



## RESEARCH ARTICLE

### MANIFESTATION OF HETEROSIS AND HETEROBELTIOSIS FOR YIELD ATTRIBUTING TRAITS IN INBRED LINES OF MAIZE (*ZEA MAYS* L.)

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#### ABSTRACT

The experiment was carried out during *rabi*, 2012-13 involving 15 inbred lines in combination with 4 testers in line x tester design to obtain 60 cross combinations for evaluation along with three checks for heterosis in terms of yield and its attributes. The results indicated significant negative relative heterosis for days to 50 per cent tasseling in 26 hybrids indicating earliness for maturity. Relative heterosis for plant height varied from 10.99 to 102.98 per cent, heterobeltiosis from -1.45 to 61.89 and standard heterosis from -35.44 to 7.75 per cent, -28.55 to 19.26 per cent and -26.88 to 22.04 per cent over DHM 117, 30 V 92 and 900 M Gold, respectively. Relative heterosis and heterobeltiosis for ear height and ear length was found to be positively significant in most of the crosses. For 100-seed weight, majority of the hybrids showed significant and positive relative heterosis and heterobeltiosis with range of relative heterosis from -21.74 to 31.97 per cent and heterobeltiosis from -38.18 to 27.63 per cent and standard heterosis from -17.07 to 21.95 per cent over DHM-117, from -17.07 to 21.95 per cent over 30 V 92 and -8.11 to 35.14 over 900 M Gold, respectively. Significant positive relative heterosis and heterobeltiosis for grain yield per plant was also recorded by many hybrids indicating simultaneous manifestation of heterosis for yield component traits.

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## INTRODUCTION

Maize is a highly cross pollinated crop and the scope for the exploitation of hybrid vigour will depend on the magnitude of heterosis, biological feasibility and the type of gene action. Though, the science of genetics and plant breeding have greatly contributed to improve the productivity through high yielding synthetics, composites and hybrids *viz.*, single, double, multiple and varietal hybrids, of late, single cross hybrids have become the most popular because single crosses show higher uniformity and heterosis than the double and three-way crosses.

Besides, identification of favourable alleles in the inbreds, the information on combining ability is a pre-requisite for development of superior hybrids. The main goal of maize breeding is to obtain new hybrids with high genetic potential for yield and positive features that exceed the existing commercial hybrids. The development of superior hybrids depends on the combining ability of lines involved in the production of the hybrids. Maize breeders, therefore, know that the probability of obtaining a highly heterotic hybrid is greater

when the crosses are between unrelated lines than crosses between related lines. Moreover, the knowledge of the nature and magnitude of genotypic and phenotypic variability present in the crop species plays a vital role in formulating a successful breeding programme to evolve superior cultivars.

## MATERIALS AND METHODS

The experiment was carried out at Agricultural Research Station, Madhira during *rabi*, 2012-13. Selected 15 inbred lines were crossed with 4 testers in line x tester (L x T) mating design to obtain 60 cross combinations. During kharif 2013, set of 60 crosses along with 19 parents and three checks *viz.*, DHM-117, 30 V 92 and 900 M Gold were sown in randomized block design replicated thrice. Each entry was sown in a row of five meters length with a spacing of 75 cm between rows and 20 cm between the plants. The recommended fertilizers of N, P and K were applied in the ratio of 120: 80: 60 kg ha<sup>-1</sup>. Necessary plant protection measures were taken to protect the crop from pests and diseases. Observations on 11 different quantitative characteristics were recorded on five random plants except for days to 50 per cent tasseling, days to 50 per cent silking and days to maturity.

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Estimates of heterosis were calculated according to Fonseca and Patterson (1968) and standard heterosis according to Virmani *et al.* (1982) for these characters and expressed as heterosis over mid parent, superior parent and standard checks viz., DHM 117, 30 V 92 and 900 M Gold.

## RESULTS AND DISCUSSION

The negative heterotic values for days to 50 per cent tasseling, days to 50 per cent silking and days to maturity indicates earliness, which is desirable. For other characters positive estimates were considered as desirable.

The characterwise heterotic estimates for hybrids is presented in Tables 1, 2, 3 and 4, the values being expressed in per cent.

Significant negative relative heterosis for days to 50 per cent tasseling was observed in 26 hybrids which ranged from -11.59 to 9.70 per cent and heterobeltiosis varied from -17.93 to 5.52 per cent. Fifty hybrids showed significant negative standard heterosis over DMH-117, 58 hybrids each over 30 V 92 and 900 M Gold. Standard heterosis over DHM-117 ranged from -16.67 to 4.02 per cent, whereas over 30 V 92 and 900 M Gold ranged from -19.89 to 0.00 per cent and -20.77 to -1.09, respectively.

**Table 1. Estimates of heterosis, heterobeltiosis and standard heterosis (over DHM-117, 30 V 92 and 900 M Gold) for days to 50 % tasseling, days 50 % silking and days to maturity in maize hybrids**

