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# COMBINING ABILITY AND SUPERIORITY IN YELLOW MAIZE UNDER THREE LOCATIONS

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## ABSTRACT

*Half diallel cross among seven maize (Zea mays L.) inbred lines (Gm1560, Gm1561,Gm1562,Gm1563,Gm1564,Gm1565 and Gm1566) were made at Gemmeiza Research Station during the growing season 2008.Twenty one crosses plus three checks (SC162,SC166and SC164) were evaluated at Gemmeiza , Sids and Mallawy Agricultural Research Stations in the growing season 2009. Data were collected on number days to 50% silking date , plant height ,ear height , resistance to late wilt disease , grain yield (Mg/ha), ear length , ear diameter , number of rows /ear , number of kernels /row and weight of 100-kernels. Data were genetically analyzed by using Griffing (1956) method -4 model- 1 fixed model. The mean squares associated with locations were found to be significant for all studied traits, except number of days to 50% silking date, resistance to late wilt disease and weight of 100-kernels as well as general GCA and specific SCA combining ability mean squares were significant for most studied traits. The magnitude of $K^2$GCA/ $K^2$SCA ratio exhibited the importance non-additive gene action for the inheritance these studied traits. Also, ratio of $K^2$GCA x loc / $K^2$SCA x loc showed the importance of non-additive gene action for all studied traits under this study. The inbred lines Gm1560, Gm1561 and Gm1565 had desirable and significant GCA effects for grain yield , the inbred line Gm1562 had desirable and significant GCA effects for short plants and lower ear position, while the inbred line 1566 had desirable and significant GCA effects for plant height ,ear length and number of kernels/row. Also, three crosses i.e. 1x4, 1x5 and 2x5 (10.85, 11.02 and 10.75 Mg/ha) surpassed significantly and out-yielded relative to the highest check SC166 (9.88 Mg/ha) as relative increasing was estimated by (9.82, 11.54 and 8.81%, respectively). These crosses could be used as good and desirable hybrids in maize breeding program.*

**Key words:** Diallel, Combining ability, GCA, SCA, Gene action, Superiority, Maize.

## INTRODUCTION

Half diallel analysis gave information about the components of genetic variance and helped the breeder in the selection of desirable parents for crossing programs and also in deciding a suitable breeding method for genetic improvement of various traits

The concept of general (GCA) and specific (SCA) combining ability was firstly defined by Sprague and Tatum (1942). El-Zeir *et al.* (1999) and Ibrahim (2001) found that SCA effects were higher than GCA effects for grain yield and most studied traits, while Mahmoud (1996), Soliman and Sadek (1999) , Nawar (1985), Ibrahim (2007) and Ibrahim and El-Ghonemy (2010) found the reverse. Amer *et al.* (1998) revealed that the GCA and SCA mean squares were highly significant for grain yield, ear length, ear diameter and number of kernels/ row. Aly (1999) indicated that both GCA and SCA variances were significant for grain yield in two years and their combined data. Motawei and Mosa (2009) found that mean squares due to both GCA and SCA were significant or highly significant for grain yield, days to mid-silk, plant height and ear height. Ibrahim (2005) found heterosis for grain yield in $F_1$ hybrids relative to the check variety SC 155, SC 3080 and to the mean of all crosses, which,

ranged from (-28.24 to 45.42 %), (-26.52 to 48.90 %) and (-33.54 to 34.67 %), respectively. Abd El- Azeem and Abd El- Moula (2009) found that four crosses (L 4 × Gz 638), (L 4 × Gm 1004), (L 7 × Gz 639) and (L 7 × Gz 649) significantly out yielded the best check SC155 by 12.88, 10.81, 17.75 and 13.87 %, respectively. Abd El-Moneam *et al.* (2009) found positive significant heterosis values for grain yield.

The objectives of this study were: 1) to determine general combining ability of new inbred lines and specific combining ability for new single crosses 2) to estimate the relative increasing % (superiority) for grain yield trait relative to the commercial hybrids as checks (SC162, SC166 and SC 164) in diallel crosses and 3) to identify promising single crosses in the present study.

## MATERIALS AND METHODS

Seven $S_8$ yellow maize inbred lines i.e.(Gm1560, Gm1561, Gm1562, Gm1563, Gm1564, Gm1565 and Gm1566 ) were used in this study are shown in Table 1. These inbred lines were developed at Gemmeiza Agricultural Research Station and had high combining ability. All possible combination were made without reciprocal among the seven inbred lines in 2008 growing season at Gemmeiza Research Station. The 21 single crosses and three checks (SC162, SC166 and SC164) were evaluated at three locations (Gemmeiza, Sids and Mallawy) Agricultural Research Stations in 2009 growing season. Entries were arranged in a randomized complete block design (RCBD) with four replications. Plot size one row, 6m long and 80 cm width and hills were spaced at 25cm. All cultural practices were applied as recommend. Data were collected on number of days to 50% silking date, plant and ear heights, resistance to late wilt disease% (was submitted to the arcsine of the square root transformation), grain yield (Mg/ha) adjusted to 15.5% moisture content, ear length, ear diameter, number of rows/ear ,number of kernels/ row and weight of 100-kernels . Data were analysed across three locations after testing the homogeneity of error mean squares according to Snedecor and Cochran, 1967. Combining ability variances and effects were calculated according to Griffing (1956) method 4 model -1 fixed model. The hybrids effect was assumed to be fixed while; the locations effect was considered random.

