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Diallel analysis of yellow maize for combining ability and heterosis

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ABSTRACT

One way cross among developed seven yellow maize inbred lines was made at Gemmeiza. Agricultural Research Station during 2006 growing season. Parents, their F_1 crosses and four yellow single crosses i.e. checks (SC 155, SC 162, SC 164 and SC 3084) were evaluated at Gemmeiza and Sids Agricultural Research Stations in 2007 growing season. Data were recorded for grain yield , days to 50 % silking, plant and ear heights , ear position , resistance to late wilt and number of ears/plant. Data were analyzed according to method-2 model-1 procedure Griffing (1956). The results indicated that mean squares due to locations were significant for all traits, except resistance to late wilt. Genotypes mean squares, their partitions and their interaction with locations were significant for most studied traits . General and specific combining ability (GCA and SCA) mean squares were significant for all of the studied traits. The magnitude of GCA / SCA ratio less than the unity indicating that the non-additive and additive gene action are more important for the studied traits. Significant interaction between locations and both types of combining ability were detected for all traits except number of ears /plants . The inbred line Gm.209 has positive GCA effects for earliness and short plants, moreover the inbred line Gm. 206 exhibited desirable and positive GCA effects for resistance to late wilt and grain yield traits. four crosses Gm.220 x Gm. 205 (33.91), Gm.220 x Gm.203 (33.37), Gm.206 x Gm.203 (33.51) and Gm.206 x Gm.220 (33.31) ard/fed show significantly positive heterotic effects relative to commercial hybrid SC 162 (30.26) ard/fed . These crosses could be advanced to the second evaluation steps for releasing as promising hybrids in maize breeding program.

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

INTRODUCTION

One way diallel analysis provides information about the components, of genetic variations and helps. The breeder in the selection of desirable parents for crossing programs and also in deciding a suitable breeding procedure for the genetic improvement of various quantitative traits. Sprage and Tatum (1942) firstly defined general and specific combining ability (GCA and SCA). They found that GCA was relatively more important than SCA for previously selected lines for influencing yield. Also, they interpreted GCA as an indication of genes having largely additive effects and SCA as indication of genes having dominance and epistatis effects. Nawar *et al.* (1980) , Sedhom (1992) , El-Shamarka (1995), Ibrahim (2001) and El- Shenawy *et al.*(2002) found that the non additive effect controlled in the inheritance of grain yield , plant height and ear height.

On the other hand, El-Hosary (1989), Al-Naggar (1991), El-Shamarka *et al*. (1994), Mosa (2001) and El-Absawy (2002) found that the additive effects was more important in the inheritance of silking date. While, Amer *et al*. (1998), Ibrahim (2005) and Motawei and Mosa (2009) cleared that the additive and non-additive effects are important in the inheritance of most studied traits. Heterosis was determined in different yield components of hybrid maize plants (Mahmoud *et al*. ,1990 ; Mosa, 2001; El-Gazzar , 2004 ;

Ibrahim, 2005; Abd El- Azeem and Abd El- Moula, 2009 and Abd El Moneam *et al*. 2009).The objectives of this investigation were to study the general (GCA) and specific (SCA) combining ability and their interactions with locations, determine heterosis percentage relative to the check hybrid under study and identify superior lines and new crosses to improve the yielding ability in maize breeding program.

MATERIALS AND METHODS

Seven yellow maize inbred lines namely Gm.206, Gm.209, Gm.211, Gm.218, Gm.220, Gm.205 and Gm.203 isolated from different populations and were developed at Gemmeiza Research Station are shown in table 1. These inbred lines had high combining ability during early testcrosses, therefore were used in this study. All possible combinations were made without reciprocals at Gemmeiza Agricultural Research Station, ARC, Egypt in 2006 growing season .The seven parental inbred lines, 21 crosses and four checks (Sc 155, SC 162, SC 164 and SC 3084) were evaluated at Gemmeiza and Sids Agricultural Research Station in summer season of 2007 during maize section evaiuation program under Experiment named AH- 26 – 2007. A randomized complete block design with four replications were 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 , No. of ears/plant and resistance to late wilt disease. Analysis of variance was done for each location and combined 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 and their partitions (GCA and SCA) were computed for each location and combined according to Griffing (1956) Method –2 , Modle – 1 , for all studied traits.

Table (1): Pedigree of the inbred lines involved this study.

No.	Name	Pedigree
1.	Gm. 206	Comp. # 45. F. 217. – P_1
2.	Gm. 209	Gm. Y. Pop. F. 317. – P_2
3.	Gm. 211	Comp. # 21 F.418. – P_3
4.	Gm. 218	Cimmyt - p_{32} – P_4
5.	Gm. 220	Cimmyt - p_2 – P_5
6.	Gm. 205	Cimmyt - p_{27} – P_6
7.	Gm. 203	Pool – 23 F. 201 – P_7

RESULTS AND DISCUSSION

Obtained results indicated that mean squares of the seven studied traits for each location and their combined are presented in Table (2). Locations mean squares were significant for all studied traits except resistance to late wilt. Genotypes variations (G) and their partitions, parents (P), P Vs C, checks (Ch) and C Vs Ch and their interaction with locations (Loc) were significant for all traits, except parents (P) and crosses(C) for ear position, while number of ears / plant for majority of partitions.

The results indicate that the genotypes and their partitions were differed in performance from location to another in most studied traits. These results are in agreement with Ibrahim (2001)Amer (2002) and Mosa (2003).

Mean performance of parents and their crosses at Gemmeiza , Sids and their combined over the two locations are presented in Table (3). Inbred line Gm. 209 show desirable mean performance for earliness , low plant and ear heights towards shortness at Gemmeiza ,Sids and their combined data, while the inbred lines Gm.206 and Gm.220 gave highly values for grain yield and most studied traits. Mean performance of crosses at Gemmeiza location ranged from 22.20 ard/fed (Gm. 218 x Gm. 220) to 34.30 ard /fed, (Gm. 306 x Gm.211) and (Gm.220 x Gm. 203) , mean performance of crosses at Sids location ranged from 22.58 ard/fed (Gm. 209 X Gm.211) to 33.75 ard/ fed (Gm.220 x Gm.205) , while mean performance of combined locations ranged from 22.42 ard /fed(Gm. 218 x Gm. 220) to 33.91 ard/fed (Gm. 220 x Gm.205) .

