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REGULAR ARTICLE

STUDIES ON HETEROSIS FOR YIELD IN BRINJAL (*SOLANUM MELONGENA*. L)

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ABSTRACT

Heterosis breeding is one of the most efficient tools to exploit the heterotic response for various useful traits. The Line × Tester mating design was undertaken with seven lines and three testers were evaluated along with twenty one hybrids in randomized block design to estimate the magnitude of heterosis for yield and its yield contributing characters. The best way to utilize heterosis in crop is to generate F_1 hybrids having maximum heterozygosity, thereby facilitating the identification and selection of hybrid vigor. The positive significant standard heterosis for fruit yield per plant was maximum with $L_3 \times T_1$ (28.94%) followed by $L_7 \times T_3$ (15.73%) and $L_7 \times T_1$ (15.10%) respectively. Some of the promising hybrids have showed desirable heterosis for plant height, number of fruits per plant,1000 seed weight, seedling shoot length, seedling root length and seedling dry weight.

Keywords: Heterosis, parents, F1 hybrids and yield characters

INTRODUCTION

Brinjal (*Solanum melongena*. L) is one among the very important vegetable crop cultivating in India [1]. Brinjal is often cross pollinated and possess considerable diversity for plant types, fruit yield and yield attributing characters and thus offers an opportunity to exploit the genetic diversity for development of hybrid varieties. In ancient system of medicine, it has been used in control of many diseases, thus brinjal has medicinal properties [2]. This crop contains wide variety of dietary nutrients and minerals together with vitamins [3]. In order to obtain more varieties with high yielding and disease resistance characteristics, many attempts have been made by researchers. Exploring hybrids is one among that techniques [4]. In the present investigation, a study was conducted to study the heterosis in various crosses.

MATERIALS AND METHODS

The experiment study was carried out in Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar during 2016 February-2017 January. The genotypes such as [Chidambaram Local-1(L_1), Chidambaram Local-2 (L_2), MDU-1(L_3), KKM-1(L_4), Bhavani Local(L_5), CO-1(L_6) and CO-2 (L_7)]and three testers [Palur-1(T_1), Palur-2 (T_2) and Annamalai (T_3)] collected from Vegetable Research Station, Palur and Department of Genetics and Plant Breeding, Annamalai University, were used for the studies. The seeds of ten parents were sown in rows on a raised bed nursery followed by the normal nursery practices. The transplanting was done on 30 d old seedlings with the spacing of 75 × 60 cm. Ten plants per genotype were maintained. Recommended practices like of manuring, irrigation and plant protection measures were followed. The observations recorded were days to first flowering, plant height, total number of branches per plant, number of fruits per plant, fruit length, fruit girth, fruit weight, fruit yield per plant, 1000 seed weight, seed germination percentage, seedling shoot length, seedling root length and seedling dry weight.

RESULTS AND DISSCUSION

Analysis of variance for combining ability revealed that significant differences among lines and testers in respect of *gca* for all the characters in both the generations. The significance of *gca* variances thus reflected the importance of non-additive gene action for these traits. Similar results were also reported by Das and Barua [5] and Rai and Asati [6]. The differences among hybrids due to interaction between lines and testers in respect of *sca* were also found significant for all the characters in F_1 generation indicating the importance of non-additive gene action. Similar results of gene action for these traits were also reported by Reddy, E. E. P. and A. I. Patel (2014). The predominant role of non-additive gene action in F_1 generation was observed for all the traits. For all the thirteen characters the ratio (*GCA*/SCA) value less than unity indicated the predominance of non-additive gene action in the inheritance of these traits (table 1).

Heterosis was estimated for thirteen characters and

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expressed as percentage. The first three cross of each characters for over mid parent (d_i-relative heterosis), better parent (d_{ii}-heterobeltiosis) and standard parent (d_{iii}-standard heterosis) has been mentioned below in table 2.

