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Heterosis for Earliness, Fruit Yield and its Component Traits in Sponge Gourd [*Luffa cylindrica* (Roem.) L.]

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Abstract

The present investigation was accomplished to study magnitude of heterosis for earliness, fruit yield and its component traits in sponge gourd [*Luffa cylindrica* (Roem.) L.] at Vegetable Research Station, Junagadh Agricultural University, Junagadh. Wide range of heterosis was observed for all traits under study indicating higher amount of variability for the heterosis. For early picking, hybrid JSG 21-16 × JSG 17-02exhibited the highest magnitude of heterobeltiosis (-12.83) as well as standard heterosis (-4.67) in desirable direction. Cross JSG 21-10 × GJSG -2 exhibited negatively significant heterosis for days to opening of first male flower, days to opening of first female flower, node number to first male flower and node number to first female flower.Hybrid JSG 21-16 × Pusa Chikni exhibited positive and significant heterobeltiosis and standard heterosis (16.18) for fruit yield per vine as well as ten fruit weight (g).JSG 21-04 × Pusa Chikni exhibited significant positive heterobeltiosis and standard heterosis for number of fruits per vine. Cross JSG 21-10 × Pusa Chikni produced positive and significant heterobeltiosis and standard heterosis for total soluble solids.Hybrid JSG 20-02 × GJSG-2 exhibited positive and significant heterobeltiosis for fruit length and heterobeltiosis and standard heterosis for fruit girth.

Key words : *Heterosis, heterobeltiosis, earliness, sponge gourd.*

Introduction

Sponge gourd is an important vegetable crop of cucurbitaceae family. Sponge gourd is commonly identified as smooth loofah, vegetable sponge, bathsponge, dish cloth gourd, climbing okra and Chinese okra. It is an allogamous herbaceous vine crop which can be grown all around the year except harsh winter. It belongs to diploid species of*luffa* genus with chromosome number of 2n=2x=26. *Luffa* has nine species but mainly two species, *Luffa cylindrica* (sponge gourd) and *Luffa acutangula* (ridge gourd) are cultivated throughout India in tropical and subtropical climate. In plant breeding, hybrid vigour is mainly exploited in form of hybrids (1, 2). Being a monoecious crop, hybridization in sponge gourd is simple as well as it produces large number of seeds per fruit. Therefore, hybrid seed production can be carried out with ease. By keeping eye on above mentioned phenomenon, present investigation was conducted to estimate heterosis for earliness, fruit yield and its component traits in sponge gourd.

Materials and Methods

A line × tester mating design involving three male parents *viz.*, JSG 17-02, GJSG-2 and Pusa Chikni as tester and six female parents *viz.,* JSG 20-02, JSG 20-06, JSG 21-02, JSG 21-04, JSG 21-10 and JSG 21-16 as line were used to produce eighteen hybrids at Vegetable Research Station, Junagadh Agricultural University, Junagadh during *zaid* 2023. All eighteen hybrids along with their nine parents and one standard check Pusa Chikni as male parent were evaluated in Randomized Block Design (RBD) with three replications during *kharif* 2023 at Vegetable Research Station, Junagadh Agricultural University, Junagadh. The observations were recorded for Days to opening of first male flower, days to opening of first female flower, node number to first male flower, node number to first female flower, days to first picking,ten fruit weight (g), fruit length (cm), fruit girth (cm), number of primary branches per vine, number of fruits per vine, fruit yield per vine (kg) and total soluble solids (°Brix). Heterobeltiosis was calculated as per formula given by (3). Standard heterosis was calculated as per formula given by (4) over standard check Pusa Chikni.

Results and Discussion

Analysis of variance for all characters under study revealed significant difference among parents, hybrids and parents *vs* hybrids was observed indicating sufficient amount of variability is present in experimental material. The magnitude of heterobeltiosis and standard heterosis in 18 hybrids are presented in table-1 to 4.

