. In addition it has got tremendous export potentiality because of its excellent keeping quality. There are a number of cultivars with wide range of variability in size, shape and color of fruits available in this country (Rashid, 1993). Snakegourd is monoecious and highly cross-pollinated in nature. Such pollination mechanism can be exploited for the production of hybrid variety. Moreover, there is a bright scope of development of open pollinated variety utilizing the existing variability. Combining ability is one of the powerful tools in identifying the best combiners that may be used to exploit heterosis or to accumulate fixable genes (Srivastaba and Bajpai, 1977). Diallel cross analysis leads to a fruitful result for identification of genetic parameters related to combining ability as well as

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dominance relationship of the parents by studying the F_1 hybrids. Thus the main objective of the present study of 5 × 5 half diallel cross was to estimate the combining ability among the selected snakegourd genotypes and to identify high heterotic parental combination in order to develop hybrid variety with good quality fruits.

MATERIALS AND METHODS

Five parents (P_1=SG001, P_2=SG004, P_3=SG007, P_4=SG008 and P_5=SG025) were crossed in a diallel fashion excluding reciprocals during Kharif 2003. The parents and their 10 F_1's were grown in following Randomized Complete Block Design (RCBD) with four replications under normal sowing condition during Kharif 2004 in the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh. The individual plot was comprised of a single row of 5 meter long. The spacing between rows and that between pits within row was 50 cm and 1.5 meter respectively. Seeds of the all five parents and their F_1's were soaked in water for 24 hours before sowing. Intercultural operations like irrigation, weeding, stacking etc. were done according to schedule and as necessary. Observations were recorded on each plant for days to male and female flower, node number of male and female flower, total number of fruits per plant, average fruit diameter (cm), average fruit length (cm) and fruit yield per plant (g). The data were analyzed for combining ability following model I (fixed effect) and method II of Griffing (1956). Genotypic and phenotypic correlation coefficients were calculated according to Miller *et al*., (1958). Heterosis based on mid and better parent was calculated following Mather and Jinks (1971).

RESULTS AND DISCUSSION

Combining ability (Griffing approach)

Combining ability analysis following Griffing's (1956) approach revealed significant general, specific combining ability for all the characters studied except fruit yield per plant, indicating involvement of both additive and non-additive gene action in the inheritance of these characters. The higher magnitude of GCA variance than that of SCA variance for all the characters except days to female flower revealed the predominant role of additive gene action in the inheritance of these attributes. So both additive and dominant genetic components are important for yield and yield components in snakegourd. Rahman (2004) and Vahab (1989) found similar results in snakegourd and bittergourd, respectively. Mishra *et al.* (1994) and Chaudhary (1987) also recorded similar genetic structure in bittergourd. The parent P_1 was the best general combiner for early male flower, node number of male flowering, long fruit, and total fruit yield per plant in snakegourd. Again parent P_3 was the best general combiner for early female flowering. But for node number of female flowering and the shortest fruit the parent P_2 was considered as the best general combiner. The above parents could be used in hybridization program for improvement of snakegourd. Based on SCA effects $P_2 \times P_3$ (SG004 × SG007) was found as the best combiner for earliness of male flower, total number of fruit and fruit yield per plant. Again the cross combination $P_1 \times P_2$ (SG001 × SG004) was found the best combiner for early female flowering whereas, the cross combination $P_1 \times P_4$ (SG001 × SG018) was shown as a good combiner for getting female flower on early node. Thus, the above combinations were the best specific combinations to improve the respective characters in snakegourd. Banik (2003) and Latif (1993) found similar results in snakegourd and bitter gourd, respectively.

Table 1. Analysis of variance for combining ability of eight characters in snakegourd

SV	df	Mean sum of squares							
		DMF	DFF	NFF	NMF	FL	FD	TFP	FYP
Rep	3	18.50	8.30	8.72	5.12	25.10*	75.97**	34.3**	5.31**
Gen	14	156.80**	83.06**	21.36**	28.09**	138.63**	51.00**	26.9**	1.59*
P	4	159.08**	78.23**	28.64**	38.42**	259.74**	75.86**	12.9**	2.00*
F_1s	9	141.35**	71.32**	19.46	21.59**	1708..90**	1708.9**	1708.9**	1708.90**
P *vs* F_1	1	285.75**	208.03**	9.35	45.26**	14478.3**	14969.50	15055.8**	15365.7**
Error	42	16.40	8.49	10.70	7.96	2.68	10.45	13.01	0.80
GCA	4	60.58**	7.73**	8.19**	13.01**	83.04**	28.03	14.2**	0.79
SCA	10	30.66**	27.98**	4.21**	4.63**	15.3**	6.64	3.7**	0.24
Error	42	4.1	2.13	2.68	1.99	0.671	2.613	3.3	0.19
Gca/sca		1.98	0.29	1.95	2.81	5.46	4.22	3.8	3.27

** = P< 0.001, * = P < 0.05

DMF =days to male flower, DFF = days to female flower, NFF = Node number of female flower, NMF = Node number of male flower, FL = Fruit length, FD = Fruit diameter, AFW = Average fruit weight, TFP = Total number of fruits per plant, and FYP = Fruit yield per plant.

