Minia J. of Agric. Res. & Develop.
Vol. (35), No. 2, pp. 299-312, 2015

VARIATION AND CLUSTER ANALYSIS OF SOME MAIZE GENOTYPES AND THEIR TOP CROSSES UNDER NORMAL AND STRESS IRRIGATIONS

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Received: 20 December (2015)   Accepted: 3Jan. (2016)

ABSTRACT

Nine maize inbred lines were top crossed to four testers: I.272, SC.10, TWC.310 and Giza 2 variety during 2013 summer season. The parental genotypes and 36 crosses were evaluated at Agricultural Experiments and Research Farm of the Faculty of Agriculture, Minia University during 2014 summer season, in both separate irrigation field trials under normal (every 2 weeks) and stressed (every 3 weeks). Soil moisture% was recorded for the two experiments (normal and stressed) at available water depletion in normal irrigation from 65 to 72% and in stressed irrigation from 92 to 95%. The experimental design was Randomized Complete Blocks with three replications for both experiments. Results exhibited highly significant differences among studied genotypes for anthesis-silking interval, yield per plant, yield per plot and drought tolerance index (DTI) under both normal (N) and stressed (S) conditions and the combined (C). Synthetic crosses possessed the shortest period between tasseling and silking (ASI). However, testers produced the highest grain yield per plant and plot. Moreover, the inbred lines were the most tolerant to drought followed by single crosses. Cluster analysis was done to explore the similarity of the performance of parents and the different top crosses in homogeneous groups for ASI(S), yield per plot (N,S,C) and DTI. From this analysis, it could be classified the studied genotypes into three groups i.e., A, B and C involving 27,8 and 11 genotypes, respectively in addition to three ungrouped genotypes i.e., I.276×I.272, G.2 and I.272. Results showed that group B was the best

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group for yield followed by Group A and C, which included SC.10, TWC.310 and six induced crosses. On the other hand, the ungrouped I.272 was the best set of genotypes for drought tolerance. Therefore, it could recommend selection in segregating populations of group B especially I.274×SC.10, I.277×TWC.310 and I.280×TWC.310 to attain high drought tolerant inbreds with high potential productivity. General combining ability of selected inbreds could determine using Sids7, Sids34 and Sids63, the parental lines of SC.10 and TWC.310, as possessed high combining ability that which, may contribute to develop drought tolerant hybrids.

Key words: Maize, Drought tolerance index, Inbred lines, Single crosses, Double crosses, Three way crosses, Synthetics, Top crosses, Cluster analysis.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops in the world. Nevertheless, Egypt ranks the fourth in the world with respect of maize productivity after USA, France and Italy, it imports every year about five million tons of corn grains.

Efforts are devoted to extend the acreage of maize; in the newly reclaimed lands, in addition to upgrading its productivity per unit area in old lands. Owing to the limited water resource, developing the crop varieties that drought tolerant and/or adapted to water deficit conditions is a must.

Water-deficit stress due to drought and salinity affects negatively on growth and development of maize plants (Moreno *et al* 2005).In maize, the development of drought tolerant varieties is an essential goal of plant breeding to alleviate the effects of water deficit. However, water stress reflected considerably in delaying silking, and increase the anthesis-silking interval(ASI), with yield failure according to Bolanos and Edmeades (1993), Byrne *et al.* (1995), Magorokosho *et al.(* 2003), Al-Naggar *et al.* (2004), Campos *et al.(* 2006), Al-Naggar *et al.(* 2011) and Kahiu *et al*. (2013a & b).

Breeding drought tolerant maize hybrids may be conducted under normal or drought conditions using selected/non-selected parental inbreds (Shadakshari and Shanthakumar 2015). Such situations may affect the resulted hybrids combinations. Drought tolerant germplasm might be specifically adapted to low yield environments as reported by Moreno *et al.*(2005), Shiri *et al*. (2010), Chen *et al.* (2012), Mohammad *et al*. (2013) and Kiani (2013).

The effective breeding program for maize drought tolerant hybrids necessitates exploring the performance and variation among newly developed maize inbred lines and their test crosses under normal and water stressed conditions. The utilization of different testers with various genetic backgrounds may offer wide range of cross-combinations that useful for breeding programs. Thus, these objectives will be explored during present studies.

