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# Gene Action and Combining ability Studies for Yield and Yield Attributes in Single Cross Hybrids of Maize (*Zea mays* L.)

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**ABSTRACT**

The studies on gene action and combining ability using ten inbreds for grain yield and its components in maize through diallel analysis revealed that the components due to *sca* variance (ó$^2$*sca*) were higher than *gca* variance (ó$^2$*gca*) in all the characters and also the ratio ó$^2$*gca* to ó$^2$*sca* was less than unity, which indicated the preponderance of non-additve gene action in controlling the expression of all most all the traits. Based on both *per se* and *gca* effects, the genotypes BML 7, BML 6 and CM 211 among parental lines were identified as good general combiners for yield and other yield related components *i.e* plant height, ear length, ear girth, number of kernel rows per ear, number of kernels per row, 100-kernel weight. High *per se* performance and significant *sca* effects were exhibited by two hybrids *viz.,* CM 133 × BML 7 and CM 131 × BML 6 which could be exploited in the heterosis breeding programmes.

**Key words :** Gene action, General combining ability, Maize, Specific combining ability.

Maize (*Zea mays* L.) is the world's most widely grown cereal and is a primary staple food in many countries. It is also rich in starch, protein, oil and sucrose when compared to other important cereals. In India, maize ranks third position after rice and wheat with an area of 8.50 million hectares, with a production and productivity of 21 million tonnes and 2470 kg ha$^{-1}$ (Ministry of Agriculture, Govt. of India, 2010-2011). In Andhra Pradesh, it covers an area of 7.83 lakh hectares, with an annual production of 27.62 lakh tonnes and a productivity of 3527 kg ha$^{-1}$ (Ministry of Agriculture, Govt. of India 2010-2011). Though many synthetics and composites have contributed to maize production in India in the initial stages of maize improvement programme, of late, single cross hybrids are playing a vital role due to their high yielding potential. However, there is a continuous need to evolve new hybrids, which should exceed the existing hybrids in yield. In maize, the scope of exploitation of hybrid vigour will depend on the type of gene action besides the direction and magnitude of heterosis. Information on combining ability also provide guidelines to the plant breeder in selecting the elite parents and desirable cross combinations and at the same time reveals the nature of gene action involved in the expression of traits and thereby helps in formulating breeding methodology to be used to improve the yield. Hence, the present investigation was carried out to understand the nature and magnitude of gene action besides combining ability, which would assist in identifying the best inbreds as well as single cross hybrids of maize in the present material.

## MATERIAL AND METHODS

Ten inbred lines of maize *viz*., CM 119, CM 120, CM 131, CM 133, CM 210, CM 211, BML 6, BML 7,BML 13 and BML 10 were crossed in a half diallel fashion during *kharif*, 2009 and *Kharif* 2010 at S.V Agricultural college farm, Tirupati. All the forty five cross combinations were evaluated during *rabi*, 2009, *summer* 2010*, kharif* 2010, *rabi* 2010 -11 and *rice fallow* 2010-11 using a Randomized Block Design (RBD) with three replications. The crop was raised as per the recommended cultural practices. The row-to-row and plant to plant distance was 75 and 20 cm, respectively. The data were recorded on randomly selected five plants on plant height, ear length, ear girth, number of kernel rows per ear, number of kernels per row, 100-kernel weight and grain yield per plant. The data were subjected to preliminary analysis of variance (Panse and Sukhatme, 1985) and the combining ability analysis was done as per the procedure of Method 4 and Model l of Griffing's (1956) and for pooled analysis over environments, the procedure given by Singh (1973) was used.

## RESULTS AND DISCUSSION

Analysis of variance for combining ability pooled over environments (Table 1) showed highly significant variances due to *gca*, *sca* and environments (L) for all the traits studied. This shows the importance of both additive and non-additive genetic variances in the inheritance of all the characters. The variances due to *gca* × L and *sca* × L were also highly significant for all the characters except number of kernel rows per ear. Hence these results clearly indicated that, additive as well as non-additive genetic variances are greatly influenced by environment for most of the traits. Several workers *viz.,* Darrah and Hallauer (1972), Mandal (1996), Appunu *et al.,* (2006), Akbar *et al.,* (2008), Cruz-Lazaro *et al.,* (2010) and Premalatha and Kalamani (2011) also reported the same findings.

