STUDY OF COMBINING ABILITY FOR FRUIT YIELD AND ITS COMPONENT TRAITS IN SPONGE GOURD (*Luffa Cylindrica* L.)

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ABSTRACT

Combining ability for fruit yield and its component traits in sponge gourd was studied using line x tester mating design involving four testers and eight lines. The variance due to gca and sca were non-significant for all the characters except node number of first female flower, length of main vine, fruit length and number of seeds per fruit were significant for gca. This indicated that both additive and non-additive type of gene action played a vital role in the inheritance of all these traits under present study. The magnitude of sca variances were higher than their respective gca variances for all the characters which confirmed the preponderance of non-additive gene action for all the traits. The estimate of gca effects indicated that the parents Pusa Chikni, JSG-14-06, JSG-14-03 and JSG-14-04, were found to be the good general combiners for fruit yield and some of the yield contributing characters. These parents need to be used for higher economic production. However, in specific combining ability studies, the hybrids ASGS-04-23 x GJSG-1, JSG-14-02 x JSG-13-07, JSG-14-03 x GSG-1 and ASGS-11-47 x Pusa Chikni were found to be good specific combinations for fruit yield and some of the yield contributing characters..

KEY WORDS: Combining ability, GCA, SCA, Sponge gourd

INTRODUCTION

Sponge gourd [*Luffa cylindrical* (Roem.) L.] is one of the most popular cucurbitaceous vegetable crops of India. It is highly cross pollinated crop, large variation observed in shape and size of fruit. Sponge gourd is known for its rich genetic diversity, particularly fruit size and shape, is cultivated widely throughout the world. It is an important component of crop rotation during *rabi*-summer and rainy season in Indian condition and is cultivated both on commercial scale and in kitchen gardens. Very few varieties and hybrids are grown for commercial cultivation in India. Being monoecious and essentially cross pollinated, it provides ample scope for successful exploitation of hybrid vigour.

During recent years, the exploitation of hybrid vigour and selection of potential parents on the basis of combining ability have expanded a new alley in crop improvement. Keeping this view, the present studies were undertaken to identify the genetic architecture of characters related to yield and its components.

MATERIALS AND METHODS

Experimental material consisting of 45 entries (32 hybrids and 12 parents) comprised of four male lines (used as testers

GSG-1, Pusa Chikni, GJSG-2, JSG-13-07) and ten female lines (used as lines 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 were 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 per cent 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. Analysis of variance for combining ability was computed according to the model given by Kempthorne (1957) which is analogous to design II of Comstock and Robinson (1952) in terms of covariance of half-sibs (H.S.) and full-sibs (F.S.).

RESULTS AND DISCUSSION

The analysis of variance for combining ability (Table 1) revealed that the mean squares due to gca and sca were non-significant for all the characters except node number of first female flower, length of main vine, fruit length and number of seeds per fruit. This indicated that both additive and non-additive type of gene effects played a vital role in the inheritance of all these traits studied. The magnitude of sca variances were higher than their respective gca variances for all the characters which confirmed the preponderance of non-additive gene action for all the traits.

An overall appraisal of gca effects revealed that parents JSG-14-03 and JSG-13-04 were good general combiners for fruit yield per vine and some of its components. JSG-14-03 ranked first in gca effects for fruit yield per vine and node to first female flower. Parents Pusa Chikni and JSG-13-04 were good combiner for days to 50 per cent flowering, while parent JSG-14-06 was good general combiner for days to 50 per cent flowering, days to opening of first male flower, node number of first female flower, number of primary branches per vine, fruit length and number of seeds per fruit. However, the parent JSG-13-04 got second position in good combiners, as showed significant gca effects in desirable direction for days to 50 per cent flowering, node to first female flower, number of primary branches per vine and number of fruits per vine. Among these traits, most of the traits were related to earliness. Hence, JSG-14-06 and JSG-13-04 could be utilized for earliness in sponge gourd. Thus, JSG-14-03 and JSG-13-04 were good general combiner for fruit yield and its components and JSG-14-06 and JSG-13-04 for earliness, which may be utilized in future crossing programme to generate the genetic variability for effective selection to develop high fruit yielding genotypes with earliness in sponge gourd (Table 2). Thus, the association between *per se* performance of parents and their gca effects suggested that while selecting the parents for hybridization programme, *per se* performance of the parents should also be given due consideration. Thus, if a character is uni-directionally controlled by a set of alleles and additive effects are important, the choice of parents on the basis of *per se* performance may be more effective. Similar findings have also been reported by Naliyadhara *et al*. (2007), Ram *et al*. (2007), Sanandia *et al*. (2008), Sanandia *et al.* (2010), Naliyadhara *et al*. (2010) and Khule *et al*. (2011).

