The Pharma Innovation Journal 2022; 11(3): 987-992

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(3): 987-992

www.thepharmajournal.com
Received: 16-12-2021
Accepted: 05-02-2022

RV Bhalerao
Department of Horticulture, College of Agriculture Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

DP Waskar
Department of Horticulture, College of Agriculture Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

VS Khandare
Department of Horticulture, College of Agriculture Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Corresponding Author:
RV Bhalerao
Department of Horticulture, College of Agriculture Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Heterosis studies for yield and yield contributing traits in ridge gourd (*Luffa acutangula* L.)

RV Bhalerao, DP Waskar and VS Khandare

Abstract
The present investigation entitled **"**Heterosis and combining ability studies for yield and yield contributing traits in ridge gourd (*Luffa acutangula* L.)" at Horticulture Research Scheme (Vegetable), Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.). The hybrids which exhibited highly significant and positive heterosis for fruit yield per vine over locations were IC 622920 x Jaipur Long, IC 622916 x Pusa Nasdar, Kokan Harita x Swarna Manjari, Padmini X Swarna Manjari, Kokan Harita X Arka Sumeet. The crosses IC 622916 x Pusa Nasdar, IC 622920 x Jaipur Long and JRGL 13 x Pusa Nasdar for number of fruits length. The crosses IC 622916 x Pusa Nasdar, JRGL-13 x Pusa Nasdar and Pdmini x Swarna Manjiri displayed highly significant and positive standard heterosis for vine length.

Keywords: Heterosis, heterobeltiosis, standard heterosis

Introduction
Ridge gourd [*Luffa acutangula* L.] is one of the important tropical cucurbitaceous vegetables. It is native of India (Whitaker, 1979) and is commonly grown throughout South East Asia and India. It is grown on large scale in the states like Andhra Pradesh, Tamil Nadu, Karnataka, Gujarat, Konkan region of Maharashtra, Assam, West Bengal etc. India is the second largest producer of vegetables in the world with an annual production estimated around 184.40 million tonnes from 10.26 million ha. (*Annon*., 2018) [1]. Most cucurbitaceous vegetables are typically grown for local consumption in relatively small areas, and thus there is a lack of statistical data on the area and production. The cucurbitaceae is one of the most important, genetically diverse and biggest family in vegetable crops. It consists of 117 genera and 825 species. Among them, *Luffa* is an essentially old world genus, originated in subtropical Asian region particularly India (Kalloo, 1993) [4]. It consists of two cultivated species *viz.*, ridge gourd *[Luffa acutangula* (Roxb.) L.] and sponge gourd *[Luffa cylindrica* (Roem.) L.]. The juice of the boiled fruit is good in adrenal type of diabetes, Jaundice and solves constipation related stomach disorders since it is rich in fiber. The fibre from fully ripen and dried fruits is used as an abrasive for scouring the motor cars, glasswares and kitchen utensils. The fibres are also used chiefly for filters of various sorts, slipper soles, bathroom mats, table mats, pot holders etc. (Whitaker and Davis, 1962). Distinct variability in fruit characters like size, shape, fruit surface, fruit colour, number of seeds per fruit, earliness, fruit weight and monoecious nature is found, that provides easy access of pollination and provides a great opportunity for developing desirable hybrids in ridge gourd through selection and hybridization. After the discovery of phenomenon of heterosis by Shull (1914) [9]. heterosis breeding has been one of the important tools of crop improvement for the plant breeders.

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 was 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 inbred 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 Arka Vikram, respectively. The 54 treatments were tested in two replications using Randomized Block Design, single row of 4.5 m length having 1.5m x1.0 m crop geometry during *summer* 2019.

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. Observations were recorded for fifteen 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 in both the years for all the characters. It indicates that the lines selected were quite variable for most of the traits under study. The mean square due to crosses were significant in both years. The data is presented in table 1.

1. Vine length (cm)

The mid parent heterosis for the vine length varied from -16.26 (Kokan Harita X Utkal Tripti) to 34.65 (IC 622916 X Pusa Nasadar). Seventeen hybrids exhibited significant and positive heterosis for the vine length. Among these, the hybrid IC 622916 X Pusa Nasdar (57.55%) had highest positively significant heterosis followed by IC 622916 X Jaipur Long (33.86%) and Padmini x Swarna Manjari (33.31%). The better parent heterosis varied from -12.9 (JRGL-13 X Utkal Tripti) to 57.5 (IC 622916 X Pusa Nasadar). The eight hybrids exhibited significant positive heterobeltiosis. Among these, the hybrid IC 622916 X Pusa Nasdar (34.65%) had highest significant and positive heterosis followed by Padmini x Swarna Manjari (28.28%) and JRGL-13 x Pusa Nasdar (27.95%). The standard heterosis varied from -16.26 per cent (JRGL-13 X Utkal Tripti) to 43.58 per cent (IC 622916 X Pusa Nasadar). The ten hybrids exhibited significant positive heterosis. Among these, highest positive standard heterosis exhibited by the hybrid IC 622916 X Pusa Nasdar (43.58%) followed by JRGL-13 x Pusa Nasdar (38.18%) and Padmini x Swarna Manjari (36.89%). The results are in agreement with the results of Chittora *et al.* (2018) [3]. Nandhini *et al.* (2018) [6] Narasannavar *et al.* (2018) [7] and Varalakshmi *et al.* (2019) in ridge gourd.

