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Combining ability studies in ridge gourd (*Luffa acutangula* L.)

RV Bhalerao, DP Waskar and SB Borgaonkar

Abstract
The present investigation entitled "Heterosis and combining ability studies for yield and yield contributing traits in ridge gourd (*Luffa acutangula* L.)" was undertaken to study combining ability for yield and yield components in ridge gourd. The experiment was conducted at Horticulture Research Scheme (Vegetable), Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.). The parents as well as hybrids were evaluated during Summer 2019 and 2020. An overall appraisal of GCA effects of the lines indicated that, in general, none of the line was found good general combiner for all the traits studied. However, the parent Kokan Harita was found good general combiner for majority of characters. Among testers, Arka Sumeet was found good general combiner for fruit weight. Out of 40 hybrids, the highest magnitude of positive SCA effects for fruit yield per vine was exhibited by cross JRGL-13 x Jaipur Long, IC 622917 x Utkal Tripti and IC 622920 x Arka Sumeet. These crosses also revealed good SCA effects for one or more traits.

Keywords: Combining ability, GCA effects, SCA effects

Introduction
Cucurbitaceous crop grown extensively throughout the tropical and subtropical region of India as well as world. Ridge gourd [*Luffa acutangula* L.] is one of the important tropical cucurbitaceous vegetables. It's tender fruits are popular and well known for culinary vegetable, preparations of chutneys and curries in India. The vegetable is easily digestible and prevent constipation with good nutritive value. However, concerted efforts towards its improvement and developing new varieties are lacking and only a few varieties have been developed. Thus, it necessitates, development of high yielding, better quality varieties through efficient breeding programmes. The hybrids were early and give higher yields in ridge gourd which helps to bridge the gap between the availability and requirement therefore the crops is selected for experimentation. Hence, the present investigation was undertaken to determine the general combining ability effects of parents and specific combining ability effects of crosses. India is considered as the centre of origin of *Luffa* species (Choudhury, 1996) and exhibits considerable amount of genetic diversity with respect to different characters. Ridge gourd, being predominantly monoecious cross pollinated crop and having large number of seeds from single pollination which, provides ample scope for utilization of hybrid vigour. Distinct variability in fruit characters like size, shape, fruit surface, fruit colour, number of seeds per fruit, earliness, fruit weight. The crop is monoecious in nature, which is easy for pollination and provides a great opportunity for developing desirable hybridization. Selection of suitable parents for hybridization plays an important role in heterosis breeding programme. Thus, the GCA helps in selection of superior parents and SCA for superior hybrid to identifying the best hybrid, which can be utilized for future hybridization programme. LxT design is frequently used in plant breeding to obtain information on genetic effects for fixed set of parental lines or to estimate general combing ability and specific combining ability, which play an important role for exploitation of fruit yield.

Materials and Method
The present investigation entitled **"**Heterosis and combining ability studies for yield and yield contributing traits in ridge gourd (*Luffa acutangula* L.)" was undertaken at Horticulture Research Scheme (Vegetable), Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.). The crossing programme undertaken in *Kharif* 2018, While the parents as well as hybrids were evaluated during *summer* seasons of 2019 and 2020.

The crosses were attempted by using L x T mating design (Kempthrone, 1957) [5] with 8 lines and 5 testers to produce 40 hybrids. The experiment constituted of 54 treatments which includes consisting of 40 hybrids, 13 parents and one standard check (ArkaVikram), respectively. Sum total of 54 treatments were tested in two replications using Randomized Block Design comprising of single row of 4.5 m length having 1.5m x1.0 m crop geometry during *summer* 2019 and 2020.The experimental material was planted using randomized Block Design with two replications. Three to four seeds were sown on the side of the channel in a well prepared hill, with a spacing of 2.5 m between channels and 0.75 m between hills. Each treatment comprised of twelve hills and two plants were allowed to grow per hill and finally one plant was kept for final observation. All the recommended agronomic practices along with plant protection measures were followed to raise a successful crop. Ten plants were randomly selected in each treatment in all the three replications and observations were recorded on fifteen important quantitative characters including yield per plant. Observations were recorded for yield and yield contributing traits *viz*; vine length (cm), number of branches per vine, internodal length (cm), number of leaves, days to anthesis of first female flower, days to anthesis of first male flower, node at which first female flower opening, days to first harvest, days to last harvest, fruit length (cm), fruit girth (cm), fruit weight (g), number of fruits per vine and total fruit yield per vine (kg). Heterosis of individual cross was calculated over mid parent, better parent and check variety.