The estimates of sca effects revealed (Table 3) that none of the crosses was consistently superior for all the characters. The highest yielding hybrid ASGS-04-23 x GSG-1 had also registered highest sca effects for fruit yield per vine. This could be due to average x average general combiner parents. This cross also showed high sca effects for nods to first female flower, number of fruits per vine and number of seeds per fruit. The high sca effect for this component was also accompanied by high heterosis as well as high *per se* performance (Table 4).

On the other hand, the cross JSG-14-02 x JSG-13-07 had second highest sca for fruit yield per vine which was due to poor x average general combiner parents. This indicated the presence of epistatic gene action and such deviation could be attributed to the genetic diversity in the form of heterozygous loci. This could also be an indication of gene dispersion and genetic interaction between favourable alleles contributed by both the parents. Such combination could be utilized for intermating segregants in F_2 or F_3 generation and simultaneous selection for desirable plant type.

In the present study, such cross combinations for fruit yield were JSG-14-03 x GSG-1 (good x average) and ASGS-11-47 x Pusa Chikni (average x average). These crosses may be expected to yield transgressive and stable performing segregants possessing enhance yielding ability. The cross ASGS-11-47 x Pusa Chikni, which recorded significant sca effect for fruit yield, resulted from average x average combiners. This indicated the inconsistent expression of sca effects in specific crosses irrespective of gca effects of the parents (Table 4). In fact, in majority of cases, the best specific combinations for different characters were either good x poor, poor x poor, average x poor, good x average, average x average and *vice versa* general combiners. This suggested that information on gca effects should be supplemented by sca effects and hybrid performance of cross combinations to predict the transgressive type possibly made available in segregating generations. Selection is rapid if gca effects of parents and sca effects of crosses are in same direction. If crosses showing high sca effects involve at least one parent possessing good gca effects and high *per se* performance, they could be exploited for practical breeding. However, Chaudhary *et al.* (1974) stated that high sca effects would not necessarily mean a high performance by the hybrid and the estimation of sca effects seemed to be superflous, as no additional information was obtained by doing so. Therefore, it is suggested that the selection of parents for further breeding programme should be based on gca effects and due consideration should be given to mean value of the cross combinations while selecting crosses for specific heterosis.

A summarized account of best performing parents, best general combiners, *per se* performance, standard heterosis and best sca effects (Table 4) indicated that in majority of the characters studied, the best performing parent was also found to be best general combiners though their relative ranking were quite different. Further, best general combiners may not always produce best cross combination for most of the characters. However in few cases, good x good combinations exhibited high sca effects. In this situation, it would be better to look for good transgressive segregants in further generations to make their use in future breeding programme.

CONCLUSION

From the study, it can be concluded that parents Pusa Chikni, JSG-14-06, JSG-14-03 and JSG-14-04, were found to be the good general combiners for fruit yield and some of the yield contributing characters, needs to be used for higher economic production. The hybrids ASGS-04-23 x GJSG-1, JSG-14-02 x JSG-13-07, JSG-14-03 x GSG-1 and ASGS-11-47 x Pusa Chikni were found to be the specific combiners for fruit yield and some of the yield contributing characters, could be further exploited for sponge gourd improvement.

