4. RESULTS AND DISCUSSION

4.1. Analysis of variance:

Analysis of variance for the studied traits in separate planting dates as well as the combined analysis is presented in (Table 4). Test of homogeneity revealed the validity of the combined analysis over both sowing dates. Sowing dates mean squares were significant for all traits except number of rows/ ear, number of kernels/ row and shelling percentage, indicating over all differences between the two sowing dates, with mean values in early sowing being higher than those in late sowing for all traits except ear husk (Table 5). The increase in these traits at early sowing date may be due to the prevailing of favorable temperature and day length leading to greater vegetative growth, yield and its components of corn plants. Therefore, the first sowing date seemed to be non-stress environments. These results are in harmony with those obtained by **Nawar *et al.* (1998), El-Hosary and El-Badawy (2005), El-Hosary *et al.* (2006) and Sedhom *et al.* (2007).**

Crosses mean squares were significant for all the studied traits at both sowing dates as well as the combined analysis except ear diameter at early sowing date, indicating the wide diversity between the parental materials used in the present study. Significant crosses x sowing date mean squares were obtained for all traits except ear height, ear husk, and ear diameter, revealing that the tested crosses varied from each other and ranked differently from sowing date to another.

Lines mean squares were significant for all traits at early and late sowing dates as well as the combined over them, indicating the wide diversity among those inbred lines. Significant lines x sowing date mean squares were detected for all traits except tasseling date, ear height, ear husk, ear diameter and shelling%.

These finding indicate that parental inbred lines differ in their mean performance in most traits.

Significant mean squares due to testers were obtained for all traits in both sowing date as well as the combined analysis except maturity dates at both sowing date as well as the combined analysis, tasseling date, silking date, leaf area, ear diameter, number of kernels/ row at early sowing, and ear length at early sowing date and the combined analysis. Such results indicated a wide range of variability among parental testers. In addition, lines mean squares were much higher than those of testers for most studied traits. Such results revealed that lines contributed much more to the total variation as compared to testers. Therefore, the total GCA variance was due to inbred lines for most traits. Also, the interaction between tester x sowing date mean squares were significant for silking date, leaf area, ear length, ear diameter, no. of kernels/ row, ear weight/ plant, 100-kernel weight and grain yield/ plant. This indicated that the testers behaved somewhat differently from one sowing date to another.

Significant line x tester mean squares were obtained for all traits except ear diameter at both sowing dates as well as the combined analysis, ear husk, number of rows/ ear and number of kernels/ row at late sowing date and shelling percentage at early sowing date. Significant interaction between line x tester x sowing date mean squares were obtained for tasseling and silking dates, plant height, leaf area, no. of rows/ ear, 100-kernel weight, shelling percentage, ear weight/ plant and grain yield/ plant.

4.2. Mean performance

Mean values of top crosses along with three hybrid checks (T.W. G 352, S.C. Pioneer 3080 and S.C. G 155) for all the studied traits in both sowing dates as well as their combined data are presented in (Table 5).

Results in (Table 5) showed that the mean performance of tasseling date was significantly lower than the best earlier check variety by one, twenty four and eighteen top crosses at early, late sowing dates as well as the combined analysis, respectively. The top cross T_1xL_1 at early sowing date had earlier than the best check variety S.C. Pioneer 3080. While, the top crosses T_3xL_{14}, T_1xL_1 and T_3xL_{16} gave the lowest mean values compared with other genotypes at late sowing date. The top crosses T_1xL_1, T_1xL_{13} and T_3xL_{14} gave the lowest mean values for tasseling date at the combined data.

For silking date, zero, twenty six and fifteen top crosses exhibited significantly earliness than the earlier check variety at early, late sowing dates as well as the combined, respectively. The top crosses T_1xL_1, T_1xL_{13}, T_2xL_{12} and T_3xL_{10} gave the lowest mean values for this trait at the combined data.

