

Original Research Article

The Magnitude of Heterosis in Sponge Gourd [*Luffa cylindrica* (L.)Roem.] Hybrids

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ABSTRACT

The present investigation was conducted to determine heterosis in 36 crosses, which were developed by using 9 parents to study the heterosis for growth, earliness, yield and quality parameters in sponge gourd. Maximum standard heterosis for vine length (26.07 %) was observed in SG-5 × SG-3, for number of leaves per plant in Kulgod local × Pusa Chikni (62.16 %), for internodal length in SG-5 × KRCCH-2 (-27.36), for number of branches per plant in Kulgod local × Pusa Chikni (41.71 %), for leaf area in Kulgod local × Pusa Chikni (26.50 %), for days to first female flower appearance in Kulgod local × Pusa Chikni (-14.42 %), for node at which first female flower appeared in Kulgod local × Pusa Chikni (-80.56 %), for sex ratio in SG-5 × SwarnaPrabha (14.14 %), for days to first harvest in Kulgod local × KRCCH-1 (-8.21%), for days to last harvest in Kulgod local × Pusa Chikni (11.01 %), for fruiting period in Kulgod local × Pusa Chikni (26.20 %), for fruit set in SG-5 × KRCCH-1 (11.90 %), for fruit length in SG-4 × KRCCH-2 (19.44 %), for fruit diameter in SG-6 × SwarnaPrabha (-21.13 %), for average fruit weight in SG-5 × KRCCH-1 (13.37 %), for number of fruits per plant in Kulgod local × Pusa Chikni (66.04 %), for fruit yield per plant in Kulgod local × Pusa Chikni (100.74 %), for number of seeds per fruit in SG-6 × KRCCH-1 (-42.66 %), for rind thickness in SG-3 × Pusa Chikni (36.70 %), for flesh thickness in Kulgod local × KRCCH-1 (1.45 %), for total soluble solids in Kulgod local × SG-3 (12.82 %) and for physiological loss of weight in SG-4 × KRCCH-1 (-56.25 %). The three best performing F₁ hybrids viz., the cross Kulgod local × Pusa Chikni (100.74 %) followed by SG-5 × SG-3 (95.11 %) and Kulgod local × KRCCH-1 (70.08 %) exhibited the highest standard heterosis for total fruit yield per plant in order of merit.

Keywords

Sponge gourd,
Heterosis, Number
of fruits per plant,
Fruit yield per
plant, Genotypes
variability

Introduction

Sponge gourd [*Luffa cylindrica* (L.) Roem.] is one of the most important cucurbitaceous vegetable crops grown extensively throughout the tropical and sub-tropical regions of the world. It is commonly called as

smooth luffa, climbingokra, dishcloth gourd and Chinese okra. This crop has a long history of cultivation in the tropical countries of Asia and Africa (Oboh and Aluyor, 2009). *Luffa* is a diploid species with 26 chromosomes (2n = 26). *Luffa* belongs to cucurbitaceous family and it is a cross-

pollinated crop (Bal *et al.*, 2004) widely cultivated in *kharif* and summer seasons in India. The family Cucurbitaceae comprises of the largest group of summer vegetables. All together there are two well defined subfamilies, eight tribes, about 118 genera and 825 species in this family. Out of these, approximately 20 species belonging to nine genera are under cultivation (Jeffrey, 1990).

Most of the cucurbitaceous vegetables, including sponge gourd are usually cultivated in relatively small area for local consumption and hence exact area and production are unknown. Cucurbits share about 5.6 per cent of the total vegetable production of India (Rai and Rai, 2006). According to FAO estimate, cucurbits are cultivated in an area of about 5.46 lakh ha having annual production of 5.40 lakh tonnes. The productivity of this crop is 10.52 tonnes per hectare (Anon., 2016). The main cucurbits producing countries are China, Korea, India, Japan, Nepal and Central America. In India, major cucurbits growing states are U.P., Punjab, Bihar, Jharkhand, Gujarat, Rajasthan, Haryana, Karnataka and Delhi.

Sponge gourd being a monoecious and cross pollinated crop, it exhibits considerable heterozygosity in population and does not suffer much due to inbreeding depression resulting in natural variability in the population. Thus provides ample scope for utilization of hybrid vigour on commercial scale to increase the production and productivity. In spite of the availability of wide range of genetic variability in plant and fruit characters and also produce large number of hybrid seed at reasonable cost, very little work has been done to exploit the hybrid vigour in this crop. One of the methods to achieve quantum jump in yield and quality is heterosis breeding. Hence, an attempt was made to study the heterosis in different crosses over the mid parent, better

parent and commercial check or standard parent to develop and identify the suitable best performing hybrids.

Materials and Methods

The present investigation entitled “Heterosis studies in sponge gourd [*Luffa cylindrica* (L.) Roem.]” conducted during *Kharif* season, 2017 at the Horticulture farm of Main Agricultural Research Station (MARS), University of Agricultural Sciences, Raichur, Karnataka, India-584104. Nine diverse parents (Kulgod local, SG-4, SG-6, SG-5, SG-3, Pusa Chikni, KRCCH-2, Swarna Prabha, KRCCH-1, KRCCH-1) were crossed in a diallel fashion (excluding reciprocals) for generating the 36 F₁ hybrids. All the nine parents, 36 hybrids and one standard check were grown in a randomized block design with three replications. Observations were recorded on 22 characters *viz.*, vine length, number of leaves per plant, internodal length, number of branches per plant, leaf area, days to first female flower appearance, node at which first female flower appeared, sex ratio, days to first harvest, days to last harvest, fruiting period, fruit set, fruit length, fruit diameter, average fruit weight, number of fruits per plant, fruit yield per plant, number of seeds per fruit, rind thickness, flesh thickness, total soluble solids and physiological loss of weight in sponge gourd.

Estimation of heterosis

Heterosis was calculated as percentage of F₁ performance in the desirable direction over mid parent, better parent and commercial check or standard parent (Anisha) was computed for each character using following formula.

1) Relative heterosis (%):

$$\text{Per cent heterosis over mid parent (MP)} = \frac{\overline{F_1} - \overline{MP}}{\overline{MP}} \times 100$$

2) Heterobeltiosis (%):

$$\text{Per cent heterosis over better parent (BP)} = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}}$$

3) Standard heterosis (%):

$$\text{Per cent heterosis over heck/standard parent (SC)} = \frac{\overline{F_1} - \overline{SC}}{\overline{SC}} \times 100$$

Where,

$\overline{F_1}$ = Mean value of the F_1

\overline{MP} = Mean performance of parents

\overline{BP} = Mean performance of better parent

\overline{SC} = Mean performance of standard check

Results and Discussion

The magnitude of heterosis was calculated as per cent increase or decrease of F_1 values over the mid parent (MP), better parent (BP) and standard parent (SP). The hybrid 'Anisha' was used as check or standard parent. The negative estimates of heterosis were considered desirable for the traits *viz.*, internodal length, days to anthesis of first female flower, node number at which first female flower appeared, days to first harvest, number of seeds per fruit and physiological loss of weight. However, for rest of the characters studied positive estimates of heterosis was consider desirable.

A perusal of data presented in Table 1 - 11 revealed that maximum standard heterosis for vine length (26.07 %) was observed in SG-5 × SG-3, for number of leaves per plant in Kulgod local × Pusa Chikni (62.16 %), for internodal length in SG-5 × KRCCH-2 (-27.36), for number of branches per plant in Kulgod local × Pusa Chikni (41.71 %), for

leaf area in Kulgod local × Pusa Chikni (26.50 %), for days to first female flower appearance in Kulgod local × Pusa Chikni (-14.42 %), for node at which first female flower appeared in Kulgod local × Pusa Chikni(-80.56 %), for sex ratio in SG-5 × SwarnaPrabha (14.14 %), for days to first harvest in Kulgod local × KRCCH-1 (-8.21%), for days to last harvest in Kulgod local × Pusa Chikni (11.01 %), for fruiting period in Kulgod local × Pusa Chikni (26.20 %), for fruit set in SG-5 × KRCCH-1 (11.90 %), for fruit length in SG-4 × KRCCH-2 (19.44 %), for fruit diameter in SG-6 × SwarnaPrabha (-21.13 %), for average fruit weight in SG-5 × KRCCH-1 (13.37 %), for number of fruits per plant in Kulgod local × Pusa Chikni (66.04 %), for fruit yield per plant in Kulgod local × Pusa Chikni (100.74 %), for number of seeds per fruit in SG-6 × KRCCH-1(-42.66 %), for rind thickness in SG-3 × Pusa Chikni (36.70 %), for flesh thickness in Kulgod local × KRCCH-1 (1.45 %), for total soluble solids in Kulgod local × SG-3(12.82 %) and for physiological loss of weight in SG-4 × KRCCH-1 (-56.25 %).

