

Original Research Article

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Heterosis Studies for Earliness and Yield Related Traits in Ridge Gourd [*Luffa acutangula* (L.) Roxb.]

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ABSTRACT

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The present study was carried out for development of hybrids in ridge gourd for earliness and yield traits. Twenty eight crosses were developed through half diallel fashion. Evaluated the crosses and along with their parents in Randomized block design (RBD). Significant differences found in the analysis of variance for early and yield related traits which indicates enormous genetic variability present in the ridge gourd. The magnitude of heterosis was found in desirable direction for early and yield traits viz., days to first female flowering is recorded in the cross DMRG-25 × DMRG-1 (-9.50%), for nodes up to first female flowering in the cross DMRG-25 × Arka Sumeet (-16.67%), for per cent fruit set in the cross DMRG-25 × Arka Sumeet (36.21%), for number of fruit per vine in the cross DMRG-25 × DMRG-44 (29.51%), for average fruit weight in (45.95%).

Introduction

Ridge gourd [*Luffa acutangula* (L.) Roxb.] Belongs to genus *Luffa* of Cucurbitaceae family. Ridge gourd also called as Chinese okra, angled gourd and ribbed gourd and has chromosome number $2n = 26$, and is native to India. Tender fruits are green in colour, which are used in soups and curries or as a cooked vegetable. Fruit contain edible protein (82%), moisture 92.5 g, protein 0.5 g, fat 0.5 g, carbohydrate 3.4 g, energy 17 k cal, calcium 18 mg, vitamin C 5m g, riboflavin 0.01 mg, phosphorous 26 mg, iron 0.5 mg and carotene

33 mg (Sheshadri and Parthasarthy, 1980) per 100 g of edible portion. Besides their use as vegetables, it is also used for various purposes. The fiber obtained from the mature dry fruit is used in industry for filters of various sorts, good pot holders, Table mats, bath room mats, slipper and shoe soles. The fiber is also proved to be a good insulator for various purposes. Sometimes the dry fruits which gave good storability are used for ornamental purposes also. It is emetic and traditionally used for the treatment of stomach

ailment and fever (Chakravarthy, 1959). Ridge gourd being a monoecious and cross-pollinated crop, it exhibits considerable heterozygosity in population and does not suffer much due to inbreeding depression, because heterozygosity has been balanced due to primitive form of hermaphrodite flower. Crop improvement depends upon genetic architecture of yield traits and magnitude of positive heterosis towards the yield attribute traits. Thus, provides ample scope for utilization of hybrid vigour on commercial scale. The possible exploitation of heterosis work has been taken up by several research centres. This wide range of genetic architecture in plant for early and yield related traits and also produce large number of hybrid seed at reasonable cost, very little work has been done to exploit the hybrid vigour in this crop. Heterosis breeding is the one of potential tool for exploitation of yield and yield contributing traits. Hence, an attempt was made to study the heterosis in different crosses over better parent, the best parent and the commercial check to develop and identify the suitable best performing hybrids.

Materials and Methods

The present investigation was undertaken at Department of Vegetable Science, K.R.C. College of Horticulture, Arabhavi, University of Horticultural Sciences, Bagalkot during *kharif* and *rabi*, 2014-2015. Experimental material consists of eight parents *viz*; DMRG-36, DMRG-25, KRCCH-1, DMRG-22, Arka Sumeet, DMRG-1, DMRG-15 and DMRG-44. 28 hybrids were developed through half diallel mating design during *kharif* 2014.

All the 28 hybrids along with their parents were evaluated in Randomised Block Design with two replications during *rabi* 2014-2015. The observations were recorded on tagged selected five plants in each replication and data recorded for various traits *viz.*, earliness and yield attributing traits of parents and

hybrids. Heterosis was calculated as percentage of F₁ performance in the favourable direction over better parent, best parent and commercial check.

Results and Discussion

The estimates of mean sum of squares due to parents showed significant differences for all the characters, except days to first female flower appearance, nodes upto first female flower, average fruit weight and per cent fruit set and it, indicating the presence of sufficient variability among the parents.

