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ESTIMATION OF HETEROSIS FOR EARLINESS, YIELD AND ITS COMPONENTS IN BRINJAL (*SOLANUM MELONGENA* .)

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Abstract

Twenty eight crosses for ten quantitative traits in 8×8 half diallel mating design in brinjal were evaluated in randomized block design with three replications to study heterosis over mid and better parents. Appreciable heterosis was observed over better parent and mid parent for all the characters studied. The lines BBSR 202, BBSR 195-1, BB 26 and BB45C were found superior on the basis of mean performance for earliness and yield related characters. In order of merit, BB 68 × BB 13, BB 13 × BB 44, BB 45C × BB 13, BBSR 202 × BB 13 and BB 26 × BBSR 195-1 showing 69.45%, 66.38%, 40.33%, 35.65% and 31.52% respectively were found to be the five best performing crosses with high heterobeltiosis and mean performance for yield per plant. These cross combinations can be advanced for further testing for commercial exploitation of hybrid vigour.

Key words: Brinjal, Heterobeltiosis, half diallel, yield

Introduction

Brinjal or eggplant (*Solanum melongena* L.) is an important solanaceous crop of sub tropics and tropics. It is a versatile crop adapted to different agro-climatic regions and can be grown throughout the year. It is a perennial but grown commercially as an annual crop. A number of cultivars are grown in India, consumer preference being dependent upon fruit colour, size and shape. Eggplant has a huge genetic divergence in India which offers much scope for improvement through heterosis breeding. Heterotic studies can also provide the basis for exploitation of valuable hybrid combinations and their commercial utilization in future breeding programs (Chowdhury *et al.,* 2010). Therefore in the present investigation the superiority of the hybrids were estimated over the mid-parent and better parent to judge the potential of crosses to be exploited in hybrid breeding programs.

Materials and Methods

The present investigation was carried out at All India Coordinated Research Project on Vegetable Crops, Orissa University of Agriculture and Technology, Bhubaneswar, during *Rabi* season of the year 2014. The experimental material consisted of eight parents namely BB 26, BB 68, BB 67, BB 45C, BBSR 195-1, BBSR 202, BB 13 and BB 44 (O.U.A.T., BBSR) were crossed in half diallel mating design. The resulting 28 F_1s. and 8 parents were transplanted to the field with spacing of 60cm × 45cm. Standard agronomic practices were followed to raise the crop. The experiment was laid out in Randomized Block Design with three replications. Observations were recorded on five randomly selected competitive plants for twelve traits *viz*. days to first flowering, days to 50% flowering, days to first harvest, plant height (cm), number of flowers per cluster, number of branches per plant, fruit length (cm), fruit girth (cm), number of fruits per cluster, number of fruits per plant, average fruit weight (g), fruit yield per plant (kg). Statistical analysis was done on the mean values as per Gomez and Gomez [1983] and heterosis over better parent and mid parent were worked out using techniques of Allard [1960].

Results and Discussion

The analysis of variance for all the traits revealed significant differences among parents and crosses

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Table 1: Mean performance of parents and crosses for earliness, yield and yield contributing traits in brinjal.