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Table 1: Analysis of variance for combining ability and variance components for various characters in sponge gourd

Source	d.f.	Days to 50 Per Cent 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)
Replications	2	1.54	8.24	10.19	0.18	0.03	10.64	0.31*
Lines	7	20.82	32.56	31.23	2.34**	2.98**	17.04	0.16**
Testers	3	94.87**	63.83**	18.92	2.71**	0.16	79.51**	0.33**
Lines x Testers	21	51.92**	53.25**	53.06**	1.62**	1.68**	43.93**	0.15*
Error	62	1.68	3.06	3.35	0.10	0.08	5.49	0.08
Variance components								
$\sigma^2 l$		1.59	2.46	2.32	0.19	0.24	0.96	0.01
$\sigma^2 t$		3.88	2.53	0.65	0.11	0.004	3.08	0.01
$\sigma^2 lt$		16.75**	16.73**	16.57**	0.51**	0.53**	12.81**	0.02*
$\sigma^2 gca$		3.12	2.51	1.21	0.13*	0.08	2.38	0.01*
$\sigma^2 sca$		16.75	16.73	16.57	0.51	0.53	12.81	0.02
$\sigma^2 sca / \sigma^2 gca$		5.37	6.67	13.69	3.92	6.63	5.38	2.00

Table 1: Contd…

Source	d.f.	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)	Number of Seeds per Fruit
Replications	2	1.96*	3.84	20.39	19.99**	44.54**	0.11	8.82
Lines	7	5.86**	53.91	3870.69	41.56**+	7.48**	0.78	528.73*++
Testers	3	6.32**	14.19	467.88	34.94**	2.18	1.05	156.01
Lines x Testers	21	5.47**	58.21**	5085.58**	16.43**	3.92**	1.79**	180.43**
Error	62	0.52	1.36	37.85	3.53	1.41	0.07	3.23
Variance components								
$\sigma^2 l$		0.44	4.38	319.40	3.17*	0.51	0.06	43.79*
$\sigma^2 t$		0.24	0.53	17.92	1.31	0.03	0.04	6.37
$\sigma^2 lt$		1.65**	18.95**	1682.57**	4.30**	0.84**	0.57**	59.07**
$\sigma^2 gca$		0.31	1.82	118.41	1.93**	0.19*	0.05	18.84**
$\sigma^2 sca$		1.65	18.95	1682.57	4.30	0.84	0.57	59.07
$\sigma^2 sca / \sigma^2 gca$		5.32	10.41	14.21	2.23	4.42	11.4	3.14

,** Significant at 5 and 1 per cent levels, respectively

+,++ Significant at 5 and 1 per cent levels, respectively against lines x testers interaction

Table 2: Summary of general combining ability effect of the parents for fifteen characters in sponge gourd

Parents	Days to 50 Per Cent 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)
Lines							
JSG-14-03	A	A	A	G	A	A	A
JSG-14-05	A	A	P	A	P	A	A
JSG-13-04	G	A	A	P	G	A	A
JSG-14-06	G	A	G	G	A	A	A
ASGS-04-23	A	A	A	A	G	A	A
JSG-14-02	A	A	A	A	A	A	A
ASGS-11-47	P	P	A	P	A	A	A
JSG-14-04	A	A	A	A	G	A	A
Testers							
GSG-1	A	A	A	A	A	A	A
Pusa Chikni	G	G	A	A	A	A	A
GJSG-2	A	A	A	G	A	A	A
JSG-13-07	A	A	A	A	A	A	A

G = Good; A = Average; P = Poor

Table 2: Contd….

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Parents	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)	Number of Seeds per Fruit
Lines							
JSG-14-03	A	P	A	A	A	G	P
JSG-14-05	P	A	P	A	A	A	A
JSG-13-04	G	G	A	A	A	A	A
JSG-14-06	G	A	A	G	A	A	G
ASGS-04-23	A	A	P	A	A	A	P
JSG-14-02	A	A	P	A	A	P	G
ASGS-11-47	A	G	G	A	A	A	G
JSG-14-04	A	G	G	P	A	A	A
Testers							
GSG-1	A	A	A	A	A	A	A
Pusa Chikni	A	A	A	A	A	A	A
GJSG-2	A	A	A	A	A	A	P
JSG-13-07	A	A	A	A	A	A	A

G = Good; A = Average; P = Poor

Table 3: Specific combining ability effects for different characters in sponge gourd

