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HETEROSIS FOR YIELD AND ITS CONTRIBUTING ATTRIBUTES IN BRINJAL *(SOLANUM MELONGENA* L.)

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ABSTRACT
A study was conducted in brinjal to estimate the magnitude of heterosis for yield and its eleven yield components. 28 F_1 hybrids generated by half diallel crosses of eight pure diverse parent and these F_1s along with 8 parents were evaluated in a randomized block design with three replication at Research farm of Main Vegetable Research Station at Anand, Gujarat (India). Appreciable heterosis was found over mid, better and standard parent for all the traits studied in desirable direction. In order of merit F_1 hybrids AB-07-08 x GP-180 (136.39%), AB-07-08 x KS-331 (102.20%) and NDB-18 x AB-07-08 (97.63%) were observed significant heterosis over mid parent while the maximum heterobeltiosis (better parent heterosis) for fruit yield per plant was exhibited by the hybrid AB-07-08 x GP-180 (125.78%) followed by NDB-18 x AB-07-08 (86.25%) and Doli-5 x GP-180 (72.09%). In case of standard heterosis, significant and positive heterosis over standard check GBL-1 for fruit yield per plant was observed in hybrid GBL-1 x KS-331 (50.41%) followed by AB-07-08 x KS-331 (43.53%) and Doli-5 x GBL-1 (42.59%). The present study reveals good scope for isolation of pure lines from the progenies of heterotic F_1s as well as commercial exploitation of heterosis in brinjal.

INTRODUCTION

Brinjal is an important vegetable crop of India and is grown throughout the year. However, it is widely cultivated in both temperate and tropical regions of the globe mainly for its immature fruits as vegetables (Rai *et al.,* 1995), but in the temperate regions it is cultivated mainly during warm season. India is regarded as the primary centre of origin/diversity of brinjal (Vavilov, 1931; Bhaduri, 1951 and Genabus, 1963). Confirmation for this fact was made by Isshiki *et al*. (1994) based on the isozyme and morphological variation noticed in large germplasm collection from India. There are specific genotypes suited for specific preparation apart from the large genetic variation observed with regard for traits like colour, shape and size of fruits. In addition, variation is also noticed for traits like vegetative growth, maturity and presence or absence of spines on leaves, stem and fruit calyx among the indigenous material.

To have such a kind of plant architecture, different breeding methods can be employed. One of the methods employed is exploitation of hybrid vigour through hybridization. For the first time, Bailey and Munson (1891) reported artificial hybridization in brinjal. However, none of the hybrids exhibited any heterosis. Nagai and Kida (1926) were probably the first to observe hybrid vigour in a cross combination of some Japanese varieties of brinjal. To obtain high yield per unit area, exploitation of hybrid vigour is one of the good way and particularly in crop like brinjal, where more seeds per fruit are obtained. Therefore, the present investigation was carried out to study the extent of heterosis in 28 F_1 hybrid over mid parent, better parent and standard parent in a diallel cross set of 8 parents excluding reciprocals. These studies would be helpful for selecting suitable parents for hybrid development and to select potent transgressive segregants which can be further evaluated for enhanced yield potential.

MATERIALS AND METHODS

The experimental material comprised of eight pure diverse parents *viz;* NDB-18, PPL-1, Pusa Uttam, Doli-5, AB-07-08, GBL-1, GP-180 and KS-331 along with its 28 F_1 hybrids generated by half-diallel in all possible combinations excluding reciprocals during *kharif-rabi* 2010-11. GBL-1 used as standard check also. The experiment was laid out in randomized block design with three replications at Research Farm of Main Vegetable Research Station, AAU, Anand, Gujarat (India) during *kharif-rabi* 2011-12. Each plot consisted of a single row of 10 plants. Inter and intra row spacing was kept 90 and 60 cm, respectively. The observations were recorded on five randomly selected plants from each treatment and replication for twelve characters *viz*; days to 50% flowering, days to first picking, fruit length, fruit girth, average fruit weight, number of fruits per plant, plant height, fruit yield per plant, fruit volume, dry matter, total phenol and total soluble sugar (TSS). Heterosis expressed as per cent increase or decrease in hybrid (F_1) over its mid parental value, better parent (BP) and standard check (SC) values in the desirable direction was calculated using the following formula.