Days to first flowering

The hybrid $L_2 \times T_2$ recorded maximum significant negative relative heterosis of (-9.21 per cent) followed by $L_2\times T_3$ recorded (-3.64 per cent) and $L_4\times T_1$ (-2.79 per cent) respectively. And the crosses$L_2 \times T_2$ (-14.57 per cent) followed by $L_1 \times T_1$ (-5.07 per cent) and $L_2 \times T_3$ (-4.95 per cent) recorded negative and significant heterobeltios. The standard heterosis ranged from-18.90 for $L_2 \times T_2$ to$L_1 \times T_2$ (-2.50) and the crosses $L_2 \times T_2$ recorded maximum negative standard heterosis (-18.90 per cent) followed by $L_4 \times T_1$ (-17.77 per cent) and $L_7\times T_1$ (-16.38 per cent) for this trait.

Plant height (cm)

The hybrids showed significantly negative heterosis over mid parent. The maximum negative relative heterosis was observed in $L_1 \times T_2$ (-25.54 per cent) followed by $L_1 \times T_1$ (-27.12) and $L_1 \times T_3$ (-15.62). The crosses $L_1 \times T_2$ (-29.92 per cent) followed by $L_1 \times T_1$ (-27.55) per cent and $L_1 \times T_3$ (-16.27 per cent) combinations recorded negative and significant heterobeltiosisfor this trait. The standard heterosis ranged from $L_1 \times T_2$ (-29.92 per cent) to $L_5\times T_3$ (9.63 per cent) and the crosses $L_1 \times T_2$ recorded maximum negative standard heterosis of (-29.92 per cent) followed by $L_1 \times T_1$ (-27.55 per cent) and $L_1 \times T_3$ (-16.27 per cent) respectively.

Total number of branches per plants

The cross $L_2 \times T_3$ recorded significant positive relative heterosis (37.17 per cent) followed $L_6 \times T_3$ (18.41 per cent) and $L_1 \times T_3$ (8.48 per cent) respectively. Two crosses have recorded significant positive heterobeltiosis *viz.*, $L_2 \times T_3$ (15.13 per cent) followed by $L_6 \times T_3$ (4.61 per cent) for this trait. And the positive significant commercial heterosis ranged from $L_3 \times T_1$ (97.73 per cent) to $L_5 \times T_2$ (10.21 per cent) and the crosses of $L_3 \times T_1$ recorded maximum significant positive standard heterosis of (97.73 per cent) followed by $L_7 \times T_1$ (87.10 per cent) and $L_4 \times T_1$ (63.36 per cent) for this trait.

Number of fruits per plant

The hybrid $L_2 \times T_3$ recorded significant positive relative heterosis of (14.56 per cent) followed by $L_6 \times T_2$ (9.38 per cent). One crosses have recorded significant positive heterobeltiosis *viz.*, $L_2 \times T_3$ (14.29 per cent) for this trait.

The positive significant commercial heterosis ranged from $L_7 \times T_1$ (62.29 per cent) to $L_5 \times T_2$ (12.07 per cent) and the cross of $L_3 \times T_1$ recorded maximum significant positive standard heterosis (77.91 per cent) followed by $L_2 \times T_3$ (74.11 per cent) and $L_7 \times T_1$ (62.29 per cent) respectively.

Fruit length (cm)

The hybrid $L_1 \times T_1$ exhibited significant positive relative heterosis (21.81 per cent) followed by $L_4 \times T_1$ (17.76 per cent) and $L_3 \times T_1$ (13.27 per cent) respectively. The crosses have recorded significant positive heterobeltiosis are $L_1 \times T_1$ (15.74 per cent) followed by $L_3\times T_1$ (8.21 per cent), $L_4 \times T_1$ (4.38 per cent) for this trait.

