# Combining ability of nine white maize (*Zea mays* L.) inbred lines in diallel crosses and stability parameters of their single crosses

**EL-Shenawy, A. A.; H. E. Mosa and A. A. Motawei**
**Maize Pesearch Section, Sakha ARS, FCRI, ARC, Egypt.**

## ABSTRACT

Combining ability is the ultimate factor determining future usefulness of inbred lines for hybrids development. The objectives of this study were to estimate combining ability of nine inbred lines;.i.e Sk6016, Sk8014, Sk5069, Sk5028, Sk5142, Sk7001, Sk5216, Sd7 and Nu 49 and stability parameters for their respective single crosses under different environments. A number of 36 single crosses obtained from crossing nine inbred lines in a half diallel system in addition to two check hybrids were evaluated in a randomized complete block design, with four replications, at three locations; i.e. Sakha, Gemmeiza and Sids Research Stations during the summer seasons of 2008. The combined analysis of variance was performed for data collected on: number of days to 50% silking, plant height, grain yield and ear length. Stability analysis was performed for grain yield according to Eberhart and Russell (1966) . Estimates of combining ability effects were determined according to Griffing (1956) Method 4 Model 1. Both additive and non-additive gene action were found to be important in controlling all studied traits. However the additive gene action was more important than the non-additive gene action in the expression of days to 50% silking and plant height. While the non-additive gene action was primary type of gene action operating in the crosses for grain yield and ear length. Also, the results showed that the non-additive gene action was more influenced by change of environments than the additive gene action for all studied traits. The best parental inbred lines for GCA effects were Sk6016, Sk7001, Sk5216 and Nu 49 for number of days to 50% silking ; Sk6016 and Sk7001 for plant height; Sd 7 for grain yield; Sk8014 and Sk5028 for ear length. The most superior crosses based on their SCA effects were Sk5028 x Nu49 for number of days to 50% silking and grain yield; Sk5069 x Sd7 for plant height; and Sk 6016 x Sk5028 for ear length

Three single crosses; i.e. Sk5028 x Sd7, Sk5028 x Nu 49 and Sd 7x Sk5216 were stable for grain yield. Moreover, they gave similar grain yield to those of the two commercial hybrids; i.e. SC10 and SC128. These new crosses are recommended for further testing in the hybrid development program.

## INTRODUCTION

The nature and magnitude of gene action is an important factor in developing an effective breeding program. Combining ability analysis is useful to asses the potential inbred lines and also, help in identifying the nature of gene action involved in various quantitative characters. This information is helpful to plant breeders for formulating hybrid breeding programs. The diallel cross technique as developed by Sprague and Tatum (1942) and Griffing (1956) provided information on gene action and combining ability of parental lines . According to them, the general combining ability effects (GCA) were due to additive types of gene action, whereas specific combining ability effects (SCA) were due to non-additive types of gene action. Hallauer *et al.* (1988) stated that most of the traits in maize have a quantitative inheritance. Nevado and Cross (1990), Zelleke (2000), Mahto and Ganguly (2001), Mosa (2006), Motawei (2006) and Alam *et al.* (2008) found that both GCA and SCA were significant for silking date, plant height, grain yield and ear length. However, Odemah (1973), Nawar *et al.* (1979),Pajic (1986), El-Hosary (1988), Crossa *et al.* (1990), Abd El-Maksoud (1997) and Mosa (2003) found that non-additive gene effects was more important for inheritance of grain yield and ear length. While, Katta *et al.* (1975), Nawar *et al.* (1979), Gonzalez (1988), El-Shamarka *et al.*(1994), and El-Shenawy (2006) reported that additive gene effects played an important role in the expression of silking date and plant height. Stability analysis is an important tool for plant breeders in predicting response of various genotypes over changing environments. Vargas *et al.* (1999) stated that multi-environment trials play an important role in selecting the best cultivars to be used in future years at different locations and in assessing a cultivars stability across environments before its commercial release. This study aimed to: estimate general and specific combining abilities and their interaction with environment, to identify new single crosses superior to the best commercial hybrids and determine the adaptability of these crosses for cultivation in different environments.