Table (3): Mean performance of seven traits in two locations(Gemmeiza and Sids) and their combined data, 2007.

Genotype	Days to 50% Silking			Plant height (cm.)			Ear height (cm.)			Ear position		
	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.
Gm 206	60.3	68.3	64.3	165.0	142.5	153.8	103.0	61.3	82.1	60.4	43.0	51.7
Gm 209	58.3	65.3	61.8	163.8	132.5	148.1	97.8	60.8	79.3	59.3	49.9	54.6
Gm 211	59.0	66.0	62.5	167.8	116.3	142.0	90.5	60.0	75.3	52.0	49.7	50.8
Gm 218	60.0	68.5	64.3	162.3	128.8	145.5	91.8	67.5	79.6	56.6	49.9	53.3
Gm 220	60.0	65.0	62.5	161.0	117.5	139.3	83.8	61.3	72.5	49.3	50.0	49.7
Gm 205	58.8	65.5	62.1	164.5	137.5	151.0	88.3	63.8	76.0	53.7	46.3	50.0
Gm 203	58.0	65.3	61.6	146.8	123.8	135.3	79.5	53.8	66.6	54.2	44.4	49.3
Gm 206 x Gm 209	53.3	58.3	55.8	256.3	187.5	221.9	137.3	105.0	121.1	53.6	55.4	54.5
,, ,, ,, x Gm 211	63.0	58.5	60.8	285.0	188.8	236.9	129.0	103.8	116.4	50.1	52.2	51.2
,, ,, ,, x Gm 218	52.5	57.8	55.1	238.3	193.8	216.0	153.3	105.0	129.1	64.3	52.4	58.4
,, ,, ,, x Gm 220	62.8	58.3	60.5	295.8	180.0	237.9	155.3	110.0	132.6	54.5	52.0	53.3
,, ,, ,, x Gm 205	53.8	58.3	56.0	267.3	202.5	234.9	147.5	107.5	127.5	55.2	20.3	52.7
,, ,, ,, x Gm 203	65.3	60.5	62.9	314.3	190.0	252.1	156.0	105.0	130.5	61.4	53.9	57.6
Gm 209 x Gm 211	55.3	59.8	57.5	237.8	186.3	212.0	135.0	110.0	122.5	56.8	53.5	55.2
,, ,, ,, x Gm 218	53.8	61.0	57.4	249.5	197.5	223.5	145.3	100.0	122.6	58.2	51.3	54.8
,, ,, ,, x Gm 220	53.5	60.5	57.0	247.8	192.5	220.1	139.8	106.3	123.0	56.4	52.6	54.5
,, ,, ,, x Gm 205	53.0	61.5	57.3	250.0	191.3	220.6	137.3	107.5	122.4	54.9	51.5	53.2
,, ,, ,, x Gm 203	54.8	60.0	57.4	257.8	198.8	228.3	137.0	112.5	124.8	53.1	54.0	53.6
Gm 211 x Gm 218	63.5	63.5	63.5	279.0	201.3	240.1	164.8	108.8	136.8	53.6	53.6	53.6
,, ,, ,, x Gm 220	53.0	59.3	56.1	259.3	188.8	224.0	140.8	107.5	124.1	54.3	51.5	52.9
,, ,, ,, x Gm 205	54.0	61.0	57.5	253.0	166.3	209.6	138.3	95.3	116.6	54.7	49.7	52.2
,, ,, ,, x Gm 203	52.5	61.3	56.9	252.8	188.8	220.8	139.5	96.3	117.9	55.2	50.6	52.2
Gm 218 x Gm 220	54.3	61.8	58.0	260.0	192.5	226.3	150.0	106.3	128.1	57.7	53.9	55.8
,, ,, ,, x Gm 205	54.8	61.0	57.9	257.0	191.3	224.1	144.5	103.8	124.1	56.2	53.9	54.9
,, ,, ,, x Gm 203	54.5	60.8	57.6	254.5	201.5	227.9	160.8	107.5	134.1	63.1	53.4	58.3
Gm 220 x Gm 205	63.8	68.0	65.9	282.3	313.8	298.0	143.0	210.0	176.5	50.7	51.5	51.1
,, ,, ,, x Gm 203	64.0	66.0	65.0	283.8	302.5	293.1	152.3	205.0	178.6	55.6	52.6	54.1
Gm 205 x Gm 203	65.5	69.0	67.3	289.8	307.5	298.6	167.8	213.8	190.8	62.2	54.9	58.5
SC 155	59.8	60.6	60.2	283.3	215.0	249.1	161.3	113.8	137.5	57.0	25.9	55.0
SC 162	62.0	64.2	63.1	295.8	242.5	269.1	173.0	126.3	140.6	58.5	25.3	55.4
SC 164	63.0	64.2	63.6	271.5	211.3	241.4	162.0	117.5	139.8	59.7	55.8	57.7
SC 3084	61.5	64.5	63.0	289.5	211.3	250.4	166.5	113.8	140.1	57.5	53.0	55.3
LSD 0.05	1.26	1.37	0.93	12.81	14.22	9.57	7.28	8.19	5.48	3.18	3.39	2.32
LSD 0.01	1.63	1.78	1.21	16.61	18.43	12.41	9.44	10.62	7.10	4.12	4.39	3.01

Table (3): Cont .

