J. Plant Production, Mansoura Univ., Vol. 7(12):1263 -1267, 2016

Combining Ability Estimation and Gene Action in Maize (*Zea mays* L.), Using Line X Tester Method under Normal Irrigation and Water Stress Conditions

Sultan, M. S. [1]**; M. A. Abdel-Moneam**[1] **and A. M. EL. Orabi**[2]

[1] **Department of Agronomy, Faculty of Agriculture, Mansoura University.**

[2] **Misr Pioneer Seeds Company**

ABSTRACT

A line x tester analysis involving 28 top-crosses generated by crossing seven elites maize inbred lines (yellow) with four testers (yellow single crosses) was conducted for different some traits during 2015 cropping season at the Experimental Farm of Agricultural Faculty, Mansoura University, Egypt. The experimental design was the Randomized Complete Block Design (RCBD), with three replications. The objectives of this study were to estimate of general and specific combining ability effects of the parents (the inbred lines and the testers) and to evaluate the top-crosses performance of the hybrids for flowering, vegetative and ears yield plant^{-1} traits. The GCA/SCA ratio was found to be less than unity in all studied traits under both conditions, except ear height under stress condition, revealing that non-additive gene effects were more important than additive gene effects in the expression of these traits. Results showed that line (1), line (2), line (6), tester (1) and tester (2) were the best general combiners among the parents for ears yield per plant. Top-crosses no. 3, 4, 7, 9, 13, 20 and 26 under both conditions, 10, 19, 21, 22, 27 and 28 under water stress condition and 14, 23, 24 and 25 under normal irrigation condition showed negative and highly significant specific combining ability estimates for tasseling date. Top-Crosses no. 3, 4, 7, 9, 10, 13, 20 and 26 under both conditions, 19, 21, 22 and 28 under water stress condition and 6, 8, 23, 24 and 25 under normal irrigation condition showed negative and highly significant specific combining ability estimates for silking date. Negative and significant or highly significant specific combining ability estimates were detected for top-crosses no. 1, 11, 16, 19 and 26 under stress condition for ear height. Significant or highly significant and negative specific combining ability estimates were detected for top-crosses no. 1, 6, 9, 16 and 20 under stress water condition and 7, 12 and 13 under normal watering condition for plant height. Highly significant and positive specific combining ability estimates were detected for top-crosses no. 3, 4, 10, 13, 17 and 24 under stress water condition, 1, 2, 9, 16 and 20 under normal water condition and 5, 8, 11, 15, 18, 22, 25 and 26 under both water conditions for ears yield per plant.

Keywords: Maize, Combining ability, Gene action, Line x Tester, Drought stress, Proportional contribution.

INTRODUTION

Drought is a worldwide phenomenon and is a major production constraint, reducing crop yields. Drought, like many other environmental stresses, has adverse effects on crop yield. Low water availability is one of the major causes for crop yield reductions affecting the majority of the farmed regions around the world. As water resources for agronomic uses become more limiting, the development of drought-tolerant lines becomes increasingly more important. Although several methods have been developed, it remains difficult to judge where water is and whether it will be scare (Araus *et al.,* 2002 and Tester and Bacic, 2005). Estimation of combining ability and genetic variance components are important in the breeding programs for hybridization (Fehr, 1993). In any breeding program, the choice of the correct parents is the secret of the success. One of the most important criteria in breeding programs for identifying the hybrids with high yield is knowledge of parents genetic structure and information regarding their combining ability (Ceyhan, 2003). To initiate effective hybrid breeding program, information on the combining ability of inbred lines is an essential and critical factor. In the current study, therefore, an attempt was made to generate information on seven elites maize inbred lines (yellow) crossed to four testers (yellow single cross) of known heterotic groups in line x tester mating fashion and evaluated with the objectives of estimation of the GCA and SCA effects of the inbred lines and evaluation of the top- cross performance of the hybrids for study traits.

The present investigation was accomplished to get information regarding general and specific combining abilities and gene action in the inheritance of some earliness, vegetative and yield characters under drought stress and non-drought stress for improving drought tolerance in maize.

MATERIALS AND METHODS

1-Genetic materials: The genetic materials used in this study were seven inbred lines (L1 (CML52), L2 (LZI3), L3 (PHG35), L4 (LH123), L5 (Inb.204), L6 (Inb.209) and L7 (R.39)) with four testers (T1 (S.C.167), T2 (S.C.168), T3 (S.C.173 and T430M84) of diverse genetic back ground. The first four inbred lines were obtained from United States of America (USA). While, the last inbred line (R39) was obtained from Quality Techno Seed Company and two inbred lines (Inb. 204 and Inb. 209) were obtained by Agriculture Research Center (ARC) and four testers were obtained by Agriculture Research Center (ARC) and Misr Pioneer Seeds Company.

Field experiments: In 2014 growing season, the seven inbred lines and the four testers were planted on April 30th and May 15th, in separate plots and top crosses were made between lines and testers on according to line x tester design II Kempthorne (1957). Each top cross was constituted by collecting pollen from 40-50 protected tassels, representing the tester, then top crossing on to protected silks of 20 plants representing the inbred lines by hand pollinating.

