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Heterosis for Vigor and Yield in Brinjal (*Solanum melongena* L.)

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Abstract An investigation was undertaken in brinjal to estimate the magnitude of relative heterosis, heterobeltosis and standard heterosis for yield and its eleven yield contributing vigor components. 36 F_1 hybrids generated by line × tester crosses involving twelve pure diverse parent lines and three wider adopted testers along with 15 parents and a standard check were evaluated in a randomized block design with three replications. Appreciable heterosis was found over mid, better and standard check for all the traits studied in desirable direction. In order of merit F_1 hybrids CBB-32 × Matti Gulla (154.67%), CBB-25 × BSR-112 (128.03%) and CBB-8 × BSR-112 (126.34%) were observed significant relative heterosis for fruit yield per plant similarly the maximum heterobeltiosis (better parent heterosis) for fruit yield per plant was exhibited by the hybrid CBB-32 × Matti Gulla (128.78%) followed by CBB-8 × BSR-112 (122.79%) and CBB-25 × BSR-112 (117.36%). In case of standard heterosis, significant and positive heterosis over standard check EPH-718 (Syngenta) for fruit yield per plant was observed in hybrid CBB-6 × BSR-112 (69.34%) followed by CBB-8 × BSR-112 (66.67%) and CBB-25 × BSR-112 (57.50%). The present study reveals good scope for commercial exploitation of heterosis as well as isolation of pure lines from the progenies of heterotic F_1s in brinjal.

Keywords Brinjal, Heterosis, Relative heterosis, Heterobeltosis, Standard heterosis.

Introduction

Bringal (*Solanum melongena* L.) belongs to family Solanaceae, has chromosomal no 2n=24. It is originated in India [1—3] and shows secondary diversity in South East Asia. Brinjal being an important vegetable crop is cultivated in India, over an area of 7.22 lakh hectares with annual production of 134.43 lakh metric tonnes and average productivity of 18.6 metric tonnes per hectare [4]. In India, it is being consumed as a cooked vegetable in many ways and is liked by both poor and rich. Year round availability, easy culture, moderate to high yield and consumption in variety of ways; salad, bhaji, stuffed brinjal, bhartha, chatni, pickles has made brinjal an important vegetable

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in India. Further, in recent years brinjal is being exported in the form of products like baigan bhartha, chatni, pickles to Middle East countries. In 2007-08, 34 million kg worth Rs 19 million rupees was exported mainly to the UK. The Netherlands, Saudi Arabia and Middle East countries [5].

To meet out the increasing demand for vegetable with increasing production, the crop improvement with respect to yield and quality becomes imperative. Similarly yield is highly correlated with vigor components. There exists large genetic variation with regard to color, shape and size of fruits. In addition, variation is also moticed for characters like vegetative growth, maturity and presence or absence of spines on leaves, stem and fruit calyx among the indigenous material. There are genotypes with certain characters which are suited for specific preparation.

Table 1. Magnitude of heterosis for plant height and stem girth at 90 and 120 DAT (cm). P_1=Lines, P_2=Testers, MP -Mid parent, BP-Better parent, CC-Commercial check, **1% level of significant, *5% level of significant.