Results

Analysis of variance revealed that the variances due to genotypes were highly significant for all the characters except days to last harvest. It indicates that the lines selected were quite variable for most of the traits under study. The mean square due to crosses were significant for all traits except days to last fruit harvest.

General Combining Ability

The general combining ability effects gives an idea about the breeding behaviour of the parental lines and helps in screening of the lines for varietal improvement programme. The utility of this technique in ridge gourd has been widely demonstrated by several workers. The estimates of *gca* effects of each parents are presented in Table 2.

Vine length (cm)

Three parents had recorded positive significant general combining ability effects for vine length. The highly significant and positive general combining ability effects were exhibited by the Kokan Harita (49.37) followed by IC 622915 (28.01) and Arka Sumeet (13.99). These parents were found good general combiners for vine length. Their hybrids were also found in high yielding hybrids. The results are in agreement with the results of Sarkar *et al.* (2015), Sarkar *et al.* (2017) [11, 12] and Narasannavar *et al.* (2018) [9].

Number of branches

Only one parent Kokan Harita had recorded significant positive general combining ability effects (1.14) for number of branches. Kokan Harita was found good general combiner for number of braches which indicates involvement of additive gene effect for the expression of this trait. These results are akin with the results of Sarkar *et al.* (2017) [12] Nandhini *et al.* (2018) [8] Narasannavar *et al.* (2018) [9].

Internodal length (cm)

Two parents exhibited significant negative general combining ability effects for internodal length. Among the parents Pusa Nasdar (-143.33) had highest negative significant general combining ability effects for vine length followed by Jaipur long (-124.46). The parents Arka Sumeet and Swarna Manjari were found good general combiner for intermodal length.

Days to 50% flowering

None of the parents exhibited significant negative general combining ability effects for the trait of days to 50 per cent flowering. Similar results were observed for days to 50 per cent flowering in ridge gourd by Prabhakar (2008) [10].

Days to first fruit harvest

Two parents had recorded significantly negative general combining ability effects for the days required to bear first fruit. The parents with highest negatively significant general combining ability effects were IC 622917 (-2.07) followed by Kokan Harita (-1.65) and is comparable with earlier findings by Sarkar *et al.* (2017) [12], Nandhini *et al.* (2018) [8] and Narasannavar *et al.* (2018) [9].

Fruit length (cm)

The fruit length is important quantitative trait that contributes directly towards yield. Five parents exhibited significant positive general combining ability effects for the trait fruit length. The parent JRGL-13 (3.39) had highest positive significant general combining ability effects for the trait fruit length followed by IC 622916 (2.50) and Kokan Harita (2.35). These results were in confirmation with results of Koppad *et al.* (2015) [6], Sarkar *et al.* (2017) [12] and Nandhini (2018) [8].

Fruit girth (cm)

Five parents displayed significant positive general combining ability effects for the trait fruit girth. Among the parents IC 622917 (0.41) had highest positive significant general combining ability effects for the trait fruit girth followed by Kokan Harita (0.39) and Pusa Nasdar (0.28). The results are in agreement with the results of Bairwa *et al.* (2015) [2], Koppad *et al.* (2015) [6] and Nandhini (2018) [8].

Fruit weight (g)

Three parents exhibited significant positive general combining ability effects for fruit weight. The parent Kokan Harita (13.99) had highest positive significant general combining ability effects for fruit weight followed by IC 622917 (9.01) and Arka Sumeet (6.23). These findings were in consonance with Koppad *et al.* (2015) [6] Sarkar *et al.* (2017) [12] Nandhini (2018) [8].

Number of fruits per vine

Only one parent IC 622917 (0.81) exhibited significant positive general combining ability effects for the trait number of fruits per vine. These results are akin with the results of Koppad *et al.* (2015) [6], Sarkar *et al.* (2017) [12] and Nandhini (2018) [8].