Among 36 crosses, the top three ranking cross combinations based on average heterosis, heterobeltiosis and economic heterosis for the 22 characters are given in Table 1-11. In cross combinations, Kulgod local × Pusa Chikni (90.16 %), SG-4 × KRCCH-1 (62.63 %) and Kulgod local × KRCCH-1 (58.89 %) exhibited the significant relative heterosis for yield per plant whereas crosses Kulgod local × Pusa Chikni (78.27 %), Kulgod local × KRCCH-1 (47.17 %) and SG-4 × KRCCH-1 (40.23 %) exhibited over better parent and Kulgod local × Pusa Chikni (100.74 %), SG-5 × SG-3 (95.11 %) and Kulgod local × KRCCH-1 (70.08 %) over standard parent. The cross Kulgod local × Pusa Chikni was the best performing cross based on *per se* performance for yield per plant and had

average heterosis for 15 yield and yield attributing characters like vine length, number of leaves per plant, number of branches per plant, leaf area, days to first female flower appearance, node at which first female flower appeared, days to first harvest, days to last harvest, fruiting period, fruit length, number of fruits per plant, fruit yield per plant, rind thickness, flesh thickness and physiological loss of weight. This cross exhibited superior performance over better parent for 14 yield and yield attributing characters like vine length, number of leaves per plant, number of branches per plant, leaf area, days to first female flower appearance, node at which first female flower appeared, days to first harvest, days to last harvest, fruiting period, fruit length, number of fruits per plant, fruit yield per plant and physiological loss of weight. It also exhibited significant economic heterosis for the 14 different characters like vine length, number of leaves per plant, number of branches per plant, leaf area, days to first female flower appearance, node at which first female flower appeared, days to last harvest, fruiting period, fruit length, number of fruits per plant, fruit yield per plant, rind thickness and physiological loss of weight. Increase in yield due to increasing of yield attributing characters and high non-additive gene action involved.

Similar results have also been reported in cucumber (Hutchins, 1939 and Singh *et al.*, 1970); muskmelon (Mishra and Seshadri, 1985); bittergourd (Singh *et al.*, 2000) and bottle gourd (Jankiram and Sirohi, 1989). The highest yielding hybrids also registered for the earliness and setting the fruit at the minimum nodal position. This result suggests that from economic point of view, it is useful to select parental lines having one or more economic character in order to achieve high yield in the F₁ hybrids through heterosis breeding.

For fruit length, Kulgod local × Pusa Chikni (45.39 %), Pusa Chikni × SwarnaPrabha (38.71 %) and SG-4 × Pusa Chikni (34.54 %) were the best three hybrids over mid parent. The hybrids registered significant positive heterobeltiosis were Kulgod local × Pusa Chikni (20.66 %), SG-4 × KRCCH-2 (18.49 %) and Kulgod local × SwarnaPrabha (15.65 %). The crosses SG-4 × KRCCH-2 (19.44 %) and Kulgod local × Pusa Chikni (16.64 %) reported significant positive heterosis over the check parent. High heterosis for this trait was also noted by Hutchins (1939), Singh *et al.*, (1970), Mishra and Seshadri (1985), Jankiram and Sirohi (1989) and Singh *et al.* (2000) in cucurbits which support the present findings. Besides recording high heterosis for this trait, they also recorded contribution of this character in increasing the yield potential of a cross.

Earliness is an important economic character, as it gives earliest yield and at the same time may widen the flowering and fruiting span of the plants, which ultimately result in higher fruit yield. Kulgod local × Pusa Chikni (-14.42 %) and SG-4 × SG-6 (-11.54 %) showed the highest economic heterosis for days to first female flower appeared. The highest economic heterosis for node at which first male flower appeared was found in cross Kulgod local × Pusa Chikni (-80.56 %) and SG-5 × SG-3 (-80.56 %) followed by Kulgod local × KRCCH-1 (-72.22 %). Similarly, for days to fruit harvesting, Kulgod local × Pusa Chikni and Kulgod local × KRCCH-1 over mid and better parent registered the high heterosis. The heterosis for earliness has also been reported by Hutchins (1939) and Om *et al.* (1987) in cucumber; Maurya and Singh (1994) and Singh *et al.* (1996) in bottle gourd; Munsri and Sirohi (1993) in bitter gourd; Tyagi (1997) and Sharma *et al.*, (2002) in ridge gourd which supports the present finding.

Table.1 Estimation of heterosis for vine length and number of leaves per plant in sponge gourd

Cross	Vine length			Number of leaves per plant		
	MP	BP	SC	MP	BP	SC
Kulgod local × SG-4	34.46**	33.35**	5.61	-2.75	-7.63	1.75
Kulgod local × SG-6	12.99	-7.64	13.33	2.31	-0.22	15.61
Kulgod local × SG-5	-10.62	-19.64*	-21.58*	3.43	2.46	12.86
Kulgod local × SG-3	-3.09	-15.15	-12.01	0.98	-15.56**	38.31**
Kulgod local × Pusa Chikni	45.86**	32.94**	25.85**	55.02**	47.22**	62.16**
Kulgod local × KRCCH-2	26.14**	9.60	15.72	-9.97	-10.26	-1.16
Kulgod local × SwarnaPrabha	8.59	-10.46	7.43	-18.72**	-31.46**	9.97
Kulgod local × KRCCH-1	23.11**	3.85	17.72	32.99**	29.09**	51.04**
SG-4 × SG-6	13.41	-6.70	14.49	17.61*	9.11	26.41**
SG-4 × SG-5	28.07**	16.01	13.21	9.25	4.71	13.19
SG-4 × SG-3	18.06*	4.11	7.97	-27.81**	-42.06**	-5.10
SG-4 × Pusa Chikni	31.84**	21.07*	14.62	27.64**	27.61**	26.47**
SG-4 × KRCCH-2	3.21	-9.69	-4.64	-8.07	-12.41	-4.15
SG-4 × SwarnaPrabha	6.02	-12.00	5.58	-28.94**	-42.52**	-7.77
SG-4 × KRCCH-1	22.10**	3.71	17.57	39.21**	28.56**	50.43**
SG-6 × SG-5	-10.38	-19.56**	-1.29	6.64	3.06	19.41*
SG-6 × SG-3	-12.27	-19.07**	-0.69	6.37	-9.20	48.74**
SG-6 × Pusa Chikni	11.63	-1.12	21.33*	5.66	-2.00	13.54
SG-6 × KRCCH-2	-5.14	-11.76	8.28	-1.07	-3.82	11.43
SG-6 × SwarnaPrabha	-13.61*	-14.57	4.83	-26.17**	-36.43**	2.00
SG-6 × KRCCH-1	-1.14	-4.91	16.69	6.17	5.65	23.62**
SG-5 × SG-3	25.26**	21.57*	26.07**	17.39**	-2.57	59.59**
SG-5 × Pusa Chikni	9.22	7.59	4.99	-6.92	-10.80	-3.59
SG-5 × KRCCH-2	-7.33	-10.84	-5.87	-9.87	-10.42	-1.98
SG-5 × SwarnaPrabha	4.04	-5.67	13.17	-19.77**	-32.86**	7.73
SG-5 × KRCCH-1	15.06*	7.06	21.36*	-24.53**	-27.40**	-15.06
SG-3 × Pusa Chikni	12.05	7.17	11.14	-19.38**	-35.31**	5.97
SG-3 × KRCCH-2	-3.30	-4.16	1.19	-31.70**	-43.04**	-6.69
SG-3 × SwarnaPrabha	-23.99**	-29.15**	-14.99	-28.21**	-28.94**	16.40
SG-3 × KRCCH-1	-26.50**	-29.63**	-20.23*	-32.78**	-42.39**	-5.63
Pusa Chikni × KRCCH-2	9.84	4.16	9.97	35.89**	29.46**	41.66**
Pusa Chikni × SwarnaPrabha	5.01	-6.07	12.70	-12.88*	-29.54**	13.05
Pusa Chikni × KRCCH-1	3.74	-4.81	7.90	-5.33	-12.59	2.28
KRCCH-2 × SwarnaPrabha	-16.95*	-21.93**	-6.34	-23.31**	-35.51**	3.48
KRCCH-2 × KRCCH-1	6.07	2.43	16.12	-9.89	-12.81	2.02
SwarnaPrabha × KRCCH-1	-1.20	-3.92	15.28	-30.38**	-39.81**	-3.42
S.Em±	0.811	0.936	0.936	6.256	7.224	7.224
C.D. @ 5%	1.646	1.900	1.900	12.701	14.666	14.666
C.D. @ 1%	2.134	2.465	2.465	16.472	19.021	19.021