The significant *sca* × environment interaction is understandable because specific combining ability represents the non-additive component of genetic variation, which is known to be less stable over environments. The general combining ability variance includes genetic variance with additive × additive type of epistasis and a greater proportion of such epistatic interaction might have been contributed to the significant *gca* × environment interaction. In this case, when both additive and non-additive genes are highly influenced by the environment, environment will cause deviation upward or downward in the actual estimates. Some sort of reciprocal recurrent selection procedure is suggested as appropriate method for exploitation of both additive and non-additive gene action.

The overall estimates of *gca* effects revealed that (Table 2) the inbreds BML 7, BML 6 and CM 211 for plant height, ear length, ear girth, number of kernels per row, 100-kernel weight and grain yield per plant and CM 133, BML 7 and BML 6 for number of kernel rows per ear were found as the best general combiners in the desired direction. Crosses involving these parents might produce heterotic hybrids and recycled inbreds with high mean performance for the respective traits. Based on *gca* effects and *per se* performance, the inbred lines BML 7, BML 6 and CM 211 were recognized as the best parental lines for most of the traits under study. The parents with high *gca* could produce superior segregants in the $F_2$ as well as in later generations. The lines BML 7, BML 6 and CM 211 recorded high *gca* effects in desirable direction for yield and other yield related components *i.e* plant height, ear length, ear girth, number of kernel rows per ear, number of kernels per row, 100-kernel weight. Therefore, these inbred lines may be utilized in the hybridization programmes for selecting superior recombinants.

The estimates of *sca* effects revealed significant *sca* effects in the desired direction for most of the cross combinations (Table 3). The promising top five hybrids which showed high *sca* effects for plant height were CM 119 × CM 210 (27.54), CM 119 × BML 10 (24.96), CM 131 × BML 7 (23.95), CM 211 × BML 13 (17.59) and CM 120 × CM 211 (17.52). Similarly, the hybrids CM 211 × BML 13 (2.76), CM 120 × BML 13 (2.24), CM 133 × BML 7 (2.15), BML 6 × BML 10 (2.02) and CM 120 × CM 210 (1.19) for ear length; CM 133 × CM 210 (1.11), CM 119 × BML 10 (1.01), BML 6 × BML 13 (0.96), CM 133 × BML 13 (0.95) and CM 133 × BML 7 (0.88) for ear girth; CM 119 × CM 120 (0.57), CM 120 × BML 13 (0.50), CM 133 × BML 13 (0.49), BML 13 × BML 10 (0.40) and CM 120 × CM 210 (0.37) number of kernel rows per ear; CM 133 × BML 7 (6.36), CM 131 × BML 6 (6.19), CM 133 × CM 210 (6.01), CM 131 × CM 210 (5.40) and CM 133 × BML 13 (5.00) for number of kernels per row; CM 133 × BML 7 (4.58), CM 131 × BML 13 (4.33), CM 210 × BML 10 (3.69), CM 133 × CM 210 (3.17) and CM 120 × CM 211 (3.00) for100-kernel weigh and CM 133 × BML 7 (32.96), CM 133 × CM 210 (28.29), CM 119 × BML 6 (27.41), BML 6 × BML 10 (26.37) and CM 131 × BML 7 (16.27) for grain yield per plant recorded significant *sca* effects in the desired direction**.**

Based on both *per se* performance and *sca* effects the crosses *viz.,* CM 133 × BML 7

Table 1. Combined analysis of variance for combining ability over environments

| Source | df | Mean squares | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Plant height (cm) | Ear length (cm) | Ear girth (cm) | No. of kernel rows/ ear | No. of kernels/ Row | 100 Seed weight (g) | Grain yield/ Plant (g) |
| Environments (L) | 4 | 1065.20** | 15.48** | 4.37** | 1.54** | 163.91** | 252.32** | 1395.94** |
| GCA | 9 | 5712.99** | 18.98** | 7.56** | 1.85** | 120.98** | 80.99** | 2786.87** |
| SCA | 45 | 3638.84** | 24.60** | 8.58** | 0.83** | 281.45** | 62.47** | 4037.47** |
| GCA x L | 36 | 196.16** | 1.06** | 0.41** | 0.24 | 4.68** | 6.28** | 94.72** |
| SCA x L | 180 | 114.87** | 0.79** | 0.39** | 0.21 | 3.94** | 3.76** | 65.93** |
| Error | 540 | 16.97 | 0.35 | 0.19 | 0.28 | 1.22 | 1.00 | 33.81 |
| $\sigma^2 gca$ | | 94.93 | 0.31 | 0.12 | 0.03 | 1.99 | 1.33 | 45.88 |
| $\sigma^2 sca$ | | 724.38 | 4.85 | 1.68 | 0.13 | 56.04 | 12.29 | 800.73 |
| $\sigma^2 gca / \sigma^2 sca$ | | 0.13 | 0.06 | 0.07 | 0.21 | 0.04 | 0.11 | 0.06 |

