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Heterosis studies for growth, yield and quality parameters in ridge gourd [*Luffa accutangula* (Roxb.) L.]

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Abstract

A field trial carried out at Department of Horticulture, Agriculture College and Research Institute, TNAU, Madurai to study the heterosis for growth, flowering, fruit and quality traits of ridge gourd. Twenty four ridge gourd hybrids, six female parents (lines), four male parents (Testers) and one commercial check were sown in the field during *kharif*, 2018. The highest standard heterosis value was noticed for days to first male flower in L5XT3 (29.50), days to first female flower in L5XT2 (32.99), L5XT4 (32.99), node to first male flower in L5XT3 (347.37), node to first female flower in L3XT1 (80.51), sex ratio in L3XT1 (-33.54), days to harvest in L3XT3 (-13.20), vine length in L5XT2 (-43.90), fruit length in L5XT1 (56.79), fruit girth in L5XT4, L5XT1 (25.53), fruit rind thickness in L6XT4 (75.00), L3XT2 (50.00), fruit flesh thickness in L6XT3 (-18.92), number of fruits per plant in L3XT2 (178.21), L3XT1 (149.82), yield per plant and yield per hectare in L2XT3 (279.45), L3XT2 (221.92), L3XT1 (204.79). The heterosis for quality parameters found to be high in L2XT2 and L3Xt2 (47.06 and 23.53) for total soluble solids, for dry matter content in L6XT2 (147.83), moisture content in L6XT2 (-8.67) and for total crude fiber content in L3XT1 (45.00). The L3XT1 and L3XT2 found to show significant heterosis in the desired direction for most of the traits under study and they can be exploited as desirable hybrids.

Keywords: Heterosis, ridge gourd, *Luffa accutangula, kharif*

Introduction

Among the cucurbitaceous vegetables ridge gourd (*Luffa accutangula)* is one of the vegetable which has good dietary fiber. It is commercially cultivated mainly during *kharif* season in India. The matured dried fruit is used for fiber extraction. Ridge gourd is popularly known as *kalitori*, angled gourd and angled loofah. It has chromosome number 2n=26. Ridge gourd is popularly consumed as vegetable in Asia, African and Arabic countries. In India it is common vegetable in daily diet (Jyothi *et al.*, 2010) [7]. Ridge gourd is also known as vegetable of diet food due its high content of moisture (92%), low calorific value due to low sugar and low protein content. The fruit contains very low total soluble sugar of 1.5g, dietary fiber 0.5g, niacin 0.4mg, vitamin-A 410 IU, vitamin C 12mg, potassium 139mg, calcium 20 mg, iron 0.36mg, magnesium 14mg and phosphorous 32mg in 100g. It also contains antioxidant compounds such as flavonoids 159mg and phenolics 0.74mg (Kandoliya *et al.*, 2016) [8]. Ridge gourd has been also used extensively in Indian traditional system of medicine as diuretic, expectorant, laxative, purgative, hypoglycemic agent and bitter tonic. Ridge gourd has sweet taste after cooking, cooling in nature and easy to digest. They form a low calorie diet, which is considered good for diabetes. Both the soft pulp and skin of ridge gourd are used in various recipes, especially in south Indian cuisine. Chutneys made from the the peel of ridge gourd is known for their health benefits (Pullaiah, 2006) [14]. It is reported to contain many phytochemicals such as flavonoids, saponins, luffangulin, sapogenin, oleanolic acid and cucurbitacin B. In India the production of ridge gourd has to be increased to meet the increased demand. To increase the productivity new varieties and hybrids has to be evolved. Presently few varieties are available in India. Hence, the present study was takenup to develop hybrids which gives higher yield. The objective of this study was to estimate heterosis over the existing commercial check to identify high yielding with good quality.