MATERIALS AND METHODS

The field trials of the present work were carried out at the Agricultural Experiments and Research Farm of the Faculty of Agriculture, Minia University, El-Minia, Egypt during 2013 and 2014 summer seasons.

Ten white maize (*Zea mays L.*) inbred lines and three cultivars, i.e. SC.10, TWC.310 and Giza.2 were used in line x tester mating design. The seeds of these genotypes were kindly provided by Maize Research Section, Field Crops Research Institute, ARC. The inbred lines were developed by Maize Research Section, ARC under drought conditions. Nine of the ten inbred lines were used as females, three (I.273, I.279 and I.280), four (I.274, I.275, I.276 and I.281) and two (I.277 and I.278) of these lines are descended to G2C.8DR, Tep.5DR and A.E.D.DR, respectively. Line I.272 descended to G2C.8, SC.10 (Sids7×Sids 63), TWC.310 (SC.10×Sids34) and G.2 variety (developed via 7 exotics and 3 local varieties and lines) were used as males (testers).

During 2013 summer season, 36 top crosses were produced using the four male testers and nine inbreds as female parents. In summer season of 2014 the 36 top crosses and their parents were evaluated under two separate irrigation trials, *i.e.* normal (N) and stressed (S). The irrigation treatments were adopted after the 1*st* irrigation, 31 days after sowing. The irrigation of normal (N) and stress (S) experiments was conducted at 14 and 21 days intervals, respectively. Soil type was clay loam and the average depletion of soil moisture reached to 65-72 and 92-95.0% in N and S, respectively. Each trial was conducted as Randomized Complete Blocks Design (RCBD) with three replications. The plot size comprised three ridges, each three meters long and 70 cm wide ($6.3m^2$). The seeds were dry planted on 27th May in one side of the ridge in hills distanced 25 cm. Seedlings were thinned to one plant / hill three weeks after sowing.

During soil preparation, calcium superphosphate fertilizer (15.5% P_2O_5) was added at a rate of 200 kg / feddan. Nitrogen fertilizer was applied at rate of 200 kg /feddan in form of urea (46% N) in two splits at 1st and 2nd irrigation. Weeds were controlled by hoeing three times. All other cultural practices were applied following recommendations in El-Minia District.

The dates of flowering were recorded as the numbers of days to anthesis (pollen shed) and silking of 50% plants per plot. The difference between these dates was considered as anthesis-silking interval (ASI). Grain yield per plant and per plot were recorded as the grain weight of average 5 individual-plant sample and all plants per plot adjusted to15.5% grain moisture, respectively.

Drought Tolerance Index (D.T.I) was calculated as the sum product of the relatives of grain yield/plot under stress to corresponding normal conditions of experimental plot, replicate, genotype and trial or Expt. This procedure was adopted to ensure unbiased estimates of these indices.

The line X tester analysis was performed for obtaining data of each trial and combined across trials according to Kempthrone (1957) following by Singh and Chaudhary (1977).

Homogeneity test were adopted of the error terms of both trials prior analysis of variance which indicate the allowance of combined analysis (Gomaz and Gomaz 1984).

Cluster analysis was performed using ASI of stressed trial, grain yield/plot (GYplot) of normal, stressed and mean of both environments and DTI, using the average linkage procedure developed by Sokal and Michener (1958).Such analysis and dendrogram were carried out using Genstat software version 9 based on Euclidean method.

RESULTS AND DISCUSSION

Significance of Mean Squares

Mean squares due to line × tester analysis under each irrigation trial (normal and stressed) for studied traits are presented in Table (1). However, the ANOVA of combined analyses of this mating design over normal (N) and stressed (S) irrigations are presented in Table (2).

Data in Tables 1 and 2 shows, genotypes (G.) included parents either lines or testers and test crosses varied highly significantly for all studied traits under each trial and over both experiments except for anthesis-silking interval (ASI) under normal irrigation. This indicates that the tested maize genotypes varied considerably not only within each of tested environments (normal and drought), but also over both conditions. However, the insignificance of anthesis-silking interval (ASI) under normal conditions may be due to that maize genotypes responded differently for this interval only under drought stress (Al-Naggar *et al.* 2011)

In spite of that environmental condition (E.) as a source of variation of combined analysis, recorded highly significant mean squares for all traits, the magnitudes are greater than those of genotypes (G.). Environments (E.) recorded 69, 8 and 11 folds as much as variances of genotypes for anthesis-silking interval (ASI), yield per plant (GY plant) and yield per plot (GY plot), respectively. Thus, the effects of environmental conditions as normal and drought on performance of maize traits were considerably predominant than genotypic influences (Al-Naggar *et al.* 2004).