*, ** Significant at 5 % and 1 %, respectively.

Table 2. Estimates of general combining ability (*gca*) effects in combined analysis for yield and yield contributing characters in maize.

| Parents | PH | EL | EG | NKRPE | NKPR | 100SKW | GYP |
|---|---|---|---|---|---|---|---|
| CM 119 | 5.97** | -0.23** | 0.10 | -0.02 | -0.28* | -0.66** | 0.38 |
| CM 120 | -7.41** | -0.65** | -0.21** | -0.17** | -1.26** | 0.23 | -3.86** |
| CM 131 | -6.95** | 0.07 | -0.07 | 0.00 | 0.03 | -0.43** | 2.72** |
| CM 133 | -5.17** | -0.24** | -0.46** | 0.25** | -0.06 | -1.49** | -6.78** |
| CM 210 | -12.48** | -0.61** | -0.29** | -0.16** | -1.79** | -1.12** | -7.26** |
| CM 211 | 13.86** | 0.73** | 0.37** | 0.13* | 1.42** | 0.35** | 2.89** |
| BML 6 | 7.31** | 0.49** | 0.47** | 0.18** | 1.52** | 1.68** | 7.28** |
| BML 7 | 15.16** | 0.96** | 0.50** | 0.19** | 2.42** | 2.19** | 11.99** |
| BML 13 | -7.03** | -0.50** | -0.42** | -0.17** | -1.74** | -0.43** | -9.37** |
| BML 10 | -3.27** | -0.02 | 0.01 | -0.22** | -0.25 | -0.32* | 2.00** |
| CD ($g_i$-$g_j$)at 5% | 1.47 | 0.21 | 0.15 | 0.15 | 0.39 | 0.35 | 2.08 |
| CD ($g_i$-$g_j$) at 1% | 1.94 | 0.27 | 0.20 | 0.20 | 0.52 | 0.47 | 2.74 |

*,** Significant at 5 % and 1 % levels, respectively.

PH=Plant height, EL=Ear length, EG=Ear girth, NKRPE=Number of kernel rows per ear, NKPR=Number of kernels per row, 100KW=100-Kernel weight, GYP=Grain yield per plant.

and CM 131× BML 6 were identified as the best crosses for yield and other yield related traits *i.e* plant height, ear length, ear girth, number of kernels per row, 100-kernel weight. In these crosses, combination of favourable genes from parents for the corresponding traits might have resulted in high *sca* effects. These two cross combinations are ideally suitable for commercial exploitation after testing their performance in multi-location and on farm trials.

By and large, in the present study the combining ability analysis indicated predominance of non-additive gene action in all the characters. Hence, by following recycling procedures such as recurrent selection and/or reciprocal recurrent selection, the frequency of favourable alleles could be increased in segregating generations and thereby superior inbreds could be isolated (Debnath, 1987). The parental lines BML 7, BML 6 and CM 211 in the present material were identified as the best

Table 3. Estimates of specific combining ability (*sca*) effects in combined analysis for yield and yield contributing characters in maize.

