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HETEROSIS AND COMBINING ABILITY IN MAIZE (*Zea mays* L.) DIALLEL CROSSES

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ABSTRACT

A half diallel cross among developed eight yellow maize inbred lines and made at Gemmeiza Agricultural Research Station, Agricultural Research center (ARC), Egypt during 2007 growing season . Parents , F_1 crosses plus two checks (SC 166 and SC 3084) were evaluated at Gemmeiza and Sids Agricultural Research Stations in 2008 growing season. Data were recorded on grain yield, resistance to late wilt ,days to 50% silking , plant height and ear height. Data were genetically analyzed according to the procedures developed by Griffing (1956) method-4 model-1.The obtained results indicated that, mean squares associated with locations were highly significant for all studied traits except resistance to late wilt . Also, mean squares due to genotypes and their partitions : crosses, parents and parents vs. crosses showed highly significant differences.

General and specific combining ability mean squares and their interaction with locations were highly significant for all studied traits. Also, the ratio of GCA /SCA revealed that additive and additive x additive type of gene action were more important in expression of all traits under two locations and their combined. Inbred lines Gm.701 and Gm.705 have significant GCA effects for grain yield and resistance to late wilt, while inbred line Gm.709 considered the best combiner for earliness and plant height under combined data. The eight crosses Gm.701 x Gm.705 (10.65 %), Gm.701 x Gm.712 (8.40 %) , Gm.705 x Gm.710 (8.40 %), Gm.701 x Gm.709 (8.07 %) , Gm.701 x Gm. 710 (7.10 %), Gm.715 x Gm.718 (6.13%) , Gm.705 x Gm.706 (3.55%) and Gm.712 x Gm.715 (2.86 %) had significantly positive heterotic effects relative to the highest commercial hybrid S.C. 166 in the combined over locations. These crosses are considered as promising genotypes for grain yield and could be used in maize breeding program.

Keywords: Combining ability, Heterosis , Gene action, Maize.

INTRODUCTION

Maize is one of the most important cereal crops. For many years, it is used as food and feed for human and different animals. Therefore, corn breeders give great and continuous efforts to improve and increase yielding ability of this crop. Hybridization in corn started as early as by the work of East (1908) and Shull (1909), who clearly indicated that hybridization is the opposite of inbreeding. The concept of general (GCA) and specific (SCA) combining ability was introduced by Sprague and Tatum (1942) and its mathematical modeling was set about by Griffing (1956) in his classical paper in conjunction with the diallel crosses.

Allard (I960) was the first researcher who observed that hybrids were often possessed the most striking and unusual vigor. Since that time, many researchers generally and corn breeders specially started a new area of plant breeding to benefit from this phenomena, which is now known as heterosis.. Mosa (1996) evaluated I0 inbred lines of maize, and 45 F_l hybrids among them and revealed that both general and specific combining abilities were significant for grain yield . Amer *et al.* (1998) revealed that the GCA and SCA mean squares were highly significant for grain yield, ear length, ear diameter and number of kernels /row.

Aly (1999) indicated that both GCA and SCA variances were significant for grain yield in two years and their combined data. Choukan (1999) indicated that general and specific combining ability effects were highly significant for grain yield and both additive and non-additive effects were important in controlling grain yield. Soliman and Sadek (1999) found that five inbred lines exhibited the highest positive and significant GCA effects for grain yield trait. El-Absawy (2002) cleared that GCA mean squares were significant for grain yield per plant. El-Shouny *et al* (2003) reported that the GCA and SCA mean squares were highly significant for grain yield/plant. Meanwhile, the GCA/SCA ratio was larger than unity for all the studied traits except grain yield/plant, indicating that the GCA were important than SCA in the inheritance of these traits. EL-Moselhy (2005) found that the mean squares for General (GCA) and Specific (SCA) combining ability were highly significant for yield and yield components under different drought stress and non-stress treatments in two seasons.

Motawei and Mosa (2009) found that mean squares due to both GCA and SCA were significant or highly significant for grain yield , days to mid-silk , plant height and ear height.