Regarding maturity date, fourty six, thirteen, fourty seven top crosses expressed significantly earliest than the earlier check variety. From breeder point of view, the previous mentioned top crosses seemed to be of prime importance since earliness in maize hybrids is a must avoid destructive pests. The top crosses T_1xL_1, T_1xL_6, T_2xL_7, T_2xL_9, T_2xL_{10}, T_2xL_{18}, T_3xL_6, T_3xL_{10} and L_3xL_{12} expressed the lowest significant values of maturity date and it were the earliest among the studied top crosses at the combined analysis.

Regarding plant height, twenty one, fiveteen and twenty top crosses expressed significant lowest values as compared with the best check variety T.W. G 352 at early, late sowing date as well as the combined analysis, respectively. The top crosses T_1xL_{10}, T_1xL_{12}, T_1xL_{18}, T_2xL_9 and T_2xL_{15} in the early sowing date, T_2xL_9, T_1xT_{13} and T_1xL_{15} at late sowing date and T_1xL_{10}, T_1xL_{15}, T_1xL_{18}, T_2xL_9, T_2xL_{15} and T_3xL_{14} at the combined analysis were the best among the studied crosses since they expressed the lowest significant values of this trait (Table 5).

As for ear height, eight, zero and nine top crosses showed significant lowest values as compared to best check variety (G155) from the three check hybrids at early, late sowing dates as well as the combined analysis, respectively (Table 5).

The three top crosses T_1xL_{10}, T_1xL_{18}, T_2xL_9 and T_2xL_{15} at the combined analysis which had the best values for plant height showed also the most desirable values for ear height. Therefore, these top crosses are prospective in maize breeding program.

For leaf area, fourteen, six and sixteen top crosses were significantly superior to the best check variety at early, late sowing dates and the combined analysis, respectively. Moreover, the seven top crosses T_1xL_6, T_1xL_1, T_2xL_2, T_2xL_{12}, T_3xL_1, T_3xL_9, T_3xL_{15} and T_3xL_{16} were the best among all studied crosses since they expressed the highest significant values of this trait in the combined analysis over both sowing dates (Table 5).

Regarding ear husk, none of the top crosses surpassed significant compared to the best check variety in both sowing dates and the combined data. However, the most top crosses exhibited insignificant values of ear husk compared with the best check variety (Table 5).

As for ear length one, ten and six top crosses exhibited significant higher than the best check variety at early, late sowing dates as well as the combined data, respectively. The top crosses T_1xL_{14}, T_2xL_3, T_2xL_{11}, T_3xL_{11} and T_3xL_{18} at the combined analysis exhibited significantly higher mean values as compared to the best check hybrid S.C. Pioneer 3080.

For ear diameter, none of the top crosses significantly surpassed the best check hybrid at early, late sowing date and the combined analysis. However, the check hybrid S.C. Pioneer 3080 gave the highest value for this trait but without superiority than most top crosses in both sowing dates as well as the combined data.

For number of rows/ ear, the top crosses T_2xL_5 at early sowing date; T_2xL_4, T_3xL_5 and T_3xL_6 at late sowing date; and T_1xL_{13}, T_2xL_5 ,T_3xL_5 and T_3xL_6 at the combined analysis, exhibited significant higher than the best check hybrid.

For number of kernels/row, with the exception of crossesT_1xL_3, $T_2xL_{11,}$$T_2xL_{20,}$ $T_3xL_{16,}$ T_3xL_9 and T_3xL_{12} at late sowing date, none of top crosses surpassed the best check hybrids in early, late sowing date as well as the combined analysis. Also, the best check variety S.C. Pioneer 3080 recorded the highest no. of kernels/ row but without superiority over that recorded by most top crosses for this trait in both sowing dates as well as the combined over them.

Regarding 100-kernel weight, the top crosses $T_1xL_{1,}$ T_1xL_3, T_1xL_{12}, T_3xL_3 and T_3xL_{10} at early sowing date; $T_1xL_{12,}$ T_2xL_3, $T_2xL_{15,}$ T_3xL_3, T_3xL_{13} and T_3xL_{19} at late sowing date and $T_1xL_{1,}$ T_1xL_7, T_1xL_{12}, T_2xL_3, $T_2xL_{15,}$ T_3xL_3 and T_3xL_{19} at the combined analysis exhibited significantly higher than the best check hybrid S.C. G 155.