Days to opening of first male flower : The range of heterobeltiosis varied from -10.49 (JSG 21-10 × GJSG-2) to 11.95 % (JSG 21-16 × GJSG-2). The highest and significant heterobeltiosis in desirable direction was recorded in the cross JSG 21-10 × GJSG-2 (-10.49%) followed by JSG 21-02 × GJSG-2 (-10.35%). Significant negative heterobeltiosis for days to opening of first male flower hass been reported by (5, 6, 7, 8). Standard

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Table-1 : Estimation of heterosis in F_1 over better parent (BP), standard check (SC) for days to opening of first male flower, days to opening of first female flower and node number to first male flower.

Sr. No.	Hybrids	Days to opening of first male flower		Days to opening of first female flower		Node number of first male flower	
		HB	SC	HB	SC	HB	SC
1.	JSG 20-02 × JSG 17-02	-1.05	0.93	-4.34	-2.07	-13.40*	-10.73
2.	JSG 20-02 × GJSG-2	-1.88	0.08	-4.00	-1.72	-15.64*	-13.03*
3.	JSG 20-02 × Pusa Chikni	-4.54	-2.63	-5.15	-2.91	-6.23	-3.33
4.	JSG 20-06 × JSG 17-02	-1.75	-2.43	-2.81	-2.60	5.41	5.50
5.	JSG 20-06 × GJSG-2	-5.42*	-6.07*	-5.80	-9.68**	14.24*	4.63
6.	JSG 20-06 × Pusa Chikni	10.39**	10.39**	8.93**	8.93**	-7.81	-7.81
7.	JSG 21-02 × JSG 17-02	7.19**	12.38**	3.72	9.47**	-7.45	3.98
8.	JSG 21-02 × GJSG-2	-10.35**	-6.01*	-12.05**	-7.17*	-14.13*	-3.52
9.	JSG 21-02 × Pusa Chikni	-4.22	0.40	-0.51	5.01	-13.11*	-2.37
10.	JSG 21-04 × JSG 17-02	0.88	-0.65	-0.68	-0.47	-15.51**	3.73
11.	JSG 21-04 × GJSG-2	-6.24*	-7.67**	-5.25	-7.30*	-22.55**	-4.91
12.	JSG 21-04 × Pusa Chikni	1.13	1.13	-0.88	-0.88	-22.78**	-5.19
13.	JSG 21-10 × JSG 17-02	-1.69	4.14	1.49	5.61	-6.99	1.32
14.	JSG 21-10 × GJSG-2	-10.49**	-5.17*	-12.36**	-8.80**	-24.15**	-17.37**
15.	JSG 21-10 × Pusa Chikni	-5.55*	0.05	-3.18	0.74	0.49	9.48
16.	JSG 21-16 × JSG 17-02	-2.13	-0.82	-5.46	-3.92	5.68	11.20
17.	JSG 21-16 × GJSG-2	11.95**	13.44**	5.92*	7.65*	-9.35	-4.63
18.	JSG 21-16 × Pusa Chikni	-3.69	-2.40	4.39	6.09*	-0.61	4.56
	S. E. ±	1.16	1.16	1.41	1.41	5.47	5.47

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

Table-2 : Estimation of heterosis in F_1 over better parent (BP), standard check (SC) for node number to first female flower, days to first picking and ten fruit weight (g).