Total fruit weight per vine (g)

Four parents exhibited significant positive general combining

ability effects for the trait total fruit weight per vine. While the parent IC 622917 (135.55) had highest positive significant general combining ability effects for the trait total fruit weight per vine followed by Kokan Harita (135.16) and Arka Sumeet (130.61). The results are in agreement with the results Sarkar *et al.* (2017) [12], Nandhini (2018) [8] and Narasannavar *et al.* (2018) [9].

Specific combining ability

In crop improvement programme specific combining ability is vital to pinpoint specific cross combination for commercial exploiation or varietal development. the specific combining ability effects of this investigation are presented below. The results of specific combining effects of crosses are illustrated in Table 3.

Table 1: Analysis of variance of Line x Tester for various characters in ridge gourd (2019 and 2020) at VNMKV, Parbhani

Source of variation		Replication	Treatment	Parents	Line	Tester	Parents (L vs T)	Parent vs crosses	Crosses	Error
D.F.		1	52	12	7	4	1	1	39	52
Mean sum of squares	Vine length (cm)	E_1	5359.51	5948.89**	3843.1	737.91	7310.73*	11708.95*	21161.60**	6277.71**
		E_2	4775.21	5606.28**	3861.53	1057.81	6598.63*	12539.20*	22469.50**	5956.82**
	Number of branches per vine	E_1	0.98	2.79**	2.16**	1.42**	3.72**	1.17	0.11	3.18**
		E_2	0.95	2.87**	2.24**	1.23*	4.14**	1.75	0.02	3.29**
	Internodal length	E_1	2.06	5.86**	5.50**	3.72**	8.62**	5.50*	10.13**	5.91**
		E_2	3.24	5.98**	5.50**	3.31*	9.54**	4.71	8.22*	6.41**
	50% flowering	E_1	14.06	13.72**	10.09	11.77	4.42	20.94	3.21	18.09**
		E_2	17.33	17.18**	17.03*	15.44	19.26	19.23	18.93	20.60**
	Node at first female flower	E_1	5.47	11.00**	9.52**	8.90**	5.39	30.37**	23.02**	11.85**
		E_2	4.51	19.60**	23.25**	26.65**	10.31**	51.27**	44.24**	16.31**
	Days to first fruit harvest	E_1	17.9	24.15**	38.96**	43.14**	39.35**	8.21	0.11	23.48**
		E_2	14.72	19.61**	11.18	10.54	8.25	27.40*	8.39	23.86**
	Fruit length (cm)	E_1	8.48	89.31**	32.50**	26.75**	43.91**	27.08*	203.92**	114.18**
		E_2	7.68	93.54**	51.35**	67.43**	32.63**	13.71	323.67**	113.33**
	Fruit girth (cm)	E_1	0.12	1.05**	0.61**	0.46**	0.88**	0.52**	5.58**	0.84**
		E_2	0.17	1.38**	0.90**	0.68**	1.46**	0.14	10.57**	1.08**
	Fruit weight (g)	E_1	181.72	511.78**	167.50*	115.38	114.77	743.26**	7466.81**	451.13**
		E_2	258.07	702.91**	303.55*	124.21	56.49	2547.19**	9045.27**	608.59**
	Number of fruits per vine	E_1	2.07	1.08	1.23	1.27	1.06	1.68	0.35	1.29
		E_2	2.73	2.44*	1.05	0.35	2.18	1.43	0.1	3.26**
	Total fruit yield per vine (g)	E_1	26671.32	108162.46**	16282.21	11036.07	28875.87	2630.5	1824852.68**	89235.12**
		E_2	40416.71	119954.43**	21760	36065.53	15695.87	6986.79	1788038.66**	103476.75**

* Significant @ 5% level ** significant @ 1% level

Table 2: Estimates of the general combining ability (GCA) effects of parents for various characters in ridge gourd at VNMKV, Parbhani