Genotype		Resistance to late wilt			No. of ears / plant			Grain yield (ard./fed.)		
		Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.
Gm 206		100.00	95.00	97.50	104.3	70.0	87.1	8.50	5.33	6.91
Gm 209		86.30	100.00	93.13	114.7	91.5	103.1	3.95	3.27	3.61
Gm 211		91.65	97.50	94.58	109.1	63.8	86.4	5.38	4.59	4.98
Gm 218		96.30	96.25	96.25	103.5	81.3	92.4	4.76	2.63	3.69
Gm 220		100.00	90.00	95.00	103.9	122.9	113.4	9.03	4.08	6.55
Gm 205		94.80	100.00	97.40	101.3	127.1	114.2	7.62	3.08	5.35
Gm 203		94.50	100.00	97.23	109.5	83.8	96.6	4.75	4.91	4.83
Gm 206 x Gm 209		100.00	100.00	100.00	112.0	95.3	103.6	27.7	27.60	27.65
,, ,, ,, x Gm 211		100.00	100.00	100.00	112.8	99.5	106.1	34.3	31.70	32.97
,, ,, ,, x Gm 218		100.00	97.11	98.56	112.2	95.6	103.9	26.5	29.20	27.87
,, ,, ,, x Gm 220		100.00	100.00	100.00	110.8	97.5	104.2	33.1	33.50	33.31
,, ,, ,, x Gm 205		100.00	98.91	99.50	109.2	100.1	104.7	28.8	28.40	28.59
,, ,, ,, x Gm 203		100.00	100.00	100.00	110.3	92.9	101.6	33.5	33.60	33.51
Gm 209 x Gm 211		100.00	96.25	98.13	108.7	87.5	89.1	23.4	22.58	23.00
,, ,, ,, x Gm 218		100.00	97.50	98.75	103.7	84.7	94.2	25.7	25.70	25.70
,, ,, ,, x Gm 220		100.00	96.25	98.13	102.5	88.9	95.7	32.6	23.60	23.56
,, ,, ,, x Gm 205		100.00	98.75	99.38	103.5	82.7	93.1	26.5	24.10	25.29
,, ,, ,, x Gm 203		100.00	96.41	98.21	108.6	88.1	98.4	32.2	24.40	23.79
Gm 211 x Gm 218		100.00	96.31	98.16	110.8	85.4	98.1	31.5	30.15	30.81
,, ,, ,, x Gm 220		93.57	97.73	95.65	106.4	100.0	103.2	26.5	25.61	26.10
,, ,, ,, x Gm 205		97.83	100.00	98.91	107.3	101.0	104.4	24.5	24.33	24.40
,, ,, ,, x Gm 203		90.97	98.81	94.89	109.8	97.5	103.7	23.2	24.60	23.88
Gm 218 x Gm 220		97.81	97.50	97.66	106.5	92.9	99.7	22.2	22.70	22.42
,, ,, ,, x Gm 205		100.00	100.00	100.00	108.6	93.8	101.2	24.7	25.18	24.95
,, ,, ,, x Gm 203		97.52	92.56	95.04	106.6	97.6	102.1	25.2	26.26	25.73
Gm 220 x Gm 205		100.00	100.00	100.00	123.0	117.8	120.4	34.1	33.75	33.91
,, ,, ,, x Gm 203		96.00	100.00	98.00	140.4	116.4	128.4	34.3	32.40	33.37
Gm 205 x Gm 203		100.00	93.93	96.96	120.4	97.3	108.8	32.9	32.85	32.89
SC 155		100.00	100.00	100.00	106.3	100.0	103.1	29.3	29.8	29.52
SC 162		100.00	100.00	100.00	109.6	106.6	108.1	31.2	29.35	30.26
SC 164		100.00	92.8	98.75	111.0	103.5	107.3	29.5	28.70	29.10
SC 3084		100.00	100.00	100.00	105.0	97.8	101.4	27.5	28.40	27.70
LSD	0.05	2.40	2.63	1.78	14.23	14.91	10.30	3.15	2.78	2.10
	0.01	3.11	3.41	2.31	18.44	19.32	13.36	4.04	3.61	2.72

Four new single crosses Gm. 220 x Gm. 205 Gm. 206 x Gm. 203 , Gm. 220 x Gm. 203 and Gm. 206 x Gm. 220, gave 33.91, 33.51, 33.37 and 33.31 ard/fed, respectively out yielded significantly the highest check hybrid SC 162 (30.26 ard/fed) indicating the importance of these new crosses herein, it could be concluded that these good possibility for improving grain yield and the other traits of maize.

Estimates of general combining ability effects for seven inbred lines are presented in Table (6). High positive values would be of interest under all studied traits, except silking date, plant and ear heights, ear position where high neagtive ones would be useful from point of view. The inbred line Gm.209 seemed to be good combiner for earliness and shortness, while the inbred lines Gm.206 and Gm. 220 have desirable and positive significant for grain yield trait under the two locations and their combined data .

These results show that the previous lines possessed favorable genes for improving hybrids with earliness ,short plants and yielding ability .

Table (4): Percentage of heterosis (superiority) of new single crosses relative to four checks that used constant hybrids for combined data of grain yield trait, 2007.