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

MP, BP and SC represent heterosis values over mid, better and standard parent/check, respectively.

Table.2 Estimation of heterosis for internodal length and number of branches per plant in sponge gourd

Cross	Internodal length			Number of branches per plant		
	MP	BP	SC	MP	BP	SC
Kulgod local × SG-4	-12.23	-14.83	-18.14	-14.25	-20.62*	-33.52**
Kulgod local × SG-6	10.67	9.63	5.36	4.20	-7.81	-22.79**
Kulgod local × SG-5	13.39	9.91	5.63	9.22	-0.08	-16.32*
Kulgod local × SG-3	13.44	9.91	5.63	-18.87**	-33.62**	-12.63
Kulgod local × Pusa Chikni	4.53	0.20	4.99	68.90**	68.58**	41.71**
Kulgod local × KRCCH-2	15.66	8.43	19.09	-23.87**	-25.63**	-34.70**
Kulgod local × SwarnaPrabha	13.08	10.13	11.67	-24.52**	-37.00**	-21.17**
Kulgod local × KRCCH-1	-1.90	-2.32	-6.12	60.28**	59.86**	33.87**
SG-4 × SG-6	34.50**	31.72*	24.23*	-5.85	-10.37	-36.10**
SG-4 × SG-5	10.87	10.74	0.12	11.66	10.24	-21.40**
SG-4 × SG-3	15.35	15.17	4.12	-23.22**	-40.81**	-22.10**
SG-4 × Pusa Chikni	2.57	-4.47	0.10	-24.32**	-30.06**	-41.21**
SG-4 × KRCCH-2	14.50	4.37	14.64	-0.16	-9.54	-20.57*
SG-4 × SwarnaPrabha	-9.04	-13.97	-12.76	-17.47*	-35.22**	-18.95*
SG-4 × KRCCH-1	14.41	11.49	6.23	63.24**	51.49**	26.19**
SG-6 × SG-5	25.15*	22.43	15.46	33.25**	28.41*	-10.76
SG-6 × SG-3	11.21	8.75	2.56	22.22**	-8.97	19.81*
SG-6 × Pusa Chikni	26.20*	19.89	25.63*	10.86	-2.08	-17.68*
SG-6 × KRCCH-2	-1.99	-8.92	0.04	-2.00	-15.04	-25.40**
SG-6 × SwarnaPrabha	1.05	-2.48	-1.11	-28.09**	-45.52**	-31.84**
SG-6 × KRCCH-1	12.02	11.45	6.19	-27.12**	-35.37**	-46.16**
SG-5 × SG-3	0.53	0.48	-9.36	32.57**	1.28	33.30**
SG-5 × Pusa Chikni	-2.38	-9.17	-4.82	23.55**	12.84	-5.14
SG-5 × KRCCH-2	-27.38**	-33.87**	-27.36*	-3.94	-13.96	-24.44**
SG-5 × SwarnaPrabha	7.01	1.10	2.52	-10.64	-30.50**	-13.05
SG-5 × KRCCH-1	17.83	14.69	9.28	-3.22	-11.24	-26.06**
SG-3 × Pusa Chikni	-11.90	-18.06	-14.14	-33.03**	-45.13**	-27.78**
SG-3 × KRCCH-2	-4.45	-13.03	-4.47	-41.93**	-51.59**	-36.29**
SG-3 × SwarnaPrabha	12.69	6.43	7.92	-48.73**	-50.00**	-34.19**
SG-3 × KRCCH-1	9.32	6.36	1.34	-5.67	-22.99**	1.37
Pusa Chikni × KRCCH-2	-11.42	-13.46	-4.95	43.66**	40.60**	23.46**
Pusa Chikni × SwarnaPrabha	5.68	3.97	8.95	-4.48	-20.15**	-0.10
Pusa Chikni × KRCCH-1	1.41	-3.19	1.44	1.86	1.40	-14.76
KRCCH-2 × SwarnaPrabha	-7.02	-10.59	-1.79	-33.53**	-43.44**	-29.24**
KRCCH-2 × KRCCH-1	-1.61	-8.13	0.91	2.75	0.11	-12.10
SwarnaPrabha × KRCCH-1	-4.50	-7.38	-6.08	-35.66**	-46.41**	-32.95**
S.Em±	1.633	1.886	1.886	0.712	0.823	0.823
C.D. @ 5%	3.315	3.828	3.828	1.446	1.670	1.670
C.D. @ 1%	4.300	4.965	4.965	1.875	2.166	2.166

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

MP, BP and SC represent heterosis values over mid, better and standard parent/check, respectively.

Table.3 Estimation of heterosis for leaf area and days to first female flower appearance in sponge gourd