Source of variation	Vine length (cm)	Number of branches per vine	Internodal length	50% flowering	Days to first fruit harvest	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per vine	Total fruit yield per vine (g)
Line										
Kokan Harita	49.37***	1.14 ***	-0.90***	-0.31	-1.58***	2.31 ***	0.38 ***	12.61***	0.39	123.79***
Padmini	-9.41	-0.51***	0.46	-0.09	-0.16	-2.12***	-0.24 ***	-8.07**	-0.41	-142.47***
JRGL-13	14.47	-0.32 *	-0.24	-0.01	0.52	3.94 ***	0.21 ***	-2.87	-0.13	-14.51
IC 622915	28.01*	0.29	-0.72 **	-1.03	-0.40	-2.21***	-0.023	6.11*	0.23	125.47***
IC 622916	-27.11*	-0.48 **	-0.16	0.90	0.76 **	2.56 ***	-0.67***	-8.91***	-0.53*	-117.59***
IC 622917	-2.87	0.06	0.60 *	-0.19	-0.64 *	-2.06***	0.21 ***	8.39***	0.51*	134.75***
IC 622920	-25.23*	-0.01	0.18	-0.31	0.26	0.75	0.23 ***	-7.91**	0.05	-42.37
IC 622921	-27.23*	-0.19	0.78**	1.02	1.26***	-3.17***	-0.08	0.65	-0.09	-67.26
S.E	10.91	0.15	0.25	0.61	0.25	0.43	0.05	2.40	0.24	29.76
C.D.95%	21.71	0.29	0.49	1.21	0.54	0.86	0.10	4.78	0.48	59.24
C.D.99%	28.80	0.39	0.66	1.60	0.71	1.14	0.14	6.34	0.64	78.57
Gi-Gj	15.42	0.21	0.35	0.86	0.38	0.61	0.07	3.40	0.34	42.08
Tester										
Arka Sumeet	10.39	0.35 **	-0.99***	-0.24	0.28	0.07	0.21 ***	5.38**	0.21	120.15***
Pusa Nasdar	7.04	-0.03	-0.06	-0.52	-.75***	1.66***	0.15 ***	0.64	0.19	-19.82
Utkal Tripti	-8.95	-0.08	-0.02	0.18	0.13	0.50	0.24 ***	-0.8	-0.15	-34.84
Swarna Manjari	-6.01	-0.59***	1.06 ***	0.88	1.025***	-3.29 ***	-0.64***	-4.051*	-0.18	-44.43
Jaipur Long	-2.48	0.35 **	0.012	-0.31	-0.68**	1.07**	0.03	-1.16	-0.07	-21.07
S.E	8.62	0.12	0.20	0.48	0.20	0.34	0.04	1.90	0.19	23.53
C.D.95%	17.17	0.23	0.39	0.96	0.43	0.68	0.08	3.78	0.38	46.84
C.D.99%	22.77	0.31	0.52	1.27	0.56	0.90	0.11	5.01	0.50	62.12
Gi-Gj	12.19	0.16	0.28	0.68	0.30	0.48	0.06	2.68	0.27	33.27

* Significant @ 5% level ** significant @ 1% level

Table 3: Estimates of SCA effects of hybrids for various characters in two seasons and pooled in ridge gourd at VNMKV, Parbhani