Characters	Plant height at 90 DAT (cm) Heterosis over (%)			Plant height at 120 DAT (cm) Heterosis over (%)		
Crosses	MP	BP	CC	MP	BP	CC
CBB-1 × Matti Gulla	29.51**	27.00**	42.85**	14.64**	5.57	19.21**
CBB-1 × CO-2	1.26	-3.34	19.59*	1.02	0.38	13.35*
CBB-1 × BSR-112	9.86	9.33	24.17**	9.50*	3,56	16.93**
CBB-2 × Matti Gulla	2.20	-0.07	8.06	5.91	4.87	1.68
CBB-2 × CO-2	-11.47	-18.77**	0.51	-16.24**	-21.70**	-12.70*
CBB-2 × BSR-112	-7.13	-11.31	0.73	-8.29	-9.97	-9.39
CBB-3 × Matti Gulla	-0.29	-3.46	11.47	8.98	1.68	11.61*
CBB-3 × CO-2	4.13	0.65	24.53**	-2.16	-2.92	8.25
CBB-3 × BSR-112	14.96*	14.02	31.64**	4.23	-0.10	9.66
CBB-5 × Matti Gulla	5.44	-5.34	28.66**	13.27**	3.91	18.34**
CBB-5 × CO-2	-11.85*	-15.80*	14.44	-9.05*	-10.00*	2.50
CBB-5 × BSR-112	-2.50	-10.52	21.63*	5.92	-0.24	13.62*
CBB-6 × Matti Gulla	11.19	6.73	25.47**	11.83*	6.81	11.56*
CBB-6 × CO-2	-13.14*	-15.31*	4.79	-5.48	-8.47	2.06
CBB-6 × BSR-112	-3.36	-5.00	11.68	17.20**	15.06**	20.18**
CBB-8 × Matti Gulla	13.48*	6.07	31.93**	15.96**	9.73	16.87**
CBB-8 × CO-2	-0.38	-0.64	23.58**	0.65	-1.61	9.71
CBB-8 × BSR-112	14.00*	9.04	35.63**	33.73**	30.06**	38.52**
CBB-12 × Matti Gulla	5.42	4.55	14.95	21.08**	20.19**	15.95**
CBB-12 × CO-2	11.18	4.99	29.90**	14.58**	6.86	19.15**
CBB-12 × BSR-112	-6.23	-7.73	4.79	` 11.59*	9.27	9.98
CBB-17 × Matti Gulla	3.23	0.38	14.88	16.41**	11.23*	16.06**
CBB-17 × CO-2	-4.81	-8.39	13.35	8.95*	5.45	17.58**
CBB-17 × BSR-112	-15.34*	-15.66*	-3.48	-7.94	-9.57	-5.64
CBB-25 × Matti Gulla	8.19	3.43	22.64*	18.50**	11.47*	20.24**
CBB-25 × CO-2	-5.00	-6.98	15.09	18.33**	16.40**	29.79**
CBB-25 × BSR-112	0.59	-1.53	16.76	19.85**	15.85**	24.96**
CBB-29 × Matti Gulla	8.70	4.36	12.84	24.98**	21.80**	15.79**
CBB-29 × CO-2	-2.41	-11.96	8.93	`18.18**	6.91	19.21**
CBB-29 × BSR-112	14.92*	7.80	22.42*	27.00**	20.43**	21.22**
CBB-32 × Matti Gulla	23.55**	5.64	14.22	49.04**	24.37**	18.23**
CBB-32 × CO-2	9.88	-10.97	10.16	24.70**	-2.09	9.17
CBB-32 × BSR-112	19.18*	-0.13	13.43	50.05**	22.43**	23.22**
CBB-47 × Matti Gulla	0.22	-5.84	15.82	27.74**	19.02**	31.04**
CBB-47 × CO-2	-0.18	-0.47	23.15**	14.79**	14.06**	27.18**
CBB-47 × BSR-112	-11.10	-14.51*	5.15	4.07	-0.39	9.66
SE Diff	3.4294	3.9600	3.9600	2.9159	3.3670	3.3670
CD @ 5%	6.8398	7.8979	7.8979	5.8157	6.7154	6.7154
CD @ 1%	9.0808	10.4856	10.4856	7.7211	8.9156	8.9156

Table 1. Continued.

