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COMBINING ABILITY STUDIES FOR YIELD AND ITS ATTRIBUTING CHARACTERS IN MAIZE (*ZEA MAYS* L.) OVER ENVIRONMENTS

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ABSTRACT
Combining ability analysis was carried out in maize using 60 experimental hybrids, 19 parents and 3 standard checks. It was found that *sca* variances were higher than *gca* variances indicating the predominance of non-additive gene action. The parents, MRC 1123, MRC 1176 and BML 13 were adjudged as good general combiners as they recorded significant positive *gca* effects for grain yield and other yield contributing traits. In case of hybrids, MRC 1176 X BML 7, MRC 1358 X BML 13, MRC 1556 X BML 14, MRC 1561 X BML 5, MRC 1564 X BML 7, MRC 1179 X BML 13, MRC 1604 X BML 5, MRC 1604 X BML 14, MRC 1123 X BML 13 and MRC 1176 X BML 13 recorded positively significant *sca* effects for grain yield and yield contributing characters. These crosses may directly be used for commercial cultivation after further testing over a range of environments.

KEY WORDS: maize, line x tester, combining ability.

INTRODUCTION
Maize is known as Queen of cereals because of its highest yield potential and wider adaptability. In India, maize is the third important cereal crop after rice and wheat. It is mainly grown in Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh, Punjab, Karnataka and Andhra Pradesh. At national level it has occupied with an area of 8.67 million hectares, production of 22.260 million tonnes and of productivity 2566.50 kg/ha. In Andhra Pradesh, maize occupies an area of 0.9 million hectares with a production of 4.8 million tonnes at an average productivity of 4994.90 kg/ha (CMIE, 2013).

Besides, identification of favourable alleles in the inbreds, the information on combining ability is a pre-requisite for development of superior hybrids, since it helps in the identification of superior parents with better *gca* and crosses with high *sca* effects. 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 commercial production of hybrids however, depends upon two factors *viz.*, the behavior of the line itself and the behavior of line in hybrid combination. The behavior of a line in hybrid combination is assessed through the estimation of general combining ability (*gca*) and specific combining ability (*sca*) effects.

MATERIAL & METHODS
The experiment was carried out at Agricultural Research Station Madhira during *rabi*, 2012-13. Selected 15 diverse inbred lines were crossed with 4 testers in line x tester (L x T) mating design to obtain 60 cross combinations. During *kharif 2013*, a 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 over three locations *viz*., Agricultural Research Station, Madhira, Khammam district, Agricultural Research Station, Tandur, Ranga Reddy district and Regional Agricultural Research Station, Warangal. Each entry was sown in a row of 5 m 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^{-1}. The entire P and K and half dose of nitrogen was applied as basal, while remaining half dose of N in two equal split doses at knee height and tasseling stages. Intercultural operations like weeding and irrigation schedules were followed. Necessary plant protection measures were taken to protect the crop from pests and diseases so as to raise a healthy crop.

Observations on 11 different quantitative characters viz., days to 50 per cent tasseling, days to 50 per cent silking, days to maturity, plant height (cm), ear height (cm), ear length (cm), ear girth (cm), number of kernel rows per ear, number of kernels per row, 100- seed weight (g), and grain yield per plant (g) were recorded on five random plants except for days to 50 per cent tasseling, days to 50 per cent silking and days to maturity. Estimates of combining ability variances and effects were obtained using line x tester method suggested by Kempthorne (1957).

RESULTS & DISCUSSION
The pooled analysis for combining ability over three locations revealed significant difference for locations for all the characters (Table 1). The differences among the parents, parents *vs* hybrids and hybrids were significant for all the characters studied. The estimates of GCA and SCA

variances and their ratios are presented in the Table 2. In the present investigation, it was found that *sca* variances were higher than *gca* variances indicating the predominance of non-additive gene action.