Cross	Leaf area			Days to first female flower appearance		
	MP	BP	SC	MP	BP	SC
Kulgod local × SG-4	-2.29	-4.69	-0.15	10.53	9.38	0.96
Kulgod local × SG-6	2.32	0.54	0.14	1.51	-1.94	-2.88
Kulgod local × SG-5	3.03	-2.55	-2.93	10.64	8.33	0.00
Kulgod local × SG-3	-9.91	-15.55*	-3.85	10.53	9.38	0.96
Kulgod local × Pusa Chikni	37.07**	27.00**	26.50**	-7.29**	-7.29**	-14.42**
Kulgod local × KRCCH-2	-2.66	-7.51	-7.87	8.16	6.00	1.92
Kulgod local × SwarnaPrabha	-7.11	-9.37	-5.10	-3.09	-4.08	-9.62
Kulgod local × KRCCH-1	25.41**	13.85*	13.40	-2.00	-5.77	-5.77
SG-4 × SG-6	10.34	5.80	10.84	-6.60**	-10.68**	-11.54**
SG-4 × SG-5	-3.39	-10.74	-6.49	18.28**	17.02*	5.77
SG-4 × SG-3	9.33	4.96	19.51*	15.96*	15.96*	4.81
SG-4 × Pusa Chikni	-7.71	-16.42*	-12.44	12.63*	11.46	2.88
SG-4 × KRCCH-2	-8.23	-14.84	-10.78	22.68**	19.00**	14.42**
SG-4 × SwarnaPrabha	-7.74	-7.76	-3.37	4.17	2.04	-3.85
SG-4 × KRCCH-1	8.69	-3.51	1.09	-4.04	-8.65	-8.65
SG-6 × SG-5	16.14*	11.72	7.40	7.69	1.94	0.96
SG-6 × SG-3	-1.35	-9.03	3.58	1.52	-2.91	-3.85
SG-6 × Pusa Chikni	21.42**	14.38	9.96	-6.53**	-9.71**	-10.58
SG-6 × KRCCH-2	19.17*	15.16	10.71	0.49	-0.97	-1.92
SG-6 × SwarnaPrabha	13.72	9.07	14.21	0.50	-1.94	-2.88
SG-6 × KRCCH-1	23.79**	14.21	9.79	3.38	2.88	2.88
SG-5 × SG-3	16.90*	4.04	18.46*	2.15	1.06	-8.65
SG-5 × Pusa Chikni	17.89*	15.34	2.44	11.70	9.38	0.96
SG-5 × KRCCH-2	14.15	13.60	1.87	11.46	7.00	2.88
SG-5 × SwarnaPrabha	12.35	3.82	8.71	14.74*	11.22	4.81
SG-5 × KRCCH-1	2.80	-1.59	-12.59*	-1.02	-6.73	-6.73
SG-3 × Pusa Chikni	-2.24	-14.64	-2.81	1.05	0.00	-7.69
SG-3 × KRCCH-2	-2.26	-12.64	-0.54	9.28	6.00	1.92
SG-3 × SwarnaPrabha	-16.67*	-20.02**	-8.93	8.33	6.12	0.00
SG-3 × KRCCH-1	11.37	-4.58	8.65	7.07	1.92	1.92
Pusa Chikni × KRCCH-2	20.84*	17.67	5.52	-3.06	-5.00	-8.65
Pusa Chikni × SwarnaPrabha	12.35	1.76	6.56	9.28	8.16	1.92
Pusa Chikni × KRCCH-1	23.45**	20.74*	2.60	16.00**	11.54	11.54
KRCCH-2 × SwarnaPrabha	-9.89	-16.36*	-12.42	20.20**	19.00**	14.42*
KRCCH-2 × KRCCH-1	2.63	-2.19	-12.29	-2.94	-4.81	-4.81
SwarnaPrabha × KRCCH-1	-5.16	-15.79	-11.82	-0.99	-3.85	-3.85
S.Em±	8.931	10.312	10.312	1.925	2.223	2.223
C.D. @ 5%	18.130	20.934	20.934	3.908	4.513	4.513
C.D. @ 1%	23.513	27.150	27.150	5.068	5.852	5.852

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

MP, BP and SC represent heterosis values over mid, better and standard parent/check, respectively.

Table.4 Estimation of heterosis for node at which first female flower appeared and sex ratio in sponge gourd

Cross	Node at which first female flower appeared			Sex ratio		
	MP	BP	SC	MP	BP	SC
Kulgod local × SG-4	2.44	0.00	-41.67**	33.75**	33.37**	-8.61
Kulgod local × SG-6	66.67**	59.09**	-2.78	65.03**	58.80**	8.82*
Kulgod local × SG-5	10.64	-3.70	-27.78**	13.89	6.90	-26.75**
Kulgod local × SG-3	85.71**	30.00	-27.78**	15.10	8.49	-16.00
Kulgod local × Pusa Chikni	-56.25**	-65.00**	-80.56**	3.46	2.87	-28.70**
Kulgod local × KRCCH-2	104.76**	95.45**	19.44*	-8.62	-20.32*	-26.60**
Kulgod local × SwarnaPrabha	51.72**	10.00	-38.89**	19.32	15.24	-15.24
Kulgod local × KRCCH-1	-56.52**	-61.54**	-72.22**	-5.13	-16.55	-24.67**
SG-4 × SG-6	44.19**	40.91**	-13.89	20.54	16.30	-20.75*
SG-4 × SG-5	37.50**	22.22	-8.33	35.45**	27.47*	-13.14
SG-4 × SG-3	31.03	-9.52	-47.22**	-0.67	-6.62	-27.70**
SG-4 × Pusa Chikni	160.61**	104.76**	19.44*	43.32**	42.11**	-1.50
SG-4 × KRCCH-2	25.58*	22.73	-25.00**	3.03	-10.38	-17.44*
SG-4 × SwarnaPrabha	53.33**	9.52	-36.11**	6.63	2.71	-24.46**
SG-4 × KRCCH-1	-40.43**	-46.15**	-61.11**	-9.66	-20.73*	-28.44**
SG-6 × SG-5	-14.29	-22.22	-41.67**	41.63**	38.01**	-12.57
SG-6 × SG-3	0.00	-31.82*	-58.33**	4.52	-4.98	-26.43**
SG-6 × Pusa Chikni	23.53	-4.55	-41.67**	31.68**	26.02*	-12.65
SG-6 × KRCCH-2	31.82**	31.82*	-19.44*	5.03	-11.37	-18.36*
SG-6 × SwarnaPrabha	41.94*	0.00	-38.89**	27.42**	18.59	-12.78
SG-6 × KRCCH-1	45.83**	34.62**	-2.78	-7.04	-20.90*	-28.59**
SG-5 × SG-3	-60.00**	-74.07**	-80.56**	1.86	-9.53	-29.95**
SG-5 × Pusa Chikni	17.95	-14.81	-36.11**	21.36	13.30	-21.47**
SG-5 × KRCCH-2	42.86**	29.63*	-2.78	29.77**	7.23	-1.23
SG-5 × SwarnaPrabha	100.00**	33.33**	0.00	70.79**	55.19**	14.14**
SG-5 × KRCCH-1	-1.89	-3.70	-27.78**	18.37	-1.41	-11.00
SG-3 × Pusa Chikni	100.00**	66.67*	-44.44**	29.60**	22.80*	-4.92
SG-3 × KRCCH-2	60.00**	9.09	-33.33**	-0.66	-8.58	-15.79
SG-3 × SwarnaPrabha	252.94**	233.33**	-16.67	4.87	2.24	-20.84*
SG-3 × KRCCH-1	94.12**	26.92*	-8.33	25.13**	16.22	4.92
Pusa Chikni × KRCCH-2	-17.65	-36.36*	-61.11**	-10.19	-21.31*	-27.51**
Pusa Chikni × SwarnaPrabha	71.43**	50.00	-50.00**	7.95	4.84	-22.89**
Pusa Chikni × KRCCH-1	31.58*	-3.85	-30.56**	-2.38	-13.71	-22.11**
KRCCH-2 × SwarnaPrabha	80.65**	27.27	-22.22*	16.02	4.33	-3.90
KRCCH-2 × KRCCH-1	-33.33**	-38.46**	-55.56**	-17.95*	-18.78*	-25.18**
SwarnaPrabha × KRCCH-1	82.86**	23.08	-11.11	4.26	-5.40	-14.60
S.Em±	0.885	1.022	1.022	1.096	1.266	1.266
C.D. @ 5%	1.796	2.074	2.074	2.225	2.570	2.570
C.D. @ 1%	2.330	2.690	2.690	2.886	3.333	3.333

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

MP, BP and SC represent heterosis values over mid, better and standard parent/check, respectively.