Superiority (%) for hybrids over check cultivars for grain yield was computed as follows:-

$$\text{Sup}(\%) = \frac{\overline{F} - \overline{M}\text{check}}{\overline{M}\text{check}} \text{x}100$$

Where: is the mean value of experimental hybrid and $\overline{M}$ check is the mean value of the check hybrid.

The significance of heterosis was estimated according the following formula:

$$\text{L.S.D. for superiority (\%)} = \sqrt{\frac{\text{Ms Hybrid} \times \text{loc.}}{\text{r} \times \text{loc.}}} \times .\text{ta}$$

**Table (1): Names and pedigree of the inbred lines in this study:**

| No | Line | Name | Pedigree |
|---|---|---|---|
| 1- | P1 | Gm1560 | CIMMYT P2 |
| 2- | P2 | Gm1561 | CIMMYT P23 |
| 3- | P3 | Gm1562 | CIMMYT P35 |
| 4- | P4 | Gm1563 | CIMMYT P38 |
| 5- | P5 | Gm1564 | CIMMYT P41 |
| 6- | P6 | Gm1565 | SK-21 |
| 7- | P7 | Gm1566 | Comp-45 |

## RESULTS AND DISCUSSION

Mean performance ($\overline{X}$), experimental error ($s^2$) and coefficient of variability (C.V.%) for the ten studied traits at each location and the combined analysis are presented in Table 2. The obtained results indicated that mean performance at Gemmeiza was higher comparing to the two other locations for all studied traits, except silking date, ear length and ear diameter, while the reverse was obtained for all traits. This indicates that accuracy of experiment was higher at Gemmeiza location or that environmental conditions were more suitable at Gemmeiza than Sids and Mallawy locations. Mosa (2003) and Ibrahim and El-Ghonemy (2010) defined that stress environment for mean performance of certain attribute is low and this stress for one trait did not mean stress for all of the rest studied traits. This indicated that the three locations differed among them and genotypes differed from location to anther.

Table 3, Exhibited that mean squares due to locations were highly significant for all studies traits, except weight of 100-kernels as well as mean squares due to crosses and their interactions with location were significant, too. Non- additive gene action effects were more importance than the additive gene action effects for all studied traits according to the ratio $K^2GCA/ K^2SCA$. Also, on the other hand, the ratio $K^2GCA \times loc / K^2SCA \times loc$ was less than the unity for all the studied traits indicating that the non-additive gene action effects played important role in the inheritance these traits through interactions with locations. These results are agreement with that reported by Shehata *et al.* (1975), El-Hosary (1989), EL-Shamarka *et al.* (1994) and El-Ghonemy and Ibrahim (2010).

Table 4, Referred to values of mean performance for number of days to 50% silking date, plant height and ear height were lower than the three checks (SC162, SC166 and SC164) towards earliness, shortness and lower ear position, usually, early maturing hybrids are shorter, and late maturing, thus, plant breeders prefer to select for lower ear position. While the other traits such as ear length, ear diameter did not differ from the three checks in this respect. Number of rows /ear, number of kernels/ row and weight of 100-kernels gave higher values of means and considered the main components of grain yield comparing to the three checks, while the mean performance for grain yield , three single crosses i.e. $1 \times 4$ , $1 \times 5$ and $2 \times 5$ (10.85, 11.02 and 10.75 Mg/ha.) gave higher values than the highest check SC166 (9.88 Mg/ha.) by relative increasing was (9.82 ,11.54 and 8.81 % , respectively), where it considered promising crosses and could be share in maize breeding program because of their highly yielding abilities.

Superiority of single crosses relative to the three checks (SC162, SC166 and SC164) for grain yield as an average of the three locations are presented in Table 5. Superiority in those traits, specially grain yield trait, is one of greatest among important agronomic traits in maize because superiority or heterosis for grain yield trait is great , ten crosses such as 1× 2 ,1× 3, 1× 4 , 1× 5, 2× 4, 2× 5, 4× 6, 4× 7, 5× 6 and 6× 7 surpassed significantly by relative increasing was estimated by values (13.49, 13.92, 18.28, 20.14, 11.85, 17.19, 15.01, 12.72, 12.40 and 8.07 %, respectively) relative to the check hybrid SC162. Three crosses such as 1× 4, 1× 5, and 2× 5 surpassed significantly and out-yielded by values (9.84 , 11.56 and 8.83 % ) relative to the check hybrid SC166 , also six crosses such as 1× 2, 1× 3, 1× 4, 1× 5, 2× 5 and 4× 6 surpassed significantly by relative increasing estimated by values (7.58, 7.99, 12.12, 13.88, 11.09 and 9.02 %) relative to the check hybrid SC164. These new crosses exhibited useful superiority in addition to it considered favorite and desirable hybrids in maize breeding program. Many investigators reported that high superiority for grain yield of maize i.e. Mahmoud *et al.* (1990), Mosa (2003), Amer (2003), Ibrahim (2005) and Ibrahim and El-Ghonemy (2010).

