Original Research Article

Evaluation of Inbred Lines of Field Corn through Line × Tester Method

ABSTRACT

Nineteen selected lines of field corn were crossed in a line × tester method with two testers to produce 38 hybrids during rabi 2018-2019. In the following year, all the hybrids were raised along with five commercial checks in an alpha lattice design with two replications. The lines E34, BML75, BML76, BML249, BIL106, CML465, CML481 and CML487 were better among the parents, showing GCA effects for yield and other traits could be used extensively in hybrid breeding program with a view to increase yield. Furthermore, based on mean, SCA effects and standard heterosis of yield value, the crosses BML75×BIL79, E34XBIL157, BML76×BIL157 and BML249×BIL157 were proved to be better to increase the grain yield along with other traits and could be used for commercial hybrid development.

Keywords: Field corn, inbred lines, Line × tester, combining ability

1. INTRODUCTION

Maize (Zea mays L.) is a versatile crop with wider genetic variability and able to grow successfully throughout the world covering tropical, subtropical and temperate agro-climatic conditions. Maize acreage and production have an increasing tendency with the introduction of hybrids due to its high yield potential. Efforts are, therefore, required to be made to develop hybrids with high yield potential in order to increase production of maize. Most efficient use of such materials would be possible only when adequate information on the amount and type of genetic variation and combining ability effects in the materials is available. Heterosis and combining ability is prerequisite for developing a good economically viable hybrid maize variety. Combining ability analysis is useful to assess the potential inbred lines and also helps in identifying the nature of gene action involved in various quantitative characters. Combining ability is dissected into two parts general combining ability (GCA) and specific combining ability (SCA). Both GCA and SCA variances have been determined and related to the possible types of gene action involved. GCA is a good estimate of additive gene action, whereas SCA is a measure of non-additive gene action [1]. This information is helpful to plant breeders for formulating hybrid breeding programmes. A wide array of biometrical tools is available to breeders for characterizing genetic control of economically important traits as a guide to decide upon an appropriate breeding methodology to involve in hybrid breeding. Line × tester mating design developed by Kempthorne [2], which provides reliable information on the general and specific combining ability effects of parents and their hybrid combinations was used to generate the information. The design has been widely used in maize by several workers like, Joshi et al. [3] and Sharma et al. [4] and continues to be applied in quantitative genetic studies. The line×tester analysis provides information on GCA of parents and specific combining ability (SCA) of hybrids which helps to identify good quality inbreds and hybrids, respectively [5, 6]. The present investigation was carried out to determine the nature and magnitude of gene action for yield and other important traits in maize.

2. MATERIALS AND METHODS

Nineteen inbred lines (as female parents) and two testers viz. BIL 79 and BIL 157 (as male parents) were selected and crossed line x Tester fashion in two isolation (Tuber Crop Research Sub Station, Bogra and

Regional Horticultural Research Centre, Sibpur, Narshingdi) in 2018-19. The present investigation was carried out during rabi, 2019-20 at the experimental field of BARI, Gazipur. Experimental materials comprised of 38 F_1's along with five checks viz. BARI hybrid maize-16, 981,Don111, Mohabir and Miracle. Seeds were sown at 1 December, 2019. Urea, Triple super phosphate (TSP), Muriate of potash (MoP), Gypsum, ZnSO4 and boric acid were used as source of nitrogen, phosphorous, potassium, Sulphur, Zinc and Boron respectively. Cow dung (5 t ha^{-1}), urea (250 kg ha^{-1}), TSP (55 kg ha^{-1}), MoP (110 kg ha^{-1}) Gypsum (40 kg ha^{-1}), ZnSO4 (5 kg ha^{-1}) and boric acid (1.5 kg ha^{-1}) was applied in the soil. The total amount of cow dung, one third of Urea, TSP and MoP, Gypsum, ZnSO4 and boric acid was applied as basal dose at the time of final land preparation. Rest of the Urea was applied with 2 equal splits at 8 leaf stage and before flowering of plant. One healthy seedling was kept after proper thinning. Irrigation and other inter cultural operations were done as and when necessary.