2. Number of branches

The mid parent heterosis for the trait number of branches varied from -38.38 per cent (Kokan Harita X Utkal Tripti) to 80.46 per cent (Padmini x Swarna Manjari). Ten hybrids exhibited significant positive heterosis. Among these, the hybrid Padmini x Swarna Manjari (80.46%) had highest significant and positive heterosis followed by IC 622920 x Utkal Tripti (67.65%) and JRGL-13 x Pusa Nasdar (55.07%). The better parent heterosis varied from-50.98 per cent (Kokan Harita X Utkal Tripti) to 75.66 per cent (Padmini x Swarna Manjari). Five hybrids exhibited significant positive heterobeltiosis for the vine length. Among these, the hybrid Padmini x Swarna Manjari (75.66%) had highest positively significant heterobeltiosis followed by IC 622920 x Utkal Tripti (39.12%) and JRGL-13 x Pusa Nasdar (30.52%). The standard heterosis varied from -40.35 per cent (IC 622921 X Arka Sumeet) to 39.12 per cent (IC 622920 X Utkal Tripti). Ten hybrids exhibited significant and positive standard heterosis. Among these, the hybrid IC 622920 x Utkal Tripti (39.12%) had highest significant and positive standard heterosis followed by IC 622916 X Pusa Nasdar (26.32%) and IC 622920 x Jaipur Long (24.56%). Narasannavar *et al.* (2018) [7] and Varalakshmi *et al.* (2019) [7] in ridge gourd also found similar results.

3. Internodal length (cm)

The mid parent heterosis for the trait internodal length varied from -31.91(IC 622916 X Pusa Nasadar) to 21.10 per cent (Kokan Harita X Utkal Tripti). The minimum internodal length is desirable. Sixteen hybrids exhibited significant negative heterosis for the internodal length. Among these, the hybrid IC 622916 X Pusa Nasdar (-31.91%) had lowest significant and negative heterosis followed by Padmini x Swarna Manjari (-26.21%) and JRGL-13 x Pusa Nasdar (-22.27%). The better parent heterosis for the trait internodal length varied from -35.09 per cent (IC 622916 X Pusa Nasadar) to 15.17 per cent (Kokan Harita X Utkal Tripti). Five hybrids exhibited significant negative heterosis for the internodal length. Among these, the hybrid IC 622916 X Pusa Nasdar (-35.09%) had highest significant negative heterosis followed by Padmini x Swarna Manjari (-34.32%) and JRGL-13 x Pusa Nasdar (-29.47%). The standard heterosis for the trait internodal length varied from -21.71 per cent (Padmini x Swarna Manjari) to 21.04 per cent (IC 622920 X Pusa Nasdar). Eight hybrids exhibited significant and negative heterosis for the internodal length. Among these, the hybrid Padmini x Swarna Manjari (-21.71%) had lowest negative heterosis followed by IC 622920 x Jaipur Long (-20.29%) and Kokan Harita x Swarna Manjari (-19.57%). These results were in confirmation with Chittora *et al.* (2018) [3]. and Nandhini *et al.* (2018) [6] in ridge gourd.

4. Day to 50% flowering

The mid parent heterosis for the trait days to 50% flowering varied from -18.63 (IC 622920 X Jaipur Long) to 18.80 per nt (Padmini x Arka Sumeet). Sixteen hybrids exhibited significant negative heterosis for the trait 50% flowering. Among these, the hybrid IC 622920 x Jaipur Long (-18.63%) had lowest negative heterosis followed by IC 622916 X Pusa Nasdar (-12.48%) and Kokan Harita x Swarna Manjari (-9.69%). The better parent heterosis for the trait days to 50% flowering varied from-21.51 per cent (IC 622920 X Jaipur Long) to 14.78 per cent (Padmini x Utkal tripti). The five hybrids exhibited significant negative heterosis for the 50% flowering. Among these, the hybrid IC 622920 x Jaipur Long (-21.51%) had highest negative heterosis followed by IC 622916 X Pusa Nasdar (-14.88%) and Kokan Harita x Swarna Manjari (-13.35%). None of the hybrids was found to have negatively significant standard heterosis for the trait days to 50% flowering. Similar results were reported by Chandan *et al.* (2018) in ridge gourd.

5. Days to first fruit harvest

The mid parent heterosis for the trait days to first fruit harvest varied from -18.27 (IC 622920 X Jaipur Long) to 14.80 per

cent (IC 622916 X Utkal Tripti). The minimum days to first harvest are highly desirable. Eight hybrids manifested significant negative heterosis for the trait days to first male flower. Among these, the hybrid IC 622920 x Jaipur Long (-18.27%) had lowest negative heterosis followed by IC 622916 X Pusa Nasdar (-10.88%) and JRGL-13 x Pusa Nasdar (-10.74%). The better parent heterosis varied from -20.86 per cent (IC 622920 X Jaipur Long) to 12.39 per cent (Padmini x Utkal tripti) and significant negative heterosis was recorded bythirteen hybrids. Among these, the hybrid IC 622920 x Jaipur Long (-20.86%) had highest positive heterosis followed by JRGL-13 x Pusa Nasdar (-13.88%) and Kokan Harita x Swarna Manjari (-13.28%). The standard heterosis varied from -7.58 per cent (IC 622916 X Pusa Nasadar) to17.83 per cent (Padmini x Arka Sumeet) but none of the hybrid was found to have negatively significant heterosis. These results were in confirmation with results of Sarkar *et al.* (2017) [8]. Nandhini *et al.* (2018) [6] and Narasannavar *et al.* (2018) [7] in ridge gourd.

