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Study of Heterosis for yield and its component traits in sponge gourd (*Luffa Cylindrica* L.)

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Abstract

An experiment was conducted to study the magnitude of heterosis of fruit yield per plant and its thirteen yield attributing components. Perusal of mean data revealed that among females, JSG-14-06, JSG-14-03, ASGS-04-23, JSG-14-04, ASGS-11-47 and JSG-14-02 and among males, Pusa Chikni exhibited higher *per se* performance for fruit yield per plant and its contributing traits. Considering *per se* performance of hybrids, the superior cross combinations for fruit yield per plant were ASGS-04-23 x GJSG-1, JSG-14-02 x JSG-13-07, JSG-13-04 x Pusa Chikni, JSG-14-03 x Pusa Chikni, JSG-14-03 x JSG-13-07, JSG-14-05 x GJSG-2, JSG-14-05 x JSG-13-07, JSG-13-04 x GJSG-1 and JSG-14-06 x JSG-13-07. These cross combinations also had high *per se* performance for one or more yield contributing traits. Four most significant heterotic cross combinations over better parents were JSG-14-03 x Pusa Chikni, ASGS-04-23 x GJSG-1, JSG-13-04 x Pusa Chikni and ASGS-11-47 x Pusa Chikni showed positive and significant heterobeltiosis for fruit yield per plant.

Keywords: Heterosis, fruit yield, hybrids, sponge gourd

Introduction

Sponge gourd [*Luffa cylindrical* (Roem.) L.] also known as dishrag gourd, dishcloth gourd, loofash gourd and smooth loofah, is one of the most popular low cost important cucurbitaceous vegetable crop grown extensively throughout the tropical and sub-tropical regions of the world. It belongs to the family cucurbitaceae and genus *Luffa* with the somatic chromosome number $2n = 2x = 26$ and widely cultivated during *Kharif* and summer seasons in India. Sponge gourd is highly cross pollinated crop, large variation observed in shape and size of fruit. In sponge gourd male and female flowers originate separately on same plant. Therefore, it is a monoecious plant which is suitable mechanism to produce hybrid seed on commercial sale is available. Besides, the fruits being medium to large in size and having greater number of seeds per fruit. Thus, the development of F_1 hybrids manually is simple and less costly which enable the breeders to exploit hybrid vigour commercially in this crop. It has fast growth, short duration and photo-in-sensitive nature therefore crops can be raised two time in a year. It has a broad spectrum of variation for early maturity, high fruit yielding, different fruit size, shape, colour, small and long fruited cluster types, dwarf to long vine type and other composition in available germplasm. But there is no systemic approach to improve this crop. There is a great scope for improvement of this crop through hybridization. Therefore, present experiment was planned to study the heterosis for fruit yield and its component traits in sponge gourd.

Materials and Methods

Experimental material consisting of 45 entries, four male lines (used as testers) *viz.*, GSG-1, Pusa Chikni, GJSG-2, JSG-13-07 and ten female lines (used as lines) *viz.*, JSG-14-03, JSG-14-05, JSG-13-04, JSG-14-06, ASGS-04-23, JSG-14-02, ASGS-11-47, JSG-14-04 and their 32 hybrids developed through line x tester mating design along with standard check (GJSG-2) were evaluated in a randomized block design with three replications. The 32 crosses made in line x tester mating design during *summer-2016* at Vegetable Research Station, Junagadh Agricultural University, Junagadh, which were evaluated during *kharif-2016* at the Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh. Five plants per each entry in each replication were randomly selected before flowering and tagged for the purpose of recording the observations of different characters *viz.*, days to 50% flowering, days to opening of first female flower, days to opening of first male flower, node number of first female flower, node number of first male flower, days to first picking, length of main vine (m), number of primary branches per vine, number of fruits per vine, fruit weight

(g), fruit length (cm), fruit girth (cm), fruit yield per vine (kg) and number of seeds per fruit. The analysis of variance for experimental design was performed to test the significance of difference among the genotypes for all the characters model as suggested by Panse and Sukhatme (1985) [7]. Heterobeltiosis was estimated as per the procedure given by Fonseca and Patterson (1968) [11] using mean values for various characters over replications. Standard heterosis referred as the superiority of F₁ over standard GJSG-2 and was estimated as per the formula given by Meredith and Bridge (1972) [4] for various characters over replications.