Parental genotypes either lines or testers varied highly significantly for all studied traits under each irrigation condition except ASI of lines and testers, drought tolerance index (D.T.I) of parents and of lines under stress trial (Table 1). Both parental genotypes (lines or testers) over environments (Table 2) recorded highly significant mean squares for all studied traits except for ASI (of both sets of genotypes). The lacking of significance due to inbred lines under stress trial (Table 1) for ASI and D.T.I may be referred to that these inbreds were developed under drought conditions. Similar insignificant variance component in combined analysis could be observed due to testers for ASI. (Shadakshari and Shanthakumar (2015).

Table (1): Significance of mean squares of line X tester analysis under irrigation trial (normal (N) or stressed (S)) for studied traits during 2013/2014 season.

S.O.V	d.f	ASI		GY/plant g		GY/plot kg		D.T.I
		N	S	N	S	N	S	
Genotypes (G.)	48	ns0.04	0.88 **	1869.47 **	791.12 **	2.51 **	0.99 **	1869.47 **
Parents (P.)	12	0.68 **	1.39 **	4627.56 **	856.45 **	5.65 **	1.11 **	0.07 ns
Crosses (C.)	35	0.38 **	0.68 *	565.83 **	363.53 **	0.79 **	0.47 **	0.02 ns
Lines (L.)	8	0.34 **	ns0.47	271.72 *	369.95 **	0.41 *	0.43 **	0.03 ns
Testers (T.)	3	0.61 **	ns0.37	2110.26 **	1117.46 **	4.03 **	1.57 **	0.01 **
L X T	24	0.37 **	0.79 **	470.81 * *	267.15 **	0.51 **	0.35 **	0.02 ns
P. *vs*. C.	1	ns0.05	1.88 **	14399.50 **	14972.91 **	25.24 **	17.66 **	0.01 *

Ns,* and ** indicate insignificant, significant at 5% and at 1% levels of probability.

Table (2): Significance of mean squares due to different sources of line × tester combined over normal (N) and stressed (S) irrigation trials for studied traits during 2013/2014 season.

S.O.V	d.f	ASI	GY plant g	GY plot kg
Env.(E.)	1	55.73**	19690.47**	33.67**
Geno.(G.)	48	0.81**	2344.96**	3.10**
Parent (P.)	12	0.96**	4668.98**	5.77**
P. *vs*. C.	1	1.31ns	29369.61**	42.57**
Crosses (C.)	35	0.75**	776.02**	1.05**
Lines (L.)	8	0.60ns	441.23**	0.63**
Testers(T.)	3	0.68ns	3147.78**	5.31**
L.xT.	24	0.80ns	591.15**	0.66**
G.xE.	48	0.53*	315.64**	0.42**
P.xE.	12	1.12**	815.05**	1.00**
(P. *vs*. C.)xE.	1	0.64ns	2.80ns	0.34ns
C.xE.	35	0.33ns	153.35ns	0.22*

Ns,* and ** indicate insignificant, significant at 5% and at 1% levels of probability

Variances due to crosses are highly significant under each environment (Table 1) and over both conditions (Table 2) for all studied traits except D.T.I. It's worth to mention that variances due to crosses are lower in magnitudes than those of their parents for all studied traits. However, parents/ crosses mean squares of combined analysis are 1.3, 6.0 and 5.5 for ASI, GY plant and GY plot, respectively. Similar higher ratios of testers to lines are recorded of combined analyses for all traits (Table 2). Such testers to lines mean squares ratios are 1.1, 7.1 and 8.4 for studied traits in the same order. This may indicate that the investigated testers represent abundant effects on cross performance than lines, which again reveals narrow variation among female lines.

The line × tester interaction mean squares under each investigated condition and combined over both, are highly significant for all studied traits except D.T.I and ASI (combined). The significance of line × tester interaction indicates that the performance of crosses varied due to lines and testers. In other words the performance of crosses varied according to the combination of both parental genotypes. This may be that testers represent different genetic background ranged from inbred lines (I.272) to open pollinated variety (G.2) in addition to SC.10 and TWC.310. Such difference produced variable breeding material, single crosses, three way crosses, double crosses and synthetics (Shiri *et al.* 2010 and Al-Naggar *et al.* 2011).