Sr. No.	Crosses	Days to 50 Per Cent 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)
1	JSG-14-03 x GSG-1	0.76	0.99	-1.71	-0.08	1.36**	0.55	0.34*
2	JSG-14-03 x Pusa	1.97*	2.64*	-0.87	-0.96**	-1.10**	1.12	-0.28
3	JSG-14-03 x GJSG-2	-2.28**	-2.07*	0.86	0.29	-0.08	-1.38	-0.01
4	JSG-14-03 x JSG-13-07	-0.45	-1.57	1.72	0.75**	-0.18	-0.29	-0.06
5	JSG-14-05xGSG-1	1.76*	0.71	4.86**	1.19**	0.18	0.60	0.15
6	JSG-14-05 x Pusa	2.64**	3.29**	3.50**	-0.49*	-0.95**	2.90*	-0.31
7	JSG-14-05 x GJSG-2	-4.95**	-3.75**	-1.31	0.03	-0.13	-3.33*	0.02
8	JSG-14-05 x JSG-13-07	0.55	-0.26	-7.05**	-0.72**	0.90**	-0.17	0.13
9	JSG-13-04 x GSG-1	-7.49**	-7.57**	-7.48**	0.67**	-0.41*	-7.98**	0.22
10	JSG-13-04 x Pusa	0.05	1.01	0.37	0.52	0.80**	-1.42	0.03
11	JSG-13-04 x GJSG-2	0.80	0.24	1.36	-0.42*	0.03	2.95*	-0.14
12	JSG-13-04 x JSG-13-07	6.64**	6.33**	5.76**	-0.77**	-0.42*	6.45**	-0.11
13	JSG-14-06 x GSG-1	-3.82**	-3.44**	4.59**	0.02	0.28	-0.92	-0.29
14	JSG-14-06 x Pusa	-2.62**	-3.99**	-2.70*	0.47*	0.95**	-3.49*	0.40*
15	JSG-14-06 x GJSG-2	9.80**	9.44**	-4.78**	0.06	-0.29	7.42**	-0.03
16	JSG-14-06 x JSG-13-07	-3.37**	-2.01	2.89**	-0.55**	-0.93**	-3.02*	-0.08
17	ASGS-04-23 x GSG-1	-0.66	-1.12	-0.05	-0.51**	-0.13	-1.29	-0.16
18	ASGS-04-23 x Pusa	0.22	1.32	-1.07	1.00**	0.22	0.87	0.26

,** Significant at 5 and 1 per cent levels, respectively

Table 3 : Contd.….

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Sr. No.	Crosses	Days to 50 Per Cent 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)
19	ASGS-04-23 x GJSG-2	0.30	1.22	2.32*	-0.94**	-0.03	-0.49	-0.15
20	ASGS-04-23 x JSG-13-	0.14	-1.42	-1.21	0.45*	-0.07	0.91	0.05
21	JSG-14-02 x GSG-1	-0.49	-0.91	-5.41**	-0.76**	0.08	-0.62	0.17
22	JSG-14-02 x Pusa	1.72*	1.41	4.83**	-0.25	-0.05	2.34	-0.15
23	JSG-14-02 x GJSG-2	0.47	-0.09	0.82	-0.19	-0.16	0.21	-0.01
24	JSG-14-02 x JSG-13-07	-1.70*	-0.41	-0.25	1.19**	0.13	-1.93	-0.01
25	ASGS-11-47 x GSG-1	7.26**	7.61**	5.08**	-0.23	-0.81**	6.74**	-0.17
26	ASGS-11-47 x Pusa	-3.20**	-3.21**	-5.57**	-0.38*	0.13	-2.46	0.18
27	ASGS-11-47 x GJSG-2	-2.45**	-2.98**	1.71	0.55**	1.16**	-2.49	0.01
28	ASGS-11-47 x JSG-13-	-1.62*	-1.42	-1.22	0.06	-0.48**	-1.79	-0.01
29	JSG-14-04 x GSG-1	2.68**	3.73**	0.12	-0.29	-0.54**	2.91*	-0.25
30	JSG-14-04 x Pusa	-0.78	-2.49*	0.10	0.09	0.00	0.14	-0.14
31	JSG-14-04 x GJSG-2	-1.70*	-1.99	-0.98	0.61**	-0.51**	-2.89*	0.30
32	JSG-14-04 x JSG-13-07	-0.20	0.76	-0.65	-0.40*	1.05**	-0.16	0.09
	SE(S_{ij})	1.58	2.14	2.24	0.39	0.35	2.87	0.35

,** Significant at 5 and 1 per cent levels, respectively

Table 3 : Contd.….