In 2015 summer growing season, each of seven inbred lines, four testers and the 28 top crosses resulting from the first season were sown in two experiments representing two irrigation treatments, which were every 12 days (normal) and every 18 days (stress) at 70cm between ridges and 25 cm between hills. Each experiment was designated in a Randomized Complete Blocks Design (RCBD) with three replicates.

Each experimental plot consisted of only one ridge at five meters long. Plants were thinned to secure one plant hill^{-1} after seedling emergence. Each experiment was hoed twice, before 1st and 2nd

irrigations. Nitrogen (Urea, 46% N) at dose of 120 kg N fad^{-1}. was added in two equal split doses, before the 1st and 2nd irrigations.

Phosphorus (calcium super phosphate, 15.5 % P_2O_5) at dose of 200 kg fad^{-1}. was added to the soil during seedbed preparation, and potassium sulphate (48 % K_2O) at a level of 50 kg fad^{-1} was applied after thinning. Moreover, other agriculture practices were applied as recommended

Studied traits: The following measurements were recorded: Tasseling date (days), silking date (days), ear height (cm), plant height (cm) and ears yield per plant (g).

Statistical analysis: Statistical procedures used in this study were done to the analysis of variance for randomized complete blocks design as outlined by Cochran and Cox (1957). Mean of values were compared at 5% level of probability using least significant difference (LSD).

An ordinary analysis of variance was performed for the data collected from top crosses to test the differences and significance of all genotypes. When differences among top crosses were significant, the line x tester analysis according to Kempthorne (1957) and Singh and Chaudhary (1977) was done to estimate variance due to general and specific combining ability of the tested lines and testers interaction as well as various types of the gene effects.

RESULTS AND DISCUSSION

1-Analysis of Variance :

The analysis of variance for maize genotypes involved 28 top crosses resulting from (7 inbred lines x 4 testers) are presented in Table 1. Genotypes i.e. parents and crosses exhibited highly significant variation for all studied traits under normal irrigation and water stress conditions, indicting differences among these genotypes under investigation. Results presented in Table 1 showed that mean squares of parents vs. crosses (which indicated the variance due to heterosis) were found to be significant and highly significant for all studied characters, illustrating the wide range of heterosis values among the hybrids for all studied traits for both normal irrigation and water stress conditions.

Table1. Mean squares of analysis of variance for studied maize traits (tasseling date, silking date, ear height, plant height and ears yield per plant) under normal irrigation and water stress conditions:

Source of		Tasselling date		Silking date		(Ear height(cm		(Plant height(cm		(plant (g/Ears weight	
Variation	Df	Normal	Stress	Normal	Stress	Normal	Stress	Normal	Stress	N	S
Replication	٢	٠.٠١	٠.٠٠١	٠.٠٠٤	٠.٠٠٢	**١٢٦.٧٨	16.06**	**٦٣.٢٢	**٢١١.١١	٠.٠٠٤	٠.٠٠٢
Genotypes	٣٨	**٥٧.٠٣	**٥١.٥٣	**٦٤.٠٦	**٥٩.٨١	**١٦٥٢.١١	**١٥٠٩.٠٧	**٣٧٦٦.٣٥	**٣٤٣٠.٣٤	**٧٩٢٧.٣٤	**٧٠١٧.٠٠
Parents(P)	١٠	**٢٤.٧٤	**٤٢.٦٦	**٣٤.٨٠	**٥٨.٤٢	**١٤٩٠.٧٤	**١٤١١.٩٣	**٣٤٥١.٥٠	**٤٤٣٣.٨٢	**١٧٦٩٢.٤٦	**١٧٨٣٣.٥٩
Crosses(C)	٢٧	**٥٩.٦٦	**٥٠.٣٢	**٦٧.٣٨	**٥٣.١٢	**١٠٤٨.٣٧	**٩٠٧.٢٥	**١٨٩٨.٢٢	**١٠٠٥.٩٤	**٤٠٥٨.٤٤	**٢٧١٢.٦٦
P.VS.C	١	**٣٠٩.٠١	**١٧٢.٨٨	**٢٦٧.٠٢	**٢٥٤.٢٧	**١٩٥٦٦.٩٠	**١٨٧٢٩.٥٩	**٥٧٣٥٤.٢٣	**٥٧٥٠٤.٦١	**١٤٧٣٦.٥٠	**١٥٠٦٨.٤٥
Lines(L)	٦	**١٥٩.٦١	**١١٢.٩٣	**١٥٦.٧١	**١١٧.٩٣	**٣٦٦٨.٩٢	**٣١٥٧.٧١	**٤١٧٥.٧١	**٣٨٤٦.٣١	**٩٩٧٩.٠٢	**٦٠١٦.٩١
Testers(T)	٣	**٦٥.٢٥	**٩٠.٠٠	**٦٥.٥٧	**٨٠.٣٩	**٤٨٩.٩٧	**٨٢٧.٦٩	**٨٦٧.٦٤	**٣٢٥.٥٠	**٧٨٤٦.٧٧	**٤٣٩٥.١٢
L X T	١٨	**٢٦.٤٢	**٢٢.٨٣	**٣٧.٩١	**٢٦.٩٨	**٢٦٧.٩٢	**١٧٠.٣٦	**١٣١٠.٨٢	**٢٤٧.٥٨	**١٤٥٣.٥٣	**١٣٣٠.٨٣
Error	٧٦	٠.٠١	٠.٠٠٢	٠.٠٠١	٠.٠٠٢	١٧٢.٠٨	١٥٧.٩٧	٢٩٩.٥٨	١٤٥.٥٨	٠.٠٠١	٠.٠٠٢