Cross	Days to 50 % tasseling						Days to 50 % silking						Days to maturity					
	Heterosis	Hetero beltiosis	Standard heterosis			Heterosis	Hetero beltiosis	Standard heterosis			Heterosis	Hetero beltiosis	Standard heterosis					
			DHM-117	30 V 92	900 M Gold			DHM-117	30 V 92	900 M Gold			DHM-117	30 V 92	900 M Gold			
MRC1112 X BML5	-6.51 **	-14.13 **	-9.20 **	-12.71 **	-13.66 **	-5.92 **	-13.02 **	-8.74 **	-12.11 **	-13.47 **	-0.91	-6.53 **	-1.81	-5.56 **	-2.51			
MRC1112 X BML7	0.00	-7.22 **	-4.02 *	-7.73 **	-8.74 **	-1.42	-8.42 **	-4.92 *	-8.42 **	-9.84 **	0.72	-6.33 **	1.44	-2.43	0.72			
MRC1112 X BML13	8.52 **	5.52 **	-1.15	-4.97 **	-6.01 **	7.46 **	4.65 *	-1.64	-5.26 **	-6.74 **	-1.45	-7.19 **	-2.17	-5.9 **	-2.87			
MRC1112 X BML14	-7.60 **	-13.14 **	-12.64 **	-16.02 **	-16.94 **	-7.2 **	-12.5 **	-12.02 **	-15.26 **	-16.58 **	-2.74	-7.96 **	-3.97 *	-7.64 **	-4.66 *			
MRC 1123 X BML5	-3.53 *	-10.87 **	-5.75 **	-9.39 **	-10.38 **	-3.64 *	-10.42 **	-6.01 **	-9.47 **	-10.88 **	-0.36	-5.5 **	-0.72	-4.51 *	-1.43			
MRC 1123 X BML7	-1.79	-8.33 **	-5.17 **	-8.84 **	-9.84 **	-1.41	-7.89 **	-4.37 *	-7.89 **	-9.33 **	-1.25	-7.67 **	0.00	-3.82 *	-0.72			
MRC 1123 X BML13	7.84 **	5.52 **	-1.15	-4.97 **	-6.01 **	7.42 **	5.23 *	-1.09	-4.74 *	-6.22 **	-1.99	-7.19 **	-2.17	-5.90 **	-2.87			
MRC 1123 X BML14	-3.32	-8.57 **	-8.05 **	-11.6 **	-12.57 **	-4.3 *	-9.24 **	-8.74 **	-12.11 **	-13.47 **	-2.18	-6.92 **	-2.89	-6.60 **	-3.58 *			
MRC 1176 X BML5	4.32 *	-8.15 **	-2.87	-6.63 **	-7.65 **	2.34	-8.85 **	-4.37 *	-7.89 **	-9.33 **	2.91	-8.93 **	-4.33 *	-7.99 **	-5.02 **			
MRC 1176 X BML7	5.00 **	-6.67 **	-3.45	-7.18 **	-8.20 **	4.12 *	-6.84 **	-3.28	-6.84 **	-8.29 **	3.44 *	-9.67 **	-2.17	-5.90 **	-2.87			
MRC 1176 X BML13	6.93 **	-0.61	-6.90 **	-10.5 **	-11.48 **	7.45 **	0.58	-5.46 **	-10.5 **	-10.36 **	6.59 **	-5.82 **	-0.72	-4.51 *	-1.43			
MRC 1176 X BML14	3.49	-6.86 **	-6.32 **	-9.94 **	-10.93 **	1.20	-8.15 **	-7.65 **	-11.05 **	-12.44 **	0.97	-10.38 **	-6.50 **	-10.07 **	-7.17 **			
MRC 1179 X BML5	-3.53 *	-10.87 **	-5.75 **	-9.39 **	-10.38 **	-3.08	-9.90 **	-5.46 **	-8.95 **	-10.36 **	7.75 **	-4.47 *	0.36	-3.47 *	-0.36			
MRC 1179 X BML7	-3.57 *	-10.00 **	-6.90 **	-10.5 **	-11.48 **	-4.23 *	-10.53 **	-7.10 **	-10.53 **	-11.92 **	7.05 **	-6.33 **	1.44	-2.43	0.72			
MRC 1179 X BML13	0.31	-1.84	-8.05 **	-11.6 **	-12.57 **	0.30	-1.74	-7.65 **	-11.05 **	-12.44 **	5.61 **	-6.51 **	-1.44	-5.21 **	-2.15			
MRC 1179 X BML14	-4.53 *	-9.71 **	-9.20 **	-12.71 **	-13.66 **	-4.30 *	-9.24 **	-8.74 **	-12.11 **	-13.47 **	5.84 **	-5.88 **	-1.81	-5.56 **	-2.51			
MRC 1209 X BML5	-5.44 **	-10.33 **	-5.17 **	-8.84 **	-9.84 **	-5.46 **	-9.90 **	-5.46 **	-8.95 **	-10.36 **	-5.63 **	-7.90 **	-3.25	-6.94 **	-3.94 *			
MRC 1209 X BML7	-6.09 **	-10.00 **	-6.90 **	-10.5 **	-11.48 **	-5.49 **	-9.47 **	-6.01 **	-9.47 **	-10.88 **	-4.68 **	-8.33 **	-0.72	-4.51 *	-1.43			
MRC 1209 X BML13	-2.44	-3.03	-8.05 **	-11.6 **	-12.57 **	-2.89	-3.45	-8.20 **	-11.58 **	-12.95 **	-3.34 *	-5.82 **	-0.72	-4.51 *	-1.43			
MRC 1209 X BML14	-6.47 **	-9.14 **	-8.62 **	-12.15 **	-13.11 **	-6.70 **	-9.24 **	-8.74 **	-12.11 **	-13.47 **	-6.71 **	-8.65 **	-4.69 *	-8.33 **	-5.38 **			
MRC 1271 X BML5	-4.45 *	-12.50 **	-7.47 **	-11.05 **	-12.02 **	-5.35 **	-12.5 **	-8.2 **	-11.58 **	-12.95 **	0.36	-5.15 **	-0.36	-4.17 *	-1.08			
MRC 1271 X BML7	-1.50	-8.89 **	-5.75 **	-10.38 **	-10.38 **	-1.98	-8.95 **	-5.46 **	-8.95 **	-10.36 **	-8.05 **	-14.33 **	-7.22 **	-10.76 **	-7.89 **			
MRC 1271 X BML13	-0.63	-3.68	-9.77 **	-13.26 **	-14.21 **	-0.30	-2.91	-8.74 **	-12.11 **	-13.47 **	1.27	-4.45 *	0.72	-3.13	0.00			
MRC 1271 X BML14	-5.49 **	-11.43 **	-10.92 **	-14.36 **	-15.30 **	-6.63 **	-11.96 **	-11.48 **	-14.74 **	-16.06 **	-1.46	-6.57 **	-2.53	-6.25 **	-3.23			
MRC 1358 X BML5	-7.19 **	-15.76 **	-10.92 **	-14.36 **	-15.30 **	-7.65 **	-15.10 **	-10.93 **	-14.21 **	-15.54 **	2.10	-8.25 **	-3.61 *	-7.29 **	-4.30 *			
MRC 1358 X BML7	9.70 **	0.56	4.02 *	0.00	-1.09	7.12 **	-1.05	2.73	-1.05	-2.59	0.38	-11.00 **	-3.61 *	-7.29 **	-4.30 *			
MRC 1358 X BML13	2.88	-1.23	-7.47 **	-11.05 **	-12.02 **	2.10	-1.16	-7.10 **	-10.53 **	-11.92 **	2.29	-8.22 **	-3.25	-6.94 **	-3.94 *			
MRC 1358 X BML14	-8.31 **	-14.86 **	-14.37 **	-17.68 **	-18.58 **	-8.41 **	-14.13 **	-13.66 **	-16.84 **	-18.13 **	-0.58	-10.38 **	-6.50 **	-10.07 **	-7.17 **			
MRC 1544 X BML5	-10.39 **	-17.93 **	-13.22 **	-16.57 **	-17.49 **	-8.47 **	-15.63 **	-11.48 **	-14.74 **	-16.06 **	2.40	-4.81 **	0.00	-3.82 *	-0.72			
MRC 1544 X BML7	-2.70	-10.00 **	-6.90 **	-10.50 **	-11.48 **	-2.84	-10.00 **	-6.56 **	-10.00 **	-11.40 **	2.18	-6.33 **	1.44	-2.43	0.72			
MRC 1544 X BML13	1.27	-1.84	-8.05 **	-11.60 **	-12.57 **	1.20	-1.74	-7.65 **	-11.05 **	-12.44 **	4.8 **	-2.74	2.53	-1.39	1.79			
MRC 1544 X BML14	-11.59 **	-17.14 **	-16.67 **	-19.89 **	-20.77 **	-10.4 **	-15.76 **	-15.30 **	-18.42 **	-19.69 **	0.56	-6.23 **	-2.17	-5.90 **	-2.87			
MRC 1556 X BML5	-6.23 **	-14.13 **	-9.20 **	-12.71 **	-13.66 **	-5.65 **	-13.02 **	-8.74 **	-13.02 **	-13.47 **	4.12 *	-4.47 *	0.36	-4.47 *	-0.36			
MRC 1556 X BML7	-2.70	-10.00 **	-6.90 **	-10.50 **	-11.48 **	-2.27	-9.47 **	-6.01 **	-9.47 **	-10.88 **	3.50 *	-6.33 **	1.44	-2.43	0.72			