## MATERIALS AND METHODS

Nine white inbred lines of maize; i.e. Sk6016, Sk8014, Sk5069, Sk5028, Sk5142, Sk7001, Sk5216, Sd7 and Nu 49;which were developed at Sakha (Sk), Sids (Sd) and Nubaria (Nu) maize Research Stations were used in this study. All possible cross combinations excluding the reciprocals were made among the nine inbreds at Sakha Agricultural Research Station in 2007 summer season. Resulting 36 single crosses in addition to two white commercial hybrids SC10 and SC128 were evaluated in a randomized complete block design experiment, with four replications, carried out at Sakha, Gemmeiza and Sids Research Stations in 2008 summer season. Each experimental plots consisted of one row 6 m long, the spacing between row to row was 80 cm, plant to plant was 25cm and one plant per hill was maintained after thinning. All other cultural practices were carried out according to the standard commercial recommendations for maize. Data were recorded for grain yield ard/fed (1 ardab = 140kg ,1 feddan = 4200 $m^2$) adjusted to 15.5% moisture content , ear length (cm), plant height (cm) and number of days from planting date to date of 50% silking emergence. Analysis of variance of the data was performed separately for each location and when homogeneity of error mean squares were proved a combined analysis over three locations was done according to Steel and Torrie (1980). The hybrids effect was considered to be fixed while the locations effect was considered random in the analysis of variance. The stability analysis for grain yield across the three locations was done according to Eberhart and Russell (1966). Variation among 36 hybrids was partitioned to GCA and SCA and their interactions with locations according to Griffing (1956)for Method-4 Model-1.

## RESULTS AND DISCUSSION

The analysis of variance Table 1, showed that the differences among locations were highly significant, indicating that the three locations differed in their environmental conditions. Variance attributable to general (GCA) and specific (SCA) combining ability effects were either significant or highly significant for all studied traits, indicating that both additive and non-additive gene action were important in controlling all the studied traits. These results are in agreement with those obtained by Nawar *et al.* (1979) and Alam *et al.* (2008) for days to 50% silking, El-Hosary (1988) and Shafiullah and Baitullah (1999) for plant height, Amer (2003) for ear length and Mosa (2006) for grain yield. However the additive gene action ($k^2$GCA) appeared to play a more important role than the non-additive gene action ($k^2$SCA) in the expression of days to 50% silking and plant height. Whereas the non-additive gene action was the primary type of gene action operating in the expression of both grain yield and ear length Table 2. These results support the findings of Gonzalez (1988) for days to 50% silking, Fan Xingming *et al.* (2001) for plant height, Huang *et al.*(1983) and Shafiullah and Baitullah (1999) for grain yield and El-Shenawy (2005) for ear length.

Table 1: Mean squares of diallel analysis of 9 inbred lines combined over three locations for four traits.

| S.O.V | d.f | Days to 50% silking | Plant height | Grain yield | Ear length |
|---|---|---|---|---|---|
| Locations (L) | 2 | 298.05** | 130312.50** | 18502.428** | 356.238** |
| Rep/loc | 9 | 11.311 | 1186.605 | 19.246 | 2.237 |
| GCA | 8 | 154.684** | 8239.009** | 200.259* | 25.261** |
| SCA | 27 | 5.151** | 438.308* | 68.628** | 20.743** |
| GCA xL | 16 | 8.153** | 927.210** | 77.02** | 5.036** |
| SCA x L | 54 | 2.058** | 260.07** | 29.862** | 3.387 |
| Error | 333† | 0.772 | 141.47 | 9.029 | 2.609 |

*,** significant at 0.05 and 0.01 levels of probability, respectively.

† including check varieties.

Table 2: Estimates of genetic and genetic x environment and environment parameters for four traits over three locations.

| Trait | Statistical estimates | | | |
|---|---|---|---|---|
| | $K^2$GCA | $K^2$ SCA | $\sigma^2$GCA x L | $\sigma^2$SCA x L |
| Days to 50% silking | 1.74 | 0.257 | 0.263 | 0.321 |
| Plant height | 87.04 | 14.853 | 28.062 | 29.65 |
| Grain yield | 1.46 | 3.23 | 2.428 | 5.208 |
| Ear length | 0.24 | 1.446 | 0.086 | 0.194 |

Regarding Table 1, mean squares of interaction between GCA x locations and SCA x locations were highly significant for all traits except that of SCA x locations for ear length. The magnitude of the interaction for $\sigma^2$SCA x locations was higher than that of $\sigma^2$ GCA x locations for all studied traits ,Table 2, indicating that the non-additive gene action was much more influenced by the change in environments than the additive gene action. These results are in agreement with those previously attained by Mosa (2003) for days to 50% silking and ear length, Abdel- Sattar *et al.* (1999) for grain yield ,and El-Shenawy (2006) for plant height.