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

Further partitioning of crosses, mean squares i.e. line x tester analysis indicated that the difference due to both lines and testers were significant and highly significant for all studied characters. Considering the interaction of lines x testers was highly significant differences for all the studied traits, indicating that testers did not express similar orders of ranking according to the performance of their crosses with the four testers .These results are in similar with those obtained by Sultan ,*et al* ;(٢٠١٣) .Abdel-Moneam ,*et al* ;(٢٠١٤) . Abdel-Moneam ,*et al* (٢٠١٥) .and Attia ,*et al* (٢٠١٥) .in their maize genotypes.

2-The proportional contributions:

The proportional contributions of lines (female), testers (male) and their interactions (top crosses) to total variance for different traits (Table 2) under different irrigation conditions revealed that females lines (maternal) contributed higher compared to male testers (paternal) under both normal irrigation and water stress conditions in all studied traits. Results showed that maternal parents play the most important role under drought stress conditions. Maternal parents should be used in further programs to improve drought stress tolerance. Studies have shown that proportional contributions of line, tester and line x tester change for different traits.

Table 2. Proportional contribution of lines, testers and their interactions to total variance under normal and water stress conditions for studied traits of maize.

Traits	Tasseling date		Silking date		Ear height(cm)		Plant height(cm)		Ears yield /plant (g)	
Source	Normal	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal	Stress
Due to lines	58.33	49.87	51.68	49.33	77.77	77.35	48.88	80.94	٥٤.٦٤	٤٩.٢٩
Due to testers	12.15	19.87	10.81	16.81	5.19	10.14	5.08	3.43	٢١.٤٨	١٨.٠٠
Due to lines x testers	29.52	30.25	37.50	33.85	17.04	12.52	46.04	15.63	٢٣.٨٨	٣٢.٧١

3-Combining ability analysis:

The results in Table 3 showed that the ratios of GCA/SCA were lesser than unity for all studied traits under normal and stress water conditions, except ear height under stress water conditions, which mean that non-additive gene effects played an important role in the inheritance of these traits in table 3. Similar results were obtained by Osman and Ibrahim (2007), Majid *et al.* (2010), Aslam *et al.* (2012), Aminu and Izge (2013) and Aminu *et al.* (2014) in their maize genotypes.

Table 3. Analysis of variance for general (GCA), specific (SCA) combining ability and GCA/SCA for studied maize traits under normal irrigation and water stress conditions.

Source of	Tasseling date		Silking date		Ear height(cm)		Plant height(cm)		Ears yield /plant (g)	
Variation	Normal	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal	Stress
σ^2GCA	٠.٧٤	٠.٦١	٠.٦٦	٠.٥٨	١٧.٣٤	١٦.٣٨	١٣.٠٥	١٧.٩٦	٥٧.٨٩	٣٠.٧١
σ^2SCA	٨.٨٠	٧.٦١	١٢.٦٤	٨.٩٩	٣١.٩٥	٤.١٣	٣٣٧.٠٨	٣٤.١٧	٤٨٤.٥١	٤٤٣.٦١
σ^2GCA/σ^2SCA	٠.٠٨	٠.٠٨	٠.٠٥	٠.٠٦	٠.٥٤	٣.٩٧	٠.٠٤	٠.٥٣	٠.١٢	٠.٠٧

General combining ability effects (gi):

Results in Table 4 showed that lines namely: L2 (LZI3) and L3 (PHG35) had negative and highly significant GCA effects for under both conditions, indicating that these inbreds could be considered as good general combiners under both conditions for earliness. Results show that testers namely: T1 (S.C.167) under normal watering and T3 (S.C.173) under both conditions had negative and highly significant GCA effects, indicating that these testers could be considered as good general combiners for earliness. Regarding silking date results show that lines L2 (LZI3) and L3 (PHG35) under both water levels and L6 (Inb.209) under stress water level had negative and highly significant GCA effects, these result indicating that parents: L2 (LZI3) and L3 (PHG35) under both water conditions and L6 (Inb.209) under water stress condition could be considered as good general combiner for earliness. Results show that testers: T1 (S.C.167) under water stress condition and T3 (S.C.173) under both water conditions had negative and highly significant GCA effects; these results indicate that parents: T1 (S.C.167) under normal irrigation condition and T3 (S.C.173) under both water conditions could be considered as good general combiners for earliness. Ear height (cm) of results show that lines: L3 (PHG35) under normal irrigation condition and L7 (R.39) under both water conditions show highly significant negative GCA effects, suggesting that these inbred lines are the best general combiners for ear height (shortness). Results show that testers under both water levels show non-significant GCA effects for ear height. Shushay *et al.* (2013) had similar results.