Characters Crosses	Stem girth at 90 DAT (cm) Heterosis over (%) MP	BP	CC	Stem girth at 120 DAT (cm) Heterosis over (%) MP	BP	CC
CBB-1 × Matti Gulla	29.94**	23.79**	-1.16	15.42**	-3.32	-3.47
CBB-1 × CO-2	12.20	7.57	-6.40	-4.84	-10.88*	-11.01*
CBB-1 × BSR-112	23.70**	21.60*	-2.91	12.10*	-1.36	-1.51
CBB-2 × Matti Gulla	42.63**	42.63**	3.10	31.65**	20.11**	-1.81
CBB-2 × CO-2	1.22	-7.35	-19.38**	14.29**	10.73	-3.47
CBB-2 × BSR-112	35.41**	31.16**	1.16	16.17**	11.99*	-8.45
CBB-3 × Matti Gulla	21.60*	20.95*	-11.63	15.69**	2.97	-11.01*
CBB-3 × CO-2	13.08	4.01	-9.50	12.25*	11.76*	-2.56
CBB-3 × BSR-112	25.42**	22.11*	-5.81	19.52**	12.22*	-3.02
CBB-5 × Matti Gulla	27.96**	24.24*	-4.65	40.53**	25.17**	7.99
CBB-5 × CO-2	6.75	0.45	-12.60	10.26*	9.69	-4.37
CBB-5 × BSR-112	16.37*	16.08	-10.47	27.63**	19.93**	3.47
CBB-6 × Matti Gulla	22.72**	0.69	13.57	25.47**	1.52	10.71*
CBB-6 × CO-2	-5.72	-16.49*	-5.81	4.07	-6.36	2.11
CBB-6 × BSR-112	13.47*	-4.47	7.75	-1.79	-16.74**	-9.20
CBB-8 × Matti Gulla	20.76**	-0.18	10.47	21.03**	0.29	2.87
CBB-8 × CO-2	5.10	-6.13	3.88	4.61	-3.24	-0.75
CBB-8 × BSR-112	29.41**	9.81	21.51**	18.85**	3.38	6.03
CBB-12 × Matti Gulla	11.54	-2.79	-5.43	8.97	-7.75	-10.26*
CBB-12 × CO-2	-7.89	-12.75	-15.12*	-9.08*	-13.80**	-16.14**
CBB-12 × BSR-112	-6.89	-16.53*	-18.80**	0.00	-11.01*	-13.42**
CBB-17 × Matti Gulla	1.56	-7.86	-18.22*	11.20*	-2.21	-13.12**
CBB-17 × CO-2	-3.86	-4.80	-15.50*	3.51	2.55	-8.90
CBB-17 × BSR-112	-0.23	-6.77	-17.25*	-2.93	-10.02	-20.06**
CBB-25 × Matti Gulla	24.81**	17.18*	-3.49	28.34**	17.19**	-4.37
CBB-25 × CO-2	5.49	2.67	-10.66	-2.41	-5.54	-17.65**
CBB-25 × BSR-112	26.12**	22.12*	0.58	21.65**	17.38**	-4.22
CBB-29 × Matti Gulla	6.17	-1.60	-16.67*	13.98**	0.69	-11.46*
CBB-29 × CO-2	0.00	-1.34	-14.15*	3.53	3.09	-9.35
CBB-29 × BSR-112	13.29	8.24	-8.33	-3.13	-9.78	-20.66**
CBB-32 × Matti Gulla	29.00**	19.84*	-13.37	61.80**	36.47**	-7.99
CBB-32 × CO-2	10.27	-5.57	-17.83*	16.16**	-11.07*	-22.47**
CBB-32 × BSR-112	18.11*	6.53	-17.83*	42.22**	14.51*	-13.12**
CBB-47 × Matti Gulla	14.14	8.74	-13.18	24.85**	10.29	-3.02
CBB-47 × CO-2	-7.32	-11.14	-22.67**	-5.25	-5.66	-17.04**
CBB-47 × BSR-112	4.69	2.91	-17.83*	32.97**	23.84**	8.90
SE Diff	0.1051	0.1213	0.1213	0.0899	0.1038	0.1038
CD @ 5%	0.2095	0.2420	0.2420	0.1793	0.2071	0.2071
CD @ 1%	0.2782	0.3212	0.3212	0.2381	0.2749	0.2749

To realize this required type of plant profile heterosis breeding is one method. Bailey and Munson [6] reported artificial hybridization in brinjal for first time. However none of the hybrids exhibited any heterosis Nagai and Kida [7] were probably the first to observe hybrid vigor, hoping some commercial acceptance in crosses among some Japanese varieties. Since then many public and private sectors have developed various hybrids in India, but these hybrids lacked regional preferences for color, shape and presence or absence of spines and lacked suitability to specific product preparations. Therefore, the present investigation was carried out to study the extent of heterosis in 36 F_1 hybrids over mid parent, better parent and standard parent in an L × T design. 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

Twelve genetically diverse genotypes viz. CBB-1, CBB-2, CBB-3, CBB-5, CBB-6, CBB-8, CBB-12, CBB-17, CBB-25, CBB-29, CBB-32 and CBB-47 pre evaluated for variability and genetic divergence were selected from germplasm maintained at COH Bagalkot. These twelve genotypes as lines are crossed with three OPV (Matti Gulla, CO-2 and BSR-112) collected from diverse regions as testers to develop 36 F_1 hybrids using line × tester mating design. These 36 F_1s, fifteen parents and one commercial hybrid viz. EPH-718 from Syngenta company formed the material for the study. The experiment was laid out in a randomized block design (RBD) with three replications. Each plot consisted of a single row of 15 plants. Inter and

Table 2. Magnitude of heterosis for plant spread in north-south and east-west direction at 90 and 120 DAT (cm). P_1=Lines, P_2=Testers, MP -Mid parent, BP-Better parent, CC-Commercial check, **1% level of significant, *5% level of significant.