2.1 Design and Layout of the Experiment

The experiment was evaluated in Alpha lattice design with two replications having plot consisted of single row of four meter lengths with row to row distance of 60 cm and plant to plant of 25 cm.

2.2 Data Collection

The data were recorded on five randomly selected competitive plants from the rows of each plot for plant height (cm) and ear height (cm). Observations were recorded on the whole plot basis in respect of days to 50% tasseling, days to 50% silking, Days to maturity and grain yield, which data was converted to t ha^{-1}.

2.3 Statistical Analysis

The collected data were compiled and tabulated, which were subjected to statistical analyses following standard procedure given by AGRISTAT Package.

3. RESULTS AND DISCUSSION

Analysis of variance for combining ability was carried out for yield and other characters as well as the mean sum of squares are presented in Table 1. The analysis of variance revealed that genotypes exhibited highly significant differences among themselves for all the traits studied indicating wide range of genetic variability among the genotypes.Talukder et al.[7] also observed genotypic difference for days to tasseling, days to silking, plant height, ear height and grain yield. The crosses showed significant differences, indicating varying performance of cross combinations. When the effects of crosses partitioned into lines, testers and line × tester effects. The parents exhibited significant differences for all the traits indicating greater diversity in the parental lines. The interaction effects (line × testers) were found to be significant for all the traits under study indicating the role of dominance and non-additive effects in all traits. Testers also showed significant variations among themselves except days to50% tasseling and days to 50% silking.Tucak et al. [8] and Atif et al. [9] observed highly significant differences for testers, lines and line x tester interaction in their study. Highly significant differences were also observed in checks for all characters except days to maturity. A comparison of magnitude of variance components due to gca and sca confirm the gene action in controlling the expression of traits. The ratio of gca and sca for all the traits were less than one except days to silking indicated that these characters were governed by non-additive gene effects. Similar findings were reported by Kumar et al. [10] and Alam et al. [11] for grain yield, days to tasseling, days to silking, plant height, ear height and some other characters in maize in their study.

Table 1.Mean square and estimates of variance for different characters of maize.

Source	d.f	DT	DS	DM	PH	EH	Yi
Genotype	42	14.62**	17.45**	38.37**	106.58**	134.76**	10.02**
Cross	37	15.63**	18.77**	43.30**	117.61**	145.86**	6.68**
Line	18	28.99*	34.15**	49.59**	157.56**	194.30**	7.73**
Tester	1	0.33	0.65	250.58**	180.12**	938.01**	43.25**
Lx T	18	3.11**	4.40**	25.50**	74.09**	53.40**	3.60**
Checks	4	8.65**	9.65**	2.35	9.85**	40.60**	4.32**
Check vs Cross	1	1.18	0.06	0.002	85.65**	100.74**	156.25**
Error	42	4.61	4.58	7.0537	37.37	16.88	0.43
Estimation of component of variance							
δ2g(Line)		6.472	7.439	6.024	20.890	35.225	1.031
δ2g(Tester)		0.352	-0.099	5.923	2.790	23.279	1.043
δ2gca		0.222	0.255	0.315	0.770	1.637	0.055
δ2sca		-0.796	-0.220	9.073	16.239	17.379	1.601
		-0.279	-1.159	0.035	0.047	0.094	0.034

* and ** Significant at 5 & 1 percent level, respectively; DT= Days to 50% Tasseling, DS= Days to 50% Silking, DM= Days to Maturity, PH= Plant height (cm), EH= Ear Height (cm), Yi= Grain Yield (t ha^{-1})

The proportional contribution of lines was higher for all traits indicating their predominant maternal influence (Table 2). Raihan and Hoque [12] and Alam et al. [11] also found higher value for contribution to line than contribution to tester and linexTester for the same characters in maize. Motamedi et al.[13] found less influence of testers for kernel yield.