Estimates of general combining ability (GCA) effects of parents for the combined data are presented in Table 6. The inbred lines i.e., Gm1560, Gm1561 Gm1563 and Gm1565 had desirable and significant GCA effects for grain yield, the inbred line Gm1562 had desirable and significant GCA effects for plant and ear heights towards (short plants and lower ear position), while the inbred line Gm1563 exhibited desirable and significant GCA effects for plant height, resistance to late wilt disease, number of rows / ear and weight of 100-kernels. The inbred line 1566 gave desirable and significant GCA effects for ear height, ear length and number of kernels/ row. These inbred lines had desirable and significant GCA effects for most studied traits.

Estimates of specific combining ability (SCA) effects of single crosses for the combined data are given in Table 7. Ten single crosses showed positive significant SCA effects for grain yield , seven single crosses for weight of 100-kernels, four single crosses for number of rows/ ear, four single crosses for ear diameter, two single crosses for ear length, one single cross for resistance to late wilt disease, while, on the other hand, three, two and four single crosses had desirable and negative significant SCA effects for number of days to 50% silking date, plant and ear heights towards (earliness, short plants and lower ear position). Also, the single cross 1 × 3 showed positive significant SCA effects for ear diameter, weight of-100 kernels and grain yield .The single crosses 1 × 6 and 1 × 7 are considered good single crosses for number of days to 50% silking date, plant and ear heights towards (earliness, short plants and lower ear position) .These single crosses for most studied traits in herein are considered favorite and desirable crosses to share in maize breeding program.

**Table (2): Mean ($\overline{X}$), exprimental error ($s^2$)and coefficient of variability (C.V%) for the following studied traits at (Gemmeiza , Sids and Mallawy) locations plus their combined analysis.**

| Location | Variable | No. of days to 50% Silking date (day) | Plant height (cm) | Ear height (cm) | Resistance to late wilt | Ear length (cm) | Ear diameter (cm) | No of rows/ ear | No. of Kernels/ row | Weight of 100-kernels ( g ) | Grain yield (Mg/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gemmeiza | $\overline{X}$ | 60.1 | 243.2 | 142.1 | 85.49 | 18.4 | 4.74 | 15.14 | 40.23 | 34.77 | 9.780 |
| | Error | 1.16 | 36.6 | 28.2 | 30.81 | 1.39 | 0.183 | 0.98 | 10.65 | 7.92 | 0.759 |
| | C.V % | 1.80 | 2.49 | 3.74 | 6.49 | 6.40 | 9.03 | 6.53 | 8.11 | 8.10 | 8.910 |
| | | | | | | | | | | | |
| Sids | $\overline{X}$ | 67.1 | 216.44 | 109.9 | 85.76 | 19.89 | 5.03 | 14.6 | 37.63 | 34.6 | 8.830 |
| | Error | 4.37 | 32.92 | 20.1 | 36.51 | 1.93 | 0.024 | 0.32 | 5.79 | 3.7 | 0.725 |
| | C.V % | 3.11 | 2.65 | 4.10 | 7.05 | 6.98 | 3.10 | 3.89 | 6.40 | 5.54 | 9.640 |
| | | | | | | | | | | | |
| Mallawy | $\overline{X}$ | 63.6 | 222.2 | 114.1 | 88.68 | 17.8 | 4.64 | 14.9 | 37.6 | 34.3 | 8.960 |
| | Error | 2.32 | 32.11 | 29.50 | 14.57 | 0.832 | 0.126 | 0.416 | 5.0 | 5.75 | 0.528 |
| | C.V % | 2.40 | 2.55 | 4.76 | 4.31 | 5.134 | 7.66 | 4.34 | 5.94 | 7.00 | 8.110 |
| | | | | | | | | | | | |
| Combined | $\overline{X}$ | 63.6 | 227.3 | 122.0 | 86.64 | 18.7 | 4.8 | 14.9 | 38.5 | 34.6 | 9.190 |
| | Error | 2.62 | 33.88 | 25.93 | 27.30 | 1.39 | 0.11 | 0.57 | 7.15 | 5.80 | 0.671 |
| | C.V % | 3.74 | 6.04 | 6.60 | 6.03 | 6.76 | 6.97 | 5.57 | 7.71 | 7.37 | 8.910 |

Table (3): Mean squares of combined analysis for the ten studied traits at three locations in 2009 season.

