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Heterosis over environments for fruit yield and its attributing traits in brinjal (*Solanum melongena* L.)

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Abstract
Brinjal is a self-pollinated, annual herbaceous vegetable crop. Brinjal is a diploid with 24 chromosomes which originated in India. The fruits of brinjal are widely consumed in various culinary preparations and are rich source of protective nutrients. In the present investigation, information on the magnitude of heterosis and combining ability and its interactions with locations were obtained for fruit yield per plant and its related components following half diallel mating design involving nine parents of Brinjal. The nine parents and their 36 F1s with one standard check were tested for thirteen characters under three environments *viz*., Navsari (E_1), Varanasi (E_2) and Waghai (E_3) in a randomized block design with three replications. Analysis of variance in the individual environment as well as pooled over environments revealed considerable genetic variation among the parents and hybrids for all the characters. The existence of overall heterosis was evident from the significance of the comparison of parents vs. hybrids in all environments for all the traits. Hybrid *viz*., GOB-1 x Pusa Upkar, GAOB-2 x GOB-1, Pusa Upkar x GRB-5, GAOB- 2 x Swarna Mani and Swarna Mani x Pusa Upkar manifested high heterosis over the standard check with high fruit yield per plant. The hybrid crosses *viz*., GOB-1 × Pusa Upkar, GAOB-2 ×GOB-1, Pusa Upkar × GRB-5, GAOB-2 x Swarna Mani and Swarna Mani x Pusa Upkar manifested high heterosis over the standard check with high fruit yield per plant.

Keywords: Heterosis, heterobeltiosis, genetic variation, analysis of variance

Introduction
1 "Brinjal" one of the versatile vegetables belong to the family Solanaceae. It is an important vegetable of sub-tropics and tropics with diploid chromosomes (2n = 24) having its primary centers of diversity at Indian sub-continent and China. Brinjal is also known as eggplant or aubergine in North America and Europe respectively, while brinjal is popular in Indian subcontinents as 'baigan' whereas the name eggplant has been derived from its white color and resemblance to chicken eggs. Botanically, brinjal classified as a berry. On wild plants, the fruit is less than 3 cm in diameter, but much larger in cultivated forms 30 cm or more in length. Heterosis breeding has been a method of increasing yield in most of the crops. Heterosis is an important phenomenon for achieving rapid growth and development, higher productivity, greater vitality, resistance, and uniformity. Therefore, breeding of suitable locally adapted hybrids with preferred fruit characters having high yield and adaptation is mainly achieved through heterosis breeding. The magnitude of heterosis aids in the identification of suitable cross combinations for use in a conventional breeding program to provide a wide range of diversity in segregating generations. The use of parents of known superior genetical worth ensures much better success. In the case of eggplant, exploitation of heterosis or hybrid vigor has become an important tool for overall improvement in eggplant reported from the very beginning.

Materials and Methods
The present investigation was carried out to elicit the information on heterosis and combining ability performance of hybrids and their parents for fruit yield and its component characters in brinjal. The experimental materials used for present investigation includes 36 F1 crosses produced using 9 × 9 Half diallel cross mating design excluding reciprocals (method 2; model 1/half-diallel cross), their nine parents and one check. The complete set of 46 genotypes comprising of 36 F1s, nine parents and one check were evaluated in a Randomized Block Design with three replications over three environments during rabi 2020- 21 at three locations *viz*., College Farm, N. M. College of Agriculture, Navsari Agriculture University, Navsari;

Niger Research Station, N.A.U., Vanarasi and Hill Millet Research Station, N.A.U, Waghai.

Table 1: Detail s o f pa rental lines used in hybridization program

Sr. No.	Parent	Pedigree	Source
1.	IGAOB-2	(Gujarat Anand Oblong Brinjal - 2)	AAU, Anand
2.	GOB-1	(Gujarat Oblong Brinjal -1)	AAU, Anand
3.	PS	(Punjab Sadabahar)	PAU, Punjab
4.	JBGR-1	(Junagadh Brinjal Green Round-1)	JAU, Junagadh
5.	SM	(Swarna Mani)	ICAR, RCER, Bihar
6.	PU	(Pusa Upkar)	ICAR, New Delhi
7.	GRB-5	(Gujarat Round Brinjal - 5)	JAU, Junagadh
8.	NBL-117	(Nay sari Brinjal Line-117)	NAU, Nay sari
9.	GJLB-4	(Gujarat Junagadh Long brinjal - 4)	JAU, Junagadh
	GABH-3 (Check)*	(Gujarat Anand Brinjal Hybrid-3)	AAU, Anand

Observations were recorded on five randomly selected plants per each entry in each replication for thirteen distinct characteristics, *viz.,* days to flowering, branches per plant, plant height (cm), fruit length (cm), fruit girth (cm), fruit weight (g), fruits per plant, seeds per fruit, fruit yield per plant (g), total phenols content (mg / 100 g FW), total soluble sugar (%), shoot and fruit borer infestation (%) and little leaf incidence (%). The observations for studied characters were recorded on five randomly selected (tagged) competitive plants of each experimental unit in each replication for various characters as described below. Days to 50 per cent flowering was recorded on plot's population basis. For quality traits, the observations were recorded on randomly selected sample of fruits from each genotype. The mean values for various characters of each experimental unit were computed and subjected for different statistical approaches as given below. Heterosis was estimated as per cent increase or decrease in the mean value of F1 hybrid over the better parent, *i.e.*, heterobeltiosis (Fonseca and Patterson, 1968) [1] and standard check, *i.e.*, standard heterosis (Meredith and Bridge, 1972) [20] for each character.

$$\text{Heterobeltiosis (\%)} = \frac{\overline{F}_1 - \overline{BP}}{\overline{BP}} \times 100$$

$$\text{Standard heterosis (\%)} = \frac{\overline{F}_1 - \overline{SC}}{\overline{SC}} \times 100$$

Where,
F1 = Mean performance of the F1 hybrid
BP = Mean value of better parent
SC = Mean value of the standard check

The significance of estimates of heterobeltiosis and standard heterosis were calculated with the help of following formula:

$$S.E.(m) = \sqrt{2\,M_E/r}$$

Where,
Me = Error mean square, r = Number of replications

$$t = \frac{\overline{F_1}\text{-}\overline{BP} \text{ or } \overline{SC}}{\text{S.E.(m) of heterosis over } \overline{BP} \text{ or } \overline{SC}}$$

The test of significance of heterobeltiosis and standard heterosis for individual environment were carried out by comparing the calculated 't' values with the tabulated 't' values at 5 per cent (1.96) and 1 per cent (2.58) levels of significance.

Result and discussion

Analysis of variance for the experimental design

Analysis of variance for individual environment revealed highly significant differences among genotypes for all the characters indicating ample amount of diversity among populations. Mean square due to parents was found significant for all the characters in all the three environments except fruit and shoot borer infestation in E_1 (Navsari) and for little leaf incidence E_1 (Navsari) and E_2 (Waghai). Similarly, mean square due to hybrids was found significant for all the characters in all the three environments revaling diverse response of hybrids. The mean square due to Parents *vs* hybrids also revealed significant differences for all the characters in all the environments except branches per plant in E_1 and E_2, plant height in E_3, fruit length in E_2, fruit weight in E_3, fruit per plant in E_1, and E_2, seeds per fruit in E_3 and fruit borer infestation in E_1 (Table 2 to Table 8). High divergence in the parental lines for most of the characters indicated their suitability for developing diverse heterotic hybrids. Similar results pertaining to analysis of variance (mean squares) over environments were also stated by Rani *et al.* (2018) [17], Pandey and Yadav (2018) [14], Kumari *et al.* (2019) [10] and Timmareddygari *et al.* (2021) [19].

The analysis of variance (mean squares) over environments for different characters is presented in Table 2 to Table 8. The mean square due to genotypes, parents and hybrids were significant for all the characters. Likewise, the mean square due to parents vs hybrids was also significant for all the traits except for branches per plant, fruit length, fruit weight and TSS. Mean square due to genotypes x environments interaction (G x E) were significant for all the traits except total soluble sugars and total phenol content suggesting diverse response of the genotype for those character at different environments. Similarly, the mean square due to parents x environments were significant for days to 50 per cent flowering, plant height, fruit length, fruit girth and shoot and fruit borer infestation. In addition to this, mean square due to hybrids x environments were significant for all the characters except total soluble sugars and total phenol content. While, the mean square due to (parent's vs hybrids) x environments were non-significant for fruit per plant, seeds per fruit, total soluble sugars and total phenol content. Significant response of sources of variances at all the three locations, indicate the performance of hybrids as a group was different than that of parents for the given characters at individual environment and as well as for over the environment confirming the presence of considerable heterosis due to directional dominance (Bhatt *et al*. 2019), suggesting the ability of parent to result as favourable crosses, providing opportunity to sort out better hybrids for over locations and simultaneously for specific location. Similar results pertaining to analysis of variance (mean squares) over environments were also stated by Patel *et al*. (2017a) [15], Rani *et al*. (2018) [17], Bagade *et al*. (2020) [5] and Bdar *et al*. (2021) [4].

Table 2: Analysis of variance over environments and for individual environments of days to 50 per cent flowering, branches per plant and plant height

Sources	D.F.	Days to 50 per cent flowering				Branches per plant				Plant height			
		E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled	E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled	E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled
Environment(E)	2	-	-	-	733.59**	-	-	-	104.21**	-	-	-	434.41**
Repl. / Env	6	18.58*	6.27	7.11	10.66*	7.64**	0.15	0.55	2.79**	30.80	34.80	49.74*	38.45*
Genotypes (G)	44	52.20**	50.43**	48.29**	137.16**	4.85**	3.99**	5.44**	11.80**	188.44**	108.68**	94.34**	247.11**
Parents (P)	8	66.95**	47.03**	41.50**	149.42**	7.81**	4.97**	2.58**	13.76**	401.93**	116.19**	124.59**	422.45**
Hybrids (F1)	35	43.12**	48.35**	45.07**	120.81**	4.27**	3.88**	6.16**	11.69**	124.06**	97.11**	89.29**	182.63**
P *vs* F1	1	252.15**	150.41**	215.33**	611.13**	1.74	0.03	3.09*	0.14	733.71**	453.77**	29.10	1101.25**
G x E	88	-	-	-	6.89**	-	-	-	1.25**	-	-	-	72.18**
P x E	16	-	-	-	3.04**	-	-	-	0.80	-	-	-	93.67**
F1 x E	70	-	-	-	7.87**	-	-	-	1.32**	-	-	-	65.24**
(P *vs* F1) x E	2	-	-	-	3.39**	-	-	-	2.37*	-	-	-	143.43**
Pooled Error	264	2.83	2.29	4.17	3.10	0.57	0.51	0.45	0.52	17.30	15.62	12.73	15.22

And ** indicate significance at 5% and 1% level of probability, respectively. For individual location, d.f. for replication and error were 2 and 88, respectively

Table 3: Analysis of variance over environments and for individual environments of fruit length, fruit girth and fruit weight

Sources	D.F.	Fruit length				Fruit girth				Fruit weight			
		E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled	E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled	E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled
Environment (E)	2	-	-	-	8.96**	-	-	-	11.59**	-	-	-	10597.59**
Repl./Env	6	0.18	0.08	1.86*	0.72	2.93	0.83	0.22	1.30	214.68	60.76	1.33	92.26
Genotypes (G)	44	13.66**	11.79**	16.03**	38.96**	24.43**	23.05**	25.62**	66.56**	565.45**	801.00**	575.8**	1723.95**
Parents (P)	8	23.68**	28.33**	31.61**	79.23**	43.91**	39.09**	50.99**	123.29**	471.24**	414.16**	330.0**	1103.69**
Hybrids (F1)	35	11.59**	8.33**	12.78**	30.87**	19.83**	18.68**	20.18**	54.76**	581.27**	899.48**	645.47**	1914.83**
P *vs* F1	1	5.89*	0.35	5.24**	0.10	29.40**	47.94**	13.06**	25.54**	765.17**	448.79**	107.55	5.05
G x E	88	-	-	-	1.26**	-	-	-	3.35**	-	-	-	109.20**
P x E	16	-	-	-	2.07**	-	-	-	5.47**	-	-	-	55.86
F1 x E	70	-	-	-	0.95**	-	-	-	2.05*	-	-	-	105.70*
(P *vs* F1) x E	2	-	-	-	5.79**	-	-	-	32.06**	-	-	-	658.23**
Pooled Error	264	0.43	0.52	0.40	0.45	1.33	1.72	1.39	1.48	75.34	60.94	48.75	61.68

And ** indicate significance at 5% and 1% level of probability, respectively. For individual location, d.f. for replication and error were 2 and 88, respectively

Table 4: Analysis of variance over environments and for individual environments of fruits per plant, total phenol content and total soluble sugars