6. Fruit length (cm)

The maximum fruit length is usually desirable. The mid parent heterosis for the trait fruit length varied from -35.96 per cent (JRGL-13 x Swarna Manjari) to 68.12 per cent (IC 622916 X Utkal Tripti). Twenty hybrids exhibited positively significant heterosis over mid parent. The hybrid IC 622916 x Utkal Tripti (68.12%) had highest positive heterosis followed by Padmini x Pusa Nasdar (63.68%) and IC 622915 x Utkal Tripti (57.06%). The better parent heterosis varied from -37.22 per cent (JRGL-13 x Swarna Manjari) to 53.42 per cent (IC 622916 X Utkal Tripti). Sixteen hybrids exhibited significant and positive better parent heterosis. The hybrid IC 622916 x Utkal Tripti (53.42%) had highest positive heterosis followed by IC 622915 x Utkal Tripti (50.41%) and IC 622917 x Swarna Manjari (49.64%). The standard heterosis varied from -49.54 per cent (IC 622917 X Utkal Tripti) to 22.29 per cent (IC 622916 X Pusa Nasadar). Nine hybrids exhibited positive and significant standard heterosis. The hybrid IC 622916 X Pusa Nasdar (22.29%) had highest positive heterosis followed by IC 622920 x Jaipur Long (21.67%) and JRGL-13 x Pusa Nasdar (18.89%). Significant positive heterosis has also been reported by several workers including Sarkar *et al.* (2017) [8]. Chittora *et al.* (2018) [3] and Varalakshmi *et al.* (2019) in ridge gourd.

7. Fruit girth (cm)

The mid parent heterosis for the trait fruit girth varied from -18.67 per cent (IC 622917 X Swarna Manjari) to 51.54 per cent (Padmini x Swarna Manjari) and twenty five hybrids recorded positive and significant heterosis. The hybrid Padmini x Swarna Manjari (51.54%) had maximum positive heterosis followed by JRGL-13 x Pusa Nasdar (49.18%) and IC 622920 x Jaipur Long (47.47%). The better parent heterosis varied from Kokan Harita x Jaipur long -22.43 per cent (JRGL-13 x Swarna Manjari) to 51.12 per cent (Padmini x Swarna Manjari). Among twenty one hybrids which manifested positive and significant heterosis over better parent, the hybrid Padmini x Swarna Manjari (51.54%) showed highest positive heterosis followed by JRGL-13 x Pusa Nasdar (49.18%) and IC 622920 x Jaipur Long (47.47%). The standard heterosis varied from -29.88 per cent (IC 622917 X Utkal Tripti) to 12.66 per cent (JRGL-13 x Pusa Nasadar) and thirteen hybrids illustrated positively significant standard heterosis. The hybrid JRGL-13 x Pusa Nasdar (12.66%) recorded highest positive heterosis followed by Padmini x Swarna Manjari (12.24%), IC 622915 x Pusa Nasdar (12.24%) and IC 622916 X Pusa Nasdar (12.24%). Significant positive heterosis for fruit girth was also reported by Chittora *et al.* (2018) [3]. Nandhini *et al.* (2018) [6] and Varalakshmi *et al.* (2019) in ridge gourd.

8. Fruit weight (g)

The mid parent heterosis for the trait average fruit weight varied from 0.54 per cent (JRGL-13 x Arka Sumeet) to 50.98 per cent (IC 622916 X Pusa Nasadar). The twenty two hybrids exhibited significant and positive heterosis for the trait fruit weight. The hybrid IC 622916 X Pusa Nasdar (50.98%) followed by Padmini x Pusa Nasdar (45.25%) and IC 622920 x Utkal Tripti (44.53%) exhibited highest positive heterosis. The better parent heterosis varied from -5.26 per cent (JRGL-13 x Arka Sumeet) to 44.08 per cent (IC 622916 X Pusa Nasadar). Nineteen hybrids illustrated positive and significant heterosis. The hybrid IC 622916 X Pusa Nasdar (44.08%) had highest positive heterosis followed by Padmini x Pusa Nasdar (43.95%) and JRGL-13 x Pusa Nasdar (31.00%). The standard heterosis varied from -17.23 per cent (IC 622920 X Arka Sumeet) to 25.41 per cent (IC 622916 X Pusa Nasadar). Ten hybrids manifested positive and significant heterosis over standard check. The hybrid IC 622916 X Pusa Nasdar (25.41%) had maximum positive heterosis followed by JRGL-13 x Pusa Nasdar (24.15%) and IC 622920 x Utkal Tripti (23.93%). Chittora *et al.* (2018) [3]. Nandhini *et al.* (2018) [6] and Varalakshmi *et al.* (2019) in ridge gourd recorded similar type of results in their investigation.

9. Number of fruits per vine

The maximum numbers of fruits per vine are desirable, because breeder is interested to increase number of fruits per plant. The character directly contributes to yield. The mid parent heterosis for the trait number of fruits per vine varied from -21.61 per cent (IC 622920 X Utkal Tripti) to 41.33 per cent (IC 622916 X Pusa Nasadar). The four hybrids exhibited positive and significant heterosis for the trait. The highest heterosis was recorded by the hybrid IC 622916 X Pusa Nasdar (41.33%) followed by IC 622920 x Jaipur Long (25.64%) and Padmini x Swarna Manjari (23.96%).