The single degree of freedom comparison, i.e. P. *vs.* C. as presumably an indication of heterosis effects showed highly significantly considerable mean squares for all traits either under each investigated trial or combined over both conditions. However, such mean squares for ASI under normal conditions and combined over irrigations didn't reach to the level of significance. This again proved that variable ASI of maize responses occurred only under drought conditions.

The G. × E. interactions recorded significant or highly significantly mean squares for all studied traits which means that studied genotypes performed differently from watering regime to another. Moreover, the interaction between P. × E. recorded highly significantly mean squares for all studied traits (Byne *et al.*1995, Shiri *et al.* 2010, Al-Naggar *et al.* 2011 and Chen *et al.* 2012). However, the interaction between (P. *vs.* C.) × E. recorded insignificant mean squares for all studied traits. This indicates that the extent of heterosis for these traits due to crossing is pronounced irrespective of environmental influences.

The C. × E. interaction recorded highly significantly mean squares only for GY plot. This indicates that grain yield of studied crosses varied differently from environment to another.

Mean performance

The mean performance of lines, testers and various types of crosses under either normal or stressed irrigation trials and combined over both conditions during 2013/2014 season are presented in Table (3).

Table(3): Mean performance of lines, testers and various types of crosses under each of normal and stressed irrigation and combined over these conditions during 2013/2014 season.

Genotype		Lines	Testers	Single crosses	TWC	Double crosses	Synthetics	LSD 0.05	
								For L&T	For crosses groups
ASI	N	1.8	2.0	1.8	2.0	1.8	1.7	0.12	0.09
	S	3.0	2.6	2.8	2.7	2.6	2.5	0.42	0.33
	C	2.4	2.3	2.3	2.4	2.2	2.1	0.24	0.18
GY/ plant(g)	N	100.0	188.0	130.2	144.0	150.8	146.1	7.56	5.93
	S	95.4	131.2	117.4	127.7	132.5	128.4	6.89	5.40
	C	97.7	159.6	123.8	135.8	141.7	137.3	4.23	3.32
GY/ plot(kg)	N	3.0	6.0	4.1	4.6	4.9	4.8	0.28	0.22
	S	2.8	4.1	3.5	3.9	4.1	4.0	0.26	0.20
	C	2.9	5.1	3.8	4.3	4.5	4.4	0.16	0.12
D.T.I		0.655	0.329	0.555	0.526	0.488	0.518	4.41	3.46

Synthetic genotypes (as the outcomes of crossing G.2 with inbred lines) possessed under both conditions shortest period between tasseling and silking (ASI) with insignificant difference with other cross groups. The ASI was wider under stressed than normal irrigation for all maize groups.

Inbred lines under both conditions produced the lowest grain yield (100.0 & 95.4 g) per plant or per plot (3.0 & 2.8 kg) under normal and stressed conditions, respectively. However, testers were the highest set of genotypes for grain yields compared to all crosses groups.

Inbred lines under both conditions were the most tolerant set of genotypes to drought (D.T.I = 0.655). However, this index of testers is the least (D.T.I = 0.329) one of all genotypes. The investigated cross combinations recorded somewhat higher drought tolerance which ranged from 0.488 to 0.555 of double crosses to single ones. This means that the tested inbred lines may improve greatly the drought indices of common test crosses.

Cluster Analysis

Mean performance of formed groups and ungrouped maize genotypes according to cluster analysis based on ASI (S), GY/plot (N), GY/plot (S), GY/plot (C) and D.T.I, are presented in Table (4). The dendrogram of average linkage of clustering the 49 maize genotypes is presented in Fig.1.

At 5% level of probability, cluster analysis grouped the investigated genotypes into three groups (A, B and C) and three ungrouped maize stocks. The first Group (A) comprised 27 genotypes. These genotypes included 6 SC's, 8 TWC's, 5 DC's and 8 synthetics. The single crosses of Group A are the combination between I.274, I.275, I.277, I.278, I.278 and I.280 with I.272. The TWC's belonged to the crosses of SC.10 with I.279, I.273, I.280, I.278, I.275, I.277, I.276 and I.281. But, DC's are outcomes of crossing I.279, I.274, I.276, I.275 and I.278 with TWC.310, while the 8 synthetics resulted from I.273, I.280, I.279, I.281, I.277, I.276, I.274 and I.275 with G.2. This cluster recorded an intermediate yield between the two other groups, i.e. B & C. Average grain yield of this group are 4.6, 3.8 and 4.2 kg per plot under normal, stressed and combined, respectively.