Crosses		SC 155 29.5 (ard/fed)	SC 162 30.3 (ard/fed)	SC 164 29.1 (ard/fed)	SC 3084 27.7 (ard/fed)
Gm 206 x Gm 209		-6.10**	-8.58**	-5.17**	0.00
,, ,, ,, x Gm 211		11.86**	8.91**	13.40**	19.13**
,, ,, ,, x Gm 218		-5.42**	-7.92	-4.12**	0.72
,, ,, ,, x Gm 220		12.88**	9.90**	14.34**	20.22**
,, ,, ,, x Gm 205		-3.05**	-5.61**	-1.72	3.25**
,, ,, ,, x Gm 203		13.56**	10.56**	15.12**	20.94**
Gm 209 x Gm 211		-22.03**	-24.09**	-20.96**	-16.97**
,, ,, ,, x Gm 218		-12.88**	-15.18**	-11.68**	-7.20**
,, ,, ,, x Gm 220		-20.88**	-22.11**	-18.90**	-14.80**
,, ,, ,, x Gm 205		-14.24**	-16.50**	-13.06**	8.66**
,, ,, ,, x Gm 203		-19.32**	-21.45**	-18.21**	-14.08**
Gm 211 x Gm 218		4.41**	1.65	5.84**	11.19**
,, ,, ,, x Gm 220		-11.53**	-13.86**	-10.31**	-5.78**
,, ,, ,, x Gm 205		-17.29**	-19.47**	-16.15**	-11.91**
,, ,, ,, x Gm 203		-18.98**	21.12**	-17.87**	-13.72**
Gm 218 x Gm 220		-24.07**	-26.07**	-23.02**	-19.13**
,, ,, ,, x Gm 205		-15.25**	-17.49**	-14.09**	-9.75**
,, ,, ,, x Gm 203		-12.88**	-15.18**	-11.68**	-7.22**
Gm 220 x Gm 205		14.92**	11.88**	16.50**	22.38**
,, ,, ,, x Gm 203		13.22**	10.23**	14.78**	20.58**
Gm 205 x Gm 203		11.53**	8.58**	13.06**	18.77**
LSD	0.05	2.10	2.10	2.10	2.10
	0.01	2.72	2.72	2.72	2.72

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

Estimates of specific combining ability effects for 21 single crosses for seven traits are shown in Table (7) : Seventy ,twenty and twenty single crosses exhibited positive significant of SCA effects for grain yield trait under Gemmeiza and Sids locations and their combined. The cross Gm.211 x Gm.218 has the highest SCA effects for grain yield trait followed by Gm. 220 x Gm.205 and Gm. 205 x Gm. 203. For number of ears/plant , five single crosses exhibited significantly positive SCA effects ,while the cross Gm. 220

x Gm. 205 gave the highest SCA effects followed by the cross Gm. 206 x Gm. 209 and Gm. 206 x Gm. 218. for this trait. For resistance to late wilt, three crosses showed significantly positive SCA effects for this traits , the cross Gm. 206 x Gm. 209 exhibited the highest SCA effects followed by the cross Gm. 220 x Gm. 205 and Gm. 206 x Gm. 211 .

On the other hand , the cross Gm. 211 x Gm. 205 has desirable SCA effects for silking date, plant and ear heights and it considered the best combiner towards earliness and shortness. These results cleared that these new crosses herein considered promising hybrids and it could be used in breeding maize program in future.

Table (5): Estimates of variance for general and specific combining ability at (Gemmeiza , Sids) locations and their interaction with two locations for seven studied traits,2007.

Trait	Location	GCA	SCA	GCA / SCA	GCA x Loc.	SCA x Loc.	GCAxLoc./ SCAx Loc.	Error
Days to %50 silking	Gm.	15.6**	20.70**	0.75	---	---	---	0.22
	Sd.	7.80**	13.80**	0.57	---	---	---	0.34
	Comb.	7.60**	13.63**	0.56	15.8**	20.9**	0.76	0.28
Plant height	Gm.	338.90**	2991.4**	0.11	---	---	---	26.2
	Sd.	1650.20**	2865.1**	0.58	---	---	---	21.1
	Comb.	656.90**	2612.2**	0.25	1332.2**	2344.3**	0.25	24.4
Ear height	Gm.	88.11**	872.53**	0.10	---	---	---	16.8
	Sd.	1316.30**	1849.8**	0.71	---	---	---	11.1
	Comb.	349.50**	1159.42**	0.30	1054.9**	1562.9**	0.67	14.4
Ear position%	Gm.	27.03**	11.00*	2.46	---	---	---	1.37
	Sd.	5.01	9.90	0.51	---	---	---	4.30
	Comb.	8.19	6.00	1.37	23.85**	14.9**	1.60	1.96
Resistance to late wilt %	Gm.	15.21**	11.83**	1.29	---	---	---	0.83
	Sd.	5.70	6.90*	0.83	---	---	---	3.62
	Comb.	4.90	3.43	1.43	16.01**	15.3**	1.05	1.80
Number of ears/ plant	Gm.	43.00	64.80	0.66	---	---	---	26.74
	Sd.	512.50**	110.00	4.66	---	---	---	25.70
	Comb.	170.70	57.30	2.98	384.8**	117.5	3.27	26.8
Grain yield	Gm.	24.70**	127.7**	0.19	---	---	---	1.39
	Sd.	19.71**	150.44**	0.13	---	---	---	0.86
	Comb.	21.42**	138.34**	0.16	23.0**	139.8**	0.17	1.09

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

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REFERENCES

Abd El-Azeem,M.E.M. and M.A. Abd El-Moula (2009). Gene action and combining ability for grain yield and other attributes of yellow maize. Egypt. J. Plant Breed., 13 : 123-139.

Abd El-Moneam,M.A; A.N. Attia, M.I.Emery and E.A.Fayed (2009). Combining ability and heterosis for some agronomic traits in crosses of maize. Pak.J. Biol. Sci., 12 (5) : 433 – 438.

Abd El Aziz, A.A. ;M.T.Diab and M.I.Dawood (1999). Estimates of combining ability through diallel crosses of maize inbred lines . Egypt J. Appl. Sci., 9 : 745-761 .

Al-Naggar , A.M. (1991). Heterosis and combining in interpopulation crosses of maize. `J. Agric. Res. Tanta Univ., 17: : 561 – 574 .

Amer, E.A. (2002). Combining ability on early maturiing inbred lines of maize. Egypt. J. Appl. Sci., 17 (5) : 162-181.

Amer, E.A. (2003). Diallel analysis for yield and its components of maize under two different locations. Minufiya. J. Agric. Res., 28 5 (1) : 1363 – 1373.

Amer, E.A., A.A. El-Shenawy and F.A. El-Zeir, (1998). Diallel analysis for ten inbred lines of maize. Egypt. J. Appl. Sci., 13: 79-91.