Parents/Hybrids	DTFF	DFPF	DFH	NFLPC	PH	NBPP	FL (cm)	FG (cm)	NFPC	NFPP	AFW (g)	FY (kg)
BB26	100.00	111.00	122.00	2.7	98.73	5.44	10.30	20.41	1.00	10.29	70.10	0.72
BB68	110.73	120.40	133.00	1.74	101.58	4.89	13.04	23.36	1.10	8.38	58.40	0.49
BB67	98.93	106.41	122.00	3.95	83.57	5.98	10.07	17.12	1.20	9.29	62.10	0.58
BB45C	95.50	102.52	120.00	2.90	76.25	5.65	10.37	16.46	3.10	12.76	56.20	0.71
BBSR 195-1	105.07	124.4	124.4	1.73	109.65	6.70	16.73	18.72	2.80	11.05	65.10	0.72
BBSR 202	100.99	100.99	132.00	3.35	74.73	6.02	13.57	17.92	1.40	12.68	68.20	0.87
BB13	96.50	108.70	125.00	2.86	75.9	4.60	14.06	12.37	2.62	7.68	60.24	0.46
BB44	101.70	112.86	131.00	2.4	108.60	5.45	13.86	13.80	1.20	6.69	74.21	0.50
BB26 × BB 68	103.40	108.23	123	1.68	105.90	6.46	11.84	18.43	1.00	13.22	62.32	0.82
BB26 × BB 67	88.20	116.47	136	5.07	103.43	5.18	10.27	16.52	1.20	10.04	84.54	0.85
BB26 × BB45C	95.00	122.53	142	3.41	100.20	4.71	11.43	14.52	1.40	10.06	92.12	0.92
BB26 ×BBSR 195-1	91.00	120.21	135	3.72	94.80	5.82	9.69	18.64	1.20	12.00	79.5	0.95
BB26 × BBSR 202	94.00	114.83	131	3.85	100.00	4.49	9.47	22.50	1.10	9.34	60.10	0.56
BB26 × BB13	100.93	115.13	126	4.01	98.50	4.26	11.75	17.03	1.30	8.56	110.70	0.95
BB26 × BB 44	86.00	101.03	114	3.45	94.30	5.66	11.28	13.87	1.20	7.61	100.00	0.76
BB68 × BB67	96.00	112.37	127	3.28	93.30	5.15	14.83	12.24	2.20	6.27	102.16	0.63
BB68 × BB45C	70.00	100.30	114	3.12	85.80	5.45	9.38	19.76	1.50	14.05	55.15	0.77
BB68 × BBSR195-1	94.85	101.83	117	3.00	89.80	4.86	15.90	18.62	2.00	8.25	69.52	0.58
BB68 × BBSR202	85.00	107.23	127	4.42	96.40	4.25	18.53	16.31	1.40	13.22	72.58	0.85
BB68 × BB13	103.00	116.78	134	3.02	97.20	5.16	13.44	12.90	1.30	10.04	82.90	0.83
BB68 × BB 44	93.00	104.83	118	2.88	93.00	6.12	17.59	16.15	1.10	8.24	65.30	0.54
BB67 × BB45C	85.00	119.20	132	3.86	93.50	5.13	16.01	18.64	1.00	16.26	45.88	0.74
BB67× BBSR195-1	82.01	109.10	127	4.20	97.40	4.12	11.29	19.81	1.70	7.71	68.21	0.53
BB67 × BBSR202	120.00	93.00	110	4.00	78.50	4.76	13.73	19.16	1.40	9.98	61.20	0.61
BB67 × BB13	91.00	115.90	132	3.48	74.30	4.92	9.33	16.14	1.60	8.67	50.95	0.44
BB67 × BB 44	88.03	111.90	123	2.93	90.10	5.91	13.04	19.78	1.50	8.00	71.40	0.57
BB45C ×BBSR195-1	92.00	112.10	128	4.38	102.20	5.62	21.02	25.16	1.60	13.20	53.60	0.71
BB45C × BBSR202	89.10	112.63	131	3.86	111.60	4.76	18.73	18.02	1.90	14.10	66.48	0.95
BB45C × BB13	83.63	92.33	108	5.18	115.20	5.00	16.14	15.02	1.50	10.16	98.24	1.00
BB45C × BB 44	93.00	119.50	132	3.86	121.10	6.12	13.27	16.15	1.20	12.91	65.31	0.85
BBSR195-1 × BBSR202	89.85	115.17	127	4.82	101.60	4.25	13.20	22.03	1.00	11.21	52.40	0.76
BBSR 195-1× BB13	91.00	95.50	111	3.67	108.00	4.12	11.66	23.26	1.30	9.95	46.20	0.47
BBSR195-1× BB 44	91.07	96.53	109	2.90	87.00	4.81	13.74	24.10	1.50	11.38	65.40	0.74
BBSR202 × BB13	91.00	101.93	119	4.33	86.10	5.20	12.20	19.62	1.40	15.8	75.61	1.18
BBSR202 × BB 44	93.99	113.43	129	2.48	95.20	6.10	13.05	16.88	3.50	12.05	65.23	0.78
BB13 × BB 44	92.94	118.60	130	3.41	77.26	5.80	12.92	24.55	3.13	10.27	80.59	0.82
SE (m)	4.40	3.73	5.77	0.22	4.65	0.30	0.13	1.52	0.15	0.65	3.30	0.05
CD (5%)	12.40	10.53	16.29	0.63	13.11	0.04	3.18	4.29	0.43	1.85	9.30	0.14
CD (1%)	16.40	13.99	21.62	0.84	17.40	1.12	4.23	5.70	0.58	2.45	12.34	0.18

