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Study on genetic diversity and its relation to heterosis in F_1 hybrids of germplasm lines of brinjal (*Solanum melongena* L.)

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Diversity is an important criterion in the selection of elite germplasm lines to develop highly heterotic F_1 hybrids. The heterosis and diversity study was conducted on 28 F_1 hybrids of brinjal derived from germplasm lines *viz.*, IC-112995, IC-111305, IC-90952, IC-99704, IC-99663, IC-136210, IC-126784 and a local cultivar Manjri Gota at botany garden, UAS Dharwad during summer 2006. Fruit weight (g), number of fruits per plant and fruit yield (g) exhibited considerably high magnitude of heterosis. High heterosis for fruit yield was attributed to increased fruit weight and number of fruits per plant. Thirty six entries comprising 28 F_1 hybrids and 8 parents were grouped in six clusters. Based on parental divergence, all 28 hybrids were grouped in 4 divergence classes. The combination of heterosis and diversity analysis indicated the high frequency of hybrids classified under DC2 and DC3 suggesting moderate genetic diversity is most desirable to produce highly heterotic hybrids.

Key words : Heterosis, Diversity, Brinjal

INTRODUCTION

Genetic divergence is the one of the criteria of selection of parents to produce potential hybrids and for isolation of transgressive segregants from hybrids in further filial generations. This study is important in the view that germplasm lines have their wide varied origin and are highly variable with respect to plant and fruit morphological aspects. As fruit production is gaining importance at domestic and international level, mining in to new germplasm lines and their systematic study is prerequisite to develop new hybrid varieties which can withhold the challenges of both quantity and quality aspects on commercial lines. Though genetically diverse parents yield maximum heterosis, the magnitude of divergence critically matters the F_1 heterosis (Busbice and Rawlings, 1974). More diverse the parents within reasonable range better are the chances of improvement in yield and other yield parameters. In view of this an investigation was carried out to understand the relationship between heterosis and parental divergence in germplasm lines (collected from NBPGR New Delhi).

MATERIALS AND METHODS

The experimental material comprised of eight parents and their all-possible hybrids combinations without reciprocals. Parents and hybrids were planted in randomized block design with two replications in the botany garden of University of Agricultural Sciences, Dharwad during summer season of 2006. Each entry with spacing of 30x10 cm was represented by two rows with ten plants in each. Observations were recorded on five randomly tagged plants in each entry on number of branches per plant, days to flowering, number of flowers per inflorescence, number of fruits per cluster, fruit weight (g), number of fruits per plant and yield per plant (g).

Genetic divergence was studied following Mahalonobis's D^2 (1936) distance technique. Tocher's method (Rao, 1952) was used for grouping the genotypes. Arunachalum's method (1984) was used to classify the parental divergence in to four divergence classes (DC_1, DC_2, DC_3, DC_4). The procedure used was as follows. The mean (m) and standard deviation (sd) of parental distance were computed. The minimum (x) and maximum (y) values of parental divergence of 28 combinations were derived. Using mean (m), standard deviation (sd), minimum (x) and maximum (y) values, parental divergence was classified into four divergence classes. The mean D^2 of 28 hybrid combinations was 383.32, sd was 342.12, x and y were 26.98 and 1249.36, respectively. Thus four intervals for four divergence classes are then DC_1 = 725.44 to 1249.36, DC_2 = 383.32 to 725.43, DC_3 = 41.20 to 383.31 and DC_4 = 26.98 to 41.19. Standardized potence (%) *i.e.* heterosis over mid parent value of hybrids for yield per plant associated with each divergence class were obtained and for each heterotic hybrid the divergence class to which corresponding D^2 values of their parents was established.