The better parent heterosis varied from -22.96 per cent (IC 622920 X Utkal Tripti) to 39.47 per cent (IC 622916 X Pusa Nasadar). Three hybrids manifested positively significant heterosis *viz*., IC 622916 X Pusa Nasdar (39.47%) followed by Padmini x Swarna Manjari (20.27%) and IC 622920 x Jaipur Long (18.42%). The standard heterosis varied from -31.62 per cent (IC 622920 X Utkal Tripti) to 8.14 per cent (IC 622916 X Pusa Nasadar). None of the hybrid was found to have positively significant standard heterosis for the trait number of fruits per vine. These findings are in agreement with the findings of Chittora *et al.* (2018) [3]. and Varalakshmi *et al.* (2019) in ridge gourd.

10. Total fruit weight per vine (g)

The mid parent heterosis for the trait total fruit weight per vine varied from -4.22 per cent (IC 622921 X Swarna Manjari) to 110.24 per cent (IC 622916 X Pusa Nasadar) and twenty nine hybrids recorded significant and positive mid parent heterosis. The highest positive heterosis illustrated by

hybrid IC 622916 X Pusa Nasdar (110.24%) followed by IC 622920 x Jaipur Long (91.28%) and JRGL-13 x Pusa Nasdar (89.43%). The better parent heterosis for the trait total fruit weight per vine varied from -7.54 per cent (IC 622921 X Swarna Manjari) to 108.39 per cent (IC 622916 X Pusa Nasadar). The twenty two hybrids showed positive and significant heterosis among which the hybrid IC 622916 X Pusa Nasdar (108.39%) had maximum positive heterosis followed by JRGL-13 x Pusa Nasdar (88.35%) and IC 622920 x Jaipur Long (80.34%). The standard heterosis varied from -32.61 per cent (JRGL-13 x Arka Sumeet) to 28.99 per cent (IC 622920 X Jaipur Long). The seven hybrids exhibited significant and positive heterosis among which the hybrid IC 622920 x Jaipur Long (28.99%) had recorded positive heterosis followed by IC 622916 X Pusa Nasdar (26.85%), Kokan Harita x Swarna Manjari (21.04%) and Padmini x Swarna Manjari (20.06%). Similar results were reported by Chittora *et al.* (2018) [3]. Nandhini *et al.* (2018) [6]. Narasannavar *et al.* (2018) [7] and Varalakshmi *et al.* (2019) in ridge gourd.

Table 1: ANOVA for various characters studied in ridge gourd (season 2019 and 2020) at VNMKV, Parbhani

Mean sum of squares										
Source of variation	**D.F.**	**Season**	**Vine length (cm)**	**Number of branches per vine**	**Internodal length**	**Number of leaves**	**Days to first female flower**	**Days to first male flower**	**50% flowering**	**Node at first female flower**
			1	2	3	4	5	6	7	8
Replication	1	E_1	5359.51	0.98	2.06	68.07	3.96	5.51	14.06	5.47
		E_2	4775.21	0.95	3.24	65.02	3.02	3.04	17.33	4.51
Treatment	53	E_1	5948.89**	2.79**	5.86**	314.15**	17.75**	8.37**	13.72**	11.00**
		E_2	5606.28**	2.87**	5.98**	285.32**	24.61**	12.52**	17.18**	19.60**
Error	53	E_1	2528.07	0.46	0.97	32.11	1.89	2.6	6.63	2.58
		E_2	2273.91	0.45	1.41	31.26	1.31	1.56	8.25	2.09

Table 3: Contd...

Mean sum of squares									
Source of variation	**D.F.**	**Location**	**Days to first fruit harvest**	**Days to last fruit harvest**	**Fruit length (cm)**	**Fruit girth (cm)**	**Fruit weight (g)**	**Number of fruits per vine**	**Total fruit yield per vine (g)**
			9	10	11	12	13	14	15
Replication	1	E_1	17.9	201.74	8.48	0.12	181.72	2.07	26671.32
		E_2	14.72	175.01	7.68	0.17	258.07	2.73	40416.71
Treatment	53	E_1	24.15**	69.14	89.31**	1.05**	511.78**	1.08	108162.46**
		E_2	19.61**	65.42	93.54**	1.38**	702.91**	2.44*	119954.43**
Error	53	E_1	9.42	95.16	4	0.05	79.01	0.9	14817.4
		E_2	6.4	78.48	3.9	0.05	143.37	1.33	21846.87

*Significant at 5% level **significant at 1% level

Table 4: Heterosis over mid parent, Better parent and Standard check for various characters in ridge gourd (*Luffa acutangula* L.)