Mean performance over three locations of the 36 single crosses and the two check cultivars SC 10 and SC128 for four traits are shown in Table 3. The best single crosses for earliness were Sk6016 x Sk7001, Sk6016 xSk5216, Sk6016 x Nu 49, Sk7001 x Sk5216, Sk7001 x Nu 49, Sk5126 x Nu 49 and SC128.Single crosses Sk6016 x Sk7001, Sk6016 x Sk5216, Sk8014 x Sd 7 and Sk5142 x SK7001 were the best crosses for short plant height compared to the shorter check SC128.14 new single crosses addition to two check hybrids given grain yield over 30 ard/fed, the best crosses from them were Sk6016 x Sk 5069 (32.88 ard/fed), Sk5069 x Sd7(34.94 ard/fed), Sk5028 xSd7(32.48 ard/fed) , Sk5028 xNu 49(32.42 ard/fed), Sk5142 x Sd 7(32.37 ard/fed) , Sd7 x Sk 7001(32.77 ard/fed), Sd7 x Sk5216(32.78 ard/fed) andSC128(32.39 ard/fed). While the best single crosses for ear length were Sk6016 x Sk5028, Sk8014 x Sk5028, Sk8014 x Sd7, Sk5069 x Sd 7, Sk5069 x Sk5216, Sk5069 x Nu 49 andSC10.

Table 3: Mean performance of 36 single crosses and two check cultivars combined over three locations for four traits.

| Cross | Days to 50% silking (days) | Plant height (cm) | Grain yield (ard/fed) | Ear length (cm) |
|---|---|---|---|---|
| Sk6016xSk8014 | 60.41 | 268.08 | 27.71 | 18.78 |
| Sk6016xSk5069 | 60.19 | 268.25 | 32.88 | 19.51 |
| Sk6016xSk5028 | 61.00 | 263.75 | 24.13 | 20.10 |
| Sk6016xSk5142 | 61.08 | 252.91 | 29.19 | 17.83 |
| Sk6016xSd7 | 60.16 | 277.58 | 31.99 | 18.53 |
| Sk6016xSk7001 | 59.08 | 243.33 | 28.36 | 18.41 |
| Sk6016xSk5216 | 59.75 | 250.41 | 23.07 | 18.96 |
| Sk6016xNu 49 | 59.25 | 263.58 | 30.28 | 17.55 |
| Sk8014xSk5069 | 64.83 | 271.25 | 30.49 | 19.80 |
| Sk8014xSk5028 | 63.25 | 279.75 | 26.20 | 20.33 |
| Sk8014xSk5142 | 62.19 | 273.66 | 28.49 | 18.26 |
| Sk8014xSd 7 | 62.58 | 247.33 | 29.61 | 20.43 |
| Sk8014xSk7001 | 60.16 | 257.25 | 27.66 | 18.48 |
| Sk8014xSk5216 | 60.58 | 276.66 | 31.57 | 19.86 |
| Sk8014xNu 49 | 61.08 | 284.0 | 28.23 | 19.26 |
| Sk5069xSk5028 | 65.83 | 275.83 | 28.82 | 18.93 |
| Sk5069xSk5142 | 64.08 | 257.50 | 27.83 | 16.53 |
| Sk5069xSd7 | 63.58 | 268.58 | 34.94 | 20.20 |
| Sk5069xSk7001 | 62.83 | 261.66 | 30.83 | 19.10 |
| Sk5069xSk5216 | 61.83 | 261.50 | 26.50 | 20.13 |
| Sk5069x Nu 49 | 61.16 | 273.66 | 30.38 | 20.06 |
| Sk5028xSk5142 | 64.50 | 274.91 | 27.0 | 18.03 |
| Sk5028xSd 7 | 64.66 | 295.58 | 32.48 | 19.45 |
| Sk5028xSk7001 | 62.58 | 271.50 | 27.24 | 19.20 |
| Sk5028xSk5216 | 62.14 | 276.16 | 27.34 | 19.93 |
| Sk5028xNu 49 | 60.16 | 276.33 | 32.42 | 19.83 |
| Sk5142xSd7 | 63.33 | 288.91 | 32.37 | 18.46 |
| Sk5142xSk7001 | 61.66 | 245.00 | 28.18 | 18.20 |
| Sk5142xSk5216 | 61.75 | 257.25 | 27.32 | 18.28 |
| Sk5142xNu 49 | 61.58 | 268.33 | 28.29 | 18.31 |
| Sd7 x Sk7001 | 61.58 | 278.0 | 32.77 | 19.81 |
| Sd7 x Sk5216 | 61.0 | 293.91 | 32.78 | 18.28 |
| Sd7 x Nu 49 | 61.66 | 287.41 | 30.82 | 19.91 |
| Sk7001xSk5216 | 59.50 | 254.25 | 28.42 | 19.38 |
| Sk7001x Nu49 | 58.58 | 254.66 | 22.13 | 17.53 |
| Sk5216 x Nu 49 | 58.83 | 266.66 | 28.54 | 19.20 |
| SC 10 check | 62.66 | 303.50 | 31.14 | 20.83 |
| SC 128 check | 59.76 | 268.50 | 32.39 | 19.86 |
| L.S.D 0.05 | 1.51 | 16.95 | 5.20 | 1.54 |
| 0.01 | 2.01 | 22.46 | 6.89 | 2.04 |