The high yielding cluster named Group B included 8 genotypes that are 2 testers (SC.10 and TWC.310) and 6 induced crosses. These crosses are 4 DC's (among TWC.310 with I.273, I.277, I.280 and I.281), one TWC (I.274 × SC.10) and one synthetic population (I.278 × G.2). This group produced the highest grain yield per plot under each trial and combined over both investigated irrigation conditions. It recorded 5.6, 4.4 and 5.0 kg grain yield per plot under normal, stressed and combined, respectively.

The lowest production of grain yields per plot were recorded by Group C (3.1, 2.9 and 3.0 kg) under normal, stressed and combined, respectively. This group included 11 maize genotypes which are 9 inbred lines and 2 induced single crosses, i.e. I.273 and I.281 with I.272.

Slight differences between these clusters for ASI (2.6, 2.5 and 2.8) under stressed conditions. In contrast to grain yield, Group C recorded the highest D.T.I (0.642) followed by Group A (0.519) and then Group B (0.465).

The ungrouped three genotypes seemed to be splitted from the aforementioned clusters, which may be due to distinctness in one or more traits. The first ungroup genotype is the single cross between I.276 and I.272. This single cross was splitted from Group A may be due to lower grain yielding ability under both investigated conditions (3.9 and 3.3 kg per plot under normal and stressed, respectively) corresponded to shortest ASI (2.0 days).

The second ungrouped genotype is the open variety, Giza.2 which seemed to be splitted from Group B. This variety recorded lower grain yield under stress (3.6 kg) with wider ASI (3.6 days), which reflected in the least D.T.I (0.273).

Nevertheless, the last ungrouped genotype I.272 produced similar grain yield (2.6 kg) under both conditions with widest ASI (4.3 days), but exhibited the highest D.T.I (0.735).

From the aforementioned results, it's may be concluded that Group B comprised the most promising crosses including SC 10 and TWC 310. Thus, crosses of this group may recommend for grain yield production under a wide range of conditions after testing stability.

Table (4): Performance of clustered maize genotypes (lines, testers and crosses) based on ASI (S), GY/plot (N), GY/plot (S), GY/plot (C) and D.T.I during 2013/2014 seasons.

Groups	**Genotypes**	**ASI (S)**			**GY/Plot (N)**			**GY/Plot (S)**			**GY/Plot (C)**			**DTI**		
		Mean	**Sd**	**Range**	**Mean**	**Sd**	**Range**	**Mean**	**Sd**	**Range**	**Mean**	**Sd**	**Range**	**Mean**	**Sd**	**Range**
Group A	n=27	2.6	0.50	2.0:3.6	4.6	0.33	4.0:5.2	3.8	0.29	3.4:4.4	4.2	0.24	3.7:4.6	0.519	0.09	0.352:0.708
Ungrouped	I.276xI.272	2.0			3.9			3.3			3.6			0.516		
Group B	n=8	2.5	0.36	2.0:3.0	5.6	0.41	5.1:6.2	4.4	0.29	4.1:5.0	5.0	0.22	4.7:5.3	0.465	0.10	0.319:0.637
Ungrouped	G.2	3.6			5.8			3.6			4.7			0.273		
Group C	n=11	2.8	0.45	2.0:3.3	3.1	0.33	2.6:3.5	2.9	0.26	2.5:3.3	3.0	0.29	2.6:3.4	0.642	0.05	0.576:0.748
Ungrouped	I.272	4.3			2.6			2.6			2.6			0.735		