* Significant at 5% ** Significant at 1%

indicating the existence of sufficient variability in the material studied. The mean performance of parents and crosses is presented in table 1. The per cent of heterosis over mid parent and over better parent is given in Table 2. Earliness is one of the major considerations taken into account in any breeding programme particularly development of hybrids. The traits like days to first flowering, days to 50 % flowering and days to first harvest are primary indicator to predict earliness in a crop like brinjal**.** Earliness, indicated by negative estimates of heterosis which helps the grower to fetch early market price. In order of merit, the best three crosses, which gave best performance over better parent in relation to earliness were, BB 68× BB 45C (-36.79 %), BB 68×

Table 2: Estimation of heterobeltiosis (HB) and relative heterosis (RH) for earliness and yield contributing traits.

Crosses	DFF		DFPF		DFH		NFLPC		NBPP		PH (cm)	
	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB
BB26×BB68	-6.62	-1.87	-10.11*	-6.45	-7.52	-3.53	-37.78**	-24.32	18.75*	25.07**	4.25	5.73
BB26×BB67	-11.80	-11.33*	4.92	7.14	11.48*	11.48	28.35**	52.48**	-13.43	-9.31	4.76	13.48*
BB26×BB45C	-5.00	-2.81	10.39*	14.77**	16.39	17.36**	17.59	21.79*	-16.64*	-15.06*	1.49	14.53*
BB26×BBSR195-1	-13.39*	-11.25*	-3.37	2.13	-2.17	3.85	37.78**	67.95**	-13.13*	-4.12	-13.55*	-9.02
BB26×BBSR202	-6.92	-6.46	3.40	3.43	-0.76	3.15	14.93	27.27**	-25.42**	-21.64**	1.28	15.30*
BB26×BB13	0.93	2.73	3.72	4.81	0.80	2.02	40.21**	44.24**	-21.69**	-15.14*	-0.24	12.81
BB26×BB44	-15.44*	-14.73**	-10.48*	-9.74*	-12.98*	-9.88	27.78*	35.29**	3.79	3.92	-13.17*	-9.04
BB68×BB67	-13.31*	-8.43	-6.67	-0.92	-4.51	-0.39	-16.96*	15.29	-13.93	-5.27	-8.15	0.78
BB68×BB45C	-36.79**	-32.12**	-16.69**	-10.01*	-14.29*	-9.88	7.59	34.48**	-3.54	3.42	-15.53*	-3.50
