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Heterosis study in sponge gourd [*Luffa cylindrica* (Roem.) L.]

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Abstract: *The heterosis for fruit yield and its attributes was carried out in sponge gourd [*Luffa cylindrica *(Roem.) L.] through ten x ten diallel mating design (excluding reciprocal). The magnitude of heterotic effects was high for fruit yield per vine, ten fruit weight and fruit length. No heterosis was observed for fruit girth and it was very low for rest of the traits. The highest, positive and significant standard heterosis for fruit yield per vine and some of its component traits were recorded in the crosses Pusa Chikni x ASGS 08-37, Pusa Chikni x ASGS 08-40, ASGS 08-38 x ASGS 06-30, ASGS 06-30 x JSG 05-7 and ASGS 08-40 x ASGS 08-37. Such crosses could be exploited for practical plant breeding programme in sponge gourd.*

INTRODUCTION

Sponge gourd [*Luffa cylindrica* (Roem.) L.] is one of the most popular cucurbitaceous vegetable crops of India. A wide range of variability in fruit and vegetative characters is available in this crop, but the same has been neither assessed nor utilized in crop improvement programme. Heterosis breeding is one of the most efficient tools to exploit the genetic diversity in sponge gourd. Being monoecious in sex expression and cross-pollinated crop provides ample scope for the utilization of hybrid vigor. Diallel analysis is useful for preliminary evalution of genetic stock for use in hybridization programmes with a view to identify heterotic hybrids, which may be used to build up population with favorable fixable genes for genetic improvement of fruit yield in sponge gourd.

MATERIALS AND METHOD

The experimental material comprised of ten parents and their F_1's developed by crossing (Pusa Chikni, GSG 1, ASGS 08-40, ASGS 08-38, ASGS 08-37, ASGS 08-39, ASGS 06-30, ASGS 02-12, JSG 05-7, JSG 05-4) in a diallel fashion excluding reciprocals during summer-2011. The experiment was laid out in a randomized block design with three replications during *kharif*-2011 at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh. The vines were spaced at a distance of 2.0 m between rows and 1.0 m within a row. Five vines of each parents and hybrids were selected randomly for recording observations for twelve characters (Table 1). The heterosis over better parent and standard check were estimated as per the formula Fonseca and Patterson (1968).

RESULTS AND DISCUSSION

The analysis of variance for experimental design revealed significant mean squares differences due to genotypes for all the characters except days to first picking and fruit girth indicating sufficient amount of genetic variability for the twelve traits studied (Table 2). In the present investigation, fruit yield per vine was found to be heterotic trait as heterosis for fruit yield per vine ranged from -17.33 to 33.00 per cent and -21.19 to 31.09 per cent over better parent and standard check, respectively (Table 1). The magnitude of heterotic effects was high for fruit yield per vine, ten fruit weight and fruit length, while significant heterosis was not observed for fruit girth and it was very low for rest of the traits. Out of 45 hybrids, 14 and 15 crosses manifested significant and positive heterosis over better parent and standard check, respectively for fruit yield per vine (kg). The Pusa Chikni x ASGS 08-37 showed highest significant and positive standard heterosis (31.09%) for fruit yield per vine followed by cross Pusa Chikni x ASGS 08-40 (29.49%), ASGS 08-38 x ASGS 06-30 (23.28%), ASGS 06-30 x JSG 05-7 (22.19%) and ASGS 08-40 x ASGS 08-37 (21.46%) (Table 3). Significant positive and high

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Table 1
Magnitude of heterobeltiosis (H) and standard heterosis (SH) in sponge gourd

Sr. No.	*Characters*	*Range of heterosis (%)*						*Number of crosses with significant heterosis*			
		H (%)			*SH (%)*			*H (%)*	*H (%)*	*SH (%)*	*SH (%)*
								+Ve	*-Ve*	*+Ve*	*-Ve*
1	Days to open first female flower	-13.90	to	14.68	-18.13	to	4.88	1	9	0	19
2	Node to first female flower	-29.75	to	22.45	-30.06	to	21.47	4	32	14	31
3	Node to first male flower	-30.30	to	17.36	-29.11	to	24.68	1	21	8	33
4	Days to first picking	-9.84	to	4.33	-16.89	to	5.91	1	7	1	15
5	Length of vine (m)	-19.47	to	22.40	-18.31	to	23.29		7	11	87
6	Number of primary branches / vine	-29.17	to	25.26	-26.67	to	19.17	4	22	2	24
7	Number of fruits per vine	-21.67	to	25.45	-21.67	to	24.85	9	3	11	5
8	Ten fruit weight (g)	-32.25	to	65.18	-32.26	to	27.26	10	18	8	24
9	Fruit length (cm)	-5.33	to	36.13	-8.73	to	26.96	11	0	10	0
10	Fruit girth (cm)	-21.54	to	19.38	-23.47	to	20.96	3	6	4	37
11	Fruit yield per vine (kg)	-17.33	to	33.00	-21.19	to	31.09	14	5	15	4
12	Fruit fly infestation (%)	-46.32	to	49.94	-47.40	to	38.52	8	8	6	5