Table 2.Propotional contribution of lines, testers and their interactions to total variance in maize

Sources	DT	DS	DM	PH	EH	Yield
Contribution due to line	90.27	88.52	55.72	65.21	64.81	56.27
Contribution due to Tester	0.06	0.09	15.64	4.14	17.38	17.50
Contribution due to L×T	9.67	11.39	28.64	30.65	17.81	26.23

DT= Days to 50% Tasseling, DS= Days to 50% Silking, DM= Days to Maturity, PH= Plant height (cm), EH= Ear Height (cm), Yi= Grain Yield (t ha^{-1})

3.1 General Combining Ability (GCA) Effects:

The GCA effects of the parents are presented in Table 3. We need line with significant gca of yield but negative significant gca for maturity and growth parameters. Lines BIL 177 & BIL189 exhibited desirable negatively significant GCA effects for days to tasseling, silking and maturity. These two lines also showed negatively significant gca for plant height and ear height. Ahmed and Amiruzzaman [14] also found similar results in some parents for the same characters in maize.But their gca for yield were negatively significant which is unexpected. Line E34, BML75, BML249 and CML481 showed positively significant gca for yield and nonsignicant and/or negatively significant gca for tasseling, silking, maturity, plant height and ear height. Ahmed and Amiruzzaman [14] also found positively significant gca for yield and nonsignicant and/or negatively significant gca for tasseling, silking, maturity, plant height and ear height in some parents in their study. Line BML76, BIL106, CML465 and CML487 showed positive and significant gca for yield and their most of the maturity and growth parameters were nonsignificant. Similar result was also observed by Mia and Biswas [15].So, Line E34, BML75, BML249, CML481 BML76, BIL106, CML465 and CML487 could be used in future breeding program.

Table 3. General combining ability (GCA) effects of yield and other characters.

Line/Tester	DT	DS	DM	PH	EH	Yield(t ha^{-1})
Line						
1.Ki 21	1.57ns	1.88ns	0.14ns	-0.99ns	6.97**	-0.43ns
2.E34	-1.68ns	-2.37*	-5.11**	5.51ns	3,72ns	0.84*
3. BML76	1.32ns	1.13ns	-5.36**	-6.49*	7.72**	1.49**
4. E37	5.32 **	5.38 **	0.89 ns	2.26 ns	-4.03 ns	-0.46 ns
5. BIL65	-1.68 ns	-1.37 ns	4.14 **	10.74 **	18.78 **	-1.04 **
6. BIL 106	0.82 ns	0.13 ns	1.39 ns	-0.49 ns	6.22 **	0.90 **
7. BIL 182	0.57 ns	0.38 ns	-1.86 ns	-9.24 **	-0.28 ns	-2.02 **
8. BML 249	0.07 ns	0.38 ns	0.89 ns	2.76 ns	0.97 ns	2.53 **
9. 900M6	-0.43 ns	0.13 ns	4.64 **	8.01 *	0.47 ns	-0.15 ns
10. 900M10	0.32 ns	1.38 ns	2.89 *	3.76 ns	-1.28 ns	-0.80 *
11. BML75	-0.43 ns	-0.62 ns	-3.36 *	3.01 ns	-0.78 ns	2.18 **
12.PINA20	-0.93 ns	-1.12 ns	1.14 ns	9.01 **	2.22 ns	-1.47 **
13. CML 465	0.82 ns	0.63 ns	0.64 ns	10.01 **	9.47 **	0.97 **

