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# COMBINING ABILITY ANALYSIS IN A MAIZE DIALLEL

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## ABSTRACT

**Combining ability analysis was carried out in an 8×8 maize diallel for days to silk, plant height, cob placement, kernel rows/cob, kernels/row, cob length, cob girth, 1000–grain weight, grain yield/plant, and stover yield/plant. The inbreds used in the crossing programme were CM 104, CM 105, CM 110, CM 111, CM 300, CM 400, CM 500, and Inbred NLD Composite. Mean squares due to gca, sca and reciprocals were highly significant for all the 10 characters. The general predictability ratio indicated that the progeny performance was based on both gca and sca. The inbred CM 500 is a good general combiner for maximum number of characters (5), followed by CM 105 and CM 110 (each for 3 characters). The cross CM 500×CM 400 showed significant desirable sca effects for 7 out of total 10 characters, followed by CM 111×CM 400, which is a good specific combiner for 6 characters. On the basis of sca effects, there was a good association between grain yield and 1000-grain weight, cob girth, kernel rows/cob and stover yield.**

**Key words:** Combining ability, maize, diallel, quantitative characters.

Combining ability analysis is of special importance in cross-fertilized crops like maize as it helps in identifying potential inbred lines that can be used for producing hybrids/synthetics/composites, and thus assists in isolating basic material on which the success of any breeding programme depends. Some lines produce outstanding progenies on crossing, while certain others, apparently equally desirable, turn out to be poor parents. The inbreds showing high gca effects are good for producing synthetics. On the other hand, the lines giving superior performance in specific combinations are used in hybrid production. The present study aims to identify superior inbreds and cross combinations from an 8×8 diallel in maize.

## MATERIALS AND METHODS

The experimental material comprised eight maize inbreds: CM 104, CM 105, CM 110, CM 111, CM 300, CM 400, CM 500, In NLD Com (Inbred NLD Composite), and their 56 $F_1$ hybrids in all possible combinations including reciprocals. All the parents and crosses were grown in randomized blocks with three replications during kharif (July–October) 1983. The distance between rows and plants was 60 and 20 cm, respectively. Each entry was represented by a single row of 20 plants. Five random competitive plants from each row were scored for 10 quantitative characters (Table 1).

The analysis was carried out according to Method 1 Model I of Griffing [1].

## RESULTS AND DISCUSSION

The mean squares, equivalent components of mean squares and general predictability ratio are presented in Table 1. The mean squares due to general combining ability (gca) as well as specific combining ability (sca) were highly significant for all the characters, indicating that both additive and nonadditive gene effects were important for the control of these characters. The mean squares for reciprocals were also significant for all the characters studied. The fixed-effect model used in the present investigation does not provide the estimates of variance components, and thus it was not possible to know precisely the relative importance of additive and dominance components in the control of characters. However, in this model, an idea about the relative importance of gca and sca in determining progeny performance can be obtained by calculating general predictability ratio on the basis of gca and sca equivalent components of mean squares. Closer the ratio to unity, greater the predictability based on gca alone. The estimates of this ratio in the present study were in no case near unity, indicating that the progeny performance was not based on gca alone but both gca and sca accounted for genetic variability. Similar results were reported earlier in maize [2–4].

**Table 1. Mean square from the analysis of variance for combining ability, equivalent components of mean squares, and general predictability ratio for ten quantitative characters in an 8×8 full diallel of maize**

| Source | d.f | Grain yield per plant | Stover yield per plant | Days to silk | Plant height | Cob placement | Kernel rows per cob | Kernels per row | Cob length | Cob girth | 1000-grain weight |
|---|---|---|---|---|---|---|---|---|---|---|---|
| General combining ability | 7 | 316.2** | 2535.0** | 18.3** | 507.8** | 382.9** | 1.9** | 16.1** | 3.1** | 1.9** | 260.1** |
| Specific combining ability | 28 | 362.3** | 2360.7** | 7.2** | 849.1** | 380.3** | 0.7** | 12.5** | 3.1** | 0.5** | 190.4** |
| Reciprocals | 28 | 314.2** | 1543.7** | 4.3** | 118.3** | 128.8** | 0.2** | 6.0** | 1.5** | 0.4** | 169.3** |
| Error | 26 | 96.4 | 605.9 | 1.5 | 27.2 | 30.9 | 0.1 | 2.5 | 0.5 | 0.1 | 47.2 |
| **Equivalent components of mean squares:** | | | | | | | | | | | |
| $\frac{1}{7}\sum_i g_i^2$ | | 13.7 | 120.6 | 1.0 | 30.0 | 22.0 | 0.1 | 0.8 | 0.2 | 0.1 | 113.3 |
| $\frac{1}{28}\sum_i\sum_j s_{ij}^2$ | | 265.9 | 1754.8 | 5.7 | 821.9 | 349.4 | 0.6 | 10.0 | 2.6 | 0.4 | 143.2 |
| **General predictability ratio:** | | | | | | | | | | | |
| $\dfrac{2(\frac{1}{7}\sum_i g_i^2)}{2(\frac{1}{7}\sum_i g_i^2)+\frac{1}{28}\sum_i\sum_j s_{ij}^2}$ | | 0.1 | 0.1 | 0.3 | 0.1 | 0.1 | 0.3 | 0.1 | 0.1 | 0.3 | 0.2 |