The negative significant commercial heterosis was ranging from $L_1 \times T_1$ (28.54 per cent) to $L_2 \times T_2$ (4.25 per cent) and the cross $L_1 \times T_1$ (28.54 per cent) recorded maximum significant positive standard heterosis followed by $L_1 \times T_2$ (20.79 per cent) and $L_3 \times T_1$ (20.18 per cent) for this trait.

Fruit girth

The hybrid $L_1 \times T_1$ exhibited significant positive relative heterosis (29.05 per cent) followed by $L_1 \times T_3$ (14.75 per cent) and $L_3 \times T_1$ (11.83 per cent) respectively. One cross has recorded significant positive heterobeltiosis *viz.*, $L_3 \times T_1$ (11.47 per cent) respectively. And positive significant commercial heterosis and it was ranging from $L_3 \times T_1$ (102.76 per cent) to $L_6 \times T_1$ (9.84 per cent) and the hybrid $L_3 \times T_1$ recorded maximum significant positive standard heterosis of (102.76 per cent) followed by $L_3 \times T_2$ (94.49 per cent) and $L_1 \times T_1$ (81.89per cent) for this trait.

Fruit weight

The hybrid $L_4 \times T_3$ exhibited significant negative relative heterosis (105.96 per cent) followed by $L_7 \times T_3$ (88.30 per cent) and $L_1 \times T_1$ (-81.33 per cent) respectively. The crosses have recorded significant positive heterobeltiosis *viz.*, $L_4 \times T_3$ (82.62 per cent) followed by $L_7 \times T_3$ (68.29 per cent) and $L_6 \times T_3$ (64.31 per cent) for this trait. And the crosses recorded positive significant commercial heterosis and it was ranging from $L_1 \times T_1$ (120.81 per cent) to $L_2 \times T_2$ (8.71 per cent) and the hybrid $L_1 \times T_1$ recorded maximum significant positive standard heterosis (120.81per cent) followed by $L_5 \times T_1$ (104.88 per cent) and $L_7 \times T_2$ (92.36 per cent) respectively.

Fruit yield per plant

The hybrids namely $L_5 \times T_2$ recorded (84.09 per cent) followed by $L_2 \times T_2$ (46.43 per cent) and $L_2 \times T_3$ (17.67 per cent) respectively. The hybrids recorded significant positive heterobeltiosis *viz.*, $L_5 \times T_2$ (77.90 per cent) followed by $L_2 \times T_2$ (40.03 per cent) for this trait. And standard heterosis for this trait and it was ranging from $L_3 \times T_1$ (28.94 per cent) to $L_5 \times T_2$ (9.75 per cent) and it was maximum with the hybrid $L_3\times T_1$ (28.94 per cent) followed by $L_7 \times T_3$ (15.78 per cent) and $L_7 \times T_1$ (15.10 per cent) for this trait.

1000 seed weight

The hybrid $L_2 \times T_2$ recorded significant positive relative heterosis of (49.94 per cent) followed by $L_6 \times T_1$ (21.88 per cent) and $L_1 \times T_2$ (20.44 per cent) respectively. One out of twenty one crosses have recorded significant positive heterobeltiosis namely, $L_2 \times T_2$ (28.25 per cent) for this trait. The crosses recorded positive significant commercial heterosis and it was ranging from $L_7\times T_1$ (72.15 per cent) to $L_7\times T_2$ (18.99 per cent) and the cross of $L_7 \times T_1$ recorded maximum significant positive standard heterosis of (72.15per cent) followed by $L_6 \times T_1$ (56.20per cent) and $L_3 \times T_1$ (38.86 per cent) for this trait.

Seed germination percentage

The hybrid $L_3 \times T_1$ exhibited significant positive relative heterosis of (5.27 per cent) followed by $L_7 \times T_1$ (2.86 per cent) and $L_3 \times T_2$ (2.14 per cent) respectively. And the crosses have recorded significant positive heterobeltiosis *viz.*, $L_3 \times T_1$ (3.58 per cent) followed by $L_2 \times T_2$ (1.23 per cent) and $L_7 \times T_1$ (1.12 per cent) respectively. The hybrid $L_3 \times T_1$ recorded maximum significant positive standard heterosis of (11.91 per cent) followed by $L_7 \times T_1$ (9.45 per cent) and $L_3 \times T_2$ (8.05 per cent) for this character.