For days to 50 per cent tasseling, the parents, MRC 1271, MRC 1544, MRC 1556 and BML 14 which recorded significant negative *gca* effects were good general combiners for earliness, whereas the hybrids MRC 1123 X BML 7, MRC 1179 X BML 13, MRC 1209 X BML 13, MRC 1604 X BML 5 and MRC 1661 X BML 13 are good specific combiners for days to 50 per cent tasseling. These results were comparable with findings of Hemalatha *et al*. (2013) and Aminu *et al*. (2014a) who reported the non additive gene action for days to 50 per cent tasseling. For days to 50 per cent silking, parents MRC 1176, BML 7 and BML 13 were poor combiners with significant positive *gca* effects revealing their contribution for late maturity. The parents MRC 1271, MRC 1544 and BML 14 which recorded negative significant *gca* effects and were good general combiners for earliness. None of the hybrid exhibited significant negative *sca* effects at all locations. The best specific crosses for days to maturity were MRC 1271 X BML 7, MRC 1556 X BML 5, MRC 1556 X BML 14, MRC 1561 X BML 7, MRC 1564 X BML 7 and MRC 1661 X BML 13 which expressed significant negative effects. These results agree with the findings of Ram Reddy *et al.* (2011) who reported the non additive gene action for days to maturity.

For plant height (cm), MRC 1561, MRC 1604, BML 7 and BML 13 were found as good general combiners, while the other parents which recorded negative significant *gca* effects contributed for dwarfness. For ear height (cm), the parents, MRC 1176, MRC 1561, MRC 1604, BML 7 and BML 13 recorded significant positive *gca* effects over locations indicating that these are good general combiners for ear height. These results are comparable with the findings of Kumar *et al.* (2012) and Ajay Singh *et al*. (2013) who reported additive gene action for ear height.

The parents MRC 1112, MRC 1123, MRC 1601 and BML 7 recorded significant positive *gca* effects for number of kernel rows per ear. The best specific crosses were MRC 1123 X BML 14, MRC 1176 X BML 7, MRC 1176 X BML 13, MRC 1209 X BML 13, MRC 1358 X BML 13, MRC 1544 X BML 7, MRC 1556 X BML 5, MRC 1556 X BML 14 and MRC 1604 X BML 14 for this trait. For number of kernels per row, MRC 1123, MRC 1176, MRC 1209, MRC 1556, MRC 1561, MRC 1604, BML 7 and BML 13 were found as best combiners with superior significant positive *gca* effects, while the best specific crosses were MRC 1123 X BML 13, MRC 1179 X BML 13, MRC 1209 X BML 7, MRC 1358 X BML 13, MRC 1561 X BML 5, MRC 1561 X BML 14 and MRC 1604 X BML 7.

The parents MRC 1123, MRC 1271, MRC 1358, MRC 1564, MRC 1582, MRC 1604, BML 7 and BML 13 in pooled analysis exhibited significant positive *gca* effects indicating that they are good general combiners for 100-seed weight. These results are comparable with findings of Kumar *et al.* (2012) and Gowda *et al*. (2013) who reported the additive gene action for 100-seed weight. The best specific crosses were MRC 1176 X BML 7, MRC 1176 X BML 13, MRC 1179 X BML 13, MRC 1209 X BML 5, MRC 1209 X BML 14, MRC 1358 X BML 13, MRC 1556 X BML 5, MRC 1556 X BML 14, MRC 1561 X BML 5, MRC 1561 X BML 14, MRC 1564 X BML 7, MRC 1601 X BML 13, MRC 1604 X BML 5 and MRC 1604 X BML 14. These results are comparable with findings of Abrha *et al*. (2013) and Lahane *et al*. (2014) who reported non additive gene action for 100-seed weight.

Among the parents, MRC 1123, MRC 1604 and BML 13 at all the three locations recorded significant positive *gca* effects for grain yield per plant. Rest of the parents showed either non significant or negative *gca* effect**.** The best specific crosses for grain yield per plant were MRC 1176 X BML 7, MRC 1358 X BML 13 and MRC 1561 X BML 5. These results are comparable with the findings of Kumar *et al*. (2012), Abrha *et al*. (2013) and Lahane *et al*. (2014) who reported the non additive gene action for grain yield per plant.

In maize the inbreds which show good GCA can be utilized in the development of hybrids, synthetics and composites. In the present study, MRC 1123, MRC 1604 and BML 13 at three locations and in pooled analysis were good combiners for grain yield per plant and hence can be used for the development of hybrids, synthetics and composites. The hybrids viz., MRC 1176 X BML 7, MRC 1358 X BML 13, MRC 1556 X BML 14, MRC 1561 X BML 5, MRC 1564 X BML 7, MRC 1179 X BML 13, MRC 1604 X BML 5, MRC 1604 X BML 14, MRC 1123 X BML 13 and MRC 1176 X BML 13 which recorded positively significant *sca* effects for grain yield and yield contributing characters considered as good specific combiners can be recommended for heterosis breeding.