Abd El-Moneam *et al* (2009) found positive significant heterosis values for grain yield. Amer *et al.* (1998) evaluated a half-diallel set of ten inbred lines of maize and showed that heterosis for grain yield as an average percentage from mid-parent was 259.76 Abd. El-Aal (2002) revealed that heterosis values relative to the better parent were negative and significant for grain yield/plant. Venugopal *et al.* (2002) evaluated a set of diallel crosses among ten parental lines of maize, these results indicated the presence of significant positive heterosis with a maximum of 136.67 % for grain yield . Mosa (2003) found that heterosis relative to mid-parents for grain yield ranged from 58.33 to 751.98% while, the values relative to better parent ranged from 24.08 to 709.88 % . El-Gazzar (2004) evaluated 28 F_1 hybrids of maize and found that heterosis was positive and highly significant for all studied vegetative and yield component traits. Ibrahim (2005) found heterosis for grain yield in F1 hybrids relative to the check variety SC 155 , SC 3080 and to the mean of all crosses ranged from (-28.24 to 45.42) , (-26.52 to 48.90) and (-33.54 to 34.67) , respectively

Abd El-Azeem and Abd El- Moula (2009) found that the four crosses (L-4 x Gz-638) , (L-4 x Gm-1004),(L-7 x Gz-639) and (L-7 x Gz-649) significantly out yielded the best check SC155 by 12.88 , 10.81, 17.75 and 13.87 %, respectively .

The objectives of this study were to determine combining ability of new single crosses and estimate the percentage of heterosis for grain yield trait relative to mid parent, high parent and constant parent (SC166 and SC 3084) in diallel crosses and determine promising single crosses in this respect.

MATERIALS AND METHODS

Eight yellow maize inbred lines namely Gm.701 , Gm.705 , Gm.706 , Gm.709,Gm.710 , Gm.712 , Gm.715 and Gm.718 isolated from different populations and were developed at Gemmeiza Research Station during the period from 2001 season to 2006 season. These inbred lines have high combining ability during early testcrosses, their for were used in this study and all possible combinations were made without reciprocals at Gemmeiza Agricultural Research Station ARC, Egypt in 2007 growing season .The eight parental lines, 28 crosses and two checks (SC 166 and SC 3084) were evaluated at Gemmeiza and Sids Agricultural Research Station in summer season of 2008. Randomized complete block design (RCBD) with four replications was used in both locations. Plot size was one row , 6 m long and 80 cm width and 25cm between hills. All cultural practices were applied as recommended. Data were recorded for grain yield (ard./fed.) adjusted to 15.5% moisture, days to 50 % silking , plant and ear heights(cm) ear position and resistance to late wilt disease. Analysis of variance was done for each location and combined over both locations. Also in each location the deviation sum squares among genotypes were partitioned into variation among crosses, parents and parents versus crosses as outlined by Steel and Torrie (1980). Genetic analysis for the diallel crosses was computed according to Griffing (1956) Method –4 , Modle – 1 , for all studied traits.

RESULTS AND DISCUSSION

Mean performance (x), environmental error (δ^2) and coefficient of variability (C.V.%) for the six studied traits at each location and the combined analysis are presented in Table (1).

Table (1): Mean performance (x), environmental error (δ^2) and coefficient of variability (CV %) for five traits in Gemmeiza and Sids locations and their combined data, 2008 season.

Location	Days to 50 % Silking date	Plant height (cm)	Ear height (cm)	Resistance to late wilt disease	Grain yield (ard/fed)
Gemmeiza					
x	59.4	251.0	140.0	98.6	24.94
Error	2.5	39.5	45.8	3.2	8.1
C.V %	2.7	2.01	4.48	1.81	11.39
Sids					
x	60.7	218.7	112.0	97.9	23.64
Error	2.2	48.4	55.6	3.61	7.61
C.V %	2.4	3.18	6.66	1.94	11.67
Combined					
x	60.05	234.9	126.0	98.25	24.29
Error	2.35	43.95	50.7	3.41	7.83
C.V %	2.55	2.82	5.65	1.88	11.53

The obtained results indicated that mean performance was higher at Gemmeiza than Sids location for all studied traits , except silking date and grain yield while, the reverse was obtained for all traits. This indicates that accuracy of experiment was higher at Gemmeiza location or that environmental conditions were more suitable at Gemmeiza than Sids location. Mosa (2003) defined that stress environment for mean performance of certain attribute is low and this stress for one trait did not mean stress for all of the rest studied traits.

Also, analysis of variance of the combined analysis for five studied traits are shown in table (2). Highly significant or significant differences were found among two locations for all studied traits. This suggested markedly differences between the two locations in their environmental conditions. Mean squares due to genotypes (G) crosses (C) , parents (P) and parents vs. crosses were highly significant for all studied traits , except parents (P) for resistance to late wilt disease, indicating that the tested parents varied from each other. Also F_1 mean values were significantly higher than parental means for all studied traits.