Estimates of general combining ability effects of the nine inbred lines for four traits over three locations are presented in Table 4. The parental inbred lines Sk6016, Sk7001, Sk5216 and Nu 49 exhibited significantly negative estimates for days to 50% silking. Therefore, these four inbred lines can be used as doner parents for earliness in hybridization programs. The parental inbred lines Sk6016 and Sk7001 showed desirable values of GCA effects for plant height, indicating that these two inbred lines could be considered as good combiners for developing short stalk genotypes. The inbred line Sd 7 exhibited significant positive GCA effects for grain yield. This inbred can be used for developing higher yielding hybrids. Inbred lines Sk8014 and Sk5028 showed significantly positive GCA effects for ear length. They can be used to breed for long ear hybrids, consequently improving productivity since ear length is important yield component.

Table 4: Estimates of general combining ability effects of nine inbred lines for four traits over three locations.

| Inbred line | Days to 50% silking | Plant height | Grain yield | Ear length |
|---|---|---|---|---|
| Sk 6016 | -1.674* | -10.154* | -0.665 | -0.371 |
| Sk ٨٠١٤ | 0.349 | 7.00* | -0.423 | 0.440* |
| Sk ٥٠٦٩ | 1.670* | -2.964 | 1.497 | 0.293 |
| Sk ٥٠٢٨ | 1.575* | 7.833* | -1.018 | 0.520* |
| Sk ٥١٤٢ | 1.075* | -5.785 | -0.609 | -1.184* |
| Sd 7 | 0.742* | 18.333* | 3.548* | 0.410 |
| Sk7001 | -1.055* | -13.333* | -1.037 | -0.298 |
| Sk5216 | -1.103* | -3.166 | -1.031 | 0.260 |
| Nu 49 | -1.579* | 2.238 | -0.262 | -0.070 |
| L.S.D $g_i$ 0.05 | 0.622 | 6.64 | 1.91 | 0.440 |

*, Significant from zero at the 0.05 level of probability.

Estimates of specific combining ability effects of 36 crosses for four traits combined over three locations are given in Table 5. The most desirable specific combining ability effects were obtained for days to 50% silking; in the crosses, Sk6016 xSk5069, Sk8014 x Sk7001 and Sk5028 x Nu 49, for plant height; in the cross, Sk5069 x Sd 7, for grain yield; in the crosses, Sk 6016 x Sk5069, Sk8014 x Sk5216 and Sk5028 x Nu 49, for ear length; in the cross Sk 6016 x Sk5028. These crosses can be used for improving earliness, shorter plant height and high grain yield.