Sources	D.F.	Fruits per plant				Total phenol content				Total soluble sugars			
		E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled	E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled	E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled
Environment (E)	2	-	-	-	708.51**	-	-	-	0.06				0.11*
Repl./Env	6	12.50	29.83*	18.45	20.26*	0.002	0.06	0.19**	0.06*	0.13**	0.08**	0.12 *	0.12**
Genotypes (G)	44	73.02**	72.76**	56.93**	179.76**	5.23**	5.06**	5.03**	15.31**	1.09**	1.29**	1.39**	3.73**
Parents (P)	8	27.52*	29.28*	14.95*	64.41**	1.78**	1.85**	1.83**	5.46**	1.44**	1.63**	1.73**	4.78**
Hybrids (F1)	35	85.47**	84.16**	66.45**	209.52**	6.09**	5.85**	5.83**	17.74**	1.04**	1.25**	1.36**	3.60**
P *vs* F1	1	1.34	21.59	59.54*	60.95*	2.86**	3.36**	2.73**	8.94**	0.03	0.011	0.01	0.01
G x E	88	-	-	-	11.48*	-	-	-	0.01	-	-	-	0.03
P x E	16	-	-	-	3.68	-	-	-	0.07	-	-	-	0.02
F1 x E	70	-	-	-	13.29*	-	-	-	0.01	-	-	-	0.03
(P *vs* F1) x E	2	-	-	-	10.76	-	-	-	0.09	-	-	-	0.02
Pooled Error	264	8.09	8.06	7.64	7.93	0.02	0.01	0.03	0.02	0.01	0.017	0.03	0.02

And ** indicate significance at 5% and 1% level of probability, respectively. For individual location, d.f. for replication and error were 2 and 88, respectively

Table 5: Analysis of variance over environments and for individual environments of fruits per plant and seeds per fruits

Sources	D.F.	Fruit yield per plant				Seeds per fruit			
		E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled	E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled
Environment (E)	2	-	-	-	23118850.70**	-	-	-	3826.07
Repl./Env	6	679344.42*	29332.65	487998.30**	398891.74**	25890.42	5834.54	12926.20	14883.72
Genotypes (G)	44	1207560.02**	987555.58**	725050.02**	2435035.62**	156314.30**	150216.16**	174976.26**	450453.83**
Parents (P)	8	420872.70*	378219.70**	238593.81**	785843.59**	300138.54**	259204.32**	345927.52**	886952.47**
Hybrids (F1)	35	1369601.74**	1142355.77**	855595.34**	2879481.10**	126627.01**	129596.25**	140558.03**	362587.27**
P *vs* F1	1	1829598.46**	444235.96**	47613.48*	72980.24*	44775.81*	7.61	12004.29	33794.28*
G x E	88	-	-	-	242565.00**	-	-	-	15526.46**
P x E	16	-	-	-	125921.31	-	-	-	9158.96
F1 x E	70	-	-	-	244035.87**	-	-	-	17097.02**
(P *vs* F1) x E	2	-	-	-	1124233.87**	-	-	-	11496.74
Pooled Error	264	144205.43	102518.95*	61919.94	102881.45	9325.88	7681.42	6217.30	7741.54

And ** indicate significance at 5% and 1% level of probability, respectively. For individual location, d.f. for replication and error were 2 and 88, respectively

Table 8: Analysis of variance over environments and for individual environments of shoot and fruit borer infestation and little leaf incidence

Sources	D.F.	Shoot and fruit borer infestation				Little leaf incidence			
		E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled	E_1 Navsari	E_2 Vanarasi	E_3 Waghai	Pooled
Environment (E)	2	-	-	-	70.61**	-	-	-	130.17**
Repl./Env	6	14.75	3.00	6.67*	8.10	1.05	27.81	39.98	22.96
Genotypes (G)	44	26.92**	15.05**	12.89**	19.83**	41.76**	30.57**	41.94**	42.83**
Parents (P)	8	15.80	17.35**	15.68**	22.38*	11.41	48.74*	29.93	29.99*
Hybrids (F1)	35	26.19*	14.17**	12.38**	17.91**	35.82**	27.20**	44.42**	39.80**
P *vs* F1	1	141.27**	27.29 *	8.36*	66.88*	492.30**	3.40	51.21	251.66**
G x E	88	-	-	-	17.54**	-	-	-	35.79**
P x E	16	-	-	-	13.28*	-	-	-	30.18*
F1 x E	70	-	-	-	17.45**	-	-	-	33.87**
(P *vs* F1) x E	2	-	-	-	55.01**	-	-	-	147.73**
Pooled Error	264	14.10	4.190	2.00	6.77	17.03	13.47	14.88	15.13

And ** indicate significance at 5% and 1% level of probability, respectively. For individual location, d.f. for replication and error were 2 and 88, respectively

Estimation of heterosis

The phenomenon of heterosis has provided the most important genetic tools for improving yield of crop plants. According to modern concept, heterosis is expression of joint effects of favorable genes, interaction between alleles, non-allelic interaction and mitochondrial genes brought together from the parents. Identification of specific parental combination capable of producing the highest level of heterotic effects in F1 has immense value for commercial exploitation of heterosis. The heterobeltiosis expressed as per cent superiority of cross over better parent value, whereas economic heterosis as check variety for character under reference, decides whether an experimental hybrid is worth exploiting or not. The extent of heterosis over standard check "GABH-03" estimated for 13 traits in individual environments is presented in Table 09. to Table 21.

While interpreting magnitude of heterosis, the positive effects were considered as favorable for the traits *viz*; plant height, branches per plant, fruit length, fruit girth and fruit weight (at some extent), fruits per plant, fruit yield per plant, total phenol content and total soluble sugars. While, negative effects were considered favorable for the traits *viz*; days to fifty per cent flowering, seeds per fruits, shoot and fruit borer infestations and little leaf incidence.

Days to 50 per cent flowering

In brinjal, earliness in flowering is desirable trait so heterobeltiosis was estimated for earliness. The highest magnitude of heterobeltiosis in desirable direction were estimated by the cross GAOB-2 x JBGR-1(-13.56%) in E1, cross GOB-1 x NBL-117 (-20.67%) for E2 and by the same cross GOB-1 x NBL-117 in E3 (-15.22%). The range of standard heterosis for days to 50 per cent flowering was Punjab Sadabahar x NBL-117 (-12.05%) to JBGR-1 x GJLB-4 (16.27%) at Navsari, GOB-1 x NBL-117 (-18.86%) to GOB-1 x JBGR-1 (15.43%) at Vanarasi and GOB- 1 x NBL-117 (-14.29%) to GOB-1 x JBGR-1 (17.03%) at Waghai. The best early flowering hybrids in Navsari (E1) were Punjab Sadabahar x NBL-117 (-12.05%), GOB-1 x NBL-117 (-20.67%) and GAOB-2 x JBGR-1(-7.83%), while GOB-1 x NBL-117 (-18.86%) and JBGR-1 x Swarna Mani (-7.43%) in E2. Furthermore, GOB-1 x NBL-117 (-14.29%) and Punjab Sadabahar x NBL- 117 (-7.14%) recorded good amount of standard heterosis at Waghai environment.

The economic heterosis over standard check (GABH-3) were negative and significant for five, eight and six hybrids in E_1, E_2 and E_3, respectively, for days to 50 per cent flowering in desirable (negative) direction. The range of standard heterosis for days to 50 per cent flowering was Punjab Sadabahar x NBL-117(-12.05%) to JBGR-1 x GJLB-4 (16.27%) at Navsari, GOB-1 x NBL-117 (-18.86%) to GOB-1 x JBGR-1 (15.43%) at Vanarasi and GOB-1 x NBL-117 (-14.29%) to GOB-1 x JBGR-1 (17.03%) at Waghai. The best early flowering hybrids in Navsari (E_1) were Punjab Sadabahar x NBL-117 (-12.05%), GOB-1 x NBL-117 (-20.67%) and GAOB-2 x JBGR-1(-7.83%), while GOB-1 x NBL-117 (-18.86%) and JBGR-1 x Swarna Mani (-7.43%) in E2. Furthermore, GOB-1 x NBL-117 (-14.29%) and Punjab Sadabahar x NBL-117 (-7.14%) recorded good amount of standard heterosis at Waghai environment. These results are in confirmation with the results of Similar results were also reported by Kumar and Arumugan (2013), Pramila *et al*. (2017) [16], Pandey and Yadav (2018) [14], Rani *et al.* (2018) [17], Sujin and Karuppaiah (2018) [18], Siva *et al.* (2020) [21] and Bdar *et al.* (2021) [4].

Branches per Plant

The range of better parent heterosis for branches per plant ranged from -38.52% (Punjab Sadabahar x JBGR-1) to 35.71% (Pusa Upkar x NBL-117) at Navsari, -30.23% (Punjab Sadabahar x GRB-5) to 34.12% (NBL-117 x GJLB-4) at Vanarasi and -30.5% (Punjab Sadabahar x GRB-5) to 37.97% (NBL-117 x GJLB-4) at Waghai. The best performing hybrids for better parent heterosis were Pusa Upkar x NBL-117 (35.71) and Pusa Upkar x GJLB-4 (34.38%), while NBL-117 x GJLB-4 (34.12%) and Pusa Upkar x GJLB-4 (31.37%) were best performing hybrids at Vanarasi. Hybrid NBL-117 x GJLB-4 (37.97%) were best performing at Waghai location for branches per plant. Out of 55 hybrids, only seven hybrids at Waghai location exhibited significant and positive heterosis. Among these, JBGR-1 x Pusa Upkar (23.83%), Pusa Upkar x GRB-5
(23.49%) and NBL-117 x GJLB-4 (23.15%) had high positive and significant economic heterosis which were reported at Waghai.

Out of 55 hybrids, only seven hybrids at Waghai location exhibited significant and positive heterosis. Among these, JBGR-1 x Pusa Upkar (23.83%), Pusa Upkar x GRB-5 (23.49%) and NBL-117 x GJLB-4 (23.15%) had high positive and significant economic heterosis which were reported at Waghai. Similar results were also reported by Pramila *et al*. (2017) [16], Kalaiyarasi *et al*. (2018) [7], Kumari *et al.* (2019) [10] and Bdar *et al.* (2021) [4].

Plant Height

The range of better parent heterosis for plant height at different environment was from Swarna Mani x GJLB-4 (-18.09%) to JBGR-1 x GRB-5 (25.91%) at Navsari, from Swarna Mani x GJLB-4 (-19.49%) to GAOB-2 x JBGR-1 (13.84%) at Vanarasi and JBGR-1 x GJLB-4 (-17.75%) to Punjab Sadabahar x Swarna Mani (16.09%) at Waghai. The best performing hybrid for better parent heterosis were JBGR-1 x GRB-5 (25.91%), Punjab Sadabahar x GRB-5 (17.06%) and Punjab Sadabahar x JBGR-1 (15.98%) for Navsari environment. The best performing hybrid for heterobeltiosis at Vanarasi were GAOB-2 x JBGR-1(13.84%) and JBGR-1x Pusa Upkar (13.22%), while hybrid Punjab Sadabahar x Swarna Mani (16.09%) and GOB-1 x Punjab Sadabahar (12.02%) were best at Waghai. Out of thirty-six hybrids, 28 of the hybrids recorded significant and desired (positive) heterosis over check at Navsari with range of JBGR-1 x GRB-5 (28.76%) to Swarna Mani x GRB- 5 (-2.73%) in addition to which seven hybrids at Vanarasi with range of Swarna Mani x GJLB-4 (-10.42%) to GRB-5 x NBL-117 (16.95%)] while five hybrids at Waghai exhibited significant and positive heterosis over standard check with range 12.56% (NBL-117 x GJLB-4) to (JBGR-1 x GJLB-4) -14.4%). The best performing hybrid for economic heterosis were JBGR-1 x GRB-5 (28.76%) and GOB-1x JBGR-1 (26.39%) at Navsari. The best performing hybrid at Vanarasi were GRB-5 x NBL-117 (16.95%) and Pusa Upkar x GJLB-4 (16.09%), while NBL-117 x GJLB- 4 (12.56%) was best performing hybrid for Waghai environment for plant height. These findings are in conformity with Pramila *et al*. (2017) [16], Kalaiyarasi *et al*. (2018) [7], Pandey and Yadav (2018) [14], Sujin and Karuppaiah (2018) [18], Kumari *et al.* (2019) [10] and Timmareddygari *et al.* (2021) [19].

Fruit length

The range of heterobeltiosis for fruit length was from -35.29% to 45.89% at Navsari, - 50.4% to 72.66% at Vanarasi and -53.13% to 53.99% at Waghai. GAOB-2 x GRB-5. (45.89%), GAOB-2 x NBL-117 (36.47%), GAOB-2 x SM (33.56%) in E1; GAOB-2 x GRB-5 (72.66%), GAOB-2 x NBL-117 (40.6%), GAOB-2 x GOB-1 (27.34%) in E2; and GAOB-2 x GRB-5 (53.99%) and GAOB-2 x GOB-1 (37.87%) in E3 were the best significant heterobeltiotic hybrids for fruit length. Hybrid GAOB-2 x Punjab Sadabahar had highest significant standard heterosis in negative direction in all three environments.