(i) Relative heterosis (RH); (Turner, 1953)

$$H_1 (\%) = \frac{\overline{F1} - \overline{MP}}{\overline{MP}} X\ 100$$

Where, MP = Mean performance of parent P_1 and P_2

F_1 = Mean performance of hybrid

(ii) Heterobeltiosis (BH); (Fonseca and Patterson, 1968)

$$BP = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}} X\ 100$$

Where, $\overline{BP}$ = Mean performance of better parent

$\overline{F_1}$ = Mean performance of F_1 hybrid

(iii) Standard heterosis (SH)

$$SH = \frac{\overline{F_1} - \overline{SC}}{\overline{SC}} X\ 100$$

Where, $\overline{SC}$ = Mean performance of standard check

RESULTS AND DISCUSSION

Wide range of variability exists among parents and their F_1 hybrids for different traits under study. Out of the 28 hybrids, the significant desirable heterotic effects over their respective mid, better and standard parent were noticed in 11, 9 and 3 crosses for days to 50 per cent flowering, 14, 7 and 2 crosses for days to first picking, 13, 6 and 2 crosses for fruit length, 15, 6 and one crosses for fruit girth, 9, 4 and 3 crosses for average fruit weight, 26, 23 and 20 crosses for number of fruits per plant, 12, 19 and 9 crosses for plant height, 23, 21 and 8 crosses for fruit yield per plant, 12, 8 and 6 crosses for fruit volume, 8, 5 and 0 for dry matter, 14, 20 and 7 crosses for total phenols, 16, 10 and one crosses for total soluble sugars. The best significant hybrids for different traits with respect to heterosis over mid parent, better parent and check variety are presented in Table 1.

An examination of performance of hybrids over better parent revealed that 21 hybrids manifested significant positive heterosis for fruit yield per plant. The maximum heterobeltiosis for fruit yield per plant was exhibited by the hybrid AB-07-08 x GP-180 (125.78%) followed by NDB-18 x AB-07-08 (86.25%) and Doli-5 x GP-180 (72.09%). Among the above hybrids, AB-07-08 x GP-180 also exhibited maximum heterobeltiosis for number of fruits per plant and plant height. Similarly, hybrid NDB-18 x AB-07-08 also exhibited maximum heterobeltiosis for number of fruits per plant and total soluble sugars. Many number of hybrids exhibited significant heterosis over better parent in desirable direction for different component traits such as days to 50% flowering, days to first picking, fruit length, fruit girth, average fruit weight, number of fruits per plant, plant height, fruit yield per plant, fruit volume, dry matter, total phenols and total soluble sugars. The heterotic response over better parent in brinjal was also reported by Singh *et al*. (2004), Shafeeq (2005), Singh and Maurya (2005), Suneetha and Kathiria (2006), Bisht *et al*. (2009), Shanmugapriya *et al*. (2009), Chowdhury *et al*. (2010), Sao and Mehta (2010).

In case of standard heterosis, 8 hybrids showed significant values for fruit yield per plant. The maximum significant and positive heterosis over standard check GBL-1 for fruit yield per plant was observed in hybrid GBL-1 x KS-331 (50.41%) followed by AB-07-08 x KS-331 (43.53%) and Doli-5 x GBL-1 (42.59%). Among these crosses, GBL-1 x KS-331 also exhibited significant and desirable heterosis for days to 50% flowering, days to first picking, number of fruits per plant, plant height and fruit volume. Likewise, hybrid AB-07-08 x KS-331 also

Table 1: The best significant hybrids for different traits with respect to heterosis over mid parent, better parent and check variety

Characters	Heterosis over MP	BP	SC
Days to 50 % flowering	Doli-5 x GBL-1 (-12.59%)	PPL-1 x Pusa Uttam (-9.46%)	Doli-5 x GBL-1 (-9.36%)
	Pusa Uttam x AB-07-08 (-11.56%)	Doli-5 x GBL-1 (-9.36%)	GBL-1 x KS-331 (-7.39%)
	PPL-1 x Pusa Uttam (-10.27%)	Pusa Uttam x AB-07-08 (-9.30%)	Pusa Uttam x AB-07-08 (-3.95%)
Days to first picking	Pusa Uttam x AB-07-08 (-14.71%)	PPL-1 x Pusa Uttam (-12.64 %)	GBL-1 x KS-331 (-4.44%)
	PPL-1 x Pusa Uttam (-13.01%)	PPL-1 x GP-180 (-12.36%)	Doli-5 x GBL-1 (-4.44%)
	PPL-1 x GP-180 (-12.97%)	-	-
Fruit length (cm)	GP-180 x KS-331 (21.11%)	GP-180 x KS-331 (12.11%)	GP-180 x KS-331 (12.09%)
	AB-07-08 x GBL-1 (17.36%)	PPL-1 x GP-180 (10.28%)	PPL-1 x GP-180 (10.25%)
	PPL-1 x GP-180 (10.78%)	GBL-1 x KS-331 (6.25%)	-
Fruit girth (cm)	GP-180 x KS-331 (34.58%)	GP-180 x KS-331 (28.83%)	GP-180 x KS-331 (26.05%)
	NDB-18 x PPL-1 (28.82%)	NDB-18 x PPL-1 (26.59%)	-
	PPL-1 x GP-180 (23.42%)	Pusa Uttam x GP-180 (14.76%)	-
Average fruit weight (g)	GP-180 x KS-331 (46.79%)	Doli-5 x KS-331 (32.24%)	GP-180 x KS-331 (81.73%)
	PPL-1 x GBL-1 (34.96%)	AB-07-08 x KS-331 (25.01%)	Doli-5 x GP-180 (54.19%)
	Doli-5 x KS-331 (33.76%)	Pusa Uttam x KS-331 (7.98%)	AB-07-08 x GP-180 (38.01%)
Number of fruits per plant	NDB-18 x GP-180 (168.45%)	PPL-1 x GP-180 (190.34%)	GBL-1 x KS-331 (65.11%)
	GBL-1 x GP-180 (122.26%)	PPL-1 x Pusa Uttam (129.82%)	Doli-5 x GBL-1 (64.75%)
	PPL-1 x GP-180 (105.88%)	PPL-1 x AB-07-08 (126.92%)	AB-07-08 x GBL-1 (63.69%)
Plant height (cm)	Doli-5 x GP-180 (42.19%)	AB-07-08 x GP-180 (53.82%)	Doli-5 x GP-180 (40.53%)
	AB-07-08 x GP-180 (34.81%)	Doli-5 x GP-180 (44.55%)	GP-180 x KS-331(18.80%)
	AB-07-08 x GBL (-122.35%)	AB-07-08 x GBL-1 (41.85%)	AB-07-08 x GP-180 (16.65%)
Fruit yield per plant (kg)	AB-07-08 x GP-180 (136.39%)	AB-07-08 x GP-180 (125.78%)	GBL-1 x KS-331 (50.41%)
	AB-07-08 x KS-331 (102.20%)	NDB-18 x AB-07-08 (86.25%)	AB-07-08 x KS-331 (43.53%)
	NDB-18 x AB-07-08 (97.63%)	Doli-5 x GP-180 (72.09%)	Doli-5 x GBL-1 (42.59%)

