EXPLOITATION OF HETEROSIS AND COMBINING ABILITY FOR YIELD AND YIELD ATTRIBUTING TRAITS IN RIDGE GOURD (*Luffa acutangula* L.)

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Abstract

Nine diverse parents were crossed in a diallel fashion (excluding reciprocals) for generating the experimental material. All the nine parents and their 36 hybrids were grown in a randomized block design with three replications. In the present study, the significant and highest general combining ability effects were recorded in fruit yield JRG-2 (0.2), highest average fruit weight was recorded in JRG-2 (20.54), for total soluble solids Pusa Nasdar (0.31) and dry matter Satputia (0.38). The maximum and significant *sca* effects showed in the crosses for their respective characters includes Pusa Nutan × Satputia (0.38) for total yield, Pusa Nasdar × Satputia (25.06) for fruit weight, Pusa Nasdar × Satputia (0.95) for total soluble solids and dry matter Pusa Nutan × JRG-2 (1.48).The highest significant heterosis over mid and better parent for fruit yield was noticed in DRG-5 × Satputia (151.85% and 139.89%). For fruit weight the highest heterosis over mid, better and standard parent was recorded in the crosses Pusa Nutan × Satputia (76.79)%, Pusa Nasdar × JRG-3 (12.06%) and JRG-2 × Swarna Manjari (27.22%), for total soluble solids maximum significant heterosis over mid, better and standard was recorded in Pusa Nasdar × Satputia, and significant dry matter content was obtained in the crosses Pusa Nasdar ×JRG-2 (41.04%) over mid, JRG-3 × Swarna Uphar (33.45%) over better and Pusa Nasdar × JRG-2 (28.78%) over standard parent.

Keywords: Ridge gourd, heterosis, total soluble solids, combining ability, yield, dry matter

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INTRODUCTION

Ridge gourd is popularly known as Nasdar turai and also called as angled gourd, angled loofah, Chinese okra, silky gourd and ribbed gourd. It belongs to the genus Luffa of Cucurbitaceae and has chromosome number 2n=26.The green immature fruits of Luffa are cooked as vegetable. Fruit is demulcent, diuretic and nutritive. The leaves are used in poultice in hemorrhoids and leprosy. The juice of fresh leaves is useful in granular conjunctivitis in children. The seeds possess purgative and emetic properties (Singh et al., 2012). Ridge gourd, being monoecious, is a cross pollinated crop and thus 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.

MATERIAL AND METHODS

The present investigation was conducted in Naturally Ventilated Polyhouse. The nine diverse parents of ridge gourd were used to make crosses in diallel fashion excluding reciprocals during summer. March 2016 and evaluated during rainy season, July 2016 at the Protected Cultivation Unit of the College of Horticulture and Forestry, Jhalawar, Rajasthan, India. The nine parental lines of diverse origin of ridge gourd were crossed in 9×9 diallel mating design excluding reciprocals. The 36 F_1 hybrids along with their parents' viz., Pusa Nasdar (P_1), Pusa Nutan (P_2), JRG-2 (P_3), JRG-3 (P_4), Swarna Uphar (P_5), DRG-5 (P_6), DRG-53 (P_7), Swarna Manjari (P_8) and Satputia (P9) were evaluated in a randomized block design with three replications. The data was recorded in fruit weight (g), yield per plant (kg), total soluble solids (°brix) and dry matter content (%). The combining ability analysis by employing Method-II, Model-I (fixed effect) of Griffing (1956) and heterosis was calculated as per the references given by Allard (1960).

Yield per plant (kg)

The weight of all the fruits harvested at different pickings on all the five plants were recorded and average yield per plant was calculated by dividing the total yield by number of plants i.e.5.

Fruit weight (g)

Average fruit weight in gram was calculated by dividing the total marketable yield by total number of marketable fruits.

Total soluble solids (°brix)

Total soluble solids (TSS) in five randomly selected fruits in each genotypes were recorded under room temperature with the help of 'ERMA Hand Refractometer' by putting 2-3 drops of juice on prism and the values was expressed in per cent (A.O.A.C. 1970).

Dry matter content (%) Mature and tender fruits from each genotype were taken and chopped into small pieces of 0.2 cm thickness followed by drying in sun light. The per cent of dry matter was calculated by dividing total weight of the fresh fruit by total weight of dried fruit and multiplied with 100.

RESULTS AND DISCUSSION

Combining ability analysis

The combining ability is a powerful tool to determine good as well as poor combiner for selecting appropriate parents to formulate an efficient breeding programme. The model-I (fixed effect) method- II (parents and their F_1s without reciprocals) purposed by Griffing (1956) was followed to estimate the combining ability effects the important features, the results on *gca* effects reported in Table 1.0 and *sca* effects in Table 2.0.