The magnitude of standard heterosis for this trait ranged from -21.15% (GRB-5 x NBL-117) to 64.14% (Punjab Sadabahar x GJLB-4), -11.04% (GAOB-2 x GJLB-4) to 65.64% (Punjab Sadabahar x GJLB-4); -23.71% (GOB-1 x NBL-117) to 70.23% (Punjab Sadabahar x GJLB-4) in E1, E2 and E3, respectively. Hybrid GAOB-2 x GJLB-4 have been found to be outstanding with highest positive significant exhibiting standard heterosis at all three locations. Other hybrids *viz*., Punjab Sadabahar x JBGR-01 (35.92%), GAOB-2 x GRB-05 (32.23%) and GAOB-2 x JBGR-1 (32.23%) in E1; three hybrids namely, GAOB-2 x GRB-05 (45.12%), GAOB-2 x NBL-117 (28.89%) and JBGR-1 x GJLB-4 (28.89%) in E2 and hybrids *i.e*., GAOB-2 x GRB-05 (44.82%), Punjab Sadabahar x Swarna Mani (40.32%) and Punjab Sadabahar x JBGR-1 (33.92%) in E3 were the top most significant and desirable standard heterotic hybrids for fruit length.

The results were in correspondence to the findings of Similar results had also been reported by Makani *et al.* (2013) [12], Pramila *et al*. (2017) [16], Sujin and Karuppaiah (2018) [18], Rani *et al.* (2018) [17], Rameshkumar and Venthamonai (2020), Bdar *et al.* (2021) [4] and Timmareddygari *et al.* (2021) [19].

Fruit Girth

The heterosis over better parent for fruit girth varied from -30.87% (JBGR-1 x GJLB-4) to 20.58% (Punjab Sadabahar x GJLB-4); -31.67% (JBGR-1 x GJLB-4) to 23.54% (Punjab Sadabahar x GRB-5), -39.97% (JBGR-1 x GJLB-4) to 30.65% (Punjab Sadabahar x GJLB-4) in E1, E2 and E3, respectively. Punjab Sadabahar x GJLB-4 (20.5%), Pusa Upkar x GRB-5 (18.67%) and NBL-117 x GJLB-4 (17.22%) in E1; Punjab Sadabahar x GRB-5 (23.54%), Punjab Sadabahar x GJLB-4 (19.69%) and NBL-117 x GJLB-4 (18.77%) in E2; and Punjab Sadabahar x GJLB-4 (30.65%), and GAOB-2 x GOB-1 (04.53%) in E3 were the top significant heterobeltiotic hybrids for fruit girth.

The magnitude of standard heterosis for this trait ranged between -12.12% (JBGR-1 x GJLB-4) and 48.25% (GAOB-2 x GOB-1); -1.34% (JBGR-1 x GJLB-4) and 58.66% (Swarna Mani x GRB-5) and -8.13% (JBGR-1 x GJLB-4) to 59.66% (GAOB-2 x GOB-1) in E1, E2 and E3, respectively. Hybrids GAOB-2 x GOB-1 (48.25%), GAOB-2 x Swarna Mani (47.37%) and Pusa Upkar x GRB-5 (36.72%) in E1; Swarna Mani x GRB-5 (58.66%), GAOB-2 x GOB-1 (57.45%) and GAOB-2 x Swarna Mani. (51.97%) in E2; and GAOB-2 x

GOB-1 (59.66%), Pant Rituraj x GJB-3 (30.35%) and GAOB-2 x Swarna Mani (50.72%) in E3 were the best significant and desirable standard heterotic hybrids for fruit girth. These results are similar to the findings of Makani *et al.* (2013), Sujin and Karuppaiah (2018) and Rani *et al.* (2018) [17], Kumari *et al.* (2019) [10] and Rameshkumar and Venthamonai (2020).

Fruit Weight

Relative fruit weight range of better parent heterosis at Navsari, Vanarasi and Waghai, were found to be in values of -22.91% (GOB-1 x GRB-5) to 29.24% (GOB-1 x Pusa Upkar), - 551.61% (Punjab Sadabahar x GRB-5) to 19.36% (GAOB-2 x Swarna Mani) and -46.42% (JBGR-1 x GRB-5) to 21.71% (GOB-1 x Pusa Upkar), respectively. The positive heterosis is desirable for the trait fruit weight. Hybrids, GOB-1 x Pusa Upkar (29.24%), NBL-117 x GJLB-4 (19.61%) and GAOB-2 x Pusa Upkar (17.66%) in E1; GAOB-2 x Pusa Upkar (19.36%) and GOB-1 x Pusa Upkar (18.22%); and GOB-1 x Pusa Upkar (21.71%), NBL-117 x GJLB-4 (19.82%) and GOB-1 x Swarna Mani (17.57%) in E3 were the best significant heterobeltiotic hybrids for average fruit weight.

The magnitude of standard heterosis for fruit weight varied from -20.04% (GRB- x GJLB- 4) to 62.07% (GOB-1 x Pusa Upkar); -38.51% (Punjab Sadabahar x GRB-5.) to 67.72% (GAOB- 2 x Swarna Mani); and -26.91% (JBGR-1 x GRB-5) to 58.77% (GOB-1 x Pusa Upkar) in E1, E2 and E3, respectively. Hybrids GOB-1 x Pusa Upkar (62.07%), GAOB-2 x Swarna Mani (58.16%) and GAOB-2 x Pusa Upkar (52.9%) in E1; GAOB-2 x Swarna Mani (67.72%), GOB-1 x Pusa Upkar (64.5%) and GAOB-2 x GOB-1 (56.92%) in E2; and GOB-1 x Pusa Upkar (58.77%), GOB-1 x Swarna Mani (58.06%) and GAOB-2 x GOB-1 (54.25%) in E3 were the top most significant and desirable standard heterotic hybrids for average fruit weight. GOB-1 x Pusa Upkar and GAOB-2 x GOB-1 have been found to be best performing hybrids in all environment due to high magnitude of standard heterosis and economic heterosis at all locations.

The results were corroborative to the reports of Sujin and Karuppaiah (2018) [18], Kalaiyarasi *et al*. (2018) [7], Rani *et al.* (2018) [17], Kumari *et al.* (2019) [10] and Timmareddygari *et al.* (2021) [19]

Fruits per Plant

Fruits per plant is one of the main fruit-yield contributing character whose, positive heterosis is desirable for improvement in brinjal. The range of heterobeltiosis over better parent for fruits per plant was from -42.25% (JBGR-1 x GJLB-4) to 27.87% (GAOB-2 x GOB-1) at Navsari, -43.44% (GAOB-2 x Punjab Sadabahar) to 51.9% (Swarna Mani x Pusa Upkar) at Vanarasi and -44.17% (GAOB-2 x Punjab Sadabahar) to 36.18% (JBGR-1 x GRB-5) at Waghai. In case of better parent heterosis estimate the best three hybrids were namely, GAOB-2 x GOB-1 (27.87%), Swarna Mani x Pusa Upkar (16.8%) and Swarna Mani x GRB-5 (13.7%) in E1; Swarna Mani x Pusa Upkar (51.9%), JBGR-1 x GRB-5 (33.61%) and JBGR-1 x Pusa Upkar (23.8%) in E2; and JBGR-1 x GRB-5 (36.18%), GOB-1 x Pusa Upkar (35.71%) and GAOB-1 x JBGR-1 (25.79%) in E3 which registered significant heterosis over better parent in desirable direction.

Range of standard heterosis varied from -31.28% (Pusa Upkar x GJLB-4) to 53.35% (Swarna Mani x GRB-5); -37.28% (Pusa Upkar x GJLB-4) to 72.09% (JBGR-1 x GRB-5); and -35.66% (Pusa Upkar x GJLB-4) to 79.21% (JBGR-1 x GRB-5) in E1, E2 and E3, respectively. The best three hybrids *viz*., Swarna Mani x GRB-5 (53.35%), GAOB-2 x GOB-1 (49.35%) and GAOB-2 x GRB-5 (41.82%) in E1; JBGR-1 x GRB-5 (72.09%), Swarna Mani x GRB-5 (55.65%) and JBGR-1 x Pusa Upkar (49.49%) in E2; and JBGR-1 x GRB-5 (79.21%), GRB-5 x NBL-117 (57.96%) and Swarna Mani x GRB-5 (57.23%) in E3 were the top most significant and desirable standard heterotic hybrids for number of fruits per plant. Similar findings have also been reported by Makani *et al.* (2013) [12], Pramila *et al*. (2017) [16], Kalaiyarasi *et al*., (2018) [7], Rani *et al.* (2018) [17], Sujin and Karuppaiah (2018) [18], Bagade *et al.* (2020) [5s] and Bdar *et al.* (2021) [4].

Fruit yield per plant

Fruit yield is the most economic important trait for improvement in brinjal and plant breeders attempt to evolve varieties/hybrids in regard with high fruit yield per plant. Positive heterosis is highly desirable for this character. The heterosis over better parent for fruit yield per plant ranged from -52.83% (JBGR-1 x GJLB-4) to 43.53% (GAOB-1 x JBGR-1); -61.77% (Pusa Upkar x GJLB-4) to 36.29% (GAOB-2 x GOB-1); and -60.46% (Pusa Upkar x GJLB-4) to 50.86% (Pusa Upkar x GRB-5) in E1, E2 and E3, respectively. GAOB-1x JBGR-1 (43.53%) followed by GOB-1 x Pusa Upkar (42.22%) and Pusa Upkar x NBL-117 (41.63%) in E1; GAOB-2 x GOB- 1 (36.21%) followed by Pusa Upkar x NBL-117 (22.43%) and GOB-1 x Pusa Upkar (21.87%) in E2; and Pusa Upkar x GRB-5 (50.86%) followed by GOB-1 x Pusa Upkar (44.92%) and GAOB2 x GOB-1 (35.05%) in E3 were the top most significant and positive heterobeltiotic hybrids for fruit yield per plant.

The magnitude of standard heterosis fruit yield per plant is the important criteria for selection of better performing hybris in compare to the check variety. Range of standard heterosis varied from -51.45% (JBGR-1 x GJLB-4) to 80.28% (GOB-1 x Pusa Upkar); -36.3% (JBGR-1 x GJLB-4) to 122.49% (GAOB-2 x GOB-1); and -32.78% (Pusa Upkar x GJLB-4) to 162.53% (Pusa Upkar x GRB-5) in E1, E2 and E3, respectively. Total 17, 13 and 18 hybrids manifested significant and positive heterobeltiosis in E1, E2 and E3, respectively. Crosses *viz.*, GOB-1 x Pusa Upkar (80.28%) followed by Swarna Mani x GRB-5 (76.6%) and GAOB-2 x JBGR-1 (74.38%) in E1; GAOB-2 x GOB-1 (122.49%) followed by Pusa Upkar x NBL-117 (114.2%) and GOB-1 x Pusa Upkar (113.22%) in E2; and Pusa Upkar x GRB-5 (162.53%) followed by GOB-1 x Pusa Upkar (147.18%) and GAOB-2 x GOB-1 (130.35%) in E3 were the top most significant and desirable standard heterotic hybrids for fruit yield per plant. Based on heterosis estimate GOB-1 x Pusa Upkar, GAOB-2 x GOB-1 and Pusa Upkar x GRB-5 were found to be best heterotic hybrid over location for hybrid vigour improvement pertaining to fruit yield per plant.

Similar finding in accordance to the above result has also been reported by Makani *et al.* (2013) [12], Patel *et al*. (2017a) [15], Pramila *et al*. (2017) [16], Kalaiyarasi *et al*., (2018) [7], Pandey and Yadav (2018) [14], Rani *et al.* (2018) [17], Sujin and Karuppaiah (2018) [18] and Bdar *et al.* (2021) [4].

Seeds per Fruit

The range heterobeltiosis for seeds per fruit varied from -65.46% (Swarna Mani x GJLB- 4) to 24.68% (Punjab

Sadabahar x NBL-117) at Navsari, -54.32% (Punjab Sadabahar x Pusa Upkar) to 27.36% (Punjab Sadabahar x NBL-117) at Vanarasi and -73.08% (Swarna Mani x GJLB-4) to 49.99% (Punjab Sadabahar x NBL-117) at Waghai. The best hybrid in terms of better parent heterosis with significant negative value were Swarna Mani x GJLB-4 (-65.46%), Punjab Sadabahar x JBGR-1 (-65.46%) and Punjab Sadabahar x Pusa Upkar (-47.2%) at Navsari, in addition to which hybrid Punjab Sadabahaar x Pusa Upkar (-54.32%), Swarna Mani x GJLB-4 (- 51.23%) and Punjab Sadabahar x JBGR-1 (-50.05%) had significant and negative heterobeltiosis at Vanarasi, while Swarna Mani x GJLB-4 (-73.08%), JBGR-1 x GJLB-4 (-47.69%) and GAOB- 2 x Punjab Sadabahar (-46.58%) had negative and significant heterobeltiosis in Waghai environment.