Source of variation	Vine length (cm)	Number of branches per vine	Internodal length	50% flowering	Days to first fruit harvest	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per vine	Total fruit yield per vine (g)
Kokan Harita x Arka Sumeet	-15.43	0.29	-0.61	-2.96*	-3.47*	5.58**	0.16	0.37	0.98	128.37
Kokan Harita x Pusa Nasdar	51.62*	0.568	-2.24**	0.72	-0.73	4.47**	0.32**	9.10	1.19*	300.14**
Kokan Harita x Utkal Tripti	-79.30**	-1.692 ***	2.02***	-1.58	-1.23	-8.07**	0.24*	-24.06**	-0.38	-171.14*
Kokan Harita x Swarna Manjari	-4.33	-0.677 *	1.54**	0.92	0.25	-4.24**	0.08	-3.61	0.16	-81.95
Kokan Harita x Jaipur Long	47.44	1.510 ***	-0.73	2.91*	5.17**	2.26*	-0.80**	18.20**	-1.95**	-175.41*
Padmini x Arka Sumeet	42.35	-0.167	-1.97***	-0.18	-0.11	-0.56	-0.024	19.85**	-0.73	10.23
Padmini x Pusa Nasdar	34.30	0.311	0.90	0.20	0.73	3.31**	0.71**	-5.72	0.19	54.90
Padmini x Utkal Tripti	-13.42	-0.144	-0.04	-0.40	-0.57	7.26**	-0.31**	-3.28	-0.08	-85.28
Padmini x Swarna Manjari	-4.05	1.071 **	-0.73	1.50	0.71	-4.25**	-0.2	-3.63	0.16	4.11
Padmini x Jaipur Long	-59.18*	-1.072 **	1.83**	-1.12	-0.77	-5.76**	-0.17	-7.22	0.45	16.05
JRGL-13 xArka Sumeet	-85.03**	-1.457 ***	2.93**	1.54	1.46	-9.07**	-0.77**	-17.46**	-0.60	-227.83**
JRGL-13 Pusa Nasdar	-24.883	-0.229	1.00	1.42	1.49	-0.95	-1.26**	-15.72**	-1.09*	-288.57**
JRGL-13 x Utkal Tripti	-3.395	-0.734 *	-0.93	2.12	2.29	0.90	0.37**	12.82 *	-0.26	-33.14
JRGL-13 x Swarna Manjari	50.87*	0.281	-0.22	-0.68	-0.03	4.19**	1.07**	-2.03	-0.22	-13.45
JRGL-13 x Jaipur Long	62.44*	2.138 ***	-2.77**	-4.40**	-5.21**	4.94**	0.59**	22.38**	2.17**	562.99**
IC 622915 x Arka Sumeet	31.03	1.333 ***	-1.20*	-3.54*	-3.39*	6.18**	0.60**	2.87	1.14*	172.094*
IC 622915 x Pusa Nasdar	77.98**	1.611 ***	-1.62**	-1.46	-2.05	9.60**	0.74**	23.20**	0.95	261.55**
IC 622915 x Utkal Tripti	-80.64**	-0.644	2.05**	1.84	1.75	-10.25**	-1.04**	-16.36 **	-0.52	-152.92*
IC 622915 x Swana Manjari	-13.07	-0.129	-1.14*	0.34	0.33	-7.56**	-0.52**	3.99	-0.88	-73.63
IC 622915 x Jaipur Long	-15.30	-2.172 ***	1.91**	2.83*	3.35*	2.04*	0.23*	-13.70*	-0.69	-207.10**
IC 622916 x Arka Sumeet	16.75	-0.015	-0.43	-0.36	-0.33	5.00**	-0.24*	-7.31	-0.21	-5.15
IC 622916 x Pusa Nasdar	-51.40*	-0.657	0.52	0.12	0.11	-10.58**	-0.52**	-6.28	-0.79	-165.39*
IC 622916 x Utkal Tripti	5.29	1.928 ***	1.69**	2.42	3.41*	-4.09**	0.21	18.46**	-0.36	79.94
IC 622916 x Swana Manjari	-1.75	-0.157	-0.60	-1.18	-1.31	8.86**	0.29*	4.01	1.28*	179.33**
IC 622916 x Jaipur Long	31.12	-1.100 **	-1.16*	-0.10	-1.89	0.81	0.26*	-8.88	0.07	-88.73
IC 622917 x ArkaSumeet	-49.69*	-0.135	2.99**	6.12**	6.86**	-6.17**	-0.36**	-4.42	-0.95	-217.09**
IC 622917 x Pusa Nasdar	-60.74*	-1.217 ***	-0.04	-2.10	-1.81	-10.66**	0.30**	-25.88**	-0.23	-177.12**
IC 622917 x Utkal Tripti	145.95 **	2.288 ***	-3.48**	-5.30**	-4.91**	11.70 **	0.41**	24.06**	1.90**	398.00**
IC 622917 x Swarna Manjari	18.11	-0.197	-0.16	0.10	-0.13	-1.51	-0.65**	4.81	-0.86	-47.91
IC 622917 x Jaipur Long	-53.62*	-0.740 *	0.69	1.19	-0.01	6.64**	0.30*	1.42	0.13	44.12
IC 622920 x Arka Sumeet	39.77	1.437 ***	-1.69**	-4.66**	-4.69**	6.31**	0.37**	24.39**	0.92	309.93**
IC 622920 x Pusa Nasdar	-22.88	-0.485	1.38*	2.12	3.15*	-1.44	-0.36**	5.92	0.12	89.70
IC 622920 x Utkal Tripti	23.41	-0.44	-0.75	2.52	2.85*	5.09**	0.30*	-2.74	-0.43	-115.08
IC 622920 x Swarna Manjari	-26.23	-0.445	0.46	0.12	-0.17	-0.58	-0.26*	-14.29**	-0.10	-75.80
IC 622920 x Jaipur Long	-14.06	-0.068	0.61	-0.10	-1.15	-9.38**	-0.05	-13.28*	-0.51	-208.75**
IC 622921 x Arka Sumeet	20.27	-1.288 ***	0.01	4.02**	3.66**	-7.26**	0.28*	-18.28**	-0.55	-170.57*
IC 622921 x Pusa Nasdar	-3.98	0.095	0.08	-1.00	-0.91	6.26**	0.06	15.36**	-0.33	-75.21
IC 622921 x Utkal tripti	2.11	-0.565	-0.56	-1.60	-3.61**	-2.55*	-0.16	-8.9	0.11	79.62
IC 622921 x Swana Manjari	-19.53	0.25	0.86	-1.10	0.37	5.10**	0.18	10.75*	0.44	109.31
IC 622921 x Jaipur Long	1.14	1.507 ***	-0.39	-0.32	0.49	-1.54	-0.37**	1.06	0.33	56.85
SE	24.39	0.33	0.56	1.36	1.35	0.97	0.11	5.37	0.54	66.54
C.D.95%	48.55	0.66	1.10	2.71	2.68	1.93	0.23	10.69	1.08	132.48
C.D.99%	64.39	0.87	1.47	3.59	3.56	2.55	0.30	14.18	1.43	175.69
Sij-Skl	34.49	0.47	0.78	1.92	1.90	1.37	0.16	7.59	0.76	94.10
Sij-Sik	29.87	0.40	0.68	1.66	1.65	1.18	0.14	6.58	0.66	81.50