Table 5: Estimates of specific combining ability of 36 crosses for four traits over three locations.

| Cross | Days to 50% silking | Plant height | Grain yield | Ear length |
|---|---|---|---|---|
| Sk6016xSk8014 | 0.068 | 1.36 | -0.321 | -0.314 |
| Sk6016xSk5069 | -0.753* | 11.49* | 3.596* | 0.555 |
| Sk6016xSk5028 | -0.574 | -3.80 | -3.298* | 0.913* |
| Sk6016xSk5142 | 0.009 | -1.02 | 1.347 | 0.351 |
| Sk6016xSd7 | -0.574 | -0.47 | -0.009 | -0.545 |
| Sk6016xSk7001 | 0.140 | -3.05 | 0.947 | 0.048 |
| Sk6016xSk5216 | 0.854* | -6.14 | -4.349* | 0.039 |
| Sk6016xNu 49 | 0.830* | 1.63 | 2.087 | -1.047* |
| Sk8014xSk5069 | 1.140* | -2.66 | 0.304 | 0.048 |
| Sk8014xSk5028 | -0.348 | -4.96 | -1.473 | 0.355 |
| Sk8014xSk5142 | -0.182 | 2.58 | 0.402 | -0.007 |
| Sk8014xSd 7 | -0.182 | 2.13 | -2.626 | 0.565 |
| Sk8014xSk7001 | -0.801* | -6.29 | 0.007 | -0.676 |
| Sk8014xSk5216 | -0.336 | 2.96 | 3.909* | 0.148 |
| Sk8014xNu 49 | 0.640 | 4.89 | -0.200 | -0.121 |
| Sk5069xSk5028 | 0.914* | 1.09 | -0.772 | -0.910* |
| Sk5069xSk5142 | -0.336 | -3.63 | -2.180 | -1.604* |
| Sk5069xSd7 | -0.503 | -16.66* | 0.773 | 0.467 |
| Sk5069xSk7001 | 0.545 | 8.09* | 1.333 | 0.077 |
| Sk5069xSk5216 | -0.408 | -2.24 | -3.084* | 0.551 |
| Sk5069x Nu 49 | -0.598 | 4.52 | 0.031 | 0.815 |
| Sk5028xSk5142 | 0.176 | 2.99 | -0.488 | -0.330 |
| Sk5028xSd 7 | 0.676 | -0.46 | 0.836 | -0.509 |
| Sk5028xSk7001 | 0.390 | 7.13 | 0.176 | -0.049 |
| Sk5028xSk5216 | 0.271 | 1.63 | 0.436 | 0.124 |
| Sk5028xNu 49 | -1.503* | -3.61 | 4.584* | 0.405 |
| Sk5142xSd7 | -0.158 | 6.49 | 0.317 | 0.213 |
| Sk5142xSk7001 | -0.027 | -5.76 | 0.709 | 0.655 |
| Sk5142xSk5216 | 0.104 | -3.67 | -0.155 | 0.179 |
| Sk5142xNu 49 | 0.414 | 2.01 | 0.048 | 0.543 |
| Sd7 x Sk7001 | 0.223 | 3.13 | 1.139 | 0.677 |
| Sd7 x Sk5216 | -0.313 | 8.88* | 1.151 | -1.416* |
| Sd7 x Nu 49 | 0.830* | -3.03 | -1.581 | 0.548 |
| Sk7001/8xSk5216 | -0.015 | 0.88 | 1.375 | 0.393 |
| Sk7001/8x Nu49 | -0.455 | -4.11 | -5.685* | -1.126* |
| Sk5126 x Nu 49 | -0.158 | -2.28 | 0.717 | -0.018 |
| L.S.D $S_{ij}$ 0.05 | 0.717 | 8.06 | 2.70 | 0.91 |

*, Significant from zero at the 0.05 level of probability.

Stability parameters of the 36 single crosses evaluated at different locations are presented in Table 6. According to the definition of Eberhart and Russell (1966) genotype with high mean grain yield(than grand mean) combined with a regression coefficient equal to the unity ($b_i$=1) and small deviations from regression( $S^2d$ =0) are considered stable. Nine new single crosses were stable for grain yield, the best crosses from them: Sk5028 x Sd7, Sk5028 x Nu 49 and Sd7 xSk5216 were stable for grain yield. Moreover these three single crosses not significantly outyielded than the two checks SC10 and SC128. These three hybrids should undergo further testing in the hybrid development program.