Seedling shoot length

The hybrid $L_7 \times T_1$ exhibited significant positive relative heterosis of (30.16per cent) followed by $L_5 \times T_1$ (24.37per cent) and $L_4 \times T_1$ (23.57 per cent) respectively. The crosses have recorded significant positive heterobeltiosis *viz.*, $L_5 \times T_1$ (23.63 per cent) followed by $L_7 \times T_1$ (23.34 per cent) and $L_4 \times T_1$ (22.84 per cent) respectively.

And the crosses recorded positive significant commercial heterosis and it was ranging from $L_7 \times T_1$ (21.58 per cent) to $L_1 \times T_2$ (8.79 per cent) and the hybrid $L_7 \times T_1$recorded maximum significant positive standard heterosis of (21.58 per cent) followed by $L_6 \times T_1$ (19.49 per cent) and $L_7 \times T_3$ (13.15 per cent) for this character.

Seedling root length

The hybrid $L_1 \times T_3$ exhibited significant positive relative heterosis of (59.54 per cent) followed by $L_2 \times T_3$ (40.62per cent) and $L_1 \times T_1$ (25.23 per cent) respectively.

The crosses have recorded significant positive heterobeltiosis *viz.*, $L_1 \times T_3$ (58.72 per cent) followed by $L_2 \times T_3$ (39.36 per cent) and $L_1 \times T_1$ (23.45 per cent) respectively. And for commercial heterosis it was ranging from $L_6 \times T_2$ (65.80 per cent) to $L_1 \times T_1$ (23.45 per cent). The hybrid of $L_6 \times T_2$ recorded maximum significant positive standard heterosis of (65.80 per cent) followed by $L_7 \times T_1$ (60.49per cent) and $L_1 \times T_3$ (60.36 per cent) was given for this trait.

Seedling dry weight

The hybrid $L_2 \times T_2$ exhibited significant positive relative heterosis (87.94 per cent) followed $L_5 \times T_3$ (64.58 per cent) and $L_5 \times T_2$ (56.10 per cent) respectively. And the crosses have recorded significant positive heterobeltiosis *viz.*, $L_2 \times T_2$ (34.53 per cent) followed by $L_5 \times T_3$ (25.40 per cent) and $L_5 \times T_2$ (15.11 per cent) respectively. And the crosses recorded positive significant commercial heterosis and it was ranging from $L_3 \times T_1$ (62.50 per cent) to $L_1 \times T_3$ (14.71 per cent) and the hybrid $L_3\times T_1$ recorded maximum significant positive standard heterosis (62.50 per cent) followed by $L_2 \times T_2$ (37.50 per cent) and $L_5 \times T_2$ (17.65 per cent) for this character.