Results and Discussion

The magnitude of heterobeltiosis and standard heterosis in 32 hybrids are presented in Table 1. For fruit yield per vine (g), a total of four cross combinations displayed significant and positive heterobeltiosis and none of the crosses displayed significant and positive standard heterosis. The hybrid JSG-14-03 x Pusa Chikni ranked first by expressing the highest heterobeltiosis followed by ASGS-04-23 x GSG-1, JSG-13-04 x Pusa Chikni and ASGS-11-47 x Pusa Chikni. The estimates of heterobeltiosis ranged from -61.95 per cent (JSG-13-04 x JSG-13-07) to 45.45 per cent (JSG-14-03 x Pusa Chikni). The hybrid (JSG-14-03 x Pusa Chikni) exhibited the highest and significant heterobeltiosis (45.45%) in desirable direction followed by ASGS-04-23 x GSG-1 (29.78%), JSG-13-04 x Pusa Chikni (28.57%) and ASGS-11-47 x Pusa Chikni (27.27%). Such crosses are likely to give better transgressive segregants which could be used for further improvement. The negative heterosis observed in some of the crosses for fruit yield per vine could be attributed to non-allelic interaction with the large number of decreasing alleles. Thus, results revealed that number of fruits per vine and weight of fruit was major contributors towards increased heterotic effect towards fruit yield. Additionally, the traits namely days to first picking, number of primary branches per vine, length of vine and length of fruit were the secondary important contributors towards increased fruit yield. High heterosis for fruit yield in these crosses appeared to be due to high heterosis for early picking, more number of primary

branches, increased length of vine, more length of fruit and more number of fruits per vine. Significant and positive heterobeltiosis for fruit yield per vine has been reported by Naliyadhra *et al.* (2007a) [6], Naliyadhara *et al.* (2007b) [6], Islam *et al.* (2009) [2], Sonavane *et al.* (2013) [8] and Kumar *et al.* (2015) [3] in sponge gourd.

In the present study, heterosis over better parent (heterobeltiosis) and over standard check, GJSG-2 (standard heterosis) was estimated. Several crosses exhibited conspicuous level of heterobeltiosis and standard heterosis for different characters are presented in Table 1. Range of heterosis as well as number of crosses exhibited significance positive as well as negative heterobeltiosis and standard heterosis are presented in Table 2.

In general, it can be concluded that the magnitude of heterosis was higher for days to 50% flowering, node number of first female flower, number of fruits per vine, fruit weight (g), number of seeds per fruit and moderate for days to opening first female flower, days to first picking, fruit length (cm) and fruit girth (cm). In case of days to opening first male flower, none of the crosses reported significant and negative standard heterosis (Table 2). Similarly, node number of first male flower, none of the crosses reported significant and negative heterobeltiosis.

The results revealed that the best three hybrids identified on the basis of *per se* performance and heterobeltiosis for fruit yield per plant *viz.*, JSG-14-03 x Pusa Chikni, ASGS-04-23 x GSG-1 and JSG-13-04 x Pusa Chikni also depicted the significant positive heterosis over GJSG-2.

The wider range of heterosis usually indicates the higher amount of variability for the heterosis. Most of the characters expressed either high or moderate range of heterosis (Table 1.1). The magnitude of heterotic effects was high for fruit weight, fruit length and fruit yield per vine while the magnitude of heterosis was very low for days to first picking and it was low to moderate for rest of the traits. Comparatively, moderate estimates of heterotic effect for various traits were mainly due to inclusion of well adapted parental lines of different region. It is imperative to know the causes of heterosis for fruit yield.

Table 1: Per cent heterosis over better parent (H₁) and Standard check (H₂) for different characters in sponge gourd