Characters	Plant spread in north-south direction at 90 DAT (cm) Heterosis over (%)			Plant spread in north-south direction at 120 DAT (cm) Heterosis over (%)		
Crosses	MP	BP	CC	MP	BP	CC
CBB-1 × Matti Gulla	19.02*	0.24	-8.81	20.04**	-3.89	-14.94**
CBB-1 × CO-2	17.16*	12.91	2.72	13.05**	12.89*	-0.10
CBB-1 × BSR-112	38.87**	33.27**	21.24**	17.38**	4.99	-7.08
CBB-2 × Matti Gulla	33.95**	17.06*	-2.55	40.45**	17.06**	-6.60
CBB-2 × CO-2	12.62	11.87	-5.61	10.83*	5.52	-6.89
CBB-2 × BSR-112	28.69**	28.39**	7.38	31.60**	23.37**	-1.56
CBB-3 × Matti Gulla	23.37**	6.09	-8.25	28.29**	6.58	-14.26**
CBB-3 × CO-2	16.40*	14.98	-0.56	6.51	1.80	-10.17*
CBB-3 × BSR-112	31.86**	29.69**	12.16	24.93**	16.68**	-6.14
CBB-5 × Matti Gulla	34.77**	19.97*	-4.27	39.98**	19.97**	-10.59*
CBB-5 × CO-2	35.09**	31.42**	10.88	13.49*	4.68	-7.63
CBB-5 × BSR-112	30.25**	27.26**	6.43	26.85**	22.84**	-8.45
CBB-6 × Matti Gulla	29.71**	-1.13	17.36*	29.73**	1.37	-4.16
CBB-6 × CO-2	5.17	-10.04	6.78	6.15	2.61	-2.99
CBB-6 × BSR-112	21.90**	3.89	23.32**	28.37**	11.58*	5.49
CBB-8 × Matti Gulla	30.52	3.40	10.15	30.06**	1.76	-4.13
CBB-8 × CO-2	13.01*	1.26	7.86	-0.75	-3.90	-9.45
CBB-8 × BSR-112	47.18**	31.37**	39.94**	28.46**	11.83*	5.36
CBB-12 × Matti Gulla	30.56**	7.43	3.58	22.26**	1.12	-17.74**
CBB-12 × CO-2	21.16**	13.59	9.52	8.12	3.90	-8.32
CBB-12 × BSR-112	5.47	-1.52	-5.05	11.28	3.39	-15.89**
CBB-17 × Matti Gulla	25.08**	6.42	-5.57	13.18*	-8.42	-21.18**
CBB-17 × CO-2	15.64*	12.80	0.09	4.60	3.31	-8.84
CBB-17 × BSR-112	1.35	-1.56	-12.65	1.04	-8.49	-21.25**
CBB-25 × Matti Gulla	33.87**	11.25	4.62	15.91*	-7.29	-17.74**
CBB-25 × CO-2	16.60*	10.61	4.02	-15.33**	-15.56**	-25.08**
CBB-25 × BSR-112	24.62**	17.72*	10.71	27.66**	14.06*	1.20
CBB-29 × Matti Gulla	30.09**	20.25*	-11.79	25.40**	10.47	-22.84**
CBB-29 × CO-2	4.52	-2.30	-17.57*	6.78	-4.34	-15.59**
CBB-29 × BSR-112	35.31**	27.00**	6.22	16.54**	16.51*	-18.62**
CBB-32 × Matti Gulla	78.13**	72.26**	7.25	81.72**	68.13**	-10.53*
CBB-32 × CO-2	9.85	-7.22	-21.72**	10.25	-16.61**	-26.41**
CBB-32 × BSR-112	36.54**	15.75	-3.20	56.58**	29.04**	-9.91
CBB-47 × Matti Gulla	9.51	-6.10	-18.22**	25.38**	7.82	-20.31**
CBB-47 × CO-2	2.01	0.42	-12.54	-3.47	-11.30	-21.73**
CBB-47 × BSR-112	-0.56	-2.53	-15.11*	23.06**	19.65**	-11.57*
SE Diff	4.5336	5.2349	5.2349	4.4640	5.1546	5.1546
CD @ 5%	9.0419	10.4407	10.4407	8.9032	10.2806	10.2806
CD @ 1%	12.0045	13.8616	13.8616	11.8203	13.6489	13.6489

Table 2. Continued.