Sd= standard devition, S = stressed, N = normal, C = combined

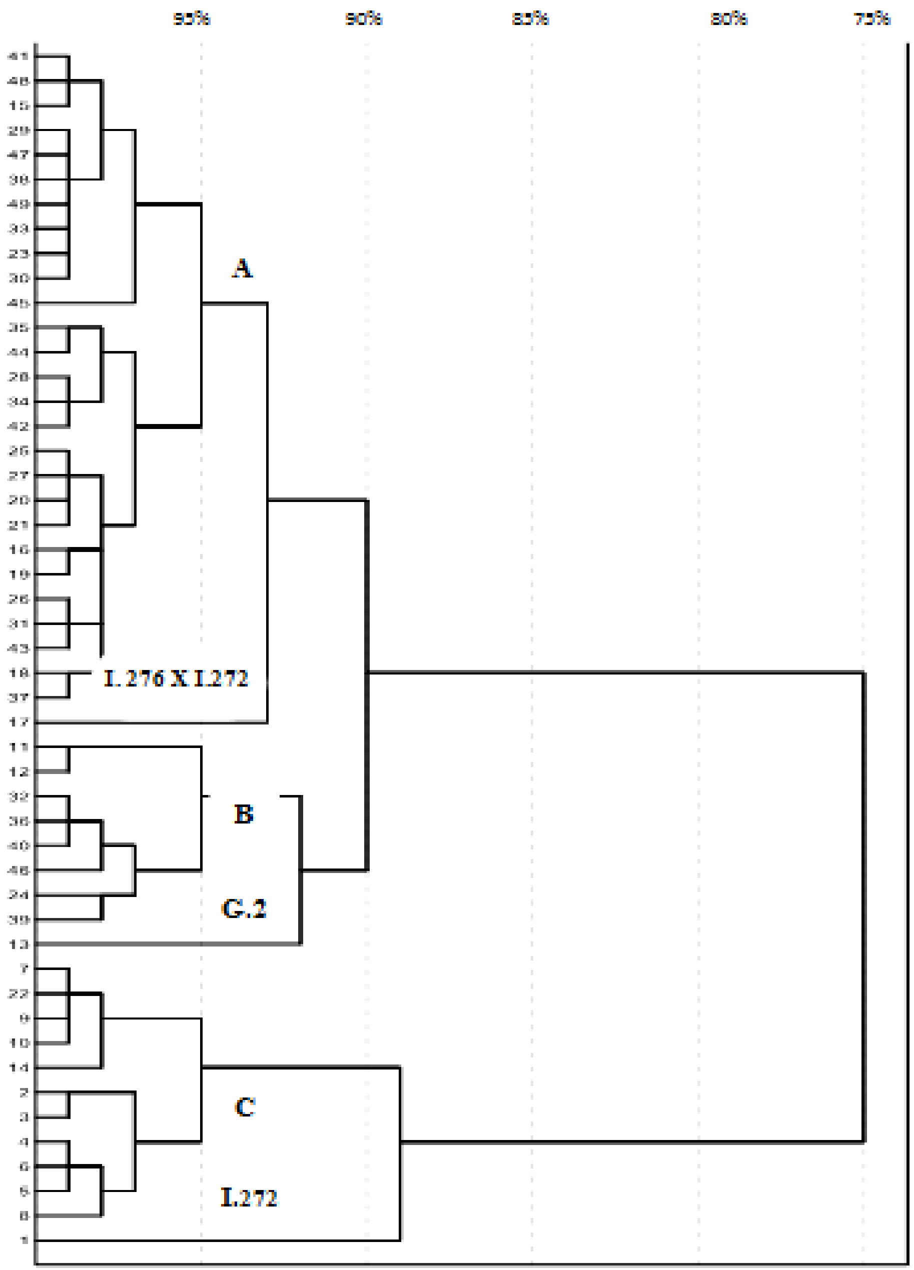

Fig.1. Dendrogram of average linkage of clustering the 49 maize genotypes (9 lines x 4 testers) for ASI (S), GY/plot (N), GY/plot (S), GY/plot (C) and DTI.

The selection within segregating populations of group B, particularly those of I.274xSC.10, I.280xTWC.310 and I.277xTWC.310 under drought condition may result new lines that performed reliable and possessed proper combining ability (Table 5).

Table (5): Mean performance of maize stocks belonged to Group B for traits in 2013/2014 season.