RESULTS AND DISCUSSION

Heterosis estimates over local check Malapur and commercial check Kalpataru for fruit weight (g), number of fruits per plant and fruit yield (g) are presented in Table1. The perusal of data indicates that, in eight hybrids the heterosis for fruit weight was significantly positive over local check Malapur. The extent of fruit weight heterosis over local check ranged between -24.91 % (IC-909XIC-136) and 26.33% (MG x IC-909), while the range was -22.53 % (IC-909 x IC-136) to 30.33 % (MG x IC-909) over commercial check, in which 12 hybrids were positively significant. For number of fruits per plant, the heterosis ranged from -9.74 % (IC-136 x IC-126) to 63.41 % (IC-112 x IC-997) and 30.17 % (IC-136 x IC-126) to 26.42 (IC-112 x IC-997) over local check and commercial check, respectively and significantly high number for fruits were harvested from as many as 19 and 9 hybrids over local check and commercial check, respectively. The hybrids which exhibited the field heterosis for fruit weight (g) and number of fruits per plant, their corresponding parents were also high performers for those characters. Such reports were in corroboration with reports of Singh *et al.* (2004). Fruit yield indicated the positive and non-additive gene action. Hybrid, IC-112 x IC-996 exhibited the maximum heterosis of 72.7 % over local check followed by six other hybrids ranging in the heterosis between 46.17 % (IC-112 x IC-909) and 60.81 % (IC-112 x IC-136). In contrast no hybrid exhibited significant yield heterosis over commercial check Kalpataru, Though as many as 12 hybrids showed positive yield heterosis. In high yielding hybrids the yield heterosis was attributed to increased fruit weight and number of fruits per plant as

Table 1. Magnitude of heterosis (%) over local check and commercial check for yield and yield parameters in brinjal

Genotypes	Fruit wt (g)		No. of frts/pl		Fruit yield/pl (g)	
	LC (%)	CC (%)	LC (%)	CC (%)	LC (%)	CC (%)
MG x IC-112	16.73**	20.43**	6.99**	-17.23**	31.83	0.05
MG x IC-111	7.17*	10.57**	-5.11**	-26.59**	12.18	-14.86
MG x IC-909	26.33**	30.33**	5.15**	-18.65**	39.97	6.23
MG x IC-997	20.02**	23.82**	1.53	-21.45**	28.53	-2.45
MG x IC-996	6.11	9.48**	-0.44	-22.97**	27.62	-3.17
MG x IC-136	23.93**	27.85**	-6.11**	-27.36**	22.58	-6.97
MG x IC-126	9.36**	12.83**	0.66	-22.13**	16.19	-11.81
IC-112 x IC-111	-15.05**	-12.33**	39.21**	7.7**	24.88	-5.22
IC-112 x IC-909	0.21	3.39	38.65**	7.26**	46.17*	10.94
IC-112 x IC-997	-12.61**	-8.8**	63.41**	26.42**	52.24*	15.54
IC-112 x IC-996	1.18	4.39	61.22**	24.73**	72.7**	31.07
IC-112 x IC-136	10.81**	14.33**	37.77**	6.59**	60.81**	22.05
IC-112 x IC-126	2.6	5.85	50.66**	16.55**	32.11	0.27
IC-111 x IC-909	11.25**	-8.44**	9.17**	-15.54**	7.05	-18.75
IC-111 x IC-997	-6.18	-3.21	19.00	-7.94**	20.94	-8.21
IC-111 x IC-996	-1.06	2.08	26.64**	-2.03	51.64*	15.09
IC-111 x IC-136	3.75	7.04*	40.23**	8.51**	60.55*	21.85
IC-111 x IC-126	0.71	3.90	57.21**	21.62**	47.75*	12.13
IC-909 x IC-997	-2.64	1.48	31.00	1.35	42.36	8.04
IC-909 x IC-996	5.23	8.57**	13.54**	-12.16**	-0.27	-24.31
IC-909 x IC-136	-24.91**	-22.53**	16.24**	-10.07**	22.25	-7.21
IC-909 x IC-126	-3.96	-0.93	38.30**	6.99**	18.34	-10.18
IC-997 x IC-996	8.55**	-11.99**	-0.66	-23.14**	27.29	-3.39
IC-997 x IC-136	3.27	-16.28**	26.64**	-2.03	22.33	-7.15
IC-997 x IC-126	-7.14*	-4.19	0.00	-22.64**	22.05	-7.37
IC-996 x IC-136	24.68**	28.64**	0.44	-22.30**	33.36	1.21
IC-996 x IC-126	0.00	2.68	20.09**	-7.09**	-5.63	-28.38
IC-136 x IC-126	-8.71**	-5.81	-9.74**	-30.17**	-13.01	-33.97

these hybrids also showed high magnitude of heterosis for fruit weight and number of fruits per plant. Gopinath and Madalgeri (1986) and Balgundi (2000) reported the similar results.