Vine length (cm)

Out of 40 F_1 hybrids five hybrids recorded positive specific combining ability effects. The highly significant and positive specific combining ability effect were recorded by hybrid IC 622917 x Utkal Tripti followed by IC 622915 x Pusa Nasdar and JRGL-13 x Jaipur Long. There was no definite trend of gca of the parental lines for involvement in the cross combinations. The combinations of low x low and low x high general combiners gave significant sca effects indicating thereby the involvement of non-allelic interactions. The results are in agreement with the results of Chandan *et al.*(2019) [3] Varalakshmi *et al.*(2019) [13] and Malve *et al.*(2020) [7].

Number of branches

Nine hybrids recorded significant positive specific combining ability effects. The highest positive and significant specific combining ability effect was exhibited by hybrid IC 622917 x Utkal Tripti followed by JRGL-13 x Jaipur Long and IC 622916 x Utkal Tripti. The combinations of low x low and low x high general combiners gave significant sca effects indicating thereby the involvement of non-allelic interactions. Selection is not effective in these cross combinations. These findings were in consonance with Narasannavar *et al.* (2018 a) [9], Acharya (2019) [1] and Varalakshmi *et al.*(2019) [13].

Internodal length (cm)

In case of pooled analysis, nine hybrids recorded negative significant specific combining ability effects. The highest negative significant specific combining ability effect was recorded by hybrid IC 622917 x Utkal Tripti followed by JRGL-13 x Jaipur Long and Kokan Harita x Pusa Nasdar. The

combinations of low x low and high x low general combiners gave significant sca effects indicating thereby the involvement of non additive gene actions. Similar results were reported by Deepa Devi *et al.* (2016) [4].

Days to 50% flowering

In case of pooled data, five hybrids recorded negative significant specific combining ability effects. The highest negative significant specific combining ability effect was exhibited by hybrid IC 622917 x Utkal Tripti followed by IC 622920 x Arka Sumeet and JRGL-13 x Jaipur Long. The combinations of low x low general combiners gave significant sca effects. Low gca effect of parents contribute for the significant sca effects. It indicate involvement of dominant gene effect for the expression of this trait. It is comparable with earlier findings by Chandan *et al.*(2019) [3] and Malve *et al.*(2020) [7].