Plant height (cm) results show that inbred parents: L3 (PHG35) under normal water level, L5(Inb.204) and L6(Inb.209) under water stress condition and L7(R.39) under both water conditions show significant and highly significant negative GCA effects, suggesting that these inbred lines are the best general combiners for plant shortness. Results show that testers under both water levels show non-significant GCA effects for plant height. Similar results were obtained by Umar *et al.* (2014). Estimates of GCA effects for ears weight per plant show that inbred parents: L1 (CML52), L2(LZI3) and L6(Inb.209) under both water levels had highly significant and positive GCA effects, indicating that these inbred lines could be considered as the best general combiners for increasing ears weight plant^{-1} under both water conditions. Estimates of GCA effects for ears weight plant^{-1} show that testers: T1 (S.C.167) and T2 (S.C.168) under both water conditions had highly significant and positive GCA effects, indicating that these testers could be considered as the best general combiners for increasing ears weight plant^{-1} under both conditions.

Table 4. Estimates of general combining ability of maize inbred lines and testers for studied traits under normal irrigation and water stress conditions.

Traits	Tasselling date		Silking date		Ear height(cm)		Plant height(cm)		plant (g/Ears yield)	
Genotypes	N	S	N	S	N	S	N	S	N	S
Lines										
L1 (CML52)	**٢.٧٩	**٢.٦٨	**٢.١١	**٢.٨٢	**٣١.٦٦	**٢٩.٨١	**٣٦.٦٠	**٣٤.٢٥	**٤٢.٣٦	**٢٧.٤٠
L2(LZI3)	**٣.٩٦-	**٢.٨٢-	**٣.٣٩-	**٢.٩٣-	٠.٧٠	٢.٦١	٠.٦٥-	٧.٨٦-	**٩.٦٦	**٢٥.٥٥
L3(PHG35)	**٥.٩٦-	**٥.٥٧-	**٦.٦٤-	**٥.٤٣-	*١٣.٥١-	٧.١٥-	*١٦.٧٨-	٨.٨٥	**١٨.٢٩-	**٣.٩٠-
L4(LH123)	**٠.٢٩	**٢.٤٣	**١.٦١	**٢.٨٢	٦.٢٤-	٥.٧٨	١٠.٠٥-	٤.٧٥	**١٩.١٤-	**١٤.٠٥-
L5(Inb.204)	**٣.٧٩	**١.١٨	**٣.٣٦	**٠.٨٢	٤.١٥	٠.٤٧	٣.٣٧	*٩.٦٩-	**٢.٣٢-	**٥.٩٥-
L6(Inb.209)	**١.٧٩	**٠.٤٣	**١.٣٦	**٠.١٨-	٦.٦٦	٨.٦٤-	٥.٥١	*١١.٠٠-	**٢٧.٩٣	**٧.٠٨
L7(R.39)	**١.٢٩	**١.٦٨	**١.٦١	**٢.٠٧	**٢٣.٤٢-	**٢٢.٨٩-	*١٧.١٠-	**١٩.٣٠-	**٤٠.١٩-	**٣٦.١٥-
SEgca (Li)	٠.٠٣٠	٠.٠٠١	٠.٠٠١	٠.٠٠٢	٣.٧٩٠	٣.٦٣٠	٥.٠٠٠	٣.٤٨٠	٠.٠٠٣	٠.٠٠٢
SEgca (Li-Lj)	٠.٠٤٠	٠.٠٠٢	٠.٠٠٣	٠.٠٠٤	٥.٣٦٠	٥.١٣٠	٧.٠٧٠	٤.٩٢٠	٠.٠٠٤	٠.٠٠٤
LSD at 5%	٠.٠٨٢	٠.٠٠٣	٠.٠٠٣	٠.٠٠٥	١٠.٤١٤	٩.٩٧٥	١٣.٧٣٩	٩.٥٦٢	٠.٠٠٨	٠.٠٠٥
LSD at 1%	٠.١٣٣	٠.٠٠٤	٠.٠٠٤	٠.٠٠٩	١٦.٨٤٦	١٦.١٣٥	٢٢.٢٢٤	١٥.٤٦٨	٠.٠١٣	٠.٠٠٩
Testers										
T1(S.C.167)	*٠.١١-	**٠.٢٩	**٠.٢١	**٠.٠٤-	٣.٥٦	٤.٤٦	٣.٨٢	٣.٣٠-	**١٤.٢٩	**١٢.٠٥
T2(S.C.168)	**٢.٠٤	**١.٥٧	**١.٩٣	**١.٢٥	٢.١١	٠.٣٦-	٦.٧٥-	٢.٧٩-	**١٣.١٣	**١١.٧٣
T3(S.C.173)	**٢.٢٥-	**٣.٠٠-	**٢.٣٦-	**٢.٧٥-	٧.١٢-	٨.٧٥-	٣.٩٩-	٠.٩٠	**٢٧.٢٩-	**١٧.٤٨-
T4(S.C.3084)	**٠.٣٢	**١.١٤	**٠.٢١	**١.٥٤	١.٤٥	٤.٦٥	٦.٩٢	٥.٢٠	**٠.١٣-	**٦.٣٠-
SEgca (Ti)	٠.٠٢٠	٠.٠٠١	٠.٠٠١	٠.٠٠١	٢.٨٦٠	٢.٧٤٠	٣.٧٨٠	٢.٦٣٠	٠.٠٠٢	٠.٠٠١
SEgca (Ti-Tj)	٠.٠٣٠	٠.٠٠٢	٠.٠٠٣	٠.٠٠٢	٤.٠٥٠	٣.٨٨٠	٥.٣٤٠	٣.٧٢٠	٠.٠٠٣	٠.٠٠٣
LSD at 5%	٠.٠٦٧	٠.٠٠٣	٠.٠٠٣	٠.٠٠٣	٩.٥١٧	٩.١١٨	١٢.٥٧٨	٨.٧٥٢	٠.٠٠٧	٠.٠٠٣
LSD at 1%	٠.١٢٨	٠.٠٠٦	٠.٠٠٦	٠.٠٠٦	١٨.٣٦٧	١٧.٥٩٦	٢٤.٢٧٥	١٦.٨٩٠	٠.٠١٣	٠.٠٠٦

