J. Agric. Sci. Mansoura Univ., 25 (6): 3063 - 3076, 2000.

GENETIC ANALYSIS OF GRAIN YIELD AND OTHER AGRONOMIC TRAITS USING DIALLEL SYSTEM OF SIX MAIZE INBRED LINES

Gado, H. E.

Maize Research Program, Field Crops Research Institute, ARC, GIZA, EGYPT

ABSTRACT

A diallel cross of six maize (Zea mays, L.) inbred lines included reciprocals was examined for grain yield and other associated agronomic characters to estimate general and specific combining ability as well as reciprocal effect at two locations (Gemmeiza and Sids Research Stations, ARC) during 1998 summer season. Days to 50 % silking, plant height, ear position and grain yield were significantly differed among genotypes (F_1 crosses and their reciprocals) and between locations. The interactions between locations and hybrids were highly significant for only days to 50% silking. The obtained data showed that the GCA/SCA ratio for all traits was greater than unity, at both locations and combined, indicating that the additive effects play an important role in the inheritance of these traits. The results revealed that the interaction variance for GCA x locations was higher than SCA x locations interaction for all traits except ear position for which SCA x locations showed the reverse. Reciprocal mean square was highly significant for days to 50% silking and grain yield at Gemmeiza and combined. It was significant for plant height and grain yield at Sids. The interaction effect of reciprocal with locations was significant in case of number of days to 50% silking. This indicates that there are a very small amount of maternal effects in all studied F_1 crosses.

INTRODUCTION

Developing high yielding maize (*Zea mays,* L.) hybrids which had a good performance and produce high yield are considered the ultimate goals of the National Maize Program to increase the national production of this vital cereal crop.

Diallel study among a set of inbred lines is helpful for maize breeders to estimate general and specific combining ability for agronomic and yield characteristics, which in turn, is helpful in determining the most suitable breeding program for improving the desirable characters. In this respect, Cokerham (1961), Hallauer and Miranda (1988) and Debnath and Sarkar (1990) mentioned that, if the genetic variance estimates or general combining ability (GCA) is of major importance, the suitable procedure will be the intrapopulation selection, while hybrid program may be an appropriate choice if the non-additive or specific combining ability (SCA) is the major component.

Paterniani and Lonnquist, (1963); Hallauer and Eberhart, (1966); El-Rouby and Galal, (1972); Shehata and Dhawan, (1975); Rashed, (1977); Galal *et al*, (1978); Paterniani, (1980); Ragheb, (1985), Mahmoud, (1989), Beck *et al*, (1990), Vasal *et al, (1992*) and Gabr (1997) support to the importance of dominance gene effects in the expression of yield, days to 50 % silking, plant height and ear position in case of advanced generations of selfing (S_5 or more). If the inbred lines under study were in early testing stages, additive genetic effects play an important role in the inheritance of most plant characters.

Combining ability of a certain genotype is the ultimate factor determining further usefulness of this genotype in a hybrid combination. El-Zeir *et al.* (1993), Mostafa *et al.* (1996) and Gabr (1997) indicated that GCA variance was less important than SCA for grain yield and number of ears/plant (prolificacy). However, several workers (El-Rouby and Galal, 1972; Shehata and Dhawan, 1975; Galal *et al.*, 1978; Nawar *et al.*, 1980; Ragheb, 1985; Lee *et al.*, 1986; Kang and Zuber, 1989; Beck *et al.*, 1990; Vasal *et al*. 1992; Altinbas, 1995; Perez-Velasquer *et al.,* 1995; Ragheb *et al.,* 1995; Gabr, 1997 and Soultan, 1998) reported that (GCA) effects were much more important than SCA in the inheritance of flowering date, plant height, ear height, ear position and grain yield. This means that additive genetic variance plays an important role in the inheritance of these characters and hence, selection for these traits would be effective.

Melchinger *et al.* (1985) and Hallauer and Miranda (1988) stated that the proportion of genetic variance attributable to reciprocal differences was relatively small. Reciprocal differences interacted significantly with environments in all F_1 crosses. The amount of reciprocal or maternal effect, in F_1 crosses; depend mainly on the heterozygosity level of the parental inbreds used in the study.

The present investigation is an attempt to study combining ability and reciprocal effects for grain yield and other agronomic characters in a set of inbred line parents.

MATERIALS AND METHODS

Six inbred lines of maize (*Zea mays,* L.), *i.e.* L Gm-4, L Gm-6, L Gm-7, Lgm-8, L Gm-9 and LGm-10 were isolated at Gemmeiza Research Station from different white maize populations imported from the International Institute of Tropical Agriculture (IITA) at Nigeria in 1983 These inbred lines were used in the present investigation as parents of 6 x 6 diallel cross system (F_1 crosses and reciprocals).

In 1997 season, the six inbred lines were crossed in all possible combinations including reciprocals at Gemmeiza Research Station. The diallel set of crosses (F_1 cross combinations and reciprocals) were tested at Gemmeiza and Sids Research Stations during 1998 summer season.