14. CML 487	1.32 ns	0.88 ns	1.39 ns	-3.24 ns	10.22 **	0.70 *
15. CML480	1.57 ns	1.63 ns	3.14 *	2.26 ns	-0.03 ns	0.51 ns
16. CML 481	-0.18 ns	-0.37 ns	2.89 *	1.26 ns	-3.53 ns	0.84 *
17. CML 496	3.57 **	4.63 **	2.89 *	-0.24 ns	-5.53 *	-0.42 ns
18. BIL 177	-6.93 **	-7.37 **	-3.86 **	-7.74 *	-8.28 **	-2.45 **
19. BIL 189	-4.93 **	-5.37 **	-7.61 **	-8.74 **	-5.53 *	-1.71 **
SE(gi)	1.084	1.099	1.356	3.225	2.159	0.316
SE(gi-gj)	1.533	1.555	1.917	4.561	3.053	0.447
Tester						
1. BIL79	0.07	-0.09	-1.82	1.54	3.51	-0.75
2. BIL157	-0.07	0.09	1.82	-1.54	-3.51	0.75
SE(gi)	0.352	0.357	0.440	1.047	0.701	0.103
SE (gi-gj)	0.497	0.504	0.622	1.480	0.991	0.145

DT= Days to 50% Tasseling, DS=Days to 50% silking, DM= Days to Maturity, PH= Plant Height(cm), EH= Ear height.

3.2 SpecificCombining Ability (SCA) Effects:

High positive estimates of SCA in absolutes values indicates that hybrid performance is relatively superior or inferior to parent lines general combining ability, showing the interactions of non-additive interactions resulting from the complementation degree among parent lines in relation frequency of alleles in loci in some dominance, while low estimates of sca in absolute value indicates that hybrids behave as expected in relation to gca of parent lines [16].In the selection of parent lines used to produce hybrids,the effect of scaanalyzed in an isolated way has a limiting value.Thus other parameters should be considered such as mean of hybrids and gca of the respective parent lines.Therefore, superior hybrid combinations, which are important for breeding are involved at least one parental line which has the most favorable effects of gca.The mean value and sca effects of the hybrids are presented in the Table 4.In respect of days to tasseling and days to silking, no cross combination was recorded for significant and negative effects. Two cross combinations (BIL177xBIL79 and BIL177xBIL157) were recorded for significant and negative effects for early maturing plant. Similar findings were also reported by Alam et al. [11] and Bhavana et al. [17].In case of maize, negative and significant value is expected for plant and ear height to develop short statured plant. No significant and negative effects were found for plant height. The lowest plant height (173 cm) was observed in BIL65xBIL157 and BIL177xBIL157. One cross (BML249xBIL79) showed significant and negative sca effect for ear height. Amin et al. [18] also observed significant and negative sca for ear height in maize. Six crosses (E34xBIL157, BML76xBIL157, E37xBIL79, BML249xBIL157, BML75xBIL79 and BIL177xBIL79) showed significant and positive sca effect for yield. Similar findings were also observed by Raihan and Hoque [12], Ahmed and Amiruzzaman [14] and Amin et al. [18].

Table 4. Mean and Specific Combining Ability (SCA) effects for different characters

