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# Heterosis for Grain yield and its Component traits in Maize (*Zea mays* L.)

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## ABSTRACT

*Heterosis was estimated in 60 hybrids obtained by crossing 20 inbred lines with three testers using line × tester mating design in maize. Sixty hybrids along with 23 parents and three standard checks were evaluated for twelve characters during rabi, 2012-13. All the 60 hybrids showed earliness for days to 50 percent tasseling and days to 50 percent silking over mid parent and 39 hybrids showed earliness over standard checks for days to maturity. The hybrid MRC 13 × BML 14 recorded positive significant heterosis over three standard checks DHM 117, 900M Gold and NK 6240 for grain yield (14.67 %, 12.94 % and 11.89 %, respectively). Over standard check NK 6240, it showed desirable significant heterosis for grain yield per plant, number of kernels per row, number of kernel rows per ear and ear length.*

***Keywords:*** *Heterosis, Hybrids, Maize, Grain.*

## INTRODUCTION

Maize (*Zea mays* L.), belonging to the family Poaceae and tribe Maydeae, is one of the most important cereal crops and occupies a prominent position in global agriculture after wheat and rice. Maize is a highly cross pollinated crop and the scope for exploitation of hybrid vigour will depend on the direction and magnitude of heterosis, biological feasibility and the type of gene action involved. The magnitude of heterosis provides information on extent of genetic diversity of parents in developing superior $F_1$s so as to exploit hybrid vigour and has direct bearing on the breeding methodology to be adapted for varietal improvement. Therefore, the present investigation was carried out to know the direction and magnitude of heterosis in maize.

## MATERIALS AND METHODS

Twenty newly developed inbred lines of maize *viz.*, MRC 1, MRC 2, MRC 3, MRC 4, MRC 5, MRC 6, MRC 7, MRC 8, MRC 9, MRC 10, MRC 11, MRC 12, MRC 13, MRC 14, MRC 15, MRC 16, MRC 17, MRC 18, MRC 19 and MRC 20 were crossed with three testers *viz.*, BML 7, BML 14 and BML 15 during *Kharif*, 2012. Subsequently, during *Rabi*, 2012-13 the resulting 60 $F_1$ crosses along with three standard checks (DHM 117, 900M Gold and NK 6240) and parents (lines and testers) were evaluated in randomized block design with three replications. Both the crossing and evaluation works were carried out at Maize Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad. Each entry was sown in two rows of four meters length with a spacing of 75 cm between rows and 20 cm between the plants. The data on twelve quantitative characters namely, plant height, ear height, ear length, ear girth, number of kernel rows per ear, number of kernels per row, 100 kernel weight, shelling percentage and grain yield per plant were recorded on five randomly selected competitive plants in each replication,

whereas days to 50 per cent tasseling, days to 50 per cent silking, days to maturity were recorded on plot basis. Computation for heterosis for all characters was carried out as per procedure suggested by Fonesca and Patterson[1] and Standard heterosis according to Virmani[2].

## RESULTS AND DISCUSSION

The analysis of variance revealed that mean squares due to parents and crosses were highly significant for all the characters (Table 1) .This reflected presence of adequate genetic variability in the experimental material included under study. Similarly, significant mean squares due to parents vs. crosses indicated presence of average heterosis for all the characters. Considerable amount of heterosis was observed for all the characters under study, however the magnitude varied with characters (Table 2). The heterosis in negative direction is considered to be desirable for days to 50 per cent tasseling, days to 50 per cent silking and days to maturity.

In the present study, Heterosis ranged from -14.53 (MRC 1 × BML 15) to -2.03 (MRC 19 × BML14) per cent for days to 50 per cent tasseling. Among 60 hybrids studied, significant negative heterosis and heterobeltiosis was recorded in all the hybrids for this trait. Out of 60 hybrids, 46 hybrids showed significant negative standard heterosis for days to 50 per cent tasseling over DHM 117. Similerly 31 hybrids over 900M Gold and 8 crosses over NK 6240 showed significant negative standard heterosis. Heterosis ranged from -14.75 (MRC 1 × BML 15) to -2.59 per cent (MRC 19 × BML 14) for days to 50 per cent silking. Among 60 hybrids studied, 50 hybrids showed significant negative standard heterosis over DHM 117. Similerly 39 hybrids over 900M Gold and 9 crosses over NK 6240 showed significant negative standard heterosis for days to 50 per cent silking. For days to 50 per cent maturity, heterosis ranged from -4.46 (MRC 17 × BML 15) to 4.00 per cent (MRC 15 × BML 14) and among 60 hybrids studied, 11 hybrids showed significant negative heterosis. Among 60 hybrids studied 39 hybrids showed significant negative standard heterosis over all the three standard checks DHM 117, NK 6240 and 900M Gold for days to 50 per cent maturity.