S. No.	Crosses	Days to 50% flowering		Days to opening of first female flower		Days to opening of first male flower	
		H ₁	H ₂	H ₁	H ₂	H ₁	H ₂
1	JSG-14-03xGSG-1	6.86**	6.86**	10.25**	17.78**	12.74**	15.69**
2	JSG-14-03 x Pusa Chikni	3.49	1.71	10.13**	14.67**	-0.99	14.38**
3	JSG-14-03 x GJSG-2	12.03**	1.14	15.28**	12.24**	7.21*	23.86**
4	JSG-14-03 x JSG-13-07	11.66**	4.00*	6.55*	12.24**	17.39**	23.53**
5	JSG-14-05xGSG-1	13.94**	7.43**	10.60**	11.43**	31.85**	35.29**
6	JSG-14-05 x Pusa Chikni	7.88**	1.71	9.40**	10.21**	17.99**	28.59**
7	JSG-14-05 x GJSG-2	5.70**	-4.57*	5.83	3.04	11.99**	22.06**
8	JSG-14-05 x JSG-13-07	12.27**	4.57*	8.32**	9.13**	0.31	5.56
9	JSG-13-04xGSG-1	-13.07**	-12.57**	-9.16**	-6.15*	-2.39	0.16
10	JSG-13-04 x Pusa Chikni	-5.23**	-6.86**	1.44	4.80	11.46**	16.01**
11	JSG-13-04 x GJSG-2	12.03**	1.14	13.33**	10.34**	18.84**	23.69**
12	JSG-13-04 x JSG-13-07	19.02**	10.86**	17.80**	21.70**	26.84**	32.03**
13	JSG-14-06xGSG-1	3.13	-5.71**	2.54	3.72	20.86**	24.02**
14	JSG-14-06 x Pusa Chikni	-2.50	-10.86**	-4.95	-3.85	-3.68	2.78
15	JSG-14-06 x GJSG-2	29.75**	17.14**	34.03**	30.49**	-3.52	2.94
16	JSG-14-06 x JSG-13-07	3.13	-5.71**	5.08	6.29*	13.35**	19.28**
17	ASGS-04-23xGSG-1	4.68*	2.29	7.20*	10.75**	12.42**	15.36**
18	ASGS-04-23 x Pusa Chikni	-1.17	-3.43	5.76*	9.26**	-6.69*	9.48*
19	ASGS-04-23 x GJSG-2	14.56**	3.43	19.31**	16.16**	1.62	23.04**
20	ASGS-04-23 x JSG-13-07	10.43**	2.86	6.28*	9.80**	6.37	11.93**
21	JSG-14-02xGSG-1	5.23**	3.43	2.53	9.53**	-1.91	0.65
22	JSG-14-02 x Pusa Chikni	1.74	0.00	3.51	7.78*	4.32	22.39**

23	JSG-14-02 x GJSG-2	15.82**	4.57*	14.86**	11.83**	-4.76	17.81**
24	JSG-14-02 x JSG-13-07	7.98**	0.57	4.62	10.21**	7.14*	12.75**
25	ASGS-11-47xGSG-1	20.11**	19.43**	27.86**	34.69**	26.43**	29.74**
26	ASGS-11-47 x Pusa Chikni	-4.07*	-5.71**	2.08	6.29*	-13.35**	0.25
27	ASGS-11-47 x GJSG-2	13.29**	2.29	16.94**	13.86**	6.64*	23.37**
28	ASGS-11-47 x JSG-13-07	11.04**	3.43	10.14**	16.02**	8.07*	13.73**
29	JSG-14-04xGSG-1	6.82**	7.43**	13.29**	21.03**	20.22**	23.37**
30	JSG-14-04 x Pusa Chikni	-4.07*	-5.71**	-2.08	1.96	5.45	23.37**
31	JSG-14-04 x GJSG-2	10.13**	-0.57	13.06**	10.07**	4.75	22.55**
32	JSG-14-04 x JSG-13-07	9.20**	1.71	8.86**	14.67**	14.91**	20.92**
	S.Em.		1.06		1.43		1.49

*, ** Significant at 5% and 1% levels, respectively.

Table 1: (Continued...)