For ear weight, one, thirty three and five top crosses out yielded the best check hybrid. Also, it is clear that the most desirable top crosses were obtained from the crossing between T_1 and each of inbred lines L_{13} and L_{17} and T_2 and each of inbred lines L_5, L_{10} and L_{12} at the combined data.

As for shelling percentage, none of the studied top crosses significantly exceeded that of the best of check hybrid. However, the most top crosses did not significantly from the best check hybrid.

Regarding grain yield/ plant, the highest mean values were recorded by S.C. Pioneer 3080 at early sowing date, but without significant superiority over those of hybrids T_1xL_{13}, T_1xL_{17}, T_2xL_5, T_2xL_{10}, T_2xL_{12} and T_2xL_{14}. While, twenty six and three top crosses exhibited significantly higher than the best check hybrid S.C. Pioneer 3080 at late sowing date and the combined analysis,respectively.

The best top crosses were T_1xL_{13}, T_1xL_{17} and T_2xL_{12} at the combined data. Also, eight top crosses at combined analysis did not differ significantly than the best check hybrid.

From such results it could be concluded that the previous top crosses could be efficient and prospective in maize breeding programs since they expressed significant desirable effects for grain yield and for one or more of yield components.

The fluctuations of hybrid performance from sowing date to another were detected for most traits. These results would be due to significance of the interaction between hybrids and sowing date.

4.3. Analysis of variance for combining ability:

The estimation of variance due to general combining ability (σ^2 GCA) and specific combining ability (σ^2 SCA) along with their interaction with sowing dates are presented in (Table 4) Results indicated that σ^2 SCA was more important than σ^2 GCA for all studied traits in both sowing dates as well as the combined analysis except tasseling date and number of rows/ ear in the combined analysis, ear diameter at early sowing date and ear husk at late sowing date σ^2 GCA= σ^2 SCA revealing that additive and non additive gene effects was similar for controling this trait . These results indicated that the largest part of the total genetic variability associated with those traits was the result of non – additive type of gene action. The importance of non-additive gene action in controlling such traits was reported by **El-Hosary (1989)** for ear length, ear diameter, number of rows/ ear, number of kernels/ row and grain yield/ plant, **Sedhom (1994)** for ear length and ear diameter; **Soliman (2000)** and **Mahmoud *et al.* (2001)** for grain yield ; **Amer *et al.* (2002)** for grain yield and number of kernels / row ; **El-Shenawy *et al.* (2003)** for grain yield and number of rows / ear; **Mosa (2004)** for silking date , plant height , grain yield , ear length , number of kernels / row and 100-kernel weight ; **Abd El-Moula (2005)** for grain yield , 50% silking , plant height and ear height ; **Motawei *et al.* (2005)** for grain yield , number of kernels / row and ear length.

The magnitude of the interaction between specific combining ability and sowing dates was much higher than that of general combining and sowing dates for all traits except ear height, ear husk and number of rows/ ear. These results led to the conclusion that non-additive gene action was more biased by the interaction with environments than the additive effects. Such results are in agreement with those reported by **El-Hosary (1985), Sedhom (1992 and 1994), Al-Naggar *et al.* (1997), Soliman (2000), Sadek *et al.*(2000); Mahmoud *et al.*(2001); Soliman *et al.*(2001);Amer *et al.*(2003); Aly (2004); Mosa**

(2004) ; Ibrahim and Motawei (2004) ; Mosa *et al.* (2004) ;Abd El-Moula (2005).

For the exceptional traits, the magnitude of σ^2 GCA x sowing date interaction was higher than that of σ^2 SCA x sowing date revealing that additive and additive x additive gene action interacted more with the environment than the non additive component. Similar results were reported by **El-Hosary (1989), Sedhom (1994), Sultan (1998), El-Zeir *et al.* (2000), Gado (2000), Barakat (2001), Amer *et al.* (2002), El-Shenawy et al (2003).**

4.3.1 General Combining ability effect:

The general combining ability effects ($\hat{g}_i$) of testers and parental inbred lines for all traits in both sowing dates as well as the combined analysis is presented in (Table 6).