Days to 50 per cent tasseling, days to 50 per cent silking and days to maturity indicate the earliness of a genotype in maize. Earliness is a desirable character as it is useful in multiple cropping and increases water and land use efficiency. Heterosis for earliness in maize was reported by Appunu *et al.* [3], Farzana Jabeen *et al.* [4], Ram Reddy *et al.* [5] and Jawaharlal *et al.* [6].

Significant positive heterosis was recorded in all the hybrids studied and the heterosis ranged from 34.95 (MRC 4 × BML 14) to 77.30 per cent (MRC 16 × BML 15) for plant height. For this trait among 60 hybrids studied, all showed significant positive heterobeltiosis and varied from 27.18 (MRC 15 × BML 14) to 74.07 per cent (MRC 15 × BML 15). Heterosis over standard checks DHM 117, 900M Gold and NK 6240 for plant height varied from -6.62 (MRC 15 × BML 14) to 11.88 per cent (MRC 10 × BML 15), -9.05 (MRC 9 × BML 14) to 9.34 per cent (MRC 10 × BML 15) and -6.42 (MRC 9 × BML 14) to 12.51 per cent (MRC 10 × BML 15) respectively.

Heterosis for ear height ranged from 36.56 (MRC 9 × BML 14) to 102.37 per cent (MRC 10 × BML 7). Hybrids, MRC 10 × BML 7, MRC 11 × BML 15, MRC 12 × BML 15, MRC 6 × BML 15 and MRC 3 × BML 15 recorded significant positive heterosis over all three standard checks DHM 117, 900M Gold and NK 6240 for ear height. All the hybrids showed significant positive heterosis and heterobeltiosis. Significant positive heterosis was recorded in all the hybrids studied for ear girth ranged from 9.53 (MRC 5 × BML 15) to 34.61 per cent (MRC 14 × BML 15) and heterobeltiosis varied from -1.71 (MRC 5 × BML 15) to 32.39 per cent (MRC 15 × BML 14). Heterosis for number of kernel rows per ear ranged from -6.31 (MRC 5 × BML 14) to 13.98 per cent (MRC 8 × BML 14). Among the 60 hybrids studied, 39 hybrids showed significant positive heterosis. Thirty two hybrids, out of 60 hybrids, showed significant positive heterosis over NK 6240 for number of kernel rows per ear.