The estimates of mean sum of squares due to crosses were highly significant for all the characters among 28 crosses, this indicates enormous amount of variability present among the hybrids under studied (Table 1). *Per se* performance and range (mean performance) of parents and crosses for various heterotic effects as well as the heterotic crosses identified on the basis of earliness and yield parameters are presented in the (Tables 2 and 3). The heterotic responses of F₁ hybrids over better parent (BTP) and best parent (BP) for eight characters significant for both positive and negative direction are presented in the (Tables 2 and 3).

Early parameters

Negative heterosis desirable for earliness, for days to first female flower appearance, maximum and significant negative heterosis over better parent was observed in the cross DMRG-25 x DMRG-1 (-9.50%) followed by DMRG-22 x DMRG-1 (-8.25%) and DMRG-36 x DMRG-22 (-4.68%). Negative heterosis with reference to days to female flower appearance was also reported by Rao and Rao (2002) in ridge gourd. The cross DMRG-25 x DMRG-1 (-9.50%) significant negative heterosis over the best parent is low,

compared with earlier reported by Jadhav *et al.*, 2009 in the bitter gourd. For nodes upto first female flower appearance, maximum and significantly negative heterosis over the better parent was observed in the cross DMRG-25 x Arka Sumeet (-16.67%) followed by DMRG-36 x DMRG-25 (-15.12%) and the cross DMRG-25 x DMRG-1 exhibited significant and negative heterosis over the commercial check (-11.49%).

Similar findings were reported by Shaha and Kale (2003b), Narasannavar *et al.*, (2014) and Shivanand (2014). The cross DMRG-22 x DMRG-1 (-37.04%) significant negative heterosis over the best parent is high, compared with earlier reported by Jadhav *et al.*, 2009 in the bitter gourd.

Yield parameters

For sex ratio maximum and significantly positive heterosis over the better parent was observed in the cross DMRG-25 x Arka Sumeet (54.51%) followed by DMRG-25 x DMRG-44 (23.02%), positive heterosis for this character was also reported by Thangamani *et al.*, (2011) in bitter gourd. The cross DMRG-36x DMRG-22 (22.45%) significant positive heterosis over the best parent is high, compared with earlier reported by Jadhav *et al.*, (2009) in the bitter gourd. For per cent fruit set, the cross DMRG-25 x Arka Sumeet (36.21%) exhibited the maximum and positive heterosis which is high compared to 19.44 per cent reported by Kallimani (2004) in bitter gourd and Narasannavar *et al.*, (2014) in ridge gourd.

Table.1 Analysis of variance with respect of eight characters in ridge gourd

Source of variation	Mean sum of square					
	Replication	Treatments	Parents	Hybrids	Parents Vs. Hybrids	Error
Degree of freedom	1	35	7	27	1	35
Characters						
Early parameters						
Days to first female flowering	0.46	5.34**	0.94	6.44**	6.19 *	1.50
Nodes to first male flowering	0.37	0.92**	0.44 *	1.05**	0.66	0.18
Nodes to first female flowering	0.027	0.82 *	0.45	0.91 **	0.99	0.36
Yield parameters						
Sex Ratio (Male:Female)	74.11 **	18.38**	17.45 *	19.09 **	5.66	5.53
Per cent fruit set (%)	7.67	180.74**	49.56	221.37**	2.10	27.00
Number of fruit per vine(kg)	0.47	3.36**	2.36**	3.75**	0.19	0.41
Fruit diameter(mm)	0.00	21.09**	4.41	26.07 **	3.71	2.59
Average fruit weight(g)	1436.39 **	396.07**	117.62	466.20**	451.62	125.88

*And ** indicate significance of values at p=0.05 and p=0.01, respectively. DAS: Days after sowing

Table.2 Top three hybrids identified based on heterosis for earliness and Yield parameters in ridge gourd