TABLE 1: Pooled analysis of variance for combining ability (L X T) for yield and yield components in maize

Source of variation	d.f.	Days to 50% tasseling	Days to 50% silking	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth (cm)	Number of kernel rows per ear	Number of kernels per row	100- Seed weight	Grain yield per plant
Replicates	2.00	0.12	0.56	0.21	29.20	4.52	0.92	0.11	0.07	1.99	0.46	1.60
Location	2.00	1541.10**	1521.11**	3132.85**	23332.30**	10053.74**	39.42**	5.42**	7.52**	278.45**	16.73**	1512.31**
Rep x Location.	4.00	0.07	0.43	0.80	25.38	0.55	0.06	0.18	0.11	0.20	0.59	5.45
Treatments	78.00	71.49**	71.67**	92.25**	6132.63**	3043.44**	36.20**	19.89**	26.03**	304.71**	107.08**	5052.91**
Parents	18.00	144.64**	141.86**	295.16**	5020.01**	1512.10**	58.29**	31.99**	38.88**	530.37**	269.20**	9400.21**
Parents (Line)	14.00	80.39**	78.48**	185.00**	1452.50**	1118.34**	16.80**	15.55**	16.24**	102.42**	154.62**	2320.77**
Parents(Testers)	3.00	73.00**	71.74**	44.63**	6310.30**	1032.25**	12.03**	6.10**	5.67**	13.85*	55.58**	287.44**
Parents (L vs T)	1.00	1258.95**	1239.41**	2589.06**	51094.23**	8464.30**	777.84**	339.74**	455.58**	8071.15**	2514.25**	135850.64**
Parent vs Crosses	1.00	440.61**	536.70**	75.25**	278747.19**	111578.13**	991.10**	658.62**	844.70**	9292.76**	950.33**	131727.97**
Crosses	59.00	42.92**	42.37**	30.64**	1851.48**	1671.06**	13.28**	5.37**	8.23**	83.53**	43.33**	1579.58**
Line effect	14.00	52.64**	54.28**	31.86**	3584.93**	3128.88**	21.82**	7.35**	20.42**	198.48**	66.38**	3354.46**
Tester effect	3.00	483.34**	475.99**	364.53**	8444.25**	10459.86**	96.55**	42.11**	24.68**	289.20**	308.79**	3332.53*
Line x Tester effect	42.00	8.22**	7.43**	6.38**	802.76**	557.34**	4.48**	2.08**	2.99**	30.52**	16.68**	862.74**
Location x Treatment	156.00	7.99**	7.59**	30.02**	493.57**	273.06**	4.16**	2.04**	1.86**	13.47**	2.99**	293.39**
Location x Parents	36.00	1.34	1.38	24.74**	4.63	0.75	0.47	0.58	0.21	1.46	0.15	10.16
Location x Parents (L)	28.00	1.13	1.12	13.68**	3.02	0.94	0.18	0.59	0.18	0.11	0.02	9.76
Location x Parents (T)	6.00	2.22	2.52	15.63**	13.38	0.03	1.14	0.10	0.31	0.21	0.47	13.00
Location x Parents (L vs T)	2.00	1.69	1.60	206.83**	0.90	0.25	2.43	1.78	0.45	24.21**	1.07	7.20
Location x Parent vs Cross	2.00	302.33**	272.76**	1142.67**	9478.05**	5286.68**	24.19**	10.82**	51.36**	66.33**	35.60**	546.53**
Location x Crosses	118.00	5.03**	4.99**	12.77**	490.46**	271.16**	4.95**	2.33**	1.52**	16.23**	3.31**	375.51**
Location x Line effect	28.00	4.71	6.38	27.13**	674.47*	417.80*	7.67**	3.83**	1.99	30.99**	3.95	625.44**
Location x Tester effect	6.00	16.96**	11.84*	28.82**	791.52	184.15	10.00*	2.54	1.16	9.39	2.62	52.29
Location x L x T effect	84.00	4.29**	4.04**	6.84**	407.62**	228.49**	3.68**	1.82**	1.40**	11.80**	3.14**	315.28**
Error	468.00	1.84	1.98	3.78	95.11	42.45	1.39	0.81	0.58	4.38	1.34	58.63