Table 2
Analysis of variance showing mean squares for fruit yield and its contributing characters in sponge gourd

Source of variation	*df*	*Days to open first female flower*	*Node to first female flower*	*Node to first male flower*	*Days to first picking*	*Length of vine (m)*	*No. of primary branches per vine*	*No. of fruits per vine*	*Ten fruit weight (g)*	*Fruit length (cm)*	*Fruit girth (cm)*	*Fruit yield per vine (kg)*	*Fruit fly infestation (%)*
Replications	2	12.63	1.50	0.15	25.88*	0.02	0.02	2.40*	9870.94	2.61	0.10	0.07*	3.78
Genotypes	54	22.98**	5.69**	1.38**	6.24	0.34**	0.39**	0.30**	62096.59**	5.68**	0.70	0.32**	44.52**
Parents	9	12.98	6.70**	0.91*	6.05	0.13	0.21**	0.47	45556.40**	1.46	3.35**	0.28**	3.18
Hybrids	44	25.06**	3.27**	1.26**	6.49	0.37**	0.31**	1.57**	65749.79**	15.17**	0.20	0.42**	47.83**
Parents Vs Hybrids	1	21.49	97.81**	9.93**	1.44	0.78**	0.25*	1.07	50211.98**	138.39**	0.04	1.56**	293.53**
Error	108	9.24	1.29	0.41	6.93	0.10	0.05	0.63	3254.85	4.15	0.74	0.02	10.11

*,** significant at 5% and 1%, respectively

heterosis in the crosses for fruit yield per vine might be due to high heterosis expression, fruit weight and fruit length. In such cases, expression of heterotic response over better and standard parents indicates the real superiority of hybrids from the commercial point of view. Naliyadhra *et al*. (2007), Sanandia *et al*. (2007), Sanandia *et al*. (2008) have also reported high values of heterosis for fruit yield in sponge gourd. Grafiius (1959) also indicated that heterosis in yield is reflected through heterosis in individual yield components or alternatively due to the multiplicative effects of partial dominance of component characters, which further substantiated the present finding. Williams and Gilbert (1960) reported that even simple dominance in respect of yield components may lead to expression of heterosis in respect of yield. Hegberg (1952) observed similar effects and termed it "combination heterosis",Early male and female flowering, lower nodal position of both male and female flowers, early picking and low fruit fly infestation are desirable features in sponge gourd cultivation. Therefore, significant and negative heterosis for these all characters are desirable. For days to open first female flower, nine and 19 F_1's expressed significant and negative heterobeltiosis and standard heterosis, respectively, of which cross ASGS 08-40 x ASGS 06-30 had highest value for former and cross ASGS 08-38 x JSG 05-4 had highest value for later. For node to first female flower, 32 and 31 F_1's expressed significant and desirable heterobeltiosis and standard heterosis respectively, of which cross ASGS 08-40 x ASGS 08-38 had highest value for former and cross ASGS 08-40 x ASGS 02-12 had highest value for later. With regards to node to first male flower, 21 and 33 F_1's expressed significant and desirable heterobeltiosis and standard heterosis respectively, of which cross Pusa Chikni x JSG 05-4 had highest value for former and cross GSG 1 x ASGS 08-39 had highest value for later. For length of main vine, seven hybrids showed positive and significant heterosis over better parent and eight hybrids exhibited positive and significant heterosis over standard parent. In case of number of primary branches per vine, four and two crosses showed positive and significant heterosis over better and standard parent, respectively. The number of cross combinations, which exceeded the better and standard parent values for number of fruits per vine, was nine and 11 crosses, respectively. The crosses 11 and ten exhibited positive and significant heterosis over better parent and standard parent for fruit length. In case of fruit girth, three and four cross combination exhibited significant and positive heterosis over better parent and standard parent. The crosses ten and eight exhibited positive and significant heterosis over better parent and standard parent for ten fruit weight. With regard to fruit fly infestation, eight hybrids showed significant and negative heterosis over better parent and five hybrid exhibited significant and negative heterosis over standard parent (Table 1).