S. No.	Crosses	Node number of first female flower		Node number of first male flower		Days to first picking	
		H ₁	H ₂	H ₁	H ₂	H ₁	H ₂
1	JSG-14-03xGSG-1	4.63	-12.40**	38.36**	18.82**	6.57*	7.12*
2	JSG-14-03 x Pusa Chikni	-16.81**	-27.13**	8.06	-21.18**	1.23	1.75
3	JSG-14-03 x GJSG-2	-2.73	-17.05**	26.98**	-5.88	13.75**	3.30
4	JSG-14-03 x JSG-13-07	8.85*	-4.65	18.18**	-8.24	6.18*	4.54
5	JSG-14-05xGSG-1	28.70**	7.75*	28.77**	10.59*	7.97*	6.19*
6	JSG-14-05 x Pusa Chikni	-2.70	-16.28**	29.03**	-5.88	5.25	3.51
7	JSG-14-05 x GJSG-2	0.00	-14.73**	42.86**	5.88	9.32**	-0.72
8	JSG-14-05 x JSG-13-07	-2.70	-16.28**	59.09**	23.53**	5.46	3.72
9	JSG-13-04xGSG-1	30.56**	9.30**	-5.48	-18.82**	-12.10**	-9.29**
10	JSG-13-04 x Pusa Chikni	15.65**	3.10	45.16**	5.88	-6.81*	-5.37
11	JSG-13-04 x GJSG-2	2.73	-12.40**	20.63**	-10.59*	17.61**	6.81*
12	JSG-13-04 x JSG-13-07	1.74	-9.30**	4.55	-18.82**	13.52**	11.76**
13	JSG-14-06xGSG-1	9.43*	-10.08**	35.94**	2.35	-2.40	0.72
14	JSG-14-06 x Pusa Chikni	10.38**	-9.30**	61.29**	17.65**	-10.87**	-9.49**
15	JSG-14-06 x GJSG-2	-0.94	-18.60**	25.40**	-7.06	24.20**	12.80**
16	JSG-14-06 x JSG-13-07	-0.94	-18.60**	7.81	-18.82**	-2.31	-3.82
17	ASGS-04-23xGSG-1	2.78	-13.95**	4.55	-18.82**	3.07	0.52
18	ASGS-04-23 x Pusa Chikni	9.40**	-0.78	24.19**	-9.41*	0.11	-2.37
19	ASGS-04-23 x GJSG-2	-15.45**	-27.91**	12.70*	-16.47**	11.14**	0.93
20	ASGS-04-23 x JSG-13-07	0.82	-4.65	6.06	-17.65**	5.24	2.63
21	JSG-14-02xGSG-1	1.85	-14.73**	30.99**	9.41*	1.10	4.33
22	JSG-14-02 x Pusa Chikni	1.82	-13.18**	51.61**	10.59*	1.12	2.68
23	JSG-14-02 x GJSG-2	-2.73	-17.05**	42.86**	5.88	15.40**	4.80
24	JSG-14-02 x JSG-13-07	24.55**	6.20*	42.42**	10.59*	2.62	1.03
25	ASGS-11-47xGSG-1	19.44**	0.00	-4.11	-17.65**	20.84**	17.60**
26	ASGS-11-47 x Pusa Chikni	9.01*	-6.20*	40.32**	2.35	-0.21	-2.89
27	ASGS-11-47 x GJSG-2	17.27**	0.00	58.73**	17.65**	12.84**	2.48
28	ASGS-11-47 x JSG-13-07	18.02**	1.55	13.64*	-11.76**	5.94	3.10
29	JSG-14-04xGSG-1	6.48	-10.85**	-6.85	-20.00**	4.70	8.05**
30	JSG-14-04 x Pusa Chikni	-0.86	-10.85**	27.42**	-7.06	-3.96	-2.48
31	JSG-14-04 x GJSG-2	6.36	-9.30**	9.52	-18.82**	8.18*	-1.75
32	JSG-14-04 x JSG-13-07	-4.31	-13.95**	39.39**	8.24	3.62	2.01
	S.Em.		0.26		0.24		1.91

*, ** Significant at 5% and 1% levels, respectively.

Table 1: (Continued...)