BB68×BBSR195-1	-14.34*	-12.09*	-18.14**	-16.80**	-15.22*	-13.65*	72.41**	72.91**	-27.46**	-16.13*	-18.11**	-14.98**
BB68×BBSR202	-23.24**	-19.71**	-10.94*	-7.34	-4.51	-4.15	31.94**	73.67**	-29.40**	-22.09**	-5.10	9.35
BB68×BB13	-6.98	-0.60	-3.00	1.95	0.75	3.88	5.59	31.30*	5.52	8.75	-4.31	9.53
BB68×BB44	-16.01**	-12.45*	-12.93**	-10.11*	-11.28	-10.61	20.00	39.13**	12.22	18.34*	-14.36*	-11.50*
BB67×BB45C	-14.08*	-12.57*	12.02*	14.11**	8.20	9.09	-2.28	12.70	-14.26	-11.81	11.89	17.01*
BB67×BBSR195-1	-21.95**	-19.60**	-12.30*	-5.46	-7.97	-2.31	6.33	47.89**	-38.56**	-35.09**	-11.17	0.82
BB67×BBSR202	18.82**	20.05**	-16.26**	-14.47**	-16.67**	-13.39*	1.27	9.59	-20.99**	-20.74	-6.06	-0.82
BB67×BB13	-8.02	-6.87	6.62	7.76	5.60	6.88	-11.90	2.20	-17.77*	-7.02	-11.09	-6.81
BB67×BB44	-13.44*	-12.25*	-0.85	2.07	-6.11	-2.77	-25.82**	-7.72	-1.23	3.35	-17.03**	-6.23
BB45C×BBSR195-1	-12.44*	-8.26	-9.89*	-1.20	-7.25	-0.78	51.03**	89.20**	-16.12*	-8.99	-6.80	9.95
BB45C×BBSR202	-11.77	-9.31	1.42	5.48	-0.76	3.97	15.22	23.52**	-20.93**	-18.42**	46.37**	47.83**
BB45C×BB13	-13.33*	-12.88*	-15.06**	-12.57**	-13.60*	-11.84	78.62**	79.86**	-11.50	-2.44	51.09**	51.43**
BB45C×BB44	-8.56	-5.68	5.88	10.97*	0.76	5.18	33.10**	45.66**	8.32	10.24	11.51	31.03**
BBSR195-1×BBSR202	-14.48*	-12.79*	-7.42	-2.17	-7.97	-5.93	43.88**	89.76**	-36.57**	-33.18**	-7.34	10.20
BBSR195-1×BB13	-13.39*	-9.71	-23.23**	-18.06**	-19.57**	-15.59**	28.32*	59.91**	-38.51**	-27.08**	-1.51	16.41**
BBSR195-1×BB44	-13.32*	-11.92*	-22.40**	-18.63**	-21.01**	-18.96**	20.83	40.44**	-28.21**	-20.84**	-20.66**	-20.28**
BBSR202×BB13	-9.89	-7.84	-8.21	-7.23	-9.85	-7.39	29.35**	39.56**	-13.62	-2.07	13.44	14.32
BBSR202×BB44	-7.58	-7.26	0.51	1.32	-2.27	-1.90	-25.97**	-13.74	1.33	6.33	-12.34	3.85
BB13×BB44	-8.62	-6.22	5.09	7.06	-0.76	1.56	19.27	29.70**	6.36	15.38*	-28.86**	-16.25*