Crosses	DT		DS		DM	
	Mean	sca	Mean	sca	Mean	sca
1.Ki 21x Bil 79	97	-0.07 ns	101.5	-0.41 ns	143	-2.43 ns
2.Ki 21 x BIL 157	97	0.07 ns	102.5	0.41 ns	151.5	2.43 ns
3.E 34 x BIL 79	94	0.18 ns	98	0.34 ns	136.5	-3.68 ns
4. E 34 X BIL 157	93.5	-0.18 ns	97.5	-0.34 ns	147.5	3.68 ns
5. BML76 X BIL 79	97.5	0.68 ns	102.5	1.34 ns	138	-1.93 ns
6. BML76 X BIL 157	96	-0.68 ns	100	-1.34 ns	145.5	1.93 ns
7. E 37 X BIL 79	99	-1.82 ns	103	-2.41 ns	145.5	-0.68 ns
8. E 37 X BIL157	102.5	1.82 ns	108	2.41 ns	150.5	0.68 ns
9. BIL65 X BIL79	94	0.18 ns	99	0.34 ns	152.5	3.07 ns
10. BIL65 X BIL157	93.5	-0.18 ns	98.5	-0.34 ns	150	-3.07 ns
11. BIL106 X BIL79	96.5	0.18 ns	100	-0.16 ns	149.5	2.82 ns
12.BIL 106 X BIL157	96	-0.18 ns	100.5	0.16 ns	147.5	-2.82 ns
13.BIL 182 XBIL79	97.5	1.43 ns	101.5	1.09 ns	142.5	-0.93 ns
14. BIL1182 X BIL157	94.5	-1.43 ns	99.5	-1.09 ns	148	0.93 ns
15. BML249 X BIL79	95	-0.57 ns	99.5	-0.91 ns	144.5	-1.68 ns
16. BML249 X BIL157	96	0.57 ns	101.5	0.91 ns	151.5	1.68 ns
17. 900M6 X BIL79	95	-0.07 ns	101	0.84 ns	148.5	-1.43 ns
18 900M6 X BIL157	95	0.07 ns	99.5	-0.84 ns	155	1.43 ns
19. 900M10 X BIL79	95.5	-0.32 ns	100	-1.41 ns	150	1.82 ns
20. 900M10 X BIL157	96	0.32 ns	103	1.41 ns	150	-1.82 ns
21. BML75 X BIL79	95	-0.07 ns	99.5	0.09 ns	142.5	0.57 ns
22. BML75 X BIL157	95	0.07 ns	99.5	-0.09 ns	145	-0.57 ns
23. PINA 20 X BIL79	95	0.43 ns	99	0.09 ns	147.5	1.07 ns

24. PINA20 X BIL157	94	-0.43 ns	99	-0.09 ns	149	-1.07 ns
25.CML465 X BIL79	96.5	0.18 ns	101	0.34 ns	147	1.07 ns
26. CML465 X BIL157	96	-0.18 ns	100.5	-0.34 ns	148.5	-1.07 ns
27. CML480 X BIL79	96.5	-0.32 ns	100	-0.91 ns	147	0.32 ns
28. CML480 X BIL157	97	0.32 ns	102	0.91 ns	150	-0.32 ns
29. CML481 X BIL79	97.5	0.43 ns	103	1.34 ns	149	0.57 ns
30. CML481 X BIL157	96.5	-0.43 ns	100.5	-1.34 ns	151.5	-0.57 ns
31. CML487 X BIL79	93	-2.32 ns	98	-1.66 ns	150	1.82 ns
32. CML487 X BIL157	97.5	2.32 ns	101.5	1.66 ns	150	-1.82 ns
33. CML496 X BIL79	99	-0.07 ns	105	0.34 ns	147.5	-0.68 ns
34. CML496 X BIL157	99	0.07 ns	104.5	-0.34 ns	152.5	0.68 ns
35. BIL177 X BIL79	89.5	0.93 ns	93.5	0.84 ns	147	5.57 **
36. BIL177 X BIL157	87.5	-0.93 ns	92	-0.84 ns	139.5	-5.57 **
37. BIL189 X BIL79	91.5	0.93 ns	95.5	0.84 ns	132.5	-5.18 **
38. BIL189 X BIL157	89.50	-0.93ns	94.00	-0.84ns	146.50	5.18**
SE(Sij)	1.533		1.555		1.917	
SE(Sij-Skl)	2.168		2.199		2.711	

Table 4. (cont'd)

Crosses	PH		EH		Yield (t ha^{-1})	
	Mean	sca	Mean	sca	Mean	sca
1.Ki 21x Bil 79	187.5	-2.04 ns	106	-1.26 ns	8.92	0.64 ns
2.Ki 21 x BIL 157	188.5	2.04 ns	101.5	1.26 ns	9.16	-0.64 ns
3.E 34 x BIL 79	196	-0.04 ns	104	-0.01 ns	8.2	-1.35 **