Materials and Methods

The experiment was conducted at Department of Horticulture, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai during *kharif* 2018 in randomized block design with three replication in order to study the heterosis for growth, yield and quality in ridge gourd. Twenty four F1 hybrids and one commercial hybrid as check utilized in the study. The hybrids were obtained from the cross between six female parents *viz.* L1 (PKM-1), L2 (CO1), L3 (Virdhunagar local), L4 (Seranmadevi Local), L5 (Arka Sujath), L6 (Arka sumeet) and four male parents *viz.* T1 (Periyakottai Local), T2 (Alathur Local), T3 (Kannapatti Local), T4 (Srirampuaram Local) crossed in Line X Tester matting design. The seeds obtained in each crosses were extracted. The field was prepared by proper and ploughing and *Azospirillum*, *Phosphobacteria* at the rate of 2kg, *Pseudomonas fluorescens* 2.5kg mixed with 50kg farm yard manure and neem cake 100kg per hectare was applied. The pits size of 30cm X 30cm X 30cm at 2.5m between row and 2m between plants in each row were taken. The pits were filled with 10kg of farm yard manure, 6g of nitrogen, 12g of phosphorous, 12g of potassium. The seed obtained in each cross was treated with *Trichoderma viride* at the rate of 4g per kg of seeds. Three seeds were dibbled in one pit, 15 days after sowing seedlings of two per pit was maintained. The recommended plant protection measures were takenup against the pest and disease occurred in the crop. The observations were registered on various parameters are days to first male flower, days to first female flower, node to first male flower, node to first female flower, sex ratio, vine length (m), days to harvest, fruit weight (g), fruit length (cm), fruit girth, rind thickness (mm), flesh thickness (mm), number of fruits/ plant, yield/plant (g), yield/ha (t/ha), total soluble solids (TSS), dry matter content (%), moisture content (%) and total crude fiber (mg/100g). The data recorded on various traits were subjected to Analysis of variance by following procedure of Gomez and Gomez (1984) [4], estimation on standard heterosis as per the method of Fonseca and Patterson (1968) [2].

Result and Discussion

The analysis of variance exhibited that the mean squares due hybrids as well as parents were significant for most of the characters (Table1). The vine length, sex ratio, fruit rind thickness, flesh thickness, fruit diameter, total soluble solids, total crude fiber content. It shows the existence of genetic variability among the hybrids and parents used in the experiment. The variance due to parents against hybrids was significant for the most of the traits. Thus parents and hybrids performance was different from each other for days to first male flower, days to first female flower, node to first male flower, node to first female flower, days to harvest, fruit length (cm), fruit weight, no. of fruits/ plant, yield/ha (t/ha), dry matter content (%) and over all heterosis presence evident from significance of parent verses hybrid.

The main aim of heterosis breeding is quantum jump in yield of crop plants. Heterosis over commercial check for 19 traits are given in the Ttable 2. The result indicated that the phenomenon of heterosis was of a general occurrence for important characters in the study. Several study reports also showed substantial heterosis for various agronomic characters by Mole *et al.* (2001) [10], Gautham *et al.* (2004) [3] and Nandhini *et al.* (2018) [11].

The significant positive heterosis was ranged from 1.24 to 29.50. The highest heterosis was observed in L5XT3 (29.50), L5xT4 (19.88) and L2XT4 (18.94) for days to first male and female flowers appearance. It is responsible for earliness in the first harvest. Hedau and Sirohi (2004) [5] also reported heterosis over top parent. The node to first male and female flowers appearance significantly maximum heterosis in cross L3XT1 (80.52), L5XT2 (76.62), L5XT3 (75.32), L1XT3 (71.43). Indistinguishable results in water melon was reported by Aravindakumar *et al.* (2005) [1]. The highest heterosis over standard check indicated earliness. The sex ratio is one of the traits for high yield. The present study showed the negative heterosis for sex ratio that is less number of male flowers and more number of female flowers. Fifteen crosses showed negative significant heterosis. Among the fifteen L3XT1 (-33.54), L4XT4 (-22.82), L3XT2 (-27.35) showed highest negative heterosis which shows the plant produce more female flower over other cross and check hybrid.

The negative significant heterosis for days to harvest found in three crosses L3XT3 (-13.20), L1XT1 (-8.05) and L3XT2 (-7.38) which was earlier than the check hybrid. The positive heterosis was registered inL4XT1 (32.21), L5XT2 (32.21) which was early among the other hybrids. Ram *et al.* (2004) [15] observed similar results in ridge gourd. The vine length among the hybrids showed that twenty were significantly negative heterosis. The maximum values of heterosis L5XT2 (-43.90), L1XT1 (-39.90), LzXT1 (-38.68) and L5XT1 (-37.80).

The heterosis for fruit weight was significantly negative in 23 hybrids indicates that fruits are smaller than the check. The highest negative value was recorded in L4XT4 (-61.86), L5XT1 (-48.45), L4XT2 (48.42), L4XT1 (-45.02). The fruit length heterosis was significantly positive in L5XT1 (56.79), L6XT4 (49.83), L5XT2 (42.00). It indicates that fruit length was larger than standard check. The fruit girth heterosis was significantly negative in twelve hybrids. The maximum heterosis was recorded in L1Xt2 (-31.91), L5XT4 (25.53), L5XT1 (25.53). Singh *et al.* (2013) [16] reported positive and significant heterosis over better parent in bottle gourd.