Days to first fruit harvest

In case of pooled data, six hybrids recorded highly significant and negative specific combining ability effects. The highest negative significant specific combining ability effects was exhibited by hybrid JRGL-13 x Jaipur Long followed by IC 622917 x Utkal Tripti and IC 622920 x Arka Sumeet. The combinations of low x low and low x high general combiners gave significant sca effects. Negative sca effects are desirable for the trait days to first fruit harvest. It indicated that the non additive gene action was involved. The results are in agreement with the results of Nandhini *et al.*(2018) [8], Narasannavar *et al.*(2018 a) [9], Chandan *et al.*(2019) [3] and Malve *et al.*(2020) [7].

Fruit length (cm)

In case of pooled data, eighteen hybrids recorded positive significant specific combining ability effects. The highest positive significant specific combining ability effect was exhibited by hybrid IC 622917 x Utkal Tripti followed by IC 622915 x Pusa Nasdar, IC 622916 x Swarna Manjari and Padmini x Utkal Tripti. The combinations of low x low, high x low, low x high and high x high general combiners displayed significant sca effects. All types of combinations of parental gca effects given significant sca effects. These results are akin with the results of Acharya (2019) [1], Chandan *et al.*(2019) [3], Varalakshmi *et al.*(2019) [13] and Malve *et al.*(2020) [7].

Fruit girth (cm)

In case of pooled data, seventeen hybrids recorded positive significant specific combining ability effects. The highest positive significant specific combining ability effect was exhibited by hybrid JRGL-13 x Swarna Manjari followed by IC 622915 x Pusa Nasdar and Padmini x Pusa Nasdar. The combinations of low x low, high x low and high x high general combiners gave significant sca effects indicating thereby the involvement of non-allelic interactions. Similar results were reported by Chandan *et al.*(2019) [3], Varalakshmi *et al.*(2019) [13] and Malve *et al.*(2020) [7] in ridge gourd.

Fruit weight (g)

In case of pooled data, ten hybrids recorded highly significant and positive specific combining ability effect effects. The highest positive significant specific combining ability effect was exhibited by hybrid IC 622920 x Arka Sumeet followed by IC 622917 x Utkal Tripti, IC 622915 x Pusa Nasdar and JRGL-13 x Jaipur Long. The combinations of high x low, low x high, low x low and low x high general combiners gave significant sca effects displayed that the non additive gene action is involved. It indicated that crosses could be useful in exploitation of heterosis. These results were in confirmation with Acharya (2019) [1], Chandan *et al.*(2019) [3], Varalakshmi *et al.*(2019) [13] and Malve *et al.*(2020) [7].

Number of fruits per vine

In case of pooled data, five hybrids recorded positive significant specific combining ability effects. The highest positive significant specific combining ability effect was exhibited by hybrid JRGL-13 x Jaipur Long followed by IC 622917 x Utkal Tripti and IC 622916 x Swarna Manjari. The combinations of low x low and low x high general combiners gave significant sca effects indicating thereby the involvement of non-allelic interactions. Positive sca effect is desirable for the trait number of fruits per vine. This non allelic interaction could be exploited through hybridization for better yield. These findings were in consonance with Acharya (2019) [1], Chandan *et al.*(2019) [3], Varalakshmi *et al.*(2019) [13] and Malve *et al.*(2020) [7].

Total fruit yield per vine (g)

In case of pooled data, seven hybrids recorded positive significant specific combining ability effects. The highest positive significant specific combining ability effect was exhibited by hybrid JRGL-13 x Jaipur Long followed by IC 622917 x Utkal Tripti, IC 622920 x Arka Sumeet and Kokan Harita x Pusa Nasdar. The combinations of low x low, low x high, high x low and high x high general combiners gave significant sca effects indicating thereby the involvement of non-allelic interactions. All types of gca combinations showed significant sca effect indicates involvement of non-additive gene action for this trait. The yield could be increased through heterosis breeding as well as selection could be effective for transgressive segregants from segregating population. Similar results were observed for total fruit yield per vine in ridge gourd by Acharya (2019) [1], Varalakshmi *et al.*(2019) [13] and Malve *et al.*(2020) [7].

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