A comparison of best performing three crosses (Table 4) in order with first three most heterobeltiotic crosses further reveled that for the characters like days to first picking, number of primary branches per vine,

Table 3
Five most heterotic crosses (Standard heterosis) for fruit yield per vine along with *per se* performance and their heterotic effects for component characters in sponge gourd

Characters	*Cross-I*	*Cross-II*	*Cross-III*	*Cross-IV*	*Cross-V*
Mean fruit yield per vine (kg)	1.91	1.90	1.89	1.87	1.85
Fruit yield per vine (kg)	31.09**	29.49**	23.28**	22.19**	21.46**
Days to open first female flower	4.88	-10.25*	-9.50*	-7.62	-8.25
Node to first female flower	-29.75**	-21.78**	-24.23*	17.79**	-27.91*
Node to first male flower	-25.95**	-18.04**	-10.76**	-7.59	-24.37**
Days to first picking	-2.74	-3.72	-7.66*	-9.82**	12.41**
Length of vine (m)	23.29**	-5.40	-17.39**	-7.25	-1.38
Number of primary branches per vine	-6.67	-2.50	-19.17**	-14.17**	-15.00**
Number of fruits per vine	6.90	7.53	2.42	-14.20**	17.53*
Ten fruit weight (g)	-4.06	-13.63**	-1.00	15.98**	26.34**
Fruit length (cm)	6.81	8.43	-1.47	1.69	7.26
Fruit girth (cm)	-19.16**	-23.47**	-9.97	-1.69	-20.70**
Fruit fly infestation (%)	-33.26**	-8.92	1.74	-2.72	-47.40**

*,** significant at 5% and 1%, respectively
Cross - I :- Pusa Chikni x ASGS 08-37
Cross - II :- Pusa Chikni x ASGS 08-40
Cross - III :- ASGS 08-38 x ASGS 06-30
Cross - IV :- ASGS 06-30 x JSG 05-7
Cross - V :- ASGS 08-40 x ASGS 08-37

Table 4

Three best crosses selected on the basis of best performing parents, heterobeltiosis and best performing crosses for different characters in sponge gourd