**Significant at 1% level.

## GENERAL COMBINING ABILITY EFFECTS

The estimates of gca (Table 2) indicate that only one inbred each for grain yield/plant (CM 500), stover yield/plant (CM 111), and kernels/row (CM 500) was a good general combiner. However, CM 111 was the poorest general combiner for grain yield/plant, and CM 500 for stover yield. The inbreds CM 104, CM 300 and In NLD Com were poor combiners for number of kernels/row. The inbreds CM 105, CM 110, and CM 500 were good general combiners for silking period. On the other hand, CM 111, CM 300 and CM 400 proved to be poor general combiners for this character. For plant height, CM 110, CM 111 and CM 300 were good combiners and CM 104, CM 500 and In NLD Com poor. Two inbreds (CM 110 and CM 300) were good general combiners for cob placement. But, inbreds CM 104, CM 105 and CM 500 were poor combiners for this character. For number of kernel rows in a cob, CM 104 and CM 105 had significant positive gca effects, but CM 111, CM 300 and CM 400 showed significant negative gca effects, and thus poor combiners for this characters. Two inbreds (CM 105 and CM 500) were good combiners for cob length. CM 300 and CM 400 proved to be poor combiners for this character. For cob girth, CM 104, CM 500 and In NLD Com were good and CM 110, CM 111 and CM 300 poor general combiners. None of the parents showed significant gca effects for 1000-grain weight.

**Table 2. Estimates gca effects for ten quantitative characters in an 8×8 maize diallel**

| Parent | Grain yield per plant | Stover yield per plant | Days to silk | Plant height | Cob placement | Kernel rows per cob | Kernels per row | Cob length | Cob girth | 1000-grain weight |
|---|---|---|---|---|---|---|---|---|---|---|
| CM 104 | 1.04 | 3.49 | 0.34 | 2.90* | 3.55** | 0.59** | −1.11 | −0.23** | 0.34** | 4.21 |
| CM 105 | −1.93 | −7.75 | −0.77** | 0.17 | 6.59** | 0.33** | 0.51 | 0.44** | −0.03** | −3.24 |
| CM 110 | 1.31 | 2.30 | −1.68** | −5.27** | −8.02** | −0.13 | 0.69 | 0.31 | −0.47** | 2.71 |
| CM 111 | −9.27** | 17.27** | 1.25** | −5.34** | −1.69 | −0.28* | −0.07 | −0.10 | −0.34** | −3.34 |
| CM 300 | −0.63 | 2.49 | 0.88** | −6.30** | −5.03** | −0.43** | −1.24** | −0.65** | −0.31** | −3.98 |
| CM 400 | 3.20 | 3.02 | 0.62* | −1.20** | −0.73** | −0.26* | 0.53 | −0.44** | 0.06 | −4.36 |
| CM 500 | 5.92** | −26.24** | −1.20** | 6.31** | 4.12** | 0.08 | 1.56** | 0.63** | 0.38** | 3.74 |
| In NLD Com | 0.37 | 5.41 | 0.54 | 8.74** | 1.21 | 0.09 | −0.88* | 0.04 | 0.37** | 4.22 |
| SE ($g_i$) | ±2.29 | ±5.76 | ±0.29 | ±1.22 | ±1.30 | ±0.11 | ±0.37 | ±0.17 | ±0.09 | ±2.58 |
| LSD (0.05) | 6.80 | 17.05 | 0.85 | 3.62 | 3.85 | 0.31 | 1.10 | 0.49 | 0.26 | 4.76 |

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

These results indicate that among the eight inbreds included in the present study, CM 500 was a good general combiner for five characters (grain yield, silking period, kernels/row, cob length, and girth). The parents CM 105 and CM 110 were next in order, each showing desirable gca effects for three characters (CM 105 for silking period, kernel rows/cob, and cob length; and CM 110 for silking period, plant height, and cob placement). Three inbreds, namely, CM 104 (for kernel rows/cob and cob girth), CM 111 (for plant height and stover yield/plant), and CM 300 (for plant height and cob placement) were associated with desirable gca effects for two characters each. The parent In NLD Com showed desirable gca effects only for cob girth. However, CM 400 did not exhibit desirable gca effects for any of the characters studied. Therefore, the inbreds CM 500, CM 105 and CM 110 have a good potential to be used as components of synthetics and composites of maize.