| S. No | Crosses | PH (cm) | | EL (cm) | | EG | | NKRPE | | NKPR | | 100-KW (g) | | GYP (g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SCA | Mean | SCA | Mean | SCA | Mean | SCA | Mean | SCA | Mean | SCA | Mean | SCA | Mean |
| 1 | CM 119 × CM 120 | 10.32** | 202.79 | 0.56* | 17.09 | 0.33 | 15.28 | 0.57** | 14.84 | 2.68** | 38.64 | 1.23** | 30.41 | 9.15** | 111.93 |
| 2 | CM 119 × CM 131 | 13.72** | 182.10 | -0.41 | 15.89 | 0.14 | 14.13 | -0.05 | 14.39 | -1.57** | 35.90 | -2.54** | 25.15 | 8.47** | 124.96 |
| 3 | CM 119 × CM 133 | 3.64* | 206.21 | 0.44 | 16.15 | 0.52** | 15.06 | -0.27 | 14.73 | 0.30 | 36.41 | -1.63** | 24.92 | -0.83 | 96.75 |
| 4 | CM 119 × CM 210 | 27.54** | 195.07 | 0.52* | 16.31 | 0.84** | 14.33 | 0.30 | 14.79 | 2.44** | 37.69 | 2.11** | 31.16 | 8.62** | 114.42 |
| 5 | CM 119 × CM 211 | 8.74** | 226.91 | 0.31 | 17.58 | 0.05 | 15.21 | 0.08 | 14.64 | 1.74** | 39.51 | 1.47** | 29.74 | 0.37 | 115.35 |
| 6 | CM 119 × BML 6 | 16.41** | 210.94 | 1.34** | 19.67 | 0.67** | 15.01 | 0.15 | 15.09 | 4.57** | 44.02 | 2.10** | 30.71 | 27.41** | 145.70 |
| 7 | CM 119 × BML 7 | 11.31** | 213.19 | 1.00** | 19.37 | 0.63** | 15.91 | 0.21 | 14.73 | 4.63** | 43.65 | 1.91** | 31.26 | 17.06** | 142.50 |
| 8 | CM 119 × BML 13 | 0.22 | 186.55 | 0.29 | 17.21 | 0.65** | 15.67 | 0.20 | 14.08 | 2.45** | 39.02 | 1.92** | 28.76 | 2.26 | 94.04 |
| 9 | CM 119 × BML 10 | 24.96** | 208.73 | 1.53** | 18.45 | 1.01** | 15.64 | 0.08 | 14.52 | 3.33** | 41.31 | 2.72** | 31.94 | 15.55** | 135.36 |
| 10 | CM 120 × CM 131 | 12.11** | 180.64 | 0.27 | 18.08 | 0.71** | 15.07 | 0.01 | 14.26 | 3.68** | 41.87 | 2.03 | 31.36 | 9.57** | 125.32 |
| 11 | CM 120 × CM 133 | 16.20** | 185.68 | -0.02 | 16.99 | 0.53** | 14.40 | -0.19 | 14.80 | 1.88** | 39.25 | 0.81 | 27.14 | 3.96 | 98.67 |
| 12 | CM 120 × CM 210 | 2.22 | 160.90 | 1.19** | 18.86 | 0.38* | 14.51 | 0.37* | 14.79 | 4.54** | 38.55 | 1.74** | 28.99 | 5.92* | 106.87 |
| 13 | CM 120 × CM 211 | 17.52** | 213.22 | 1.07** | 19.03 | 0.87** | 14.94 | 0.14 | 14.39 | 3.67** | 42.50 | 3.00** | 33.84 | 15.24** | 127.39 |
| 14 | CM 120 × BML 6 | 14.75** | 210.31 | 1.24** | 19.40 | 0.57** | 15.85 | -0.15 | 13.77 | 3.79** | 41.34 | -0.47 | 32.15 | 9.60** | 141.59 |
| 15 | CM 120 × BML7 | 7.71** | 208.08 | 0.03 | 18.34 | 0.44* | 15.27 | 0.14 | 14.93 | 1.22** | 43.95 | 0.40 | 32.66 | 3.56 | 123.99 |
| 16 | CM 120 × BML 13 | 7.50** | 169.35 | 2.24** | 19.46 | 0.78** | 15.64 | 0.50** | 14.53 | 3.99** | 41.50 | 2.23** | 33.77 | 24.66** | 124.63 |
| 17 | CM 120 × BML 10 | 10.15** | 169.65 | 1.51** | 18.23 | 0.79** | 15.06 | 0.25 | 13.73 | 4.05** | 39.24 | 2.71** | 34.67 | 17.09** | 128.93 |