A randomized complete block design with three replications was used at the two locations. Each plot consisted of one rows, 6 meters long and 80 cm apart. Planting was done, in summer season, in hills spaced 25 cm along the row. All entries received the recommended agricultural practices of the National Maize Program through the growing season.

Obtained data included days to 50% silking, plant height (cm), ear position (%) and grain yield (ardab/fad). The statistical analyses were made on an entry mean basis according to Steel and Torrie (1980). Combined analysis of variance was also carried out if the homogeneity of error mean square of separate location was not significant according to Bartlett test.

The experiments were analyzed according to Method III Model I (fixed model) of Griffing (1956).

RESULTS AND DISCUSSION

I. Analysis of variance:

Highly significant differences were detected among entries for all studied traits at the two locations and combined (Table 1). Highly significant interaction of genotypes and locations were observed for only number of days to 50% silking.

General (GCA) combining ability mean square was highly significant for all studied traits at the two locations and combined. Significant specific combining ability (SCA) mean square was detected in case of plant height at Gemmeiza, plant height and grain yield at Sids and days to 50% silking, plant height as well as grain yield in the combined analysis. Also, significant reciprocal mean square was observed for days to 50% silking and grain yield at Gemmeiza and in the combined analysis as well as plant height and grain yield at Sids.

The ratio of GCA/SCA exceeded the unity for all studied traits at both locations and in the combined analysis, indicating that the GCA variance was more important than the SCA variance in the inheritance of these traits. This means that the additive genetic effects were predominant and played the major role in the expression of these traits. However, the non-additive genetic effects had little effect and played minor role in the inheritance of these traits (respecting the materials used in this study) This was expected since all genotypes used in this study are still in early segregating generations and need more selection studies Many investigators reached to the same conclusions (El-Rouby and Galal, 1972; Galal *et al.*, 1978; Nawar *et al.*, 1980 and Ragheb, 1985 and El-Zeir, 2000). On the other hand, El-Zeir *et al.* (1993), Ragheb *et al.* (1995) and Mostafa *et al.* (1996), reported that the lowest GCA/SCA ratio was observed for grain yield.

Significant interaction effect between genotypes (F_1's and their reciprocals) and locations were detected for only number of days to 50% silking. The GCA x locations interaction was significant in all traits except ear position. However, both SCA and reciprocal effect x location interactions were not significant for all studied traits, except the interaction of effect with locations in case of number of days to 50% silking. Generally, the significance of the interaction variances of crosses and GCA effects with locations means that the behavior of these variances would be differed from one location to another. This indicates that the magnitude of the interaction variance was higher for GCA x locations than SCA x locations for all studied traits. This suggested that for number of days to 50% silking, plant height, ear position and grain yield, the additive effects were more biased by the interaction with environments than the non-additive effects. El-Zeir *et al.* (1993) and Ragheb *et al.* (1995) obtained the same results. Also, the reciprocal variance significantly interacted with locations for only number of days to 50% silking indicating that the amount of maternal effects was the same in all crosses and much affected by the environments.

Table (1): Mean squares and degrees of freedom for grain yield and other agronomic traits of 15 F_1 crosses and it's reciprocals evaluated at Gemmeiza, Sids and combined, 1998 season.

S.O.V	DF	Days to 50% silking	Plant height (cm)	Ear position %	Grain yield (ardab/fad)
		GEMMEIZA			
Replications	2	1.23	2530.68	27.31	58.89
Genotypes	29	12.56**	697.37**	19.11*	141.40**
GCA	5	54.28**	3147.18**	52.58**	640.78**
SCA	9	1.41	218.14**	20.12	17.55
Reciprocal	15	5.34**	168.30	7.35	49.25**
Residual	58	1.14	120.23	11.84	24.25
C.V. %		1.6	4.7	6.0	21.8
GCA/SCA		38.50	14.43	2.61	36.51
		SIDS			
Replications	2	3.10	357.64	5.68	26.24
Genotypes	29	3.86**	610.43**	19.48**	75.05**
GCA	5	15.02**	2401.78**	73.90**	348.98**
SCA	9	1.70	345.93**	8.88	23.96**
Reciprocal	15	1.44	172.01**	7.70	14.39*
Residual	58	1.45	79.63	7.02	8.18
C.V. %		1.9	3.9	4.5	13.2
GCA/SCA		8.83	6.94	8.32	14.57
		COMBINED			
Locations	1	708.05**	527.02**	119.95**	38.12
Loc (reps)	4	2.17	1444.16	16.49	42.57
Genotypes	29	13.91**	1180.28**	29.46**	196.50**
GCA	5	62.77**	5318.14**	122.67**	950.18**
SCA	9	2.65*	403.21**	16.04	33.35*
Reciprocal	15	4.38**	267.23	6.44	43.16**
Loc x G	29	2.51**	127.52	9.14	19.95
Loc x GCA	5	6.53**	230.81*	3.82	39.59*
Loc x SCA	9	0.45	160.86	12.97	8.15
Loc x Recip	15	2.41*	73.08	8.61	20.48
Residual	116	1.29	99.93	9.43	16.21
C.V. %		1.73	4.30	5.31	18.21
GCA/SCA		23.69	13.19	7.65	28.49
GCA x Loc/SCA x Loc		14.51	1.43	0.29	4.86