For total fruit yield per plant, *gca* effects among all the parents ranged from -0.11 (DRG-53) to 0.22 (JRG-2). Out of nine parents, three parents *viz.*, JRG-2 (0.2), Pusa Nasdar (0.10) and Pusa Nutan (0.04) showed *gca* effect in positive direction. Two parents namely JRG-2 and Pusa Nasdar was to be found to be good general combiner for this trait and the magnitude of specific combining ability effects ranged from -0.19 (Swarna Uphar × Satputia) to Pusa Nutan × Satputia (0.38). Out of 36 crosses, only six cross combinations showed *sca* effect in positive direction. The three best crosses *viz.*, Pusa Nutan × Satputia (0.38), DRG-5 × Satputia (0.31), JRG-2 × Swarna Uphar (0.30) gave positive and significant *sca* effects for yield per plant. Identifying the most desirable parents based on per se performance as well as *gca* effects is important. The three best parents were JRG-2, Pusa Nasdar and Pusa Nutan for total yield per plant. For fruit weight (g) highly significant and positive *gca* effects were recorded for only three parents. The *gca* effects of parents for fruit weight ranged from -18.65 (Satputia) to 20.54 (JRG-2). Three parents *viz.*, JRG-2 (20.54), Swarna Manjari (5.31) and Pusa Nasdar (4.03) had the positive significant *gca* effects and the *sca* effect for fruit weight and it was ranged from -35.01 (Pusa Nutan × JRG-2) to 25.06 (Pusa Nasdar × Satputia) the three best crosses.

Total soluble solids (°brix): the general combining ability effects for total soluble solids varied between -0.14 (Swarna Uphar) to 0.31 (Pusa Nasdar). Only two parents viz., Pusa Nasdar (0.31) and DRG-53 (0.03) showed highly significant positive *gca* effects and the specific combining ability effects for this trait aand it is varied from -0.63 (Pusa Nasdar × DRG-5) to 0.95 (Pusa Nasdar × Satputia). Three crosses namely Pusa Nutan × DRG-5, Pusa Nasdar × Swarna Uphar and JRG-3 × DRG-53 showed positive and significant *sca* effects at lower level for total soluble solids. general combining ability effects for dry matter revealed that only three parents namely Satputia (0.38), Pusa Nutan (0.14) and DRG-53 (0.11) had significant positive general combining ability effects and the specific combining ability effects for dry matter and it varied from -0.63 (Pusa Nasdar × DRG-5) to 0.95 (Pusa Nasdar × Satputia). The three crosses namely Pusa Nutan × DRG-5, Pusa Nasdar × Swarna Uphar and JRG-3 × DRG-53 showed positive and significant *sca* effects at lower level for dry matter content. Similar association between these two parameters was also observed by Gill and Kumar (1988) in water melon, Musmade and Kale (1986) in cucumber, Maurya et al., (1991 and 1994) in bottle gourd.

Magnitude of heterosis

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 MHRG-7 of Mahyco was used as check or standard parent. The values of heterosis reported in Table -3.

The relative heterosis fruit yield ranged from -22.95 per cent (Pusa Nutan × DRG-53) to 151.85 per cent (DRG-5 × Satputia), 39.99 per cent (Pusa Nutan × DRG-53) to 139.89 per cent (DRG-5 × Satputia) over mid parent and -55.10 per cent (Swarna Uphar × Satputia) to 89.94 per cent (Pusa Nutan × Swarna Uphar) over standard parent. Increase in yield is due to such characters has also been reported in cucumber Hutchins (1939) and Singh et al., (1970).

The magnitude of relative heterosis for fruit weight ranged from -28.67 per cent (JRG-3 × DRG-5) to 76.79 per cent (Pusa Nutan × Satputia).Heterosis over better parent for fruit weight was varied from -35.23 per cent (Pusa Nutan × JRG-2) to 12.06 per cent (Pusa Nasdar × JRG-3) and (JRG-3 × Satputia) to 27.22 per cent (JRG-2 × Swarna Manjari) over standard parent. Mishra and Seshadri (1985) reported both positive and negative heterosis over mid and better parent in muskmelon.

The relative heterosis for total soluble solids varied from -24.64 per cent in the cross (DRG-5 × DRG53) to 37.52 per cent in (Pusa Nasdar × Satputia). The heterobeltiosis ranged from -21.78 per cent in (DRG-5 × DRG-53) to 29.45 per cent in (Pusa Nasdar × Satputia) and the standard heterosis varied from -14.30 per cent in (JRG-3 × Swarna Uphar) to 57.14 per cent in (Pusa Nasdar × Satputia) for total soluble solids. The heterosis over mid parent for dry matter content ranged from -21.23 per cent in the cross (DRG-53 × Satputia) to 41.04 per cent in the cross (Pusa Nasdar × JRG-2), the range of heterobeltiosis varied from -31.51 per cent in (DRG-53 × Satputia) to 33.45 per cent in (JRG-3 × Swarna Uphar) and the standard heterosis ranged from -9.74 per cent in (DRG-53 × Satputia) to 28.78 per cent in (Pusa Nasdar × JRG-2) for dry matter content. The findings are in accordance with the reports of Singh et al., (2012). Crosses like Pusa Nutan × Satputia, JRG-2 × Swarna Uphar, JRG-2 × Swarna Manjari and JRG-2 × JRG-3 were best performing hybrids for majority of the yield and yield contributing traits as they have better per se performance and specific combining ability.