Characters	*Best performing parents*	*Best performing crosses*	*Heterobeltiosis*	*Standard heterosis*
Days to open first female flower	JSG 05-7	ASGS 08-40 x ASGS 06-30	ASGS 08-40 x ASGS 06-30	ASGS 08-38 x JSG 05-4
	ASGS 06-30	GSG 1 x JSG 05-7	ASGS 08-37 x ASGS 06-30	ASGS 08-37 x ASGS 06-30
	ASGS 08-40	ASGS 08-38 x ASGS 02-12	GSG 1 x JSG 05-7	ASGS 08-40 x ASGS 06-30
Node to first female flower	JSG 05-4	ASGS 08-40 x ASGS 02-12	ASGS 08-40 x ASGS 08-38	ASGS 08-40 x ASGS 02-12
	ASGS 08-40	P.Chikni x ASGS 08-38	ASGS 08-38 x ASGS 08-39	ASGS 08-40 x ASGS 08-38
	Pusa Chikni	P.Chikni x ASGS 08-37	P.Chikni x ASGS 08-37	P.Chikni x ASGS 08-37
Node to first male flower	ASGS 08-39	GSG 1 x ASGS 08-38	P.Chikni x JSG 05-4	GSG 1 x ASGS 08-39
	Pusa Chikni	P.Chikni x JSG 05-4	P.Chikni x ASGS 08-37	P.Chikni x JSG 05-4
	JSG 05-4	GSG 1 x ASGS 08-39	P.Chikni x GSG 1	P.Chikni x ASGS 08-37
Days to first picking	GSG 1	P.Chikni x ASGS 08-38	P.Chikni x ASGS 08-37	P.Chikni x ASGS 06-30
	Pusa Chikni	GSG 1x ASGS 02-12	GSG 1 x ASGS 02-12	P.Chikni x ASGS 02-12
	ASGS 08-37	ASGS 08-40 x JSG 05-7	P.Chikni x ASGS 06-30	ASGS 08-40 x JSG 05-7
Length of vine (m)	Pusa Chikni	ASGS 08-39 x ASGS 02-12	P.Chikni x GSG 1	P.Chikni x ASGS 08-37
	JSG 05-7	ASGS 08-40 x JSG 05-7	ASGS 02-12 x JSG 05-7	P.Chikni x GSG 1
	ASGS 02-12	P.Chikni x GSG 1	ASGS 08-40 x JSG 05-7	ASGS 02-12 x JSG 05-7
Number of primary branches per vine	Pusa Chikni	P.Chikni x ASGS 02-12	P.Chikni x ASGS 08-38	P.Chikni x ASGS 02-12
	ASGS 08-40	ASGS 02-12 x JSG 05-4	ASGS 08-40 x ASGS 08-38	P.Chikni x ASGS 08-38
	JSG 05-4	P.Chikni x ASGS 08-40	ASGS 08-40 x ASGS 02-12	-
Number of fruits per vine	Pusa Chikni	P.Chikni x ASGS 06-30	P.Chikni x JSG 05-7	P.Chikni x GSG 1
	ASGS 08-38	ASGS 08-39 x ASGS 02-12	P.Chikni x GSG 1	P.Chikni x JSG 05-7
	ASGS 08-40	ASGS 08-37 x ASGS 06-30	P.Chikni x ASGS 06-30	ASGS 08-37 x ASGS 08-39
Ten fruit weight (g)	ASGS 08-39	P.Chikni x JSG 05-7	ASGS 06-30 x JSG 05-7	P.Chikni x JSG 05-7
	ASGS 02-12	ASGS 02-12 x JSG 05-7	P.Chikni x ASGS 06-30	ASGS 02-12 x JSG 05-7
	P.Chikni	GSG 1 x ASGS 08-37	P.Chikni x ASGS 08-39	GSG 1 x ASGS 08-37
Fruit length (cm)	GSG 1	ASGS 08-40 x JSG 05-7	ASGS 08-40 x JSG 05-7	ASGS 08-40 x JSG 05-7
	Pusa Chikni	GSG 1 x ASGS 08-40	GSG 1 x ASGS 08-37	GSG 1 x ASGS 08-37
	ASGS 08-40	GSG 1 x ASGS 08-37	P.Chikni x GSG 1	GSG 1 x ASGS 06-30
Fruit girth (cm)	ASGS 08-38	P.Chikni x ASGS 08-39	P.Chikni x ASGS 08-39	P. Chikni x JSG 05-4
	Pusa chikni	ASGS 08-38 x JSG 05-4	ASGS 08-39 x JSG 05-4	P.Chikni x ASGS 08-39
	ASGS 08-39	GSG 1 x ASGS 06-30	ASGS 08-39 x JSG 05-7	P. Chikni x JSG 05-7
Fruit yield per vine (kg)	ASGS 08-37	P.Chikni x ASGS 08-37	ASGS 08-40 x JSG 05-4	P.Chikni x ASGS 08-37
	JSG 05-7	P.Chikni x ASGS 08-40	ASGS 08-38 x ASGS 08-39	P.Chikni x ASGS 08-40
	Pusa Chikni	ASGS 08-38 x ASGS 06-30	JSG 05-7 x JSG 05-4	ASGS 08-38 x ASGS 06-30
Fruit fly infestation (%)	ASGS 08-40	GSG 1 x JSG 05-4	ASGS 08-40 x ASGS 08-37	ASGS 08-40 x ASGS 08-37
	Pusa Chikni	P.Chikni x JSG 05-4	GSG 1 x JSG 05-4	GSG 1 x JSG 05-4
	ASGS 02-12	ASGS 08-38 x ASGS 06-30	ASGS 08-39 x JSG 05-7	P.Chikni x ASGS 08-37

number of fruits per vine, fruit length, fruit yield per vine and fruit fly infestation, the performance of crosses was not associated with the heterobeltiotic response, i.e. the best performing and most heterobeltiotic crosses were different. On the other hand, one cross for node to first female flower, node to first male flower, days to first picking, number of fruits per vine and fruit fly infestation; and two crosses each in case of days to open first female flower, length of vine, fruit girth and fruit length were common in comparison between best performing three crosses with three most heterobeltiotic crosses. This indicated that the selection of crosses on the basis of either *per se* performance or heterotic response over better parent would be equally important, but the former being more desirable.

CONCLUSION

On the basis of heterotic response of yield and its components, five crosses *viz.,* Pusa Chikni x ASGS 08-37, Pusa Chikni x ASGS 08-40, ASGS 08-38 x ASGS 06-30, ASGS 06-30 x JSG 05-7 and ASGS 08-40 x ASGS 08-37 appeared to be most suitable for exploitation in practical plant breeding programme in sponge gourd. These hybrids recorded 31.09, 29.49, 23.28, 22.19, and 21.46 per cent higher yield over standard parent (Pusa Chikni) for fruit yield and some of its components traits. Therefore, these five crosses could be exploited for heterosis breeding programme to boost the fruit yield in sponge gourd.

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