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MRC 1271 X BML7	68.94**	26.00**	-15.66**	-6.65	-4.48	111.34 **	68.39 **	-10.31	11.06	16.00 *	16.88 *	-6.25	-8.16	-21.05 **	9.76
MRC 1271 X BML13	37.17**	29.55**	-13.29**	-4.03	-1.79	74.76 **	70.99 **	-4.81	17.87 *	23.11 **	47.37 **	16.67 *	14.29 *	-1.75	36.59 **
MRC 1271 X BML14	48.55**	14.66*	-23.26**	-15.06**	-13.08*	23.40 *	12.26	-40.21 **	-25.96 **	-22.67 **	35.14 **	4.17	2.04	-12.28 *	21.95 **
MRC 1358 X BML5	46.99**	37.60**	-14.87**	-5.78	-3.58	40.32 **	39.87 **	-24.05 **	-5.96	-1.78	29.87 **	25.00 **	2.04	-12.28 *	21.95 **
MRC 1358 X BML7	81.30**	38.87**	-14.08**	-4.90	-2.69	97.6 **	56.33 **	-15.12 *	5.11	9.78	36.23 **	17.50 *	-4.08	-17.54 **	14.63
MRC 1358 X BML13	65.06**	61.89**	0.16	10.86*	13.44**	71.25 **	69.14 **	-5.84	16.60 *	21.78 **	73.53 **	47.50 **	20.41 **	3.51	43.90 **
MRC 1358 X BML14	68.44**	33.76**	-17.25**	-8.41	-6.27	43.86 **	29.75 *	-29.55 **	-12.77	-8.89	42.42 **	17.50 *	-4.08	-17.54 **	14.63
MRC 1544 X BML5	10.99	1.21	-33.70**	-26.62**	-24.91**	12.97	3.16	-32.65 **	-16.60 *	-12.89	-2.27	-15.69 *	-12.24	-24.56 **	4.88
MRC 1544 X BML7	65.27**	24.15**	-18.67**	-9.98*	-7.89	97.87 **	46.84 **	-4.12	18.72 *	24.00 **	22.50 **	-3.92	0.00	-14.04 *	19.51 *
MRC 1544 X BML13	29.37**	23.43**	-19.15**	-10.51*	-8.42	31.25 **	21.58 *	-20.62 **	-1.70	2.67	46.84 **	13.73 *	18.37 **	1.75	41.46 **
MRC 1544 X BML14	26.71**	-1.45	-35.44**	-28.55**	-26.88**	14.20	-4.74	-37.8 **	-22.98 **	-19.56 *	3.90	-21.57 **	-18.37 **	-29.82 **	-2.44
MRC 1556 X BML5	39.27**	25.77**	-15.82**	-6.83	-4.66	28.65 **	18.92	-24.4 **	-6.38	-2.22	-2.33	-14.29 *	-14.29 *	-26.32 **	2.44
MRC 1556 X BML7	67.04**	24.59**	-16.61**	-7.71	-5.56	74.73 **	30.81 **	-16.84 **	2.98	7.56	23.08 **	-2.04	-2.04	-15.79 **	17.07 *
MRC 1556 X BML13	41.68**	33.81**	-10.44*	-0.88	1.43	42.94 **	34.05 **	-14.78 *	5.53	10.22	50.65 **	18.37 **	18.37 **	1.75	41.46 **
MRC 1556 X BML14	58.65**	22.46**	-18.04**	-9.28	-7.17	31.41 **	10.81	-29.55 **	-12.77	-8.89	4.00	-20.41 **	-20.41 **	-31.58 **	-4.88
MRC 1561 X BML5	26.34**	16.63*	-25.63**	-17.69**	-15.77**	45.88 **	22.51 **	-2.75	20.43 **	25.78 **	17.65 *	4.17	2.04	-12.28 *	21.95 **
MRC 1561 X BML7	81.01**	37.22**	-12.50**	-3.15	-0.90	70.28 **	19.05 *	-5.50	17.02 *	22.22 **	11.69	-10.42	-12.24	-24.56 **	4.88
MRC 1561 X BML13	64.83**	59.31**	1.58	12.43*	15.05**	70.99 **	45.45 **	15.46 *	42.98 **	49.33 **	34.21 **	6.25	4.08	-10.53	24.39 **
MRC 1561 X BML14	46.92**	15.38*	-26.42**	-18.56**	16.67**	49.16 **	15.58 *	-8.25	13.62	18.67 *	21.62 **	-6.25	-8.16	-21.05 **	9.76
MRC 1564 X BML5	20.37**	9.64	-28.01**	-20.32**	-18.46**	-5.24	-19.56 *	-37.8 **	-22.98 **	-19.56 *	7.32	-2.22	-10.2	-22.81 **	7.32
MRC 1564 X BML7	91.33**	43.61**	-5.70	4.38	6.81	59.62 **	12.44	-13.06 *	7.66	12.44	13.51	-6.67	-14.29 *	-26.32 **	2.44
MRC 1564 X BML13	33.25**	26.99**	-16.61**	-7.71	-5.56	24.55 **	7.11	-17.18 **	2.55	7.11	17.81 *	-4.44	-12.24	-24.56 **	4.88
MRC 1564 X BML14	36.43**	6.02	-30.38**	-22.94**	-21.15**	-6.25	-26.67 **	-43.3 **	-29.79 **	-26.67 **	15.49	-8.89	-16.33 *	-28.07 **	0.00
MRC 1582 X BML5	22.66**	5.73	-21.20**	-12.78*	-10.75*	13.24	1.52	-30.93 **	-14.47	-10.67	10.11	-5.77	0.00	-14.04 *	19.51 *
MRC 1582 X BML7	50.22**	8.28	-19.30**	-10.68*	-8.60	59.31 **	16.67	-20.62 **	-1.70	2.67	38.27 **	7.69	14.29 *	-1.75	36.59 **
MRC 1582 X BML13	22.55**	10.19	-17.88**	-9.11	-6.99	36.11 **	23.74 *	-15.81 *	4.26	8.89	45.00 **	11.54	18.37 **	1.75	41.46 **
MRC 1582 X BML14	40.66**	4.67	-21.99**	-13.66**	-11.65**	13.85	-6.57	-36.43 **	-21.28 **	-17.78 *	17.95 *	-11.54	-6.12	-19.3 **	12.20
MRC 1601 X BML5	28.26**	28.07**	-30.70**	-23.29**	-21.51**	28.03 **	28.03 *	-30.93 **	-14.47	-10.67	8.43	-2.17	-8.16	-21.05 **	9.76
MRC 1601 X BML7	76.36**	41.81**	-23.26**	-15.06**	-13.08**	93.57 **	53.50 **	-17.18 **	2.55	7.11	22.67 **	0.00	-6.12	-19.30 **	12.20
MRC 1601 X BML13	28.69**	22.87**	-26.90**	-19.09**	-17.20**	53.61 **	51.23 **	-15.81 *	4.26	8.89	40.54 **	13.04	6.12	-8.77	26.83 **
MRC 1601 X BML14	44.41**	20.76*	-34.65**	-27.67**	-25.99**	29.58 **	17.20	-36.77 **	-21.70 **	-18.22 *	16.67 *	-8.70	-14.29 *	-26.32 **	2.44
MRC 1604 X BML5	58.29**	49.61**	-9.34*	0.35	2.69	47.12 **	24.89 **	-3.44	19.57 *	24.89 **	33.33 **	22.73 **	10.20	-5.26	31.71 **
MRC 1604 X BML7	96.28**	51.44**	-8.23	1.58	3.94	75.39 **	23.56 **	-4.47	18.30 *	23.56 **	47.95 **	22.73 **	10.20	-5.26	31.71 **
MRC 1604 X BML13	48.09**	46.74**	-11.08*	-1.58	0.72	46.77 **	26.22 **	-2.41	20.85 **	26.22 **	52.78 **	25.00 **	12.24	-3.51	34.15 **
MRC 1604 X BML14	78.79**	43.08**	-13.29**	-4.03	-1.79	51.14 **	18.22 *	-8.59	13.19	18.22 *	48.57 **	18.18 *	6.12	-8.77	26.83 **
MRC 1661 X BML5	32.02**	19.86**	-20.73**	-12.26*	-10.22*	51.46 **	49.04 **	-19.59 **	-0.43	4.00	9.76	0.00	-8.16	-21.05 **	9.76
MRC 1661 X BML7	50.80**	12.92	-25.32**	-17.34**	-15.41**	90.16 **	52.63 **	-20.27 **	-1.28	3.11	18.92 *	-2.22	-10.2	-22.81 **	7.32
MRC 1661 X BML13	41.81**	34.69**	-10.92*	-1.40	0.90	89.17 **	83.33 **	2.06	26.38 **	32.00 **	39.73 **	13.33	4.08	-10.53	24.39 **
MRC 1661 X BML14	49.69**	16.03*	-23.26**	-15.06**	-13.08*	56.99 **	44.08 **	-24.74 **	-6.81	-2.67	18.31 *	-6.67	-14.29 *	-26.32 **	2.44