## SPECIFIC COMBINING ABILITY EFFECTS

The estimates of sca effects of 8 crosses showing significant positive values for grain yield (Table 3) show that cross CM 500×CM 400 had significant desirable sca effects for 7 out of 10 characters (except for days to silk, plant height, and kernels/row),

**Table 3. Estimates of sca effects of eight hybrids good specific combiners for grain yield**

| Cross | Grain yield per plant | Stover yield per plant | Days to silk | Plant height | Cob place-ment | Kernel rows per cob | Kernels per row | Cob length | Cob girth | 1000-grain weight |
|---|---|---|---|---|---|---|---|---|---|---|
| CM 110×CM 400 | 15.62* | −1.16 | 0.94 | −2.43 | −13.38 | −0.40 | −1.18 | −0.17 | −0.03 | 15.81** |
| CM 111 ×CM 400 | 25.46** | 81.88** | −0.16 | 5.42 | 9.02* | 0.65* | 4.15** | 1.28** | 0.10 | 5.69** |
| CM 300×In NLD Com | 18.31** | 13.72 | −0.33 | 10.04** | −6.54 | 0.78** | 2.50* | 0.29 | 0.50* | 3.81* |
| CM 105×CM 104 | 23.50** | 57.58** | −1.53 | 7.66* | 2.73 | 0.23 | 1.47 | 0.27 | −0.13 | 6.75** |
| CM 111×CM 104 | 14.58* | −17.07 | −3.33** | 12.80** | 12.03** | 0.47 | 1.13 | 0.51 | 0.71** | 2.00 |
| CM 400×CM 104 | 18.92** | 36.78** | −2.03* | 5.83** | 15.83** | 0.83** | 1.87 | 0.29 | 0.82** | 1.08 |
| CM 300×CM 111 | 18.50** | 8.58 | 1.33 | 1.03 | 5.73 | 0.07 | 0.90 | 0.17 | 0.04 | 11.42** |
| CM 500×CM 400 | 22.33** | 44.58** | −1.03 | −3.13 | −10.10* | 0.73* | 0.67 | 1.22* | 0.73** | 18.75** |
| SE $s_{ij}$ | 4.86 | 9.38 | 0.77 | 2.66 | 2.87 | 0.20 | 0.99 | 0.34 | 0.19 | 1.43 |
| LSD (0.05) $s_{ij} - s_{kl}$ | 16.66 | 41.78 | 1.08 | 8.86 | 9.44 | 0.81 | 2.68 | 1.21 | 0.64 | 11.66 |
| $r_{ij} - r_{kl}$ | 19.24 | 48.24 | 2.41 | 10.23 | 10.90 | 0.94 | 3.10 | 1.39 | 0.74 | 13.46 |

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

followed by cross CM 111×CM 400, which was a good specific combiner for six characters including grain yield (except for silking period, plant height, cob placement, and cob girth). Crosses Cm 300 × In NLD Com and CM 400×CM 104 exhibited significant desirable sca effects each for five characters: CM 330 × In NLD Com for grain yield, kernel rows/cob, kernels/row, cob girth, and 1000-grain weight; and cross CM 400×CM 104 for grain yield, stover yield, silking period, kernel rows/cob, and cob girth. Three crosses, namely, CM 110×CM 400 (for grain yield, cob placement, and 1000-grain weight), CM 105×CM 104 (for grain yield, stover yield, and 1000-grain weight), and CM 111×CM 104 (for grain yield, silking period, and cob girth) were good specific combiners for three characters each. Cross CM 300×CM 111 showed significant desirable sca effects only for grain yield and 1000-grain weight.

One conclusion can easily be drawn from the results of Table 3 that crosses CM 500×CM 400, CM 111×CM 400, CM 300×In NLD Com, and CM 400×CM 104 showed a good association between grain yield and other characters. This association, however, varied across characters. The character 1000-grain weight, for which none of the parents showed significant gca effects, showed maximum association with grain yield (in 6 out of 8 crosses), followed by cob girth, kernel rows/cob, and stover yield (4 crosses each). Similarly, inbred CM 400 which did not exhibit desirable significant gca effects for any of the characters studied, was involved in three top crosses showing positive association between grain yield and other characters. These results also indicate that grain yield in maize may be improved by improving its three important component characters, namely, grain weight, kernel rows/cob, and cob girth. Characters like cob placement, kernels/row, and cob length proved to be of little importance for grain yield. Plant height showed undesirable or no association with grain yield on the basis of sca effects.

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