Characters	Plant spread in east-west direction at 90 DAT (cm) Heterosis over (%)			Plant spread in east-west direction at 120 DAT (cm) Heterosis over (%)		
Crosses	MP	BP	CC	MP	BP	CC
CBB-1 × Matti Gulla	2906**	8.62	-8.42	16.59*	-11.05	-26.02**
CBB-1 × CO-2	22.45**	19.77*	0.98	4.94	4.18	-12.07*
CBB-1 × BSR-112	45.91**	43.37**	20.88**	18.20**	7.31	-10.75
CBB-2 × Matti Gulla	46.09**	35.41**	-8.63	45.80**	18.33*	-16.98**
CBB-2 × CO-2	12.26	3.11	-16.88*	9.75	0.49	-15.18**.
CBB-2 × BSR-112	49.67**	36.89**	11.39	33.48**	31.27**	-7.9
CBB-3 × Matti Gulla	32.84**	13.64	-7.91	37.83**	12.36	-22.06**
CBB-3 × CO-2	32.25**	31.90**	6.89	14.25*	4.07	-12.16*
CBB-3 × BSR-112	28.43**	28.16**	4.29	28.51**	27.10**	-11.84*
CBB-5 × Matti Gulla	40.81**	20.11*	-2.00	44.06**	17.31*	-18.38**
CBB-5 × CO-2	21.05**	20.32*	`-1.83	4.18	-4.98	-19.79**
CBB-5 × BSR-112	29.66**	29.49**	5.65	20.50**	19.00*	-17.21**
CBB-6 × Matti Gulla	31.91**	`-2.15	13.90	42.26**	6.11	-5.64
CBB-6 × CO-2	10.66	-6.35	9.01	6.37	3.67	-7.81
CBB-6 × BSR-112	19.86**	1.83	18.54*	19.67**	5.48	-6.2
CBB-8 × Matti Gulla	30.11**	-1.44	10.25	16.63*	-13.65*	-21.44**
CBB-8 × CO-2	9.34	-5.93	5.23	0.00	-3.62	-12.31*
CBB-8 × BSR-112	32.23**	14.22*	27.76**	24.04**	8.26	-1.5
CBB-12 × Matti Gulla	25.71**	-0.94	-0.94	15.33*	-11.49	-27.64**
CBB-12 × CO-2	14.60*	3.49	3.49	5.51	3.86	-12.33*
CBB-12 × BSR-112	-1.88	-11.01	-11.01	11.70	2.19	-16.45**
CBB-17 × Matti Gulla	28.38**	11.98	-13.35	11.95	-12.81	-31.63**
CBB-17 × CO-2	12.22	9.97	-11.35	-3.79	-7.20	-21.67**
CBB-17 × BSR-112	12.96	10.19	-10.33	-7.35	-13.60	-32.25**
CBB-25 × Matti Gulla	34.37**	8.89	1.06	24.26**	-5.34	-20.94**
CBB-25 × CO-2	12.38	4.99	-2.55	-8.04	-8.52	-22.79**
CBB-25 × BSR-112	24.43**	16.77**	8.38	15.44**	4.61	-12.63*
CBB-29 × Matti Gulla	27.81**	14.16	-16.37*	34.90**	11.08	-24.90**
CBB-29 × CO-2	9.86	4.85	-15.48**	5.76	-4.77	-19.62**
CBB-29 × BSR-112	27.14**	20.79*	-1.70	14.27*	14.07	-22.61**
CBB-32 × Matti Gulla	85.96**	81.77*	4.72	116.68**	109.40**	-8.43
CBB-32 × CO-2	8.09	-9.07	-26.70**	5.28	-21.92**	-34.10**
CBB-32 × BSR-112	20.82*	1.25	-17.60*	40.20**	12.25	-23.85**
CBB-47 × Matti Gulla	9.38	-7.92	-22.41**	28.72**	4.62	-26.87**
CBB-47 × CO-2	-3.71	-5.80	-20.62**	-2.85	-11.20	-25.05**
CBB-47 × BSR-112	3.44	1.66	-14.33	19.02**	17.27*	-18.03**
SE Diff	4.98	5.75	5.75	5.36	6.19	6.19
CD @ 5%	9.94	11.47	11.47	10.69	12.35	12.35
CD @ 1%	13.19	15.23	15.23	14.19	16.3	16.3

intra row spacing was kept at 75 cm each. The observation were recorded on five randomly selected plants from each treatment and replication for vigor and yield characters viz. plant height, stem girth, plant spread in each north-south and east-west direction, leaf area, number of primary branches per plant and yield per plant. Heterosis expressed as percent 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.

Relative heterosis (RH) [8]

$$H\ (\%) = \frac{\overline{F}_1 - \overline{\overline{MP}}}{\overline{\overline{MP}}} \times 100$$

Where, $\overline{\overline{MP}}$ is the mean of superior parent involved in development of respective $\bar{F}_1$ and $\bar{F}_1$ is mean of F_1 hybrid.