The fruit rind thickness positively significant in three hybrids L6XT4 (75.00), L6XT1 (50.70), L3xT2 (50.00) and in the eleven hybrids it was negatively significant (-25.00). Similar heterosis effect was obtained by Yadav and Kumar (2012) [18] in bottle gourd.The fruit flesh thickness was significantly negative in only three hybrids L6XT3 (-18.92), L3XT2 (-16.22) and L4XT4 (16.22). Maximum heterosis was reported by Jadhav *et al.* (2009) in bitter gourd.

The number of fruits per plant was significantly positive in all the 24 hybrids. The maximum heterosis was recorded in L3XT2 (178.21), L2XT2 (169.50), L4XT2 (157.07), L3XT1 (149.82). Pradip *et al.* (2014) [13] reported significant heterosis in ridge gourd.The heterosis for yield per plant was significantly positive in 23 hybrids. The highest value was found in L2XT3 (279.45), L3XT2 (221.92), L3XT1 (204.79), L2XT4 (202.74). Lodam *et al.* (2009) [9] obtained significant positive heterosis in ridge gourd. The heterosis for yield per hectare was significantly positive in 23 hybrids.L2XT3, L3XT2, L2Xt2, L3XT1, L2XT4 hybrids were superior (281.10, 253.01, 216.49, 206.19, 203.78) Narasannavar *et al.* (2018) obtained significant positive heterosis in ridge gourd.

The total soluble solids (TSS), dry matter content, moisture content and total crude fiber content in the fruits are quality parameters of ridge gourd for identifying best hybrids. Two hybrids (L2XT2 and L3T2) exhibited significant positive heterosis (47.06 and 23.53) and another ten hybrids exhibited significant negative heterosis. Venugopalareddy *et al.* (2019) [17] observed positive heterosis in the hybrid of Kulgod Local X SG-3 (12.82). The dry matter content heterosis was positive and significant in fourteen hybrids. The high standard heterosis was exhibited in L6XT2 (147.83), L5XT3 (135.74) and L4XT2(109.21).The less moisture content in the fruits is more preparable. The negative significant heterosis is more desirable among the hybrids. The hybrids L6XT2 (-8.67), L5XT3 (-7.96) and L4XT2 (-6.40).The total crude fiber heterosis was positively significant in all the 24 hybrids. The high level of heterosis occurred in L3XT1 (45.00), L4XT4 (42.50) and L3XT2 (40.00).

Table 1: Analysis of variance for Line X Tester various characters of ridge gourd

S. No.	Character	Replications	Genotypes	Crosses	Lines	Testers	Line X Tester	Error
	Degrees of freedom	2	24	23	5	3	15	24
1	Days to first male flower	4.205	11.120 **	10.489 **	8.860 *	29.777 **	7.175 **	2.571*
2	Days to first female flower	0.295	24.682 **	21.838**	50.440 *	21.631 **	12.346 **	5.137 **
3	Node to first male flower	0.295	15.053 **	12.867 **	19.637 *	20.578 **	9.068 **	5.137 **
4	Node to first female flower	0.295	13.273 **	7.866 **	15.645 *	1.804	6.484 **	5.137 **
5	Sex ratio	0.124	0.847	0.854	1.640 **	1.610	0.439	0.060
6	Days to harvest	0.290	188.63 **	189.090 **	463.29 *	45.460 **	126.417 **	5.142 **
7	Vine length (m)	0.000	1.871	1.790	3.282 *	1.575	1.3360	0.004
8	Rind thickness (cm)	0.000	0.023	0.025	0.041	0.003	0.0240	0.002
9	Flesh thickness (cm)	0.003	0.316	0.323	0.298	0.761	0.244	0.059
10	Fruit length (cm)	12.741 *	114.060 **	118.980 **	129.550 *	112.990 **	116.66 **	3.130 **
11	Fruit diameter (cm)	0.001	0.498	0.495	0.278	0.265	0.614	0.059
12	Fruit weight (g)	122.30 **	5637.80 **	5468.800**	10049.88*	6806.58**	3674.26 **	43.340**
13	TSS (brix)	0.001	0.842	0.876	0.961	0.303	0.963	0.059
14	No. of fruits/plant	9.219	13.960 **	9.000 **	20.250 *	20.570 **	2.940 *	3.050 **
15	Yield (kg/plant)	0.001	1.886	1.706	3.383 *	1.488	1.191	0.059
16	Yield /ha (tone)	12.720 *	33.300 **	29.990 **	54.210 *	44.150 **	19.090 **	3.130 **
17	Dry matter content (%)	0.001	16.950 **	17.480 **	14.910 *	33.060 **	15.218 **	0.059
18	Moisture content (%)	0.001	16.950 **	17.480 **	14.910 *	33.060 **	15.218 ** *	0.059
19	Total crude fiber (mg/100g)	0.0014	0.004	0.004	0.007	0.002	0.003	0.001