**Table 1. Analysis of variance for combining ability for yield and yield component characters in maize**

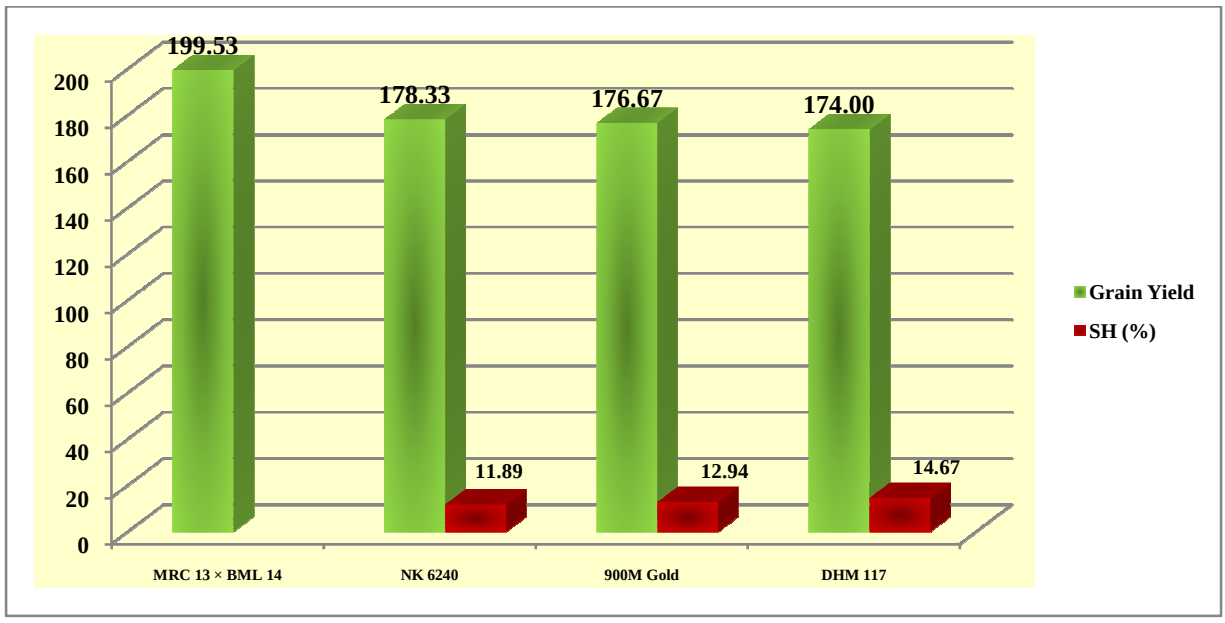
| Source | d.f. | Days to 5o % tasseling | Days to 50 % silking | Days to maturity | Plant height (cm) | Ear height (cm) | Ear length (cm) | Ear girth (cm) | Number of kernel rows per ear | Number of kernels per row | 100-kernel weight (g) | Shelling percentage | Grain yield per plant (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Replications** | 2 | 3.48 | 2.48 | 0.41365 | 28.51 | 201.16* | 0.89 | 0.59 | 0.26 | 1.09 | 4.22 | 1.15 | 136.68 |
| **Genotypes** | 82 | 35.02** | 38.47** | 18.28** | 5107.23** | 1603.36** | 20.77** | 6.74** | 4.00** | 113.65** | 118.42** | 32.88** | 6172.84** |
| **Parents** | 22 | 47.75** | 44.87** | 23.67** | 871.33** | 243.53** | 6.56** | 1.79** | 6.95** | 46.34** | 39.45** | 55.76** | 750.99** |
| **Parents Vs crosses** | 1 | 872.40** | 1120.71** | 24.76** | 379223.99** | 109157.28** | 1425.33** | 348.06** | 0.17 | 7209.41** | 6238.61** | 563.95** | 428033.74** |
| **Crosses** | 59 | 16.09** | 17.74** | 16.16** | 345.76** | 287.47** | 2.26** | 2.80** | 2.96** | 18.48** | 44.14** | 15.34** | 1044.36** |
| **Lines** | 19 | 26.84** | 31.41** | 35.24** | 802.09** | 454.84** | 3.27 | 2.40** | 5.45** | 23.58* | 53.40** | 18.96 | 1081.92 |
| **Testers** | 2 | 99.83** | 113.77** | 41.87** | 1055.12** | 2079.65** | 1.33 | 41.53** | 20.81** | 108.02** | 487.69** | 55.87* | 7661.56** |
| **Line × Testers** | 38 | 6.30** | 5.85** | 5.26** | 80.26** | 109.45** | 1.81** | 0.97** | 0.78** | 11.22** | 16.17** | 11.40** | 677.30** |
| **Error** | 164 | 1.48 | 1.23 | 0.58 | 26.37 | 51.1288 | 0.68 | 0.37 | 0.42 | 2.72 | 4.79 | 3.39 | 53.82 |

* Significant at 5 per cent level; ** Significant at 1 per cent level

**Table 2: The range of heterosis, heterobeltiosis and standard heterosis and number of crosses showing significant standard heterosis for 12 characters in maize (*Zea mays* L.)**

| Character | Range of heterosis | Range of heterobeltiosis | Range of Standard heterosis over three checks | | | Number of Cross combinations showing significant standard heterosis | | |
|---|---|---|---|---|---|---|---|---|
| | | | DHM 117 | 900M Gold | NK 6240 | DHM 117 | 900M Gold | NK 6240 |
| **Days to 5o % tasseling** | -14.53 to -2.03 | -21.26 to -4.74 | -13.04 to 0.43 | -11.11 to 2.67 | -7.41 to 6.94 | 46 | 31 | 8 |
| **Days to 50 % silking** | -14.75 to -2.59 | -21.21 to -4.96 | -13.33 to 0.01 | -11.86 to 1.69 | -7.56 to 6.67 | 50 | 39 | 9 |
| **Days to maturity** | -4.46 to 4.00 | -6.48 to 3.54 | -5.14 to 2.29 | -5.14 to 2.29 | -5.14 to 2.29 | 39 | 39 | 39 |
| **Plant height (cm)** | 34.95 to 77.30 | 27.18 to 74.07 | -6.62 to 11.88 | -9.05 to 9.34 | -6.42 to 12.51 | 5 | 1 | 8 |
| **Ear height (cm)** | 36.56 to 102.37 | 28.05 to 95.27 | -17.17 to 25.78 | -16.96 to 26.09 | -14.60 to 29.68 | 5 | 5 | 7 |
| **Ear length (cm)** | 21.49 to 64.39 | 11.58 to 62.06 | -7.42 to 14.96 | -8.59 to 13.51 | -13.82 to 7.01 | 47 | 40 | 13 |
| **Ear girth (cm)** | 9.53 to 34.61 | -1.71 to 32.39 | -20.32 to 2.84 | -14.80 to 9.97 | -17.69 to 6.24 | 2 | 18 | 7 |
| **Number of kernel rows per ear** | -6.31 to 13.98 | -15.42 to 10.28 | -22.57 to 7.96 | -22.57 to 7.96 | -15.87 to 17.31 | 8 | 8 | 32 |
| **Number of kernels per row** | 32.35 to 93.14 | 9.64 to 85.21 | -17.27 to 16.14 | -21.08 to 10.80 | -12.74 to 22.50 | 17 | 7 | 30 |
| **100-kernel weight (g)** | 17.24 to 80.86 | 10.44 to 67.55 | -16.94 to 30.23 | -17.11 to 29.96 | -30.81 to 8.49 | 34 | 34 | 3 |
| **Shelling percentage** | -3.40 to 14.58 | -6.91 to 13.34 | -3.45 to 10.19 | -6.66 to 6.52 | -7.44 to 5.64 | 38 | 14 | 4 |
| **Grain yield per plant (g)** | 82.80 to 304.70 | 54.79 to 216.33 | -37.87 to 14.67 | -38.81 to 12.94 | -39.38 to 11.89 | 1 | 1 | 1 |