Table.5 Estimation of heterosis for days to first harvest and days to last harvest in sponge gourd

Cross	Days to first harvest			Days to last harvest		
	MP	BP	SC	MP	BP	SC
Kulgod local × SG-4	15.08**	12.40**	8.21*	8.75*	3.59	-0.31
Kulgod local × SG-6	-3.10	-3.10	-6.72	-10.39**	-10.97*	-13.21**
Kulgod local × SG-5	5.06	4.65	0.75	2.19	-0.98	-4.72
Kulgod local × SG-3	14.40**	10.85*	6.72	-7.69*	-11.18**	-7.55
Kulgod local × Pusa Chikni	-6.25**	-6.98**	-10.45*	20.27**	15.36**	11.01**
Kulgod local × KRCCH-2	1.57	0.00	-3.73	-6.98	-9.57*	-7.86
Kulgod local × SwarnaPrabha	-0.40	-3.10	-6.72	2.54	-0.31	1.57
Kulgod local × KRCCH-1	-3.91*	-4.65*	-8.21*	11.22**	8.50	4.40
SG-4 × SG-6	2.38	0.00	-3.73	6.98	1.29	-1.26
SG-4 × SG-5	13.15**	10.94*	5.97	9.93*	8.01	-2.52
SG-4 × SG-3	18.03**	17.07**	7.46	2.63	-5.74	-1.89
SG-4 × Pusa Chikni	1.60	0.00	-5.22	2.15	1.42	-10.38*
SG-4 × KRCCH-2	12.10**	11.20*	3.73	-10.48**	-16.98**	-15.41**
SG-4 × SwarnaPrabha	7.76*	7.32	-1.49	-7.82*	-14.51**	-12.89**
SG-4 × KRCCH-1	-1.60	-3.15	-8.21*	10.56**	7.90	-1.26
SG-6 × SG-5	5.84	5.43	1.49	-2.85	-6.45	-8.81*
SG-6 × SG-3	-0.80	-3.88	-7.46	-4.84	-7.85	-4.09
SG-6 × Pusa Chikni	2.34	1.55	-2.24	5.25	0.32	-2.20
SG-6 × KRCCH-2	1.57	0.00	-3.73	-17.67**	-19.44**	-17.92**
SG-6 × SwarnaPrabha	3.59	0.78	-2.99	1.89	-0.31	1.57
SG-6 × KRCCH-1	5.47	4.65	0.75	13.81**	10.32*	7.55
SG-5 × SG-3	-2.81	-5.47	-9.70*	8.74*	1.51	5.66
SG-5 × Pusa Chikni	2.75	2.34	-2.24	18.31**	17.07**	5.66
SG-5 × KRCCH-2	1.98	0.78	-3.73	12.93**	6.48	8.49*
SG-5 × SwarnaPrabha	8.00*	5.47	0.75	2.13	-3.70	-1.89
SG-5 × KRCCH-1	1.18	0.78	-3.73	16.96**	16.15**	6.29
SG-3 × Pusa Chikni	-0.81	-3.15	-8.21*	4.90	-3.02	0.94
SG-3 × KRCCH-2	4.88	3.20	-3.73	-12.67**	-13.60**	-10.06*
SG-3 × SwarnaPrabha	6.17	5.74	-3.73	-2.90	-3.93	0.00
SG-3 × KRCCH-1	7.26	4.72	-0.75	4.82	-1.51	2.52
Pusa Chikni × KRCCH-2	-0.79	-1.57	-6.72	4.13	-2.78	-0.94
Pusa Chikni × SwarnaPrabha	3.61	1.57	-3.73	1.16	-5.56	-3.77
Pusa Chikni × KRCCH-1	14.17**	14.17**	8.21*	4.55	2.75	-5.97
KRCCH-2 × SwarnaPrabha	1.21	0.00	-6.72	-7.41*	-7.41	-5.66
KRCCH-2 × KRCCH-1	5.56	4.72	-0.75	2.76	-2.47	-0.63
SwarnaPrabha × KRCCH-1	6.83	4.72	-0.75	3.41	-1.85	0.00
S.Em±	1.542	1.780	1.780	3.778	4.363	4.363
C.D. @ 5%	3.130	3.614	3.614	7.671	8.857	8.857
C.D. @ 1%	4.060	4.688	4.688	9.948	11.487	11.487

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

MP, BP and SC represent heterosis values over mid, better and standard parent/check, respectively.

Table.6 Estimation of heterosis for fruiting period and fruit set in sponge gourd

Cross	Fruiting period			Fruit set		
	MP	BP	SC	MP	BP	SC
Kulgod local × SG-4	3.86	-2.78	-6.42	-1.01	-3.84	-4.87
Kulgod local × SG-6	-15.38*	-16.30*	-17.65*	10.72*	5.50	4.37
Kulgod local × SG-5	0.00	-5.00	-8.56	-3.53	-8.30	0.67
Kulgod local × SG-3	-21.63**	-27.70**	-17.65*	-14.95**	-18.71**	-11.79*
Kulgod local × Pusa Chikni	40.06**	31.11**	26.20**	13.03**	10.73*	9.54
Kulgod local × KRCCH-2	-12.57	-17.33*	-10.70	8.11	8.00	6.84
Kulgod local × SwarnaPrabha	4.42	-1.95	7.49	7.09	4.27	8.89
Kulgod local × KRCCH-1	22.19**	17.78*	13.37	12.73**	8.31	7.14
SG-4 × SG-6	10.26	2.17	0.53	20.04**	17.67**	9.76
SG-4 × SG-5	7.21	5.56	-8.56	5.99	-1.97	7.61
SG-4 × SG-3	-7.57	-19.72**	-8.56	6.37	-1.09	7.32
SG-4 × Pusa Chikni	2.55	2.55	-13.90	13.68**	12.72*	6.96
SG-4 × KRCCH-2	-25.91**	-34.16**	-28.88**	13.94**	10.81*	9.39
SG-4 × SwarnaPrabha	-18.23**	-27.80**	-20.86**	0.13	-5.22	-1.01
SG-4 × KRCCH-1	19.75**	16.17	3.74	18.57**	17.22**	9.35
SG-6 × SG-5	-9.25	-14.67	-16.04*	8.84	-1.16	8.50
SG-6 × SG-3	-7.30	-13.62*	-1.60	4.59	-4.53	3.60
SG-6 × Pusa Chikni	7.33	-0.54	-2.14	16.86**	13.60*	7.80
SG-6 × KRCCH-2	-30.05**	-33.17**	-27.81**	13.62**	8.36	6.98
SG-6 × SwarnaPrabha	0.77	-4.39	4.81	14.69**	6.54	11.26*
SG-6 × KRCCH-1	19.66**	14.13	12.30	16.55**	15.54**	5.33
SG-5 × SG-3	16.27*	2.35	16.58*	-1.65	-2.21	7.35
SG-5 × Pusa Chikni	34.17**	32.10**	14.44	2.99	-3.99	5.40
SG-5 × KRCCH-2	20.33**	8.42	17.11*	1.32	-3.78	5.63
SG-5 × SwarnaPrabha	-1.91	-12.20	-3.74	-3.32	-5.67	3.55
SG-5 × KRCCH-1	28.88**	26.95**	13.37	11.38*	1.94	11.90*
SG-3 × Pusa Chikni	8.65	-5.63	7.49	4.84	-1.73	6.63
SG-3 × KRCCH-2	-22.89**	-24.88**	-14.44	-14.09**	-17.97**	-10.99*
SG-3 × SwarnaPrabha	-8.13	-9.86	2.67	3.03	1.10	9.70
SG-3 × KRCCH-1	3.16	-7.98	4.81	7.70	-0.91	7.52
Pusa Chikni × KRCCH-2	7.52	-4.46	3.21	7.33	5.25	3.90
Pusa Chikni × SwarnaPrabha	-0.55	-12.20	-3.74	11.38*	6.29	11.01*
Pusa Chikni × KRCCH-1	-3.09	-5.99	-16.04*	14.65**	12.40*	6.66
KRCCH-2 × SwarnaPrabha	-12.53*	-13.17	-4.81	3.77	0.93	5.41
KRCCH-2 × KRCCH-1	0.81	-7.92	-0.53	10.65*	6.41	5.05
SwarnaPrabha × KRCCH-1	1.08	-8.29	0.53	6.63	-0.14	4.29
S.Em±	3.999	4.618	4.618	3.477	4.014	4.014
C.D. @ 5%	8.119	9.375	9.375	7.058	8.150	8.150
C.D. @ 1%	10.530	12.158	12.158	9.153	10.569	10.569

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

MP, BP and SC represent heterosis values over mid, better and standard parent/check, respectively.