El-Absawy, E. A. (2002). Estimation of combining abilities and heterotic effects in maize. Minufiya J. Agric. Res., 27: 1363-1373.

El-Gazzar, A.I., (2004). Genetic variability in some maize inbred lines. M.Sc. Thesis, Fac. of Agric. Mansoura Univ. ,Egypt.

El-Hosary, A.A. (1989). Heterosis and combining ability of six inbred lines of maize in diallel crosses over two years. Egypt, Agric., 14 : 47 – 58.

El- Shamarka, Sh.A. (1995). Estimation of heterotsis and combining ability for some quantitative characters in maize under two nitrogen levels. Minufiya J. Agric. Res., 20 (2) : 441 – 462.

El-Shamarka, Sh.A.; AM.I. Dawood and A.M. Shehata (1994). Genetic analysis of diallel crosses in maize under two nitrogen levels. Minufiya J. Agric. Res., 19 (2) : 1051 – 1064.

El-Shenawy,A.A.; H.E. Mosa and R.S.H. Aly (2002). Genetic analysis for grain yield per plant and other traits on maize early inbred lines. J. Agric. Sci. Mansoura Univ., 27 (4) : 2019 – 2026.

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

Ibrahim, M.H.A. (2001). Studies on corn breeding Ph.D. Thesis, Fac. Agric., Kafer EL-Sheikh, Tanta University , Egypt.

Ibrahim, M.H.A. (2005). Heterosis and combining ability in yellow maize (Zea mays, L) over two locations (Sakha and Nubaria). Egypt. J. plant Breed., 9 : 65 – 75. Special Issue.

Mahmoud , A.A. (1996). Evaluation of combining ability of newly developed inbred lines of maize. Ph. D. Thesis, Fac. Agric. Cairo. Univ., Egypt.

Mahmoud , I.M.; M.A. Rashed; Eman, M. Fahmy and M. H. Abo-Dheaf (1990). Heterosis , combining ability and types of gene action in a 6x6 diallel of maize. Annals Agric.Sci. , Special Issue, 307-317.

Mosa, H.E. (2003). Heterosis and combining ability in maize *(Zea mays* L). Minufiya J. Agric. Res., 28 : I375-1386.

Mosa, H.E. (2001). A comparative study of the efficiency of some maize testers for evaluation of white inbred lines and their combining ability under different environmental conditions. Ph.D. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta, Egypt.

Motawei, A.A. and H.E. Mosa (2009). Genetic analysis for some quantitative traits in yellow maize via half diallel. Egypt. J. Plant Breed., 13 : 223 – 233.

Nawar ,A.A.; M. E.Gomaa and M.S. Rady (1980) . Heterosis and combining ability in maize. Egypt. J.Genet. Cytol., 9: 255-267.

Sedhom , S. A. (1992). Development and evaluation of some new inbred lines of maize . Proc.5 th Conf. Agron. Zagazig, 13-15 Spet., (1) 269-280.

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

Steel, R.G. and J. H. Torrie (1980). Principles and Procedures of Statistics. A biometrical approach. 2^{nd} Ed. Mc Graw - Hill , New York.

تحليل الهجن التبادلية لقوة الهجين والقدرة علي الأئتلاف في هجن الذرة الصفراء

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قسم بحوث الذرة الشامية بمعهد بحوث المحاصيل الحقلية - محطة البحوث الزراعية بالجميزة بمركز البحوث الزراعية بالجيزة – مصر

- تم عمل التهجينات الممكنة لسبع سلالات من الذرة الشامية الصفراء الجديدة المستنبطة بنظام الدياليل الغير كامل في محطة البحوث الزراعية بالجميزة خلال الموسم الزراعى ٢٠٠٦ لتعطي ٢١ هجين فردي.تم تقييم الـــ ٢١ هجين والآباء بالإضافة إلي اربعة من الهجن الفردية التجارية الصفراء للمقارنة وهى (هـ ف١٥٥ – هـ ف١٦٢ - هـ ف ١٦٤ – هـ ف ٣٠٨٤) في محطتي البحوث الزراعية بالجميزة وسدس خلال الموسم الزراعي٢٠٠٧ .
- وأخذت البيانات علي صفة محصول الحبوب (أردب / فدان) ، عدد الأيام حتى ظهور٥٠ % من الحراير ، ارتفاع النبات(سم) ، ارتفاع الكوز(سم) ، صفة موقع الكوز % (كنسبة مئوية بين ارتفاع الكوز: ارتفاع النبات) و صفة المقاومة لمرض الذبول المتأخر% وعدد الكيزان / نبات.
- وقـد تم تحليل النتائج وراثيا تبعا للطريقة الثانية - الموديل الأول للعالم جرفنج (١٩٥٦)

ويمكن تلخيص أهم النتائج كما يلـي :-

- أظهر التباين الراجع إلي المواقع فروقا معنوية لكل الصفات المدروسة عدا صفة المقاومة لمرض الذبول المتأخر
- أظهرت التراكيب الوراثية ومكوناتها من هجن وآباء وقوة الهجين بينهما فروقا معنوية وكذلك القدرة العامة والخاصة علي التآلف وتفاعلاتها مع المواقع المدروسة.
- كان الفعل الجينى الغيرمضيف اكثر أهمية للصفات المدروسة عدا صفة موقع الكوز- المقاومة لمرض الذبول المتأخروعدد الكيزان/نبات.
- أظهرت السلالة جميزة ٢٠٩ تـأثيرات للقدرة العامة علـى التـآلف مرغوبة لصفتى التبكير وارتفاع النبات وكانت السلالة جميزة ٢٠٦ أفضل السلالات للقدرة العامة علي التآلف لصفة المقاومة لمرض الذبول المتأخرو محصول الحبوب .