The interaction among (G x Loc) ; (C x Loc), (P x Loc) and (P vs. C x Loc) were significant for all studied traits (table 2).

Table (2): Analysis of variance for studied traits in (Gemmeiza , Sids) locations and their combined .

Locations	DF	Days to 50% Silking date	Plant height (cm)	Ear height (cm)	Resistance to late wilt disease	Grain yield (ard/fed)
Gemmeiza						
Reps	3	4.53	86.04*	82.0	3.37	7.41
Genotypes	35	85.0**	11096.4**	3230.6**	37.60**	47.24**
Parents	7	104.84**	94.60**	182.04**	24.05**	12.38
Crosses	27	35.88**	1959.32**	297.14**	39.76 **	39.63**
P Vs C	1	1272.36**	334810.2**	103773.94**	74.13**	496.73**
Error	105	2.5	39.5	45.8	3.2	8.1
Sids						
Reps	3	3.01	360.7**	5442.29**	15.9**	3.06
Genotypes	35	56.2**	17604.9**	4862.6**	42.7**	539.24**
Parents	7	46.93**	9822.4**	1048.2**	22.42**	438.76**
Crosses	27	41.52**	403.87**	2218.29**	42.80**	568.97**
P Vs C	1	517.45**	536510.2**	123249.0**	181.96**	439.75**
Error	105	2.2	48.4	55.6	3.61	7.61
Combined						
Locations (Loc)	1	845.6**	79496.9**	58719.2**	33.6*	128.2**
Reps/ Loc	6	3.77	223.4	154.83	9.62	2.22
Genotypes	35	98.2**	25446.7**	7377.6**	47.31**	490.9**
Parents	7	18.1**	2655.4**	543.0**	16.7	369.0**
Crosses	27	63.7**	919.9**	1830.0**	51.4**	517.8**
P Vs C	1	1590.4**	865009.4**	205005.0**	151.15**	617.9**
G x Loc	35	43.0**	3254.6**	1295.29**	32.99**	95.58**
P x Loc	7	133.67**	7261.6**	687.24**	29.77**	82.14**
C x Loc	27	13.7**	1443.29**	685.43**	31.16**	90.8**
P Vs C x Loc	1	199.41**	6311.0**	22017.94**	104.94**0	318.58**
Pooled error	210	2.35	43.95	50.7	3.41	7.83

***.** refer to 0.05 and 0.01 levels of significant probability, respectively.**

Table 3. Mean squares associated with general and specific combining ability (GCA and SCA) were highly significant for all studied traits, while the magnitude of the ratios of GCA / SCA revealed that the additive and additive x additive gene action were more important for all studied traits under the two locations and their combined , indicating that the additive effects played important role in inheritance studied traits.

Table (3). Estimates of variance for general and specific combining ability according to Method - 4 Modell-1 at (Gemmeiza , Sids locations and their interaction with two locations for the studied traits.

Traits	Locations	GCA	SCA	GCA// SCA	GCAx Loc	SCAx Loc.	GCAx Loc/ SCAx Loc.	Error
Days to% 50 silking	Gm.	35.9**	22.8**	1.6	--	--	--	0.62
	Sd.	46.9**	4.4**	10.7	--	--	--	0.55
	Comb.	22.1**	9.8**	2.3	60.7**	17.4**	3.49	0.59
Plant height	Gm.	1363.7**	184.0**	7.41	--	--	--	9.90
	Sd.	9822.4**	2819.7**	3.48	--	--	--	12.10
	Comb.	2655.4**	677.1**	3.9	8530.7**	2326.6**	3.67	11.00
Ear height	Gm.	182.1**	36.6**	4.98	--	--	--	11.45
	Sd.	3048.2**	731.8**	4.17	--	--	--	13.90
	Comb.	543.0**	118.8**	4.57	2687.3**	649.6**	4.14	12.70
Resistance to late wilt %	Gm.	24.1**	7.7**	3.13	--	--	--	0.80
	Sd.	22.4**	6.6**	3.4	--	--	--	0.90
	Comb.	16.7**	2.9*	5.76	29.8**	11.4**	2.61	0.85
Grain yield	Gm.	12.4**	9.1**	1.36	--	--	--	2.03
	Sd.	438.8**	38.5**	11.4	--	--	--	1.90
	Comb.	12.62**	9.15**	1.4	438.6**	38.45**	11.41	1.44