**Figure 1: Top hybrid identified based on mean grain yield per plant and standard heterosis (%) over three checks DHM 117, 900M Gold and NK 6240 in the present investigation**




Among the 60 hybrids studied, all hybrids were showed significant positive heterosis and heterobeltiosis for number of kernels per row and the range of haterosis and heterobeltiosis is 32.35 (MRC 6 × BML 7) to 93.14 per cent (MRC 17 × BML 15) and 9.64 (MRC 4 × BML 14) to 85.21 per cent (MRC 17 × BML 15). Heterosis for 100-kernel weight ranged from 17.24 (MRC 5 × BML 15) to 80.86 (MRC 11 × BML 7) per cent. The range of heterosis over standard checks DHM 117, 900M Gold and NK 6240 for 100-kernel weight varied from -16.94 (MRC 7 × BML 15) to 30.23 (MRC 8 × BML 14) per cent, -17.11 (MRC 7 × BML 15) to 29.96 (MRC 8 × BML 14) per cent and -30.81 (MRC 7 × BML 15) to 8.49 (MRC 8 × BML 14) per cent respectively.

For shelling percentage, the range of heterosis and heterobeltiosis varied from -3.40 (MRC 3 × BML 15) to 14.58 (MRC 12 × BML 7) and -6.91 (MRC 9 × BML 7) to 13.34 (MRC 12 × BML 7) per cent. Among 60 hybrids studied, 38 hybrids showed significant positive heterosis over standard check DHM 117 and four hybrids *viz*., MRC 6 × BML 14 (3.32 %), MRC 8 × BML 15 (3.29 %), MRC 9 × BML 14 (5.64 %) and MRC 14 × BML 7 (3.73 %) recorded significant and positive heterosis over standard check NK 6240 for shelling percentage. Heterosis for grain yield per plant ranged from 82.80 (MRC 16 × BML 14) to 304.70 (MRC 11 × BML 15) per cent and Heterobeltiosis varied from 54.79 (MRC 10 × BML 15) to 216.33 (MRC 11 × BML 15) per cent. All the hybrids obtained in the present study showed significant positive heterosis and heterobeltiosis for this trait. The hybrid MRC 13 × BML 14 recorded positive significant heterosis over three standard checks DHM 117, 900M Gold and NK 6240 (14.67 %, 12.94 % and 11.89 %, respectively) for grain yield per plant, (figure1). High and significant heterosis for grain yield accompanied by significant heterosis for one or more yield contributing characters was earlier reported by several workers Premalatha *et al.* [7], Bhavana *et al.* [8], Ram Reddy *et al.* [5], Sumalini *et al.* [9], Jawaharlal *et al.* [6], and Raghu *et al.* [10].

## CONCLUSION

Considering the entire yield contributing characters for standard heterosis, the hybrid MRC 13 × BML 14 can be given the status of good hybrid combination and genetically worthy cross, which showed desirable heterosis over standard checks for yield and important yield components. The hybrid MRC 13 × MRC 14 showed desirable significant heterosis for grain yield per plant, shelling percentage, 100-kernel weight, number of kernel rows per ear, ear length, days to 50 % tasseling and days to 50 % silking over standard

check DHM 117. Over standard check 900M Gold, it showed desirable significant heterosis for grain yield per plant, 100-kernel weight, ear girth, number of kernel rows per ear, ear length, days to 50 % tasseling and days to 50 % silking. Over standard check NK 6240, it showed desirable significant heterosis for grain yield per plant, number of kernels per row, number of kernel rows per ear, ear length.

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