- أوضحت النتائج أن متوسطات المحصول لعدد أربعة من الهجن المدروسة تتفوق معنويا علي أفضل هجن المقارنة هو الهجين الفردى ١٦٢ (٣٠.٢٦ أردب/فدان) وهذه الهجن كانت عبارة عن (السلالة جميزة ٢٠٦ مع كل من السلالتين جميزة ٢٠٣ ، جميزة ٢٢٠) ، (السلالة جميزة ٢٢٠ مع كل من السلالتين جميزة ٢٠٥ ، جميزة ٢٠٣) فأعطت الهجن الأربعة التالية:-
  Gm.220 x Gm. 205 (33.91 ard/fed) , Gm.206 x Gm. 203 (33.51 ard/fed)
  Gm. 220 x Gm. 203(33.37 ard/fed) , Gm.206 x Gm. 220 (33.31 ard/fed).

وتعتبر هذه الهجن متفوقة معنويا عن أفضل هجن المقارنة تحت الدراسة ويمكن استخدامها مستقبلا في برامج التربية بالقسم لأستنباط هجن جديدة جيدة ومبشرة.

قام بتحكيم البحث

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Table (2): Daillel analysis of mean squares for seven traits in two locations (Gm. and Sd.) and their combined,2007.

S.O.V	D.F.	Days to 50 % Silking			Plant Height (cm.)			Ear height (cm.)			Ear Position		
		Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.
Locations Loc.	1	--	--	1560.3**	--	--	180731.3**	--	--	55873.2**	--	--	1374.2**
Reps / Loc.	6	--	--	1.69	--	--	73.40	--	--	53.30	--	--	16.3**
Genotypes (G)	(31)	69.3**	46.63**	89.61**	9994.0**	9594.9**	16646.0**	2942.8**	6113.1**	7315.0**	52.8**	31.96**	50.1**
Parents (P)	6	15.6**	7.8**	7.68**	338.9**	1650.2**	656.9**	88.1**	1316.3**	349.5**	27.1**	2.0	8.2
Crosses (Cr.)	20	20.7**	13.8**	13.6**	2991.4**	2865.1**	2612.2**	872.5**	1849.8**	1159.4**	10.9**	9.9	6.0
P. Vc. Cr.	1	1583.3**	1005.2**	2321.9**	214501.2**	210206.8**	411584.5**	56555.0**	140228.2**	185111.9**	876.4**	621.86**	1222.1**
Checks (Ch.)	3	12.42**	34.20**	41.34**	10153.6**	5722.1**	15214.6**	5273.4**	844.5**	5069.5**	33.0**	49.7**	52.2**
Cr.Vs. Ch.	1	20.14**	14.91**	13.88**	2990.6**	2865.7**	2612.2**	873.0**	1849.3**	1159.5**	280.9**	9.8	6.1
G. x Loc.	(31)	--	--	26.33**	--	--	2942.9**	--	--	1740.9**	--	--	35.66**
P. x Loc.	6	--	--	15.72**	--	--	1332.2**	--	--	1054.9**	--	--	20.9**
Cr. X Loc.	20	--	--	20.9**	--	--	3244.3**	--	--	1562.9**	--	--	14.8**
P. Vs. Cr. x Loc.	1	--	--	266.6**	--	-	13123.5**	--	--	11671.3**	--	--	276.16**
Ch. x loc	3	--	--	5.28**	--	--	661.1**	--	--	1048.4**	--	--	30.5**
Cr.Vs. Ch. x Loc.	1	--	--	21.17**	--	--	3244.1**	--	--	1562.8**	--	--	284.6**
Error	186	0.80	0.95	0.88	82.90	102.10	92.5	26.80	33.90	30.30	5.10	5.80	5.45
C.V.%		1.60	1.55	1.55	2.00	53	4.4	3.8	6.2	452	4.1	4.6	4.33

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

Table (2): Cont.

S.O.V	D.F.	Resistance to late wilt (%)			No. of ears/ plant			Grain yield (ard./fed.)		
		Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.
Locations Loc.	1	--	--	0.50	--	--	12687.1**	--	--	24.7**
Reps / Loc.	6	--	--	42.19	--	--	169.30	--	--	8.0
Genotypes (G)	(31)	46.65**	25.00**	30.0**	213.5*	719.7**	585.8**	388.8**	446.4**	688.6**
Parents (P)	6	15.2**	5.67	8.2**	42.97	512.5**	170.7**	24.7**	19.7**	21.4**
Crosses (Cr.)	20	11.8**	6.93	5.97	46.80	110.1	57.3	127.7**	150.4**	138.3**
P. Vc. Cr.	1	1003.9**	518.7**	608.8**	4855.9**	16154.4**	15585.8**	8389.1**	9732.3**	16864.6**
Checks (Ch.)	3	29.4**	18.9**	40.2**	48.0	257.6**	115.30	244.8**	262.9**	483.0**
Cr.Vs. Ch.	1	26.7**	26.9**	32.7**	42478	109.6	57.26	227.7**	190.4**	138.3**
G. x Loc.	(31)	--	--	41.65**	--	--	347.5**	--	--	146.6**
P. x Loc.	6	--	--	12.67**	--	--	384.77**	--	--	23.0**
Cr. X Loc.	20	--	--	12.76**	--	--	99.6	--	--	139.8**
P. Vs. Cr. x Loc.	1	--	--	913.8**	--	--	5424.5**	--	--	1256.8**
Ch. x loc	3	--	--	8.1**	--	--	190.3	--	--	24.7**
Cr.Vs. Ch. x Loc.	1	--	--	20.9**	--	--	477.12	--	--	279.8**
Error	186	2.90	3.50	3.20	102.20	112.20	107.20	5.00	2.91	3.96
C.V.%		1.7	1.9	1.83	9.2	11.1	10.1	9.6	7.5	8.64

Table (6): Estimates of general combining ability effects for seven parents in two locations (Gemmeiza and Sids). and their combined analysis, 2007.