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

TABLE 2: Estimates of general and specific combining ability variances and proportionate gene action in maize for 11 characters pooled over locations

Character	Source of variation		
	$\pm^2$ *gca*	$\pm^2$ *sca*	$\pm^2$ *gca*/ $\pm^2$ *sca*
Days to 50% tasseling	0.13	1.25	0.11
Days to 50% silking	0.14	1.06	0.13
Days to maturity	0.13	0.96	0.14
Plant height (cm)	4.63	148.07	0.03
Ear height (cm)	4.57	98.55	0.04
Ear length (cm)	0.04	0.85	0.05
Ear girth (cm)	0.01	0.36	0.04
Number of kernel rows per ear	0.02	0.44	0.04
Number of kernels per row	0.23	4.55	0.05
100 - seed weight (g)	0.10	2.10	0.04
Grain yield per plant (g)	3.19	146.37	0.02

TABLE 3: Estimates of general and specific combining ability in maize for 11 characters pooled over locations

Parents	Days to 50 percent tasseling	Days to 50 percent silking	Days to maturity	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear girth	Number of kernel rows per ear	Number of kernels per row	100-seed weight (g)	Grain yield per plant (g)
MRC1112	-0.62**	-0.75**	-0.31	-8.05**	-3.96**	0.94**	-0.20	0.65**	0.51	-1.33**	0.87
MRC 1123	1.04**	0.99**	0.54*	3.58*	2.28	1.88**	1.18**	1.48**	2.01**	2.97**	25.95**
MRC 1176	2.20**	2.30**	0.57*	16.67**	21.12**	0.52*	0.51**	-0.48**	2.73**	-0.22	5.57**
MRC 1179	0.31	0.21	0.24	-10.32**	-8.24**	-0.42*	-0.06	0.31**	0.20	-1.80**	-11.23**
MRC 1209	0.29	0.32	-0.89**	-5.91**	-4.18**	0.35	-0.14	-0.62**	0.93*	-0.49**	-0.54
MRC 1271	-1.37**	-1.39**	-1.25**	7.19**	-0.76	-0.22	-0.03	-0.43**	-1.15**	1.30**	-0.48
MRC 1358	0.40	0.16	-0.87**	11.05**	-1.12	0.07	-0.25	-0.15	-0.26	0.39*	1.20
MRC 1544	-2.98**	-2.94**	-1.64**	-7.60**	-3.93**	-0.25	-0.31*	0.26*	-1.54**	-0.13	-0.87
MRC 1556	-1.12**	-1.05**	-0.50	-3.35	-5.71**	-0.64**	0.24	0.48**	1.01**	-2.02**	-3.70*
MRC 1561	0.84**	0.94**	0.87**	11.33**	14.34**	0.16	0.29*	-0.32**	3.79**	-0.30	3.95**
MRC 1564	-0.01	0.32	-0.09	-8.32**	-8.12**	-0.80**	-0.53**	-1.01**	-0.51	0.94**	-7.20**
MRC 1582	0.17	0.10	1.01**	-4.69**	-9.71**	-0.11	-0.70**	-0.96**	-2.73**	0.75**	-11.90**
MRC 1601	0.59**	0.82**	1.82**	-13.30**	-6.68**	-1.11**	-0.09	1.17**	-3.76**	-1.08**	-6.20**
MRC 1604	0.65**	0.52*	-0.06	15.55**	14.25**	0.49*	0.10	-0.71**	2.73**	1.61**	12.23**