4. E 34 X BIL 157	193	0.04 ns	97	0.01 ns	12.41	1.35 **
5. BML76 X BIL 79	177.5	-6.54 ns	105.5	-2.51 ns	9.17	-1.03 *
6. BML76 X BIL 157	187.5	6.54 ns	103.5	2.51 ns	12.74	1.03 *
7. E 37 X BIL 79	199	6.21 ns	100.5	4.24 ns	9.17	0.92 *
8. E 37 X BIL157	183.5	-6.21 ns	85	-4.24 ns	8.84	-0.92 *
9. BIL65 X BIL79	184	4.21 ns	82.5	0.99 ns	8.28	0.60 ns
10. BIL65 X BIL157	172.5	-4.21 ns	73.5	-0.99 ns	8.59	-0.60 ns
11. BIL106 X BIL79	187.5	-2.54 ns	110.5	3.99 ns	9.99	0.38 ns
12.BIL 106 X BIL157	189.5	2.54 ns	95.5	-3.99 ns	10.74	-0.38 ns
13.BIL 182 XBIL79	185.5	4.21 ns	99.5	-0.51 ns	6.33	-0.36 ns
14. BIL1182 X BIL157	174	-4.21 ns	93.5	0.51 ns	8.57	0.36 ns
15. BML249 X BIL79	186	-7.29 ns	92.5	-8.76 **	8.97	-2.27 **
16. BML249 X BIL157	197.5	7.29 ns	103	8.76 **	15.02	2.27 **
17. 900M6 X BIL79	204.5	5.96 ns	105.5	4.74 ns	9.03	0.46 ns
18 900M6 X BIL157	189.5	-5.96 ns	89	-4.74 ns	9.62	-0.46 ns
19. 900M10 X BIL79	191	-3.29 ns	96	-3.01 ns	7.99	0.07 ns
20. 900M10 X BIL157	194.5	3.29 ns	95	3.01 ns	9.35	-0.07 ns
21. BML75 X BIL79	193.5	-0.04 ns	94	-5.51 ns	12.41	1.51 **
22. BML75 X BIL157	190.5	0.04 ns	98	5.51 ns	10.9	-1.51 **
23. PINA 20 X BIL79	205.5	5.96 ns	102	-0.51 ns	7.15	-0.09 ns
24. PINA20 X BIL157	190.5	-5.96 ns	96	0.51 ns	8.84	0.09 ns
25.CML465 X BIL79	199	-1.54 ns	110.5	0.74 ns	9.32	-0.37 ns
26. CML465 X BIL157	199	1.54 ns	102	-0.74 ns	11.57	0.37 ns
27. CML480 X BIL79	186.5	-0.79 ns	111.5	0.99 ns	8.87	-0.55 ns
28. CML480 X BIL157	185	0.79 ns	102.5	-0.99 ns	11.48	0.55 ns
29. CML481 X BIL79	191.5	-1.29 ns	104.5	4.24 ns	8.95	-0.28 ns
30. CML481 X BIL157	191	1.29 ns	89	-4.24 ns	11.02	0.28 ns

31. CML487 X BIL79	188.5	-3.29 ns	94	-2.76 ns	9.62	0.06 ns
32. CML487 X BIL157	192	3.29 ns	92.5	2.76 ns	11	-0.06 ns
33. CML496 X BIL79	188	-2.29 ns	92.5	-2.26 ns	7.94	-0.35 ns
34. CML496 X BIL157	189.5	2.29 ns	90	2.26 ns	10.16	0.35 ns
35. BIL177 X BIL79	189.5	6.71 ns	95.5	3.49 ns	8.02	1.75 **
36. BIL177 X BIL157	173	-6.71 ns	81.5	-3.49 ns	6.02	-1.75 **
37. BIL189 X BIL79	179.5	-2.29 ns	98.5	3.74 ns	7.27	0.27 ns
38. BIL189 X BIL157	181	2.29 ns	84	-3.74 ns	8.25	-0.27 ns
SE(Sij)		4.561		3.053		0.472
SE(Sij-Skl)		6.451		4.318		0.632