From the breeder's point of view, high negative values for tasseling, silking and maturity dates as well as plant and ear heights along with high positive values for yield and its components would be useful for maize breeding program.

Testers:

Results in (Table 6) indicated that the tester T_1 (L_{100}) exhibited significant desirable ($\hat{g}_i$) effects for plant and ear heights and 100-Kernel weight at early, late sowing dates, as well as the combined data, ear diameter, ear weight / plant and grain yield / plant at late sowing date and the combined data; and ear length at late sowing date. Also, it gave significant undesirable or insignificant ($\hat{g}_i$) effects for other cases.

The parental tester S.C. (El-Hosary 101) expressed significant positive ($\hat{g}_i$) effects for leaf area and shelling percentage at late sowing date and the combined data and ear husk at early sowing date and the combined data; ear weight, grain yield/ plant and 100-Kernel weight at early sowing date, Also, it gave significant positive (undesirable) ($\hat{g}_i$) effects at late sowing date and the combined data for tasseling date and late sowing date for silking date. However, it gave insignificant ($\hat{g}_i$) effects for other cases.

Parental tester (Gem. Pop.) expressed significant desirable ($\hat{g}_i$) effects for number of rows/ ear in both sowing dates and the combined data; leaf area at late sowing date; tasseling date and silking date at late sowing date and the combined data. Also, it gave significant undesirable or insignificant ($\hat{g}_i$) effects for other cases.

Inbred lines:

six, four and four inbred lines expressed significant and negative ($\hat{g}_i$) effects for tasseling date at early, late sowing dates as well as the combined analysis, respectively.

For silking date seven, four and six inbred lines gave significant negative ($\hat{g}_i$) effects at early, late sowing dates and the combined over them, respectively. The parental inbred lines L_1 and L_{13} exhibited the highest ($\hat{g}_i$) effects for tasseling and silking dates in both sowing dates as well as the combined data. Moreover, both inbred lines L_1 and L_{13} were the best combiners for both traits together.

Consequently, they could be utilized in developing new hybrids characterized by earliness in flowering.

For maturity date, the parental inbred lines L_6 and L_{10} seemed to be the best combiners for earliness in both sowing dates as well as the combined analysis .Consequently, they could be utilized in developing new hybrids characterized by earliness in maturity.

Regarding plant height, seven, five and seven inbred lines gave significant negative ($\hat{g}_i$) effects at early, late sowing dates as well as the combined data, respectively. The best inbreds in general ($\hat{g}_i$) effects were $L_{2,}$ L_9, L_{10}, L_{15} and L_{18} in both sowing dates and the combined analysis.

On the other hand, L_6, L_{19}, L_4 and L_5 gave significant positive ($\hat{g}_i$) effects for plant height in both sowing dates and the combined data. Therefore, they could be of great value in breeding programs for developing new hybrids with highest plant stature for forage crops..

For ear height, six, two and four inbred lines exhibited significant negative ($\hat{g}_i$) effects at early, late sowing dates as well as the combined data, respectively. The inbred lines L_9 and L_{15} were the best combiners for both traits (plant and ear heights). Therefore, they could be of great value in breeding programs for developing new hybrids with short plant stature.

For leaf area, six, eight and nine inbred lines exhibited significant positive ($\hat{g}_i$) effects at early, late sowing dates and the combined analysis, respectively. From these lines, the three inbred lines L_1, L_2, $L_{11}$and L_{16} were good combiners for this trait in both sowing dates and the combined analysis. Therefore, they could be of great value in breeding programs for developing hybrids with highest leaf area of upper ear increased forage crops and grain yield.

The inbred lines L_2, L_9 and L_{17} expressed significant positive ear husk in both sowing dates as well as the combined analysis.

Regarding ear length, the best general combiners which had significant positive ($\hat{g}_i$) effects was L_{11} in both sowing dates as well as the combined analysis. While, L_{19} exhibited significant positive ($\hat{g}_i$) effects in both sowing dates as well as the combined data for ear diameter.