MRC 1661	-0.40	-0.58*	0.57*	-3.82*	0.45	-0.86**	0.01	0.34**	-3.98**	-0.58**	-7.65**
SE (i)	0.2281	0.2362	0.2682	1.7930	1.2296	0.2110	0.1497	0.1217	0.3768	0.1879	1.4327
BML 5	-0.55**	-0.55**	-0.21	-4.58**	-5.25**	0.19	0.05	0.34**	-0.05	-0.15	-3.92**
BML 7	1.47**	1.44**	1.29**	7.41**	9.03**	-0.52**	0.35**	0.35**	0.77**	0.35**	0.98
BML 13	1.52**	1.53**	1.16**	5.92**	5.72**	1.10**	0.40**	-0.18**	1.30**	1.72**	6.63**
BML 14	-2.44**	-2.41**	-2.24**	-8.75**	-9.50**	-0.77**	-0.80**	-0.51**	-2.02**	-1.92**	-3.69**
SE (j)	0.1178	0.1220	0.1385	0.9259	0.6350	0.1090	0.0773	0.0629	0.1946	0.0970	0.7398
Crosses											
MRC1112 X BML5	-0.78	-0.83	-0.44	6.50	4.53	0.17	0.41	0.12	-0.55	0.56	-1.43
MRC1112 X BML7	0.52	0.27	1.04	-0.49	2.02	0.21	-0.43	-0.22	0.61	-0.93*	1.98
MRC1112 X BML13	1.14*	1.19*	-0.16	-11.67**	-10.00**	-0.52	-0.04	0.32	0.75	-0.20	0.22
MRC1112 X BML14	-0.89	-0.63	-0.42	5.66	3.45	0.14	0.05	-0.23	-0.80	0.56	-0.77
MRC 1123 X BML5	0.21	0.19	0.24	-5.02	-11.38**	0.22	-0.41	0.18	-1.17	-1.29**	-7.18*
MRC 1123 X BML7	-1.24**	-1.02*	0.51	-7.24*	2.43	-1.06*	-0.48	-0.72**	0.33	0.53	-3.21
MRC 1123 X BML13	0.70	0.55	-1.02	8.46*	10.29**	0.30	0.12	0.05	1.91*	0.49	8.58**
MRC 1123 X BML14	0.32	0.27	0.26	3.80	-1.35	0.52	0.77**	0.48*	-1.08	0.26	1.80
MRC 1176 X BML5	0.27	0.33	-0.44	-11.88**	-13.55**	-0.85*	-0.41	-0.84**	-0.78	-1.98**	-12.12**
MRC 1176 X BML7	0.14	-0.10	0.37	19.89**	29.60**	1.40**	0.62*	0.91**	1.27	2.84**	16.40**
MRC 1176 X BML13	-0.57	-0.42	0.83	4.71	-2.75	0.33	0.34	0.91**	0.30	1.35**	7.86**
MRC 1176 X BML14	0.16	0.19	-0.75	-12.72**	-13.29**	-0.88*	-0.55	-0.98**	-0.80	-2.20**	-12.14**
MRC 1179 X BML5	0.49	0.52	-0.00	6.78	1.47	-0.02	-0.27	-0.42	0.07	-0.51	-5.65*
MRC 1179 X BML7	0.02	-0.13	0.37	7.55*	4.41	-0.75	0.09	0.33	-0.97	0.20	4.87
MRC 1179 X BML13	-0.91*	-0.89	-0.38	-21.28**	-6.61**	0.83*	0.48	0.43	2.05**	0.93*	6.89*
MRC 1179 X BML14	0.38	0.50	0.01	6.94	0.72	-0.05	-0.30	-0.34	-1.16	-0.62	-6.11*
MRC 1209 X BML5	1.19**	1.19*	-0.42	-0.30	1.86	0.08	-0.30	-0.26	-1.53*	1.06**	3.42
MRC 1209 X BML7	-0.72	-0.58	0.17	8.03*	-2.20	0.79	0.95**	-0.16	2.19**	-1.65**	-0.48
MRC 1209 X BML13	-1.55**	-1.55**	0.41	-6.47	-1.78	-1.27**	-0.20	0.82**	-0.44	-0.36	-5.02