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

Table 2: Estimates of heterosis (%) over standard check (SV) for various characters in ridge gourd

		1	2	3	4	5	7	6	12	10	11	8	9	14	18	19	13	15	16	17
		Days to first male flower	**Days to first female flower**	**Node to first male flower**	**Node to first female flower**	**Sex ratio**	**Vine length (m)**	**Days to harvest**	**Fruit weight (g)**	**Fruit length (cm)**	**Fruit girth**	**Rind thick ness (mm)**	**Flesh thick ness (mm)**	**No.of fruits/ plant**	**yield / plant (g)**	**Yield/ha (t/ha)**	**TSS (brix)**	**Dry matter content (%)**	**Moisture content (%)**	**Total crude fiber (mg/100g)**
1	L1 X T1	3.77	13.20 *	78.95	58.44 **	-11.15 *	-39.90 **	-8.05 *	-27.84 **	4.53 ns	-19.15 **	0.0 ns	-13.51 ns	103.34 **	101.37 **	102.06 **	5.88 ns	64.62 **	-3.79 **	12.50 **
2	L1 X T2	15.53 **	19.80 **	215.79 **	61.04 **	-4.18 ns	25.26 **	1.95 ns	-14.09 **	24.58 **	-31.91 **	-25.00 **	0.00 ns	108.50 **	115.75 **	146.65 **	-20.59 **	31.77 **	-1.86 **	17.50 **
3	L1 X T3	13.35 *	19.29 **	105.26	71.43 **	-16.29 **	-5.75 **	24.29 **	-15.81 **	18.47 **	-4.26 ns	-25.00 **	-2.70 ns	74.29 **	101.37 **	102.06 **	-26.47 **	-21.30 **	1.25 **	32.50 **
4	L1 X T4	10.87 *	18.27 **	184.21 **	51.95 **	-19.49 **	-27.18 **	22.71 **	-26.08 **	-26.83 **	-8.51 ns	-25.00 **	0.00 ns	71.39 **	73.97 **	74.40 *	2.94 ns	-5.05 ns	0.30 ns	20.00 **
5	L2 X T1	5.75	13.20 **	121.05	54.55 **	-17.25 **	-38.68 **	30.42 **	-37.46 **	-16.03 *	-10.64 ns	0.00 ns	-13.51 ns	126.58 **	94.52 **	95.19 **	17.65 *	82.49 **	-4.84 **	27.50 **
6	L2 X T2	3.26	14.21 *	78.95	66.23 **	-19.86 **	-33.62 **	5.32 ns	-14.78 **	9.95 ns	-12.77 ns	0.00 ns	-5.41 ns	169.50 **	185.62 **	216.49 **	47.06 **	71.48 **	-4.19 **	33.75 **
7	L2 X T3	11.80 *	17.77 **	115.79	46.75 **	-10.37 *	-30.92 **	15.32 **	13.40 **	-26.83 **	-4.26 ns	-25.00 **	0.00 ns	144.01 **	279.45 **	281.10 **	2.94 ns	24.73 **	-1.45 **	25.00 **
8	L2 X T4	18.94 **	12.69 *	268.46 **	58.44 **	-17.60 **	-36.41 **	24.73 **	-1.37 ns	31.71 **	4.26 ns	0.00 ns	10.81 ns	123.67 **	202.74 **	203.78 **	-5.88 ns	-58.84 **	3.45 **	22.50 **
9	L3 X T1	13.98 **	16.75 **	178.95 **	80.52 **	-33.54 **	-36.93 **	-5.14 ns	-10.96 **	-19.16 **	-17.02 **	-25.00 **	-13.51 ns	149.82 **	204.79 **	206.19 **	-17.65 *	-29.06 **	1.70 **	45.00 **
10	L3 X T2	6.83	9.64	126.32 *	38.96 *	-27.35 **	-31.88 **	-7.38 *	-7.22 **	2.28 ns	-14.89 **	50.00 **	-16.22 *	178.21 **	221.92 **	253.01 **	23.53 **	6.86 ns	-0.40 ns	40.00 **
11	L3 X T3	11.18 *	5.08	126.32 *	55.84 **	-10.71 *	-27.26 **	-13.20 **	-21.99 **	-12.54	-19.15 **	-25.00 **	-37.84 **	129.48 **	145.89 **	146.56 **	-14.71 ns	19.86 **	-1.16 **	27.50 **