| Sources | DF | No.of days to 50% silking date | Plant height (cm) | Ear height (cm) | Resistance to late wilt disease | Ear length (cm) | Ear diameter (cm) | No. of rows /ear | No. of kernels /row | Weight of 100-kernels (g) | Grain yield (Mg/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Locations (Loc.) | 2 | 1053.7** | 16618.6** | 25750.3** | 263.33** | 99.4** | 3.37** | 6.27** | 190.41** | 4.13ns | 22.374** |
| Reps/ Loc. | 9 | 1.9 | 85.9 | 111.5 | 26.87 | 1.69 | 0.580 | 0.49 | 3.34 | 9.66 | 0.92 |
| GCA | 6 | 15.00 ns | 2778.6** | 1344.12** | 123.6 ns | 10.66** | 0.588** | 9.30** | 66.65** | 229.24** | 31.56** |
| SCA | 14 | 64.32** | 2786.76** | 1170.12** | 107.4 ns | 4.74* | 0.468** | 6.13** | 27.85ns | 148.62** | 26.04** |
| GCAx Loc. | 12 | 25.37** | 825.38** | 83.08** | 46.83ns | 3.03* | 0.100ns | 1.53** | 13.01ns | 13.45* | 1.520** |
| SCA x Loc. | 28 | 16.59** | 909.06** | 303.23** | 72.61* | 2.10ns | 0.120ns | 1.07ns | 17.55* | 7.95ns | 1.321** |
| Error | 180 | 2.62 | 33.87 | 25.91 | 27.30 | 1.39 | 0.111 | 0.57 | 7.144 | 5.776 | 0.67 |
| $K^2GCA/ K^2SCA$ | | -0.045 | 0.2080 | 0.291 | 0.115 | 0.578 | 0.280 | 0.307 | 0.723 | 0.307 | 0.243 |
| $\frac{K^2 \text{ GCA x loc}}{K^2 \text{ SCA x loc}}$ | | 0.331 | 0.0002 | 0.200 | 0.086 | 0.462 | -0.244 | 0.384 | 0.113 | 0.706 | 0.261 |

*.** refer to 0.05 and 0.01 levels of significantly, respectively.

**Table (4): Mean performance of maize genotypes for combined data at three locations (Gemmeiza , Sids and Mallawy ) in 2009 season.**

| Crosses | | No. of days to 50% silking date (day) | Plant height (cm.) | Ear height (cm.) | Resistance to late wilt disease | Ear length (cm.) | Ear diameter (cm.) | No. of rows /ear | No. of kernels /row | Weight of-100 kernel (g) | Grain Yield (Mg/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1x2 | | 64.5 | 244.6 | 131.4 | 89.04 | 18.8 | 4.8 | 14.6 | 40.8 | 37.3 | 10.41 |
| 1x3 | | 64.1 | 234.7 | 128.7 | 87.85 | 17.9 | 4.8 | 15.2 | 38.4 | 37.8 | 10.45 |
| 1x4 | | 66.4 | 236.7 | 128.7 | 90.00 | 19.2 | 4.7 | 16.4 | 37.9 | 37.3 | 10.85 |
| 1x5 | | 67.5 | 228.1 | 123.4 | 87.74 | 19.3 | 5.1 | 16.2 | 39.1 | 37.9 | 11.02 |
| 1x6 | | 60.1 | 223.0 | 116.8 | 84.98 | 17.8 | 4.7 | 14.9 | 36.2 | 31.3 | 7.84 |
| 1x7 | | 59.7 | 203.0 | 106.2 | 78.88 | 19.4 | 4.7 | 14.1 | 39.3 | 28.0 | 7.19 |
| 2x3 | | 61.2 | 233.1 | 129.7 | 84.76 | 18.1 | 4.8 | 14.9 | 36.4 | 34.4 | 8.62 |
| 2x4 | | 64.1 | 232.4 | 127.8 | 88.38 | 18.6 | 4.6 | 14.9 | 38.6 | 38.4 | 10.26 |
| 2x5 | | 62.9 | 237.7 | 128.0 | 82.53 | 18.6 | 4.9 | 15.1 | 39.2 | 39.3 | 10.75 |
| 2x6 | | 62.8 | 238.3 | 129.6 | 87.51 | 19.4 | 4.8 | 14.7 | 38.7 | 36.9 | 9.49 |
| 2x7 | | 63.3 | 228.5 | 125.1 | 88.08 | 19.1 | 4.9 | 13.3 | 40.1 | 35.7 | 8.67 |
| 3x4 | | 63.3 | 176.5 | 97.1 | 87.97 | 17.7 | 4.5 | 14.3 | 36.9 | 28.7 | 6.66 |
| 3x5 | | 63.6 | 210.8 | 100.4 | 83.87 | 19.2 | 4.5 | 15.0 | 34.9 | 26.6 | 6.45 |
| 3x6 | | 62.8 | 229.7 | 122.8 | 88.21 | 17.8 | 4.8 | 14.5 | 37.3 | 35.2 | 8.82 |
| 3x7 | | 63.5 | 222.8 | 117.3 | 81.52 | 19.0 | 4.5 | 13.8 | 36.7 | 28.2 | 6.91 |
| 4x5 | | 61.3 | 221.4 | 116.2 | 90.00 | 18.9 | 4.7 | 14.0 | 35.9 | 32.9 | 7.65 |
| 4x6 | | 65.8 | 240.3 | 130.3 | 89.04 | 18.9 | 5.3 | 15.9 | 40.3 | 35.8 | 10.55 |
| 4x7 | | 64.8 | 238.5 | 130.4 | 85.62 | 19.4 | 4.9 | 15.1 | 40.8 | 36.5 | 10.34 |
| 5x6 | | 63.5 | 233.8 | 130.9 | 89.04 | 18.2 | 4.9 | 15.2 | 40.1 | 36.5 | 10.31 |
| 5x7 | | 63.9 | 234.0 | 123.4 | 90.00 | 20.1 | 5.0 | 14.6 | 41.0 | 36.1 | 9.77 |
| 6x7 | | 66.9 | 225.3 | 117.3 | 84.46 | 19.1 | 5.1 | 15.6 | 39.9 | 35.0 | 9.98 |
| Checks | SC 162 | 65.5 | 245.6 | 138.2 | 90.00 | 21.9 | 5.10 | 14.95 | 42.6 | 36.2 | 9.31 |
| | SC 166 | 64.7 | 235.5 | 125.3 | 89.30 | 22.6 | 5.18 | 17.70 | 42.6 | 36.5 | 9.88 |
| | SC 164 | 64.1 | 230.2 | 129.5 | 89.30 | 21.8 | 4.95 | 14.90 | 40.7 | 38.0 | 9.68 |
| L.S.D | 0.05 | 3.63 | 24.52 | 12.70 | 9.77 | 1.27 | 0.28 | 0.91 | 3.32 | 2.56 | 0.97 |
| | 0.01 | 4.85 | 32.77 | 16.98 | 13.06 | 1.70 | 0.37 | 1.21 | 4.44 | 3.42 | 1.30 |