Heterobeltiosis (BP) [9]

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

Where, $\overline{BP}$ is the mean of the best parent among parents involved in development of F_1's for each character.

Standard heterosis (SH)

$$SH\ (\%) = \frac{\bar{F}_1 - \overline{\overline{CC}}}{\overline{\overline{CC}}} \times 100$$

Table 3. Magnitude of heterosis for leaf area at 90, number of primary branches at 90 and 120 DAT and total fruit yield per plant. P_1=Lines, P_2=Testers, MP -Mid parent, BP-Better parent, CC-Commercial check, **1% level of significant, *5% level of significant.

Characters	Leaf area at 90 DAT (cm^2) Heterosis over (%)			Number of primary branches per plant at 90 DAT Heterosis over (%)		
Crosses	MP	BP	CC	MP	BP	CC
CBB-1 × Matti Gulla	-2.41	-5.89	17.45	16.56*	10.00	-10.20
CBB-1 × CO-2	16.49*	3.78	20.30*	15.34*	13.25	-4.08
CBB-1 × BSR-112	-4.57	-9.88	4.47	22.09**	14.13	7.14
CBB-2 × Matti Gulla	-29.79**	-34.17**	-6.14	21.25**	8.99	-1.02
CBB-2 × CO-2	-11.84	-27.90**	2.79	1.16	-2.25	-11.22
CBB-2 × BSR-112	-7.39	-20.24**	13.71	23.76**	21.74**	14.29*
CBB-3 × Matti Gulla	3.33	-10.23	51.89**	27.15**	20.00*	-2.04
CBB-3 × CO-2	-10.51	-31.29**	16.25	33.74**	31.33**	11.22
CBB-3 × BSR-112	20.80**	-2.82	64.42**	22.09*	14.13	7.14
CBB-5 × Matti Gulla	21.96**	-3.57	107.02**	31.65**	19.54*	6.12
CBB-5 × CO-2	-31.28**	-51.14**	4.90	15.29*	12.64	0.00
CBB-5 × BSR-112	-23.29**	-43.24**	21.84*	28.49**	25.00**	17.35*
CBB-6 × Matti Gulla	-0.31	-15.85**	52.62**	30.48**	5.17	24.49**
CBB-6 × CO-2	-14.74*	-36.07**	15.95	20.60**	3.45	22.45**
CBB-6 × BSR-112	11.10*	-12.90*	57.98**	9.62	-1.72	16.33*
CBB-8 × Matti Gulla	36.98**	15.02**	111.29**	12.71	-7.27	4.08
CBB-8 × CO-2	12.10*	-16.30**	53.76**	9.84	-3.64	8.16
CBB-8 × BSR-112	59.55**	24.51**	128.73**	9.90	0.91	13.27
CBB-12 × Matti Gulla	-20.19**	-22.74**	-3.58	35.80**	20.88**	12.24
CBB-12 × CO-2	0.53	-10.75	4.27	40.23**	34.07**	24.49**
CBB-12 × BSR-112	26.38**	18.91*	38.91**	0.55	0.00	-6.12
CBB-17 × Matti Gulla	-6.64	-13.40	8.08	9.76	-3.23	-8.16
CBB-17 × CO-2	-14.75	-21.18*	-15.88	19.32**	12.90	7.14
CBB-17 × BSR-112	-12.49	-14.02	-8.24	-3.78	-4.30	-9.18
CBB-25 × Matti Gulla	37.22**	19.63**	49.30**	19.50*	7.95	-3.06
CBB-25 × CO-2	2.18	0.98	-6.29	32.16**	28.41**	15.31*
CBB-25 × BSR-112	0.71	-4.27	-1.39	13.33	10.87	4.08
CBB-29 × Matti Gulla	-21.64**	-31.59**	-14.62	12.73	-1.06	-5.10
CBB-29 × CO-2	-5.79	-7.06	-13.45	2.82	-3.19	-7.14
CBB-29 × BSR-112	-16.83*	-20.81*	-18.43*	3.23	2.13	-2.04
CBB-32 × Matti Gulla	7.59	-4.44	19.27*	14.47	7.41	-11.22
CBB-32 × CO-2	-12.44	-15.28	-17.91*	21.95**	20.48*	2.04
CBB-32 × BSR-112	-10.38	-13.04	-10.42	-7.51	-13.04	-18.37*
CBB-47 × Matti Gulla	-21.72**	-29.81**	-12.40	6.75	-5.43	-11.22
CBB-47 × CO-2	4.00	-0.41	-1.38	23.43**	17.39*	10.20
CBB-47 × BSR-112	-7.64	-9.42	-6.70	11.96	11.96	5.10
SE Diff	6.00	6.93	6.93	0.40	0.46	0.46
CD @ 5%	11.98	13.83	13.83	0.80	0.93	0.93
CD @ 1%	15.92	18.36	18.36	1.07	1.23	1.23

Table 3. Continued.