***.** refer to 0.05 and 0.01 levels of significant probability, respectively.**

Mean performance of genotypes for the studied traits as combined data except grain yield(ard/fed) under two locations and their combined are shown in Table 4. Great differences were found between means of parents and F_1's for grain yield. In Gemmeiza location, mean grain yield for parents ranged from 2.83 ard/fed for inbred line Gm.706 to 14.8 ard/fed for Gm.710, while, the mean values for crosses ranged from 24.3 ard/fed for the cross (Gm.709 x Gm.715) to 34.45 ard /fed for the cross (Gm 701 x Gm.712) . In Sids location, mean grain yield for parents ranged from 3.2 ard/fed for inbred line Gm.701 to 5.8 ard/fed for inbred line Gm.710 ,while , the mean values for crosses ranged from 23.6 ard/fed for the cross (Gm.705 x Gm.712) to 35.2 ard/fed for the cross (Gm. 701 x Gm.705) .In the combined locations, mean grain yield for parents ranged from 3.2 ard/fed for inbred line Gm. 706 to 10.3 ard/fed for inbred line Gm.710 , while , the mean values for crosses ranged from 24.5 ard/fed for cross (Gm.709 x Gm.715) to 34.4 ard/fed for cross (Gm.701 x Gm.705) . Also, The highest mean grain yield obtained from the crosses : Gm. 701 x Gm. 705 (34.3 ard/fed), Gm. 701 x Gm. 712 (33.6 ard/fed) , Gm. 705 x Gm. 710 (33.6 ard/fed), Gm.701x Gm. 709 (33.5 ard/fed), Gm. 701 x Gm.710 (33.2 ard/fed), Gm.715 x Gm.718 (32.9 ard/fed) , Gm.705 x Gm.706 (32.1 ard/fed), Gm.712 x Gm. 715(31.7 ard/fed) and Gm. 701 x Gm. 715 (31.3 ard/fed) . These crosses out yielded the commercial hybrids S.C. 166 (31.0 ard/fed) and S.C. 3084 (29.9 ard/fed).

Table (4): Mean performance of the studied traits for maize genotypes for combined data, except grain yield in (Gemmeiza , Sids) locations and their combined.