**Table (5): Superiority of 21 single crosses relative to the three checks (SC162 ,SC164 and SC 166 ) for grain yield as an average of the three locations.**

| Single crosses | Grain yield ( Mg/ha ) | ( % ) Superiority of 21 single crosses relative to the following checks | | |
|---|---|---|---|---|
| | | SC162 ( 9.173 Mg/ha) | SC166 ( 9.878 Mg/ha) | SC164 ( 9.677 Mg/ha ) |
| 1x2 | 10.41 | 13.49** | 5.39** | 7.58** |
| 1x3 | 10.45 | 13.92** | 5.79** | 7.99** |
| 1x4 | 10.85 | 18.28** | 9.84** | 12.12** |
| 1x5 | 11.02 | 20.14** | 11.56** | 13.88** |
| 1x6 | 7.84 | -14.53** | -20.63** | -18.98** |
| 1x7 | 7.19 | -21.62** | -27.21** | -25.70** |
| 2x3 | 8.62 | -6.03** | -12.74** | -10.92** |
| 2x4 | 10.26 | 11.85** | 3.87** | 6.02** |
| 2x5 | 10.75 | 17.19** | 8.83** | 11.09** |
| 2x6 | 9.49 | 3.46** | -3.93** | -1.93** |
| 2x7 | 8.67 | -5.48** | -21.23** | -10.41** |
| 3x4 | 6.66 | -27.40** | -32.58** | -31.18** |
| 3x5 | 6.45 | -29.68** | -34.70** | -33.35** |
| 3x6 | 8.82 | -3.85** | -10.71** | -8.87** |
| 3x7 | 6.91 | -24.67** | -30.05** | -28.59** |
| 4x5 | 7.65 | -16.60** | -22.56** | -20.95** |
| 4x6 | 10.55 | 15.01** | 6.80** | 9.02** |
| 4x7 | 10.34 | 12.72** | 4.68** | 6.86** |
| 5x6 | 10.31 | 12.40** | 4.37** | 6.54** |
| 5x7 | 9.77 | 6.51** | -1.09 | 0.96ns |
| 6x7 | 9.98 | 8.07** | 1.03 | 3.13** |
| L.S.D 0.05 | | 1.19 | | |
| L.S.D 0.01 | | 1.59 | | |

*.** refer to 0.05 and 0.01 levels of significantly, respectively.