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Sr. No.	Crosses	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)	Number of Seeds per Fruit
1	JSG-14-03 x GSG-1	0.64	-4.83**	39.72**	-0.43	-0.52	-1.12**	-5.43**
2	JSG-14-03 x Pusa	0.39	-4.69**	-44.78**	-1.31	-0.35	0.75**	-5.09**
3	JSG-14-03 x GJSG-2	-0.88*	2.69**	-29.07**	0.63	-0.11	-0.004	6.12**
4	JSG-14-03 x JSG-13-07	-0.15	6.82**	34.14**	1.10	0.97	0.38*	4.40**
5	JSG-14-05 x GSG-1	-0.65	-2.74**	-24.37**	0.52	-0.25	-0.30	-0.45
6	JSG-14-05 x Pusa	-0.42	0.87	-23.60**	-1.07	-0.17	-0.66**	-3.05**
7	JSG-14-05 x GJSG-2	0.50	1.52*	51.25**	2.36*	0.47	0.54**	-5.83**
8	JSG-14-05 x JSG-13-07	0.57	0.37	-3.28	-1.80	-0.06	0.42**	9.32**
9	JSG-13-04 x GSG-1	3.12**	5.55**	67.15**	2.16	3.06**	0.58**	8.35**
10	JSG-13-04 x Pusa	-1.72**	-4.58**	18.92**	-3.09**	-0.31	0.91**	7.62**
11	JSG-13-04 x GJSG-2	-0.33	1.97**	-39.97**	0.03	-1.22	-0.14	-6.63**
12	JSG-13-04 x JSG-13-07	-1.07*	-2.94**	-46.09**	0.91	-1.53*	-1.36**	-9.35**
13	JSG-14-06 x GSG-1	-1.90**	-5.57**	-27.69**	-2.60*	-0.79	-0.45**	-12.23**
14	JSG-14-06 x Pusa	-0.74	6.01**	71.54**	1.93	1.89**	-0.62**	4.78**
15	JSG-14-06 x GJSG-2	0.59	-2.11**	-15.55**	0.70	-0.03	0.57**	8.45**
16	JSG-14-06 x JSG-13-07	2.05**	1.67*	-28.30**	-0.02	-1.06	0.51**	-0.99
17	ASGS-04-23 x GSG-1	0.34	1.92**	-15.64**	-2.64*	-0.93	1.17**	9.04**
18	ASGS-04-23 x Pusa	-0.37	-1.94**	-24.71**	3.96**	-0.13	0.18	-9.96**

,** Significant at 5 and 1 per cent levels, respectively

Table 3: Contd…

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Sr. No.	Crosses	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)	Number of Seeds per Fruit
19	ASGS-04-23 x GJSG-2	0.02	-1.99**	45.74**	-0.75	0.50	-0.38*	2.92**
20	ASGS-04-23 x JSG-13-	0.02	2.02**	-5.39	-0.57	0.56	-0.97**	-1.99
21	JSG-14-02 x GSG-1	0.09	2.91**	12.88**	-0.45	0.13	-0.54**	8.34**
22	JSG-14-02 x Pusa	-0.16	1.52*	-14.95**	-3.00**	-0.54	-0.37*	3.14**
23	JSG-14-02 x GJSG-2	0.44	1.57*	-6.37	0.58	-0.46	-0.19	-7.11**
24	JSG-14-02 x JSG-13-07	-0.37	-5.99**	8.44*	2.87*	0.87	1.10**	-4.36**
25	ASGS-11-47 x GSG-1	-0.03	1.70*	-50.10**	1.85	-1.29	0.39*	-6.89**
26	ASGS-11-47 x Pusa	2.13**	4.74**	46.50**	3.34**	0.73	0.45**	7.44**
27	ASGS-11-47 x GJSG-2	-0.15	-6.91**	3.28	-2.11	0.17	-0.50**	-3.28**
28	ASGS-11-47 x JSG-13-	-1.95**	0.47	0.32	-3.07**	0.39	-0.34*	2.74*
29	JSG-14-04 x GSG-1	-1.60**	1.07	-1.95	1.59	0.59	0.27	-0.73
30	JSG-14-04 x Pusa	0.89*	-1.92**	-28.92**	-0.75	-1.12	-0.63**	-4.86**
31	JSG-14-04 x GJSG-2	-0.18	3.27**	-9.30*	-1.43	0.68	0.11	5.35**
32	JSG-14-04 x JSG-13-07	0.89*	-2.42**	40.17**	0.59	-0.15	0.26	0.24
	SE(S_{ij})	0.88	1.42	7.53	2.30	1.45	0.33	2.20