Table 2. General combining ability (GCA) effects of five snakegourd genotypes

Genotype	DMF	DFF	NMF	NFF	FL	FD	TFP	FYP
P_1	-4.59**	-0.90**	-1.20	-0.28	5.58**	-3.2**	1.36	0.35**
P_2	2.20**	1.48	-0.33	-0.74	-3.35**	0.75	-2.16**	-0.52**
P_3	-1.10	-1.01	-1.14	-1.21**	-0.24	0.46	-0.21	0.16
P_4	2.59**	0.62	0.62	1.35**	-2.23**	2.27**	-0.23	-0.12
P_5	0.90	-0.19	2.05	0.88	0.25	-0.31	1.24	0.13
SE(gi)	.685	0.493	0.477	0.553	0.270	0.550	0.609	0.150
SE'd(gi-gj)	1.082	0.779	0.754	0.874	0.430	0.870	0.964	0.230

** = P< 0.01, * = P < 0.05

DMF =days to male flower, DFF = days to female flower, NFF = Node number of female flower, NMF = Node number of male flower, FL = Fruit length, FD = Fruit diameter, AFW = Average fruit weight, TFP = Total number of fruits per plant, and FYP = Fruit yield per plant.

Table 3. Specific combining ability (SCA) effects of crosses for eight characters in snakegourd

Genotype	DMF	DFF	NMF	NFF	FL	FD	TFP	FYP
$P_1 \times P_2$	–4.67*	–6.16**	0.11	0.90	–2.15**	1.83**	–2.01	–0.34
$P_1 \times P_3$	6.38**	5.94**	2.16	–0.13	–7.56**	0.56**	1.29	–0.10
$P_1 \times P_4$	–7.06**	-0.18	–4.21**	-0.18	5.18**	–5.38**	0.43	–0.51
$P_1 \times P_5$	–3.12	–0.25	–1.52	–1.22	–0.28	0.26	0.85	0.12
$P_2 \times P_3$	–7.91**	–1.80	0.79	1.33	9.14**	–4.43**	5.81**	0.96**
$P_2 \times P_4$	5.77**	5.44	1.66	3.27**	-3.94**	–1.32**	–3.79**	–0.76
$P_2 \times P_5$	–6.40**	–5.50**	0.11	–3.8**	2.87**	2.84**	2.12	0.66
$P_3 \times P_4$	–0.29	–1.45	–0.28	0.36	3.35**	0.31**	–0.84	0.67
$P_3 \times P_5$	–0.35	–0.89	–0.21	0.71	–1.34	–0.63	–1.08	–0.13
$P_4 \times P_5$	0.32	–3.64**	–1.34	–1.34	–2.67**	2.55**	0.68	0.17
SE(sij)	1.76	1.27	1.23	1.42	0.71	1.41	1.57	0.39
SE(sij-sik)	2.65	1.90	1.85	2.14	1.07	2.116	2.36	0.58
SE(sij-skl)	2.42	1.74	1.68	1.95	0.97	1.93	2.15	0.53

* = P< 0.05, ** = P < 0.01

DMF =days to male flower, DFF = days to female flower, NFF = Node number of female flower, NMF = Node number of male flower, FL = Fruit length, FD = Fruit diameter, AFW = Average fruit weight, TFP = Total number of fruits per plant, and FYP = Fruit yield per plant.

Correlation Coefficients

Genotypic and phenotypic correlation coefficients between yield and its related traits are presented in Table 4. In most of the character combinations the genotypic correlation coefficient was higher than the phenotypic correlation coefficients, which indicate the apparent association may be largely due to genetic reason (strong coupling linkage). The difference between genotypic and phenotypic correlation was low in most of the cases indicating the environmental effects did not have much influence on these characters. Ahmad *et al.*, (1978) also reported that the magnitudes of genotypic correlation were higher than their respective phenotypic correlations.