Table.7 Estimation of heterosis for fruit length and fruit diameter in sponge gourd

Cross	Fruit length			Fruit diameter		
	MP	BP	SC	MP	BP	SC
Kulgod local × SG-4	13.07	9.64	5.99	3.18	-0.76	0.43
Kulgod local × SG-6	8.54	4.46	9.19	-3.10	-5.06	-11.25
Kulgod local × SG-5	-28.99**	-33.29**	-26.63*	6.61	6.41	-0.17
Kulgod local × SG-3	-1.40	-8.59	3.46	-4.40	-8.28	-6.70
Kulgod local × Pusa Chikni	45.39**	20.66**	16.64*	-2.44	-5.82	-5.41
Kulgod local × KRCCH-2	-8.97	-10.83	-10.12	5.34	1.36	2.49
Kulgod local × SwarnaPrabha	16.36	15.65*	13.18	5.78	5.59	-0.95
Kulgod local × KRCCH-1	14.43	8.37	17.18	-4.09	-8.46	-14.43*
SG-4 × SG-6	8.66	1.53	6.13	-5.85	-11.21	-10.14
SG-4 × SG-5	5.17	-4.00	5.59	4.32	0.51	1.72
SG-4 × SG-3	11.36	0.35	13.58	-8.04	-8.28	-6.70
SG-4 × Pusa Chikni	34.54**	14.52	3.99	-8.82	-9.17	-8.08
SG-4 × KRCCH-2	24.67*	18.49**	19.44**	2.25	2.21	3.44
SG-4 × SwarnaPrabha	18.00	13.74	11.32	1.06	-2.63	-1.46
SG-4 × KRCCH-1	11.91	2.96	11.32	6.14	-2.38	-1.20
SG-6 × SG-5	-3.91	-6.30	3.06	13.30*	10.81	3.95
SG-6 × SG-3	-0.18	-4.00	8.66	-4.67	-10.30	-8.76
SG-6 × Pusa Chikni	24.68*	0.38	4.93	5.38	-0.26	0.17
SG-6 × KRCCH-2	-4.02	-5.73	-1.46	5.18	-0.76	0.34
SG-6 × SwarnaPrabha	-3.42	-6.50	-2.26	-14.04*	-15.93*	-21.13**
SG-6 × KRCCH-1	-3.07	-4.68	3.06	16.08**	13.03	1.37
SG-5 × SG-3	-8.95	-10.24	1.60	1.76	-2.20	-0.52
SG-5 × Pusa Chikni	31.95**	4.24	14.65	1.90	-1.45	-1.03
SG-5 × KRCCH-2	4.49	0.12	10.12	-2.51	-6.03	-4.98
SG-5 × SwarnaPrabha	3.91	-1.82	7.99	1.19	1.19	-5.07
SG-5 × KRCCH-1	-6.11	-6.90	2.40	7.83	2.75	-3.61
SG-3 × Pusa Chikni	10.01	-14.00	-2.66	1.57	0.93	2.66
SG-3 × KRCCH-2	-19.10	-23.53*	-13.45	-11.48*	-11.74	-10.22
SG-3 × SwarnaPrabha	-15.46	-21.18*	-10.79	3.34	-0.68	1.03
SG-3 × KRCCH-1	-20.70*	-22.47*	-12.25	10.72	1.60	3.35
Pusa Chikni × KRCCH-2	19.42	-2.51	-1.73	-6.91	-7.22	-6.19
Pusa Chikni × SwarnaPrabha	38.71**	14.56	12.12	5.62	2.14	2.58
Pusa Chikni × KRCCH-1	8.60	-13.67	-6.66	-7.23	-14.37*	-14.00*
KRCCH-2 × SwarnaPrabha	-4.02	-5.42	-4.66	3.39	-0.34	0.77
KRCCH-2 × KRCCH-1	-7.84	-10.96	-3.73	7.57	-1.02	0.09
SwarnaPrabha × KRCCH-1	17.00	11.45	20.51	10.81	5.59	-0.95
S.Em±	2.536	2.928	2.928	0.204	0.235	0.235
C.D. @ 5%	5.148	5.945	5.945	0.414	0.478	0.478
C.D. @ 1%	6.677	7.710	7.710	0.537	0.620	0.620

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

MP, BP and SC represent heterosis values over mid, better and standard parent/check, respectively.

Table.8 Estimation of heterosis for average fruit weight and number of fruits per plant in sponge gourd

Cross	Average fruit weight			Number of fruits/plant		
	MP	BP	SC	MP	BP	SC
Kulgod local × SG-4	31.57**	24.39**	3.15	-31.01**	-33.33**	-14.01
Kulgod local × SG-6	27.47**	23.50**	-2.72	-20.93	-26.05*	2.17
Kulgod local × SG-5	48.67**	44.59**	6.81	-24.10*	-36.16**	12.56
Kulgod local × SG-3	14.20*	-4.33	4.63	-26.91*	-32.67**	-3.86
Kulgod local × Pusa Chikni	24.73**	24.71**	-7.84	37.62**	37.21**	66.04**
Kulgod local × KRCCH-2	20.27*	7.44	-20.64**	35.70**	22.89	47.83**
Kulgod local × SwarnaPrabha	3.78	-4.77	-15.77*	-12.45	-18.66	14.01
Kulgod local × KRCCH-1	38.89**	27.39**	-5.89	30.25*	13.25	36.23*
SG-4 × SG-6	1.67	-0.88	-17.80**	-4.88	-8.04	27.05
SG-4 × SG-5	45.35**	33.85**	11.00	-20.73*	-31.37**	21.01
SG-4 × SG-3	8.84	-4.32	4.64	-8.45	-12.87	24.40
SG-4 × Pusa Chikni	29.62**	22.56**	1.64	-15.94	-18.54	5.07
SG-4 × KRCCH-2	-17.93*	-30.21**	-42.13**	3.62	-8.99	17.39
SG-4 × SwarnaPrabha	-22.22**	-24.65**	-33.35**	-11.87	-15.39	18.60
SG-4 × KRCCH-1	43.79**	25.33**	3.93	47.07**	24.21*	60.22**
SG-6 × SG-5	-35.73**	-39.39**	-52.26**	-27.65**	-35.48**	13.77
SG-6 × SG-3	-13.06*	-25.22**	-18.21**	-0.18	-1.79	40.22*
SG-6 × Pusa Chikni	-32.36**	-34.45**	-48.36**	-7.18	-12.94	20.29
SG-6 × KRCCH-2	36.37**	18.49*	-6.67	-1.43	-15.91	16.18
SG-6 × SwarnaPrabha	-1.85	-7.22	-17.94**	-9.57	-10.22	25.85
SG-6 × KRCCH-1	53.10**	36.46**	7.49	9.36	-10.14	24.15
SG-5 × SG-3	12.06	-8.20	0.40	-7.17	-16.00	48.12**
SG-5 × Pusa Chikni	33.85**	30.14**	-3.83	-25.59**	-37.26**	10.63
SG-5 × KRCCH-2	40.54**	28.76**	-10.11	-20.46*	-38.22**	8.94
SG-5 × SwarnaPrabha	30.39**	16.65*	3.17	-41.54**	-47.53**	-7.49*
SG-5 × KRCCH-1	72.50**	62.41**	13.37**	-12.02	-33.84**	16.67
SG-3 × Pusa Chikni	12.23	-5.97	2.84	-15.03	-21.50	12.08
SG-3 × KRCCH-2	12.95	-13.52*	-5.42	-11.37	-25.39*	6.52
SG-3 × SwarnaPrabha	6.47	-3.72	5.31	-11.05	-11.86	25.85
SG-3 × KRCCH-1	15.15*	-9.97	-1.54	-17.42	-33.01**	-4.35
Pusa Chikni × KRCCH-2	34.60**	20.21*	-11.16	15.36	4.19	26.09
Pusa Chikni × SwarnaPrabha	13.14	3.84	-8.15	-11.40	-17.46	15.70
Pusa Chikni × KRCCH-1	29.64**	18.89*	-12.14	28.19*	11.18	34.54*
KRCCH-2 × SwarnaPrabha	-19.92*	-33.66**	-41.32**	-10.60	-24.18*	6.28
KRCCH-2 × KRCCH-1	63.36**	58.67**	-2.19	55.70**	48.76**	45.17**
SwarnaPrabha × KRCCH-1	-19.08*	-31.34**	-39.27**	-14.16	-29.86**	-1.69
S.Em±	10.903	12.589	12.589	1.896	2.189	2.189
C.D. @ 5%	22.133	25.558	25.558	3.848	4.444	4.444
C.D. @ 1%	28.705	33.146	33.146	4.991	5.763	5.763

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

MP, BP and SC represent heterosis values over mid, better and standard parent/check, respectively.