Table 6: Stability parameters of grain yield (ard/fed) for 36 single crosses evaluated at different locations.

| Cross | $\bar{X}$ | $b_i$ | $S^2d$ |
|---|---|---|---|
| Sk6016xSk8014 | 27.71 | 0.959 | 0.047 |
| Sk6016xSk5069 | 32.88 | 0.545* | 5.177 |
| Sk6016xSk5028 | 24.13 | 0.860 | -2.008 |
| Sk6016xSk5142 | 29.19 | 0.696* | -1.513 |
| Sk6016xSd7 | 31.99 | 1.214 | 11.615* |
| Sk6016xSk7001 | 28.36 | 1.062 | -1.32 |
| Sk6016xSk5216 | 23.07 | 0.742 | 3.362 |
| Sk6016xNu 49 | 30.28 | 0.940 | -2.263 |
| Sk8014xSk5069 | 30.49 | 0.935 | -0.22 |
| Sk8014xSk5028 | 26.20 | 0.555* | -1.85 |
| Sk8014xSk5142 | 28.49 | 0.802 | 1.215 |
| Sk8014xSd 7 | 29.61 | 1.006 | 4.602 |
| Sk8014xSk7001 | 27.66 | 0.886 | 4.10 |
| Sk8014xSk5216 | 31.57 | 0.930 | -0.438 |
| Sk8014xNu 49 | 28.23 | 1.037 | -0.468 |
| Sk5069xSk5028 | 28.82 | 1.142 | 7.74* |
| Sk5069xSk5142 | 27.83 | 1.062 | 4.585 |
| Sk5069xSd7 | 34.94 | 1.309* | 0.19 |
| Sk5069xSk7001 | 30.83 | 1.313* | 22.795** |
| Sk5069xSk5216 | 26.50 | 0.860 | 2.147 |
| Sk5069x Nu 49 | 30.38 | 0.993 | 2.252 |
| Sk5028xSk5142 | 27.00 | 1.113 | -1.775 |
| Sk5028xSd 7 | 32.48 | 1.276 | 3.157 |
| Sk5028xSk7001 | 27.24 | 1.033 | -2.31 |
| Sk5028xSk5216 | 27.34 | 1.207 | 9.612* |
| Sk5028xNu 49 | 32.42 | 1.021 | -1.285 |
| Sk5142xSd7 | 32.37 | 1.183 | 6.625* |
| Sk5142xSk7001 | 28.18 | 0.953 | 0.985 |
| Sk5142xSk5216 | 27.32 | 0.867 | 3.967 |
| Sk5142xNu 49 | 28.29 | 1.084 | -1.27 |
| Sd7 x Sk7001 | 32.77 | 1.411* | 5.595 |
| Sd7 x Sk5216 | 32.78 | 1.038 | 1.997 |
| Sd7 x Nu 49 | 30.82 | 1.152 | -0.795 |
| Sk7001xSk5216 | 28.42 | 1.010 | 6.045 |
| Sk7001x Nu49 | 22.13 | 0.861 | 2.402 |
| Sk5216 x Nu 49 | 28.54 | 0.793 | 4.26 |
| SC 10 | 31.14 | 1.078 | -2.305 |
| SC128 | 32.39 | 1.069 | -1.875 |

*,**Significant at the 0.05 and 0.01 levels of probability, respectively.

## REFERENCES

Abd El-Maksoud, M.M. (1997). Heterosis and gene action for grain yield and ear characters in maize inbred lines. J. Agric. SCi. Mansoura Univ. 22: 1087-1100.

Abdel-Sattar, A.A.; A.A. El-Hosary and M.H. Motawea (1999). Genetic analysis of maize grain yield and its components by diallel crossing Minufiya J. Agric. Res. 24: 43-63.

Alam, A.K. M.M. ; S. Ahmed; M.Begum and M. K. Sultan (2008). Heterosis and combining ability for grain yield and its contributing characters in maize. Bangladesh J. Agril. Res. 33:375-379.

Amer, E.A. (2003). Diallel analysis for yield and its components of maize under two different locations. Minufiya J. Agric. Res. 28: 1363-1373.

Crossa, J.; S.K. Vasal and D.L. Beck (1990). Combining ability estimates of Cimmyt's tropical late yellow maize germplasm. Maydica, 35: 273-278.