II - Mean performance:

Highly significant differences were observed among genotypes means for grain yield and other studied traits (Table 2). Mean performance of the studied genotypes at the two locations and combined analysis showed that the F_1 crosses (L Gm-10 x L Gm-9), (L Gm-9 x L Gm-6), (L Gm-9 x L Gm-4), (L Gm-9 x L Gm-7) and (L Gm-10 x L Gm-8) produced the highest grain yield (32.2, 31.0, 28.3, 28.4 and 28.4 ard/fad, respectively at Gemmeiza, 28.6, 26.4, 26.1, 25.6 and 26.8, respectively at Sids and 30.4, 28.7, 27.2, 27.0 and 27.6, respectively in the combined data) The same trend was observed when these crosses were inverted (reciprocal). On the other hand, the crosses (L Gm-10 x L Gm-9), (L Gm-10 x L Gm-7) and (L Gm-9x L Gm-8) exhibited good performance in its reciprocal fashion than in the straight once. Generally, the reciprocal F_1 crosses were less in its performance than the F_1 crosses for other studied traits with little exceptions.

III. General, specific combining ability and reciprocal effects in F_1's:

The estimates of general combining ability effects (g_i) of the parental inbred lines for the studied traits at the two locations and combined are presented in Table (3). Estimates either positive or negative would indicate that a given inbred is much better or much poorer than the average of the group involved with it in the diallel crossing. However, parents with negative estimates for silking date, plant height and ear position are better because they are earlier and shorter with relatively low ear placement. Therefore, it might be more resistant to stalk breakage and lodging.

For grain yield, all parental inbred lines exhibited high and significant GCA effect at both locations and combined, except L Gm-7 and L Gm-8 at Sids. Two inbred lines (L Gm-9 and L Gm-10) showed positive and highly significant GCA effect toward high yield (7.307**, 5.590** at Gemmeiza, 5.568**, 3.279** at Sids and 6..438** and 4.434** in the combined analysis, respectively). However, the GCA effect for other inbred lines was negative toward low yield potentiality. Therefore, these two inbred lines should be used either in hybrid breeding program or used for further selection studies.

Respecting number of days to 50% silking, all inbred lines, except L Gm-6 and L Gm-8 had negative GCA effects toward earliness at both locations and combined. On the other hand, all inbred lines possessed highly significant GCA effect at both locations and combined, except L Gm-4 and L Gm-7.which expressed negative but insignificant GCA effect.

For plant height, L Gm-4 and L Gm-8 at Gemmeiza and combined and L Gm-4, L Gm-7 and L Gm-8 at Sids had the highest, negative and significant GCA effects (toward shortness). However, inbred lines L Gm-6 and L Gm 10 possessed highly significant and positive estimates of GCA (toward tallness) at both locations and combined data, respectively. L gm-7 and L Gm-9 exhibited positive but not significant GCA values at both locations, expect L Gm-7 at Sids. Based on the combined data, the same two inbred lines exhibited insignificant GCA effect with negative value fore the first inbred lines.

Table (3): General combining ability effect 6 inbred lines for grain yield and other agronomic traits at Gemmeiza, Sids and combined, 1998 season.

Inbred Lines	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)
	GEMMEIZA			
L Gm – 4	-0.333	-14.264**	0.558	-5.205**
L Gm – 6	2.375**	11.653**	1.266*	-2.612**
L Gm – 7	-0.042	2.778	0.615	-1.531*
L Gm – 8	1.000**	-12.931**	-0.147	-3.550**
L Gm – 9	-1.667**	0.903	-2.880**	7.307**
L Gm – 10	-1.333**	11.861**	0.588	5.590**
SE g_i	0.199	2.043	0.641	0.918
SE g_i - g_j	0.308	3.165	0.993	1.421
	Sids			
L Gm – 4	-0.250	-12.200**	0.716	-5.091**
L Gm – 6	1.167**	7.847**	2.300**	-1.678*
L Gm – 7	-0.083	- 3.990**	0.504	-1.200
L Gm – 8	0.708**	- 8.030**	-0.549	-0.878
L Gm – 9	-0.708**	1.931	-3.006**	5.568**
L Gm – 10	-0.833**	14.390**	0.034	3.279**
SE g_i	0.224	1.663	0.493	0.533
SE g_i – g_j	0.347	2.576	0.765	0.904
	Combined			
L Gm – 4	-0.292*	-13.208**	0.637*	-5.148**
L Gm – 6	1.771**	9.750**	1.783**	-2.145**
L Gm – 7	-0.063	- 0.604	0.559	-1.365**
L Gm – 8	0.854**	-10.479**	-0.348	-2.214**
L Gm – 9	-1.188**	1.417	-2.943**	6.438**
L Gm – 10	-1.083**	13.125**	0.311	4.434**
SE g_i	0.122	1.075	0.330	0.433
SE g_i - g_j	0.190	1.666	0.812	0.671

Regarding ear position, L Gm-9 showed negative and highly significant GCA effect toward lower ear placement at both locations and combined. However, L Gm-6 exhibited significant and positive GCA effect toward high ear placement at both locations and combined.