Range of significant and negative standard heterosis exhibited by hybrid at Navsari was between Swarna Mani x GJLB-4 (-68.08%) to JBGR-1 x Swarna Mani (14.48%) and at Vanarasi range varied as Swarna Mani x GJLB-4 (-52.36%) to JBGR-1 x Pusa Upkar (29.95%), while at Waghai it was between Swarna Mani x GJLB-4 (-77.41%) to Swarna Mani x Pusa Upkar (6.3%). Top hybrids in term of seeds per fruits were Swarna Mani x GJLB-4 (-68.08%), NBL-117 x GJLB- 4 (-48.43%) and GAOB-2 x GJLB-4 (-37.17%) exhibited significant and negative heterosis over check for this trait at Navsari. Hybrid *viz*., Swarna Mani x GJLB-4 (-52.36%), Punjab Sadabahar x Pusa Upkar (-49.79%) and Punjab Sadabahar x JBGR-1 (-40.95%) were rewarding at Vanarasi environment, while hybrids Swarna Mani x GJLB-4 (-77.41%), NBL-117 x GJLB-4 (-47.08%) and Punjab Sadabahar x Pusa Upkar (-44.01%) were superior at Waghai location. Similar results were reported by Balwani *et al*. (2017) [6], Rani *et al.* (2018) [17] and Kumari *et al.* (2019) [10].

Total phenol content

Negative and significant value of total phenol content is desirable and whose range of better parent heterosis were reported in between -57.58% (Pusa Upkar x GJLB-4) to 77.51% (GAOB- 2 x Punjab Sadabahar) at Navsari, -60.95% (GOB-1 x GJLB-4) to 64.81% (GAOB-2 x Punjab Sadabahar) at Vanarasi and -62.68% (Pusa Upkar x GJLB-4) to 76.1% (GAOB-2 x Punjab Sadabahar) at Waghai. Hybrids namely Pusa Upkar x GJLB-4 (57.58%), GOB-1 x GJLB-4 (-60.26%) and Punjab Sadabahar x JBGR-1 (-55.15%) in E1; GOB-1 x GJLB-4 (-60.95%), Pusa Upkar x GJLB-4 (-58.92%) and Punjab Sadabahar x JBGR-1 (54.39%) in E2; and Pusa Upkar x GJLB-4 (-62.68%), GOB-1 x GJLB-4 (-60.46%) and GOB-1 x GRB-5 (-54.15%) in E3 were the best negatively significant heterobeltiotic hybrids for total soluble sugars. Range of Standard heterosis were reported in between -47.51% (GOB-1 x GJLB-4) to 19.53% (GAOB-2 x Punjab Sadabahar) at Navsari, -50.9% (Pusa Upkar x GJLB-4) to 91.36% (GAOB-2 x Punjab Sadabahar) at Vanarasi and -52.66% (Pusa Upkar x GJLB-4) to 16.9% (GAOB-2 x Punjab Sadabahar) at Waghai. The promising hybrids were *viz.*, GOB-1 x GJLB-4 (- 47.51%) and Pusa Upkar x GJLB-4 (-46.12%) at Navsari; GAOB-2 x Punjab Sadabahar (-50.9%) and GOB-1 x GJLB-4 (50.9%) at Vanarasi exhibited significant and negative standard heterosis. While, Pusa Upkar x GJLB-4 (-52.66%) and GOB-1 x GJLB-4 (46.81%) reported significant and negative standard heterosis at Waghai. Similar results were also reported by Makani *et al.* (2013) [12], Rani *et al.* (2018) [17], Patel *et al.* (2017a) [15], Kumari *et al.* (2019) [10] and Timmareddygari *et al.* (2021) [19].

Total Soluble Sugars

The range of heterobeltiosis for total soluble sugars (%) was from -50.53% (GAOB-2 x Swarna Mani) to 40.71% (GAOB-2 x JBGR-1) at Navsari, -55.44% (Swarna Mani x Pusa Upkar) to 46.51% (GAOB-2 x JBGR-1) at Vanarasi and -53.35% (Swarna Mani x Pusa Upkar) to 48.59% (Pusa Upkar x GJLB-4) at Waghai. Hybrids GAOB-2 x JBGR-1 (40.71%), GAOB-2 x GJLB- 4 (27.79%) and GOB-1 x NBL-117 (25.51%) in E1; GAOB-2 x JBGR-1 (46.51%), GOB-1 x NBL-117 (39.08%) and Pusa Upkar x GJLB-4 (34.38%) in E2; and Pusa Upkar x GJLB-4 (48.59%), Pusa Upkar x GJLB-4 (48.59%) and GAOB-2 x JBGR-1 (45.39%) in E3 were the best significant heterobeltiotic hybrids for total soluble sugars.

The magnitude of standard heterosis for this TSS ranged from -49.64% (Pusa Upkar x NBL-117) to 27.71% (Pusa Upkar x GJLB-4), -45.47% (GAOB-2 x GOB-1) to 35.61% (Pusa Upkar x GJLB-4) and -54.88% (GAOB-2 x GOB-1) to 34.95% (Pusa Upkar x GJLB-4) in E1, E2 and E3, respectively. Top hybrids in term of total soluble sugars were Pusa Upkar x GJLB-4 (27.71%), Swarna Mani x GJLB-4 (22.35%) and GOB-1 x Punjab Sadabahar (21.51%) at Navsari, Pusa Upkar x GJLB-4 (35.61%), Punjab Sadabahar x Pusa Upkar (28.15%) and Swarna Mani x GJLB- 4 (23.23%) at Vanarasi and Pusa Upkar x GJLB-4 (34.95%) and Punjab Sadabahar x Pusa Upkar (24.19%) at Waghai exhibited significant and negative heterosis over check. The derived results were in conformity with Makani *et al.* (2013) [12] and Patel *et al.* (2017a) [5], Modh (2018) [13], Kumari *et al.* (2019) [10] and Timmareddygari *et al.* (2021) [19].

Shoot and Fruit Borer Infestation

Negative heterosis is desirable for biotic stress such as shoot and fruit borer infestation. The heterobeltosis performance ranged from -23.24% (Swarna Mani x GRB-5) to 70.02% (GOB- 1 x GRB-5); -22.15% (Pusa Upkar x GJLB-4) to 58.34% (GAOB-2 x Swarna Mani); and -31.49% (Pusa Upkar x GRB-5) to 32.29% (JBGR-1 x NBL117) in E1, E2 and E3, respectively. Swarna Mani x GRB-5 (-23.24%) followed by GOB-1 x NBL-117 (-17.82%) and Swarna Mani x NBL- 117 (-16.55%) in E1; Pusa Upkar x GJLB-4 (-22.15%) followed by Swarna Mani x GJLB-4 (-21.87%) and JBGR-1 x GJLB-4 (-21.74%) in E2; and Pusa Upkar x GRB-5 (-31.49%) followed by GAOB-2 x Punjab Sadabahar (-27.45%) and Swarna Mani x GJLB-4 (-27.35%) in E3 were the best heterobeltiotic hybrids to sustain shoot and fruit borer infestation.

The magnitude of standard heterosis ranged from -7.88% (GAOB-2 x GOB-1) to 72.02% (GOB-1 x GRB-5); -20.21% (GAOB-2 x GOB-1) to 45.83% (Punjab Sadabahar x JBGR-1); and -18.73% (Pusa Upkar x GRB-5) to 39.82% (JBGR-1 x NBL-117) in E1, E2 and E3 respectively. The only hybrid with negatively significant standard heterosis for shoot and fruit borer infestation was Pusa Upkar x GRB-5 (-18.73%) at Waghai. Similar finding was also reported by Sujin and Karuppaiah (2018) [18], Kumari *et al.* (2019) [10] and Rameshkumar and Venthamonai (2020).

Table 9: Estimates of heterosis over better parent (BP) and standard check (SH) under individual environments for days to 50 per cent flowering

Sr.	Hybrids	E1		Days to 50 per cent flowering E2			E3
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	GAOB-2 x GOB-1	-4.52	1.81	1.66	5.14*	3.21	6.04*
2	GAOB-2 x PS	-1.13	5.42*	3.31	6.86**	3.74	6.59*
3	GAOB-2 x JBGR-1	-13.56**	-7.83**	-6.63**	-3.43	-5.88*	-3.30
4	GAOB-2 x SM	-5.65*	0.61	2.21	5.71**	1.60	4.40
5	GAOB-2 x PU	2.82	9.64**	4.97*	8.57**	3.21	6.04*
6	GAOB-2 x GRB-5	-7.34**	-1.22	-6.63**	-3.43	-4.28	-1.65
7	GAOB-2 x NBL-117	-3.95	2.41	-1.66	1.71	-1.60	1.10
8	GAOB-2 x GJLB-4	-3.76	7.83**	3.28	8.00**	4.21	8.79**
9	GOB-1 x PS	0.59	2.41	3.35	5.71**	4.35	5.49*
10	GOB-1 x JBGR-1	7.10**	9.04**	12.85**	15.43**	15.76**	17.03**
11	GOB-1 x SM	-1.18	0.61	-2.79	-0.57	-1.63	-0.55
12	GOB-1 x PU	3.55	5.42*	5.03*	7.43**	7.07*	8.24**
13	GOB-1 x GRB-5	7.69**	9.64**	7.82**	10.29**	8.15**	9.34**
14	GOB-1 x NBL-117	-12.43**	-10.84**	-20.67**	-18.86**	-15.22**	-14.29**
15	GOB-1 x GJLB-4	0.54	12.65**	-0.55	4.00	3.16	7.69**
16	PS x JBGR-1	6.02*	6.02*	3.93	5.71**	4.37	4.95
17	PS x SM	15.03**	6.02*	12.96**	4.57*	13.61**	5.49*
18	PS x PU	0.65	-7.23**	0.01	-7.43**	-0.59	-7.69**
19	PS x GRB-5	2.42	1.81	-3.98	-3.43	-1.10	-1.10
20	PS x NBL-117	-4.58	-12.05**	-0.62	-8.00**	-0.59	-7.14*
21	PS x GJLB-4	-0.54	11.45**	0.55	5.14*	1.58	6.04*
22	JBGR-1 x SM	5.42*	5.42*	-8.99**	-7.43**	-6.01*	-5.49*
23	JBGR-1 x PU	4.22	4.22	-7.87**	-6.29**	-6.01*	-5.49*
24	JBGR-1 x GRB-5	1.20	1.21	-6.18**	-4.57*	-4.37	-3.85
25	JBGR-1 x NBL-117	5.42*	5.42*	1.12	2.86	3.28	3.85
26	JBGR-1 x GJLB-4	3.76	16.27**	3.83	8.57**	5.79*	10.44**
27	SM x PU	3.97	-5.42*	5.73*	-5.14*	1.18	-6.04*
28	SM x GRB-5	2.42	1.81	1.14	1.71	2.20	2.20
29	SM x NBL-117	6.62*	-3.01	4.32	-3.43	7.06*	0.10
30	SM x GJLB-4	3.76	16.27**	0.01	4.57*	0.11	4.40
31	PU x GRB-5	5.45*	4.82	3.41	4.00	2.20	2.20
32	PU x NBL-117	17.45**	5.42*	1.23	-6.29**	3.53	-3.30
33	PU x GJLB-4	-3.23	8.43**	2.73	7.43**	3.68	8.24**
34	GRB-5 x NBL-117	1.82	1.20	-1.70	-1.14	-0.55	-0.55
35	GRB-5 x GJLB-4	0.11	12.05**	1.64	6.29**	0.53	4.95
36	NBL-117 x GJLB-4	-1.61	10.24**	2.73	7.43**	4.21	8.79**
	SE ±	1.37	1.37	1.23	1.23	1.66	1.66

And ** indicate significance at 5% and 1% levels of probability, respectively

Table 10: Estimates of heterosis over better parent (BP) and standard check (SH) under individual environments for branches per plant

Sr.	Hybrids	E1		Branches per plant E2			E3
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	GAOB-2 x GOB-1	-6.98	-3.78	4.79	-4.37	-1.90	3.69
2	GAOB-2 x PS	-10.30	-7.22	-5.56	-4.37	-7.62	-2.35
3	GAOB-2 x JBGR-1	-9.97	-6.87	7.88	-1.56	-3.81	1.68
4	GAOB-2 x SM	-8.97	-5.84	6.85	-2.50	-15.24**	-10.40
5	GAOB-2 x PU	-28.90**	-26.46**	-13.01*	-20.63**	-19.05**	-14.43*
6	GAOB-2 x GRB-5	-33.44**	-25.43**	-24.71**	-19.06**	-11.32*	-5.37
7	GAOB-2 x NBL-117	-22.59**	-19.93**	-4.45	-12.81*	-4.13	1.34
8	GAOB-2 x GJLB-4	-35.55**	-33.33**	-19.52**	-26.56**	-20.63**	-16.11**
9	GOB-1 x PS	-30.04**	-31.96**	-18.52**	-17.50**	-15.20**	-15.77**
10	GOB-1 x JBGR-1	-6.14	-26.46**	-12.63*	-22.19**	-6.52	-13.42*
11	GOB-1 x SM	12.28	-12.03	14.13*	-1.56	19.92**	3.02
12	GOB-1 x PU	20.18*	-5.84	22.83**	5.94	36.23**	21.14**
13	GOB-1 x GRB-5	-32.21**	-24.05**	-20.06**	-14.06*	-16.04**	-10.40
14	GOB-1 x NBL-117	-14.91	-33.33**	-21.38**	-32.19**	-9.60	-24.16**
15	GOB-1 x GJLB-4	-4.82	-25.43**	-14.13*	-25.94**	-10.53	-20.13**
16	PS x JBGR-1	-38.52**	-40.21**	-22.22**	-21.25**	-10.81	-11.41*
17	PS x SM	-21.91**	-24.05**	-7.41	-6.25	4.73	4.03
18	PS x PU	-28.62**	-30.58**	-24.38**	-23.44**	-7.77	-8.39
19	PS x GRB-5	-37.42**	-29.90**	-30.23**	-25.00**	-30.50**	-25.84**
20	PS x NBL-117	-36.04**	-37.80**	-23.15**	-22.19**	-13.85*	-14.43*
21	PS x GJLB-4	-37.10**	-38.83**	-26.85**	-25.94**	-22.97**	-23.49**