Eberhart, S.A. and W.A. Russell (1966). Stability parameters for comparing varieties. Crop SCi. 6: 36-40.

El-Hosary, A.A. (1988). Heterosis and combining ability of ten maize inbred lines as determined by diallel crossing over two planting dates. Egypt. J. Agron. 13: 13-25.

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

El-Shenawy, A.A. (2005). Combining ability of prolific and non-prolific maize inbred lines in their diallel crosses for yield and other traits. J. Agric. Res. Tanta Univ. 31:16-31.

El-Shenawy, A.A. (2006). Diallel analysis and heterosis of eight yellow maize inbred lines (*Zea mays* L.). J. Agric. Res. Tanta Univ. 32:383-394.

Fan Xingming, Tan Jing, Huang Bihua and Liu Feng (2001). Analysis of combining ability and heterotic groups of yellow grain quality protein maize inbreds. Seventh Eastern and Southern Africa Regional maize conferenc, 143-148.

Gonzalez, J.M. (1988). Diallel crossing system in sets of flint and dent inbred lines of maize (*Zea mays* L.). Maydica. 33:37-49.

Griffing, B.(1956). Concept of general and specific combining ability in relation to diallel crossing systems. Aust. J. Biological SCi. 9: 463-493.

Hallauer, A.R. ; W.A. Russell, K.R. Lamkey (1988). Corn as a livestock feed. In: G. F. Sprague; J.W. Dudley (Ed) Corn and corn improvement. Madison: ASA, Cap 8: 941-963.

Huang, S.Z.; J. Dong and T.Y. Zhang (1983). Effect of parental relationship on combining ability in maize inbred lines. Shanze Agric. SCi. 7:15-17.

Katta, Y.S.; H.E. Galal and S.A. Abd-Alla (1975). Diallel analysis of yield and agronomic characters in maize (*Zea mays* L.). J. Agric. Res. Tanta, Univ. 1:195-213.

Mahto, R.N. and D.K. Ganguly (2001). Heterosis and combining ability studies in maize (*Zea mays* L.). J. Res. Birsa Agric. Univ. 13:197-199.

Mosa, H.E. (2003). Heterosis and combining ability in maize( *Zea mays* L.). Minufiya. J. Agric. Res. 28: 1375-1386.

Mosa, H.E. (2006). Diallel analysis of nine white maize inbred lines for different characters under different locations. J. Agric. SCi. Mansoura Univ. 31: 2073-2080.

Motawei, A.A. (2006). Gene action and Heterosis in diallel crosses among ten inbred lines of yellow maize across various environments. Egypt. J. Plant Breed. 10:407-418.

Nawar, A.A.; M.E. Gomaa and M.S. Rady (1979). Heterosis and combining ability in maize. Egypt .J. Genet. Cytol. 9:255-269.

Nevado, M.E. and H.Z. Cross (1990). Diallel analysis of relative growth rates in maize synthetics crop SCi. 30: 549-552.

Odemah, M.A. (1973). Estimation of general and specific combining ability in maize under different environments. M. SC. Thesis, Fac. of Agric., Alexanddria Univ. Egypt.

Pajic, Z. (1986). Combining ability of maize (*Zea mays* L.). inbred lines in different generation of inbreding. Wageningen, Nether lands, pudoc., 175 (C.F.Pl. Breed. Abst., 47:7904).

Shafiullah, J. and Baitullah (1999). Estimation of combining ability for grain yield and its components in 4x4 diallel cross of maize (*Zea mays* L.). Pakistan J. Biolog. SCi. 2:1423-1426.

Sprague, G.F. and L.A. Tatum (1942). General vs specific combining ability in single crosses of corn. J. Amer. SCo. Agron. 34: 923-932.

Steel, R.G.D. and J. H. Torrie (1980). Principles and Procedures of Statistics. A. Biometrical Approach. 2*nd*. Ed. Me. Graw Hill, N.Y. USA.

Vargas, M.; J. Crossa; F.A. Eeuwijk; M.E. Ramirez and K. Sayre (1999). Using partial least square regression factorial regression and Ammi models for interpreting genotype x environment interaction. Crop SCi. 39: 995-967.

Zelleke, H. (2000). Combining ability for grain yield and other agronomic characters in inbred lines of maize (*Zea mays* L.). Indian J. Genetics and Plant Breed. 60:63-70.