Sr. No.	Hybrids	Node number of first female flower		Days to first picking		Ten fruit weight (g)	
		HB	SC	HB	SC	HB	SC
1.	JSG 20-02 × JSG 17-02	-16.56**	-9.77**	-0.55	5.26*	-11.29	-22.65**
2.	JSG 20-02 × GJSG-2	-10.70**	-4.02	-7.73**	-2.33	-31.31**	-16.68*
3.	JSG 20-02 × Pusa Chikni	-8.73**	-1.92	-7.18**	-1.75	-14.82*	-14.82*
4.	JSG 20-06 × JSG 17-02	-12.31**	-5.17	-3.37	0.58	-1.47	-14.98*
5.	JSG 20-06 × GJSG-2	-0.10	-0.57	-3.43	-1.16	-35.13**	-21.31**
6.	JSG 20-06 × Pusa Chikni	2.30	2.30	-3.43	-1.16	-8.81	-8.81
7.	JSG 21-02 × JSG 17-02	-4.34	3.45	1.12	5.26*	-8.84	-21.33**
8.	JSG 21-02 × GJSG-2	-5.62	-3.45	-1.13	2.33	-38.10**	-24.92**
9.	JSG 21-02 × Pusa Chikni	-0.56	1.72	2.82	6.43**	-6.01	-6.01
10.	JSG 21-04 × JSG 17-02	9.98**	24.52**	1.12	5.26*	-3.59	-16.81*
11.	JSG 21-04 × GJSG-2	-19.28**	-8.62**	-5.20*	-4.09	-22.59**	-6.10
12.	JSG 21-04 × Pusa Chikni	2.03	15.52**	-0.58	0.58	-10.69	-10.69
13.	JSG 21-10 × JSG 17-02	-0.98	16.09**	-0.56	3.50	-29.37**	-26.14**
14.	JSG 21-10 × GJSG-2	-17.65**	-3.45	1.74	2.33	-37.47**	-24.15**
15.	JSG 21-10 × Pusa Chikni	-13.73**	1.15	-5.23*	-4.67*	-30.70**	-27.52**
16.	JSG 21-16 × JSG 17-02	-5.61*	6.32*	-12.83**	-4.67*	-20.18**	-26.83**
17.	JSG 21-16 × GJSG-2	-10.20**	1.15	-8.02**	0.58	-35.49**	-21.75**
18.	JSG 21-16 × Pusa Chikni	-11.09**	0.15	-10.16**	-1.75	14.64*	14.64*
	S. E. ±	0.52	0.52	1.19	1.19	80.75	80.75

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

heterosis ranged from -7.67 (JSG 21-04 × GJSG-2) to 13.44 % (JSG 21-16 × GJSG-2). The highest and significant standard heterosis in desirable direction was observed in cross JSG 21-04 × GJSG-2 (-7.67 %) followed by JSG 20-06 × GJSG-2 (-6.07 %).Significant negative standard heterosis for this trait was reported by (5).

Days to opening of first female flower : The range of heterobeltiosis was observed from -12.36 (JSG 21-10 × GJSG-2) to 8.93 % (JSG 20-06 × Pusa Chikni) for days to opening of first female flower. The highest desirable heterobeltiosis was recorded in the cross JSG 21-10 × GJSG-2 (-12.36%) followed by JSG 21 -02 × GJSG-2

Table-3 : Estimation of heterosis in F_1 over better parent (BP), standard check (SC) for fruit length (cm), fruit girth (cm) and Number of primary branches per vine.

Sr. No.	Hybrids	Fruit length (cm)		Fruit girth (cm)		Number of primary branches per vine	
		HB	SC	HB	SC	HB	SC
1.	JSG 20-02 × JSG 17-02	-9.80*	7.96	-11.15**	-10.58**	-8.61	-16.96**
2.	JSG 20-02 × GJSG-2	-1.62	17.74**	13.85**	14.59**	12.68*	2.39
3.	JSG 20-02 × Pusa Chikni	-8.96*	8.97	-13.00**	-12.44**	-28.15**	-28.15**
4.	JSG 20-06 × JSG 17-02	-13.71**	0.19	10.01**	3.13	-11.16	-30.76**
5.	JSG 20-06 × GJSG-2	-17.81**	-4.58	5.70*	2.32	16.17*	-9.46
6.	JSG 20-06 × Pusa Chikni	-14.15**	-0.31	-10.01**	-10.01**	1.63	1.63
7.	JSG 21-02 × JSG 17-02	-6.33	2.77	-10.60**	-6.76*	7.98	-29.40**
8.	JSG 21-02 × GJSG-2	-17.71**	-7.79	-14.17**	-10.48**	-25.36**	-43.37**
9.	JSG 21-02 × Pusa Chikni	-5.49	3.70	-15.36**	-11.73**	-24.62**	-24.62**
10.	JSG 21-04 × JSG 17-02	-9.34	-5.08	-2.51	2.17	12.79*	-14.24**
11.	JSG 21-04 × GJSG-2	-11.25*	-0.56	-13.06**	-8.88**	-6.00	-28.53**
12.	JSG 21-04 × Pusa Chikni	4.91	9.84	-4.40	0.19	-14.18**	-14.18**
13.	JSG 21-10 × JSG 17-02	-3.82	-0.56	11.64**	4.44	12.76*	10.43*
14.	JSG 21-10 × GJSG-2	-8.06	3.01	3.45	0.14	-6.71	-8.64
15.	JSG 21-10 × Pusa Chikni	6.62	10.23*	-9.12**	-9.12**	-22.12**	-22.12**
16.	JSG 21-16 × JSG 17-02	-12.37**	-6.71	0.46	-1.82	1.12	2.83
17.	JSG 21-16 × GJSG-2	-13.09**	-2.63	3.89	1.53	-1.55	0.11
18.	JSG 21-16 × Pusa Chikni	4.02	10.73*	-6.71*	-6.71*	9.89*	11.73*
	S. E. ±	1.30	1.30	0.37	0.37	0.29	0.29