Genotypes		50 % Silking date	Plant Height (cm.)	Ear height (cm.)	Resistance to late wilt (%)	Grain yield (ard/fed)		
						Gm.	Sd.	Comb.
Gm. 701		66.1	139.4	70.0	98.3	5.4	3.2	4.1
Gm. 705		66.9	117.5	63.6	94.9	4.9	3.5	4.2
Gm. 706		63.0	138.7	76.1	93.8	2.8	3.6	3.2
Gm. 709		61.9	158.5	80.4	97.1	6.6	3.6	5.1
Gm. 710		59.4	171.3	84.8	97.1	14.6	5.8	10.3
Gm. 712		62.0	153.8	75.3	100.0	6.7	3.5	5.1
Gm. 715		63.3	146.8	72.3	100.0	7.9	3.5	5.7
Gm. 718		64.6	139.6	72.1	98.4	6.3	3.5	4.9
Gm. 701 x Gm. 705		66.1	315.8	162.5	100.0	33.4	35.2	34.3
" " " " x Gm. 706		63.5	264.9	142.5	100.0	30.3	29.2	29.8
" " " " x Gm. 709		65.8	293.6	160.5	100.0	33.8	33.2	33.5
" " " " x Gm. 710		65.9	306.8	163.9	100.0	33.3	33.1	33.2
" " " " x Gm. 712		66.1	305.6	138.8	100.0	34.5	32.7	33.6
" " " " x Gm. 715		62.4	307.3	160.5	100.0	30.9	31.7	31.3
" " " " x Gm. 718		56.9	258.9	142.9	100.0	26.9	25.3	26.1
Gm. 705 x Gm. 706		62.1	286.5	146.1	100.0	32.8	31.4	32.1
" " " " x Gm. 709		57.4	235.5	134.1	100.0	28.5	27.7	28.2
" " " " x Gm. 710		66.0	286.4	162.1	100.0	34.0	33.2	33.6
" " " " x Gm. 712		57.9	225.4	123.5	100.0	26.0	23.6	24.8
" " " " x Gm. 715		58.0	239.4	127.9	100.0	29.8	25.8	27.8
" " " " x Gm. 718		61.6	246.1	136.1	100.0	30.5	28.5	29.5
Gm. 706 x Gm. 709		57.4	230.6	126.5	100.0	26.3	27.5	26.9
" " " " x Gm. 710		57.1	232.0	136.5	98.2	25.6	24.2	24.9
" " " " x Gm. 712		62.4	247.6	134.6	100.0	30.5	28.3	29.4
" " " " x Gm. 715		57.6	224.5	131.0	100.0	27.0	26.6	26.8
" " " " x Gm. 718		57.1	235.9	139.8	100.0	28.0	26.8	27.4
Gm. 709 x Gm. 710		57.4	208.0	115.0	96.7	32.0	30.0	31.0
" " " " x Gm. 712		56.6	209.0	113.1	98.8	25.4	25.6	25.5
" " " " x Gm. 715		57.3	213.5	119.9	96.3	24.3	24.7	24.5
" " " " x Gm. 718		56.4	215.3	119.8	98.9	25.4	24.9	25.2
Gm. 710 x Gm. 712		57.5	228.3	127.0	92.3	31.0	29.7	29.9
" " " " x Gm. 715		55.8	228.5	128.6	93.9	27.9	26.5	27.2
" " " " x Gm. 718		62.4	275.1	154.3	93.3	31.5	30.1	30.8
Gm. 712 x Gm. 715		63.4	291.1	131.9	92.9	32.0	31.4	31.7
" " " " x Gm. 718		62.9	252.5	132.6	95.3	31.6	30.0	30.8
Gm. 715 x Gm. 718		61.9	300.8	156.0	98.4	33.6	32.2	32.9
Checks	S.C. 166	62.9	292.3	154.9	100.0	28.2	29.2	31.0
	S.C .3084	62.6	301.3	162.4	99.3	29.2	30.6	29.9
L.S.D.	0.05	1.94	8.87	9.16	3.72	2.12	2.27	2.34
	0.01	2.54	11.68	12.06	4.90	2.75	2.95	3.08

Heterosis percentages relative to check hybrid (SC 166 and S.C. 3084) under the two locations (Gemmeiza, Sids) and their combined are presented in Table (5). Eleven, fourteen single crosses surpassed significantly heterotic positive for the two checks (SC 166, SC 3084), respectively in Gemmeiza location. Also seven, nine single crosses surpassed significantly heterotic positive for the checks (SC166 and SC 3084) in Sids location. On the other hand, the crosses Gm. 701 x Gm. 705

(10.65%), Gm. 701 x Gm.712 (8.4%), Gm. 705 x Gm. 710 (8.4%), Gm.701 x Gm.709 (8.07%), Gm. 701 x Gm.710 (7.10 %), Gm. 715 x Gm. 718 (6.13%), Gm. 705 x Gm. 706 (3.55%) and Gm. 712 x Gm. 715 (2.86%) significantly exceeded the highest constant parent (S.C. 166), in addition to these crosses Gm. 701 x Gm.715 (4.68 %), Gm. 709 x Gm. 710 (3.68 %), Gm. 710 x Gm.718 (3.01 %), Gm. 712 x Gm. 718 (3.01 %) significantly exceeded the (S.C. 3084). Results indicated that these new single crosses and their parents are considered desirable and promising crosses and could be used in maize breeding programs. Many investigators found that high heterosis for grain yield of maize relative to constant variety as reported by El-Hosary (1989), Mahmoud (1996) and Ibrahim (2005).

Estimates of general combining ability effects for eight inbred lines are presented in Table (5). High positive values would be of interest for grain yield and resistance to late wilt disease ,while, high negative values are desirable for silking date , plant height and ear height.

Table (5): Heterosis Percentage for 28 single crosses relative to constant varieties (S.C.166 and S.C. 3084) as checks for grain yield in (Gemmeiza, Sids) locations and their combined.