**Table ( 6): Estimates of general combining ability effects for the seven inbred lines by using combined analysis at the three locations.**

| Inbred Lines | | No of days to 50% silking date | Plant height | Ear height | Resistance to late wilt | Ear length | Ear diameter | No.of rows /ear | No. of kernels /row | Weight of 100-kernels | Grain Yield (Mg/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1- Gm 1560 | | 0.112 | 1.257 | 0.667 | -0.272 | 0.030 | -0.033 | 0.431** | 0.147 | 0.441* | 0.525** |
| 2- Gm 1561 | | -0.588 | 10.157* | 7.933** | 0.091 | 0.058 | 0.002 | -0.347** | 0.559** | 2.931** | 0.610** |
| 3- Gm 1562 | | -0.655 | -11.242** | -7.167** | -1.136 | -0.872** | -0.186** | -0.306** | -2.079** | -3.298** | -1.444** |
| 4- Gm 1563 | | 0.812 | -3.576* | -0.300 | 2.232* | 0.120 | -0.018 | 0.263** | -0.124 | 0.429* | 0.235 |
| 5- Gm 1564 | | 0.212 | 0.407 | -1.900 | 0.666 | 0.073 | 0.062 | 0.183* | -0.178 | 0.391 | 0.161 |
| 6- Gm 1565 | | 0.029 | 5.323 | 3.183* | 0.677 | 0.066 | 0.129** | 0.336** | 0.309 | 0.679** | 0.368* |
| 7- Gm 1566 | | 0.079 | -2.326 | -2.417* | -2.258* | 0.526* | 0.044 | -0.561** | 1.366** | -1.571** | -0.455** |
| LSD gi | 0.05 | 1.32 | 7.49 | 2.37 | 1.78 | 0.45 | 0.08 | 0.15 | 0.19 | 0.42 | 0.32 |
| | 0.01 | 1.85 | 10.47 | 3.32 | 2.50 | 0.63 | 0.12 | 0.21 | 0.26 | 0.59 | 0.45 |
| LSD gi-gj | 0.05 | 2.02 | 11.43 | 3.63 | 2.72 | 0.69 | 0.13 | 0.49 | 1.44 | 0.45 | 1.70 |
| | 0.01 | 2.83 | 16.00 | 5.08 | 3.81 | 0.97 | 0.18 | 0.69 | 2.01 | 0.63 | 2.39 |

*,** refer to 0.05 and 0.01 levels of significantly, respectively

**Table ( 7): Estimates of specific combining ability effects of single crosses for the combined of the three locations (Gemmeiza , Sids and Mallawy).**

| Crosses | | No. of days to 50% silking date | Plant height | Ear height | Resistance to late wilt | Ear Length | Ear diameter | No. of rows/ ear | No.of Kernels /row | Weight of 100-kernels | Grain Yield (Mg/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1x2 | | 1.361 | 5.88 | 0.84 | 2.581 | 0.012 | 0.003 | -0.351 | 1.618 | -0.684 | 0.081 |
| 1x3 | | 1.011 | 17.37* | 13.19** | 2.616 | 0.009 | 0.183* | 0.249 | 1.831 | 6.077** | 2.179** |
| 1x4 | | 1.878 | 11.70 | 6.33 | 1.398 | 0.309 | -0.085 | 0.789** | -0.616 | 1.884** | 0.903** |
| 1x5 | | 3.561** | -0.87 | 2.68 | 0.706 | 0.539 | 0.302** | 0.719** | 0.571 | 2.531** | 1.146** |
| 1x6 | | -3.672** | -10.87 | -8.99* | -2.072 | -0.988** | -0.240** | -0.784** | -2.716* | -4.383** | -2.239** |
| 1x7 | | -4.139** | -23.22** | -14.06** | -5.229* | 0.119 | -0.163 | -0.621* | -0.689 | -5.424** | -2.071** |
| 2x3 | | -1.206 | 6.88 | 6.93 | -0.837 | 0.172 | 0.198* | 0.686** | -0.606 | 0.196 | 0.266 |
| 2x4 | | 0.244 | -1.45 | -1.86 | -0.581 | -0.319 | -0.145 | 0.117 | -0.377 | 0.452 | 0.221 |
| 2x5 | | -0.322 | -0.18 | -0.01 | -4.872* | -0.319 | 0.075 | 0.397 | 0.359 | 1.449* | 0.786** |
| 2x6 | | -0.222 | -4.52 | -3.51 | 0.099 | 0.567 | -0.167* | -0.139 | -0.661 | -1.239 | -0.675* |
| 2x7 | | 0.144 | -6.62 | -2.41 | 3.609 | -0.243 | 0.035 | -0.709** | -0.334 | -0.173 | -0.678* |
| 3x4 | | -0.439 | -35.97** | -17.42** | 0.229 | -0.223 | -0.082 | -0.541* | 0.628 | -2.994** | -1.318** |
| 3x5 | | 0.411 | -5.70 | -12.49** | -2.304 | -0.643 | -0.212* | 0.222 | -1.369 | -5.055** | -1.463** |
| 3x6 | | -0.239 | 8.30 | 4.84 | 2.026 | 1.264** | 0.055 | -0.364 | 0.578 | 3.306** | 0.701* |
| 3x7 | | 0.461 | 9.12 | 4.94 | 1.731 | -0.579 | -0.143 | -0.251 | -1.062 | -1.528* | -0.366 |
| 4x5 | | -3.36** | -2.70 | -3.61 | 0.461 | 0.099 | -0.130 | -1.296** | -2.324* | -2.524** | -1.932** |
| 4x6 | | 1.294 | 11.30 | 5.39 | -0.509 | 0.039 | 0.337** | 0.451 | 1.589 | 0.146 | 0.755** |
| 4x7 | | 0.328 | 17.12* | 11.16* | -0.999 | 0.096 | 0.105 | 0.481 | 1.099 | 3.037** | 1.371** |
| 5x6 | | -0.356 | 0.82 | 7.66 | 1.058 | -0.648 | -0.093 | -0.153 | 1.493 | 0.842 | 0.588* |
| 5x7 | | 0.011 | 8.63 | 5.76 | 4.951* | 0.842* | 0.058 | 0.111 | 1.269 | 2.759** | 0.874** |
| 6x7 | | 3.194** | -5.03 | -5.41 | -0.602 | -0.234 | 0.108 | 0.991** | -0.284 | 1.329 | 0.870** |
| L S D | 0.05 | 1.97 | 14.56 | 8.40* | 4.11 | 0.70 | 0.17 | 0.50 | 2.02 | 1.36 | 0.56 |
| Sij | 0.01 | 2.65 | 19.60 | 11.33 | 5.54 | 0.94 | 0.23 | 0.67 | 2.73 | 1.83 | 0.75 |
| L S D | 0.05 | 3.05 | 22.57 | 13.03 | 6.38 | 1.08 | 0.26 | 0.77 | 3.14 | 2.11 | 0.86 |
| Sij-Sik | 0.01 | 4.10 | 30.39 | 17.55 | 8.59 | 1.46 | 0.35 | 1.04 | 4.22 | 2.84 | 1.16 |
| L.S.D | 0.05 | 2.64 | 19.55 | 11.29 | 5.52 | 0.94 | 0.22 | 0.67 | 2.72 | 1.83 | 0.75 |
| Sij-Skl | 0.01 | 3.56 | 26.31 | 15.20 | 7.44 | 1.26 | 0.30 | 0.90 | 3.66 | 2.46 | 1.00 |