\* Significant at 5% level; \*\* Significant at 1% level

**Table 3. Estimates of heterosis, heterobeltiosis and standard heterosis (over DHM-117, 30 V 92 and 900 M Gold) for ear girth, number of kernel rows per ear and number of kernels per row in maize hybrids**

Cross	Ear girth					Number of kernel rows per ear					Number of kernels per row						
	Heterosis	Hetero beltiosis	Standard heterosis	DHM-117	30 V 92	900 M Gold	Heterosis	Hetero beltiosis	Standard heterosis	DHM-117	30 V 92	900 M Gold	Heterosis	Hetero beltiosis	Standard heterosis	DHM-117	30 V 92
MRC1112 X BML5	20.59 **	0.00	-14.58 **	-6.82	-6.82	37.14 **	14.29 **	0.00	4.35	4.35	28.95 **	-10.91 *	-4.85	-7.55	-2.00		
MRC1112 X BML7	2.86	-12.20 *	-25.00 **	-18.18 **	-18.18 **	33.33 **	14.29 **	0.00	4.35	4.35	43.84 **	-4.55	1.94	-0.94	5.00		
MRC1112 X BML13	27.03 **	14.63 **	-2.08	6.82	6.82	36.11 **	16.67 **	2.08	6.52	6.52	66.43 **	8.18	15.53 **	12.26 *	19.00 **		
MRC1112 X BML14	7.04	-7.32	-20.83 **	-13.64 **	-13.64 **	15.79 **	4.76	-8.33	-4.35	-4.35	22.67 **	-16.36 **	-10.68 *	-13.21 **	-8.00		
MRC 1123 X BML5	35.48 **	20.00 **	-12.50 **	-4.55	-4.55	47.06 **	25.00 **	4.17	8.70	8.70	55.04 **	14.94 *	-2.91	-5.66	0.00		
MRC 1123 X BML7	40.63 **	28.57 **	-6.25	2.27	2.27	40.00 **	22.50 **	2.08	6.52	6.52	77.24 **	25.29 **	5.83	2.83	9.00		
MRC 1123 X BML13	41.18 **	37.14 **	0.00	9.09 *	9.09 *	48.57 **	30.00 **	8.33	13.04 **	13.04 **	86.67 **	28.74 **	8.74	5.66	12.00 *		
MRC 1123 X BML14	38.46 **	28.57 **	-6.25	2.27	2.27	37.84 **	27.50 **	6.25	10.87 *	10.87 *	44.88 **	5.75	-10.68 *	-13.21 **	-8.00		
MRC 1176 X BML5	22.22 **	-2.22	-8.33 *	0.00	0.00	5.13	-18.00 **	-14.58 **	-10.87 *	-10.87 *	40.54 **	-1.89	0.97	-1.89	4.00		
MRC 1176 X BML7	27.03 **	4.44	-2.08	6.82	6.82	25.00 **	0.00	4.17	8.70	8.70	67.61 **	12.26 *	15.53 **	12.26 *	19.00 **		
MRC 1176 X BML13	25.64 **	8.89 *	2.08	11.36 *	11.36 *	22.5 **	-2.00	2.08	6.52	6.52	66.91 **	9.43 *	12.62 *	9.43 *	16.00 **		
MRC 1176 X BML14	9.33 *	-8.89 *	-14.58 **	-6.82	-6.82	-9.52 *	-24.00 **	-20.83 **	-17.39 **	-17.39 **	34.25 **	-7.55	-4.85	-7.55	-2.00		
MRC 1179 X BML5	22.86 **	0.00	-10.42 *	-2.27	-2.27	23.94 **	2.33	-8.33	-4.35	-4.35	44.93 **	4.17	-2.91	-5.66	0.00		
MRC 1179 X BML7	22.22 **	2.33	-8.33 *	0.00	0.00	26.03 **	6.98	-4.17	0.00	0.00	68.18 **	15.63 **	7.77	4.72	11.00 *		
MRC 1179 X BML13	21.05 **	6.98	-4.17	4.55	4.55	31.51 **	11.63 *	0.00	4.35	4.35	76.74 **	18.75 **	10.68 *	7.55	14.00 **		
MRC 1179 X BML14	9.59 *	-6.98	-16.67 **	-9.09 *	-9.09 *	11.69 *	0.00	-10.42 *	-6.52	-6.52	22.06 **	-13.54 *	-19.42 **	-21.70 **	-17.00 **		
MRC 1209 X BML5	33.33 **	21.21 **	-16.67 **	-9.09 *	-9.09 *	27.27 **	10.53	-12.50 **	-8.70	-8.70	68.81 **	37.31 **	-10.68 *	-13.21 **	-8.00		
MRC 1209 X BML7	45.16 **	36.36 **	-6.25	2.27	2.27	20.59 **	7.89	-14.58 **	-10.87 *	-10.87 *	115.53 **	65.67 **	7.77	4.72	11.00 *		