Table.9 Estimation of heterosis for fruit yield per plant and number of seeds per fruit in sponge gourd

Cross	Fruit yield per plant			Number of seeds/fruit		
	MP	BP	SC	MP	BP	SC
Kulgod local × SG-4	11.18	2.83	1.32	0.46	-1.35	-10.33
Kulgod local × SG-6	-5.43	-5.83	-7.22	14.67	0.98	-8.21
Kulgod local × SG-5	0.50	-5.74	-7.13	-3.80	-13.73	-21.58
Kulgod local × SG-3	-24.06**	-41.14**	5.41	10.98	4.95	-4.60
Kulgod local × Pusa Chikni	90.16**	78.27**	100.74**	-21.69	-26.66	-33.33**
Kulgod local × KRCCH-2	-4.98	-9.83	-1.05	20.76	17.63	12.78
Kulgod local × SwarnaPrabha	-31.71**	-46.40**	-7.31	2.40	-2.61	-11.47
Kulgod local × KRCCH-1	58.89**	47.17**	70.08**	-13.96	-19.71	-15.77
SG-4 × SG-6	10.53	2.63	0.27	-24.09	-32.07*	-40.48**
SG-4 × SG-5	16.91	15.17	-0.60	10.27	0.52	-11.92
SG-4 × SG-3	-17.73*	-39.63**	8.11	13.75	9.46	-4.08
SG-4 × Pusa Chikni	-0.86	-13.57	-2.68	11.62	6.35	-6.81
SG-4 × KRCCH-2	-16.65	-26.53*	-19.37	3.03	-1.40	-5.46
SG-4 × SwarnaPrabha	-30.72**	-48.59**	-11.08	34.72**	30.40*	14.27
SG-4 × KRCCH-1	62.63**	40.23**	62.06**	-26.04*	-32.13**	-28.80*
SG-6 × SG-5	8.16	1.85	-0.49	18.82	16.40	-16.04
SG-6 × SG-3	2.32	-20.92**	41.60**	13.93	5.62	-14.43
SG-6 × Pusa Chikni	7.49	0.38	13.03	-5.00	-11.08	-29.44*
SG-6 × KRCCH-2	18.75	12.24	23.17	15.39	-0.66	-4.76
SG-6 × SwarnaPrabha	-38.70**	-52.03**	-17.05	10.26	1.65	-16.64
SG-6 × KRCCH-1	8.28	-0.10	15.46	-34.13**	-45.34**	-42.66**
SG-5 × SG-3	47.04**	8.96	95.11**	-5.64	-10.81	-27.74*
SG-5 × Pusa Chikni	16.79	3.15	16.15	50.06**	43.23**	13.66*
SG-5 × KRCCH-2	11.11	-0.75	8.91	-10.32	-21.42	-24.66
SG-5 × SwarnaPrabha	-23.94**	-42.99**	-1.41	34.30*	26.21	3.50
SG-5 × KRCCH-1	-3.30	-15.54	-2.39	-27.13*	-38.51**	-35.50**
SG-3 × Pusa Chikni	-33.71**	-46.01**	-3.33	15.74	14.56	-7.19
SG-3 × KRCCH-2	-47.30**	-57.50**	-23.91	20.79	11.43	6.84
SG-3 × SwarnaPrabha	-36.56**	-37.64**	11.66	28.44*	27.66	4.70
SG-3 × KRCCH-1	-26.95**	-39.90**	7.62	18.65	5.14	10.30
Pusa Chikni × KRCCH-2	20.74*	19.21	34.23**	6.73	-2.47	-6.49
Pusa Chikni × SwarnaPrabha	-13.76	-28.81**	23.12	15.19	13.33	-7.06
Pusa Chikni × KRCCH-1	-21.24*	-22.25*	-10.14	0.30	-11.92	-7.60
KRCCH-2 × SwarnaPrabha	-37.11**	-48.60**	-11.10	14.44	6.17	1.79
KRCCH-2 × KRCCH-1	-12.88	-15.08	-1.85	4.33	-0.16	4.74
SwarnaPrabha × KRCCH-1	-43.29**	-52.69**	-18.19	3.33	-7.94	-3.43
S.Em±	0.160	0.185	0.185	31.160	35.981	35.981
C.D. @ 5%	0.325	0.375	0.375	63.258	73.044	73.044
C.D. @ 1%	0.421	0.486	0.486	82.040	94.732	94.732

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

MP, BP and SC represent heterosis values over mid, better and standard parent/check, respectively.

Table.10 Estimation of heterosis for rind thickness and flesh thickness in sponge gourd

Cross	Rind thickness			Flesh thickness		
	MP	BP	SC	MP	BP	SC
Kulgod local × SG-4	39.62**	39.20**	1.75	3.00	-1.55	-8.04
Kulgod local × SG-6	31.59**	19.64**	6.87	10.87*	3.77	1.34
Kulgod local × SG-5	-3.37	-24.69**	-1.46	0.12	-5.57	-9.26
Kulgod local × SG-3	-22.84**	-37.58**	-26.17**	-11.27*	-18.23**	-17.41**
Kulgod local × Pusa Chikni	52.29**	30.62**	33.48**	12.98*	10.84	-1.90
Kulgod local × KRCCH-2	34.29**	21.29**	9.94	-1.66	-7.31	-10.83
Kulgod local × SwarnaPrabha	3.44	-17.34**	1.02	4.55	-2.60	-3.91
Kulgod local × KRCCH-1	61.77**	59.42**	20.03**	17.59**	16.09*	1.45*
SG-4 × SG-6	21.84**	10.47	-1.32	-3.86	-5.94	-8.15
SG-4 × SG-5	15.37**	-10.28*	17.40**	1.53	0.12	-3.79
SG-4 × SG-3	4.75	-15.45**	0.00	-1.72	-5.41	-4.46
SG-4 × Pusa Chikni	13.31*	-3.06	-0.94	-2.21	-4.78	-11.05
SG-4 × KRCCH-2	21.22**	9.19	-1.02	0.65	-0.81	-4.58
SG-4 × SwarnaPrabha	-5.78	-24.88**	-8.19	-10.87*	-13.24*	-14.40*
SG-4 × KRCCH-1	61.26**	58.45**	19.30**	11.85*	8.24	1.12
SG-6 × SG-5	4.78	-11.84*	15.35*	-3.46	-4.23	-6.47
SG-6 × SG-3	11.13*	-2.47	15.35*	0.11	-1.55	-0.56
SG-6 × Pusa Chikni	24.58**	16.74**	19.30**	-6.24	-10.63	-12.72*
SG-6 × KRCCH-2	-4.96	-5.65	-14.47*	-1.67	-2.40	-4.69
SG-6 × SwarnaPrabha	-4.35	-17.22**	1.17	-5.40	-5.88	-7.14
SG-6 × KRCCH-1	38.90**	27.99**	14.33*	6.03	0.46	-1.90
SG-5 × SG-3	-4.69	-9.27	18.71**	4.53	1.99	3.01
SG-5 × Pusa Chikni	-20.20**	-28.94**	-7.02	7.01	2.79	-1.23
SG-5 × KRCCH-2	12.21*	-5.03	24.27**	-3.54	-3.60	-7.25
SG-5 × SwarnaPrabha	-20.39**	-23.02**	0.73	-3.72	-4.98	-6.25
SG-5 × KRCCH-1	-29.65**	-44.58**	-27.49**	4.50	-0.23	-4.13
SG-3 × Pusa Chikni	24.01**	15.57**	36.70**	-3.65	-9.61	-8.71
SG-3 × KRCCH-2	3.15	-8.90	7.75	3.00	0.55	1.56
SG-3 × SwarnaPrabha	7.60	5.86	29.39**	-10.34*	-11.38*	-10.49
SG-3 × KRCCH-1	33.08**	8.90	28.80**	-3.67	-10.17	-9.26
Pusa Chikni × KRCCH-2	21.15**	14.31*	16.81*	2.24	-1.86	-5.58
Pusa Chikni × SwarnaPrabha	2.15	-6.22	14.62*	3.40	-1.92	-3.24
Pusa Chikni × KRCCH-1	33.61**	16.02*	18.57**	11.80*	11.10	-1.67
KRCCH-2 × SwarnaPrabha	0.27	-12.68*	6.73	0.69	-0.57	-1.90
KRCCH-2 × KRCCH-1	32.69**	21.45**	10.09	5.90	1.04	-2.79
SwarnaPrabha × KRCCH-1	25.09**	1.08	23.54**	1.14	-4.64	-5.92
S.Em±	0.128	0.148	0.148	0.144	0.166	0.166
C.D. @ 5%	0.260	0.300	0.300	0.292	0.338	0.338
C.D. @ 1%	0.337	0.389	0.389	0.379	0.438	0.438

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

MP, BP and SC represent heterosis values over mid, better and standard parent/check, respectively.