The abovementioned results indicated that the two parental inbred lines, *i.e*. L Gm-9 and L Gm-10 possessed favorable breeding estimates (good combiners) and it could be used as breeding materials in a hybrid-breeding program.

Several investigators (Lee *et al.*, 1986, Mahmoud, 1989, Beck *et al*. (1990), El-Zeir *et al.*, 1993, Altinbas, 1995, Ragheb *et al.*, 1995, Mostafa *et al.*, 1996 and Soultan, 1998), revealed that the additive genetic variance played an important role in the inheritance of flowering date, plant height, ear position as well as grain yield. However, they added that the proportion of non-additive genetic variance (dominance) was less important in the inheritance of these traits.

The estimates of specific combining ability effects (s_{ij}) of the 15 crosses for the studied traits are presented in Table (4). Positive or negative estimates would indicate that a given cross hybrid performs much better or much poorer than the average for all studied crosses. However, crosses exhibited negative estimates for silking date, plant height position and ear position are better because they are earlier and had short plants with low ear placement.

Concerning SCA effects for all studied traits, its worthy to note that most of the F_1 crosses possessed low and insignificant SCA estimates at both locations and combined This indicates that the additive effect still constitute the major part of the total genetic variance and hence the inbred lines used in this study need more improvement through suitable selection and inbreeding schemes to improve their specific combing ability for most of the studied traits.

For number of days to 50% silking, 8, 1 and 4 out of 15 crosses showed significant negative or positive SCA effects at both locations and combined. On the other hand, 2, 6 and 7 crosses possessed significant SCA effects for plant height at both locations and combined.

Respecting ear position, the cross (L Gm-6 x L Gm-7) at Gemmeiza and (L Gm 8 x L Gm-10) at Sids had significant SCA effect (-2.34* and 2.02**, respectively). In the contrary, four crosses, *i.e.* (L Gm-4 x L Gm-8), (L Gm--4 x L Gm-9), (L Gm-8 x L Gm-10) and (L Gm-9 x L Gm-10) showed significant and negative or positive SCA effect when the data were combined over the two locations.

Concerning grain yield, none of the studied F_1 crosses exhibited significant SCA effect at Gemmeiza. However, four and three crosses possessed significant and positive SCA effect at Sids and when the data were combined over the two locations except (L Gm 4 x L Gm-8) at Sids and (L Gm-9 x L Gm-10) in the combined data, which had negative estimates of SCA effect (- 1.86* and –1.93**, respectively).

Generally, out of the 15 F_1 crosses, the two crosses (L Gm-8 x L Gm-10) and (L Gm-9 x L Gm-10) performed good performance (early maturity, short plants with low ear placement) and produced high grain yield at both locations and combined. Therefore it should be released as new single crosses or used for further studies in a breeding program.

Ragheb *et al.* (1995), Mostafa *et al.* (1996), Gabr (1997) and El-Zeir (2000) mentioned that variance of SCA (dominance) plays an important role in the inheritance of grain yield. They added that good SCA cross may come from two parents possessing good GCA or from one with good GCA and another with poor GCA effects.

Concerning reciprocal effects, it was noting that three, one and six out of the 15 crosses exhibited significant effect regarding days to 50% silking at both locations and combined.

Respecting plant height, only one cross (L Gm 7 x L Gm-4) at Gemmeiza and two crosses (L Gm-10 x L Gm-4 and L Gm-7 x L Gm-6) at Sids and combined possessed significant reciprocal effect.

None of the studied crosses exhibited significant reciprocal effect at both locations and combined in case of ear position.

Concerning grain yield, two, three and six crosses possessesignificant reciprocal effects at both locations and combined, respectively.

REFERENCES

Altinbas, M. (1995). Heterosis and combining ability in maize for grain yield and some plant characters. Anadolu, 5: 35-51. (C.F. Plant Breed. Abst, 66:4716).

Beck, D.L., S.K. Vasal and J. Crosa (1990). Heterosis and combining ability of CYMMIT's tropical early and intermediate maturity maize germplasm. Maydica, 35: 279-285.

Cokerham, C.C. (1961). Implication of genetic variances in a hybrid-breeding program. Crop Sci., 1:47-52.