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

Specific combining ability effects (Si):

Results in table 5 show that top crosses: L1 X T3, L1 X T4, L2 X T3, L3 X T1, L4 X T1, L5 X T4 and L7 X T2 under both watering conditions, L3 X T2, L5 X T3, L6 X T1, L6 X T2, L7 X T3 and L7 X T4 under water stress and L4 X T2, L6 X T3, L6 X T4 and L7 X T1 had negative and highly significant SCA effects, indicating that these crosses are the best combinations between lines and testers for tasseling date (days) (earliness). Results of silking date (days) show that top crosses: L1 X T3, L1 X T4, L2 X T3, L3 X T1, L3 X T2, L 4 X T1, L5 X T4 and L7 X T2under both water conditions, L2 X T2, L2 X T4, L6 X T3, L6 X T4, and L7 X T1 under normal water condition and L5 X T3, L5 X T4, L6 X T1, L6 X T2 and L7 X T4L2 X T4, L3 X T1, L5 X T3, L6 X T1, L6 X T2 and L7 X T4 under water stress had negative and highly significant SCA effects, indicating that these crosses are the best combinations between lines and testers for earliness. Results of ear height (cm) show that crosses L1 X T1, L3 X T3, L4 X T4, L5 X T3 and L7 X T2 under water stress condition showed significant, highly significant and negative SCA effects for ear height, indicating that these crosses are the best combinations between lines and testers for ear height shortness. Plant height (cm) results show that top crosses: L2 X T3, L3 X T4 and L4 X T1 under normal irrigation and L1 X T1, L2 X T2, L3 X T1, L4 X T4 and L5 X T4under water stress showed significant, highly significant and negative SCA effects for plant height, indicating that these crosses are the best combinations between lines and testers for plant height shortness. Ears weight plant $^{-1}$(g) results show that top crosses: L1 X T1, L1 X T2, L3 X T1, L4 X T4 and L5 X T4 under normal watering, L1 X T3, L1 X T4, L3 X T2, L4 X T1, L5 X T1 and L6 X T4 under water stress and L2 X T1, L2 X T4, L3 X T3, L4 X T3, L5 X T2, L6 X T2, L7 X T1 and L7 X T2 under both water conditions showed highly significant positive SCA effects for ears weight plant^{-1}, indicating that these crosses are the best combinations between lines and testers for increasing ears weight plant^{-1}.

Table 5. Estimates of the specific combining ability of maize top-crosses (line x tester) for tasseling date, silking date, ear height (cm), plant height (cm) and ears yield per plant (g) under normal irrigation and water stress conditions:

Traits	Tasseling date		Silking date		Ear height(cm)		Plant height(cm)		Ears yield /plant (g)	
Line X Tester	N	S	N	S	N	S	N	S	N	S
L1 X T1(1)	**٣٫٣٦	**١٫٤٦	**٣٫٠٤	**٢٫٠٤	٣٫٨٥	**٩٫٧٤-	١٠٫٧٨-	*٨٫٥٢-	**١٠٫٤١	**١٦٫٨٠-
L1 X T2(2)	**١٫٢١	**٠٫١٨	**١٫٣٢	**٠٫٧٥	١٫٨٦-	٠٫٩٢	٧٫٥٤-	٤٫٦٤-	**٢٣٫٦٧	**٢٦٫٤٨-
L1 X T3(3)	**٣٫٥٠-	**١٫٢٥-	**٣٫٣٩-	**١٫٢٥-	١٠٫٦٣-	٠٫٧٤	٠٫١٣٣-	١٫٣٩-	**١٩٫١١-	**١٦٫٧٣
L1 X T4(4)	**١٫٠٧-	**٠٫٣٩-	**٠٫٩٦-	**١٫٥٤-	٨٫٦٣	*٨٫٠٨	١٨٫٤٦	**١٤٫٥٥	**١٤٫٩٧-	**٢٦٫٥٥
L2 X T1(5)	**١٫١١	**٠٫٩٦	**٤٫٥٤	**٠٫٧٩	٥٫٣١	٠٫٠٦	١٤٫٩٧	١٫٢٢	**٣٧٫١١	**٢٢٫٠٥
L2 X T2(6)	٠٫٠٤-	**٠٫٦٨	**٠٫١٨-	**١٫٥٠	٠٫١٠	٥٫٣٢-	١١٫٥٤	*٨٫٢٩-	**٤١٫٩٣-	**٣٥٫٦٣-
L2 X T3(7)	**١٫٧٥-	**١٫٧٥-	**٣٫٨٩-	**٢٫٥٠-	٢٫٥٠-	٤٫٨٨	**٣٨٫٧٢-	١٫٨٥	**١٫٥١-	**٠٫٤٣-
L2 X T4(8)	**٠٫٦٨	**٠٫١١	**٠٫٤٦-	**٠٫٢١	٢٫٩١-	٠٫٣٨	١٢٫٢١	٥٫٢٢	**٦٫٣٣	**١٤٫٠٠
L3 X T1(9)	**٠٫٨٩-	**١٫٢٩-	**٠٫٢١-	**٠٫٧١-	١٫٨١-	٢٫٣٧-	١٨٫٠٩	**١١٫٣٢-	**٢٫٠٦	**١٥٫٢٠-
L3 X T2(10)	٠٫٠٤-	**٠٫٥٧-	**٠٫٩٣-	**١٫٠٠-	١٥٫٦٤	**١٣٫٠٨	١٠٫١٠	٤٫١٧-	**٣٫٠٨-	**٥٫٨٣
L3 X T3(11)	**٠٫٢٥	**١٫٠٠	**٠٫٣٦	**١٫٠٠	٣٫١٣-	**١٠٫٧٢-	١٤٫٥٨	٤٫٥٥	**١٣٫٧٤	**١٤٫٥٣
L3 X T4(12)	**٠٫٦٨	**٠٫٨٦	**٠٫٧٩	**٠٫٧١	١٠٫٧٠-	٠٫٠١	**٤٣٫٦٧-	**١٠٫٩٥	**١٢٫٧٢-	**٥٫١٥-
L4 X T1(13)	**٥٫١٤-	**٦٫٢٩-	**٨٫٤٦-	**٦٫٩٦-	١٥٫٠٨-	*٧٫٦٩	*٣٠٫١٤-	**١٠٫٦٥	**١٨٫١٩-	**٠٫٧٥
L4 X T2(14)	**٠٫٢٩-	**٠٫٤٣	**٠٫٨٢	**٠٫٧٥	٩٫٥٦-	٠٫٥٨	١٢٫٠٢	٠٫١٦	**٢٠٫٤٣-	**٧٫٩٣-
L4 X T3(15)	**٤٫٠٠	**٥٫٠٠	**٥٫١١	**٤٫٧٥	١١٫٧٦	١٫٥١	٤٫١٠	*٦٫٨٥	**١١٫٢٩	**١٢٫١٨
L4 X T4(16)	**٠٫٤٣	**٠٫٨٦	**٢٫٥٤	**١٫٤٦	١٢٫٨٨	**٩٫٧٩-	١٣٫١٢	**١٧٫٦٥-	**٢٧٫٣٣	**٥٫٠٠-
L5 X T1(17)	**٠٫٣٦	**٣٫٩٦	**١٫٧٩	**٤٫٠٤	١٫٩٣	٤٫٤٩	١٫٤٣-	*٨٫٧٢	**١٠٫٣١-	**٩٫٤٥
L5 X T2(18)	**٠٫٢١	**١٫٦٨	**٠٫٠٧	**١٫٧٥	٧٫١٨-	٤٫٨٦	١١٫٢٧-	٤٫١٧	**٢٫٠٥	**٢١٫١٨
L5 X T3(19)	**٠٫٥٠	**٤٫٧٥-	**٠٫٣٦	**٥٫٢٥-	١٫٣٨-	*٨٫٨٥-	١١٫٠٢	٤٫٧٥-	**١٫٢٤-	**٥٫٦٣-
L5 X T4(20)	**٢٫٠٧-	**٠٫٨٩-	**٢٫٢١-	**٠٫٥٤-	٦٫٦٤	٠٫٤٥-	١٫٦٨	*٨٫١٥-	**٩٫٥٠	**٢٥٫٠٠-
L6 X T1(21)	**٢٫٣٦	**١٫٢٩-	**٠٫٧٩	**٠٫٩٦-	٣٫٦٥-	٢٫٩٢-	٦٫٨٦-	٠٫٤٦	**٢٧٫٣٦-	**٣٫٨٨-
L6 X T2(22)	**٣٫٢١	**١٫٥٧-	**٣٫٠٧	**٢٫٢٥-	٢٫٤٧	٥٫١٧-	١٩٫٢٩-	٦٫٢١	**٣٣٫٥٠	**٢٣٫٩٥
L6 X T3(23)	**٢٫٥٠-	**٢٫٠٠	**١٫٦٤-	**٢٫٧٥	٦٫٠٤	**٩٫٦٣	١٣٫٢٨	١٫٩٠-	**١٫٧٩-	**٢٨٫٦٥-
L6 X T4(24)	**٣٫٠٧-	**٠٫٨٦	**٢٫٢١-	**٠٫٤٦	٤٫٨٧-	١٫٥٤-	١٢٫٨٧	٤٫٧٧-	**٤٫٣٥-	**٨٫٥٨
L7 X T1(25)	**٢٫١٤-	**٢٫٤٦	**١٫٤٦-	**١٫٧٩	٩٫٤٤	٢٫٨٣	١٦٫١٤	١٫٢٠-	**٦٫٢٦	**٣٫٦٥
L7 X T2(26)	**٤٫٢٩-	**٠٫٨٢-	**٤٫١٨-	**١٫٥٠-	٠٫٣٩	*٨٫٩٥-	٣٫٥٥	*٦٫٥٥	**٦٫٢٢	**١٩٫٠٨
L7 X T3(27)	**٣٫٠٠	**٠٫٢٥-	**٣٫١١	**٠٫٥٠	٠٫١٦-	٢٫٨١	٥٫٠٣-	٥٫٢٠-	**١٫٣٦-	**٨٫٧٣-
L7 X T4(28)	**٣٫٤٣	**١٫٣٩-	**٢٫٥٤	**٠٫٧٩-	٩٫٦٧-	٣٫٣١	١٤٫٦٧-	٠٫١٤-	**١١٫١٢-	**١٤٫٠٠-
(TL)S.E.sca	٠٫٠٥٠	٠٫٠٠٢	٠٫٠٠١	٠٫٠٠٢	٧٫٥٧٠	٢٫٧٤٠	٩٫٩٩٠	٢٫٦٣٠	٠٫٠٠٥	٠٫٠٠٢
$(TL_1\text{-}l_2)$S.E.sca	٠٫٠٨٠	٠٫٠٠٣	٠٫٠٠٣	٠٫٠٠٣	١٠٫٧١٠	٣٫٨٨٠	١٤٫١٣٠	٣٫٧٢٠	٠٫٠٠٨	٠٫٠٠٤
%٥L.S.D. at	٠٫١٢٠	٠٫٠٠٥	٠٫٠٠٢	٠٫٠٠٥	١٨٫٢٣٢	٦٫٥٩٩	٢٤٫٠٦٠	٦٫٣٣٤	٠٫٠١٢	٠٫٠٠٥
%١L.S.D. at	٠٫١٧٥	٠٫٠٠٧	٠٫٠٠٣	٠٫٠٠٧	٢٦٫٤٧٥	٩٫٥٨٣	٣٤٫٩٣٩	٩٫١٩٨	٠٫٠١٧	٠٫٠٠٧