MRC 1209 X BML13	24.24 **	24.24 **	-14.58 **	-6.82	-6.82	29.41 **	15.79 **	-8.33	-4.35	-4.35	104 **	52.24 **	-0.97	-3.77	2.00		
MRC 1209 X BML14	17.46 **	12.12 *	-22.92 **	-15.91 **	-15.91 **	8.33	2.63	-18.75 **	-15.22 **	-15.22 **	79.44 **	43.28 **	-6.80	-9.43 *	-4.00		
MRC 1271 X BML5	36.36 **	15.38 **	-6.25	2.27	2.27	31.34 **	12.82 *	-8.33	-4.35	-4.35	64.52 **	24.39 **	-0.97	-3.77	2.00		
MRC 1271 X BML7	23.53 **	7.69	-12.50 **	-4.55	-4.55	24.64 **	10.26	-10.42 *	-6.52	-6.52	66.1 **	19.51 **	-4.85	-7.55	-2.00		
MRC 1271 X BML13	25.00 **	15.38 **	-6.25	2.27	2.27	27.54 **	12.82 *	-8.33	-4.35	-4.35	75.65 **	23.17 **	-1.94	-4.72	1.00		
MRC 1271 X BML14	21.74 **	7.69	-12.5 **	-4.55	-4.55	12.33 *	5.13	-14.58 **	-10.87 *	-10.87 *	54.1 **	14.63 *	-8.74	-11.32 *	-6.00		
MRC 1358 X BML5	35.48 **	20.00 **	-12.5 **	-4.55	-4.55	34.33 **	15.38 **	-6.25	-2.17	-2.17	44.53 **	4.21	-3.88	-6.60	-1.00		
MRC 1358 X BML7	40.63 **	28.57 **	-6.25	2.27	2.27	30.43 **	15.38 **	-6.25	-2.17	-2.17	69.47 **	16.84 **	7.77	4.72	11.00 *		
MRC 1358 X BML13	35.29 **	31.43 **	-4.17	4.55	4.55	44.93 **	28.21 **	4.17	8.70	8.70	57.81 **	6.32	-1.94	-4.72	1.00		
MRC 1358 X BML14	16.92 **	8.57	-20.83 **	-13.64 **	-13.64 **	12.33 *	5.13	-14.58 **	-10.87 *	-10.87 *	37.78 **	-2.11	-9.71 *	-12.26 *	-7.00		
MRC 1544 X BML5	21.62 **	-4.26	-6.25	2.27	2.27	27.78 **	4.55	-4.17	0.00	0.00	40.00 **	0.00	-4.85	-7.55	-2.00		
MRC 1544 X BML7	21.05 **	-2.13	-4.17	4.55	4.55	35.14 **	13.64 **	4.17	8.70	8.70	49.25 **	2.04	-2.91	-5.66	0.00		
MRC 1544 X BML13	15.00 **	-2.13	-4.17	4.55	4.55	16.22 **	-2.27	-10.42 *	-6.52	-6.52	61.83 **	8.16	2.91	0.00	6.00		
MRC 1544 X BML14	14.29 **	-6.38	-8.33 *	0.00	0.00	10.26 *	-2.27	-10.42 *	-6.52	-6.52	33.33 **	-6.12	-10.68 *	-13.21 **	-8.00		
MRC 1556 X BML5	32.35 **	9.76 *	-6.25	2.27	2.27	37.31 **	17.95 **	-4.17	0.00	0.00	56.83 **	12.37 *	5.83	2.83	9.00		
MRC 1556 X BML7	20.00 **	2.44	-12.5 **	-4.55	-4.55	33.33 **	17.95 **	-4.17	0.00	0.00	69.92 **	16.49 **	9.71 *	6.60	13.00 *		
MRC 1556 X BML13	18.92 **	7.32	-8.33 *	0.00	0.00	27.54 **	12.82 *	-8.33	-4.35	-4.35	55.38 **	4.12	-1.94	-4.72	1.00		
MRC 1556 X BML14	18.31 **	2.44	-12.50 **	-4.55	-4.55	23.29 **	15.38 **	-6.25	-2.17	-2.17	48.91 **	5.15	-0.97	-3.77	2.00		
MRC 1561 X BML5	32.35 **	9.76 *	-6.25	2.27	2.27	26.76 **	4.65	-6.25	-2.17	-2.17	77.44 **	29.67 **	14.56 **	11.32 *	18.00 **		
MRC 1561 X BML7	17.14 **	0.00	-14.58 **	-6.82	-6.82	17.81 **	0.00	-10.42 *	-6.52	-6.52	55.91 **	8.79	-3.88	-6.60	-1.00		
MRC 1561 X BML13	24.32 **	12.20 *	-4.17	4.55	4.55	17.81 **	0.00	-10.42 *	-6.52	-6.52	67.74 **	14.29 *	0.97	-1.89	4.00		
MRC 1561 X BML14	18.31 **	2.44	-12.50 **	-4.55	-4.55	9.09	-2.33	-12.50 **	-8.70	-8.70	70.99 **	23.08 **	8.74	5.66	12.00 *		