S. No.	Crosses	Length of main vine (m)		Number of primary branches per vine		Number of fruits per vine	
		H ₁	H ₂	H ₁	H ₂	H ₁	H ₂
1	JSG-14-03 x GSG-1	36.56**	8.05	23.78**	-7.81	-12.19*	-46.39**
2	JSG-14-03 x Pusa Chikni	-7.84	-20.54	9.79	-18.23**	-7.17	-43.33**
3	JSG-14-03 x GJSG-2	0.15	-17.74	-3.50	-28.13**	37.14**	-15.97**
4	JSG-14-03 x JSG-13-07	-7.70	-18.64	8.39	-19.27**	58.06**	-3.50
5	JSG-14-05 x GSG-1	24.60	-1.45	-1.27	-19.27**	-3.72	-26.48**
6	JSG-14-05 x Pusa Chikni	-10.71	-23.02*	-9.55	-26.04**	15.19**	-12.04**
7	JSG-14-05 x GJSG-2	0.44	-17.50	-0.64	-18.75**	22.06**	-6.78*
8	JSG-14-05 x JSG-13-07	0.58	-11.34	3.82	-15.10**	15.76**	-11.60**
9	JSG-13-04 x GSG-1	23.05	2.56	59.73**	23.96**	27.01**	7.00*
10	JSG-13-04 x Pusa Chikni	8.40	-6.55	0.00	-22.40**	-9.35*	-23.63**
11	JSG-13-04 x GJSG-2	-8.47	-23.71*	14.09*	-11.46*	19.87**	0.98
12	JSG-13-04 x JSG-13-07	-10.30	-20.94	10.74	-14.06**	-0.52	-16.19**
13	JSG-14-06 x GSG-1	-0.57	-21.36*	-0.61	-15.10**	-17.07**	-36.76**
14	JSG-14-06 x Pusa Chikni	26.14*	8.75	-4.65	-14.58**	36.15**	3.83

15	JSG-14-06 x GJSG-2	-2.35	-19.79	12.88*	-4.17	5.31	-19.69**
16	JSG-14-06 x JSG-13-07	-10.13	-20.78	24.71**	10.42*	20.23**	-8.32**
17	ASGS-04-23xGSG-1	-13.97	-21.21	11.80*	-6.25	-1.96	-12.25**
18	ASGS-04-23x Pusa Chikni	5.67	-3.23	-4.97	-20.31**	-13.20**	-22.32**
19	ASGS-04-23 x GJSG-2	-24.41*	-30.77**	-1.24	-17.19**	-9.90*	-19.37**
20	ASGS-04-23 x JSG-13-07	-13.54	-20.81	2.48	-14.06**	3.67	-7.22*
21	JSG-14-02 x GSG-1	30.97*	3.59	8.86	-10.42*	8.44*	-4.38
22	JSG-14-02 x Pusa Chikni	2.76	-11.40	-3.80	-20.83**	6.20	-6.35*
23	JSG-14-02 x GJSG-2	4.30	-14.33	1.90	-16.15**	9.93**	-3.06
24	JSG-14-02 x JSG-13-07	-1.68	-13.33	-1.90	-19.27**	-19.35**	-28.88**
25	ASGS-11-47xGSG-1	6.76	-7.09	16.35**	-3.65	37.62**	-3.94
26	ASGS-11-47x Pusa Chikni	23.78	7.72	26.42**	4.69	55.64**	8.64**
27	ASGS-11-47 x GJSG-2	4.26	-9.26	5.03	-13.02**	5.33	-26.48**
28	ASGS-11-47 x JSG-13-07	3.32	-8.93	-8.18	-23.96**	38.56**	-3.28
29	JSG-14-04 x GSG-1	14.61	-9.35	-4.27	-18.23**	21.81**	-5.91
30	JSG-14-04 x Pusa Chikni	10.11	-5.07	6.59	-7.29	12.46**	-13.13**
31	JSG-14-04 x GJSG-2	28.13*	5.25	-0.61	-15.63**	38.53**	7.00
32	JSG-14-04 x JSG-13-07	9.86	-3.17	10.18	-4.17	13.03**	-12.69**
	S.Em.		0.23		0.59		0.95

*,** Significant at 5% and 1% levels, respectively.

Table 1: (Continued...)