* Significant at 5% ** Significant at 1%

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Crosses	FL (cm)		FG (cm)		NFPC		NFPP		FW (g)		FY (kg)							
	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB
BB 26×BB 68	-9.23	1.41	-21.10*	-15.79	-9.09	-4.76	28.47**	41.62**	-11.10	-3.00	13.76	35.97**						
BB 26×BB67	-0.36	0.77	-19.06	-11.96	0.00	9.09	-2.43	2.55	20.60**	27.90**	16.89	29.92**						
BB 26×BB 45C	10.26	10.60	-28.86**	-21.24*	-54.84**	-31.71**	-21.16**	-12.71	31.41**	45.87**	27.66**	28.63**						
BB 26× BBSR 195-1	-42.05**	-28.28**	-8.67	-4.73	-57.14**	-36.84**	9.05	12.93	-6.95	-3.51	31.52**	32.04**						
BB26×BBSR 202	-30.20*	-20.65	10.24	17.40	-21.43	-8.33	-26.34**	-18.68**	-14.27*	-13.09*	-35.26**	-29.40**						
BB 26×BB 13	-16.43	-3.54	-16.56	3.90	-50.38**	-28.18**	-16.81	-4.73	57.92**	69.86**	31.11**	60.42**						
BB26×BB 44	-18.42	-6.51	-32.04**	-18.91	0.00	9.09	-26.04**	-10.37	34.75**	38.59**	5.20	24.92*						
BB 68×BB 67	13.73	28.32*	-47.59**	-39.51**	83.33**	91.30**	-32.51**	-29.03**	64.51**	69.56**	9.10	18.44						
BB 68× BB 45C	-28.09*	-19.88	-15.41	-0.75	-51.61**	-28.57**	10.11	32.92**	-5.57	-3.75	8.41	28.78**						
BB68×BBSR195-1	-4.92	6.85	-20.29*	-11.50	-28.69**	2.39	42.99**	62.64**	16.14*	22.45**	-19.85*	-4.50						
BB 68×BBSR202	36.61**	39.31**	-30.19**	-20.99*	0.00	12.00	4.26	25.55**	6.42	14.66*	-2.57	24.80**						
BB68×BB13	-4.43	-0.84	-44.78**	-27.79**	-50.38**	-30.11**	19.81	25.03*	37.62**	39.75**	69.45**	74.45**						
BB68×BB 44	27.22*	30.94**	-30.86**	-13.08	-8.33	-4.35	-1.67	9.36	-12.01**	-1.52	8.41	9.29						
BB 67× BB 45C	54.47**	56.69**	8.88	11.02	-67.74**	-53.49**	-20.38**	-7.85	58.20**	66.09**	3.08	13.80						
BB 67×BBSR195-1	-32.50**	-15.75	5.82	10.55	-39.29**	-15.00	-30.23**	-24.19**	4.78	7.25	-26.58**	-18.67*						
BB 67×BBSR 202	1.23	16.19	6.92	9.36	0.00	7.69	-21.29**	-9.15	-10.26	-6.06	-29.70**	-15.63						
BB 67×BB13	-33.67**	-22.71	-5.72	9.46	-38.93**	-16.23	-6.67	2.18	-17.95*	-16.71*	-24.29*	-15.60						
BB67×BB 44	-5.69	9.12	15.54	27.94*	25.00	25.00	-13.89	0.13	-3.79	4.76	-1.55	6.08						
BB45C×BBSR195-1	25.69**	55.19**	34.40**	43.04**	-48.39**	-45.76**	3.45	10.88	-17.67*	-11.62	-1.90	-1.54						
BB 45C× BBSR 202	38.06**	56.52**	0.56	4.83	-38.71**	-15.56	10.50	10.85	-2.52	6.88	8.79	19.47*						
BB 45C×BB13	14.79	32.15**	-8.75	4.20	-51.61**	-47.55**	27.43**	59.10**	-23.84**	-21.20**	40.33**	70.67**						
BB 45C×BB 44	-4.00	9.73	-1.88	6.74	-61.29**	-44.19**	1.18	32.75**	-11.99	0.16	18.55	39.90**						
BBSR 195-1×BBSR 202	-21.08*	-12.85	17.68	20.25	-64.29**	-52.38**	-11.59	-5.52	-23.17**	-21.38**	-12.66	-4.41						
BBSR 195-1×BB13	-30.29**	-24.25**	24.25*	49.63**	-53.57**	-52.03**	-9.95	6.25	-29.03**	-26.28**	-34.97**	-20.68*						
BBSR 195-1× BB 44	-17.88	-10.08	28.74*	48.22**	-46.43**	-25.00**	2.99	28.30**	-11.87	-6.11	3.48	22.48*						
BBSR 202×BB13	-13.23	-11.68	9.49	29.55*	-46.56**	-30.35**	-34.94**	-18.96*	1.94	8.25	35.65**	77.42**						
BBSR 202×BB 44	-5.59	-4.70	-5.80	6.43	150.00**	169.23**	-5.36	23.90**	7.13	11.65*	-10.02	14.59						
BB13×BB 44	-8.08	-7.32	77.92**	87.64**	19.59*	64.05**	33.72 **	42.94 **	8.60	19.88 **	66.38**	72.64**						

*Significant at 5% ** Significant at 1%

DTFF: days to first flowering, DFPF: Days to 50% flowering, DFH: Days to first harvest, PH: plant height, NFLPC: Number of flowers per cluster, NBPP: Number of branches per plant, FL: Fruit length, FG: Fruit girth, NFPC: Number of fruits per cluster, NFPP: Number of fruits per plant, AFW: Average fruit weight, FYPP: Fruit yield per plant.