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MRC 1564 X BML5	21.74 **	0.00	-12.5 **	-4.55	-4.55	18.92 **	-4.35	-8.33	-4.35	-4.35	55.73 **	14.61 *	-0.97	-3.77	2.00
MRC 1564 X BML7	26.76 **	7.14	-6.25	2.27	2.27	15.79 **	-4.35	-8.33	-4.35	-4.35	45.6 **	2.25	-11.65 *	-14.15 **	-9.00
MRC 1564 X BML13	14.67 **	2.38	-10.42 *	-2.27	-2.27	5.26	-13.04 **	-16.67 **	-13.04 **	-13.04 **	57.38 **	7.87	-6.80	-9.43 *	-4.00
MRC 1564 X BML14	8.33	-7.14	-18.75 **	-11.36 *	-11.36 *	2.50	-10.87 *	-14.58 **	-10.87 *	-10.87 *	48.84 **	7.87	-6.80	-9.43 *	-4.00
MRC 1582 X BML5	29.41 **	7.32	-8.33 *	0.00	0.00	23.94 **	2.33	-8.33	-4.35	-4.35	53.49 **	13.79 *	-3.88	-6.60	-1.00
MRC 1582 X BML7	22.86 **	4.88	-10.42 *	-2.27	-2.27	20.55 **	2.33	-8.33	-4.35	-4.35	49.59 **	5.75	-10.68 *	-13.21 **	-8.00
MRC 1582 X BML13	16.22 **	4.88	-10.42 *	-2.27	-2.27	20.55 **	2.33	-8.33	-4.35	-4.35	80.00 **	24.14 **	4.85	1.89	8.00
MRC 1582 X BML14	15.49 **	0.00	-14.58 **	-6.82	-6.82	6.49	-4.65	-14.58 **	-10.87 *	-10.87 *	46.46 **	6.90	-9.71 *	-12.26 *	-7.00
MRC 1601 X BML5	34.33 **	12.50 *	-6.25	2.27	2.27	38.24 **	17.50 **	-2.08	2.17	2.17	21.99 **	-13.13 *	-16.5 **	-18.87 **	-14.00 **
MRC 1601 X BML7	24.64 **	7.50	-10.42 *	-2.27	-2.27	37.14 **	20.00 **	0.00	4.35	4.35	40.74 **	-4.04	-7.77	-10.38 *	-5.00
MRC 1601 X BML13	12.33 **	2.50	-14.58 **	-6.82	-6.82	28.57 **	12.50 *	-6.25	-2.17	-2.17	40.91 **	-6.06	-9.71 *	-12.26 *	-7.00
MRC 1601 X BML14	20 **	5.00	-12.50 **	-4.55	-4.55	24.32 **	15.00 **	-4.17	0.00	0.00	13.67 *	-20.20 **	-23.30 **	-25.47 **	-21.00 **
MRC 1604 X BML5	29.58 **	4.55	-4.17	4.55	4.55	13.92 **	-11.76 **	-6.25	-2.17	-2.17	92.42 **	41.11 **	23.3 **	19.81 **	27.00 **
MRC 1604 X BML7	31.51 **	9.09 *	0.00	9.09 *	9.09 *	11.11 *	-11.76 **	-6.25	-2.17	-2.17	112.7 **	48.89 **	30.1 **	26.42 **	34.00 **
MRC 1604 X BML13	14.29 **	0.00	-8.33 *	0.00	0.00	-8.64	-27.45 **	-22.92 **	-19.57 **	-19.57 **	69.11 **	15.56 **	0.97	-1.89	4.00
MRC 1604 X BML14	24.32 **	4.55	-4.17	4.55	4.55	12.94 **	-5.88	0.00	4.35	4.35	89.23 **	36.67 **	19.42 **	16.04 **	23.00 **
MRC 1661 X BML5	24.64 **	2.38	-10.42 *	-2.27	-2.27	46.27 **	25.64 **	2.08	6.52	6.52	47.37 **	7.69	-4.85	-7.55	-2.00
MRC 1661 X BML7	26.76 **	7.14	-6.25	2.27	2.27	36.23 **	20.51 **	-2.08	2.17	2.17	38.58 **	-3.30	-14.56 **	-16.98 **	-12.00 *
MRC 1661 X BML13	22.67 **	9.52 *	-4.17	4.55	4.55	27.54 **	12.82 *	-8.33	-4.35	-4.35	53.23 **	4.40	-7.77	-10.38 *	-5.00
MRC 1661 X BML14	11.11 *	-4.76	-16.67 **	-9.09 *	-9.09 *	26.03 **	17.95 **	-4.17	0.00	0.00	40.46 **	1.10	-10.68 *	-13.21 **	-8.00

Table 4. Estimates of heterosis, heterobeltiosis and standard heterosis (over DHM-117, 30 V 92 and 900 M Gold) for 100 seed weight and grain yield per plant in maize hybrids

Cross	100 seed weight					Grain yield per plant				
	Heterosis	Hetero beltiosis	Standard heterosis			Heterosis	Hetero beltiosis	Standard heterosis		
			DHM-117	30 V 92	900 M Gold			DHM-117	30 V 92	900 M Gold
MRC1112 X BML5	-2.53	-18.95 **	-6.10	-6.10	4.05	42.06 **	-3.50	-7.97	-3.76	4.07
MRC1112 X BML7	-6.36	-14.74 **	-1.22	-1.22	9.46 *	66.6 **	16.98 **	11.57 **	16.67 **	26.16 **
MRC1112 X BML13	-0.58	-10.53 **	3.66	3.66	14.86 **	94.21 **	26.68 **	20.82 **	26.34 **	36.63 **
MRC1112 X BML14	-10.13 **	-25.26 **	-13.41 **	-13.41 **	-4.05	45.17 **	-0.81	-5.40	-1.08	6.98
MRC 1123 X BML5	9.09 *	-7.69 *	2.44	2.44	13.51 **	82.07 **	31.13 **	1.80	6.45	15.12 **
MRC 1123 X BML7	8.88 **	1.10	12.20 **	12.20 **	24.32 **	95.58 **	46.36 **	13.62 **	18.82 **	28.49 **
MRC 1123 X BML13	19.76 **	9.89 **	21.95 **	21.95 **	35.14 **	143.37 **	67.22 **	29.82 **	35.75 **	46.80 **
MRC 1123 X BML14	3.90	-12.09 **	-2.44	-2.44	8.11	105.94 **	49.34 **	15.94 **	21.24 **	31.10 **
MRC 1176 X BML5	-14.45 **	-32.73 **	-9.76 *	-9.76 *	0.00	29.73 **	-12.73 **	-13.62 **	-9.68 *	-2.33
MRC 1176 X BML7	-3.19	-17.27 **	10.98 **	10.98 **	22.97 **	67.10 **	16.10 **	14.91 **	20.16 **	29.94 **
MRC 1176 X BML13	2.15	-13.64 **	15.85 **	15.85 **	28.38 **	97.59 **	27.79 **	26.48 **	32.26 **	43.02 **
MRC 1176 X BML14	-21.39 **	-38.18 **	-17.07 **	-17.07 **	-8.11	29.75 **	-12.21 **	-13.11 **	-9.14 *	-1.74
MRC 1179 X BML5	-12.05 **	-29.13 **	-10.98 **	-10.98 **	-1.35	24.11 **	-15.82 **	-19.28 **	-15.59 **	-8.72
MRC 1179 X BML7	-14.92 **	-25.24 **	-6.10	-6.10	4.05	38.05 **	-3.22	-7.20	-2.96	4.94
MRC 1179 X BML13	-9.50 **	-21.36 **	-1.22	-1.22	9.46 *	66.26 **	8.31	3.86	8.60	17.44 **
MRC 1179 X BML14	-18.07 **	-33.98 **	-17.07 **	-17.07 **	-8.11	22.59 **	-16.35 **	-19.79 **	-16.13 **	-9.30
MRC 1209 X BML5	7.69 *	-9.68 **	2.44	2.44	13.51 **	78.16 **	32.96 **	-7.71	-3.49	4.36
MRC 1209 X BML7	-12.28 **	-19.35 **	-8.54 *	-8.54 *	1.35	73.81 **	35.19 **	-6.17	-1.88	6.10
MRC 1209 X BML13	-1.78	-10.75 **	1.22	1.22	12.16 **	115.14 **	52.59 **	5.91	10.75 *	19.77 **
MRC 1209 X BML14	0.00	-16.13 **	-4.88	-4.88	5.41	76.85 **	32.96 **	-7.71	-3.49	4.36
MRC 1271 X BML5	19.73 **	4.76	7.32	7.32	18.92 **	71.01 **	27.01 **	-10.54 *	-6.45	1.16
MRC 1271 X BML7	2.47	-1.19	1.22	1.22	12.16 **	74.06 **	34.67 **	-5.14	-0.81	7.27