MRC 1209 X BML14	1.07*	0.94*	-0.17	-1.25	2.11	0.39	-0.44	-0.40	-0.22	0.95*	2.08
MRC 1271 X BML5	0.07	-0.08	0.82	1.14	1.11	0.00	0.14	0.10	-0.22	0.48	-0.29
MRC 1271 X BML7	0.27	0.36	-1.68**	-0.41	-2.61	0.04	-0.04	-0.24	0.38	-1.35**	-6.65*
MRC 1271 X BML13	-0.32	-0.28	-0.11	-2.14	1.24	-0.02	-0.09	0.18	0.08	0.49	7.70**
MRC 1271 X BML14	-0.03	0.00	0.96	1.41	0.25	-0.02	0.00	-0.04	-0.24	0.37	-0.75
MRC 1358 X BML5	-0.69	-0.52	0.32	-5.49	0.58	0.25	-0.52	-0.06	-0.67	-1.37**	-8.09**
MRC 1358 X BML7	2.16**	1.91**	-0.29	-4.71	-6.70**	-1.47**	0.73*	-0.52*	-0.27	0.45	-4.90
MRC 1358 X BML13	-0.66	-0.83	-0.16	16.54**	5.15*	1.00*	0.57	0.91**	1.64*	2.29**	21.45**
MRC 1358 X BML14	-0.80	-0.55	0.12	-6.33	0.95	0.22	-0.77**	-0.31	-0.69	-1.37**	-8.44**
MRC 1544 X BML5	-0.08	0.02	0.10	-5.71	-4.60	-0.30	-0.13	-0.26	-0.94	-0.62	-4.01
MRC 1544 X BML7	-0.22	-0.30	-0.51	2.17	4.43	0.29	0.23	0.72**	1.33	0.64	10.84**
MRC 1544 X BML13	0.50	0.49	0.27	9.65**	5.52*	0.33	-0.04	-0.06	0.58	0.71	-2.46
MRC 1544 X BML14	-0.19	-0.22	0.12	-6.11	-5.35*	-0.33	-0.05	-0.40	-0.97	-0.73	-4.36
MRC 1556 X BML5	-0.72	-0.85	-1.36*	6.25	0.83	-0.46	0.30	0.51*	-0.17	1.26**	6.26*
MRC 1556 X BML7	1.14*	1.36**	2.01**	-12.30**	0.32	-0.09	-0.43	-0.16	0.11	-0.35	0.45
MRC 1556 X BML13	0.42	0.49	0.69	0.74	-1.25	1.05*	-0.04	-0.95**	-0.19	-1.84**	-12.85**
MRC 1556 X BML14	-0.83	-1.00*	-1.34*	5.30	0.09	-0.49	0.16	0.59*	0.25	0.92*	6.13*
MRC 1561 X BML5	0.19	0.36	0.35	-4.55	4.89*	1.05*	0.58	0.43	4.27**	1.09**	15.92**
MRC 1561 X BML7	-0.72	-1.19*	-1.70**	-4.55	-9.17**	-0.89*	-0.60*	-0.58*	-5.22**	-0.62	-20.43**
MRC 1561 X BML13	0.00	0.16	1.30*	13.38**	0.35	-0.85*	-0.42	-0.25	-3.30**	-1.67**	-9.85**
MRC 1561 X BML14	0.52	0.66	0.04	-4.27	3.92	0.69	0.44	0.40	4.25**	1.20**	14.35**
MRC 1564 X BML5	0.49	0.75	0.44	-2.88	-2.96	0.25	0.19	0.35	0.69	-0.70	-1.12
MRC 1564 X BML7	-0.85	-0.91	-1.40**	11.33**	8.07**	0.52	0.23	0.22	0.30	2.56**	10.84**
MRC 1564 X BML13	-0.02	-0.44	0.50	-4.61	-1.28	-0.99*	-0.48	-0.78**	-1.66*	-1.14**	-9.35*
MRC 1564 X BML14	0.38	0.61	0.46	-3.83	-3.82	0.22	0.05	0.20	0.66	-0.70	-0.36
MRC 1582 X BML5	0.30	-0.02	0.10	9.14*	6.95**	-0.10	0.02	0.07	0.24	0.70	4.79
MRC 1582 X BML7	-0.16	0.41	-0.07	-15.63**	-9.67**	0.04	-0.04	0.05	-0.80	-1.12**	-8.46**
MRC 1582 X BML13	-0.32	-0.11	-0.16	-2.92	-3.36	0.19	0.01	-0.06	0.33	-0.06	0.33
MRC 1582 X BML14	0.19	-0.27	0.12	9.41**	6.09*	-0.13	0.00	-0.06	0.22	0.48	3.33
MRC 1601 X BML5	-0.33	-0.30	-0.14	-3.35	3.25	-0.10	-0.13	-0.17	-1.28	-0.34	-5.57
MRC 1601 X BML7	-0.13	0.02	0.23	8.97*	-3.47	0.27	-0.21	0.47	1.44	-0.85*	4.06
MRC 1601 X BML13	0.92*	0.60	0.02	-0.31	-0.61	0.08	0.40	-0.31	1.14	1.54**	8.53**
MRC 1601 X BML14	-0.44	-0.33	-0.12	-5.30	0.84	-0.24	-0.05	0.01	-1.30	-0.34	-7.02*
MRC 1604 X BML5	-1.50**	-1.44**	0.30	4.89	6.42**	-0.49	0.44	0.15	0.88	0.95*	9.42**
MRC 1604 X BML7	-0.30	-0.22	-0.09	-2.55	-10.42**	0.99*	-0.29	-0.30	1.61*	0.56	-1.37
MRC 1604 X BML13	2.42**	2.24**	-0.75	-6.06	-1.67	-0.30	-0.90**	-0.97**	-3.35**	-2.36**	-15.02**
MRC 1604 X BML14	-0.61	-0.58	0.54	3.72	5.67*	-0.19	0.75*	1.12**	0.86	0.84*	6.97*
MRC 1661 X BML5	0.88	0.66	0.10	4.50	0.56	0.30	0.08	0.10	1.16	0.70	5.65*
MRC 1661 X BML7	0.08	0.11	1.04	-10.05**	-7.06**	-0.31	-0.32	0.19	-2.33**	-0.90*	-3.93
MRC 1661 X BML13	-1.74**	-1.19*	-1.27*	1.99	6.79**	-0.16	0.29	-0.25	0.14	-0.17	-7.02*
MRC 1661 X BML14	0.77	0.41	0.12	3.55	-0.29	0.16	-0.05	-0.04	1.02	0.37	5.30
SE (ij)	0.4562	0.4723	0.5363	3.5861	2.4592	0.4221	0.2994	0.2435	0.7536	0.3757	2.8654