Table 4. Genotypic and phenotypic correlations among yield and its related characters in snakegourd

Character		DFF	NMF	NFF	FL	FD	TFP	FYP
DMF	r_g	0.787	0.736	0.794	-0.761	0.497	-0.217	-0.309
	r_p	0.717	0.594	0.263	-0.606	0.319	-0.210	-0.188
DFF	r_g		0.444	0.662	-0.412	-0.156	0.003	-0.265
	r_p		0.339	0.328	-0.344	-0.160	-0.116	-0.222
NMF	r_g			0.720	-0.446	0.539	0.212	0.354
	r_p			0.428	-0.282	0.074	0.058	0.141
NFF	r_g				-0.236	-0.020	-0.076	-0.091
	r_p				-0.089	-0.151	-0.005	0.119
FL	r_g					-0.765	0.505	0.757
	r_p					-0.524	0.285	0.463
FD	r_g						-0.402	-0.308
	r_p						-0.054	-0.255
TFP	r_g							0.812
	r_p							0.286

DMF =days to male flower, DFF = days to female flower, NFF = Node number of female flower, NMF = Node number of male flower, FL = Fruit length, FD = Fruit diameter, AFW = Average fruit weight, TFP = Total number of fruits per plant, and FYP = Fruit yield per plant.

Among the yield contributing characters days to male flower, days to female flower, node number of female flower, node number of male flower, fruit length, fruit diameter, average fruit weight and total number of fruits per plant were found to have highly significant and positive genotypic and phenotypic association with fruit yield per plant. Results indicated that these characters have the major contribution towards the fruit yield per plant in snakegourd. It was also evident that stem characters contributed more towards the fruit yield per plant than leaf characters. Plant height was significantly and positively correlated with stem diameter, weight of stem per plant and weight of plant indicating yield increased with increasing plant height and stem diameter. It is therefore indicated that more importance may be given to select plants with longer stem, high stem diameter and more weight of stem per plant.

Heterosis

Mean performance of five parents and their 10 hybrids for eight characters are presented in Table 5. In this study both better parent and mid parent heterosis were estimated. Both positive and negative heterosis was obtained for different characters of hybrids of which a few hybrids showed desirable and significant values (Table 6). In case of mid parental heterosis, the highest significant negative heterosis for first male flower opening days was (21.18%) from the hybrid $P_2 \times P_5$ followed by $P_1 \times P_2$ (–19.59). For days to female flower opening the highest significant negative heterosis was found by the cross combination $P_2 \times P_5$ (–20.08%) followed by $P_2 \times P_3$ (19.34%). Therefore, these hybrids might be used in future breeding program to exploit heterosis for earliness in flowering. Significant heterotic effect over mid parent were found (–23.73%) for female node number by the cross combination $P_2 \times P_5$, – 41.88%, for node number of male flower by the cross $P_1 \times P_4$, (14.33%) for fruit length by $P_1 \times P_4$, 12.64% for fruit diameter by $P_2 \times P_5$, (12.28%) for total fruit per plant by $P_2 \times P_5$ and 35.27% for fruit per plant by $P_2 \times P_5$.

Table 5. Mean performance for 8 characters of 5 × 5 diallel population in snakegourd

Genotype	DMF	DFF	NMF	NFF	FL	FD	TFP	FYP
Parents:								
P_1	41.62	47.5	21.37	12.63	44.54	37.34	235.23	17.25
P_2	56.65	58.25	20.62	13	20.16	41.73	162.08	15
P_3	44.5	48.37	19.37	11.5	27.54	42.72	177.87	11.37
P_4	52.37	50.12	23.25	16.65	21.56	48.75	164.02	18.62
P_5	53.12	53.75	26.25	18.87	28.18	39.17	151.39	16
Hybrids:								
$P_1 \times P_2$	39.5	43.37	21.5	11.87	27.05	41.72	166.62	12
$P_1 \times P_3$	47.23	53	20	13.12	24.75	40.16	180.53	17.25
$P_1 \times P_4$	37.5	48.5	22.5	8.5	35.50	36.02	170.23	17.87
$P_1 \times P_5$	39.75	47.62	21	12.62	32.52	39.08	196.21	18.25
$P_2 \times P_3$	41.62	43	18.37	9.2	26.84	44.28	187.49	12.12
$P_2 \times P_4$	57.12	56.5	25.5	15.25	17.45	44.01	143.37	8.63
$P_2 \times P_5$	43.25	44.75	17.87	15.	26.74	45.57	195.78	16
$P_3 \times P_4$	47.75	47.12	22.12	12.5	27.84	45.34	225.63	13.5
$P_3 \times P_5$	46	46.87	22	14	25.63	41.83	189.98	14.75
$P_4 \times P_5$	50.37	45.75	22.5	14.62	22.31	46.81	94.63	16.5
SE(sij)	39.5	43.37	21.5	11.87	27.05	41.72	166.62	12
SE(sij-sik)	47.23	53	20	13.12	24.75	40.16	180.53	17.25
SE(sij-skl)	37.5	48.5	22.5	8.5	35.50	36.02	170.23	17.87