| 18 | CM 131 × CM 133 | 14.89** | 171.22 | 0.65** | 19.46 | 0.49** | 15.03 | 0.14 | 14.79 | -1.51** | 35.27 | 0.78 | 29.52 | 9.89** | 92.72 |
| 19 | CM 131 × CM 210 | 2.05 | 155.36 | 1.50** | 20.56 | 0.82** | 15.67 | 0.27 | 14.63 | 5.40** | 41.55 | 0.65 | 26.24 | 13.24** | 107.95 |
| 20 | CM 131 × CM 211 | 13.62** | 203.17 | 1.39** | 20.63 | 0.88** | 15.73 | -0.15 | 14.22 | 3.62** | 43.38 | 1.06* | 29.97 | 12.99** | 119.09 |
| 21 | CM 131 × BML 6 | -4.74** | 189.61 | 1.95** | 21.00 | 0.79** | 16.33 | 0.15 | 15.33 | 6.19** | 44.93 | 3.17** | 33.12 | 26.11** | 144.71 |
| 22 | CM 131 × BML 7 | 23.95** | 204.13 | 1.32** | 18.77 | 0.80** | 14.72 | 0.15 | 14.38 | 5.57** | 44.70 | 2.45** | 30.03 | 16.27* | 135.97 |
| 23 | CM 131 × BML 13 | 15.12** | 185.27 | 0.96** | 16.41 | 0.33 | 13.27 | 0.17 | 14.93 | 4.66** | 40.62 | 4.33** | 31.98 | 12.34** | 114.51 |
| 24 | CM 131 × BML 10 | 14.59** | 177.11 | 0.80** | 18.08 | 0.56** | 15.19 | 0.28 | 14.53 | 2.70** | 39.33 | 0.58 | 27.05 | 13.14** | 143.03 |
| 25 | CM 133 × CM 210 | 10.43** | 173.07 | 1.54** | 18.79 | 1.11** | 15.99 | 0.08 | 14.66 | 6.01** | 40.80 | 3.17** | 30.83 | 28.29** | 111.79 |
| 26 | CM 133 × CM 211 | 16.39** | 200.47 | 1.00** | 19.07 | 0.40* | 14.84 | -0.17 | 14.66 | 4.63** | 44.10 | 0.66 | 27.74 | 10.83** | 98.73 |
| 27 | CM 133 × BML 6 | 9.60** | 187.42 | 0.32 | 18.27 | 0.38* | 15.12 | -0.09 | 14.73 | 2.78** | 42.83 | 0.24 | 27.38 | 4.35 | 113.43 |
| 28 | CM 133 × BML 7 | 15.72** | 193.07 | 2.15** | 19.79 | 0.88** | 15.42 | 0.04 | 14.93 | 6.36** | 44.15 | 4.58** | 31.38 | 32.96** | 146.18 |
| 29 | CM 133 × BML 13 | 11.74** | 168.71 | 0.80** | 16.94 | 0.95** | 14.35 | 0.49** | 15.09 | 5.00** | 38.67 | 2.62** | 30.58 | 9.32** | 106.53 |
| 30 | CM 133 × BML 10 | 5.36** | 171.19 | -0.31 | 16.25 | 0.06 | 13.82 | 0.13 | 14.75 | 0.25 | 36.09 | 1.63** | 27.66 | -0.17 | 92.42 |
| 31 | CM 210 × CM 211 | 9.22** | 211.37 | 1.48** | 20.75 | 0.47** | 15.13 | 0.22 | 14.79 | 3.49** | 40.32 | 2.80** | 30.10 | 14.64** | 124.10 |
| 32 | CM 210 × BML 6 | 4.91** | 168.30 | -0.87** | 15.69 | 0.10 | 13.95 | 0.29 | 14.77 | 1.65** | 39.60 | -0.51** | 24.36 | -7.42** | 102.48 |
| 33 | CM 210 × BML7 | 8.32** | 178.26 | 0.73** | 18.43 | 0.67** | 15.72 | -0.02 | 14.66 | 1.87** | 39.83 | 0.79** | 31.57 | 14.03** | 126.81 |
| 34 | CM 210 × BML 13 | 14.65** | 166.64 | 0.58* | 17.93 | 0.78** | 14.69 | 0.23 | 14.99 | 1.19** | 37.78 | -0.78** | 27.73 | -0.13 | 88.40 |
| 35 | CM 210 × BML 10 | 3.01 | 160.63 | 1.79** | 16.89 | 0.62** | 14.17 | 0.50** | 14.69 | 3.29** | 34.33 | 3.69** | 33.52 | 23.81** | 135.26 |
| 36 | CM 211 × BML 6 | 8.97** | 219.58 | -0.71** | 19.82 | 0.14 | 16.04 | -0.45* | 14.59 | -2.46** | 38.70 | -1.59** | 29.59 | 3.39 | 120.75 |