,** Significant at 5 and 1 per cent levels, respectively

Table 4: Information on best three parents on the basis of *per se* and gca effects as well as three best crosses on the basis of *per se*, heterobeltiosis, standard heterosis and sca effects for various characters in sponge gourd

Sr. No.	Character	Best parents		Best crosses			
		per se	gca effects	*per se*	Heterobeltiosis	Standard heterosis	sca effects
1	Days to 50 Per Cent Flowering	GJSG-2 JSG-14-06 JSG-13-07	Pusa Chikni	JSG-14-03 × Pusa Chikni JSG-14-02 × Pusa Chikni JSG-14-05 × Pusa Chikni	JSG-13-04×GSG-1 JSG-13-04 × Pusa Chikni ASGS-11-47 × Pusa Chikni	JSG-13-04×GSG-1 JSG-14-06 × Pusa Chikni JSG-14-06 × JSG-13-07	JSG-13-04×GSG-1 JSG-14-05 × GJSG-2 JSG-14-06 × GSG-1
2	Days to Opening of First Female Flower	GJSG-2 JSG-14-05 JSG-14-06	Pusa Chikni	JSG-14-03 × Pusa Chikni JSG-14-02 × Pusa Chikni ASGS-11-47×GSG-1	JSG-13-04×GSG-1	JSG-13-04×GSG-1	JSG-13-04×GSG-1 JSG-14-06 × Pusa Chikni JSG-14-05 × GJSG-2
3	Days to Opening of First Male Flower	GSG-1 JSG-13-04 JSG-13-07	JSG-14-06	JSG-14-06 × GSG-1	ASGS-11-47 × Pusa Chikni ASGS-04-23 × Pusa Chikni	-	JSG-13-04×GSG-1 JSG-14-05 × JSG-13-07 JSG-14-02 × GSG-1
4	Node Number of First Female Flower	JSG-14-06 GSG-1 GJSG-2	JSG-14-03	JSG-13-04 × GJSG-2 JSG-14-05×GSG-1	JSG-14-03 × Pusa Chikni ASGS-04-23 × GJSG-2	ASGS-04-23 × GJSG-2 JSG-14-03 × Pusa Chikni JSG-14-06 × JSG-13-07	JSG-14-03 × Pusa Chikni ASGS-04-23 × GJSG-2 JSG-13-04 × JSG-13-07
5	Node Number of First Male Flower	Pusa Chikni GJSG-2 JSG-14-06	ASGS-04-23	JSG-14-05×GSG-1 ASGS-04-23 × JSG-13-07	-	JSG-14-03 × Pusa Chikni JSG-14-04×GSG-1 JSG-13-04×GSG-1	JSG-14-03 × Pusa Chikni JSG-14-05 × Pusa Chikni JSG-14-06 × JSG-13-07
6	Days to First Picking	GJSG-2 ASGS-11-47 ASGS-04-23	-	JSG-14-02 × Pusa Chikni JSG-14-05×GSG-1	JSG-13-04×GSG-1 JSG-14-06 × Pusa Chikni	JSG-14-06 × Pusa Chikni JSG-13-04×GSG-1	JSG-13-04×GSG-1 JSG-14-06 × Pusa Chikni JSG-14-05 × GJSG-2
7	Length of Main Vine (m)	ASGS-04-23	-	JSG-14-02 × Pusa Chikni JSG-14-05 × JSG-13-07 JSG-14-03×GSG-1	JSG-14-03×GSG-1 JSG-14-02×GSG-1 JSG-14-04 × GJSG-2	-	JSG-14-06 × Pusa Chikni JSG-14-03×GSG-1

Table 4: Contd....