BBSR 202 (-23.24 %) and BB 67× BBSR 195-1 (-21.95 %) for days to first flowering and for relative heterosis out of twenty eight cross combinations, thirteen combinations showed significant negative heterosis maximum being in BB 68× BB 45C (-32.12%) **;** BBSR 195-1 × BB 13 (-23.23 %), BBSR 195-1 × BB 44 (-22.40 %) and BB 68× BBSR 195-1 (-18.14%) for days to 50% flowering while significant negative relative heterosis was represented by eight cross combinations; BBSR 195-1 × BB 44 (-21.01 %), BBSR 195-1 × BB 13 (-19.57 %) and BB 67 × BBSR 202 (-16.67 %) for days to first harvest and relative heterosis for this trait was revealed by only four cross combinations. Significant and desirable (negative) heterosis of variable magnitude for earliness has been reported by Bisht *et al.,* (2009), Shanmugapriya *et al.,*(2009), Sao and Mehta (2010), Chowdhury *et al.,* (2010), Dharwad *et al.,* (2011), Dubey *et al.,* (2014),

The ultimate goal of any breeding programme is target to achieve maximization of marketable yield. Since yield is a complex and polygenically inherent trait, number of fruits per plant and average fruit weight are directly contributing to yield in brinjal breeding. In order of superiority, the best three cross combinations, which gave highest performance over better parent and mid parent in relation to yield and its contributing characters were BB 45C × BB 13 (78.62% and 79.86%), BB 68 × BBSR 195-1 (72.41 % and 72.91%), BB 45C × BBSR 202 (51.03 % and 89.20 %) for number of flowers per cluster, BBSR 202 × BB 44 (150.00% and 42.94%), BB 26 × BB 68 (28.47 % and 41.62 %) and BB 13× BB 44 (19.59% and 64.05 %) for number of fruits per cluster, BB 45C × BB 13 (51.09 % and 51.43 %) and BB 45C × BBSR 202 (46.37 % and 47.83 %) for plant height, BB 26 × BB 68 (18.75% and 25.07 %) for number of branches per plant, BB 67 × BB 45C (54.47 % and 56.69 %), BB 45C × BBSR 202 (38.06 % and 56.52 %) and BB 68 × BBSR 202 (36.61 % and 39.31 %) for fruit length, BB 13 × BB 44 (77.92% and 87.64%) , BB 45C × BBSR 195-1 (34.40 % and 43.04 %) and BBSR 195-1 × BB 44 (28.74 % and 48.22%) for fruit girth, BB 68 × BBSR 195-1 (42.99 % and 62.64%), BB 13 × BB 44 (33.72 % and 42.94 %) and BB 26 × BB 68 (28.47 % and 41.62 %) for number of fruits plant, BB 68 × BB 67 (61.51% and 69.56%), BB 67× BB 45C (58.20% and 66.09%) and BB 26× BB 13 (57.92 % and 69.86 %) for fruit weight, BB 68 × BB 13 (69.45% and 74.45%), BB 13× BB 44 (66.38 % and 72.64 %) and BB 45C × BB 13(40.33 % and 70.67%) for fruit yield per plant. Significant and desirable heterosis of variable magnitude for yield traits has been reported by Singh *et al.,*(2003), Murthy *et al.,* (2011), Kumar *et al.,* (2013), VenkataNaresh *et al.,* (2014), Suneetha *et al.,* (2008), Sharma *et al.,* (2010), Makani *et al.,* (2013), Patel *et al.,* (2013), Thimmapur *et al.,* (2008).

The results of the present study indicated that maximum yield per plant in the crosses mentioned above was attributed by maximum number of fruits per plant and average fruit weight. Based on the performance of 28 cross combinations, five best performing crosses BB 68 × BB 13, BB 13 × BB 44, BB 45C × BB 13, BBSR 202 × BB 13 and BB 26 × BBSR 195-1 showing 69.45%, 66.38%, 40.33%, 35.65% and 31.52% heterobeltiosis for yield per plant. Such combinations are expected to throw better segregants for fruit yield and yield attributes in the subsequent generations which can be exploited effectively for improvement of brinjal.

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