Hybrids	**Vine length (cm)**			**Number of branches**			**Internodal length (cm)**		
	Mid parent	**Better parent**	**Standard check**	**Mid parent**	**Better parent**	**Standard check**	**Mid parent**	**Better parent**	**Standard check**
Kokan harita x Arka Sumeet	21.78 **	21.35 *	20.57 *	23.03 **	-6.09	17.63 *	-13.07 *	-15.62 **	-16.63 **
Kokan harita x Pusa Nasdar	22.74 **	21.09 *	20.32 *	-25.20 **	-35.57 **	-19.30 *	-20.32 **	-24.50 **	-16.65 **
Kokan harita x Utkal Tripti	-11.25	-16.26 *	-6.2	-38.38 **	-50.98 **	-38.60 **	21.10 **	15.17 *	13.79 *
Kokan harita x Swarna Manjari	22.50 **	17.60 *	27.00 **	11.74	-3.36	21.05 *	-17.89 **	-18.60 **	-19.57 **
Kokan harita x Jaipur Long	8.47	7.06	9.22	-20.20 **	-33.05 **	-16.14	-15.17 **	-20.53 **	-10.13
Padmini x Arka Sumeet	-4.45	-7.71	-1.59	-22.27 **	-27.17 **	-8.77	13.97 **	7.1	20.33 **
Padmini x Pusa Nasdar	11.9	7.79	15.6	20.72 **	-6.16	17.54 *	-17.95 **	-20.13 **	-16.65 **
Padmini x Utkal Tripti	5.63	0.92	10.09	-35.84 **	-46.78 **	-33.33 **	-4.92	-10.37 *	0.04
Padmini x Swarna Manjari	33.31 **	28.28 **	36.89 **	80.46 **	75.66 **	15.88	-26.21 **	-34.32 **	-21.71 **
Padmini x Jaipur Long	15.43 *	10.01	17.4	7.8	-8.91	-17.54 *	-3.42	-6.99	10.87
JRGL-13 xArka Sumeet	-0.93	-3.27	8.35	11.83	3.08	-23.68 **	2.28	-10.62 *	6.54
JRGL-13 Pusa Nasdar	28.71 **	27.95 **	38.18 **	55.07 **	30.52 **	19.30 *	-22.27 **	-29.47 **	-15.93 **
JRGL-13 x Utkal Tripti	-12.9	-14.81	-9.1	-10.48	-22.31 *	-34.04 **	-10.76 *	-13.06 **	3.64
JRGL-13 x Swarna Manjari	-11.2	-11.24	-5.28	-23.67 **	-40.06 **	-34.39 **	-9.23 *	-11.84 *	5.09
JRGL-13 x Jaipur Long	-7.75	-7.98	-1.31	17.02	11.11	-22.81 **	0.49	-5.78	12.32 *
IC 622915 x Arka Sumeet	-4.52	-5.57	3.02	16.27	2.13	-15.7	-7.04	-10.00 *	7.28
IC 622915 x Pusa Nasdar	13.86	0.6	-0.74	-8.12	-23.21 **	-24.56 **	0.88	-11.71 *	9.42
IC 622915 x Utkal Tripti	17.27	4.53	1.08	-21.93 **	-25.00 **	-26.32 **	-10.94 *	-15.80 **	4.35
IC 622915 x Swana Manjari	16.95 *	-2.01	9.76	-22.61 **	-32.14 **	-33.33 **	-12.92 **	-25.15 **	-7.23
IC 622915 x Jaipur Long	1.74	-13.48	-6.56	-16.74 *	-19.64 *	-21.05 *	0.34	-10.53 *	10.89
IC 622916 x Arka Sumeet	14.04	-0.68	1.33	20.69 **	12.5	10.53	-5.21	-9.36 *	12.34 *
IC 622916 x Pusa Nasdar	57.50 **	34.65 **	43.58 **	21.62 **	15.38 *	26.32 **	-31.91 **	-35.09 **	-19.55 **
IC 622916 x Utkal Tripti	16.39	-0.74	6.46	-7.95	-21.43 *	-22.81 **	-14.91 **	-21.64 **	-2.88
IC 622916 x Swana Manjari	8.76	-7.89	0.49	-20.43 *	-26.79 **	-28.07 **	-12.62 **	-16.96 **	2.92
IC 622916 x Jaipur Long	33.86 **	20.83 *	19.22 *	20.15 *	13.48	-15.79	6.33	-5.99	13.81 *
IC 622917 x ArkaSumeet	18.34 *	7.79	4.23	4.37	-5.04	-14.04	-7.33	-11.41 *	7.25
IC 622917 x Pusa Nasdar	29.96 **	11.07	24.42 **	1.78	1.65	-24.56 **	0.67	-12.60 **	5.8
IC 622917 x Utkal Tripti	18.97 *	3.25	11.5	-4.66	-13.63	-21.05 *	-12.31 **	-20.98 **	-4.35