Debnath, S.C. and K.R. Sarkar (1990). Combining ability analysis of grain yield and some of its attributes in maize (*Zea mays,* L). Indian J. Genet. 50: 57-61.

El-Rouby, M.M. and A.A. Galal (1972). Heterosis and combining ability in variety crosses of maize and their implication in breeding schemes. Egyptian J. Genet. Cytol., 1:270-279.

El-Zeir, F.A.A., A.A. Abd El-Aziz and A. A. Galal (1993). Estimates of heterosis and combining ability effects in some new top crosses of maize. J. Agric. Res., Minoufiya, 18:2179-2190.

------------------- (2000). Combining ability of new maize inbred lines and type of gene action using top crosses of maize. Egypt J. Appl. Sci., 15 (2): 116-128.

Gabr, A. F. (1997). Breeding for downy mildew disease resistance in maize. Ph. D. Thesis, Fac. Agric., Cairo Univ., Egypt.

Galal, A.A., M.M El-Rouby and A.M. Gad (1978). Studies on heterosis and variety crosses diallel in maize. Alex. J. Agric. Res., 26:99-108.

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

Hallauer, A.R. and S.A. Eberhart (1966). Evaluation of synthetic varieties of maize for yield. Crop Sci., 6:423-427.

---------- and J.B. Miranda (1988). Quantitative genetics in maize breeding. Iowa State Univ. Press, Ames, USA.

Kang, M.S. and M.S. Zuber (1989). Combining ability for grain moisture, husk moisture and maturity in maize with yellow and white endosperm. Crop Sci., 29:689-692.

Lee, T.G., G.I. Shich, C.L. Ho and J.R. Juang (1986). Analysis of diallel set of dent and flint maize inbreds for combining ability and heterosis. J. Agic. Res. of China 35:145-146. (C.F. Maize Abst. 3: 1254).

Mahmoud, A.A. (1989). Genetic studies through diallel cross of maize inbred lines. M. Sc. Thesis, Fac. Agric., Cairo Univ., Egypt.

Melchinger, A. E., H. H. Geiger and F. W. Schnell (1985). Reciprocal differences in single cross hybrids and their F_2 and backcross progenies in maize. Mydica, 30:395-405.

Mostafa, M.A.N., A.A. Abd El-Aziz, G.M.A. Mahgoub and H.Y.S. El-Sherbiney (1996). Diallel analysis of grain yield and natural resistance to late wilt disease in newly developed inbred lines of maize. Bull. Fac. Agric., Cairo Univ., 47: 393-404.

Nawar, A.A., A.A. Abul-Nas and N.E. Gomaa (1980). Heterosis and general *vs* specific combining ability among inbred lines of corn. Egyptian J. Genet. and Cytol., 10:19-29.

Paterniani, E. (1980). Heterosis in intervarietal crosses of maize (*Zea mays* L) and their advanced generations. Revista Brasileira de Genetica, 3:235-249 (C.F. Plant Breed. Abst.51: 7040).

----------------- and J.H. Lonnquist (1963). Heterosis in interracial crosses of corn (*Zea mays* L). Crop Sci., 3:504-507.

Perez-Velasquer, J. C., H. Ceballos, S. Pandy and C. Diaz-Amaris (1995). Analysis of diallel crosses among Colombian landraces and improved populations of maize. Crop Sci., 35: 572-578.

Ragheb, M.M. (1985). Physiological explanation of heterosis in corn. Ph.D. Thesis. Fac. Agric., El-Azhar Univ., Egypt.

------------------, A.A. Abel-Aziz, F.H. Soliman and F.A. El-Zeir (1995). Combining ability analysis for yield and other agronomic traits in maize (*Zea mays,* L). Zagazig J. Agric. Res., 22: 647-661.

Rashed., M.A. (1977). Genetic studies on corn (*Zea mays,* L). M. Sc. Thesis, Fac. Agric., Ain-Shams Univ., Egypt.

Shehata, A.H. and N.L. Dhawan (1975). Genetic analysis of grain yield in maize as manifested in genetically diverse varietal populations and their crosses. Egypt. J. Genet. Cytol., 4: 90-116.

Steel, R.C. and J.H. Torrie (1980). Principles and procedures of statistics: A biometrical approach 2nd (ed). Mc Graw Hill Book Co. Inc., N.Y., USA.

Soultan, M. A. (1998). Estimates of combining ability of yellow maize inbred lines in top crosses. J. Agric. Sci., Mansoura Univ., 23(12): 5837-5851.

Vasal, S.K., G. Srinivasan, F, Gonzalez, G.C. Han, S. Pandy, D.L. Becl and J. Crossa (1992). Heterosis and combining ability of CIMMYT's tropical x subtropical maize germplasm. Crop Sci. 32: 1483-1489.