*,** refer to 0.05 and 0.01 levels of significantly, respectively.

## REFERENCES


**Abd El-Azeem,M.E.M. and M.A. Abd El-Moula 2009 .** Gene action and combining ability for grain yield and other attributes yellow maize. Egypt. J. Plant Breed. 13: 123-139.

**Abd El-Moneam,M.A; A.N. Attia, M.I.El.Emery and E.A.Fayed 2009.** Combining ability and Heterosis for some agronomic traits in crosses of maize. Pak.J. Biol. Sci. 12 : 433 – 438.

**Aly, R. S.H. 1999.** Genetical studies for some agronomical and technological characters of maize (Zea *mays* L). M.Sc. Thesis, Faculty of Agriculture, Kafr El-Sheikh, Tanta University, Egypt. 50 : 733 –743.

**Amer, E.A. 2003.** Diallel analysis for yield and it's components of maize under two different locations. Minufiya. J. Agric. Res. 28: 1363 – 1373.

**Amer, E.A., A.A. El-Shenawy and F.A. EL-Zeir 1998 .** Diallel analysis for ten inbred lines of maize. Egypt J. Appl Sci. 13. 79-91.

**El- Ghonemy, M.A. and M.H.A. Ibrahim (2010)** . Diallel analysis of yellow maize for combining ability and heterosis.J. Agric .Sci. Mansoura Univ. 1: 779 – 792

**El-Hosary, A.A. 1989.** Heterosis and combining ability of six inbred lines of maize in diallel crosses over two years. Egypt, J. Agron. 14: 47 – 58.

**El-Shamarka, Sh.A.; AM.I. Dawood and A.M. Shehata 1994.** Genetic analysis of diallel crosses in maize under two nitrogen levels. Minufiya J. Agric. Res. 19: 1051 – 1064.

**EL-Zeir, F.A.A.; E.A. Amer and A. Abd EL-Aziz 1999.** Combining ability analysis for grain yield and other agronomic traits in yellow maize inbreeds (*Zea mays L.)* Minufiya. J. Agric. Res. 24: 829 – 868.

**Griffing, B. 1956 .** Concept of general and specific combining ability in relationto diallel crossing systems. Aust. J. Biol. Sci., 9: 463 – 493.

**Ibrahim , M.H.A. and M. A.El-Gonemy (2010).** Heterosis and combining ability in maize (*Zea mays L.*) diallel crosses. J. Plant production, Agric .Sci. Mansoura univ.,1 : 733-743.

**Ibrahim, M.H.A. (2005).** Heterosis and combining ability in yellow maize (*Zea mays L. )* over two locations (Sakha and Nubaria). Egypt. J. Plant Breed. 9 : 65 – 75. Special Issue.

**Ibrahim, M.H.A. ,M.M.A. Osman and M.A. El-Ghonemy 2007.** Combining ability of new yellow maize inbred lines under two different locations. Minufiya J. Agric. Res. 32 : 185 – 201.