Distance analysis was done to find out the generalized distance among 8 parents and 28 hybrids. Data relating to number of clusters formed and number of parents and hybrids included in each cluster are presented in Table 2. Genotypes under study (8 parents and 28 F_1s) were grouped in 8 clusters using Tocher's method. Number of genotypes distributed per cluster were 11, 9, 4, 5, 1, 1, 1 and 4 for cluster I, II, III, IV, V, VI, VII and VIII, respectively. Of eight parents, five fell in I cluster, two in II and one in IV cluster. The twenty-eight hybrids fell in as many as eight clusters, of which hybrids MG X IC – 909, IC – 112 X IC – 997, IC – 111 X IC – 136 formed solitary clusters represented as cluster V, VI, VII.

Intra and inter cluster distances for 36 genotypes were presented in Table 3. Intra-cluster distance ranges between 186.081(III) and 850.503 (I) and inter-cluster distance ranged from 146.703 (V and VI) to 1940.024 (IV and VII). Cluster I having the maximum inter- cluster distance of 850.51 comprised of five parents and six hybrids showed to be genetically more diverse followed by cluster II in which 9 genotypes were classified. The heterotic hybrids resulting from their corresponding parents were distantly placed in different clusters *i.e.* apart from parental cluster. Thus it is evident that considerable variation has been generated from these hybrids though limited number of parents were involved. Parents of many hybrids belonged to the same cluster (I).This suggests, sometimes selecting the parents from intra- cluster groups did produce high standardized potence in F_1's. These results are in agreement with findings of Bhatt (1976). Arunachalum's method (1984) was modified and used to classify the parental divergence in to 4 divergence classes.

The relationship between D^2 values of parental combinations classified in four divergence classes and standardized potence (%) in respect of yield per plant in 28 hybrid combinations is presented in Table 4. Each heterotic hybrid assigned respective divergence class, accordingly there were eight hybrids showed significant standardized potence (%), of which five were grouped under DC_3, two in DC_2, one in DC1 and no hybrid was grouped under DC_4. Heterosis occurring in DC_1 could be explained by high parental divergence and that in DC_4 could be explained by low parental divergence. The number of heterotic hybrids found in DC_3 (5) followed by DC_2 (2) was thus based on large number of hybrids made in them which also showed heterosis of higher magnitude. The cross IC-909 X IC-126 with maximum parental divergence (1249.36) exhibited limited heterosis of 3.97%. Similarly, IC-909 X IC-996 having high parental

Table 2 : Distribution of 8 parents and 28 F_1 hybrids in different clusters obtained by multivariate analysis

Sr. No.	No. of genotypes	Name of genotypes
1.	11	MG, IC-136 X IC-126, IC-112, 1C-111, IC-996 X IC-126, IC-136, MG X IC-136, IC-112 X IC-126, IC-909 X IC-996, IC-909, IC-997 X IC-136
2.	9	MG X IC-126, IC-909 X IC-136, IC-126, IC-111 X IC-909, MG X IC-997, IC-997, IC-997 X IC-126, IC-112 X IC-996, IC-111 X IC-126
3.	4	MG X IC-112, IC-112 X IC-111, IC-111 X IC-997, IC-909 X IC-126
4.	5	IC-996, IC-996 X IC-136, IC-909 X IC-997, MG X IC-996, IC-112 X IC-136
5.	1	MG X IC-909
6.	1	IC-112 X IC-997
7.	1	IC-111 X IC-136
8.	4	IC-112 X IC-909, IC-997 X IC-996, MG X IC-11, IC-111 X IC-996