Parameters	No. of hybrids having significant heterotic effects (based on better, best and standard heterosis)		Best three hybrids based on		
	+ve	-ve	BP	BTP	CC
Early parameters					
Days to first female flowering	10	06	DMRG-25 × DMRG-1 (-9.50%)	DMRG-25 × DMRG-1 (-9.50%)	DMRG-25 × DMRG-1 (-11.49%)
	04	07	DMRG-22 × DMRG-1 (-8.25%)	DMRG-36 × DMRG-22 (-8.25%)	DMRG-36 × DMRG-22 (-9.27%)
	02	09	DMRG-36 × DMRG-22 (-4.68%)	DMRG-36 × Arka Sumeet (-7.25%)	DMRG-36 × Arka Sumeet (-9.29%)
Nodes upto first male flowering	9	17	DMRG-22 × DMRG-1 (-37.04%)	DMRG-22 × DMRG-1 (-37.04%)	DMRG-22 × DMRG-1 (-20.93%)
	3	20	DMRG-36 × DMRG-1 (-31.48%)	DMRG-36 × DMRG-25 (-33.33%)	DMRG-36 × DMRG-22 (-18.60%)
	11	12	DMRG-25 × DMRG-22 (-30.61%)	DMRG-36 × DMRG-1 (-31.48%)	DMRG-36 × DMRG-25 (-16.28%)
Nodes up to first female flowering	11	10	DMRG-25 × Arka Sumeet (-16.67%)	DMRG-36 × DMRG-25 (-18.89%)	DMRG-25 × DMRG-1 (-11.49%)
	05	14	DMRG-36 × DMRG-25 (-15.12%)	DMRG-25 × Arka Sumeet (-16.67%)	DMRG-36 × DMRG-25 (-8.75%)
	15	07	DMRG-36 × DMRG-15 (-11.76%)	DMRG-36 × DMRG-22 (-11.11 %)	-
Yield parameters					
Sex ratio	08	19	DMRG-25 × Arka Sumeet (54.51%)	DMRG-36 × DMRG-22 (22.45%)	DMRG-25 × DMRG-1 (36.20%)
	06	22	DMRG-25 × DMRG-44 (23.02%)	DMRG-25 × DMRG-22 (14.22%)	DMRG-36 × Arka Sumeet (29.85%)
	06	21	DMRG-36 × DMRG-22 (23.01%)	DMRG-22 × DMRG-1 (12.07%)	DMRG-25 × Arka Sumeet (26.80%)
Per cent fruit set	05	14	DMRG-25 × Arka Sumeet (36.21%)	DMRG-25 × DMRG-1 (29.93%)	DMRG-25 × DMRG-1 (36.20%)
	05	18	DMRG-25 × DMRG-1 (31.54%)	DMRG-36 × Arka Sumeet (23.88%)	DMRG-36 × Arka Sumeet (29.85%)
	06	16	DMRG-36 × Arka Sumeet (25.37%)	DMRG-25 × Arka Sumeet (20.96%)	DMRG-25 × Arka Sumeet (26.80%)
Number of fruit per vine	09	19	DMRG-25 × DMRG-44 (29.51%)	DMRG-25 × Arka Sumeet (12.50%)	DMRG-25 × Arka Sumeet (18.41%)
	05	21	DMRG-25 × DMRG-1 (24.66%)	DMRG-25 × DMRG-1 (10.98%)	DMRG-25 × DMRG-1 (16.82%)
	07	19	DMRG-25 × Arka Sumeet (18.27%)	DMRG-25 × DMRG-22 (9.76%)	DMRG-25 × DMRG-22 (15.53%)
Fruit diameter	07	10	DMRG-25 × Arka Sumeet (24.72%)	DMRG-25 × Arka Sumeet (20.62%)	DMRG-25 × Arka Sumeet (24.20%)
	06	15	DMRG-25 × DMRG-1 (19.86%)	DMRG-25 × DMRG-1 (15.51%)	DMRG-25 × DMRG-1 (18.95%)
			-	-	-
Average fruit weight	03	01	DMRG-25 × Arka Sumeet (45.95%)	DMRG-25 × Arka Sumeet (42.47%)	DMRG-25 × Arka Sumeet (48.84%)
	01	03	Arka Sumeet × DMRG-15 (26.60%)	-	-