IC 622917 x Swarna Manjari	10.52	-1.71	0.28	-18.41 *	-23.55 *	-35.09 **	-11.45 **	-14.37 **	3.66
IC 622917 x Jaipur Long	19.92 *	4.64	11.58	-19.77 *	-32.69 **	-26.32 **	-3.73	-7.18	12.36 *
IC 622920 x Arka Sumeet	1.22	-11.9	-5.51	-5.25	-8.27	-31.93 **	0.98	-5.99	13.81 *
IC 622920 x Pusa Nasdar	1.51	-12.28	-4.3	-1.51	-6.48	-22.81 **	4.04	-0.01	21.04 **
IC 622920 x Utkal Tripti	29.60 **	24.46 **	33.38 **	67.65 **	39.12 **	39.12 **	-1.45	-3.37	-10.13
IC 622920 x Swarna Manjari	-10.72	-15.08	-8.99	-31.86 **	-35.09 **	-35.09 **	18.30 **	7.04	18.17 **
IC 622920 x Jaipur Long	17.05 *	14.52	28.29 **	43.15 **	24.56 **	24.56 **	-10.7	-10.83	-20.29 **
IC 622921 x Arka Sumeet	3.95	3.56	11.84	-37.67 **	-40.35 **	-40.35 **	18.15 **	13.45 *	10.16
IC 622921 x Pusa Nasdar	4.79	2.27	9.61	-29.79 **	-35.09 **	-35.09 **	-9.09	-18.62 **	-7.97
IC 622921 x Utkal tripti	-11.97	-12.19	-5.89	-22.95 **	-26.28 **	-19.30 *	9.92 *	-1.32	10.87
IC 622921 x Swana Manjari	-8.11	-8.15	-1.49	7.66	-8.77	-8.77	10.74 *	2.8	7.27
IC 622921 x Jaipur Long	-5.77	-6.6	1.9	26.86 **	15.79	15.79	3.85	-6.49	4.37
SE	29.8699	34.4908	34.4908	0.404	0.4665	0.4665	0.6797	0.7848	0.7848
C.D.95%	59.4667	68.6662	68.6662	0.8044	0.9288	0.9288	1.3532	1.5625	1.5625
C.D.99%	78.8673	91.0681	91.0681	1.0668	1.2318	1.2318	1.7946	2.0723	2.0723

* Significant at 5% level ** significant at 1% level

Table 2 continued

Table 5: Heterosis over mid parent, Better parent and Standard check for various characters in ridge gourd (*Luffa acutangula* L.)

Hybrids	Number of fruits per vine			Days to 50% flowering			Fruit length (cm)		
	Mid parent	Better parent	Standard check	Mid parent	Better parent	Standard check	Mid parent	Better parent	Standard check
Kokan harita x Arka Sumeet	11.26	5.35	1.02	-6.27	-10.18 *	-4.71	47.22 **	46.93 **	15.54 **
Kokan harita x Pusa Nasdar	-15.91 *	-21.28 *	-24.51 **	4.98	3.46	3.6	14.56 **	5.31	-17.18 **
Kokan harita x Utkal Tripti	-8.74	-16.99 *	-20.40 *	1.29	-7.33	8.59	-14.44 **	-22.61 **	-24.77 **
Kokan harita x Swarna Manjari	11.86	5.32	0.99	-9.69 *	-13.35 **	-8.31	46.17 **	31.50 **	3.41
Kokan harita x Jaipur Long	-12.36	-17.02 *	-20.43 *	5.09	1.6	5.82	46.65 **	45.67 **	14.55 **
Padmini x Arka Sumeet	-3.57	-13.83	-17.37 *	18.80 **	13.84 **	20.78 **	-20.60 **	-24.29 **	-34.37 **
Padmini x Pusa Nasdar	5.56	1.06	-3.09	-6.97	-7.1	-9.42	63.68 **	43.70 **	13.00 **
Padmini x Utkal Tripti	-5.39	-15.96	-19.41 *	18.12 **	14.78 **	18.28 **	-31.00 **	-35.96 **	-41.18 **
Padmini x Swarna Manjari	23.96 **	20.27 *	3.06	2.16	-1.31	4.71	38.84 **	29.67 **	17.03 **
Padmini x Jaipur Long	3.11	1.22	-15.33	4.38	3.73	3.88	27.65 **	10.46 *	-0.31
JRGL-13 xArka Sumeet	-6.41	-7.59	-25.53 **	-0.51	-8.27	7.48	12.30 **	8.28	5.26