Table.11 Estimation of heterosis for TSS and physiological loss of weight in sponge gourd

Cross	TSS			Physiological loss of weight		
	MP	BP	SC	MP	BP	SC
Kulgod local × SG-4	2.01	-0.49	4.10	0.64	-6.33**	-15.10**
Kulgod local × SG-6	5.26	2.44	7.69	44.40**	35.71**	20.48**
Kulgod local × SG-5	0.47	-7.76	9.74	87.88**	62.51**	26.91**
Kulgod local × SG-3	3.77	-4.35	12.82*	108.77**	68.20**	31.35**
Kulgod local × Pusa Chikni	-3.15	-8.68	2.56	-56.12**	-65.19**	-53.64**
Kulgod local × KRCCH-2	-6.44	-10.00	-3.08	69.93**	58.39**	43.13**
Kulgod local × SwarnaPrabha	-0.23	-8.58	9.23	119.85**	77.18**	38.36**
Kulgod local × KRCCH-1	0.00	-1.98	1.54	-13.87**	-19.71**	-37.30**
SG-4 × SG-6	2.69	2.44	7.69	-2.35**	-3.35**	-12.40**
SG-4 × SG-5	-11.93**	-17.24**	-1.54	77.21**	44.34**	30.82**
SG-4 × SG-3	-4.15	-9.57	6.67	69.61**	29.48**	17.35**
SG-4 × Pusa Chikni	-15.84**	-18.72**	-8.72	26.97**	6.68**	42.10**
SG-4 × KRCCH-2	-8.70	-10.00	-3.08	34.61**	34.41**	21.82**
SG-4 × SwarnaPrabha	-5.26	-11.16*	6.15	103.95**	55.73**	41.15**
SG-4 × KRCCH-1	3.45	2.94	7.69	-44.66**	-51.72**	-56.25**
SG-6 × SG-5	-2.97	-8.62	8.72	60.24**	31.57**	16.80**
SG-6 × SG-3	1.15	-4.35	12.82*	-12.57**	-32.78**	-40.32**
SG-6 × Pusa Chikni	-8.02	-10.96*	0.00	-5.14**	-20.96**	5.28**
SG-6 × KRCCH-2	-10.84*	-11.90*	-5.13	36.29**	35.08**	22.07**
SG-6 × SwarnaPrabha	-9.63*	-15.06**	1.49	90.64**	46.62**	30.16**
SG-6 × KRCCH-1	-5.65	-6.34	-1.54	70.63**	50.19**	33.32**
SG-5 × SG-3	-13.42**	-13.79**	2.56	-8.70**	-16.12**	-52.18**
SG-5 × Pusa Chikni	-28.16**	-30.17**	-16.92**	56.64**	11.84**	48.97**
SG-5 × KRCCH-2	-12.67**	-16.81**	-1.03	86.10**	51.75**	37.13**
SG-5 × SwarnaPrabha	-12.26**	-12.45*	4.62	134.42**	115.45**	22.82**
SG-5 × KRCCH-1	1.29	-5.26	12.72*	62.08**	49.48**	0.90
SG-3 × Pusa Chikni	-18.04**	-20.00**	-5.64	38.88**	-5.67**	25.64**
SG-3 × KRCCH-2	-10.00*	-13.91**	1.54	83.41**	40.15**	26.65**
SG-3 × SwarnaPrabha	-17.06**	-17.60**	-1.54	13.56**	13.51**	-45.77**
SG-3 × KRCCH-1	-2.78	-8.70	7.69	42.05**	21.26**	-18.15**
Pusa Chikni × KRCCH-2	-7.69	-9.59	1.54	-41.73**	-51.10**	-34.87**
Pusa Chikni × SwarnaPrabha	-16.81**	-19.31**	-3.59	9.78**	-25.42**	-0.66
Pusa Chikni × KRCCH-1	4.04	0.00	12.31*	-2.48**	-26.53**	-2.14**
KRCCH-2 × SwarnaPrabha	-15.12**	-19.31**	-3.59	19.36**	-8.77**	-17.55**
KRCCH-2 × KRCCH-1	-5.34	-7.14	0.00	56.23**	36.46**	23.31**
SwarnaPrabha × KRCCH-1	-0.23	-6.87	11.28	153.67**	116.61**	46.21**
S.Em±	0.324	0.374	0.374	0.136	0.157	0.157
C.D. @ 5%	0.658	0.760	0.760	0.276	0.319	0.319
C.D. @ 1%	0.854	0.986	0.986	0.358	0.413	0.413

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

MP, BP and SC represents heterosis values over mid, better and standard parent/check, respectively.

It was also noted that most of the hybrids which flowered earlier than the better or check variety also showed earliness in maturity indicating the positive association between these two characters. However, the hybrids flowering earlier need not necessarily borne the fruit at lower nodes.

The cross Kulgod local × Pusa Chikni was the best hybrid over mid parent (37.07 %), better parent (27.00 %) and standard parent (26.50 %) for leaf area. These results are in accordance with the reports of Arinia *et al.* (2013) for heterobeltosis and standard heterosis in cucumber.

Cross Kulgod local × SG-3 (12.82 %) was the best hybrid standard parent for total soluble solids. The findings are in accordance with the reports of Singh *et al.* (2012) for heterobeltosis and standard heterosis.

Number of fruits per plant is an important character for which 6, 3 and 8 crosses exhibited significant heterosis over mid, better and check parent, respectively. For this trait, the cross KRCCH-2 × KRCCH-1 had maximum and significant positive heterosis over mid parent followed by KRCCH-2 × KRCCH-1 for heterobeltosis and Kulgod local × Pusa Chikni for standard heterosis.

The extent of heterosis over the three best crosses for total yield per plant (58.89 - 90.16 % over mid parent; 40.23 - 78.27 % over better parent and 70.08 - 100.74 % over check variety) revealed that there was a great scope of realizing higher yield in sponge gourd through heterosis breeding.

Six cross combinations showed significant and positive standard heterosis for fruit yield per plant. The range of standard heterosis was from -23.91 (SG-3 × KRCCH-2) to 100.74 per cent (Kulgod local × Pusa

Chikni). The top three hybrids were Kulgod local × Pusa Chikni (100.74 %), SG-5 × SG-3 (95.11 %) and Kulgod local × KRCCH-1 (70.08 %).

Relative heterosis besides epistatic effect also indicates presence of dominance effects (intra allelic interaction), while heterobeltosis is indicative of over dominance. In such situation economic heterosis or mean performance of a cross is more reliable criteria for identifying a commercially valuable cross. The crosses showing high heterosis for yield and also exhibiting high heterosis for different yield contributing characters by Kulgod local × Pusa Chikni and Kulgod local × KRCCH-1 are more suitable because has strong heterotic capability compared to other ones during hybridization process. These crosses may be further tested and recommended for commercial cultivation to boost the fruit yield per unit area of sponge gourd.

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