Crosses		Gemmeiza		Sids		Combined	
		SC 166	SC 3084	SC166	SC 3084	SC166	SC 3084
Gm. 701 x Gm. 705		7.74**	11.71**	13.55**	17.73**	10.65**	14.720**
“ “ “ “ x Gm. 706		-2.26*	1.34	-5.81**	-2.34**	-0.040	-0.330
“ “ “ “ x Gm. 709		9.03**	13.04**	7.10**	11.04**	8.070**	12.040**
“ “ “ “ x Gm. 710		7.42**	11.37**	6.77**	10.70**	7.100**	11.040**
“ “ “ “ x Gm. 712		11.29**	15.38**	5.48**	9.36**	8.400**	12.370**
“ “ “ “ x Gm. 715		-0.32	3.34**	2.26**	6.02**	0.970	4.680**
“ “ “ “ x Gm. 718		-13.23**	-10.03**	-18.39**	-15.38**	-0.150	-12.370**
Gm. 705 x Gm. 706		5.81**	9.7****	1.29	5.02**	3.557**	7.360**
“ “ “ “ x Gm. 709		-8.06**	-4.68**	-10.65**	-7.36**	-0.090	-5.690**
“ “ “ “ x Gm. 710		9.68**	13.71**	7.10**	11.04**	8.400**	12.370**
“ “ “ “ x Gm. 712		-16.13**	-13.04**	-23.87**	-21.07**	-20.00**	-17.060**
“ “ “ “ x Gm. 715		-3.07**	-0.33	-16.77**	-13.71**	-10.320**	-7.020**
“ “ “ “ x Gm. 718		-1.61*	2.01*	-8.06**	-4.68**	-4.840**	-1.340
Gm. 706 x Gm. 709		-15.16**	-12.04**	-11.29**	-8.03**	-13.230**	-10.030**
“ “ “ “ x Gm. 710		-17.42**	-14.38**	-21.94**	-19.06**	-19.680**	-16.720**
“ “ “ “ x Gm. 712		-1.61*	2.01*	-8.71**	-5.31**	-5.160**	-1.670
“ “ “ “ x Gm. 715		-12.90**	-9.70**	-14.19**	-11.04**	-13.550**	-10.370**
“ “ “ “ x Gm. 718		-9.68**	-6.35**	-13.55**	-11.37**	-11.610**	-8.360**
Gm. 709 x Gm. 710		3.23**	7.02**	-3.23**	0.33	0.000	3.680**
“ “ “ “ x Gm. 712		-18.06**	-15.05**	-17.42**	-14.38**	-17.740**	-14.720**
“ “ “ “ x Gm. 715		-21.61**	-18.73**	-20.32**	-17.39**	-20.970**	-18.060**
“ “ “ “ x Gm. 718		-18.06**	-15.05**	-19.68**	-16.72**	-19.030**	-16.050**
Gm. 710 x Gm. 712		-2.90**	0.67	-4.19**	-0.67.	-3.550*	0.000
“ “ “ “ x Gm. 715		-10.00**	-4.45**	-14.52**	-11.37**	-12.260**	-9.030**
“ “ “ “ x Gm. 718		1.61*	7.88**	-2.90**	0.67	-0.650	3.010**
Gm. 712 x Gm. 715		3.23**	7.02**	1.29*	5.02**	2.868**	6.020**
“ “ “ “ x Gm. 718		1.94*	5.69**	-3.23**	0.33	-0.650	3.010*
Gm. 715 x Gm. 718		3.39**	12.37**	3.87**	7.69**	6.130**	10.030**
L.S.D.	0.05	1.41	1.41	1.36	1.36	1.18	1.18
	0.01	1.84	1.84	1.78	1.78	1.55	1.55

***.** significantly differences at 0.05 and 0.01 levels of probability, respectively.**

Inbred line Gm.709 considered the best combiner for earliness and short plants (low ear position). Also, inbred lines Gm.701 and Gm.705 were the best combiners for grain yield and resistance to late wilt disease. These results indicated that the three previous lines have desirable genes for improving hybrids for earliness , plant height and high yield.

Estimates of specific combining ability effects for twenty eight single crosses are given in Table (6). Thirteen single crosses showed significant positive SCA effects for grain yield. The crosses (Gm. 709 x Gm.718 and Gm.706 x Gm.712) have the highest SCA effects followed by cross (Gm.715 x Gm.718). Nine crosses exhibited desirable and significant SCA effects for resistance to late wilt disease. For silking date ,ten crosses had negative and significant SCA effects towards earliness. Fourteen crosses had desirable and significant SCA effects for plant height. While, for ear height, twelve crosses showed desirable SCA effects. Moreover, the cross (Gm. 709 x Gm. 710) had desirable SCA effects for silking date , plant height and ear height towards earliness and short plants. These results showed importance of these single crosses which could be used in maize breeding programs in the future.