22	JBGR-1 x SM	13.39	-12.71*	4.21	-7.19	29.35**	19.8**
23	JBGR-1 x PU	-4.46	-26.46**	-15.79*	-25.00**	33.70**	23.83**
24	JBGR-1 x GRB-5	-19.94**	-10.31	-6.40	0.63	7.23	14.43*
25	JBGR-1 x NBL-117	-5.36	-27.15**	-6.32	-16.56**	6.52	-1.34
26	JBGR-1 x GJLB-4	7.59	-17.18**	1.05	-10.00	3.26	-4.36
27	SM x PU	25.00**	-3.78	24.90**	-2.81	16.98**	4.03
28	SM x GRB-5	-36.20**	-28.52**	-27.62**	-22.19**	-18.24**	-12.75*
29	SM x NBL-117	26.80**	-15.46*	17.08*	-12.19*	-1.56	-15.44**
30	SM x GJLB-4	0.01	-24.40**	2.75	-18.13**	-6.39	-16.44**
31	PU x GRB-5	-15.03**	-4.81	-7.27	-0.31	15.72**	23.49**
32	PU x NBL-117	35.71**	4.47	18.88**	-7.50	2.64	-8.72
33	PU x GJLB-4	34.38**	3.44	31.37**	4.69	29.32**	15.44**
34	GRB-5 x NBL-117	-23.31**	-14.09*	-19.77**	-13.75*	-5.35	1.01
35	GRB-5 x GJLB-4	-34.05**	-26.12**	-26.74**	-21.25**	-20.13**	-14.77**
36	NBL-117 x GJLB-4	25.00**	-5.50	34.12**	6.88	37.97**	23.15**
	SE ±	0.61	0.61	0.58	0.58	0.47	0.47

And ** indicate significance at 5% and 1% levels of probability, respectively

Table 11: Estimates of heterosis over better parent (BP) and standard check (SH) under individual environments for plant height

Sr.	Hybrids	E1		Plant height E2			E3
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	GAOB-2 x GOB-1	1.50	12.66**	-1.01	-0.55	-2.81	-3.56
2	GAOB-2 x PS	4.38	14.38**	1.90	5.86	-6.11	-6.84*
3	GAOB-2 x JBGR-1	2.96	9.52*	13.84**	10.52**	-1.55	-2.31
4	GAOB-2 x SM	5.21	11.91**	-2.16	-5.02	-2.30	-3.05
5	GAOB-2 x PU	4.02	13.60**	8.36*	5.20	-10.00**	-2.25
6	GAOB-2 x GRB-5	15.48**	22.84**	8.93*	5.76	1.55	0.76
7	GAOB-2 x NBL-117	-5.69	8.43	-16.64**	-5.16	-8.93**	-9.63**
8	GAOB-2 x GJLB-4	-12.97**	15.72**	-4.39	6.38	0.12	4.18
9	GOB-1 x PS	15.85**	28.59**	-4.09	-0.37	12.06**	1.40
10	GOB-1 x JBGR-1	13.87**	26.39**	3.51	3.98	9.18*	1.55
11	GOB-1 x SM	9.42*	21.45**	12.4**	12.91**	7.27*	-0.14
12	GOB-1 x PU	3.18	14.53**	8.67*	9.16*	-5.80	2.31
13	GOB-1 x GRB-5	14.28**	26.85**	10.96**	11.46**	9.01*	0.66
14	GOB-1 x NBL-117	-11.70**	1.52	-10.30**	2.05	4.47	3.52
15	GOB-1 x GJLB-4	-7.44*	23.08**	-1.73	9.34*	-3.37	0.56
16	PS x JBGR-1	15.98**	27.09**	-1.32	2.51	3.45	-3.79
17	PS x SM	7.58	17.89**	0.05	3.93	16.09**	8.07*
18	PS x PU	8.94*	19.38**	-10.38**	-6.90	-7.23*	0.76
19	PS x GRB-5	17.06**	28.27**	3.29	7.30	0.17	-7.51*
20	PS x NBL-117	7.79*	23.93**	-6.80*	6.03	9.22**	8.23*
21	PS x GJLB-4	-17.17**	10.14*	-10.46**	-0.37	-9.94**	-6.28
22	JBGR-1 x SM	13.39**	8.64	4.94	-4.12	10.18**	2.57
23	JBGR-1 x PU	11.32**	21.58**	13.22**	6.35	-2.25	6.17
24	JBGR-1 x GRB-5	25.91**	28.76**	9.27*	3.64	9.48**	1.82
25	JBGR-1 x NBL-117	-0.15	14.8**	-16.03**	-4.46	-9.32**	-10.14**
26	JBGR-1 x GJLB-4	-11.87**	17.19**	-15.75**	-6.26	-17.75**	-14.4**
27	SM x PU	-4.23	4.59	3.59	-2.70	-12.95**	-5.45
28	SM x GRB-5	-4.88	-2.73	0.10	-5.15	-0.40	-7.27*
29	SM x NBL-117	-9.34*	4.23	-14.75**	-3.02	-4.55	-5.41
30	SM x GJLB-4	-18.09**	8.92*	-19.49**	-10.42**	-14.06**	-10.57**
31	PU x GRB-5	-0.61	8.55	10.38*	4.70	-1.78	6.68*
32	PU x NBL-117	0.39	15.42**	-5.84	7.13	-6.01	2.09
33	PU x GJLB-4	-11.57**	17.59**	2.36	13.89**	-3.22	5.11
34	GRB-5 x NBL-117	-5.82	8.27	2.79	16.95**	-9.23**	-10.06**
35	GRB-5 x GJLB-4	-5.21	26.05**	-8.26*	2.07	2.69	6.86*
36	NBL-117 x GJLB-4	-5.46	25.72**	-5.60	7.39	8.16*	12.56**
	SE ±	3.31	3.31	3.22	3.22	2.52	2.52

And ** indicate significance at 5% and 1% levels of probability, respectively

Table 12: Estimates of heterosis over better parent (BP) and standard check (Sh) under individual environments for fruit length

Sr.	**Hybrids**	**E1**		**Fruit length E2**			**E3**
		BP (%)	**SH (%)**	**BP (%)**	**SH (%)**	**BP (%)**	**SH (%)**
1	GAOB-2 x GOB-1	19.45**	29.68**	27.34**	28.30**	37.87**	33.85**
2	GAOB-2 x PS	-35.29**	0.10	-50.40**	-9.69	-53.13**	-12.75*
3	GAOB-2 x JBGR-1	12.55**	32.23**	-4.50	28.44**	-12.73**	20.26**

4	GAOB-2 x SM	33.56**	26.62**	8.70	22.32**	28.32**	25.95**
5	GAOB-2 x PU	28.17**	17.52**	12.15*	16.26**	27.90**	25.08**
6	GAOB-2 x GRB-5	45.89**	32.23**	72.66**	45.12**	53.99**	44.82**
7	GAOB-2 x NBL-117	36.47**	23.69**	40.60**	30.73**	17.11**	14.27**
8	GAOB-2 x GJLB-4	-31.06**	-6.91	-34.91**	-11.04	-34.94**	-18.09**
9	GOB-1 x PS	-27.14**	12.71*	-37.15**	14.43*	-42.39**	7.25
10	GOB-1 x JBGR-1	-12.12**	3.25	-25.75**	-0.14	-19.54**	10.87*
11	GOB-1 x SM	-3.05	5.25	6.33	19.65**	17.51**	15.34**
12	GOB-1 x PU	7.57	16.78**	11.88*	15.99*	11.71*	9.26
13	GOB-1 x GRB-5	-13.99**	-6.62	2.06	2.84	3.10	0.10
14	GOB-1 x NBL-117	-25.37**	-18.98**	-10.27	-9.58	-21.43**	-23.33**
15	GOB-1 x GJLB-4	-30.90**	-6.69	-29.19**	-3.22	-25.30**	-5.95
16	PS x JBGR-1	-12.13**	35.92**	-27.67**	31.70**	-28.06**	33.92**
17	PS x SM	-16.64**	28.95**	-28.60**	30.00**	-24.62**	40.32**
18	PS x PU	-27.91**	11.51*	-42.09**	5.43	-45.90**	0.71
19	PS x GRB-5	-17.46**	27.68**	-29.25**	28.82**	-31.14**	28.19**
20	PS x NBL-117	-20.98**	22.23**	-34.45**	19.34**	-38.06**	15.31**
21	PS x GJLB-4	6.11	64.14**	-9.03**	65.64**	-8.55**	70.23**
22	JBGR-1 x SM	7.92	26.78**	-8.90	22.53**	-8.31*	26.34**
23	JBGR-1 x PU	-19.65**	-5.61	-27.89**	-3.01	-30.74**	-4.56
24	JBGR-1 x GRB-5	-20.44**	-6.53	-22.69**	3.98	-21.89**	7.64
25	JBGR-1 x NBL-117	-20.93**	-7.10	-23.59**	2.77	-28.04**	-0.84
26	JBGR-1 x GJLB-4	-20.73**	7.04	-5.70	28.89**	-23.06**	6.02
27	SM x PU	-7.46	-12.26*	-13.87*	-3.08	-4.62	-6.38
28	SM x GRB-5	12.73*	6.88	1.88	14.64*	1.48	-0.39
29	SM x NBL-117	-12.03*	-16.59**	-15.04**	-4.39	-6.76	-8.48
30	SM x GJLB-4	-27.50**	-2.10	-27.90**	-1.45	-28.35**	-9.81
31	PU x GRB-5	21.78**	11.66*	10.55	14.60*	1.92	-0.32
32	PU x NBL-117	9.48	0.38	0.97	4.67	2.15	-0.10
33	PU x GJLB-4	-13.30**	17.07**	-12.3**	19.86**	-14.6**	7.51
34	GRB-5 x NBL-117	-1.86	-21.15**	0.52	-6.54	-14.62**	-16.70**
35	GRB-5 x GJLB-4	-34.88**	-12.07*	-34.23**	-10.10	-33.75**	-16.60**
36	NBL-117 x GJLB-4	-12.29**	18.44**	-13.54**	18.17**	-12.80**	9.77
	SE ±	0.54	0.54	0.59	0.59	0.51	0.51

And ** indicate significance at 5% and 1% levels of probability, respective

Table 13: Estimates of heterosis over better parent (BP) and standard check (SH) under individual environments for fruit girth

Sr.	Hybrids	E1		Fruit girth E2			E3
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	GAOB-2 x GOB-1	14.43**	48.25**	17.24**	57.45**	4.53	59.66**
2	GAOB-2 x PS	-6.91	20.59**	13.50*	41.28**	-10.87**	36.14**
3	GAOB-2 x JBGR-1	-4.17	24.15**	-6.63	38.65**	-5.42	44.75**
4	GAOB-2 x SM	11.02**	47.37**	6.01	51.97**	-1.33	50.72**
5	GAOB-2 x PU	1.52	31.52**	-0.44	35.78**	-6.58	42.70**
6	GAOB-2 x GRB-5	-5.60	22.30**	8.46	35.00**	-15.19**	29.54**
7	GAOB-2 x NBL-117	-1.89	27.09**	14.51**	42.53**	-20.47**	21.47**
8	GAOB-2 x GJLB-4	-16.98**	7.55	-1.21	22.96**	-26.65**	12.03*
9	GOB-1 x PS	-19.06**	2.89	-17.62**	10.63	-24.34**	6.37
10	GOB-1 x JBGR-1	-15.24**	7.74	-15.21**	25.91**	-15.42**	29.43**
11	GOB-1 x SM	2.05	35.45**	4.47	49.77**	2.25	47.17**
12	GOB-1 x PU	-1.12	25.69**	3.98	41.81**	-7.84	35.32**
13	GOB-1 x GRB-5	-1.47	25.24**	4.33	40.11**	0.34	41.30**
14	GOB-1 x NBL-117	-17.42**	4.97	-13.59**	16.04*	-26.33**	3.57
15	GOB-1 x GJLB-4	-25.15**	-4.85	-15.93**	12.90	-30.22**	-1.90
16	PS x JBGR-1	-12.09**	11.75*	-22.25**	15.45*	-15.62**	29.14**
17	PS x SM	-8.43*	21.55**	-7.92	32.00**	-14.17**	23.54**
18	PS x PU	-5.50	8.88	-13.38**	18.12**	-23.53**	12.28*
19	PS x GRB-5	6.44	16.81**	23.54**	23.75**	-3.37	36.08**
20	PS x NBL-117	15.45**	13.96**	3.50	19.14**	2.93	25.59**
21	PS x GJLB-4	20.58**	-2.62	19.69**	15.83*	30.65**	15.31*
22	JBGR-1 x SM	-4.33	26.98**	-5.42	40.45**	-12.86**	33.36**
23	JBGR-1 x PU	-9.91*	14.52**	-18.57**	20.93**	-24.86**	15.00*
24	JBGR-1 x GRB-5	4.14	32.38**	-4.83	41.32**	-15.66**	29.08**
25	JBGR-1 x NBL-117	-4.60	21.27**	-3.90	42.70**	-16.16**	28.31**
26	JBGR-1 x GJLB-4	-30.87**	-12.12*	-31.76**	1.34	-39.97**	-8.13
27	SM x PU	-3.12	28.59**	4.87	50.34**	-3.73	41.36**