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

REFERENCES

Abdel-Moneam M. A.; M.S. Sultan; S.E. Sadek and M.S. Shalof (2015 .(Combining abilities for yield and yield components in diallel crosses of six new yellow maize inbred lines. International Journal of Plant Breeding and Genetics 9 (2): 86-94

Abdel-Moneam, M. A.; Sultan,M. S.; S.M.G. Salama and A.M. El. Orabi (2014). Evaluation of combining ability and heterosis for yield and its components traits of five maize inbreds under normal and stress nitrogen fertilization. Asian Journal of Crop Science, 6 (2): 142-149.

Aminu, D. and A. U. Izge (2013). Gene action and heterosis for yield and yield traits in maize (*Zea mays* L.), under drought conditions in Northern guinea and Sudan savannas of Borno State, Nigeria. Peak J. of Agric. Sci., 1 (1):17-23.

Aminu, D.; S.G. Muhammed and B.G. Kabir (2014). Estimates of combining ability and heterosis for yield and yield traits in maize population (Zea mays L.) under drought conditions in the Northern Guinea and Sudan savanna zones of Borno State, Nigeria. Intern. J. of Agric., Innovations and Res., 2(5): 824-830.

Araus J, G.A. Slafer, M.P. Reynolds and C.Toyo (2002). Plant breeding and drought in C_3 cereals, what should we breed for? Ann. Bot., 89: 925-940.

Aslam M., I. A. Khan and S. M. A. Basra (2012). Combining ability estimates and mode of inheritance for drought related traits in genetically distant maize accessions (*Zea mays* L.). The J. of Animal & Plant Sci., 22(3): 679-682.

Attia, A.N.; M.S. Sultan; M.A. Badawi; M.A. Abdel-Moneam and A.R.M. Al-Rawi (2015). Estimation of combining ability and heterosis for some maize inbred lines and its single crosses. J. Plant Production, Mansoura Univ., Vol. 6 (1): 83-99.

Ceyhan, E. (2003). Determination of some agricultural characters and their heredity through line x tester method in pea parents and crosses. Selcuk University, Graduate School Nat. Applied Science, p. 103 (C.F. Computer Search).

Cochran, W.C. and G.M. Cox (1957). Experimental Design. 2nd ed. John Willey and Sons Inc., New York, USA.

Fehr, W.R. (1993). Principles of Cultivar Development. MacMillan publication Co. New York. 342P.