التحليل الوراثى لمحصول الحبوب وبعض الصفات الزراعية الأخرى لجميع الهجن الممكنة لست سلالات نقية من الذرة الشامية

حمدى المرزوقى جادو

برنامج بحوث الذرة الشامية – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية

تم اختبار جميع الهجن الممكنة الناتجة من ستة سلالات نقية من الذرة الشامية مع الهجن العكسية لها وذلك لمحصول الحبوب وبعض الصفات الزراعية الأخري لتقدير القدرة العامة والخاصة علي التآلف بالإضافة الى تأثير الهجن العكسية وذلك فى موء ئوٍرقعين (محطة البحوث الزراعية بكل من الجميزة وسدس) فى موسم ١٩٩٨ ، وقد اختلفت التراكيب الوراثية موضع الدراسة (الجيل الأول والهجن العكسية) فيما بينها معنويا بالنسبة إلى تاريخ ظهور ٥٠% حريرة , وارتفاع النبات ، وموقع الكوز ، محصول الحبوب بالأردب/فدان وكان تأثير التفاعل بين التراكيب الوراثية والجهات عالى المعنوية لصفة التزهير فقط.

وقد دلت النتائج المتحصل عليها فى كلا الجهتين والتحليل التجميعى على أن النسبة بين القدرة العامة والخاصة على التآلف لصفات عدد الأيام من الزراعة حتى ظهور ٥٠ % حريرة وارتفاع النبات وموضع الكوز ومحصول الحبوب كانت أكبر من الواحد الصحيح مما يدل على أن الفعل الجينى المضيف هو الذى يلعب دورا مهما فى وراثة هذه الصفات وبالتالى فإنه يمكن تحسين هذه الصفات عن طريق برامج الانتخاب ، ومن ناحية أخرى فقد كان التباين الراجع للتفاعل بين الجهات والقدرة العامة على التآلف أكبر من كمية التباين الراجع الى التفاعل بين الجهات والقدرة الخاصة على التآلف لكل الصفات موضع الدراسة فيما عدا موضع الكوز حيث كان العكس هو الصحيح.

وكان التباين الراجع للتأثير العكسى معنويا لصفتى تاريخ التزهير ، ومحصول الحبوب وذلك فى الجميزة والتحليل المشترك ، كما كان معنويا أيضا لصفتى ارتفاع النبات ومحصول الحبوب فى محطة بحوث سدس. أما التفاعل بين التأثير العكسى والجهات فقد كان معنويا فى صفة التزهير فقط مما يدل على عدم وجود أية تأثيرات أمية فى هجن الجيل الأول موضع الدراسة.

Table (2): Mean performance of F_1 crosses and reciprocals for grain yield and other agronomic traits at Gemmeiza, Sids and combined, 1998 season.

Locations	GEMMEIZA				SIDS				COMBINED			
Crosses	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)
F_1 crosses												
L Gm- 6 x L Gm-4	69.7	243.7	55.4	9.6	65.0	225.0	62.5	13.3	67.3	234.3	58.9	11.5
L Gm- 7 x L Gm-4	67.7	226.0	61.1	15.1	62.7	206.7	59.8	12.2	65.2	216.3	60.4	13.6
L Gm- 8 x L Gm-4	68.3	199.7	58.1	10.9	64.3	218.7	58.3	11.9	66.3	209.2	58.2	11.4
L Gm- 9 x L Gm-4	64.7	220.3	57.2	28.3	62.3	219.3	57.4	26.1	63.5	219.8	57.3	27.2
L Gm-10 x L Gm-4	65.7	232.3	57.1	14.4	63.0	240.7	59.6	20.1	64.3	236.5	58.3	17.3
L Gm- 7 x L Gm-6	70.0	262.7	54.9	18.9	65.0	255.7	65.3	21.5	67.5	259.2	60.1	20.2
L Gm– 8 x L Gm-6	73.0	220.7	60.2	13.3	65.7	220.3	58.2	18.1	69.3	220.5	59.2	15.7
L Gm– 9 x L Gm-6	67.3	242.7	56.8	31.0	64.3	240.0	58.2	26.4	65.8	241.3	57.5	28.7
L Gm-10 x L Gm-6	67.7	251.0	59.0	27.4	63.7	254.0	59.3	26.5	65.7	252.5	59.2	26.9
L Gm- 8 x L Gm-7	68.7	226.0	56.8	14.7	65.3	225.0	57.2	19.8	67.0	225.5	57.0	17.2
L Gm- 9 x L Gm-7	64.3	241.0	54.5	28.4	62.7	239.7	56.2	25.6	63.5	240.3	55.3	27.0
L Gm-10 x L Gm-7	64.3	239.7	60.1	26.1	62.0	232.0	58.6	21.9	63.2	235.8	59.3	24.0
L Gm- 9 x L Gm-8	67.3	224.0	50.6	23.8	64.7	225.7	55.4	24.1	66.0	224.8	53.0	23.9
L Gm-10 x L Gm-8	67.3	242.0	58.8	28.4	63.0	234.7	60.8	26.8	65.2	238.3	59.8	27.6
L Gm-10 x L Gm-9	64.3	253.7	52.2	32.2	62.0	248.3	55.0	28.6	63.2	251.0	53.6	30.4

Table (2): Continued .