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

Table-4 : Estimation of heterosis in F_1 over better parent (BP), standard check (SC) for number of fruits per vine, fruit yield per vine (kg) and total soluble solids (°Brix).

Sr. No.	Hybrids	Number of fruits per vine		Fruit yield per vine (kg)		Total soluble solids (°Brix)	
		HB	SC	HB	SC	HB	SC
1.	JSG 20-02 × JSG 17-02	-10.51*	-8.81	-11.16	-25.17**	-11.36**	-7.57**
2.	JSG 20-02 × GJSG-2	-8.32*	2.02	-21.15**	-17.75*	-11.17**	-3.90
3.	JSG 20-02 × Pusa Chikni	-13.75**	-13.75**	-29.23**	-29.23**	5.35	9.86**
4.	JSG 20-06 × JSG 17-02	-15.05**	-13.43**	-15.59	-28.90**	-0.89	10.93**
5.	JSG 20-06 × GJSG-2	-14.19**	-4.51	-29.85**	-26.82**	4.58	17.04**
6.	JSG 20-06 × Pusa Chikni	-3.67	-3.67	-15.80	-15.80	-9.70**	1.07
7.	JSG 21-02 × JSG 17-02	-9.48*	-7.75	-15.54	-28.86**	-5.95*	-6.96*
8.	JSG 21-02 × GJSG-2	0.53	11.86**	-21.46**	-18.07*	-3.32	4.59
9.	JSG 21-02 × Pusa Chikni	0.61	0.61	-9.83	-9.83	7.34*	7.34*
10.	JSG 21-04 × JSG 17-02	-10.73*	-9.03*	-13.53	-27.16**	0.39	-0.69
11.	JSG 21-04 × GJSG-2	-18.68**	-9.51*	-22.09**	-18.73*	-20.49**	-13.99**
12.	JSG 21-04 × Pusa Chikni	12.07**	12.08**	-4.06	-4.06	4.97	4.97
13.	JSG 21-10 × JSG 17-02	-14.21**	-8.71	-29.87**	-28.12**	-1.62	-2.68
14.	JSG 21-10 × GJSG-2	-21.96**	-13.17**	-32.36**	-29.44**	-13.71**	-6.65*
15.	JSG 21-10 × Pusa Chikni	-15.98**	-10.61*	-36.04**	-34.44**	16.43**	16.44**
16.	JSG 21-16 × JSG 17-02	-13.82**	-12.18**	-8.86	-23.23**	-19.39**	-17.05**
17.	JSG 21-16 × GJSG-2	-12.22**	-2.32	-28.60**	-25.52**	0.78	9.02**
18.	JSG 21-16 × Pusa Chikni	-8.68	-8.68	16.18*	16.18*	0.37	3.29
	S. E. ±	0.54	0.54	0.13	0.13	0.12	0.12

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

(-12.05%). Similar findings of heterobeltiosis were reported by (8, 9, 10). The standard heterosis varied from -9.68 (JSG 20-06 × GJSG-2) to 9.47 % (JSG 21-02 × JSG 17-02). The hybrid JSG 20-06 × GJSG-2 (-9.68%) exhibited significant and the highest magnitude of standard heterosis in desirable direction followed by JSG 21-10 × GJSG-2 (-8.80%). Similar results for standard heterosis were also reported by (9, 10).