28	SM x GRB-5	-2.36	29.60**	10.67*	58.66**	0.60	44.79**
29	SM x NBL-117	-21.58**	4.08	-22.13**	11.63	-23.86**	9.59
30	SM x GJLB-4	-23.40**	1.67	-26.10**	5.94	-27.45**	4.43
31	PU x GRB-5	18.67**	36.72**	6.33	45.01**	-8.58*	34.24**
32	PU x NBL-117	5.16	21.15**	-4.30	30.52**	-5.31	39.04**
33	PU x GJLB-4	-10.88*	2.68	-20.29**	8.70	-28.61**	4.83
34	GRB-5 x NBL-117	-7.96	1.01	3.37	18.99**	-17.06**	16.80**
35	GRB-5 x GJLB-4	-7.75	1.24	4.51	4.69	-22.31**	9.40
36	NBL-117 x GJLB-4	17.22**	15.70**	18.77**	36.71**	4.01	26.91**
	SE ±	0.81	0.81	1.07	1.07	0.93	0.93

And ** indicate significance at 5% and 1% levels of probability, respectively

Table 14: Estimates of heterosis over better parent (BP) and standard check (SH) under individual environments for fruit weight

Sr.	Hybrids	E_1		Fruit weight E_2		E_3	
		BP (%)	**SH (%)**	**BP (%)**	**SH (%)**	**BP (%)**	**SH (%)**
1	GAOB-2 x GOB-1	13.47	47.46**	8.77	56.92**	14.74	54.25**
2	GAOB-2 x PS	-6.46	21.55*	-21.76**	5.83	-1.37	30.42**
3	GAOB-2 x JBGR-1	1.42	31.79**	10.87	49.96**	2.45	35.46**
4	GAOB-2 x SM	13.10	58.16**	19.36*	67.72**	17.30*	56.1**
5	GAOB-2 x PU	17.66*	52.90**	-1.11	54.34**	-6.63	37.14**
6	GAOB-2 x GRB-5	-20.90**	2.78	-15.95	13.69	-27.65**	-1.31
7	GAOB-2 x NBL-117	-11.20	15.39	-6.51	26.46*	-9.42	19.77
8	GAOB-2 x GJLB-4	2.12	32.70**	-8.3	24.04*	-3.95	27.01*
9	GOB-1 x PS	9.96	35.05**	5.01	51.49**	-8.25	23.35*
10	GOB-1 x JBGR-1	-11.92	8.18	-33.10**	-3.48	12.74	51.57**
11	GOB-1 x SMs	-6.13	31.26**	-3.34	39.45**	17.57*	58.06**
12	GOB-1 x PU	29.24**	62.07**	18.22*	64.50**	21.71**	58.77**
13	GOB-1 x GRB-5	-22.91**	-5.32	-47.79**	-24.67*	-44.51**	-24.30*
14	GOB-1 x NBL-117	-11.88	8.23	-40.21**	-13.74	-22.32**	4.43
15	GOB-1 x GJLB-4	-17.38*	1.48	-31.64**	-1.38	-30.84**	-7.02
16	PS x JBGR-1	12.66	19.38	-8.43	11.21	-6.24	8.31
17	PS x SM	-13.36	21.15*	-5.19	33.21**	-10.22	19.47
18	PS x PU	-11.07	11.52	-39.12**	-4.99	-26.36**	8.16
19	PS x GRB-5	-15.24	-10.19	-51.61**	-38.51**	-45.86**	-26.15*
20	PS x NBL-117	-3.13	2.65	-17.16	0.62	-19.68*	-7.21
21	PS x GJLB-4	18.43	25.49*	4.35	26.74*	-4.06	10.83
22	JBGR-1 x SM	-13.09	21.53*	-16.00*	18.03	-28.01**	-4.20
23	JBGR-1 x PU	-9.96	12.91	-37.01**	-1.69	-35.98**	-5.96
24	JBGR-1 x GRB-5	-1.77	-0.49	-38.74**	-22.16*	-46.42**	-26.91*
25	JBGR-1 x NBL-117	16.68	13.12	-19.57	-14.83	9.55	10.26
26	JBGR-1 x GJLB-4	-20.02	-19.54	-43.55**	-34.39**	-25.59**	-18.70
27	SM x PU	-1.59	37.61**	-8.02	43.55**	-3.96	41.07**
28	SM x GRB-5	1.87	42.45**	6.92	50.24**	-5.81	28.48**
29	SM x NBL-117	-21.49**	9.79	-21.77**	9.92	-25.41**	-0.73
30	SM x GJLB-4	-17.11*	15.90	-24.76**	5.72	-1.55	31.01**
31	PU x GRB-5	10.13	38.10**	-1.11	54.33**	-1.57	44.57**
32	PU x NBL-117	13.10	41.82**	-4.43	49.15**	-13.25	27.42**
33	PU x GJLB-4	0.46	25.98*	-26.33**	14.97	-6.69	37.05**
34	GRB-5 x NBL-117	16.62	18.14	-12.55	11.11	-24.42**	3.10
35	GRB-5 x GJLB-4	-21.06*	-20.04	-30.79**	-12.06	-39.85**	-17.95
36	NBL-117 x GJLB-4	19.61**	30.38**	12.22	30.44**	19.82**	41.84**
	SE ±	7.08	7.08	6.37	6.37	5.07	5.07

And ** indicate significance at 5% and 1% levels of probability, respectively

Table 15: Estimates of heterosis over better parent (BP) and standard check (SH) under individual environments for fruits per plant

Sr.	Hybrids	E_1		Fruits per plant E_2		E_3	
		BP (%)	**SH (%)**	**BP (%)**	**SH (%)**	**BP (%)**	**SH (%)**
1	GAOB-2 x GOB-1	27.87**	49.35**	21.45*	46.05**	25.77*	51.25**
2	GAOB-2 x PS	-24.41**	-16.24	-43.44**	-31.99**	-44.17**	-32.87**
3	GAOB-2 x JBGR-1	10.39	36.67**	5.67	28.35*	25.79**	54.55**
4	GAOB-2 x SM	12.76	24.94**	-4.57	14.76	13.63	36.64**
5	GAOB-2 x PU	3.24	14.40	-4.58	14.74	-1.90	17.97
6	GAOB-2 x GRB-5	5.16	41.82**	-1.06	27.43*	-0.09	31.47**
7	GAOB-2 x NBL-117	10.43	27.95**	16.81	44.98**	7.71	39.73**
8	GAOB-2 x GJLB-4	-1.84	8.76	-16.53	0.38	-1.71	18.20
9	GOB-1 x PS	-11.32	3.58	-20.32*	-6.32	-16.91	-4.19

10	GOB-1 x JBGR-1	5.28	30.35**	5.71	28.39*	11.72	37.27**
11	GOB-1 x SM	2.36	19.56*	-5.27	11.38	18.17	36.89**
12	GOB-1 x PU	6.08	23.90*	-3.04	14.00	32.71**	53.02**
13	GOB-1 x GRB-5	3.01	38.93**	0.01	28.79**	-0.72	30.65*
14	GOB-1 x NBL-117	0.47	17.35	-6.44	16.12	-9.56	17.33
15	GOB-1 x GJLB-4	-26.81**	-14.51	-15.89	-1.12	-22.7*	-10.88
16	PS x JBGR-1	-15.05	5.18	-12.51	6.26	-18.35	0.33
17	PS x SM	-6.46	0.70	4.60	8.13	10.86	28.43*
18	PS x PU	0.36	6.67	-10.99	-7.98	14.41	18.69
19	PS x GRB-5	-17.65*	11.07	-2.38	25.74*	-4.39	25.82*
20	PS x NBL-117	-11.84	2.14	-17.08	2.91	-21.88*	1.35
21	PS x GJLB-4	-30.15**	-25.76**	-14.64	-11.76	0.56	6.07
22	JBGR-1 x SM	5.69	30.86**	13.07	37.33**	15.57	42.01**
23	JBGR-1 x PU	0.74	24.73*	23.08*	49.49**	13.85	39.88**
24	JBGR-1 x GRB-5	-3.63	29.98**	33.61**	72.09**	36.18**	79.21**
25	JBGR-1 x NBL-117	-8.16	13.70	-19.07*	0.44	-4.68	23.66*
26	JBGR-1 x GJLB-4	-42.25**	-28.50**	-27.35**	-11.76	-14.26	5.34
27	SM x PU	16.80	25.76**	51.90**	45.53**	15.40	33.69**
28	SM x GRB-5	13.70	53.35**	20.85*	55.65**	19.48*	57.23**
29	SM x NBL-117	-5.46	9.54	-12.69	8.37	-18.03	6.34
30	SM x GJLB-4	-32.68**	-27.52**	-22.56*	-25.81*	-12.04	1.90
31	PU x GRB-5	-17.34*	11.48	-9.52	16.54	12.16	47.60**
32	PU x NBL-117	3.52	19.94*	5.49	30.93**	-3.10	25.71*
33	PU x GJLB-4	-30.42**	-31.28**	-33.12**	-37.28**	-39.00**	-35.66**
34	GRB-5 x NBL-117	-0.03	34.82**	8.04	39.15**	20.03*	57.96**
35	GRB-5 x GJLB-4	-27.93**	-2.80	-7.50	19.13	-9.12	19.59
36	NBL-117 x GJLB-4	-9.49	4.86	-24.24**	-5.97	-6.70	21.04
	SE ±	2.31	2.31	2.36		2.36	2.25

And ** indicate significance at 5% and 1% levels of probability, respectively

Table 16: Estimates of heterosis over better parent (BP) and standard check (SH) under individual environments for fruit yield per plant

Sr.	Hybrids	E_1		Fruit yield per plant E_2			E_3
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	GAOB-2 x GOB-1	30.35*	65.24**	36.29**	122.49**	35.05**	130.35**
2	GAOB-2 x PS	-28.52*	-13.16	-57.80**	-33.67	-46.33**	-13.90
3	GAOB-2 x JBGR-1	43.53**	74.38**	15.59	81.69**	24.03*	98.98**
4	GAOB-2 x SM	24.46*	72.36**	0.51	57.99**	9.99	110.33**
5	GAOB-2 x PU	25.58	52.57**	-16.60	45.90*	-2.33	66.05**
6	GAOB-2 x GRB-5	10.89	45.37**	-21.86*	34.67	-21.01	37.45*
7	GAOB-2 x NBL-117	6.73	29.66	15.75	81.95**	5.82	69.77**
8	GAOB-2 x GJLB-4	17.47	42.71**	-16.17	31.77	-2.98	55.65**
9	GOB-1 x PS	1.42	28.56	-27.66*	18.08	-29.22**	20.72
10	GOB-1 x JBGR-1	4.49	32.45*	-13.25	41.61*	20.65	105.78**
11	GOB-1 x SM	-1.84	35.94*	-22.86*	25.92	4.42	99.68**
12	GOB-1 x PU	42.22**	80.28**	21.87*	113.22**	44.92**	147.18**
13	GOB-1 x GRB-5	-4.11	25.71	-41.85**	0.22	-39.41**	5.45
14	GOB-1 x NBL-117	-3.68	22.1	-33.88**	7.93	-24.16*	29.36
15	GOB-1 x GJLB-4	-33.84**	-16.14	-34.83**	6.39	-53.17**	-20.12
16	PS x JBGR-1	18.61	17.01	-19.71	6.04	-2.89	24.73
17	PS x SM	-13.34	20.02	-4.63	36.55	-9.33	73.38**
18	PS x PU	4.14	15.18	-46.57**	-6.52	-19.56	36.76
19	PS x GRB-5	-33.32**	-12.59	-55.13**	-22.67	-42.94**	-0.70
20	PS x NBL-117	-22.74	-25.25	-31.60*	-2.20	-44.94**	-12.44
21	PS x GJLB-4	-31.27*	-29.26	9.88	19.72	-8.41	10.60
22	JBGR-1 x SM	12.26	55.47**	-6.50	33.87	-26.57**	40.42*
23	JBGR-1 x PU	27.17	40.65*	-14.25	50.03**	-21.98	32.64
24	JBGR-1 x GRB-5	12.36	47.30**	-25.43*	28.52	-30.57**	20.82
25	JBGR-1 x NBL-117	32.82*	31.02	-36.03**	-8.53	-8.19	45.98*
26	JBGR-1 x GJLB-4	-52.83**	-51.45**	-51.77**	-36.30	-37.59*	-19.84
27	SM x PU	10.10	52.47**	17.88	106.23**	-1.76	87.87**
28	SM x GRB-5	27.13*	76.06**	15.40	98.9**	7.56	105.69**
29	SM x NBL-117	-16.15	16.12	-9.06	30.20	-46.84**	1.65
30	SM x GJLB-4	-39.82**	-16.67	-45.06**	-21.34	-25.04*	43.35*
31	PU x GRB-5	15.01	50.78**	10.55	93.40**	50.86**	162.53**
32	PU x NBL-117	41.63**	56.65**	22.43*	114.2**	-2.28	66.14**
33	PU x GJLB-4	-33.66*	-26.62	-61.77**	-33.12	-60.46**	-32.78