Results in (Table 6) showed that the best general combiners which had significant and positive ($\hat{g}_i$) effects for number of rows/ ear was the inbred L_5, L_6 and L_{13} in both sowing dates as well as the combined data.

For no. of Kernels/ row, the best general combiners which had significant and positive ($\hat{g}_i$) effects were the parental inbred lines L_{11} and L_{12} in both sowing dates and the combined over them.

Regarding 100-kernel weight, seven , five and seven parental inbred lines exhibited significant positive ($\hat{g}_i$) effects at early, late sowing dates and the combined analysis, respectively .However , the most desirable ($\hat{g}_i$) effects for this trait were detected for the parental inbred lines L_3 followed by L_{19} in both sowing dates and the combined data.

For shelling percentage, four, two and five parental inbred lines exhibited significant and positive ($\hat{g}_i$) effects at early, late sowing dates as well as the combined analysis, respectively.

Moreover, the most desirable combiner for this trait was L_{18} in both sowing and the combined analysis.

Seven, ten and nine parental inbred lines for ear weight / plant; six, eight and seven parental inbred lines for grain yield/ plant exhibited significant positive ($\hat{g}_i$) effects at early, late sowing dates as well as the combined analysis, respectively. Moreover, the most desirable combiners for ear and grain yield/ plant were the inbred lines L_5 and L_{13} in both sowing dates and the combined analysis.

From the previous results it could be concluded that the parental inbred lines L_5 and L_{13} should be of great values in breeding programs for improving grain yield and its components and earliness (L_{13}). Also, it is clear that the parental inbred line which exhibited significant desirable ($\hat{g}_i$) effects for grain yield/ plant might express the same effects for one or more of traits contributing grain yield. For example, parental inbred line L_{13} expressed significant desirable ($\hat{g}_i$) effects for grain yield/ plant, ear weight/ plant, number of rows/ ear, plant height, tasseling and silking dates. While, L_5 gave significant positive ($\hat{g}_i$) effects for grain yield/ plant, ear weight/ plant, no. of rows/ ear and plant and ear heights (grain or fodder yield).

4.3.2 Specific combining ability effects:

Specific combining ability effects of the top crosses for all traits in both sowing dates as well as the combined analysis are presented in (Table 7).

Significant and negative SCA effects for tasseling date in top crosses; T_1xL_1, T_2x L_{15} and T_2xL_{19} at early sowing date; T_1xL_7, T_1xL_{19}, T_2xL_3, T_2xL_{12}, T_3xL_2, T_3xL_{10}, T_3xL_{14} and T_3xL_{16} at late sowing date , and T_1xL_1, T_2xL_3, T_2xL_{19}, T_3xL_{10} and T_3xL_{14} at The combined analysis. The most desirable SCA effects for this trait were detected for the top cross T_2xL_3 followed by the crosses T_3xL_{14} and T_2xL_{19}. This means that the immediate use of line 3 and 19 as aparent of three way cross with S.C (S.C El-Hosary 101) could be recommended.

Also, in (Table 7) showed that the tester (Gem. Pop). expressed the highest number of significantly negative SCA effects especially at late sowing date and the combined analysis in their crosses and showed the highest negative SCA effects for tasseling date at late sowing and the combined analysis. Also, exhibited the widest range of SCA effects –2.41 to 2.70 at late sowing date and –1.31 to 1.75 in the combined analysis.

Regarding to silking date, three, two and zero top crosses exhibited significant and negative SCA effects were obtained for the tester T_1 (L_{100}), T_2 (S.C El-Hosary 101) and T_3 (Gem.pop.), respectively at early sowing date ;Three, three and three top crosses at late sowing gave significant negative SCA effects in the same order. While, one, three and three top crosses gave significant negative SCA effects in the same order at the combined analysis. Moreover, the most desirable SCA effects for this trait were obtained for the top cosses T_1xL_1 at early sowing date; T_2xL_3 and T_2xL_{12} at late sowing date and the combined analysis. Meanwhile, the tester T_2 (S.C El-Hosary 101) gave the best SCA effects for this trait. While, T_3 (Gem. pop.) had the widest range of SCA effects for this trait at late sowing and the combined analysis. However, T_1 (L_{100}) expressed the widest range of SCA effects for this trait at early sowing date. It could be concluded that the tester T_2 (S.C El-Hosary 101) was the best among all tester for silking date since it exhibited the largest number of significantly negative SCA effects over both sowing dates and the combined analysis. Also, the tester T_3 (Gem. pop.) expressed the widest range of SCA effects at late sowing date and the combined analysis.