Locations	Gemmeiza				SIDS				COMBINED			
Crosses	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)
F_1 reciprocals												
L Gm- 6 x L Gm-4	69.7	243.3	58.6	18.6	64.0	229.0	61.8	18.2	66.8	236.2	60.2	18.4
L Gm- 7 x L Gm-4	67.3	212.0	58.9	15.9	63.7	207.0	59.8	15.5	65.5	209.5	59.4	15.7
L Gm- 8 x L Gm-4	68.0	207.0	55.3	16.5	63.3	216.3	56.2	15.8	65.7	211.7	55.7	16.1
L Gm- 9 x L Gm-4	65.0	220.3	56.2	26.0	62.0	227.0	58.0	25.0	63.5	223.7	57.1	25.5
L Gm-10 x L Gm-4	67.7	224.7	56.5	28.9	64.3	222.3	58.6	17.7	66.0	223.5	57.6	23.3
L Gm- 7 x L Gm-6	69.7	234.3	58.2	16.0	64.7	230.0	58.8	16.7	67.2	232.2	58.5	16.4
L Gm– 8 x L Gm-6	69.7	231.3	59.2	17.3	66.0	215.3	60.4	17.9	67.8	223.3	59.8	17.6
L Gm– 9 x L Gm-6	69.3	244.0	56.8	27.1	64.7	235.3	58.3	24.0	67.0	239.7	57.5	25.5
L Gm-10 x L Gm-6	69.3	263.0	61.0	25.7	63.0	267.3	61.8	20.5	66.2	265.2	61.4	23.1
L Gm- 8 x L Gm-7	67.7	232.3	59.0	21.9	63.3	222.3	60.2	23.1	65.5	227.3	59.6	22.5
L Gm- 9 x L Gm-7	68.3	240.3	53.6	26.1	63.0	224.0	54.5	26.0	65.7	232.2	54.1	26.1
L Gm-10 x L Gm-7	68.0	251.3	57.7	30.3	63.7	235.0	59.8	24.7	65.8	243.2	58.8	27.5
L Gm- 9 x L Gm-8	67.7	220.3	53.8	27.5	63.3	221.0	55.7	25.6	65.5	220.7	54.7	26.6
L Gm-10 x L Gm-8	66.7	236.7	57.0	23.1	63.3	245.7	59.4	26.5	65.0	241.2	58.2	24.8
L Gm-10 x L Gm-9	64.7	244.0	55.2	34.0	62.0	244.3	53.6	29.5	63.3	244.2	54.4	31.7
LSD 0.05	**1.7**	**17.8**	**3.2**	**4.62**	**1.9**	**14.5**	**4.3**	**4.65**	**1.3**	**11.3**	**3.47**	**4.56**

Table (4): Specific combining ability (SCA) effect for grain yield and other agronomic traits of 15 single crosses evaluated at two locations and combined, 1998 season.

Locations	GEMMEIZA				SIDS				COMBINED			
Crosses	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)
L Gm-4 x L Gm- 6	-0.01	11.77**	- 1.84	- 0.67	- 0.08	0.38	0.51	0.90	-0.05	6.08**	-0.67	0.11
L Gm-4 x L Gm- 7	0.24*	- 3.86	1.87	- 0.33	- 0.17	- 7.95**	- 0.04	- 1.55	0.04	-5.90**	0.92	-0.94-
L Gm-4 x L Gm- 8	-0.13	- 3.82	- 0.74	- 0.14	- 0.29	6.76*	- 1.56	- 1.86*	-0.21	1.47	-1.15*	-1.01
L Gm-4 x L Gm- 9	-0.80**	- 0.65	2.03	2.43	- 0.54	2.47	1.38	3.45**	-0.67**	0.91	1.71**	2.94**
L Gm-4 x L Gm-10	0.70**	- 3.44	- 1.32	- 1.30	1.08**	- 1.66	- 0.30	- 0.93	0.89**	-2.55	-0.81	-1.12
L Gm-6 x L Gm- 7	-0.13	- 0.28	- 2.34*	- 0.98	0.08	8.05**	0.64	0.31	-0.03	3.89*	-0.85	-0.33
L Gm-6 x L Gm- 8	0.33**	- 7.07*	1.57	- 1.11	0.29	-12.91**	- 1.07	- 1.13	0.31	-9.99**	0.25	-1.12
L Gm-6 x L Gm- 9	-0.01	- 3.57	1.43	1.75	0.38	- 3.03	0.31	- 0.32	0.18	-3.30	0.87	0.72
L Gm-6 x L Gm-10	-0.18	- 0.86	1.18	0.99	- 0.67	7.51**	- 0.39	0.23	-0.42*	3.33	0.39	0.61
L Gm-7 x L Gm- 8	-0.43**	4.98	0.46	0.82	0.04	4.76	0.15	1.88*	-0.19	4.87**	0.30	1.34
L Gm-7 x L Gm- 9	0.41**	2.64	- 0.66	- 1.09	- 0.04	2.97	- 0.79	- 0.19	0.18	2.80	-0.72	-0.64
L Gm-7 x L Gm-10	-0.09	- 3.48	0.67	1.58	0.08	- 7.83**	0.04	- 0.46	-0.01	-5.65**	0.35	0.56
L Gm-8 x L Gm- 9	0.53**	- 0.15	- 1.78	- 0.70	0.33	- 1.49	0.46	- 1.50	0.43*	-0.82	-0.66	-1.10
L Gm-8 x L Gm-10	-0.30**	6.06	0.48	1.13	- 0.38	2.88	2.02**	2.61**	-0.34	4.47*	1.25*	1.87
L Gm-9 x L Gm-10	-0.13	1.73	- 1.02	- 2.40	- 0.12	- 0.91	- 1.37	- 1.45	-0.13	0.41	-1.19*	-1.93
SE for S_{ii}	0.11	3.47	1.09	1.56	0.38	2.82	0.84	0.90	0.21	1.83	0.56	0.74
$S_{ii} - S_{ik}$	0.285	5.482	1.721	2.46	0.60	4.46	1.33	1.43	0.33	2.89	0.89	1.16
$S_{ij} - S_{kl}$	0.190	4.476	1.405	2.01	0.49	3.64	1.08	1.17	0.27	2.36	0.72	0.95