JRGL-13 Pusa Nasdar	19.75 *	16.87	-1.05	-5.55	-8.64	-3.32	55.31 **	31.73 **	18.89 **
JRGL-13 x Utkal Tripti	-11.66	-14.29	-26.55 **	4.77	2.13	6.37	-15.14 **	-21.10 **	-28.79 **
JRGL-13 x Swarna Manjari	15.03	11.39	-10.23	-5.14	-8.36	-2.77	-35.96 **	-37.22 **	-43.34 **
JRGL-13 x Jaipur Long	5.45	1.16	-11.25	10.58 *	9.8	8.59	25.46 **	4.05	-6.1
IC 622915 x Arka Sumeet	6.58	2.53	-17.37 *	2.61	0.54	3.6	15.95 **	14.93 **	5.57
IC 622915 x Pusa Nasdar	2.5	-2.38	-16.35 *	-2.82	-5.48	0.28	-0.76	-4.74	-25.39 **
IC 622915 x Utkal Tripti	-2.53	-6.1	-21.45 **	3.94	3.87	4.16	57.06 **	50.41 **	8.36
IC 622915 x Swana Manjari	1.96	1.3	-20.43 *	2.42	-4.96	11.36 *	26.94 **	10.51 *	7.43
IC 622915 x Jaipur Long	-0.63	-4.82	-19.41 *	4.57	1.83	7.76	-20.13 **	-25.23 **	-46.13 **
IC 622916 x Arka Sumeet	-8.75	-13.1	-25.53 **	12.20 **	10.11	14.68 **	17.24 **	13.05 *	-12.29 **
IC 622916 x Pusa Nasdar	41.33 **	39.47 **	8.14	-12.48 **	-14.88 **	-9.7	54.09 **	41.07 **	22.29 **
IC 622916 x Utkal Tripti	-3.67	-9.27	-20.40 *	12.89 **	11.33 *	11.63 *	68.12 **	53.42 **	10.53 *
IC 622916 x Swana Manjari	10.1	7.93	-16.32 *	2.18	0.81	3.88	-8.8	-18.64 **	-25.26 **
IC 622916 x Jaipur Long	-0.54	-4.37	-11.22	8.69	2.87	9.14	-1.67	-4.58	-25.26 **
IC 622917 x ArkaSumeet	-8.67	-13.19	-19.41 *	14.29 **	11.20 *	11.36 *	-12.64 *	-17.23 **	-39.01 **
IC 622917 x Pusa Nasdar	-7.14	-14.29	-20.43 *	-0.39	-9.93 *	5.54	23.91 **	8.92 *	5.88
IC 622917 x Utkal Tripti	-13.79	-17.58 *	-23.49 **	5.25	-0.26	5.54	-26.08 **	-31.51 **	-49.54 **
IC 622917 x Swarna Manjari	1.71	-2.2	-9.21	7.24	2.39	6.65	53.50 **	49.64 **	16.10 **
IC 622917 x Jaipur Long	-5.42	-14.26	-20.40 *	6.76	1.04	7.2	-13.13 **	-19.64 **	-30.34 **
IC 622920 x Arka Sumeet	-8.47	-10.99	-17.37 *	11.24 *	9.66	6.93	22.09 **	10.29	-18.73 **
IC 622920 x Pusa Nasdar	3.69	-6.57	-13.26	8.4	4.03	7.2	4.73	-5.63	-13.31 **
IC 622920 x Utkal Tripti	-21.61 **	-22.96 *	-31.62 **	3.61	2.29	11.36 *	21.11 **	7.69	8.36
IC 622920 x Swarna Manjari	-1.78	-4.6	-15.33	-3.51	-7.38	0.83	-16.17 **	-30.62 **	-30.19 **
IC 622920 x Jaipur Long	25.64 **	18.42 *	5.1	-18.63 **	-21.51 **	-8.03	23.00 **	20.92 **	21.67 **
IC 622921 x Arka Sumeet	-8.21	-10.32	-20.40 *	1.68	0.25	9.14	14.58 **	-6.92	-6.35
IC 622921 x Pusa Nasdar	-8.77	-10.34	-20.43 *	-2.47	-4.58	3.88	17.44 **	4	4.64
IC 622921 x Utkal tripti	10.59	2.33	-9.18	-0.52	-1.78	6.93	15.70 **	7.69	8.36
IC 622921 x Swana Manjari	-9.83	-10.34	-20.43 *	-0.13	-5.34	3.05	-15.67 **	-32.92 **	-32.51 **
IC 622921 x Jaipur Long	6.28	-2.27	-13.26	0.13	-2.54	6.09	-17.29 **	-20.89 **	-20.40 **
SE	0.6617	0.764	0.764	1.6646	1.9221	1.9221	1.1849	1.3682	1.3682
C.D.95%	1.3173	1.521	1.521	3.314	3.8266	3.8266	2.359	2.7239	2.7239
C.D.99%	1.747	2.0173	2.0173	4.3951	5.075	5.075	3.1285	3.6125	3.6125