Regarding to maturity date, one, zero and one at early sowing date; two, zero and two at late sowing date and one, two and three top crosses at the combined analysis exhibited significant negative SCA effects for tester T_1,T_2 and T_3, respectively. Also, the cross T_1xL_1 at early ,late sowing date and the combined analysis, T_3xL_{15} at early sowing date and the top cross T_3xL_{17} at late sowing date and the combined analysis had the most desirable $\hat{S}_{ij}$ effects for this trait.

For plant height, five, five and four top crosses at early sowing date; six, three and three top crosses at late sowing date and five, four and four top crosses at the combined analysis expressed significant negative $\hat{S}_{ij}$ effects for the tester T_1 (L_{100}), T_2 (S.C El-Hosary 101) and T_3(Gem. pop.), respectively. The highest desirable $\hat{S}_{ij}$ effects to short plants were detected by cross $T_{1X}L_3$ and $T_{1X}L_{10}$ in both sowing dates as well as the combined analysis. In addition this tester expressed the largest number of significantly negative $\hat{S}_{ij}$ effects and had the widest range of $\hat{S}_{ij}$ effects for this trait. In this respect, **Zambezi *et al.* (1986)** pointed out that inbred testers are preferred over broad base testers and mentioned two practical reasons for preferring inbred line (narrow base) testers to broad – base testers. First, sampling errors are likely to occur with heterogeneous testers. Second, use of an inbred line or (single cross) tester may permit quicker utilization of new lines in commercial hybrids, especially if the tester is already in commercial use.

For ear height, the top crosses T_1xL_4, T_2xL_{15} ,T_2x L_{16} , T_2xL_{17}, T_3xL_3, T_3xL_{14} and T_3xL_{15} at early sowing date; T_1xL_{11}, T_2xL_{16}, T_3xL_3, T_3xL_{14} at 1ate sowing date and T_1xL_{11}, T_1XL_{18}, T_2xL_9, T_2xL_{15}, T_2xL_{16}, T_2xL_{17}, T_3xL3 and T_3xL_{14} at the combined analysis, expressed significant negative $\hat{S}_{ij}$ effects. However, the most desirable $\hat{S}_{ij}$ effects were detected for the top crosses T_2xL_{16}, T_3xL_3 and T_3xL_{14} at early, late sowing dates as well as the combined analysis, respectively. The T_2 (S.C El-Hosary 101) exhibited the largest number of desirable $\hat{S}_{ij}$ effects (4 crosses). While, the T_3 (Gem. pop.) expressed the widest range between $\hat{S}_{ij}$ effects at both sowing dates as well as the combined analysis. This may suggest the immediate use of T_2 (S.C El-Hosary 101) as parents in the development or three way crosses to improve ear height.

Leaf area of upper ear, the cross $T_{1X}L_{6,}$ $T_{1X}L_{9,}$ T_1xL_{20}, T_2xL_2, $T_{2X}L_{4,}T_2xL_{12}$, T_3xL_{15} and T_3xL_{16} at early sowing date; T_1 and each of L_4 and L_8; T_2 with each of L_2, L_{10} and L_{12}; and T_3 with each of L_9, $L_{15,}$ L_{17} and L_{18} at late sowing date and T_1 with each of L_6, L_8 and L_{20}; T_2 and each of L_2, $L_{10,}$ L_{12} and L_{14}; T_3 and each of $L_{9,}$ L_{15}, L_{16} and L_{18}, gave significant positive $\hat{S}_{ij}$ effects. However, the other top crosses exhibited either significant negative or insignificant $\hat{S}_{ij}$ effects.