34	GRB-5 x NBL-117	20.49	57.97**	-19.37	38.97*	4.15	81.24**
35	GRB-5 x GJLB-4	-35.22**	-15.08	-28.89**	22.56	-32.10**	18.16
36	NBL-117 x GJLB-4	17.29	20.72	2.20	46.13*	14.51	82.07**
	SE ±	310.05	310.05	261.43	261.43	203.17	203.17

And ** indicate significance at 5% and 1% levels of probability, respectively

Table 17: Estimates of heterosis over better parent (BP) and standard check (SC) under individual environments for seeds per fruit

Sr.	Crosses	E_1		Seeds per Fruit E_2			E_3
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	GAOB-2 x GOB-1	-17.03**	-0.08	-8.54	1.10	-17.89**	-7.09
2	GAOB-2 x PS	-45.63**	-34.53**	-37.58**	-31.00**	-46.58**	-39.56**
3	GAOB-2 x JBGR-1	-25.35**	-7.09	-26.68**	-13.31	-28.29**	-11.36
4	GAOB-2 x SM	-33.74**	-20.21**	-33.08**	-26.03**	-33.21**	-24.43**
5	GAOB-2 x PU	-6.55	13.23	-8.01	1.68	-24.43**	-14.49*
6	GAOB-2 x GRB-5	-14.97*	2.40	-8.27	1.40	-8.74	3.25
7	GAOB-2 x NBL-117	-17.41**	-0.54	-19.49**	-11.01	-13.66**	-2.31
8	GAOB-2 x GJLB-4	-47.83**	-37.17**	-33.55**	-26.55**	-40.95**	-33.18**
9	GOB-1 x PS	-17.20	-31.9**	0.51	-24.08**	-7.68	-26.52**
10	GOB-1 x JBGR-1	-30.61**	-13.64	-22.27**	-8.09	-23.01**	-4.83
11	GOB-1 x SM	3.63	-4.23	-0.50	-2.80	0.01	-16.09**
12	GOB-1 x PU	-24.32**	-8.31	-8.97	0.04	-6.90	-10.93
13	GOB-1 x GRB-5	27.73**	6.79	15.11	-5.54	14.37*	-7.95
14	GOB-1 x NBL-117	-9.73	-25.76**	15.54	-12.72	3.49	-17.63**
15	GOB-1 x GJLB-4	-22.96**	-29.76**	-13.00	-28.70**	-21.27**	-35.67**
16	PS x JBGR-1	-49.18**	-36.75**	-50.05**	-40.95**	-51.78**	-40.4**
17	PS x SM	-18.88*	-25.04**	-38.30**	-39.73**	-31.3**	-42.35**
18	PS x PU	-47.20**	-36.02**	-54.32**	-49.79**	-41.48**	-44.01**
19	PS x GRB-5	-8.35	-23.38**	-12.71	-28.37**	-11.78	-29.00**
20	PS x NBL-117	24.68	-32.57**	27.36*	-30.64**	49.99**	-36.11**
21	PS x GJLB-4	-7.09	-15.29*	8.00	-11.49	-19.35**	-34.10**
22	JBGR-1 x SM	-8.02	14.48	-2.02	15.84*	-23.19**	-5.06
23	JBGR-1 x PU	-19.43**	0.28	9.91	29.95**	-20.62**	-1.87
24	JBGR-1 x GRB-5	-14.92*	5.89	-10.89	5.35	-17.27**	2.26
25	JBGR-1 x NBL-117	-27.21**	-9.40	-16.48**	-1.26	-31.12**	-14.85*
26	JBGR-1 x GJLB-4	-41.04**	-26.62**	-37.04**	-25.56**	-47.69**	-35.34**
27	SM x PU	-13.73*	4.52	-18.98**	-10.95	10.83	6.03
28	SM x GRB-5	-6.09	-13.21	-9.67	-11.76	10.82	-7.01
29	SM x NBL-117	-4.49	-11.73	1.43	-0.91	11.77	-6.21
30	SM x GJLB-4	-65.46**	-68.08**	-51.23**	-52.36**	-73.08**	-77.41**
31	PU x GRB-5	0.86	22.21**	10.96	21.95**	17.28**	12.20*
32	PU x NBL-117	-21.12**	-4.43	-7.06	2.15	0.57	-3.79
33	PU x GJLB-4	-41.42**	-29.02**	-44.74**	-39.27**	-37.37**	-40.09**
34	GRB-5 x NBL-117	34.95**	12.83	5.53	-13.40	-6.98	-25.13**
35	GRB-5 x GJLB-4	-25.63**	-32.19**	-24.91**	-38.37**	-25.57**	-39.18**
36	NBL-117 x GJLB-4	-43.43**	-48.43**	-27.22**	-40.36**	-35.23**	-47.08**
	SE ±	78.84	78.84	71.56	71.56	64.30	64.30

And ** indicate significance at 5% and 1% levels of probability, respectively

Table 18: Estimates of heterosis over better parent (BP) and standard check (SH) under individual environments for total phenol content

Sr.	Hybrids	E_1		Total phenol content E_2			E_3
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	GAOB-2 x GOB-1	33.89**	76.87**	32.30**	66.25**	31.62**	77.07**
2	GAOB-2 x PS	77.51**	109.53**	64.81**	91.36**	76.10**	106.94**
3	GAOB-2 x JBGR-1	42.91**	98.29**	42.22**	86.46**	41.68**	97.66**
4	GAOB-2 x SM	-28.27**	-28.18**	-28.56**	-31.99**	-27.64**	-27.51**
5	GAOB-2 x PU	-19.36**	2.43	-19.98**	-4.35	-19.79**	1.75
6	GAOB-2 x GRB-5	-23.15**	-32.18**	-21.27**	-34.80**	-22.72**	-31.18**
7	GAOB-2 x NBL-117	-28.92**	-30.57**	-27.55**	-33.60**	-26.83**	-30.57**
8	GAOB-2 x GJLB-4	-9.67**	-7.37*	-8.36**	-10.12**	-10.27*	-5.03
9	GOB-1 x PS	5.10*	38.84**	2.29	28.54**	0.74	35.53**
10	GOB-1 x JBGR-1	-48.74**	-28.88**	-47.93**	-31.73**	-47.62**	-26.93**
11	GOB-1 x SM	-32.55**	-10.89**	-31.93**	-14.46**	-31.31**	-7.59
12	GOB-1 x PU	-49.58**	-33.40**	-48.96**	-35.86**	-43.10**	-23.45**
13	GOB-1 x GRB-5	-49.69**	-33.54**	-51.04**	-38.48**	-54.15**	-38.32**
14	GOB-1 x NBL-117	-23.35**	1.25	-25.05**	-5.82*	-21.54**	5.55
15	GOB-1 x GJLB-4	-60.26**	-47.51**	-60.95**	-50.90**	-60.46**	-46.81**

16	PS x JBGR-1	-55.15**	-37.77**	-54.39**	-40.20**	-52.01**	-33.05**
17	PS x SM	-47.20**	-37.67**	-47.80**	-39.39**	-44.64**	-34.94**
18	PS x PU	-31.44**	-12.91**	-30.56**	-16.99**	-28.53**	-9.33*
19	PS x GRB-5	-23.26**	-9.42**	-23.83**	-11.57**	-22.67**	-9.12*
20	PS x NBL-117	-32.19**	-19.95**	-35.22**	-24.78**	-32.19**	-20.32**
21	PS x GJLB-4	-26.29**	-12.99**	-30.37**	-19.16**	-24.6**	-11.39**
22	JBGR-1 x SM	-38.31**	-14.4**	-36.07**	-16.18**	-39.18**	-15.15**
23	JBGR-1 x PU	-33.20**	-7.32*	-34.61**	-14.27**	-35.78**	-10.41*
24	JBGR-1 x GRB-5	12.14**	55.59**	11.05**	45.60**	11.87**	56.07**
25	JBGR-1 x NBL-117	-16.73**	15.53**	-16.57**	9.39**	-17.65**	14.89**
26	JBGR-1 x GJLB-4	-27.33**	0.83	-29.25**	-7.25**	-29.06**	-1.04
27	SM x PU	-41.59**	-25.81**	-40.57**	-28.95**	-35.24**	-17.84**
28	SM x GRB-5	-20.02**	-19.91**	-21.18**	-24.96**	-19.05**	-18.90**
29	SM x NBL-117	-34.10**	-34.01**	-32.29**	-35.53**	-29.18**	-29.05**
30	SM x GJLB-4	4.17	6.82*	0.63	-1.30	-1.66	4.09
31	PU x GRB-5	-16.10**	6.57	-15.72**	0.75	-15.48**	7.22
32	PU x NBL-117	15.68**	46.94**	17.86**	40.89**	17.83**	49.49**
33	PU x GJLB-4	-57.58**	-46.12**	-58.92**	-50.90**	-62.68**	-52.66**
34	GRB-5 x NBL-117	-13.27**	-15.29**	-12.62**	-19.91**	-12.64**	-17.11**
35	GRB-5 x GJLB-4	3.68	6.32	-4.11	-5.95*	2.15	8.12
36	NBL-117 x GJLB-4	40.65**	44.23**	42.20**	39.47**	33.68**	41.50**
	SE ±	0.12	0.12	0.10	0.10	0.15	0.15

And ** indicate significance at 5% and 1% levels of probability, respectively

Table 19: Estimates of heterosis over better parent (BP) and standard check (SH) under individual environments for total soluble sugars

Sr.	Hybrids	E_1		Total soluble sugars E_2			E_3
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	GAOB-2 x GOB-1	-33.51**	-47.38**	-31.41**	-45.47**	-43.46**	-54.88**
2	GAOB-2 x PS	-23.55**	-13.71**	-18.31**	-11.89**	-20.00**	-14.59**
3	GAOB-2 x JBGR-1	40.71**	8.34*	46.51**	6.57	45.39**	2.27
4	GAOB-2 x SM	-50.53**	-36.05**	-55.77**	-41.05**	-52.47**	-37.39**
5	GAOB-2 x PU	19.66**	21.51**	21.91**	23.02**	34.43**	22.09**
6	GAOB-2 x GRB-5	-36.90**	-19.07**	-43.89**	-26.58**	-44.88**	-32.93**
7	GAOB-2 x NBL-117	-11.81**	-19.43**	-17.50**	-26.98**	-17.24**	-30.48**
8	GAOB-2 x GJLB-4	27.79**	-1.61	30.28**	-5.24	33.42**	-6.15
9	GOB-1 x PS	7.66*	21.51**	14.06**	23.02**	14.35**	22.09**
10	GOB-1 x JBGR-1	21.61**	-3.75	21.66**	-3.28	20.71**	-3.65
11	GOB-1 x SM	-31.67**	-11.68**	-36.76**	-15.71**	-35.25**	-14.71**
12	GOB-1 x PU	17.02**	18.83**	21.07**	22.17**	31.79**	19.69**
13	GOB-1 x GRB-5	-31.13**	-11.68**	-31.21**	-9.99*	-29.34**	-14.02**
14	GOB-1 x NBL-117	25.51**	14.66**	39.08**	23.08**	38.86**	16.65**
15	GOB-1 x GJLB-4	2.56	-18.83**	-2.08	-22.15**	-13.33*	-30.83**
16	PS x JBGR-1	-7.66*	4.23	-3.82	3.74	-3.34	3.20
17	PS x SM	-15.63**	9.06*	-17.08**	10.52**	-14.74**	12.32*
18	PS x PU	8.98**	23.00*	18.82**	28.15**	16.32**	24.19**
19	PS x GRB-5	-32.48**	-13.41**	-32.13**	-11.18**	-26.93**	-11.09*
20	PS x NBL-117	-6.39	5.66	-5.44	1.99	-8.24	-2.03
21	PS x GJLB-4	-0.21	12.63**	-0.22	7.61	-2.52	4.08
22	JBGR-1 x SM	-16.74**	7.63*	-19.76**	6.95	-21.17**	3.84
23	JBGR-1 x PU	10.09**	11.80**	20.72**	21.82**	30.56**	18.58**
24	JBGR-1 x GRB-5	-22.12**	-0.12	-20.87**	3.55	-17.64**	0.22
25	JBGR-1 x NBL-117	-18.33**	-25.39**	-19.28**	-28.56**	-20.67**	-33.36**
26	JBGR-1 x GJLB-4	14.02*	-22.94**	5.85	-29.19**	3.25	-33.64**
27	SM x PU	-49.75**	-35.04**	-55.44**	-40.61**	-53.35**	-38.55**
28	SM x GRB-5	-40.06**	-22.53**	-45.53**	-27.40**	-41.67**	-23.15**
29	SM x NBL-117	-45.46**	-29.5**	-53.96**	-38.63**	-51.45**	-36.05**
30	SM x GJLB-4	-5.35	22.35**	-7.55*	23.23**	-9.10*	19.75**
31	PU x GRB-5	-36.71**	-18.83**	-40.64**	-22.32**	-39.07**	-25.86**
32	PU x NBL-117	-50.41**	-49.64**	-43.08**	-42.56**	-42.22**	-47.52**
33	PU x GJLB-4	25.76**	27.71**	34.38**	35.61**	48.59**	34.95**
34	GRB-5 x NBL-117	-31.88**	-12.63**	-31.30**	-10.10**	-33.72**	-19.35**
35	GRB-5 x GJLB-4	-50.37**	-36.35**	-46.28**	-29.71**	-46.61**	-35.04**
36	NBL-117 x GJLB-4	-0.85	-9.42*	-8.37	-18.9**	-10.96	-25.20**
	SE ±	0.10	0.10	0.11	0.11	0.19	0.19