Table (6): Estimates of general combining ability effects over combined data for the parental eight nbred lines .

Inbred lines and their base population		50 % Silking	Plant Height	Ear Height	Resistance to late wilt	Grain yield
Gm.701 (Gm.Y. Pop.)		3.910**	43.600**	17.422**	1.870**	2.734**
Gm.705 (Pop. 31- 69)		0.995	7.307*	4.234*	1.870**	0.755**
Gm.706 (Comp. 21)		-0.984**	-11.526**	-1.662	1.578**	-1.474**
Gm.709 (Pop. 24- 610)		-2.505**	-30.943**	-13.016**	0.328	-1.807**
Gm.710 (Comp. 45)		-0.193	-4.360	3.401*	-2.380**	0.818**
Gm.712 (Pop. 445)		0.600	-5.276	-10.910**	-1.589**	0.026
Gm.715 (SK. 21)		-1.151**	2.3o7	-1.870	-1.193**	-0.599*
Gm.718 (Pop. 446)		-0.672	-1.109	2.401	-0.484	-.0453
L.S.D Gi Lines	0.05	0.73	6.41	3.33	0.76	0.49
	0.01	0.96	8.44	4.38	1.00	0.65
L.S.D gi-gj Lines	0.05	1.12	9.8	5.10	1.40	1.98
	0.01	1.45	12.8	6.63	1.82	2.58

***.** significantly differences at 0.05 and 0.01 levels of probability, respectively.**

Table (7): Estimates of specific combining ability effects for single crosses over combined data,

Crosses		Days to 50 % Silking	Plant Height	Ear Height	Resistance to late wilt	Grain yield
Gm. 701 x Gm. 705		0.768	8.96	2.710	-2.137	1.460**
“ “ “ “ x Gm. 706		0.122	-23.08**	-11.00	-1.845	-0.940
“ “ “ “ x Gm. 709		3.893	25.09	17.960	-0.595	3.270**
“ “ “ “ x Gm. 710		1.705	11.63	4.910	2.113	0.520
“ “ “ “ x Gm. 712		1.164	11.42	-5.900**	1.321	1.570**
“ “ “ “ x Gm. 715		-0.836*	5.46	6.810	0.926	-0.310
“ “ “ “ x Gm. 718		-6.815**	-39.49**	-15.090**	0.217	-5.580
Gm. 705 x Gm. 706		1.664	34.84	5.410	-1.845	3.300**
“ “ “ “ x Gm. 709		1.565	3.26	4.770	-0.595	0.010
“ “ “ “ x Gm. 710		4.747	27.55	16.350	2.113	2.630**
“ “ “ “ x Gm. 712		-4.170**	-32.54**	-7.960**	1.321	-5.58
“ “ “ “ x Gm. 715		-2.295**	-26.295**	-12.630**	0.926	-1.710
“ “ “ “ x Gm. 718		0.851	-15.950**	-8.650**	0.217	-5.31
Gm. 706 x Gm. 709		0.414	17.210	3.040	-0.304	-3.76
“ “ “ “ x Gm. 710		-2.149**	-7.990*	-3.380*	0.655	-1.89
“ “ “ “ x Gm. 712		2.310	8.550	9.060	1.613	6.02**
“ “ “ “ x Gm. 715		-0.690	-22.16**	-3.610*	1.217	3.31**
“ “ “ “ x Gm. 718		-1.670**	-7.370**	0.870	0.509	1.47
Gm. 709 x Gm. 710		-0.978**	-12.580**	-13.520**	0.405	0.15
“ “ “ “ x Gm. 712		-1.920**	-10.660**	-1.090	1.613	-3.76
“ “ “ “ x Gm. 715		0.455	-13.740**	-3.380*	-1.158	-1.89
“ “ “ “ x Gm. 718		-0.899	-8.580**	-7.770**	0.634	6.02**
Gm. 710 x Gm. 712		-3.357**	-17.990**	-3.630*	-2.054	3.31**
“ “ “ “ x Gm. 715		-3.357**	-25.330**	-11.040**	-0.949	1.47
“ “ “ “ x Gm. 718		2.89	24.710	10.310	-2.283	1.090**
Gm. 712 x Gm. 715		3.476	38.210	6.520	-2.741	3.020**
“ “ “ “ x Gm. 718		2.476	3.010	3.000	-1.074	1.880**
Gm. 715 x Gm. 718		3.247	43.670	17.330	1.780	4.630**
L.S.D.$_{Sij}$	0.05	0.74	6.48	5.46	2.39	1.10
	0.01	0.96	8.44	7.12	3.10	1.43
L.S.D$_{Sij-Sik}$	0.05	2.50	11.10	9.46	2.59	1.68
	0.01	3.25	14.46	12.33	3.35	2.19
L.S.D$_{Sij-Skl}$	0.05	2.23	12.60	10.16	5.37	1.50
	0.01	2.91	16.68	13.24	6.96	1.96