Inbred line		Days to 50 % Silking			Plant height			Ear height			Ear position		
		Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.
1- Gm. 206		1.071	-1.318**	-0.123	7.996	-8.413**	-0.208	2.742	-9.444**	-3.373	1.401	-0.976	0.212
2- Gm. 209		-2.373**	-0.929**	-1.651**	-9.810**	-9.358**	-9.597**	-3.619**	-9.044**	-6.331**	0.373	0.829	0.601
3- Gm. 211		-0.234	-0.512**	-0.373	-1.393	-16.746**	-9.069**	-3.480**	-11.433**	-7.456**	-2.155**	-0.032	-1.192**
4- Gm. 218		-0.901**	0.312	-0.290	-5.792**	-7.579**	-6.680**	4.714	-8.655**	-1.970	2.068	0.885	1.476
5- Gm. 220		1.099	0.433	0.766	3.996	11.310	7.653	-1.230	13.706	6.238	-2.238**	0.385	-0.927*
6- Gm. 205		0.099	1.099	0.599	1.496	16.032	8.764	-0.536	13.429	6.446	-0.683	-0.837	-0.760
7- Gm. 203		1.239	0.905	1.071	3.496	14.754	9.140	1.409	11.484	6.446	1.234	-0.254	0.590
L.S.D	0.05	0.29	0.36	0.49	1.52	3.10	4.45	1.29	2.04	3.76	0.72	1.27	0.86
Gi	0.01	0.37	0.46	0.64	1.98	4.01	5.77	2.06	2.65	4.87	0.93	1.65	1.11
L.S.D	0.05	0.44	0.54	0.76	2.33	4.72	6.80	2.42	3.12	5.74	1.10	1.95	1.31
gi-gj	0.01	0.57	0.71	0.98	3.02	6.12	8.82	3.14	4.05	7.44	1.42	2.52	1.70

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

Table (6): Cont.

Inbred line		Resistance to late wilt			No. of ears/ plant			Grain yield (ard/fed)		
		Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.
1- Gm. 206		1.984**	0.464	1.984**	-0.512	-4.143	-2.327	2.306**	2.210**	2.260**
2- Gm. 209		-1.072	0.353	-0.359	-1.318	-5.365	-3.341	-2.444	-2.290	-2.367
3- Gm. 211		-1.766	0.242	-0.762	-0.623	-6.587	-3.605	-0.611	-0.706	-0.659
4- Gm. 218		0.623	-0.952	-0.165	-2.706	-5.087	-3.897	-1.556	-0.984	-1.270
5- Gm. 220		0.568	-1.147	-0.289	1.933	11.274**	6.603**	1.333**	0.571*	0.952**
6- Gm. 205		0.595	1.075	0.835	-0.623	9.968**	4.673**	0.722**	0.099	0.411
7- Gm. 203		-0.933	-0.036	-0.484	3.849**	-0.060	1.895	0.250	1.099**	0.675**
L.S.D	0.05	1.10	2.10	1.48	3.18	6.64	3.76	0.72	0.57	0.47
gi	0.01	1.37	2.71	1.92	4.12	8.61	4.88	0.94	0.74	0.61
L.S.D	0.05	1.62	3.19	2.26	4.85	10.15	5.75	1.10	0.87	0.72
gi-gj	0.01	2.10	4.14	2.93	6.29	13.16	7.45	1.43	1.13	0.93

Table (7): Estimates of the specific combining ability effects for 21 crosses in two locations (Gemmeiza and Sids) and their combined analysis for seven traits,2007.

Cross		Days to 50 % Silking			Plant height			Ear height			Ear position		
		Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.
Gm 206 x Gm 209		-3.118**	-2.552**	-2.552**	18.715	17.40	18.056	5.681	18.01	11.847	-4.292	4.299	0.003
,, ,, ,, x Gm 211		4.493	1.170	1.170	39.049	26.01	32.528	-2.708	19.15	8.222	-5.014	1.910	-1.552
,, ,, ,, x Gm 218		-5.340**	-4.538**	-4.538**	-3.313	21.84	9.264	13.347	17.63	15.486	5.014	0.993	3.003
,, ,, ,, x Gm 220		2.910	-0.219	-0.219	44.410	-10.80**	16.806	21.292	0.26	10.778	-0.431	1.243	0.406
,, ,, ,, x Gm 205		-5.090**	-4.552**	-4.552**	18.410	6.98	12.694	12.847	-1.96	5.444	-1.486	0.715	-0.385
,, ,, ,, x Gm 203		5.271	1.851	1.851	36.410	-4.27	29.569	19.403	-2.51	8.444	2.847	3.632	3.240
Gm 209 x Gm 211		0.188	-0.552	-0.552	9.604	24.48	17.042	9.653	24.96	17.306	2.514	1.354	1.934
,, ,, ,, x Gm 218		-0.646	-0.760	-0.760	25.743	26.56	26.153	11.708	12.18	11.944	-0.208	-1.354	-0.885
,, ,, ,, x Gm 220		-2.896**	-2.191**	-2.191**	14.215	2.67	8.444	12.153	-3.93	4.111	2.347	-1.563	1.267
,, ,, ,, x Gm 205		-2.396**	-1.774**	-1.774*	18.965	-3.30**	7.833	8.958	-2.40	3.278	-0.708	0.188	-0.399
,, ,, ,, x Gm 203		-1.785**	-2.122**	-2.122**	24.715	5.45	15.083	6.764	4.54	5.653	-4.625	-0.090	-1.149
Gm 211 x Gm 218		6.965	4.087	4.087	46.826	37.67	42.250	31.069	23.32	27.194	-2.625*	2.326	-0.316
,, ,, ,, x Gm 220		-5.535**	-4.344**	-4.344**	17.299	6.28	11.792	13.014	-0.29	6.361	2.625	1.549	1.212
,, ,, ,, x Gm 205		-3.535**	-2.802**	-2.802**	-13.549**	-20.94**	-3.694	-9.819**	-12.51**	-6.347**	1.319	-0.201	0.170
,, ,, ,, x Gm 203		-6.174**	-3.899**	-3.899**	11.299	2.81	7.056	9.125	-9.32	-0.097	0.153	-0.563	-0.205
Gm 218 x Gm 220		-3.618**	-2.552**	-2.552**	22.438	0.87	11.653	14.069	-4.32*	-4.875*	1.903	1.382	1.642
,, ,, ,, x Gm 205		-2.118**	-2.510**	-2.510**	21.938	-5.10**	8.417	7.875	-6.54**	0.667	-0.903	2.354	0.726
,, ,, ,, x Gm 203		-3.507**	-3.2.33**	-3.233**	17.438	6.15	11.792	2.181	-0.85	10.667	3.681	1.521	2.601
Gm 220 x Gm 205		4.882	4.434	4.434	37.410	98.15	67.958	12.319	77.35	44.833	-2.597*	0.604	-0.997
,, ,, ,, x Gm 203		3.993	3.087	3.087	36.910	88.51	62.708	19.625	74.29	46.958	0.736	1.021	-0.878
Gm 205 x Gm 203		6.493	5.503	5.503	45.410	88.78	67.097	34.431	83.32	58.875	5.681	4.743	5.212
LSD Sij	0.05	0.84	1.04	1.44	4.43	3.09	4.15	4.61	4.30	4.80	2.10	3.70	2.50
	0.01	1.08	1.35	1.86	5.75	4.00	4.90	5.98	4.80	5.32	2.71	4.80	3.24
LSD Sij-Sij	0.05	1.24	1.54	2.14	6.58	5.35	6.54	6.86	6.20	7.50	3.10	5.50	3.71
	0.01	1.61	2.00	2.77	8.54	7.30	7.60	8.89	7.80	8.40	4.02	5.60	4.81
L.SD Sij-Skl	0.05	1.16	1.44	2.00	6.16	5.88	6.23	6.41	5.60	6.60	2.90	4.15	3.47
	0.01	1.51	1.87	2.59	7.98	6.18	7.24	8.31	7.70	8.44	3.76	4.65	4.50