Table 1: Analysis of variance for thirteen characters in brinjal

Source	df	Days to first flowering	Plant height	Total number of branches per plant	Number of fruits per plant	Fruit length	Fruit girth	Fruit weight	Fruit yield per plant	1000 seed weight	Seed germination percentage	Seedling shoot length	Seedling root length	Seedling dry weight
		Mean Sum of Square												
Replication	2	36.49	2109.71	30.16	30.01	3.0897	32.70	625.38	165305.80	29.5660	28.15	28.75	29.94	0.24
Lines	6	146.79**	623.6186**	26.53**	30.02**	4.1004**	62.28**	1190.77	44694.1	1.0765	51.28**	3.9019**	1.2722**	0.03**
Testers	2	39.31**	280.1652**	45.57**	13.67**	0.2372	13.43	2114.36	5152.6667	0.7020	104.73**	3.3044	0.7799	0.007
L× T	12	128.41**	129.5082**	9.57**	7.93**	1.2737**	9.17**	1241.61**	162009.19**	1.4619**	12.82**	1.7634**	1.0810**	0.04**
Error	60	0.11	7.9310	0.03	0.07	0.0337	0.056	3.76	698.2100	0.0611	0.09	0.0315	0.0939	0.0008
GCA	-	-0.0884	4.2526	0.2262	0.1875	0.0194	0.4261	1.8755	-1204.2450	-0.0050	0.5398	0.0207	0.0007	-0.0002
SCA	-	42.7665	40.5257	3.1820	2.6220	0.4133	3.0380	412.6168	53770.3281	0.4669	4.2448	0.5773	0.3290	0.0159
***GCA*/SCA**	-	0.00020	0.10493	0.07108	0.071510	0.04693	0.14025	0.004545	0.02239	0.01070	0.12716	0.03585	0.00212	0.0125

*, **: Significant at 1 percent and 5 per cent level

Table 2: Heterosis for the first three best hybrids in relative heterosis, heterobeltiosis and standard heterosis

CHARACTERS	1	2	3	4	5	6	7	8	9	10	11	12	13
Relative Heterosis (di)	$L_2 \times T_2$ (9.21 %)	$L_1 \times T_2$ (-25.54 %)	$L_2 \times T_3$ (37.17%)	$L_2 \times T_3$ (14.56%)	$L_1 \times T_1$ (21.81%)	$L_1 \times T_1$ (29.05%)	$L_4 \times T_3$ (105.96%)	$L_5 \times T_2$ (84.09%)	$L_2 \times T_2$ (49.94%)	$L_3 \times T_1$ (5.27%)	$L_7 \times T_1$ (30.16%)	$L_1 \times T_3$ (59.54%)	$L_2 \times T_2$ (87.94%)
	$L_2 \times T_3$ (3.64 %)	$L_1 \times T_1$ (- 27.12 %)	$L_6 \times T_3$ (18.41%)	$L_6 \times T_2$ (9.38%)	$L_4 \times T_1$ (17.76%)	$L_1 \times T_3$ (14.75%)	$L_7 \times T_3$ (88.30%)	$L_2 \times T_2$ (46.43%)	$L_6 \times T_1$ (21.88%)	$L_7 \times T_1$ (2.86%)	$L_5 \times T_1$ (24.37%)	$L_2 \times T_3$ (40.62%)	$L_5 \times T_3$ (64.58%)
	$L_4 \times T_1$ (-2.79 %)	$L_1 \times T_3$ (-15.16%)	$L_1 \times T_3$ (8.48%)	----	$L_3 \times T_1$ (13.27%)	$L_3 \times T_1$ (11.83%)	$L_1 \times T_1$ (-81.33%)	$L_2 \times T_3$ (17.67%)	$L_1 \times T_2$ (20.44%)	$L_3 \times T_2$ (2.14%)	$L_4 \times T_1$ (23.57%)	$L_1 \times T_1$ (25.23%)	$L_5 \times T_2$ (56.10%)
Heterobeltiosis (dii)	$L_2 \times T_2$ (-14.57 %)	$L_1 \times T_2$ (- 29.92%)	$L_2 \times T_3$ (15.13%)	$L_2 \times T_3$ (14.29%)	$L_1 \times T_1$ (15.74%)	$L_3 \times T_1$ (11.47%)	$L_4 \times T_3$ (82.62%)	$L_5 \times T_2$ (77.90%)	$L_2 \times T_2$ (28.25%)	$L_3 \times T_1$ (3.58%)	$L_5 \times T_1$ (23.63%)	$L_1 \times T_3$ (58.72%)	$L_2 \times T_2$ (34.53%)