Node number to first male flower : The heterosis over better parent ranged from -24.15 (JSG 21-10 × GJSG-2) to 14.24 % (JSG 20-06 × GJSG-2). The hybrid JSG 21-10 × GJSG-2 exhibited highest significant heterobeltiosis in

desirable direction (-24.15%) followed by JSG 21-04 × Pusa Chikni (-22.78%). Singh and Singh (2018), Bhardwaj and Kumar (2021) reported similar findings. The range of heterosis over standard check (Pusa Chikni) was ranged from -17.37 (JSG 21-10 × GJSG-2) to 11.20 (JSG 21-16 × JSG 17-02) %. Significant and highest desirable standard heterosis was observed in JSG 21-10 × GJSG-2 (-17.37%) followed by JSG 20-02 × GJSG-2 (-13.03%). (5, 6) reported similar results.

Node number to first female flower : The range of heterobeltiosis varied from -19.28 (JSG 21-04 × GJSG-2) to 9.98 % (JSG 21-04 × JSG 17-02). The highest desirable heterobeltiosis was recorded in the cross JSG 21-04 × GJSG-2 (-19.28%) followed by JSG 21-10 × GJSG-2 (-17.65%). The results are in conformity with the findings of (5, 6, 7). The heterosis over standard check (Pusa Chikni) ranged from -9.77 (JSG 20-02 × JSG 17-02) to 24.52 % (JSG 21-04 × JSG 17-02). The hybrid JSG 20-02 × JSG 17-02 (-9.77%) exhibited the highest magnitude of standard heterosis in desirable direction followed by JSG 21-04 × GJSG-2 (-8.62%). The results are in conformity with the findings of (5, 6).

Days to first picking : The heterobeltiosis ranged from -12.83 (JSG 21-16 × JSG 17-02) to 2.82 % (JSG 21-02 × Pusa Chikni). Hybrid JSG 21-16 × JSG 17-02 exhibited the highest magnitude of heterobeltiosis (-12.83%) in desirable direction followed by JSG 21-16 × Pusa Chikni (-10.16%).The findings are in congruent with observations of Islam *et al*., (2012), Singh and Singh (2018) and Bhoomi *et al*., (2019).The standard heterosis values varied from -4.67 (JSG 21-10 × Pusa Chikni and JSG 21-16 × JSG 17-02) to 6.43 % (JSG 21-02 × Pusa Chikni). Hybrid JSG 21-10 × Pusa Chikni and JSG 21-16 × Pusa Chikni exhibited the highest magnitude of standard heterosis (-4.67%) in desirable direction.The findings are in congruent with observations of (5, 6, 9).

Ten fruit weight (g) : The heterobeltiosis ranged from -38.10 (JSG 21-02 × GJSG-2) to 14.64 % (JSG 21-16 × Pusa Chikni). Hybrid JSG 21-16 × Pusa Chikni exhibited the highest magnitude of heterobeltiosis (14.64%) in desirable direction. The standard heterosis values varied from -27.52 (JSG 21-10 × Pusa Chikni) to 14.64 % (JSG 21-16 × Pusa Chikni). Hybrid JSG 21-16 × Pusa Chikni produced highest standard heterosis (14.64%) in desirable direction.

Fruit length (cm) : The spectrum of variation for heterobeltiosis was ranged from -17.81 (JSG 20-06 × GJSG-2) to 6.62 (JSG 21-10 × Pusa Chikni). None of the hybrid exhibited significant and positive heterosis over better parent.The spectrum of variation for standard heterosis was from -7.79 (JSG 21-02 × GJSG-2) to 17.74 % (JSG 20-02 × GJSG-2). The hybrid JSG 20-02 × GJSG-2 (17.74%) exhibited significant and positive standard heterosis followed by JSG 21 -16 × Pusa Chikni (10.73%) and JSG 21-10 × Pusa Chikni (10.23%).The results of standard heterosis are in accordance with findings of (5, 6, 11).