## الملخص العربى

## القدرة على الائتلاف لتسعة سلالات بيضاء من الذرة الشامية فى تهجينات تبادلية وتقدير الثبات للهجن الفردية الناتجة منها

عباس عبد الحى الشناوى – حاتم الحمادى موسى– عاصم عبده مطاوع
مركز البحوث الزراعية– معهد المحاصيل الحقلية– محطة بحوث سخا– قسم بحوث الذرة الشامية

حيث ان القدرة على الائتلاف تكون عامل محدد للاستفادة من السلالات فى تكوين الهجن لذلك تهدف هذه الدراسة لمعرفة القدرة على الائتلاف لتسعه سلالات و هى سخا ٦٠١٦وسخا ٨٠١٤ و سخا ٥٠٦٩ و سخا ٥٠٢٨ و سخا ٥١٤٢ و سخا ٧٠٠١و سخا ٥٢١٦ وسدس٧ و نوبارية ٤٩ ومعرفة قدره الهجن الناتجة منها على الثبات تحت ظروف بيئية مختلفة. تم تقييم ٣٦ هجينا فرديا ناتجة من التهجين بين ٩ سلالات من الذرة الشامية البيضاء بنظام التهجين التبادلى مع استبعاد التزاوجات العكسية بالإضافة الى هجينين تجاريين فى تصميم القطاعات الكاملة العشوائية فى أربع مكرارات فى ثلاث موقع بحثية بسخا والجميزة وسدس فى موسم صيف ٢٠٠٨. تم عمل التحليل المشترك للثلاث مواقع للصفات التالية تاريخ ظهور حرائر ٥٠% من النورات المؤنثة وارتفاع النبات ومحصول الحبوب وطول الكوز. كذلك تم تحليل الثبات لصفه المحصول

بطريقة (١٩٦٦) Eberhart and Russell وتقدير القدرة على الائتلاف طبقاً للطريقة الرابعة للنموذج الأول عن (١٩٥٦) Griffing.

أظهرت النتائج ان كل من الفعل الوراثى المضيف وغير المضيف للجين له دورا مهم فى وراثة جميع الصفات .و كان الفعل الوراثى المضيف للجين ألاكثر اهميه من الفعل الوراثى غير المضيف فى وراثة صفات تاريخ ظهور حرائر ٥٠% من النورات المؤنثة وارتفاع النبات بينما الفعل الوراثى غير المضيف كان اكثر اهمية فى وراثة صفات محصول الحبوب وطول الكوز. أظهرت النتائج أيضا ان الفعل الوراثي غير المضيف للجين كان أكثر تأثرا بالبيئة من الفعل الوراثي المضيف لجميع الصفات. القيم المرغوبة المتحصل عليها لتأثيرات القدرة العامة على الائتلاف كانت فى سلالات سخا٦٠١٦و سخا٧٠٠١و سخا ٥٢١٦ ونوبارية ٤٩ لصفة ظهور حرائر ٥٠% من النورات المؤنثة وسلالات سخا ٦٠١٦و سخا ٧٠٠١ لارتفاع النبات وسلاله سدس ٧ لمحصول الحبوب وسلالات سخا ٨٠١٤ وسخا ٥٠٢٨ لطول الكوز.الهجن المرغوبة لتاثيرات القدرة الخاصة على الائتلاف هى سخا ٥٠٢٨ × نوبارية٤٩ لصفة ظهور حرائر ٥٠% من النورات المؤنثة ومحصول الحبوب وسخا٥٠٦٩ × سدس٧ لصفةارتفاع النبات وسخا ٦٠١٦ × سخا ٥٠٢٨ لصفة طول الكوز .اظهرت الهجن الفردية سخا٥٠٢٨ × سدس ٧ و سخا ٥٠٢٨ × نوبارية ٤٩ وسدس ٧ × سخا ٥٢١٦ ثباتا لصفة المحصول تحت الظروف البيئة المختلفة .كما اعطت محصول لا يختلف عن محصول الهجن التجارية هـ.ف ١٠و هـ.ف ١٢٨ ولذلك توصى الدراسة باستخدام هذه الهجن للاختبارات الاخرى المتقدمة فى برنامج بحوث الذرة الشامية.