	$L_1 \times T_1$ (- 5.07 %)	$L_1 \times T_1$ (-27.55%)	$L_6 \times T_3$ (4.61%)	--------	$L_3 \times T_1$ (8.21%)	------	$L_7 \times T_3$ (68.29%)	$L_2 \times T_2$ (40.03%)	------	$L_2 \times T_2$ (1.23%)	$L_7 \times T_1$ (23.34%)	$L_2 \times T_3$ (39.36%)	$L_5 \times T_3$ (25.40%)
	$L_2 \times T_3$ (-4.95 %)	$L_1 \times T_3$ (-16.27%)	------	---------	$L_4 \times T_1$ (4.38%)	-------	$L_6 \times T_3$ (64.31%)	------	-------	$L_7 \times T_1$ (1.12%)	$L_4 \times T_1$ (22.84%)	$L_1 \times T_1$ (23.45%)	$L_5 \times T_2$ (15.11%)
Standard Heterosis (diii)	$L_2 \times T_2$ (- 18.90 %)	$L_1 \times T_2$ (- 29.92 %)	$L_3 \times T_1$ (97.73%)	$L_3 \times T_1$ (77.91%)	$L_1 \times T_1$ (28.54%)	$L_3 \times T_1$ (102.76%)	$L_1 \times T_1$ (120.81%)	$L_3 \times T_1$ (28.94%)	$L_7 \times T_1$ (72.15%)	$L_3 \times T_1$ (11.91%)	$L_7 \times T_1$ (21.58%	$L_6 \times T_1$ (65.80%)	$L_3 \times T_1$ (62.50%)
	$L_4 \times T_1$ (-17.77 %)	$L_1 \times T_1$ (-27.55%)	$L_7 \times T_1$ (87.10%)	$L_2 \times T_3$ (74.11%)	$L_1 \times T_2$ (20.79%)	$L_3 \times T_2$ (94.49%)	$L_5 \times T_1$ (104.88%)	$L_7 \times T_3$ (15.78%)	$L_6 \times T_1$ (56.20%)	$L_7 \times T_1$ (9.45%)	$L_6 \times T_1$ (19.49%)	$L_7 \times T_1$ (60.49%)	$L_2 \times T_2$ (37.50%)
	$L_7 \times T_1$ (- 16.38 %)	$L_1 \times T_3$ (-16.27%)	$L_4 \times T_1$ (62.29%)	$L_7 \times T_1$ (62.29%)	$L_3 \times T_1$ (20.18%)	$L_1 \times T_1$ (81.89%)	$L_7 \times T_2$ (92.36%)	$L_7 \times T_1$ (15.10%)	$L_3 \times T_1$ (38.86%)	$L_3 \times T_2$ (38.86%)	$L_7 \times T_3$ (13.15%)	$L_1 \times T_3$ (60.36%)	$L_5 \times T_2$ (17.65%)

CONCLUSION

The hybrids $L_3\times T_1$, $L_7\times T_3$ and $L_7\times T_1$ recorded as superior hybrids based on the magnitude of standard heterosis for fruit yield per plant. The crosses $L_2\times T_2$, $L_4\times T_1$ and $L_7\times T_1$ recorded for days to first flowering based on the magnitude of standard heterosis. Hybrids such as $L_7\times T_1$, $L_6\times T_1$ and $L_3\times T_1$ for 1000 seed weight, the crosses $L_3\times T_1$, $L_7\times T_1$ and $L_3\times T_2$ for seed germination percentage, the crosses $L_7 \times T_1$, $L_6\times T_1$ and $L_7\times T_2$ for seedling shoot length and the crosses $L_6\times T_2$, $L_7\times T_1$ and $L_1\times T_3$ for seedling root length. The hybrid $L_3 \times T_1$ was identified as the best hybrid since it had significant standard heterosis for all the traits. The next best hybrids were $L_7 \times T_1$ and $L_7 \times T_3$ since they possessed desirable standard heterosis for major traits. Our results are in agreement with previous studies [7-11].

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