Table 1: Conti.....

Characters	Heterosis over MP	MP	MP
Fruit volume (cc)	GP-180 x KS-331 (78.40%)	GP-180 x KS-331 (40.84%)	GP-180 x KS-331 (138.08%)
	AB-07-08 x GBL-1 (39.74%)	Doli-5 x AB-07-08 (22.94%)	Pusa Uttam x GBL-1 (35.11%)
	PPL-1 x Doli-5 (23.10%)	GBL-1 x KS-331 (18.68%)	Doli-5 x GP-180 (24.55%)
Dry matter (mg/100 mg)	Doli-5 x GP-180 (24.55%)	PPL-1 x Pusa Uttam (11.01%)	-
	NDB-18 x Pusa Uttam (12.10%)	NDB-18 x Pusa Uttam (9.04%)	-
	PPL-1 x Pusa Uttam (11.43%)	Pusa Uttam x KS-331 (5.90%)	-
Total phenols (mg/100 mg)	NDB-18 x PPL-1 (-19.38%)	NDB-18 x PPL-1 (-24.09%)	NDB-18 x GP-180 (-10.96%)
	NDB-18 x GP-180 (-16.00%)	NDB-18 x GP-180 (-18.60%)	NDB-18 x PPL-1 (-10.49%)
	PPL-1 x Pusa Uttam (-13.64%)	PPL-1 x AB-07-08 (-18.25%)	Doli-5 x KS-331 (-9.20%)
Total soluble sugars (mg/100 mg)	PPL-1 x Pusa Uttam (23.48%)	PPL-1 x Pusa Uttam (21.16%)	Doli-5 x GBL-1 (2.07%)
	PPL-1 x KS-331 (21.69%)	PPL-1 x KS-331 (21.05%)	-
	NDB-18 x Pusa Uttam (19.86%)	NDB-18 x Pusa Uttam (18.43%)	-

exhibited significant and desirable heterosis for number of fruits per plant and plant height. The heterotic response over the standard check in brinjal was also reported by Chadha *et al*. (2001), Das and Barua (2001), Indiresh and Kulkarni (2002), Mallikarjun (2002), Patel (2003), Shafeeq (2005), Suneetha and Kathiria (2006), Chowdhury *et al*. (2010), Nalini *et al*. (2011).

The hybrids exhibited heterobeltiosis and economic heterosis for fruit yield per plant and other characters were found to be most promising for fruit yield and other desirable traits, hence could be further evaluated to exploit the heterosis or utilized in future breeding programme to obtain desirable segregants for the development of superior genotypes.

The present study reveals ample variability among the parents and high scope for the exploitation of heterosis for advancement of fruit yield in brinjal. The crosses exhibited highly significant positive heterosis over better parent were AB-07-08 x GP-180, NDB-18 x AB-07-08, Doli-5 x GP-180 and over standard check GBL-1 were GBL-1 x KS-331, AB-07-08 x KS-331, Doli-5 x GBL-1. These crosses were recognized as the best heterotic crosses for fruit yield and these crosses can be further evaluated and used in hybrid breeding programme to boost up the fruit yield.

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