The top cross T_1xL_9 at early sowing date and the combined analysis and T_1xL_{18} and T_1xL_{19} at the combined analysis gave significantly positive $\hat{S}_{ij}$ effects for ear husk. However, the other top crosses gave either significant negative or insignificant $\hat{S}_{ij}$ effects for this trait.

For ear length, the top crosses T_1xL_{14}, T_2xL_3, T_2xL_5 and T_3xL_{10} at early sowing date; T_1xL_9, T_2xL_3 and T_2xL_{20} at late sowing date; T_1xL_{14}, T_2xL_3, T_3xL_{10} and T_3xL_{18} at the combined analysis expressed significant positive $\hat{S}_{ij}$ effects. However, the most desirable $\hat{S}_{ij}$ effects were detected for the top cross $T_{2X}L_3$ at both sowing dates as well as the combined analysis.

For ear diameter, the top cross T_2xL_{12} at the combined analysis gave significant positive $\hat{S}_{ij}$ effects. However, the other top crosses gave either significant negative or insignificant $\hat{S}_{ij}$ effects for this trait.

For number of rows/ ear, the top crosses T_1xL_{13}, T_1xL_{14}, T_2xL_6 and T_3xL_{10} at early sowing date; T_1xL_{13}, T_2x L_4 and T_3xL_6

at late sowing date and T_1xL_{13}, T_2xL_4, T_2xL_6, T_3xL_3 and T_3xL_{10} at the combined analysis, exhibited significantly positive $\hat{S}_{ij}$ effects. While, the other top crosses gave either significant negative or insignificant $\hat{S}_{ij}$ effects. The most desirable $\hat{S}_{ij}$ effects were obtained from top cross $T_3x\ L_{10}$, T_2xL_4 and T_1xL_{13} at early, late sowing dates as well as the combined analysis, respectively.

Regarding number of kernels/ row, the top crosses T_1xL_{16} and T_3xL_{16} at early sowing; T_1xL_{18}, T_2xL_{15} and T_2xL_{20} at late sowing date; and T_1xL_5, T_1xL_{16}, T_2xL_{15} and T_2xL_{20} at the combined analysis exhibited significantly positive $\hat{S}_{ij}$ effects for this trait. The rest top crosses showed either significant negative or insignificant $\hat{S}_{ij}$ effects.

Five, three and five top crosses at early sowing date; seven, four and five at late sowing date; seven, three and seven at the combined analysis expressed significant positive $\hat{S}_{ij}$ effects for 100-kernel weight for the T_1, T_2 and T_3, respectively. Moreover, the most desirable $\hat{S}_{ij}$ effects for this trait were obtained for the top crosses T_1xL_1, T_1xL_{12} and T_1xL_{12} at early, late sowing dates as well as the combined analysis, respectively.

It could be concluded that the tester L_{100} was the best among all testers for this trait since it exhibited the largest number of significant positive $\hat{S}_{ij}$ effects, in addition this tester T_1 expressed the best $\hat{S}_{ij}$ effect over all crosses and had the widest range of $\hat{S}_{ij}$ effect. In this respect, **Zambezi *et al.* (1986)** pointed out that inbred testers are preferred over broad base testers and mentioned two practical reasons for preferring inbred line (narrow base) testers to broad-base testers. First, sampling errors are likely to occur with heterogeneous testers. Second, use of an inbred line or (single cross) tester may permit quicker utilization of new lines in commercial hybrids especially if the tester is already in commercial use.

Concerning ear weight, seven, eight and nine top crosses at early sowing date; eight, seven and seven at late sowing date; eight, seven and nine top crosses at the combined analysis expressed significant positive $\hat{S}_{ij}$ effects for T_1, T_2 and T_3, respectively. The most desirable $\hat{S}_{ij}$ effects were recorded for the top crosses T_1xL_{17} and T_2xL_5 at early sowing date; T_1xL_{18}, T_2xL_{12} and T_3xL_9 at late sowing date; and T_1xL_{13} and T_2xL_{12} at the combined analysis.