* Significant at 5% level ** significant at 1% level

Table 6 continued

Table 6: Heterosis over mid parent, Better parent and Standard check for various characters in ridge gourd (*Luffa acutangula* L.)

Hybrids	Fruit girth (cm)			Fruit weight (g)			Total fruit yield per vine (g)		
	Mid parent	Better parent	Standard check	Mid parent	Better parent	Standard check	Mid parent	Better parent	Standard check
Kokan harita x Arka Sumeet	23.98 **	6.64 *	9.96 **	30.94 **	20.49 **	15.61 **	64.08 **	61.79**	17.75*
Kokan harita x Pusa Nasdar	0.22	-9.46 **	-6.64	32.54 **	24.04 **	14.73 *	27.60 **	23.52*	-10.1
Kokan harita x Utkal Tripti	-4.87	-15.49 **	-12.86 **	4.43	-2.9	-8.91	20.37 *	12.56	-18.07 **
Kokan harita x Swarna Manjari	22.90 **	7.44 *	10.79 **	28.46 **	18.88 **	12.67 *	79.18 **	66.30 **	21.04 **
Kokan harita x Jaipur Long	-18.54 **	-22.43 **	-20.02 **	9.98	3.99	-5.89	27.51 **	24.47 *	-9.41
Padmini x Arka Sumeet	7.64 *	-7.14 *	-4.25	30.00 **	25.21 **	8.98	41.07 **	28.49 **	-6.48
Padmini x Pusa Nasdar	22.18 **	8.05 *	11.41 **	45.25 **	43.95 **	18.19 **	58.87 **	54.67 **	18.87 **
Padmini x Utkal Tripti	15.51 **	0	3.11	6.04	-1.94	-6.92	12.24	11.47	-17.73 *
Padmini x Swarna Manjari	51.54 **	51.12 **	12.24 **	32.51 **	23.56 **	18.56 **	81.41 **	69.70 **	20.06 **
Padmini x Jaipur Long	36.86 **	29.18 **	7.47 *	5.33	-0.08	-7.58	27.94 **	21.82 *	-17.00 *
JRGL-13 xArka Sumeet	-1.35	-5.18	-24.07 **	0.54	-5.26	-11.12	7.86	6.38	-32.61 **
JRGL-13 Pusa Nasdar	49.18 **	45.97 **	12.66 **	39.69 **	31.00 **	24.15 **	89.43 **	88.35 **	17.39 *
JRGL-13 x Utkal Tripti	-12.60 **	-21.69 **	-26.97 **	5.35	0.98	-8.62	5.16	-0.68	-31.16 **
JRGL-13 x Swarna Manjari	45.71 **	44.80 **	8.30 *	5.5	3.05	-10.31	42.12 **	40.03 **	-13.72 *
JRGL-13 x Jaipur Long	24.25 **	20.03 **	-4.88	22.48 **	21.83 **	1.1	34.00 **	20.71 *	-7.23
IC 622915 x Arka Sumeet	30.51 **	29.16 **	-2.59	28.56 **	20.48 **	14.36 *	16.73	7.09	-20.96 **
IC 622915 x Pusa Nasdar	40.52 **	31.31 **	12.24 **	6.35	-2.99	-6.92	28.89 **	19.90 *	-15.17 *
IC 622915 x Utkal Tripti	4.31	2.91	-12.03 **	8.58	0.72	-6.85	11.24	5.32	-28.24 **
IC 622915 x Swana Manjari	34.59 **	30.34 **	11.41 **	25.89 **	16.01 **	8.84	36.54 **	33.88 **	-15.20 *
IC 622915 x Jaipur Long	-4.85	-9.47 *	-22.61 **	8.09	-0.85	-6.04	40.05 **	38.42 **	-13.73 *
IC 622916 x Arka Sumeet	0.52	-3.67	-10.17 **	28.01 **	19.93 **	8.54	31.39 **	23.39 *	-14.47 *
IC 622916 x Pusa Nasdar	40.06 **	31.31 **	12.24 **	50.98 **	44.08 **	25.41 **	110.24 **	108.39 **	26.85 **
IC 622916 x Utkal Tripti	34.26 **	29.37 **	10.58 **	16.22 **	14.08 *	-6.33	11.59	-0.01	-23.15 **
IC 622916 x Swana Manjari	17.60 **	10.68 **	-5.39	9.69	0.54	-4.57	32.41 **	20.81 *	-10.83
IC 622916 x Jaipur Long	12.58 **	4.16	-9.02 **	19.32 **	10.21	5.74	17.65 *	8.81	-9.41
IC 622917 x ArkaSumeet	-15.33 **	-17.34 **	-27.80 **	4.15	-2.15	-9.5	2.44	-6.87	-22.46 **
IC 622917 x Pusa Nasdar	28.87 **	23.52 **	7.88 *	9.08	1.81	-4.49	16.69 *	2.74	-14.46 *
IC 622917 x Utkal Tripti	-14.75 **	-19.71 **	-29.88 **	21.04 **	12.43 *	6.55	25.46 **	9.68	-8.68
IC 622917 x Swarna Manjari	-18.67 **	-21.25 **	-26.56 **	11.19	5.53	-4.49	20.65 **	10.55	-7.97
IC 622917 x Jaipur Long	-10.94 **	-17.34 **	-27.80 **	29.31 **	25.04 **	8.84	31.21 **	12.73	-6.15
IC 622920 x Arka Sumeet	-2.86	-7.36	-19.09 **	1.31	0.81	-17.23 **	-1.32	-5.11	-21.00 **
IC 622920 x Pusa Nasdar	2.74	-4.28	-16.39 **	22.02 **	13.27 *	7.51	15.40 *	8.85	-9.38
IC 622920 x Utkal Tripti	18.78 **	16.62 **	-13.38 **	44.53 **	29.16 **	23.93 **	20.21 *	19.56 *	-14.49 *
IC 622920 x Swarna Manjari	11.93 **	4.11	-13.38 **	7.1	-2.71	-10.01	14.7	11.98	-19.91 **
IC 622920 x Jaipur Long	47.47 **	39.64 **	11.83 **	36.52 **	23.23 **	15.61 **	91.28 **	80.34 **	28.99 **
IC 622921 x Arka Sumeet	33.89 **	29.03 **	-0.41	12.32 *	0.93	-4.34	24.53 **	16.52	-16.66 *
IC 622921 x Pusa Nasdar	5.22	-7.01	-13.28 **	6.16	-2.6	-11.86 *	5.52	3.89	-25.69 **
IC 622921 x Utkal tripti	44.58 **	41.47 **	5.81	33.42 **	24.62 **	8.47	55.66 **	42.90 **	2.21
IC 622921 x Swana Manjari	31.50 **	25.13 **	-0.83	8.64	4.3	-14.36 *	-4.22	-7.54	-28.94 **
IC 622921 x Jaipur Long	17.15 **	14.17 **	-13.90 **	20.26 **	7.99	2.5	21.81 **	19.93 *	-11.49
SE	0.14	0.1616	0.1616	6.5767	7.5941	7.5941	81.497	94.1047	94.1047
C.D.95%	0.2787	0.3218	0.3218	13.0932	15.1187	15.1187	162.2488	187.3488	187.3488
C.D.99%	0.3696	0.4268	0.4268	17.3648	20.0511	20.0511	215.1814	248.47	248.47

*Significant at 5% level **significant at 1% level

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