S. No.	Crosses	Fruit weight (g)		Fruit Length (cm)		Fruit Girth (cm)	
		H ₁	H ₂	H ₁	H ₂	H ₁	H ₂
1	JSG-14-03 x GSG-1	7.10**	-0.27	-0.60	3.35	-12.99	-17.90**
2	JSG-14-03 x Pusa Chikni	-5.87	-36.66**	10.86	-0.67	-9.19	-14.32*
3	JSG-14-03 x GJSG-2	-30.12**	-34.14**	4.03	-0.15	-12.23	-17.19*
4	JSG-14-03 x JSG-13-07	37.81**	-4.48	8.44	0.23	-0.40	-6.03
5	JSG-14-05 x GSG-1	-24.68**	-29.86**	-2.62	1.43	-7.90	-13.56*
6	JSG-14-05 x Pusa Chikni	-5.13	-27.83**	-9.10	-5.31	2.26	-10.64
7	JSG-14-05 x GJSG-2	7.52**	1.34	-3.09	0.94	-4.00	-10.82
8	JSG-14-05 x JSG-13-07	2.47	-22.05**	-19.88**	-16.54**	2.44	-10.49
9	JSG-13-04 x GSG-1	20.56**	12.27**	10.09	14.46*	16.84*	14.12*
10	JSG-13-04 x Pusa Chikni	12.66**	-7.78**	12.31	-6.47	-3.90	-6.14
11	JSG-13-04 x GJSG-2	-35.14**	-38.87**	2.75	-1.38	-14.80*	-16.78*
12	JSG-13-04 x JSG-13-07	-27.25**	-40.45**	8.84	0.61	-12.89	-14.92*
13	JSG-14-06 x GSG-1	-24.68**	-29.86**	-2.48	1.39	-1.53	-7.57
14	JSG-14-06 x Pusa Chikni	52.14**	16.54**	24.97**	18.32**	28.33**	12.86
15	JSG-14-06 x GJSG-2	-22.82**	-27.26**	11.01	6.55	2.80	-4.50
16	JSG-14-06 x JSG-13-07	-11.00**	-31.83**	8.12	2.36	5.20	-7.48
17	ASGS-04-23 x GSG-1	-27.74**	-32.71**	-4.71	-0.93	-10.38	-15.89*
18	ASGS-04-23 x Pusa Chikni	-1.14	-35.12**	29.32**	23.95**	9.19	-8.13
19	ASGS-04-23 x GJSG-2	-2.31	-7.93**	2.89	-1.25	-1.40	-8.40
20	ASGS-04-23 x JSG-13-07	1.30	-29.78**	2.29	-1.96	13.98	-4.10
21	JSG-14-02 x GSG-1	-7.90**	-14.24**	-6.00	-2.27	6.14	-0.38
22	JSG-14-02 x Pusa Chikni	4.11	-25.10**	-8.23	-12.75*	16.62*	-2.51
23	JSG-14-02 x GJSG-2	-21.26**	-25.79**	-1.95	-5.89	0.74	-6.41
24	JSG-14-02 x JSG-13-07	14.07**	-17.93**	6.79	1.53	29.89**	6.43
25	ASGS-11-47 x GSG-1	-17.58**	-23.25**	-4.27	2.31	-3.77	-9.68
26	ASGS-11-47 x Pusa Chikni	65.21**	21.96**	0.57	7.48	15.93*	6.32
27	ASGS-11-47 x GJSG-2	3.90	-2.07	-25.72**	-20.61**	5.52	-1.97
28	ASGS-11-47 x JSG-13-07	32.45**	-2.22	-30.52**	-25.74**	12.75	3.41
29	JSG-14-04 x GSG-1	-0.21	-7.07**	-7.13	-3.44	8.71	2.04
30	JSG-14-04 x Pusa Chikni	18.19**	-17.54**	-7.68	-13.12*	6.31	-7.08
31	JSG-14-04 x GJSG-2	-7.97**	-13.26**	-19.52**	-22.75**	8.22	0.54
32	JSG-14-04 x JSG-13-07	57.98**	10.21**	-11.11	-16.35**	13.15	-1.10
	S.Em.		5.02		1.53		0.97

*,** Significant at 5% and 1% levels, respectively.

Table 1: (Continued...)

S. No.	Crosses	Fruit yield per vine (kg)		Number of seeds per fruit	
		H ₁	H ₂	H ₁	H ₂
1	JSG-14-03 x GSG-1	-40.00**	-52.25**	-3.13	-22.38**
2	JSG-14-03 x Pusa Chikni	45.45**	-0.97	8.18**	-18.94**
3	JSG-14-03 x GJSG-2	1.09	-17.77**	12.96**	-10.96**
4	JSG-14-03 x JSG-13-07	0.00	-0.09	13.44**	-5.94**
5	JSG-14-05 x GSG-1	-38.32**	-41.64**	13.21**	-9.29**
6	JSG-14-05 x Pusa Chikni	-46.45**	-49.34**	20.20**	-9.94**