***.** significantly differences at 0.05 and 0.01 levels of probability, respectively.**

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قوة الهجين والقدرة علي الأئتلاف في هجن الذرة

محمد حسن على ابراهيم و محمد أحمد الغنيمي
قسم بحوث الذرة الشامية بمعهد بحوث المحاصيل الحقلية - محطة البحوث الزراعية بالجميزة بمركز البحوث الزراعية بالجيزة – مصر

- تم عمل التهجينات الممكنة لثماني سلالات من الذرة الشامية الصفراء الجديدة المستنبطة بنظام الدياليل الغير كامل في محطة البحوث الزراعية بالجميزة خلال الموسم الزراعي ٢٠٠٧ لتعطي ٢٨ هجين فردي.تم تقييم الـ ٢٨ هجين والآباء بالإضافة إلي اثنين من الهجن الفردية التجارية الصفراء للمقارنة وهى (هـ ف.١٦٦ – هـ.ف ٣٠٨٤) في محطتي البحوث الزراعية بالجميزة وسدس خلال الموسم الزراعي ٢٠٠٨.
- وأخذت البيانات علي صفة محصول الحبوب (أردب / فدان) ، عدد الأيام حتى ظهور٥٠ % من الحراير، ارتفاع النبات(سم) ، ارتفاع الكوز(سم) و صفة المقاومة لمرض الذبول المتأخر% .
- وقد تم تحليل النتائج وراثيا تبعا للطريقة الثانية - الموديل الأول للعالم جرفنج (١٩٥٦)

ويمكن تلخيص أهم النتائج كما يلي :-

- أظهر التباين الراجع إلي المواقع فروقا عالية المعنوية لكل الصفات المدروسة عدا ا صفة المقاومة لمرض الذبول المتأخر
- أظهرت التراكيب الوراثية ومكوناتها من هجن وآباء والعلاقة العكسية بينهما فروقا عالية المعنوية وكذلك القدرة العامة والخاصة علي التآلف وتفاعلاتها مع المواقع المدروسة و كذلك التحليل المشترك بينهم.
- أعطى الفعل الجينى المضيف قيما عالية من خلال النسبة بين القدرة العامة والقدرة الخاصة على التآلف وتفاعلها مع المواقع.
- كانت السلالتين جميزة٧٠١ وجميز٧٠٥ أفضل السلالات تأثيرا للقدرة العامة علي التألف لصفة محصول الحبوب كما أظهرت السلالة جميزة ٧٠٩ تأثيرات مرغوبة لصفتى التبكير وارتفاع النبات بالنسبة للتحليل المشترك بين الموقعين.
- أوضحت النتائج أن السلالتين ٧٠١ و ٧٠٥ أفضل السلا لات قدرة على التآلف والحصول على ثمانية هجن فردية صفراء المقارنة من حيث المحصول كمتوسط للموقعين وكانت النسبة المئوية لقوة الهجين كما يلى:-

مقارنة بالهجين التجاري الأعلى محصول وهو:- .S.C. 166 (31.0 ard./fed)
وتعتبر هذه الهجن متفوقة معنويا عن هجن المقارنة ويمكن استخدامها مستقبلا في برامج التربية بالقسم لاستنبا ط هجن جديدة جيدة ومبشرة.

Gm. 701 x Gm. 705 (10.65 %), Gm. 701 x Gm. 712 (8.40 %.)
Gm. 705 x Gm. 710 (8.40 %), Gm.701 x Gm. 709 (8.07 %).
Gm. 701 x Gm. 710 (7.10 %), Gm. 715 x Gm. 718 (6.13 %)
Gm. 705 x Gm. 706 (3.55 %) and Gm.712 x Gm. 715 (2.86 %).

قام بتحكيم البحث

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