*And ** indicate significance of values at p=0.05 and p=0.01, respectively

Table.3 Range and heterosis for earliness and yield parameters in ridge gourd

<i>Per se</i> performance	Range		Heterosis (%)		
	Parents	Crosses	BTP	BP	CC
Early parameter					
Days to first female flowering	38.20 to 40.00	36.20 to 41.80	-9.50 to 8.86	-9.50 to 4.50	11.49 to 5.13
Nodes up to first male flowering	4.10 to 5.40	3.40 to 5.70	-37.04 to 16.33	-37.04 to 9.26	20.93 to 37.21
Nodes up to first female flowering	7.70 to 9.00	7.30 to 10.10	-16.67 to 18.75	-18.89 to 6.67	11.49 to 20.00
Yield parameter					
Sex ratio	5.16 to 12.09	4.36 to 14.81	-63.95 to 54.15	-63.95 to 22.45	60.05 to 35.19
Per cent fruit set	39.23 to 52.12	26.10 to 67.73	-43.62 to 36.21	-49.93 to 29.93	47.51 to 36.20
Number of fruit per vine	5.10 to 8.20	4.20 to 9.22	-48.78 to 29.51	48.78 to 12.50	46.08 to 18.41
Fruit diameter	32.31 to 37.23	30.34 to 44.90	-16.00 to 24.75	16.00 to 20.62	15.12 to 24.20
Average fruit weight	56.10 to 86.20	52.98 to 119.25	-35.15 to 45.95	36.70 to 42.47	33.87 to 48.84

BTP: Heterosis over better parent BP: Heterosis over best parent CC: Heterosis commercial check

For number of fruit per vine, the maximum and positive significant heterosis was observed in the cross DMRG-25 × DMRG-44 (29.51%) over better parent and DMRG-25 × Arka Sumeet (18.41%) shown positive significant heterosis over the commercial check. Similar findings were made for significant and positive heterosis over better parent by Shaha and Kale (2003a) and Narasannavar *et al.*, (2014) and over commercial check by Mole *et al.*, (2001) in ridge gourd. The cross DMRG-25 x Arka Sumeet (12.50%) significant negative heterosis over the best parent is low, compared with earlier reported by Jahan *et al.*, (2012) in the pumpkin. For average fruit weight, the cross DMRG-25 × Arka Sumeet (45.95%) exhibited maximum heterosis over better parent, which is very high compared to 19.99 per cent reported by Shaha and Kale (2003a) and Narasannavar *et al.*, (2014) in ridge gourd, for average fruit weight, the cross DMRG-25 × Arka Sumeet also exhibited maximum and significant heterosis of 48.84 per cent over commercial check and is very high compared to 10.74 per cent in sponge gourd as reported by Naliyadhara *et al.*, (2007).

For fruit diameter, the cross DMRG-36 × Arka Sumeet showed maximum heterosis (24.72%) over better parent compared with the results of 24.66 per cent as reported by Hedau and Sirohi (2004a) and Narasannavar *et al.*, (2014) in ridge gourd. The cross DMRG-25 × Arka Sumeet exhibited maximum and positive heterosis of 24.20 per cent over commercial check and is

high compared to 18.56 per cent reported by Hedau and Sirohi (2004a). The cross DMRG-25 x Arka Sumeet (20.62%) significant negative heterosis over the best parent is high, compared with earlier reported by Jadhav *et al.*, 2009 in the bitter gourd. The hybrid DMRG-25 × DMRG-1 was selected for number of fruit per vine and had high total yield of 4.83 t/ha yielding ability compared to 3.07 t/ha yield of commercial check with 55.56 per cent standard heterosis. Its performance is attributed by significant standard heterosis observed in the desirable direction for nodes upto first male flowering, per cent fruit set and fruit diameter.

The hybrid DMRG-25 × DMRG-44 was selected for number of fruit per vine and its total yield of 2.73 t/ha with 18.41 per cent standard heterosis. High magnitude of heterosis observed in these hybrids for number of fruit per vine. These hybrids also attributed by significant heterosis observed over commercial check in desirable direction for sex ratio, per cent fruit set and fruit diameter.

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Author contributions

K. Muthaiah – Design of the research programme, crossing work, data collection, data analysis and interpretation, critical revision of the article, final approval of the version to be published and acted as corresponding author.

V.D. Gasti – Helped during data analysis
Sanganamoni Mallesh – Helped during research article writing

Kattula Nagaraju – Critical revision of the research article

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