Table 4: Contd...

Sr. No.	Character	Best parents		Best crosses			
		per se	gca effects	*per se*	Heterobeltiosis	Standard heterosis	sca effects
8	Number of Primary Branches per Vine	Pusa Chikni	JSG-14-06	JSG-14-03 × Pusa Chikni JSG-14-04 × Pusa Chikni	JSG-13-04×GSG-1 ASGS-11-47 × Pusa Chikni JSG-14-06 × JSG-13-07	JSG-13-04×GSG-1	JSG-13-04×GSG-1 ASGS-11-47 × Pusa Chikni JSG-14-06 × JSG-13-07
9	Number of Fruits per Vine	ASGS-04-23	JSG-14-04	JSG-14-05 × JSG-13-07 JSG-14-03 × Pusa Chikni JSG-14-02 × Pusa Chikni	JSG-14-03 × JSG-13-07 ASGS-11-47 × Pusa Chikni ASGS-11-47 × JSG-13-07	ASGS-11-47 × Pusa Chikni	JSG-14-03 × JSG-13-07 JSG-14-06 × Pusa Chikni JSG-13-04×GSG-1
10	Fruit Weight (g)	-	ASGS-11-47	JSG-14-05 × JSG-13-07 JSG-14-02 × Pusa Chikni JSG-14-03 × Pusa Chikni	ASGS-11-47 × Pusa Chikni JSG-14-04 × JSG-13-07 JSG-14-06 × Pusa Chikni	ASGS-11-47 × Pusa Chikni JSG-14-06 × Pusa Chikni JSG-13-04×GJSG-1	JSG-14-06 × Pusa Chikni JSG-13-04×GJSG-1 JSG-14-05 × GJSG-2
11	Fruit Length (cm)	ASGS-11-47 JSG-14-05 GJSG-1	JSG-14-06	JSG-14-05 × GJSG-2 JSG-14-02 × Pusa Chikni	ASGS-04-23 × Pusa Chikni JSG-14-06 × Pusa Chikni	ASGS-04-23 × Pusa Chikni JSG-14-06 × Pusa Chikni JSG-13-04×GJSG-1	ASGS-04-23 × Pusa Chikni ASGS-11-47 × Pusa Chikni JSG-14-02 × JSG-13-07
12	Fruit Girth (cm)	JSG-13-04	-	JSG-14-03 × Pusa Chikni JSG-14-02 × Pusa Chikni JSG-14-04 × GJSG-2	JSG-14-02 × JSG-13-07 JSG-14-06 × Pusa Chikni JSG-13-04×GJSG-1	JSG-13-04×GJSG-1	JSG-13-04×GJSG-1 JSG-14-06 × Pusa Chikni
13	Fruit Yield per Vine (kg)	JSG-13-07	JSG-14-03	JSG-14-03 × GJSG-2 JSG-14-05×GJSG-1	JSG-14-03 × Pusa Chikni ASGS-04-23×GJSG-1 JSG-13-04 × Pusa Chikni	-	ASGS-04-23×GJSG-1 JSG-14-02 × JSG-13-07 JSG-13-04 × Pusa Chikni
14	Number of Seeds per Fruit	-	JSG-14-02	JSG-14-06 × GJSG-2 JSG-14-02 × GJSG-2 JSG-14-02 × Pusa Chikni	JSG-14-02 × Pusa Chikni JSG-14-02×GJSG-1 ASGS-11-47 × Pusa Chikni	JSG-14-02×GJSG-1 JSG-14-02 × Pusa Chikni JSG-14-06 × Pusa Chikni	JSG-14-05 × JSG-13-07 ASGS-04-23×GJSG-1 JSG-14-06 × GJSG-2

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