Fruit girth (cm) : The range of heterobeltiosis was from -15.36 (JSG 21-02 × Pusa Chikni) to 13.85 % (JSG 20-02 × GJSG-2). Hybrid JSG 20-02 × GJSG-2 exhibited the highest, significant and positive heterobeltiosis (13.85%) followed by JSG 21-10 × JSG 17-02 (11.64%) and JSG 20-06 × JSG 17-02 (10.01%). These results are akin to results reported by (5, 6, 8). While range of standard heterosis was from -12.44 (JSG 20-02 × Pusa Chikni) to 14.59 % (JSG 20-02 × GJSG-2). Cross JSG 20-02 × GJSG-2 showed the highest and significant value (14.59%) of standard heterosis in desirable direction. These results are akin to results reported by (5, 6).

Number of primary branches per vine : The magnitude of heterobeltiosis varied from -28.15 (JSG 20-02 × Pusa Chikni) to 16.17 % (JSG 20-06 × GJSG-2). The significant and the highest heterobeltiosis in desirable direction was observed in the cross JSG 20-06 × GJSG-2 (16.17%) followed by JSG 21-04 JSG 17-02 (12.79%) and JSG 21-10 × JSG 17-02 (12.76%). The results are in accordance with findings of (5, 6, 12). The spectrum of variation for standard heterosis was observed from -43.37 (JSG 21-02 × GJSG-2) to 11.73 % (JSG 21-16 × Pusa Chikni). The hybrid JSG 21-16 × Pusa Chikni ranked first by expressing the highest, significant and positive standard heterosis (11.73%) followed by JSG 21-10 × JSG 17-02 (10.43%).The results are in accordance with findings of (5, 11).

Number of fruits per vine : The magnitude of heterobeltiosis ranged from -21.96 (JSG 21-10 × GJSG-2) to 12.07 % (JSG 21-04 × Pusa Chikni). Only one hybrid JSG 21-04 × Pusa Chikni exhibited the highest and significant heterobeltiosis (12.07%) in desirable direction. Similar findings were reported by (5, 6, 8, 11). Heterosis over standard check (Pusa Chikni) ranged from -13.75 (JSG 20-02 × Pusa Chikni) to 12.08 (JSG 21-04 × Pusa Chikni) %. Highest and positive standard heterosis produced by JSG 21-04 × Pusa Chikni (12.08%) hybrid followed by JSG 21-02 × GJSG-2 (11.86%).Similar findings were reported by (5, 6, 11).

Fruit yield per vine (kg) : The estimates of heterobeltiosis ranged from -36.04 (JSG 21-10 × Pusa Chikni) to 16.18 % (JSG 21-16 × Pusa Chikni). The hybrid JSG 21-16 × Pusa Chikni exhibited the highest and significant desirable heterobeltiosis (16.18%). Similar results were reported by (9, 10, 11). Heterotic effects over standard check ranged from -34.44 (JSG 21-10 × Pusa Chikni) to 16.18 % (JSG 21-16 × Pusa Chikni). Only one

hybrid JSG 21-16 × Pusa Chikni (16.18%) exhibited heterosis over standard check (Pusa Chikni). Similar results were reported by (9, 10, 11).

Total soluble solids (°Brix) : The range of heterobeltiosis for this trait ranged from -20.49 (JSG 21-04 × GJSG-2) to 16.43 % (JSG 21-10 × Pusa Chikni). The hybrid JSG 21-10 × Pusa Chikni exhibited the highest heterobeltiosis (16.43%) in desirable direction followed by JSG 21-02 × Pusa Chikni (7.34%).The estimate of standard heterosis for this trait ranged from -17.05 (JSG 21-16 × JSG 17-02) to 17.04 % (JSG 20-06 × GJSG-2). The hybrid JSG 20-06 × GJSG-2 exhibited the highest and significant standard heterosis (17.04%) in desirable direction followed by JSG 21-10 × Pusa Chikni (16.44%) and JSG 20-06 × JSG 17-02 (10.93%).The results are in accordance with findings of (12).

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