(Genotypes in bold letter represent parents)

Table 3 : Intra and Inter cluster D^2 values for 8 parents and 28 F_1 hybrids

Cluster no.	I	II	III	IV	V	VI	VII	VIII
I	850.51	1315.45	1312.15	1546.80	1013.23	1323.17	1213.35	1319.95
II		816.35	1266.77	1728.96	1396.82	1470.93	1588.46	1703.86
III			186.08	1280.52	1556.03	1648.41	1756.91	1624.66
IV				554.29	1766.34	1847.96	1940.03	1143.32
V					0.000	146.71	265.27	1680.26
VI						0.000	198.26	1680.26
VII							0.000	1763.44
VIII								339.5

Table 4 : Genetic diversity of parents in relation to standardized potence (%)

Sr. No.	F_1 hybrids	Corresponding D^2 between parents	Divergence class	Standardized potence (%) for yield/plant
1.	MG x IC-112	253.84	DC3	38.27*
2.	MG x IC-111	715.12	DC2	15.78
3.	MG x IC-909	1089.43	DC1	27.59
4.	MG x IC-997	119.92	DC3	32.90
5.	MG x IC-996	31.64	DC4	-5.01
6.	MG x IC-136	33.35	DC4	17.75
7.	MG x IC-126	75.59	DC3	10.33
8.	IC-112 x IC-111	194.49	DC3	37.19*
9.	IC-112 x IC-909	413.65	DC2	40.73*
10.	IC-112 x IC-997	85.45	DC3	157.12**
11.	IC-112 x IC-996	197.94	DC3	55.27**
12.	IC-112 x IC-136	137.58	DC3	63.71**
13.	IC-112 x IC-126	334.19	DC3	32.84
14.	IC-111 x IC-909	94.73	DC3	1.57
15.	IC-111 x IC-997	332.66	DC3	30.89
16.	IC-111 x IC-996	686.38	DC2	34.47
17.	IC-111 x IC-136	508.02	DC2	60.98**
18.	IC-111 x IC-126	895.29	DC1	46.28*
19.	IC-909 x IC-997	643.97	DC2	35.30
20.	IC-909 x IC-996	1062.62	DC1	-20.59
21.	IC-909 x IC-136	874.14	DC1	8.57
22.	IC-909 x IC-126	1249.36	DC1	3.97
23.	IC-997 x IC-996	147.34	DC3	27.81
24.	IC-997 x IC-136	73.81	DC3	21.34
25.	IC-997 x IC-126	294.13	DC3	1.73
26.	IC-996 x IC-136	26.98	DC4	18.44
27.	IC-996 x IC-126	58.08	DC3	-22.14
28.	IC-136 x IC-126	102.99	DC3	-19.60

divergence (1062.62) exhibited negative heterosis of –20.59%. On the other hand, IC-996 X IC-136 having the parental divergence of 26.98 showed lower heterosis (18.44) fallowed by MG X IC-996 (31.64) exhibited heterosis of –5.01%. However high heterotic hybrids, IC-112 X IC-996, IC-112 X IC-136 and IC-111 X IC-136 with moderate genetic diversity of 85.45, 137.58 and 508.02 respectively, exhibited positive significant standardized potence (%).On the similar line Oganesyan (1976) reported that more the parents differ in yield the less marked was the heterosis. The results indicate that frequency and magnitude of heterotic hybrids were more in DC_3 fallowed by DC_2 than other two classes. In contrast to this hybrids having either high or low parental divergence failed to give significant positive heterosis. This suggests that the standardized potence (%) is not always co-related with genetic diversity. Moderate genetic divergence is good for getting high heterotic hybrids which is not appreciable by extreme divergence levels. Such non- correspondence between divergence and heterosis was reported by Singh and Krinshnaprasad (1991) and Ramanujam *et al*. (1974). Thus it is conluded that the moderate genetic diversity can hold promises to expect high heterotic hybrids, which is not appreciable by extreme divergence levels.

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