#	Stock	ASI(S)	GY/Plot (N)	GY/Plot (S)	GY/Plot (C)	D.T.I
11	SC.10	2.3	6.2	4.1	5.2	0.319
12	TWC.310	2.0	6.1	4.5	5.3	0.396
32	I.273xTWC.310	2.3	5.3	4.2	4.8	0.446
36	I.277xTWC.310	2.3	5.4	4.5	5.0	0.489
40	I.281xTWC.310	2.6	5.1	4.2	4.7	0.490
46	I.278xG.2	2.6	5.7	4.3	5.0	0.414
24	I.274xSC.10	3.0	5.3	5.0	5.2	0.637
39	I.280xTWC.310	3.0	5.3	4.5	4.9	0.525
	L.S.D$_{0.05}$	1.00	0.65	0.61	0.37	10.40

However, the genotypes of group C possessed higher D.T.I, but need to improve yielding ability through cross breeding programs. The testing of combining ability of the present inbred lines using Sids 7 or Sids 34 and/or Sids 63 as a good combiners (Shehata *et al.* 1997, Gado *et al.* 2000 and Gabr *et al.* 2008) may discover new drought tolerant inbred mater/s that produce promising hybrid/s.

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التباين و التحليل العنقودي لبعض تراكيب الذرة الوراثية و هجنها القمية في الري العادي و الجفاف

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تم التهجين بين 9 سلالات نقية من الذرة الشامية مع 4 كشافات وهما (السلالة النقية 272 ، هـ ف 10، هـ ث 310، جيزة 2) خلال موسم 2013 . وتم تقييم الاباء مع 36 هجين في مزرعة التجارب والبحوث الزراعية – كلية الزراعة – جامعة المنيا خلال موسم 2014 ،فى تجربتين حقليتين منفصلتين باستخدام الري العادي (الري كل اسبوعين) والري الاجهادى (كل ثلاثة اسابيع) وسجلت قياسات الرطوبة الارضية للتجربتين عند متوسط استنفاذ للماء المتاح في التجربة الاولى من 65-72% و في التجربة الثانية من 92-95%. وكان التصميم التجريبي المستخدم هو القطاعات كاملة العشوائية في ثلاث مكرارات لكلا التجربتين.

أظهرت النتائج وجود اختلافات عالية المعنوية للتراكيب الوراثية المختلفة للفترة بين ظهور اللقاح والحريرة، محصول النبات، محصول القطع التجريبية و دليل تحمل الجفاف تحت كل من ظروف الري العادي والاجهاد المائي والتجميعي لهم.

أظهرت النتائج أن الاصناف التركيبية الناتجة اعطت اقل فترة ما بين ظهور اللقاح والحريرة في حين ان الكشافات اعطت اعلي محصول للنبات وللقطع التجريبية. علاوة علي ذلك، نجد ان السلالات النقية هي الاكثر تحملا للجفاف يأتي بعدها الهجن الفردية الناتجة.

تم اجراء التحليل العنقودي لاستبيان مدى تشابه اداء الاباء و الهجن القمية المختلفة لمجموعات متجانسة على اساس صفات الفترة بين اللقاح والحريرة تحت ظروف الاجهاد، محصول القطع التجريبية في الري العادي والاجهاد والتجميعي بينهم وكذلك لدليل تحمل الجفاف. أظهرت نتائج التحليل العنقودي امكانية تقسيم التراكيب الوراثية المستخدمة في الدراسة الي ثلاث مجموعات هما (أ، ب ، ج) تتضمن 27 ، 8، 11تركيب وراثي على التوالي بالإضافة الى ثلاث تراكيب وراثية غير منتمية لهذه المجموعات هي I.276×I.272، G.2، I.272. اظهرت النتائج ان المجموعة (ب) هي الافضل من حيث المحصول يأتي بعدها المجموعة (أ) ثم المجموعة (ج) حيث ان مجموعة (ب) تحتوي علي الهجين فردى 10 ، الهجين الثلاثي 310 و 6 هجن جديدة . علي الجانب الاخر، نجد ان السلالة النقية 272 الغير منتمية لأى المجموعات هي الافضل من حيث تحمل الجفاف.

و قد يمكن بالانتخاب في العشائر الانعزالية للمجموعة ب و خاصة I.274xSC.10, I.277xTWC.310, I.280xTWC.310 للوصول الى سلالات ذات مستوى عالي من تحمل الجفاف مع القدرة المحصولية العالية و خاصة في ظروف شح الماء و خاصة لو تم تحديد القدرة العامة على التآلف سواء في مجموعة السلالات الحالية او المقترح انتخابها باستخدام السلالات الابوية (سدس 7 و سدس 34 و سدس 63) للهجن هـ. ف10 و هـ. ث 310 السابق تحديد قدرتها العالية على التآلف مما قد يساهم في الوصول الى هجين يتحمل ظروف الجفاف.