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Table-1. Effect of general combining ability on various parameters in Ridge Gourd

Parents	Fruit weight (g)	Yield per plant(kg)	Total soluble solids (°brix)	Dry matter (%)
Pusa Nasdar	4.03**	0.10**	0.31**	-0.18**
Pusa Nutan	-1.88**	0.04**	0.00	0.14**
JRG-2	20.54**	0.22*	0.01	-0.10**
JRG-3	-0.78	0.00	-0.06**	-0.22**
Swarna Uphar	0.83	-0.07**	-0.14**	0.00
DRG-5	-3.83**	-0.08**	-0.13**	0.03
DRG-53	-4.57**	-0.11**	0.03**	0.11**
Swarna Manjari	4.31**	-0.08**	-0.01	-0.15**
Satputia	-18.65**	-0.02**	0.00	0.38**
Gi-Gj5%	2.24	0.05	0.04	0.06
Gi-Gj1%	3.26	0.08	0.05	0.09

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

Table-2. Specific combining ability studies in 9×9 diallel cross of Ridge Gourd

Cross combinations	Yield per plant(kg)	Fruit weight(g)	Total soluble solids(°brix)	Dry matter(%)
Pusa Nasdar×Pusa Nutan	0.16**	1.43	0.65**	0.34**
Pusa Nasdar×JRG-2	-0.05	-15.33**	-0.56**	-0.50**
Pusa Nasdar×JRG-3	-0.03	19.19**	0.40**	-0.13*
Pusa Nasdar×Swarna Uphar	0.01	-9.48**	0.08*	0.73**
Pusa Nasdar×DRG-5	0.05	-7.02**	-0.63**	-0.74**
Pusa Nasdar×DRG-53	-0.06	-7.09**	-0.49**	0.24**
Pusa Nasdar×Swarna Manjari	0.02	-2.70	0.35**	0.74**
Pusa Nasdar×Satputia	0.08	25.06**	0.95**	0.38**
Pusa Nutan×JRG-2	-0.06	-35.01**	0.55**	1.48**
Pusa Nutan×JRG-3	0.04	8.24**	0.32**	-0.44**
Pusa Nutan×Swarna Uphar	-0.09	-2.44	-0.40**	0.32**
Pusa Nutan×DRG-5	-0.03	1.23	0.09*	-0.18**
Pusa Nutan×DRG-53	-0.14**	9.16**	0.43**	0.70**
Pusa Nutan×Swarna Manjari	-0.08	-4.52*	-0.53**	0.08
Pusa Nutan×Satputia	0.38**	23.64**	-0.44**	-0.50**
JRG-2×JRG-3	0.16**	3.95	0.31**	1.15**
JRG-2×Swarna Uphar	0.30**	-2.45	-0.61**	-0.43**
JRG-2×DRG-5	-0.07	0.87	-0.12**	0.28**
JRG-2×DRG-53	0.05	-6.39**	0.52**	-0.25**
JRG-2×Swarna Manjari	0.28**	21.53**	0.06	0.69**
JRG-2×Satputia	-0.17**	24.09**	0.35**	-0.08
JRG-3×Swarna Uphar	0.03	8.33**	-0.05	1.32**
JRG-3×DRG-5	-0.11*	-33.88**	-0.15**	-0.84**
JRG-3×DRG-53	0.09	4.66*	0.08*	0.53**
JRG-3×Swarna Manjari	-0.06	-2.49	0.33**	-0.78**
JRG-3×Satputia	0.02	-7.47**	-0.38**	0.57**
SwarnaUpahar×DRG-5	0.01	-3.48	0.13**	-0.34**
SwarnaUpahar×DRG-53	0.02	-22.08**	-0.24**	-0.05
Swarna Uphar × Swarna Manjari	-0.05	-11.50**	0.31**	0.52**
SwarnaUpahar × Satputia	-0.19**	15.80**	0.10**	-0.14*
DRG-5×DRG-53	0.02	4.64*	-0.45**	0.09
DRG-5×SwarnaManjari	-0.09	2.16	0.00	0.54**
DRG-5×Satputia	0.31**	23.39**	0.29**	0.34**
DRG-53×SwarnaManjari	0.06	-11.24**	-0.06	-0.63**
DRG-53×Satputia	0.00	19.19**	-0.57**	-1.55**
Swarna Manjari× Satputia	-0.05	11.24**	-0.03	-0.93**
Sij	0.10	4.23	0.07	0.12
Sij-Sjk	0.15	6.24	0.10	0.18