**Ibrahim, M.H.A. 2001.** Studies on corn breeding. Ph.D. Thesis, Fac. Agric. Kafer EL-Sheikh, Tanta University, Egypt.

**Mahmoud, A.A. 1996.** Evaluation of combining ability of newly developed inbred lines of maize. Ph. D. Thesis, Agric. Cairo. Univ., Egypt.

**Mahmoud, I.M., M.A. Rashed, Eman, M. Fahmy and M. H. Abo-Dheaf 1990.** Heterosis, combining ability and types of gene action in a 6x6 diallel of maize. Annals Agric.Sci., Special Issue, 307-317.

**Mosa, H.E. (2003).** Heterosis and combining ability in maize (*Zea mays L).* Minufiya J. Agric. Res. 28: I375-1386.

**Motawei, A.A. and H.E. Mosa (2009).** Genetic analysis for some quantitative traits in yellow maize via half diallel. Egypt. J. Plant Breed. 13: 223 – 233.

**Nawar, A.A. (1985).** Hybrid vigor and combining ability and their interactions with years in maize *(Zea mays L* ) Minufiya J. Agric. Res. 10: 115-132.

**Shehata, A.H. and N.L. Dhawan. 1975.** Genetic analysis of grain yield in maize as manifested in genetically diverse varietal population and their crosses. Egypt. J. Genet Cytol. 4: 96-116.

**Snedecor, G.W. and W.G. Cochran (1967).** Statistical Methods. 6th ed. Iowa State Univ. Press, Ames.,Iowa, USA.

**Soliman, F.H.S. and S.E. Sadek. 1999.** Combining ability of new maize inbred lines and its utilization in the Egyptian hybrid program. Bull. Fac. Agric. Cairo Univ.,

**Sprague, G.F. and L.A. Tatum 1942.** General vs. specific combining ability in single crosses of corn J. Amer Soc. Agron. 34 : 923 – 932.

## الملخص العربى

## القدرة على التآلف وقوة الهجين في الذرة الصفراء تحت ثلاث مواقع

**محمد حسن علي إبراهيم ، محي الدين محمد أحمد عثمان ومحمد أحمد الغنيمي**

قسم بحوث الذرة الشامية – معهد بحوث المحاصيل الحقليـــة – مركز البحوث الزراعية بالجيزة -مصر

١. تم عمل كل التهجينات الممكنة بين سبع سلالات من الذرة الصفراء بنظام الدياليل الغير كامل لنحصل على 21 هجين فردي بمحطة البحوث الزراعية بالجميزة موسم 2008.

٢. تم تقيم هذه الهجن بالإضافة إلى ثلاثة هجن فردية تجارية هم (هـــ ف 162، هـــ ف 166، هـــ ف 164)في ثلاث تجارب بمحطات البحوث الزراعية بالجميزة وسدس وملوي خلال الموسم الزراعي 2009وقد اشتملت الدراسة على صفة ميعاد التزهير حتى ظهور 50% للحرابر ، ارتفاع النبات سم ، ارتفاع الكوز سم، والمقاومة لمرض الذبول المتأخر حيث تم تحويلها بطريقة الـــ Arcsine، ومحصول الحبوب ( مليون جرام / هكتار) وتم تعديل المحتوى الرطوبي لصفة المحصول على 15.5%رطوبة – طول الكوز سم ، قطر الكوز سم، عدد الصفوف بالكوز، عدد الحبوب بالصف، ووزن الـــ 100حبه بالجرام.

٣. تم تحليل النتائج الوراثية طبقا للطريقة الرابعة الموديل الأول للعالم جرفنج 1956 الموديل الثابت وكانت النتائج كما يلي :

١. التباين الراجع إلى المواقع كان معنوي لمعظم الصفات المدروسه وكذلك تباين القدرة العامة والخاصة على الائتلاف كان معنوياً لمعظم الصفات المدروسة.

٢. أظهر فعل الجين غير المضيف أهمية أكثرفى وراثة الصفات المدروسة مقارنة بفعل الجين المضيف .

٣. أظهر تفاعل الجين المضيف مع المواقع أكثر أهمية مقارنة بالجين الغير مضيف لكل الصفات المدروسة.

٤. أظهرت السلالات جميزة(1560، 1561، 1565 ) تأثيرات معنوية مقبولة لصفة محصول الحبوب . وأظهرت السلالة 1562تأثيرات معنوية ومقبولة لصفة قصر النبات وانخفاض موقع الكوز وكذلك أظهرت السلالة 1566تأثيرات معنوية وجيدة لطول الكوز ، عدد الحبوب للصف الواحد.

تفوقت ثلاثة هجن فردية وهي هـــ ف 4 × 1، هـــ ف 5 × 1، هـــ .ف 5 × 2 بقيم محصولية قدرها 10.75 -11.02 ( 10.85-مليون جرام /هكتار) مقارنة بالهجين الفردي التجاري .هـــ ف 166 (9.88 مليون جرام /هكتار ) وتعتبر هذه الهجن جيدة ومرغوبة ويمكن استخدامها في المستقبل في برنامج تربية الذرة الشامية.