DT= Days to 50% Tasseling, DS= Days to 50% Silking, DM= Days to Maturity, PH= Plant height (cm), EH= Ear Height (cm), Yi= Grain Yield (t ha^{-1})

Table 5. Heterosis(%) standard heterosis over check BHM16 for different characters

Crosses	DT	DS	DM	PH	EH	YIELD
1.Ki 21x Bil 79	3.19 ns	3.05 ns	-1.72 ns	-1.32 ns	10.99 *	-21.75 **
2.Ki 21 x BIL 157	3.19 ns	4.06 ns	4.12 *	-0.79 ns	6.28 ns	-19.69 **
3.E 34 x BIL 79	0.00 ns	-0.51 ns	-6.19 **	3.16 ns	8.90 *	-28.07 **
4. E 34 X BIL 157	-0.53 ns	-1.02 ns	1.37 ns	1.58 ns	1.57 ns	8.90 ns
5. BML76 X BIL 79	3.72 ns	4.06 ns	-5.15 **	-6.58 *	10.47 *	-19.56 **
6. BML76 X BIL 157	2.13 ns	1.52 ns	0.00 ns	-1.32 ns	8.38 ns	11.80 *
7. E 37 X BIL 79	5.32 *	4.57 *	0.00 ns	4.74 ns	5.24 ns	-19.56 **
8. E 37 X BIL157	9.04 **	9.64 **	3.44 ns	-3.42 ns	10.99 *	-22.41 **
9. BIL65 X BIL79	0.00 ns	0.51 ns	4.81 *	-3.16 ns	13.61 **	-27.37 **
10. BIL65 X BIL157	-0.53 ns	0.00 ns	3.09 ns	-9.21 **	23.04 **	-24.69 **
11. BIL106 X BIL79	2.66 ns	1.52 ns	2.75 ns	-1.32 ns	15.71 **	-12.37 *
12.BIL 106 X BIL157	2.13 ns	2.03 ns	1.37 ns	-0.26 ns	0.00 ns	-5.75 ns