Characters	Number of primary branches per plant at 120 DAT Heterosis over (%)			Yield per plant (kg) Heterosis over (%)		
Crosses	MP	BP	CC	MP	BP	CC
CBB-1 × Matti Gulla	14.95*	4.24	-15.17*	17.08*	14.93	-18.65**
CBB-1 × CO-2	29.85**	16.00**	20.00**	25.44**	11.51	1.46
CBB-1 × BSR-112	50.45**	41.53**	15.17*	112.96**	110.47**	52.54**
CBB-2 × Matti Gulla	62.19**	55.24**	12.41*	12.45*	-5.02	-6.04
CBB-2 × CO-2	12.94*	-4.00	-0.69	18.30**	13.56*	12.33*
CBB-2 × BSR-112	49.28**	48.57**	7.59	57.32**	36.29**	34.81**
CBB-3 × Matti Gulla	20.72**	6.35	-7.59	64.02**	48.86**	1.49
CBB-3 × CO-2	21.74**	12.00*	15.86*	72.20**	38.68**	26.19**
CBB-3 × BSR-112	67.83**	53.17**	33.10**	113.43**	88.55**	36.65**
CBB-5 × Matti Gulla	37.14**	26.32**	-0.69	51.91**	31.45**	22.66**
CBB-5 × CO-2	19.70**	5.33	8.97	38.48**	36.75**	27.61**
CBB-5 × BSR-112	66.06**	58.77**	24.83**	32.37**	17.58**	9.72
CBB-6 × Matti Gulla	52.49**	20.61**	37.24**	82.57**	60.56**	44.25**
CBB-6 × CO-2	18.73**	13.33*	28.97**	32.74**	31.91**	20.02**
CBB-6 × BSR-112	34.57**	9.70	24.83**	108.64**	88.48**	69.33**
CBB-8 × Matti Gulla	38.33**	15.28*	14.48*	92.10**	83.60**	37.33**
CBB-8 × CO-2	8.16	6.00	9.66	41.98**	29.35**	17.69**
CBB-8 × BSR-112	47.58**	27.08**	26.21**	126.33**	122.82**	66.66**
CBB-12 × Matti Gulla	8.68	-3.25	-17.93**	8.86	-9.30	-7.19
CBB-12 × CO-2	22.34**	11.33	15.17*	-0.69	-6.19	-4.01
CBB-12 × BSR-112	33.04**	22.76**	4.14	44.10**	23.08**	25.94**
CBB-17 × Matti Gulla	2.18	-12.03	-19.31**	54.11**	43.00**	13.92*
CBB-17 × CO-2	9.54	-14.67*	-11.72	60.56**	50.57**	37.00**
CBB-17 × BSR-112	2.95	-8.27	-15.86*	74.64**	66.75**	32.85**
CBB-25 × Matti Gulla	11.21	-5.15	-11.03	85.47**	82.05**	24.12**
CBB-25 × CO-2	8.39	-12.67*	-9.66	58.28**	36.25**	23.97**
CBB-25 × BSR-112	45.83**	28.68**	20.69**	128.01**	117.30**	57.49**
CBB-29 × Matti Gulla	6.49	-8.89	-15.17*	61.59**	53.55**	4.69
CBB-29 × CO-2	14.39*	-18.67**	-15.86*	30.29**	9.11	-0.72
CBB-29 × BSR-112	16.32*	2.96	-4.14	39.96**	29.26**	-6.32
CBB-32 × Matti Gulla	62.01**	51.04**	0.00	154.66**	128.76**	55.97**
CBB-32 × CO-2	5.58	-18.00**	-15.17*	103.80**	62.73**	48.07**
CBB-32 × BSR-112	55.08**	39.42**	0.00	116.74**	89.58**	37.40**
CBB-47 × Matti Gulla	36.63**	12.93*	14.48*	71.17**	67.58**	19.25**
CBB-47 × CO-2	17.17**	16.00**	20.00**	9.56	-2.37	-11.17*
CBB-47 × BSR-112	41.04**	20.41**	22.07**	36.18**	34.94**	-2.20
SE Diff	0.52	0.60	0.60	1.1418	1.3184	1.3184
CD @ 5%	1.03	1.19	1.19	2.2772	2.6295	2.6295
CD @ 1%	1.37	1.59	1.59	3.0233	3.4910	3.4910

Where, $\overline{\overline{CC}}$ is the mean of commercial checks (EPH-718)

$$\text{SE for (BP and Check)} = \sqrt{\frac{2 \text{ Error variance}}{r}}$$

Critical differences (CD) were calculated by multiplying the SE with table '*t*' value at 5% and 1% of probabilities for error degrees of freedom.