Table 6. Percent heterosis over mid parent and better parent for eight characters in snakegourd

Crosses	Character							
	DMF		DFF		NFF		NMF	
	MP	BP	MP	BP	MP	BP	MP	BP
$P_1 \times P_2$	–19.59**	-30.2**	–17.96**	-25.6**	2.38	0.58	–7.32	-8.65
$P_1 \times P_3$	9.73**	6.17	10.56**	9.56**	–1.84	-6.43	8.80	0.96
$P_1 \times P_4$	–20.22**	-28.4**	–0.64	-3.24	0.84	-3.25	–41.88**	-32.6*
$P_1 \times P_5$	–16.09**	-25.2**	–5.9**	-11.4**	–11.8	-20**	–19.84**	-24.06
$P_2 \times P_3$	–17.67**	-26.5**	–19.34**	-26.2**	–8.12	-10.99	–24.89**	-29.23
$P_2 \times P_4$	4.816	0.88	4.26**	-3.04	16.24**	9.67	2.95	-8.27
$P_2 \times P_5$	–21.18**	-23.6**	–20.08**	-23.2**	–23.73**	-31.9**	–5.09	-19.87
$P_3 \times P_4$	–1.42	-8.83	–4.32**	-5.98	3.812	-4.8	–11.1	-24.8**
$P_3 \times P_5$	–5.76	-13.4**	–8.2**	-12.7**	–3.56	-16.19	–7.82	-25.8**
$P_4 \times P_5$	–4.51	-5.17	–11.92**	-14.88	–9.09	-14.28	–17.61**	-22.5**

Table 6. Continued…………

Crosses	Character							
	FL		FD		TFP		FYP	
	MP	BP	MP	BP	MP	BP	MP	BP
$P_1 \times P_2$	–10.87**	-33.3**	5.5	-0.03	–19.32	-30.44**	–23.56	-43.6**
$P_1 \times P_3$	–27.29**	-38.9**	0.3	-5.99	7.39	0	–6.0	-19.12
$P_1 \times P_4$	14.33**	-12.4**	–16.3**	-26.1**	–1.87	-5.07	–25.9**	-37.3**
$P_1 \times P_5$	–5.3**	-19.8**	2.1	-0.2	9.77	5.797	3.51	-13.87
$P_2 \times P_3$	12.55**	-2.53	4.8	3.7	–11.41	-18.48	3.6585	-13.90
$P_2 \times P_4$	–16.33**	-19.1**	–2.7	-9.7**	–39.7**	-46.51**	–43.7**	-52.5**
$P_2 \times P_5$	10.63**	-5.12	12.6**	9.2**	12.28	0	35.27**	16.2
$P_3 \times P_4$	13.42**	1.11	–0.8	-7.0	–12.90	-16.27	26.13	23.85
$P_3 \times P_5$	–7.99**	-9.05**	2.1	-2.0	–4.45	-7.81	7.67	3.40
$P_4 \times P_5$	–10.3**	-20.9**	6.4**	-3.9	2.73	2.32	10.5	8.04

* = P< 0.05, ** = P < 0.01

DMF =days to male flower, DFF = days to female flower, NFF = Node number of female flower, NMF = Node number of male flower, FL = Fruit length, FD = Fruit diameter, TFP = Total number of fruits per plant, and FYP = Fruit yield per plant.

These hybrids might be used in future breeding program to exploit heterosis for better yield. Latif (1993) reported two F_1 hybrids showed highly significant positive heterosis over their respective mid parental values and one showed significant negative heterosis over its mid parental value for fruit weight in a five parent half diallel cross of ribbed gourd. For better parent heterosis both positive and negative heterosis were observed for different characters of the F_1's hybrids. The highest significant negative heterosis for days to male and female flower was exhibited by the cross combinations $P_1 \times P_2$ (−30.24%) and $P_2 \times P_3$ (−26.18%), respectively. The highest significant negative better parent heterosis for node number of male and female flower were found by the cross combination $P_1 \times P_4$ (−32.67%) and $P_2 \times P_5$ (31.90%), respectively. Significant heterotic effect over better parent were found for fruit diameter by the cross $P_2 \times P_5$ and for fruit yield per plant by the cross $P_3 \times P_4$. Therefore, these hybrids might be used in future breeding program to exploit heterosis. Ahmed (1998) reported both positive and negative heterosis over better parent for yield contributing characters in snakegourd. Banik (2003) and Rahman (2004) also found similar results in snakegourd.

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