| 37 | CM 211 × BML 7 | 13.00** | 228.99 | 0.72** | 20.46 | 0.26 | 16.14 | 0.02 | 14.49 | 4.66** | 46.70 | 2.08** | 32.94 | 22.72** | 146.28 |
| 38 | CM 211 × BML 13 | 17.59** | 205.95 | 2.76** | 21.01 | 0.72** | 15.24 | 0.22 | 14.72 | 4.75** | 40.95 | 2.82** | 31.91 | 20.96** | 124.49 |
| 39 | CM 211 × BML 10 | 10.55** | 199.47 | 0.42 | 18.48 | -0.40* | 14.33 | -0.54** | 13.46 | 4.51** | 41.53 | -1.04* | 26.28 | -2.44 | 115.82 |
| 40 | BML 6 × BML 7 | 3.25 | 196.40 | 0.06 | 19.13 | -0.65** | 15.12 | -0.35 | 14.35 | 0.89 | 42.47 | -1.86** | 30.58 | -4.24 | 124.37 |
| 41 | BML 6 × BML 13 | 11.70** | 183.42 | 1.03** | 19.25 | 0.96** | 16.24 | 0.27 | 14.88 | 2.70** | 41.47 | 1.85** | 31.92 | 10.84** | 110.76 |
| 42 | BML 6 × BML 10 | 7.46** | 168.42 | 2.02** | 19.98 | 0.60** | 15.51 | 0.17 | 14.39 | 4.55** | 37.77 | 2.15** | 30.56 | 26.37** | 144.75 |
| 43 | BML 7 × BML 1 | 8.38** | 198.97 | 0.80** | 18.71 | 0.24 | 15.15 | -0.15 | 14.06 | 1.60** | 41.22 | -0.06 | 32.49 | -2.90 | 106.59 |
| 44 | BML 7 × BML 10 | 11.15** | 206.57 | 0.68** | 18.53 | 0.23 | 15.28 | -0.02 | 14.39 | 4.22** | 44.36 | 1.77** | 32.80 | 19.76** | 141.20 |
| 45 | BML13 × BML 10 | 14.18** | 176.22 | 0.78** | 17.75 | 0.72** | 14.31 | 0.40* | 14.76 | 2.03** | 36.78 | -0.89* | 27.45 | 2.99 | 100.68 |
| | CD ($S_{ij}$) at 5 % | 4.90 | - | 0.70 | - | 0.52 | - | 0.53 | - | 1.31 | - | 1.19 | - | 6.92 | - |
| | CD ($S_{ij}$) at 1 % | 6.45 | - | 0.92 | - | 0.69 | - | 0.69 | - | 1.73 | - | 1.57 | - | 9.10 | - |
| | CD ($S_{ij}$ - $S_{ik}$) at 5 % | 4.67 | - | 0.67 | - | 0.50 | - | 0.50 | - | 1.25 | - | 1.13 | - | 6.59 | - |
| | CD ($S_{ij}$ - $S_{ik}$) at 1 % | 6.15 | - | 0.88 | - | 0.65 | - | 0.66 | - | 1.65 | - | 1.49 | - | 8.68 | - |

*,** Significant at 5 % and 1 % levels, respectively. PH=Plant height, EL=Ear length, EG=Ear girth, NKRPE=Number of kernel rows per ear, NKPR=Number of kernels per row, 100KW=100-Kernel weight, GYP=Grain yield per plant.

general combiners for yield and other yield related traits *i.e* plant height, ear length, ear girth, number of kernel rows per ear, number of kernels per row, 100-kernel weight which could be exploited in hybrid breeding programmes to develop superior cross combinations and/or for the development of synthetic varieties. The crosses *viz.,* CM 133 × BML 7 and CM 131 × BML 6 were identified as the best crosses for yield and other yield related traits *i.e* plant height, ear length, ear girth, number of kernels per row, 100-kernel weight based on *per se* and *sca* performance hence, these two hybrids could be exploited for commercial cultivation after testing their performance in multi-location trials.

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