Test of significance
for heterosis

The significance of heterosis values were tested by comparing the difference between mean of a particular F_1 and the grand mean of the F_1 in the experiment with CD values obtained separately for MP, BP and

SC employing the formula given below.

$$\text{CD for MP} = \sqrt{\frac{3/2 \times \text{MSSe}}{r}} \times \text{'}t\text{' value}$$

$$\text{CD for BP and SC} = \sqrt{\frac{2\ \text{MSSe}}{r}} \times \text{'}t\text{' value}$$

Where, MSSe = Error mean sum of squares, r =Number of replications,'*t*' table '*t*' value at error degrees of freedom. The calculated value was compared with the table value of '*t*' at error degrees of freedom to assess the significance.

Results and Discussion

Investigated F_1 hybrids showed significant variability for heterotic effects over their parents and commercial check for different traits studied which is in accordance with the results of Makani et al. [10]. Out of 36 hybeids, the significant desirable heterotic effects over their respective mid parent, better parent and commercial check at 90 days after transplanting were noticed in 7, 1 and 15 crosses for plant height, 16, 10 and 1 for stem girth, 27, 12 and 4 for plant spread in north-south direction, 24, 13 and 3 for plant spread in east-west direction, 7, 2 and 10 for leaf area and 20, 10 and 8 for number of primary branches per plant. Whereas a greater number of crosses viz. 23, 14 and 24 for plant height, 23, 10 and 1 for stem girth, 25, 12 and zero for plant spread in north-south durection, 22, 7 and zero for plant spread in east-west direction, 27, 19 and 15 for number of primary branches per plant exhibited significant positive heterotic effects at 120 days after transplanting. But still higher counts of crosses viz.34, 29 and 26 were significant and positive for yield per plant. Heterosis percent recorded from 36 crosses over mid parent, better parent and commercial check are presented in Tables 1,2 and 3.

Practically in plant breeding, the utility of hybrids relies mainly upon its higher heterosis over better parent and the commercial check. An examination of performance of hybrids over better parent revealed that the maximum heterobeltosis for total fruit yield per plant was exhibited by the hybrid CBB-32 × Matti Gulla (128.78%) succeeded by CBB-8 × BSR-112 (122.79%) and CBB-25 × BSR-112 (117.36%). Among the above hybrids, CBB-8 × BSR-112 also exhibited maximum significant heterosis for plant height, plant spread in north-south direction and leaf area indicating their close association. Similarly, the cross CBB-5 × BSR-112 (58.77%) exhibited maximum heterobeltosis for number of primary branches per plant. Many number of hybrids exhibited significant desirable heterobeltiosis for different growth and yield parameters studied. The heterotic response over better parent in brinjal was also reported by earlier reporters [10—15].

Considering the performance of hybrids over commercial check which is of economic importance, the hybrid CBB-6 × BSR-112 (69.34%) followed by CBB-8 × BSR-112 (66.67%) and CBB-25 × BSR-112 (57.50%) recorded maximum significant heterosis for total fruit yield per plant. It is also good to notice that the above hybrids even got its place in previous paragraph too. Similarly these hybrids possessed higher standard heterosis for plant height, plant spread in north-south direction, plant spread in east-west direction and for leaf area. The results reported are also supported by the findings of recent research workers [10—17].

The hybrids exhibited heterobeltiosis and economic heterosis for vigor characters and fruit yield per plant 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 program to obtain desirable segregants for the development of superior lines.

Presence of higher heterosis for different traits studied indicates the future prospects for exploitation of heterosis and development of high yielding and qualitative hybrids in brinjal. CBB-6 × BSR-112, CBB-8 × BSR-112, CBB-25 × BSR-112, CBB-32 × Matti Gulla and CBB-1 × BSR-112 were recognized as most promising for yield and vigor, which can be advanced for evaluation and use in hybrid breeding programs to enhance the productivity in brinjal.

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