Table (7): Cont.

Cross		Resistance to late wilt (%)			No. of ears/ plant			Grain yield (ard./fed.)		
		Gm.	Sd.	Comb.	Gm.	Sd.	Comb.	Gm.	Sd.	Comb.
Gm 206 x Gm 209		1.319	1.424	1.372	3.785	9.91	6.86	5.451**	5.722**	5.587**
,, ,, ,, x Gm 211		2.014*	1.535	1.774	3.840	15.38	9.61	9.868**	8.389**	9.129**
,, ,, ,, x Gm 218		-0.375	-0.021	-0.198	5.424	16.13	7.78	3.313**	6.417**	4.865**
,, ,, ,, x Gm 220		-0.319	2.924	1.302	-0.175	-4.23	-2.47	6.924**	9.111**	8.017**
,, ,, ,, x Gm 205		-0.347	-0.299	-0.323	0.340	-0.42	-0.04	3.285**	4.083**	3.684**
,, ,, ,, x Gm 203		1.181	1.813	1.497	-3.132	2.35	-0.39	8.257**	8.333**	8.295**
Gm 209 x Gm 211		5.069**	-2.104	1.483	0.646	4.60	2.63	3.868**	3.638**	4.754**
,, ,, ,, x Gm 218		2.0681*	0.340	1.510	-2.271	0.35	-0.96	7.313**	7.167**	7.240**
,, ,, ,, x Gm 220		2.736**	-0.715	1.010	-8.160	-11.76	-9.96	1.924	3.361**	2.642**
,, ,, ,, x Gm 205		2.708**	-0.438	1.135	-4.604	-16.70	-10.65	5.535**	4.583**	5.059**
,, ,, ,, x Gm 203		4.236**	-1.576	1.330	-4.076	-1.17	-2.63	3.007**	3.583**	3.295**
Gm 211 x Gm 218		3.375**	-0.799	1.288	4.285	2.22	3.31	11.229**	10.083**	10.656**
,, ,, ,, x Gm 220		-3.069	1.146	-0.962	-4.854	0.47	-2.19	3.590**	3.778**	3.684**
,, ,, ,, x Gm 205		1.403	0.924	1.163	-1.299	3.52	1.11	1.701	3.000**	2.351**
,, ,, ,, x Gm 203		-3.819	0.785	-1.517	-3.521	9.55**	3.01	1.174	2.500**	1.837**
Gm 218 x Gm 220		-1.208	1.840	0.316	-2.771	-8.03	-5.40	-0.215	1.306	0.545
,, ,, ,, x Gm 205		1.014	2.118	1.566	2.035	-5.98	-1.97	3.146**	4.278**	3.712**
,, ,, ,, x Gm 203		0.042	-4.271	-2.115	-4.438	8.05**	1.81	4.368**	4.528**	4.448**
Gm 220 x Gm 205		1.069	2.313	1.691	11.646**	1.91	6.78**	9.757**	11.472**	10.615**
,, ,, ,, x Gm 203		-1.403	3.424*	1.010	24.674**	10.44**	17.56**	10.229**	8.972**	9.601**
Gm 205 x Gm 203		2.569**	-4.799	-1.115	6.979**	-7.26	-0.14	9.340**	10.194**	9.767**
LSD	0.05	1.63	3.40	2.40	5.24	4.60	5.10	2.10	1.65	1.37
Sij	0.01	2.12	4.41	3.10	6.94	5.44	6.20	2.73	2.14	1.77
LSD	0.05	2.42	5.10	3.55	9.72	7.33	8.60	3.12	2.46	2.03
Sij-Sij	0.01	3.13	6.55	4.60	11.60	10.23	10.60	4.05	3.19	2.63
L.SD	0.05	2.26	4.72	3.32	10.88	9.44	8.88	2.92	2.30	1.90
Sij-Skl	0.01	2.93	6.12	4.31	12.20	11.42	11.86	3.79	2.98	2.46

***.**indicate significance at 0.05 and 0.01 levels of probability, re spectively.**