13.BIL 182 XBIL79	3.72 ns	3.05 ns	-2.06 ns	-2.37 ns	4.19 ns	-44.47 **
14. BIL1182 X BIL157	0.53 ns	1.02 ns	1.72 ns	-8.42 *	-2.09 ns	-24.87 **
15. BML249 X BIL79	1.06 ns	1.02 ns	-0.69 ns	-2.11 ns	-3.14 ns	-21.27 **
16. BML249 X BIL157	2.13 ns	3.05 ns	4.12 *	3.95 ns	7.85 ns	31.75 **
17. 900M6 X BIL79	1.06 ns	2.54 ns	2.06 ns	7.63 *	10.47 *	-20.75 **
18 900M6 X BIL157	1.06 ns	1.02 ns	6.53 **	-0.26 ns	-6.81 ns	-15.66 **
19. 900M10 X BIL79	1.60 ns	1.52 ns	3.09 ns	0.53 ns	0.52 ns	-29.91 **
20. 900M10 X BIL157	2.13 ns	4.57 *	3.09 ns	2.37 ns	-0.52 ns	-17.98 **
21. BML75 X BIL79	1.06 ns	1.02 ns	-2.06 ns	1.84 ns	-1.57 ns	8.82 ns
22. BML75 X BIL157	1.06 ns	1.02 ns	-0.34 ns	0.26 ns	2.62 ns	-4.39 ns
23. PINA 20 X BIL79	1.06 ns	0.51 ns	1.37 ns	8.16 *	6.81 ns	-37.24 **
24. PINA20 X BIL157	0.00 ns	0.51 ns	2.41 ns	0.26 ns	0.52 ns	-22.46 **
25.CML465 X BIL79	2.66 ns	2.54 ns	1.03 ns	4.74 ns	15.71 **	-18.25 **
26. CML465 X BIL157	2.13 ns	2.03 ns	2.06 ns	4.74 ns	6.81 ns	1.49 ns
27. CML480 X BIL79	2.66 ns	1.52 ns	1.03 ns	-1.84 ns	16.75 **	-22.19 **
28. CML480 X BIL157	3.19 ns	3.55 ns	3.09 ns	-2.63 ns	7.33 ns	0.70 ns
29. CML481 X BIL79	3.72 ns	4.57 *	2.41 ns	0.79 ns	9.42 *	-21.49 **
30. CML481 X BIL157	2.66 ns	2.03 ns	4.12 *	0.53 ns	-6.81 ns	-3.33 ns
31. CML487 X BIL79	-1.06 ns	-0.51 ns	3.09 ns	-0.79 ns	-1.57 ns	-15.61 **
32. CML487 X BIL157	3.72 ns	3.05 ns	3.09 ns	1.05 ns	-3.14 ns	-3.46 ns
33. CML496 X BIL79	5.32 *	6.60 **	1.37 ns	-1.05 ns	-3.14 ns	-30.31 **
34. CML496 X BIL157	5.32 *	6.09 **	4.81 *	-0.26 ns	-5.76 ns	-10.92 ns
35. BIL177 X BIL79	-4.79 *	-5.08 *	1.03 ns	-0.26 ns	0.00 ns	-29.65 **
36. BIL177 X BIL157	-6.91 **	-6.60 **	-4.12 *	-8.95 **	14.66 **	-47.15 **
37. BIL189 X BIL79	-2.66 ns	-3.05 ns	-8.93 **	-5.53 ns	3.14 ns	-36.18 **
38. BIL189 X BIL157	-4.79 *	-4.57 *	0.69 ns	-4.74 ns	12.04 **	-27.63 **
SE	1.518	1.514	1.878	4.322	2.905	0.464

CD(0.05)	4.315	4.303	5.338	12.287	8.259	1.320
CD(0.01)	5.753	5.737	7.118	16.382	11.012	1.760

DT= Days to 50% Tasseling, DS= Days to 50% Silking, DM= Days to Maturity, PH= Plant height (cm), EH= Ear Height (cm), Yi= Grain Yield (t ha^{-1})

3.3 HETEROSIS

The standard heterosis expressed by the F_1 hybrids over standard check BHM16 for different characters are presented in Table 5.Significant and positive heterosis is expected for yield and negatively significant heterosis for other characters. Negative and significant heterosis were observed in 3, 3, 4 and 4 crosses for days to tasseling, days to silking, plant height and ear height respectively. Talukder et al. [12] also observed negative and significant heterosis in some crosses of said characters of maize in their studies. Significant and positive standard heterosis is expected for grain yield. Significant and positive standard heterosis was observed in BML76xBIL157(11.80%) and BML249xBIL157 (31.75%) for grain yield. On the other hand, non-significant and positive heterosis was observed in E34xBIL157 (8.90%) and BML75xBIL79 (8.82%). Akhi et al. [19] and Ahmed and Amiruzzaman [14] also observed positive and significant standard heterosis in some crosses and positive and nonsignificant heterosis in some crosses in maize in their studies.

4. CONCLUSION

The parental lineE34, BML75, BML76, BML249, BIL106, CMl 465, CML 481 and CML487 were found promising and could be used extensively in hybrid breeding program owing to increase yield. Considering heterosis, sca value, mean value and gca of their parent the crosses E34 X BIL157, BML75 X BIL79, BML76 X BIL157, BML249 X BIL157 were found promising and could be used in future breeding program to develop high yielding hybrids with desirable traits.

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