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

Table-3. Expression of heterosis for yield per plant (kg)and fruit weight(g) in Ridge gourd hybrids

Cross combinations	**Yield per plant(kg)**			**Fruit weight(g)**		
	MP	**BP**	**SC**	**MP**	**BP**	**SC**
Pusa Nasdar × Pusa Nutan	45.48**	29.44*	57.74**	2.19	-1.81	-3.66
Pusa Nasdar×JRG-2	15.33	6.50	53.26**	-10.60**	-20.64**	0.43
Pusa Nasdar×JRG-3	9.81	-6.59	13.82	15.40**	12.06**	9.96**
Pusa Nasdar×Swarna Uphar	12.15	-12.48	6.65	-10.88**	-13.72**	-9.57**
Pusa Nasdar×DRG-5	23.96	-8.05	12.05	-6.83**	-9.46**	-11.16**
Pusa Nasdar×DRG-53	-3.24	-30.58*	-15.40	-6.40**	-10.05**	-11.74**
Pusa Nasdar×Swarna Manjari	15.43	-10.70	8.82	-0.78	-1.26	-2.16
Pusa Nasdar×Satputia	50.02**	7.83	31.40*	74.19**	3.24	1.30
Pusa Nutan×JRG-2	17.44	-2.52	40.29**	-24.45**	-35.23**	-18.04**
Pusa Nutan×JRG-3	27.47	21.07	15.01	6.94**	5.78*	-2.21
Pusa Nutan×Swarna Uphar	-6.73	-19.82	-23.83	-6.53**	-12.94**	-8.75**
Pusa Nutan×DRG-5	11.21	-9.91	-14.42	-1.08	-2.23	-9.48**
Pusa Nutan×DRG-53	-22.95	-39.99*	-42.99**	5.82*	5.79*	-4.28
Pusa Nutan×Swarna Manjari	-6.03	-20.03	-24.03	-2.64	-6.89**	-7.74**
Pusa Nutan×Satputia	140.75**	87.94**	78.54**	76.79**	6.17*	-3.99
JRG-2×JRG-3	53.73**	22.51*	76.30**	1.25	-12.39**	10.87**
JRG-2×Swarna Uphar	78.41**	31.56**	89.34**	-7.15**	-15.13**	7.41**
JRG-2×DRG-5	12.82	-20.49	14.42	-2.85	-15.89**	6.45**
JRG-2×DRG-53	33.00*	-9.01	30.94*	-7.23**	-20.45**	0.67
JRG-2×Swarna Manjari	75.74**	28.59**	85.06**	12.77**	0.53	27.22**
JRG-2×Satputia	8.68	-25.53**	7.18	55.47**	-11.10**	12.51**
JRG-3×Swarna Uphar	19.78	7.78	-7.90	1.19	-4.77*	-0.19
JRG-3×DRG-5	-15.37	-28.51	-38.91*	-28.67**	-28.73**	-34.01**
JRG-3×DRG-53	39.42*	12.94	-3.49	1.97	0.88	-6.73**
JRG-3×Swarna Manjari	-3.25	-13.87	-26.40	-1.31	-4.61	-5.48*
JRG-3×Satputia	43.26*	16.33	-0.59	34.43**	-19.56**	-25.64**
Swarna Uphar×DRG-5	12.47	4.72	-28.44	-9.75**	-15.01**	-10.92**
Swarna Uphar×DRG-53	13.19	0.48	-31.34*	-23.05**	-28.32**	-24.87**
Swarna Uphar×Swarna Manjari	-10.68	-11.75	-39.70*	-12.53**	-14.92**	-10.82**
SwarnaUpahar×Satputia	-26.19	-34.30	-55.10**	50.10**	-11.93**	-7.70**
DRG-5×DRG-53	15.18	9.39	-35.55*	-0.53	-1.66	-8.95**
DRG-5×Swarna Manjari	-20.13	-24.78	-49.84**	-0.18	-3.45	-4.33
DRG-5×Satputia	151.85**	139.89**	41.34**	70.47**	1.97	-5.58*
DRG-53×Swarna Manjari	24.42	11.65	-25.54	-9.82**	-13.74**	-14.53**
DRG-53×Satputia	36.84	36.42**	-27.25	67.24**	0.43	-9.14**
Swarna Manjari×Satputia	16.51	4.84	-30.09	56.11**	-7.62**	-8.47**
SE	0.067	0.077	0.077	2.791	3.223	3.223
CD5%	0.135	0.156	0.156	5.667	6.544	6.544
CD1%	0.176	0.203	0.203	7.350	8.487	8.487