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MRC 1271 X BML13	13.75 **	8.33 *	10.98 **	10.98 **	22.97 **	111.89 **	49.64 **	5.40	10.22 *	19.19 **
MRC 1271 X BML14	11.56 **	-2.38	0.00	0.00	10.81 *	69.76 **	27.01 **	-10.54 *	-6.45	1.16
MRC 1358 X BML5	16.42 **	9.86 *	-4.88	-4.88	5.41	102.14 **	57.08 **	-3.08	1.34	9.59
MRC 1358 X BML7	14.09 **	8.97 *	3.66	3.66	14.86 **	105.64 **	67.08 **	3.08	7.80	16.57 **
MRC 1358 X BML13	31.97 **	27.63 **	18.29 **	18.29 **	31.08 **	178.75 **	105.00 **	26.48 **	32.26 **	43.02 **
MRC 1358 X BML14	7.46	1.41	-12.20 **	-12.2 **	-2.70	101.06 **	57.50 **	-2.83	1.61	9.88 *
MRC 1544 X BML5	-10.11 **	-30.43 **	-2.44	-2.44	8.11	49.03 **	0.26	-0.77	3.76	12.21 *
MRC 1544 X BML7	-9.84 **	-24.35 **	6.10	6.10	17.57 **	66.73 **	15.84 **	14.65 **	19.89 **	29.65 **
MRC 1544 X BML13	-8.9 **	-24.35 **	6.10	6.10	17.57 **	62.65 **	5.19	4.11	8.87	17.73 **
MRC 1544 X BML14	-16.85 **	-35.65 **	-9.76 *	-9.76 *	0.00	48.18 **	0.26	-0.77	3.76	12.21 *
MRC 1556 X BML5	-2.96	-22.64 **	0.00	0.00	10.81 *	45.82 **	-0.81	-5.91	-1.61	6.40
MRC 1556 X BML7	-21.74 **	-32.08 **	-12.20 **	-12.20 **	-2.70	51.45 **	6.50	1.03	5.65	14.24 **
MRC 1556 X BML13	-17.58 **	-29.25 **	-8.54 *	-8.54 *	1.35	41.08 **	-7.86	-12.6 **	-8.60	-1.16
MRC 1556 X BML14	-11.24 **	-29.25 **	-8.54 *	-8.54 *	1.35	45.35 **	-0.54	-5.66	-1.34	6.69
MRC 1561 X BML5	-5.39	-24.04 **	-3.66	-3.66	6.76	61.51 **	9.70 *	4.63	9.41 *	18.31 **
MRC 1561 X BML7	-13.19 **	-24.04 **	-3.66	-3.66	6.76	23.22 **	-13.48 **	-17.48 **	-13.71 **	-6.69
MRC 1561 X BML13	-5.56	-18.27 **	3.66	3.66	14.86 **	59.5 **	4.04	-0.77	3.76	12.21 *
MRC 1561 X BML14	-11.38 **	-28.85 **	-9.76 *	-9.76 *	0.00	60.55 **	9.70 *	4.63	9.41 *	18.31 **
MRC 1564 X BML5	4.76	-16.19 **	7.32	7.32	18.92 **	42.46 **	-3.23	-7.71	-3.49	4.36
MRC 1564 X BML7	4.92	-8.57 **	17.07 **	17.07 **	29.73 **	36.28 **	-4.31	-8.74 *	-4.57	3.20
MRC 1564 X BML13	-3.87	-17.14 **	6.10	6.10	17.57 **	35.95 **	-11.32 *	-15.42 **	-11.56 *	-4.36
MRC 1564 X BML14	-2.38	-21.9 **	0.00	0.00	10.81 *	41.62 **	-3.23	-7.71	-3.49	4.36
MRC 1582 X BML5	-8.29 **	-29.66 **	1.22	1.22	12.16 **	49.31 **	1.06	-2.31	2.15	10.47 *
MRC 1582 X BML7	-18.37 **	-32.2 **	-2.44	-2.44	8.11	31.94 **	-7.71	-10.8 *	-6.72	0.87
MRC 1582 X BML13	-8.25 **	-24.58 **	8.54 *	8.54 *	20.27 **	76.28 **	14.63 **	10.8 *	15.86 **	25.29 **
MRC 1582 X BML14	-14.92 **	-34.75 **	-6.10	-6.10	4.05	48.83 **	1.33	-2.06	2.42	10.76 *
MRC 1601 X BML5	3.95	-11.24 **	-3.66	-3.66	6.76	50.64 **	5.04	-9.00 *	-4.84	2.91
MRC 1601 X BML7	-1.80	-7.87 *	0.00	0.00	10.81 *	63.04 **	17.80 **	2.06	6.72	15.41 **
MRC 1601 X BML13	0.61	-6.74	1.22	1.22	12.16 **	64.44 **	9.79	-4.88	-0.54	7.56
MRC 1601 X BML14	-3.95	-17.98 **	-10.98 **	-10.98 **	-1.35	49.68 **	5.04	-9.00 *	-4.84	2.91
MRC 1604 X BML5	4.76	-16.19 **	7.32	7.32	18.92 **	91.41 **	29.29 **	25.96 **	31.72 **	42.44 **
MRC 1604 X BML7	-1.64	-14.29 **	9.76 *	9.76 *	21.62 **	77.32 **	23.75 **	20.57 **	26.08 **	36.34 **
MRC 1604 X BML13	-8.29 **	-20.95 **	1.22	1.22	12.16 **	41.87 **	-7.92	-10.28 *	-6.18	1.45
MRC 1604 X BML14	-2.38	-21.90 **	0.00	0.00	10.81 *	82.52 **	24.01 **	20.82 **	26.34 **	36.63 **
MRC 1661 X BML5	3.85	-12.90 **	-1.22	-1.22	9.46 *	64.45 **	14.97 **	-1.29	3.23	11.63 *
MRC 1661 X BML7	-8.77 **	-16.13 **	-4.88	-4.88	5.41	50.41 **	8.98	-6.43	-2.15	5.81
MRC 1661 X BML13	0.59	-8.60 *	3.66	3.66	14.86 **	76.29 **	17.96 **	1.29	5.91	14.53 **
MRC 1661 X BML14	-5.13	-20.43 **	-9.76 *	-9.76 *	0.00	62.98 **	14.67 **	-1.54	2.96	11.34 *