Regarding shelling percentage, the top crosses T_2xL_{19} at early sowing; T_1xL_3, T_2xL_9, T_2xL_{18} and T_3xL_{13} at late sowing date; T_1xL_{13}, $T_2xL_{9,}$ T_2xL_{18}, and T_3xL_{13} at the combined analysis exhibited significant positive $\hat{S}_{ij}$ effects. The other top crosses exhibited either significant negative or insignificant $\hat{S}_{ij}$ effects for this trait.

For grain yield/ plant, five, seven and six top crosses at early sowing date; six, six and six top crosses at late sowing date; seven, six and eight top crosses at the combined analysis for testers T_1, T_2 and T_3, respectively. The best $\hat{S}_{ij}$ effects were obtained from top crosses T_1xL_{17}, T_2xL_5, T_2xL_{12} and T_3xL_{15} at early sowing date;T_1xL_{18},T_2xL_{12} and T_3xL_6 at late sowing date; T_2xL_{12} and T_1xL_{17} at the combined analysis. Furthermore, the tester T_2 (S.C El-Hosary 101) exhibited the widest range between $\hat{S}_{ij}$ effects for this trait at the combined analysis. Therefore, the immediate use of lines L_4, L_5, L_{10} and L_{12} as parents in the development of three way crosses with T_2 (S.C El-Hosary 101). Also, the immediate use of lines L_7, L_{13} and L_{17} as parents in development of single crosses with T_1 (L_{100}).

4.4. Heterosis:

Heterosis for grain yield/ plant was computed for individual top crosses as the percentage increase of hybrid performance relative to T.W. G 352, S.C. Pioneer 3080 and S.C. G 155 at early, late sowing date and the combined over them (Table8).

Eight, fourty one and twenty top crosses expressed significant and positive heterotic effects in early, late sowing dates as well as the combined analysis relative to T.W. G 352. However, most desirable heterotic effects were detected for the top crosses T_1xL_{13}, T_1xL_{17}, T_2xL_5, T_2xL_{10}, T_2xL_{12} and T_3xL_{10} at both sowing dates and the combined analysis. The useful heterotic effects relative to T.W. G 352 ranged from -31.8 to 17.42, -11.63 to 65.32 and -17.12 to 30.62% at early, late sowing dates and the combined over them, respectively.

Regarding useful heterotic effects relative to S.C G 155, zero, fifty eight and nineteen top crosses exhibited significant and positive values for grain yield/ plant at early, late sowing dates as well as the combined analysis, respectively. Eight top crosses at early sowing dates did not differ significant compared S.C. G 155. However, the best heterotic effects were obtained for the top crosses T_1xL_7, T_1xL_{13}, T_1xL_{17}, T_2xL_4, T_2xL_5, T_2xL_{10} and T_2xL_{12} in the combined data. The useful heterotic effects relative to S.C. G 155 ranged from -39.37 to 4.38, -11.29 to 106.82, and -17.49 to 30.03% at early, late sowing dates and the combined analysis, respectively.

Regarding useful heterotic effects relative to S.C. Pioneer 3080 Zero, twenty six and three top crosses exhibited significant and positive values for grain yield/ plant at early, late sowing date as well as the combined analysis, respectively. Also, five, twelve and eight top crosses did not differ significant compared S.C. Pioneer 3080 in the same order. Insignificant useful heterotic effects in these top crosses revealed that a hybrid program based on these materials may be useful for testing under different location and years. However, the best useful heterotic effects were obtained for the top crosses T_1xL_{13}, T_1xL_{17} and T_2xL_{12} in the combined data. The heterotic effects relative to S.C. Pioneer 3080 ranged from -41.09 to 1.42, -39.22 to 41.69 % and -28.62 to 12.49% at early, late sowing dates as well as the combined analysis. Hence, it could be concluded that the previous top crosses offer possibility for improving grain yield in maize. Many investigates reported useful heterosis for yield in maize **Shehata *et al.* (1997), Mahmoud *et al.* (2001), Amer *et al.* (2002), Mosa *et al.* (2004) and Abd El-Moula (2005).**