12	L3 X T4	10.87 *	15.23 **	147.37 *	35.06 *	-5.49 ns	-34.32 **	2.48 ns	-26.12 **	-33.45 **	-6.38 ns	0.00 ns	0.00 ns	77.20 **	79.45 **	80.24 *	-23.53 **	-41.88 **	2.46 **	15.00 **
13	L4 X T1	2.48	6.09	73.68	33.77 *	-13.59 **	-30.75 **	32.21 **	-45.02 **	-15.68 *	-10.64 ns	-25.00 **	-5.41 ns	123.67 **	68.49 **	69.42 *	11.76 ns	-25.99 **	1.52 **	18.75 **
14	L4 X T2	4.35	28.93 **	94.74	48.05 **	-4.18 ns	-27.35 **	12.93 **	-48.42 **	-1.55 ns	0.00 ns	0.00 ns	10.81 ns	157.88 **	64.38 **	95.10 **	-5.88 ns	109.21 **	-6.40 **	32.50 **
15	L4 X T3	5.59	23.35 **	105.26	42.86 **	8.01 ns	-35.54 **	3.83 ns	-17.87 **	-25.78 **	-17.02 **	0.00 ns	-21.62 **	141.10 **	171.92 **	172.68 **	-17.65 *	24.55 **	-1.44 **	37.50 **
16	L4 X T4	15.53 **	17.26 **	168.42 **	51.95 **	22.82 **	-24.56 **	4.27 ns	-61.86 **	-37.28 **	-21.28 **	-25.00 **	-16.22 *	106.25 **	8.22 ns	8.25 ns	-38.24 **	-11.55 *	0.68 *	42.50 **
17	L5XT1	1.24	22.34 **	152.63 *	64.94 **	-13.24 **	-37.80 **	23.25 **	-48.45 **	56.79 **	-25.53 **	0.00 ns	-2.70 ns	100.44 **	41.78 *	42.27 ns	-2.94 ns	7.76 ns	-0.46 ns	10.00 **
18	L5XT2	16.15 **	32.99 **	189.47 **	76.62 **	-12.11 **	-43.90 **	32.21 **	-2.06 ns	42.00 **	17.02 **	-25.00 **	-8.11 ns	91.07 **	122.60 **	153.44 **	-11.76 ns	20.94 **	-1.23 **	17.50 **
19	L5XT3	29.50 **	28.43 **	347.37 **	75.32 **	-6.10 ns	-27.35 **	20.10 **	-15.77 **	-14.69 *	-17.02 **	1.25 ns	-13.51 ns	71.39 **	97.95 **	98.63 **	-2.94 ns	135.74 **	-7.96 **	25.00 **
20	L5XT4	19.88 **	32.49 **	242.11 **	58.44 **	-3.05 ns	-2.96 *	12.04 **	-12.37 **	-10.80	-25.53 **	-25.00 **	2.70 ns	94.63 **	134.25 **	134.88 **	2.94 ns	64.80 **	-3.80 **	22.50 **
21	L6XT1	1.24 *	4.06	84.21	40.26 *	-18.12 **	18.12 **	30.72 **	-42.61 **	-24.74 **	-8.51 ns	50.00 **	-13.51 ns	112.06 **	67.12 **	67.53 *	-17.65 *	6.14 ns	-0.36 ns	5.00 ns
22	L6XT2	17.39 **	10.66	126.32 *	49.35 **	-12.46 **	12.02 **	20.26 **	-35.74 **	-6.78 ns	-4.26 ns	-25.00 **	0.00 ns	152.07 **	100.00 **	130.58 **	-35.29 **	147.83 **	-8.67 **	12.50 **
23	L6XT3	16.15 **	27.41**	194.74 **	46.75 **	-3.83 ns	-4.36 **	23.25 **	-40.21 **	-23.69 **	-12.77 *	25.00 **	-18.92 **	132.39 **	90.41 **	91.41 **	5.88 ns	34.30 **	-2.01 **	17.50 **
24	L6XT4	17.25 **	8.12	157.89 *	51.95 **	0.00 ns	0.00 ns	20.2 **	-15.77 **	49.83 **	-4.26 ns	75.00 **	-2.70 ns	106.25 **	138.36 **	139.18 **	11.76 ns	15.16 **	-0.89 **	22.50 **
	SE	1.60	2.27	2.27	2.27	0.24	0.07	2.27	6.58	1.77	0.24	0.02	0.24	1.75	0.24	1.77	0.24	0.24	0.24	0.01

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