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

REFERENCES

Abrha, S.W., Zeleke, H.Z and Gissa, D.W. 2013. Line x tester analysis of maize inbred lines for grain yield and yield related traits. *Asian Journal of Plant Science and Research*. 3 (5): 12-19.

Ajay Singh, Shahi, J.P and Langade, D.M. 2013. Combining Ability Studies for Yield and its Related Traits in Inbred Lines of Maize (*Zea mays* L.). *Molecular Plant Breeding*. 4(22): 177-188.

Aminu, D., Mohammed, S.G and Kabir, B. G. 2014a. Estimates of Combining Ability and Heterosis for Yield and Yield Traits in Maize Population (*Zea mays* L.),under Drought Conditions in the Northern Guinea and Sudan Savanna Zones of Borno State, Nigeria. *International Journal of Agriculture Innovations and Research* 2(5): 824-830.

Centre for Monitoring Indian Economy (CMIE). 2013. Annual Reports, Centre for Monitoring Indian Economy Private Limited. Apple Heritage, Mumbai.

Gowda, R.K., Kage, U., Lohithaswa, H. C., Shekara, B. G and Shobha, D. 2013. Combining ability studies in maize (*Zea mays* L.). *Molecular Plant Breeding*. 4 (14): 116-127.

Hemalatha,V., Sai Kumar, R., Swarnalatha, V and Suresh, J. 2013. Combining ability and gene action for morphological parameters in quality protein maize (*Zea mays* L.). *International Journal of Plant, Animal and Environmental Sciences*. 4(2):230-235.

Kempthorne, O. 1957. *An introduction to genetic statistics*. New York, John Wiley and Sons, Inc. London: Chapman and Hall Limited.

Kumar, B.S., Prakash, M., Sathyanarayanan, G and Padmavathi, S. 2012. Studies on combining ability and heterosis through line x tester analysis in maize (*Zea mays L.*). *Crop Research.* 43 (1, 2 & 3): 153 - 157.

Lahane, G.R., Chauhan, R.M and Patel, J.M. 2014. Combining Ability and Heterosis Studies for Yield and Quality Traits in Quality Protein Maize. *Journal of Agri Search* 1(3): 135-137.

Ram Reddy, V., Seshagiri Rao, A and Sudarshan, M.R. 2011. Heterosis and combining ability for grain yield and its components in maize (*Zea mays* L.). *Journal of Research. ANGRAU.* 39(3): 6-15.