Kempthorne, O. (1957). An introduction to genetic statistics. Iowa State Univ., John Wiley and Sons Inc., New York, USA. 545 pp.

Majid, S.; C.Rajab; M. Eslam and D. Farokh (2010). Estimation of combining ability and gene action in maize using line x tester method under three irrigation regimes. J. of Res. in Agric. Sci., 6: 19-28.

Osman, M.M.A. and M.H.A. Ibrahim (2007). Study on combining ability of new yellow maize inbred lines using lines x testers analysis. J. Agric. Sci. Mansoura Univ. 32 (2) : 815 – 830.

Shushay, W. A.; Z. Z. Habtamu and W. G. Dagne (2013). Line x tester analysis of maize inbred lines for grain yield and yield related traits. Asian J. of Plant Sci. and Res., 3(5):12-19.

Singh, R.K. and B.D. Chaudhary (1977). Biometrical methods in quantitative genetic analysis. Kalyani, Publishers, Daragnai, New Delhi (C.F. Computer Search).

Sultan, M.S.; M.A. Abdel-Moneam; S.M.G. Salama and A.M. El. Orabi (2013).Combining ability and heterosis for some flowering and vegetative traits of five maize inbreds under two nitrogen levels fertilization. J. Plant Prod., Mansoura Univ.Vol.4 (3):485-495.

Trester, M. and A. Bacic (2005). Abiotic stress tolerance in grasses, from model plants to crop plants. Plant Physiol., 137: 791-793.

Umar U. U.; S.G. Ado; D.A. Aba and S.M. Bugaje (2014). Estimates of combining ability and gene action in maize (*Zea mays* L.) under water stress and non-stress conditions J. of Biology, Agric. and Healthcare. ISSN 2224-3208.

القدرة علي التآلف و الفعل الجيني في الذرة الشامية بنظام السلالة فى الكشاف تحت ظروف الري العادى و الإجهاد المائي

محمود سليمان سلطان[١]، مأمون أحمد عبد المنعم[١] و أحمد محمد السيد عرابي[٢]
[١] قسم المحاصيل – كلية الزراعة – جامعة المنصورة
[٢] شركة مصر بايونير للبذور

الهدف من البحث أجراء دراسات على الذرة الشامية تحت مستويين من الري (أحدهما كل ١٢ يوم والثاني كل ١٨ يوم) لبعض السلالات النقية والكشافات والهجن القمية الناتجة من التهجين بينهما وتقدير القدرة العامة والخاصة علي التآلف لهم في موسم ٢٠١٤ تم التهجين بين سبع سلالات نقية (ستة صفراء + واحدة حمراء) و ٤ كشافات من الهجن الفردية الصفراء وفي موسم ٢٠١٥ قيمت السلالات والكشافات والهجن القمية الناتجة منها تحت مستويين من الجفاف لصفات التزهير والصفات الخضرية وصفة محصول الكيزان لكل نبات وهي: عدد الأيام حتي ظهور ٥٠% من النورات المذكرة، عدد الأيام حتي ظهور ٥٠% من الحريرة، إرتفاع الكوز، إرتفاع النبات و صفة محصول الكيزان لكل نبات حيث كانت متوسط التباين للتراكيب الوراثية لكل الصفات المدروسة معنوية تحت كلا ظروف الري العادى والجفاف. كان التباين للقدرة العامة والخاصة علي التآلف معنوية لكل الصفات المدروسة تحت مستويين الجفاف. اظهرت النسبة بين القدرة العامة والخاصة علي التألف أن الفعل الجيني الغير مضيف له دور رئيسى فى توريث كل الصفات المدروسة ماعدا إرتفاع الكوز تحت ظروف الإجهاد المائي. أظهرات السلالات رقم: ١، ٢ و ٦ والكشافات رقم: ١ و ٢ أفضل قدرة عامة علي التألف للصفات المدروسة تحت كلا ظروف الري العادى والجفاف حيث يمكن استخدمها في برامج تربية لتحسين هذه الصفات. أظهرت الهجن القمية رقم: ٣، ٤، ٧، ٩، ١٣، ٢٠ و ٢٦ تحت كلا ظروف الري العادى والجفاف لصفة عدد الايام من الزراعة وحتى ظهور ٥٠% من النورات المذكرة، والهجن القمية رقم: ٣، ٤، ٧، ٩، ١٠، ١٣، ٢٠ و ٢٦ تحت كلا ظروف الري العادى والجفاف لصفة عدد الايام من الزراعة وحتى ظهور ٥٠% الحريرة، ١، ١١، ١٦، ١٩ و ٢٠ تحت ظروف الإجهاد المائي لصفة إرتفاع الكوز، الهجن القمية رقم: ١، ٦، ٩، ١٦و٢٠ تحت ظروف الإجهاد المائي لصفة إرتفاع النبات و الهجن القمية رقم: ٥، ٨، ١١، ١٥، ١٨، ٢٢، ٢٥ و ٢٦ تحت كلا ظروف الري العادى والجفاف لصفة محصول الكيزان لكل نبات لذلك يمكن انتخاب هذه الهجن وادخالها في برامج تربية لتحسين هذه الصفات.