\* Significant at 5% level; \*\* Significant at 1% level

The relative heterosis for days to 50 per cent silking ranged from -10.40 to 7.55 per cent while the heterobeltiosis ranged from -15.76 to 5.23 per cent. The standard heterosis over DHM-117, 30 V 92 and 900 M Gold ranged from -15.30 to 3.28 per cent, -18.42 to -0.53 per cent and -19.69 to -2.07 per cent, respectively. Relative heterosis for days to maturity ranged from -8.05 to 7.90 per cent, heterobeltiosis from -14.33 to -2.74 per cent and standard heterosis over DHM-117, 30 V 92 and 900 M Gold ranged from -7.22 to 2.53 per cent, -10.76 to -1.39 and -7.89 per cent to 1.79 per cent, respectively. Days to 50 per cent tasseling, days to 50 per cent silking and days to maturity indicate the earliness of a genotype. Earliness is a desirable character as it useful in multiple cropping and increases water and land use efficiency. Heterosis for earliness in maize was reported by Sadaiah *et al.* (2013) and Tajwar Izhar and Chakraborty (2013). Relative heterosis for plant height varied from 10.99 to 102.98 per cent, heterobeltiosis from -1.45 to 61.89 and standard heterosis from -35.44 to 7.75 per cent, -28.55 to 19.26 per cent and -26.88 to 22.04 per cent over DHM 117, 30 V 92 and 900 M Gold, respectively. Relative heterosis and heterobeltiosis for ear height and ear length was found to be positively significant in most of the crosses. The present results were comparable with the findings of Sadaiah *et al.* (2013), Tajwar Izhar and Chakraborty (2013), Rajesh *et al.* (2014) and Preeti Sharma *et al.* (2015). Among 60 hybrids studied, 57 hybrids for relative heterosis, 21 for heterobeltiosis, none of the hybrid for standard heterosis over DHM-117, three hybrids each for standard heterosis over 30 V 92 and 900 M Gold recorded significant positive values for ear girth. Number of kernel rows per ear showed relative heterosis values from -9.52 (MRC 1176 X BML 14) to 48.57 per cent (MRC 1123 X BML 13) and heterobeltiosis from -27.45 (MRC 1604 X BML 13) to 30.00 per cent (MRC 1123 X BML 13). The standard heterosis over DHM-117 ranged from -22.92 (MRC 1604 X BML 13) to 8.33 per cent (MRC 1123 X BML 13), over 30 V 92 from -19.57 (MRC 1604 X BML 13) to 13.04 per cent (MRC 1123 X BML 13) and -19.57 (MRC 1604 X BML 13) to 13.04 (MRC 1123 X BML 13) over 900 M Gold. Heterosis for number of kernels per row varied from 13.67 (MRC 1601 X BML 14) to 115.53 per cent (MRC 1209 X BML 7), heterobeltiosis from -20.20 (MRC 1601 X BML 14) to 65.67 per cent (MRC 1209 X BML 7). Standard heterosis over DHM-117 ranged from -23.30 (MRC 1601 X BML 14) to 30.10 per cent (MRC 1604 X BML 7), over 30 V 92 from -25.47 (MRC 1601 X BML 14) to 26.42 per cent (MRC 1604 X BML 7) and over 900 M Gold from -21.00 (MRC 1601 X BML 14) to 34.00 (MRC 1604 X BML 7). Heterosis estimation for number of kernels per row had also been conducted by Netra Hiremath *et al.* (2013), Rajesh *et al.* (2014) and Preeti Sharma *et al.* (2015) who reported significant positive heterosis for number of kernels per row. For 100-seed weight, majority of the hybrids showed significant and positive relative heterosis and heterobeltiosis with range of relative heterosis from -21.74 to 31.97 per cent and heterobeltiosis from -38.18 to 27.63 per cent and standard heterosis from -17.07 to 21.95 per cent over DHM-117, from -17.07 to 21.95 per cent over 30 V 92 and -8.11 to 35.14 over 900 M Gold, respectively. The above results are in agreement with the findings of Rajitha *et al.* (2014) and Preeti Sharma *et al.* (2015) who reported significant positive heterosis for 100-seed weight.

Most of the hybrids exhibited significant positive relative heterosis and heterobeltiosis for grain yield per plant. Relative heterosis varied from 22.59 (MRC 1179 X BML 14) to 178.75 per cent (MRC 1358 X BML 13), heterobeltiosis from -16.35 (MRC 1179 X BML 14) to 105 per cent (MRC 1358 X BML 13) and standard heterosis from -19.79 (MRC 1179 X BML 14) to 29.82 per cent (MRC 1123 X BML 13) over DHM-117, -16.13 (MRC 1179 X BML 14) to 35.75 per cent (MRC 1123 X BML 13) over 30 V 92 and from -9.30 (MRC 1179 X BML 14) to 46.80 per cent (MRC 1123 X BML 13) over 900 M Gold. Significant positive heterosis grain yield per plant was also reported by Sandeep Kumar and Mohan Reddy (2013), Rajesh *et al.* (2014) and Preeti Sharma *et al.* (2015). Estimates of relative heterosis, heterobeltiosis and standard heterosis were variable among crosses in desirable direction and some of them turned out to be best specific crosses. Heterosis for grain yield per plant is mainly because of simultaneous manifestation of heterosis for yield component traits. The highest standard heterosis for grain yield per plant was recorded for hybrids, MRC 1123 X BML 13, MRC 1358 X BML 13, MRC 1123 X BML 14, MRC 1123 X BML 7 and MRC 1176 X BML 7 along with *per se*, average heterosis, heterobeltiosis and with high *sca* effects. These hybrids may be further exploited in multilocation evaluation before releasing them for commercial cultivation.

## REFERENCES

- Fonseca, S and F.L. Patterson.1968: Hybrid vigour in a seven parent diallel cross in common winter wheat (*Triticum aestivum* L.). *Crop Sci.* 8:85-88.
- Netra Hiremath. 2013: Heterosis breeding for maturity, yield and quality characters in maize (*Zea mays* L.), *Mole. Pl. Br.* 4: 44-49.
- Preeti Sharma, M. S. Punia And M. C. Kamboj. 2015: Estimates of heritability, heterosis and inbreeding depression for yield and quality traits in maize. *Forage Res.*, 41 : 139-146.
- Rajesh, V., S. Sudheer Kumar, V. Narsimha Reddy A. and Siva sankar. 2014: Heterosis studies for grain yield and its component traits in single cross hybrids of maize (*Zea mays* L.). *Intl. J. Pl., Ani. and Env. Sc.* 4:304-306.
- Rajitha, A., D. Ratna Babu, M. Lal Ahamed and V. Srinivasa Rao. 2014: Heterosis and combining ability for grain yield and yield component traits in maize (*Zea mays* L.). *Elec. J. Pl. Br.* 5: 378-384.
- Sadaiah, K., V. Narsimha Reddy and S. Sudheer Kumar. 2013: Heterosis and combining ability studies for sugar content in sweet corn (*Zea mays saccharata* L.). *Intl. J. Sc. and Res. Pub.* 3: 1-5.
- Sandeep Kumar, T and. D.Mohan Reddy. 2013: Heterosis and combining ability estimates for yield and yield components in maize (*Zea mays* L.). *Intl. J. of Biotech. and Bioengg. Res.* 4: 509-510.
- Tajwar Izhar and M. Chakraborty. 2013: Combining ability and heterosis for grain yield and its components in maize inbreds over environments (*Zea mays* L.). *Afr. J. of Ag. Res.*8: 3276-3280.
- Virmani, S.S., R.O. Aquino and G.S. Khush., 1982: Heterosis breeding in rice (*Oryza sativa* L.). *Theo. and App. Gene.* 63: 373-380.