And ** indicate significance at 5% and 1% level of probability, respectively

Table 20: Estimates of heterosis over better parent (BP) and standard check (SH) under individual environments for shoot and fruit borer infestation

Sr.	Hybrids	E_1	Shoot and fruit borer incidence E_2				E_3
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	GAOB-2 x GOB-1	-10.99	-7.88	-14.72	-20.21	21.04**	18.19**
2	GAOB-2 x PS	-4.40	14.00	20.28*	28.27**	-27.45**	-9.06
3	GAOB-2 x JBGR-1	-3.17	0.22	24.18*	24.44*	14.61*	21.13**
4	GAOB-2 x SM	13.03	40.48*	58.34**	40.60**	-16.43*	-11.56
5	GAOB-2 x PU	-8.29	18.60	7.06	15.28	-0.82	10.71
6	GAOB-2 x GRB-5	61.73**	67.4**	-10.69	6.73	-9.50	7.35
7	GAOB-2 x NBL-117	11.09	33.70	20.34	12.85	8.68	6.12
8	GAOB-2 x GJLB-4	20.51	24.73	-20.19*	0.10	-12.94*	11.88
9	GOB-1 x PS	0.73	20.13	19.83*	27.79**	-18.17**	2.58
10	GOB-1 x JBGR-1	26.34	18.60	4.97	5.19	-4.76	0.66
11	GOB-1 x SM	-9.68	12.25	14.15	6.80	-16.93**	-12.09
12	GOB-1 x PU	17.43	51.86*	4.26	12.26	-3.45	7.78
13	GOB-1 x GRB-5	70.02**	72.02**	1.01	20.71*	-9.70	7.11
14	GOB-1 x NBL-117	-17.82	-1.09	26.66*	18.78	5.00	-1.6
15	GOB-1 x GJLB-4	30.97	21.23	-19.05*	1.43	-21.35**	1.07
16	PS x JBGR-1	21.65	45.08*	36.75**	45.83**	-12.92*	9.16
17	PS x SM	21.30	50.77*	-1.95	4.56	-16.79**	4.31
18	PS x PU	-11.68	14.22	13.08	21.76*	-19.73**	0.63
19	PS x GRB-5	2.57	22.32	-21.52*	-6.21	-24.68**	-5.58
20	PS x NBL-117	-5.09	14.22	-10.37	-4.42	-6.34	17.40*
21	PS x GJLB-4	18.53	41.36*	-15.36	6.06	-11.48*	13.76*
22	JBGR-1 x SM	5.63	31.29	10.21	10.44	4.17	10.25
23	JBGR-1 x PU	-10.32	15.97	-5.14	2.14	-12.75*	-2.61
24	JBGR-1 x GRB-5	28.01	28.01	-12.76	4.25	3.49	22.75**
25	JBGR-1 x NBL-117	-8.18	10.50	-5.94	-5.75	32.29**	39.82**
26	JBGR-1 x GJLB-4	20.51	13.13	-21.74*	-1.94	-23.43**	-1.60
27	SM x PU	-22.00	0.88	-6.43	0.76	-9.46	1.07
28	SM x GRB-5	-23.24	-4.60	-21.47*	-6.15	-7.97	9.16
29	SM x NBL-117	-16.55	3.72	13.16	6.12	-10.24	-5.00
30	SM x GJLB-4	1.94	26.70	-21.87**	-2.11	-27.35**	-6.63
31	PU x GRB-5	6.94	38.29	-3.96	14.77	-31.49**	-18.73**
32	PU x NBL-117	12.86	45.95*	0.61	8.33	-14.80*	-4.89
33	PU x GJLB-4	-10.32	15.97	-22.15**	-2.46	-11.48*	13.76*
34	GRB-5 x NBL-117	-3.82	15.75	-18.55*	-2.67	-7.05	10.25
35	GRB-5 x GJLB-4	50.77*	50.77*	-13.36	8.56	-24.21**	-2.61
36	NBL-117 x GJLB-4	12.73	35.67	-18.70*	1.87	-4.48	22.75**
	SE ±	3.06	3.06	1.67	1.67	1.15	1.15

And ** indicate significance at 5% and 1% level of probability, respectively

Table 21: Estimates of heterosis over better parent (BP) and standard check (SH) under individual environments for little leaf incidence

Sr.	Hybrids	E_1		Little leaf incidence E_2			E_3
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	GAOB-2 x GOB-1	13.58	27.80	13.51	22.24	43.58*	30.46
2	GAOB-2 x PS	63.66*	55.69*	-8.17	20.54	-44.99**	-24.72
3	GAOB-2 x JBGR-1	18.07	-0.02	27.85	63.15**	-1.51	-2.18
4	GAOB-2 x SM	25.88	31.07	20.66	4.78	-38.55**	-14.99
5	GAOB-2 x PU	26.83	21.95	-5.92	24.60	5.16	12.64
6	GAOB-2 x GRB-5	73.29**	68.52**	-21.96	21.41	62.46**	62.07**
7	GAOB-2 x NBL-117	17.20	40.92	18.02	2.48	5.72	24.02
8	GAOB-2 x GJLB-4	-0.97	-18.86	-21.44	-21.61	-8.20	-11.82
9	GOB-1 x PS	31.14	47.56*	-3.30	26.92	-24.54	3.26
10	GOB-1 x JBGR-1	9.13	22.79	-19.08	3.27	12.68	11.91
11	GOB-1 x SM	18.49	33.33	-9.90	-2.97	-34.04*	-8.75
12	GOB-1 x PU	35.23	52.16*	-31.21*	-8.89	37.85*	47.65*
13	GOB-1 x GRB-5	66.5**	87.35**	-50.84**	-23.52	51.09**	50.73**
14	GOB-1 x NBL-117	-0.36	19.81	13.23	21.95	-19.74	-5.85
15	GOB-1 x GJLB-4	7.42	20.88	-9.61	-2.65	23.23	18.37
16	PS x JBGR-1	45.4	38.32	-2.14	28.45	-22.71	5.76
17	PS x SM	30.37	35.75	-4.49	25.37	0.76	39.40*
18	PS x PU	42.3	36.83	-6.11	24.34	-32.88*	-8.15
19	PS x GRB-5	24.95	21.51	-47.81**	-18.81	-12.43	19.83
20	PS x NBL-117	5.82	27.24	-11.54	16.11	-9.44	23.93

21	PS x GJLB-4	40.10	33.27	-26.43	-3.44	-3.09	32.62
22	JBGR-1 x SM	25.43	30.61	-16.24	6.89	-7.15	28.46
23	JBGR-1 x PU	58.15*	52.07*	-29.83*	-7.07	27.07	36.10
24	JBGR-1 x GRB-5	7.93	4.95	-24.46*	17.51	24.79	24.49
25	JBGR-1 x NBL-117	19.89	44.16	12.05	42.99*	32.87*	55.86**
26	JBGR-1 x GJLB-4	31.88	11.67	-22.57	-1.19	12.20	11.43
27	SM x PU	-5.51	-1.61	-12.17	16.32	-27.44*	0.38
28	SM x GRB-5	5.82	10.19	-20.63	23.47	-20.14	10.48
29	SM x NBL-117	-5.31	13.86	13.88	-1.21	-35.29*	-10.48
30	SM x GJLB-4	21.56	26.58	7.37	7.15	-24.61	4.30
31	PU x GRB-5	60.16*	55.75*	-27.43*	12.90	-6.18	0.48
32	PU x NBL-117	43.48*	72.52**	-0.42	31.88	1.75	19.36
33	PU x GJLB-4	-16.32	-19.53	-25.37	-1.16	33.89	43.41*
34	GRB-5 x NBL-117	-16.64	0.23	-30.22*	8.55	-21.59	-8.02
35	GRB-5 x GJLB-4	69.58**	64.91**	-53.7**	-27.97	35.03	34.71
36	NBL-117 x GJLB-4	1.56	22.13	-2.69	-2.90	39.63*	63.79**
	SE ±	3.37	3.37	2.99	2.99	3.14	3.14

* And ** indicate significance at 5% and 1% level of probability, respectively

Little Leaf Incidence

The heterosis estimate over better parent ranged from -16.64% (GRB-5 x NBL-117) to 73.29% (GAOB-2 x GRB-5); -53.7% (GRB-5 x GJLB-4) to 27.85% (GAOB-2 x JBGR-1); and -44.99% (GAOB-2 x Punjab Sadabahar) to 62.46% (GAOB-2 x GRB-5) in E_1, E_2 and E_3, respectively. GRB-5 x NBL-117 (-16.64%) and Pusa Upkar x GJLB-4 (-16.32%) in E1; GRB-5 x GJLB-4 (-53.7%) followed by GOB-1 x GRB-5 (-50.84%) and Punjab Sadabahar x GRB-5 (- 47.81%) in E_2; and GAOB-2 x Punjab Sadabahar (-44.99%) followed by GAOB-2 x Swarna Mani (-38.55%) and Swarna Mani x NBL-117 (-35.29%) in E_3 were the best significant and negative heterobeltiotic hybrids for this trait.

The magnitude of standard heterosis for little leaf incidence ranged from -19.53% (Pusa Upkar x GJLB-4) to 87.35% (GOB-1 x GRB-5); -27.97% (GRB- x GJLB-4) to 63.15% (GAOB- 2 x JBGR-1); and -24.72% (GAOB-2 x Punjab Sadabahar) to 63.79% (NBL-117 x GJLB-4) in E_1, E_2 and E_3, respectively. Hybrids *viz*., Pusa Upkar x GJLB-4 (-19.53%) and GAOB-2 x GJLB- 4 (-18.86%) in E1; GRB- x GJLB-4 (-27.97%) and GOB-1 x GRB-5 (-23.52%) in E_2; and GAOB- 2 x Punjab Sadabahar (-24.72%) and GAOB-2 x Swarna Mani (-14.99%) in E_3 were the best hybrid with desirable standard heterosis for little leaf incidence. Similar finding was also reported by Kumar *et al.* (2013) [11] and Sujin and Karuppaiah (2018) [14].

Conclusions

The analysis of variance revealed highly significant differences among genotypes in the individual environment as well as pooled over environments revealed considerable genetic variation among the parents and hybrids for most the characters. The existence of overall heterosis was evident from the significance of the comparison of pare nts vs. hybrids in all environments for all the traits. The significance of genotype x environment for all the characters suggested that genotypes interacted differentially in the diverse environments.

The maximum value of standard heterosis for fruit yie ld per plant was observed for GOB-1 x Pusa Upkar followed by GAOB-2 x GOB-1 and Pusa Upkar x GRB-5. Hybrids *viz.*, Punjab Sadabahar x NBL-117, GOB-1 x NBL-117 and GOB-1 x NBL-117 were the earliest flowering crosses among all. GOB-1 x Pusa Upkar, GAOB-2 x Swarna Mani and GOB-1 x Pusa Upkar had highest and significant heterotic response for fruit weight. The high heterotic response in these hybrids for fruit yield per plant resulted mainly due to substantial heterosis for fruit length, fruit girth, fruit weigh t and fruits per plant. The high heterotic response in these hybrids for fruit yield per plant resulted mainly due to substantial heterosis for fruit length, fruit girth, fruit weight and fruits per plant.

Conflict of Interest

Conflict of interest none declared.

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