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

Table (5): Reciprocal effect for grain yield and other agronomic traits of 15 single crosses evaluated at two locations and combined, 1998 season.

Locations / Crosses	GEMMEIZA				SIDS				COMBINED			
	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)	Days to 50% silking	Plant height (cm)	Ear position (%)	Grain yield (ard/fad)
L Gm- 6 x L Gm-4	0.01	- 0.17	1.59	4.4*	- 0.50	2.00	- 0.35	2.44*	- 0.25	0.92	0.62	3.46**
L Gm- 7 x L Gm-4	- 0.17	-21.17**	- 1.09	0.41	0.50	0.17	0.04	1.64	0.17	- 3.42	- 0.52	1.02
L Gm- 8 x L Gm-4	- 0.17	3.67	- 1.39	2.81	- 0.50	- 1.17	- 1.03	1.94	- 0.33	1.25	- 1.21	2.37*
L Gm- 9 x L Gm-4	0.17	0.01	- 0.49	-1.14	- 0.17	3.83	0.31	- 0.55	0.01	1.92	- 0.09	- 0.85
L Gm-10 x L Gm-4	1.00	- 3.83	- 0.30	7.25*	0.67	- 9.17**	- 0.48	- 1.19	0.83**	- 6.50**	- 0.39	3.03**
L Gm- 7 x L Gm-6	- 0.17	5.33	1.62	-1.46	- 0.17	-12.83**	- 3.28**	- 2.38*	- 0.17	-13.50**	- 0.83	- 1.92*
L Gm- 8 x L Gm-6	- 1.67**	0.67	- 0.50	2.01	0.17	- 2.50	1.06	- 0.08	- 0.75**	1.42	0.28	0.96
L Gm- 9 x L Gm-6	1.00*	6.00	- 0.02	-1.98	0.17	- 2.33	0.06	- 1.21	0.58*	- 0.83	0.02	- 1.59
L Gm-10 x L Gm-6	0.83	3.17	0.98	-0.86	- 0.33	6.67	1.26	- 3.01**	0.25	6.33	1.11	- 1.94*
L Gm- 8 x L Gm-7	- 0.50	- 0.33	1.10	3.62	- 1.00*	- 1.33	1.48	1.68	- 0.75**	0.92	1.29	2.65**
L Gm- 9 x L Gm-7	2.00**	5.83	- 0.42	-1.12	0.17	- 7.83*	- 0.86	0.19	1.08**	- 4.08	- 0.64	- 0.46
L Gm-10 x L Gm-7	1.83**	- 1.83	- 1.19	2.10	0.83	1.50	0.63	1.41	1.33**	.67	- 0.28	1.76
L Gm- 9 x L Gm-8	0.17	- 2.67	1.62	1.89	- 0.67	- 2.33	0.14	0.75	- 0.25	- 2.08	0.88	1.32
L Gm-10 x L Gm-8	- 0.33	- 4.83	- 0.91	-2.69	0.17	5.50	- 0.71	- 0.17	- 0.08	1.42	- 0.81	- 1.43
L Gm-10 x L Gm-9	0.17	- 4.83	1.51	0.88	0.01	- 2.00	- 0.68	0.43	0.08	- 3.42	0.42	0.65
SE for R_{ij}	0.44	4.48	1.41	4.28	0.49	3.64	1.08	1.17	0.27	2.36	0.72	0.95

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