7	JSG-14-05 x GJSG-2	-9.35	-14.24*	-0.35	-21.45**
8	JSG-14-05 x JSG-13-07	-9.73	-9.81	29.12**	7.06**
9	JSG-13-04 x GSG-1	-3.33	-23.08**	17.14**	7.89**
10	JSG-13-04 x Pusa Chikni	28.57**	-12.47*	19.25**	9.84**
11	JSG-13-04 x GJSG-2	-22.83**	-37.22**	-10.58**	-17.64**
12	JSG-13-04 x JSG-13-07	-61.95**	-61.98**	-6.65**	-14.02**
13	JSG-14-06 x GSG-1	-26.67**	-41.64**	5.21*	-15.69**
14	JSG-14-06 x Pusa Chikni	-18.18*	-44.30**	43.80**	10.96**
15	JSG-14-06 x GJSG-2	11.09	-9.64	37.57**	8.45**
16	JSG-14-06 x JSG-13-07	-3.54	-3.63	23.85**	2.69
17	ASGS-04-23 x GSG-1	29.78**	3.27	3.96	-9.75**
18	ASGS-04-23 x Pusa Chikni	16.23	-20.87**	-23.10**	-33.24**
19	ASGS-04-23 x GJSG-2	-17.39*	-32.80**	-11.23**	-22.93**
20	ASGS-04-23 x JSG-13-07	-40.71**	-40.76**	-10.59**	-22.38**
21	JSG-14-02 x GSG-1	-47.22**	-58.00**	48.55**	19.03**
22	JSG-14-02 x Pusa Chikni	-35.00**	-51.72**	53.16**	14.76**
23	JSG-14-02 x GJSG-2	-30.98**	-43.85**	17.79**	-7.15**
24	JSG-14-02 x JSG-13-07	-1.77	-1.86	25.53**	4.09
25	ASGS-11-47 x GSG-1	4.44	-16.89**	8.23**	-13.28**
26	ASGS-11-47 x Pusa Chikni	27.27**	-13.35*	46.34**	9.66**
27	ASGS-11-47 x GJSG-2	-20.65**	-35.46**	10.48**	-12.91**
28	ASGS-11-47 x JSG-13-07	-23.45**	-23.52**	24.08**	2.88
29	JSG-14-04 x GSG-1	-7.33	-26.26**	3.16	-9.19**
30	JSG-14-04 x Pusa Chikni	-23.90**	-48.19**	0.00	-11.98**
31	JSG-14-04 x GJSG-2	-8.48	-25.55**	7.49**	-5.39*
32	JSG-14-04 x JSG-13-07	-13.81*	-13.88*	7.81**	-5.11*
	S.Em.		0.22		1.47

*, ** Significant at 5% and 1% levels, respectively

Table 2: Range of heterobeltiosis (H₁) and standard heterosis (H₂) as well as number of crosses with specific heterotic effects for various traits in sponge gourd

S. No.	Characters	Range of heterosis (%)		Number of crosses with significant heterosis			
		Heterobeltiosis (H ₁) (%)	Standard heterosis (H ₂) (%)	H ₁ (%)		H ₂ (%)	
				+Ve	-Ve	+Ve	-Ve
1	Days to 50% flowering	-13.07 to 29.75	-12.57 to 19.43	22	4	9	8
2	Days to opening of first female flower	-9.16 to 34.03	-6.15 to 34.69	21	1	26	1
3	Days to opening of first male flower	-13.35 to 31.85	9.48 to 35.29	18	2	26	0
4	Node number of first female flower	-16.81 to 30.56	-27.91 to 9.30	12	2	3	22
5	Node number of first male flower	12.70 to 61.29	-11.76 to 23.53	23	0	8	13
6	Days to first picking	-12.10 to 24.20	-9.49 to 17.60	13	2	7	2
7	Length of main vine (m)	-24.41 to 36.56	-30.77 to -21.36	4	1	0	4
8	Number of primary branches per vine	11.80 to 59.73	-28.13 to 23.96	8	0	2	23
9	Number of fruits per vine	-19.35 to 58.06	-46.39 to 8.64	18	5	2	21
10	Fruit weight (g)	-35.14 to 65.21	-40.45 to 21.96	11	11	4	23
11	Fruit length (cm)	-30.52 to 29.32	-25.74 to 23.95	2	4	3	7
12	Fruit girth (cm)	-14.80 to 29.89	-17.90 to 14.12	5	1	1	7
13	Fruit yield per vine (kg)	-61.95 to 45.45	-61.98 to -12.47	4	16	0	25
14	No. of seeds per fruit	-23.10 to 48.55	-33.24 to 19.03	22	5	8	21

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