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COMBINING ABILITY FOR YIELD AND SOME AGRONOMIC TRAITS IN FIVE MAIZE POPULATIONS AND THEIR CROSSES UNDER NORMAL IRRIGATION AND DROUGHT STRESS

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ABSTRACT

Five maize populations were used to create a complete diallel. The resulted 20 direct F_1 s and their reciprocals in addition to the five parental populations were evaluated under normal irrigation and drought stress at Nubaria and Sids Agric. Res. Stations. Results indicated that both GCA and SCA mean squares were significant for yield, days to 50 % tasselling and silking, and number of ears/plant under both irrigation regimes, while GCA mean squares for plant and ear height were significant only under normal irrigation. The magnitude of GCA mean squares was considerably higher than that of SCA indicating that additive gene effects play an important role in the inheritance of those traits. Giza-2 C8 and DTP.1 C7 populations revealed significant positive GCA effects for grain yield and number of ears/plant and negative GCA effects for plant and ear height and number of days to 50% tasselling and silking. Tep.5, AED, and Laposta populations exhibited significant negative GCA effects for yield and number of ears/plant, while they had significant positive GCA effects for the other traits. Results indicated that Giza 2 C8 and DTP.1 C7 populations are good combiners and they can be considered as good sources for developing drought tolerant inbred lines. Most of the population crosses displayed significant positive SCA effects for grain yield under either one or both irrigation regimes. On the basis of SCA effects, it was found that the cross DTP.1 x AED was the only one that showed tendency to produce good yield with early flowering and relatively shorter plants. Significant reciprocal effects were found for yield and days to 50% silking. The magnitude of some reciprocal differences was big enough to be considered in any breeding program which will involve any of these populations.

Key Words: ***Maize, Corn, Zea mays, GCA, SCA, Reciprocal Effects, Diallel, Drought Stress.***

INTRODUCTION

The diallel mating design has proved to be of considerable value to plant breeders in making decisions concerning the type of breeding system to use and in selecting breeding materials that show great promise for success (Lonnquist and Gardener 1961). Diallels have been used primarily to estimate general (GCA) and specific (SCA) combining ability effects from crosses of a fixed set of parents. If reciprocal crosses are involved, information about material effects can be obtained. However, such information are restricted to this particular set of parents and their crosses.

Introduction of new exotic germplasm to any breeding program would enhance the possibility of obtaining new heterotic groups and provide a good source for selection for many traits (Singh *et al* 1983). Looking for drought tolerant germplasm has become of great importance in Egypt in the last decade because of the increasing demand for irrigation water due to expansion in the area of new reclaimed lands and the limited amount of water available for Egypt from the River Nile.

Five maize populations varying in their genetic background were used in this study. Three of them, i.e. DTP.1 C7, Tep.5 and Laposta are exotic populations while the other two, i.e. AED and Giza 2 are local populations. The objectives of this study were: (1) to determine the relative importance of general (GCA) versus specific (SCA) combining ability for yield, plant and ear height, days to 50% tasselling and silking, and number of ears per plant under normal irrigation and drought stress conditions; and (2) to determine if any of the parental populations could be used as a direct source for developing drought tolerant inbred lines to be used as parents for developing drought tolerant hybrids.

MATERIALS AND METHODS

Five maize populations with different genetic backgrounds were used to create a complete diallel in the summer of 1999. These populations were, (1) DTP-1 C_7 (a Drought Tolerant Population developed at CIMMYT); (2) Tepalsengo No 5; (3) American Early Dent (AED); (4) Synthetic Laposta; and (5) Giza 2 C8. In 2000 season, the resulted 20 direct F_1 s and their reciprocals in addition to the five parental populations were evaluated in a randomized complete block design (RCBD) with 4 replications. Two replications received the normal number of irrigations i.e. 8 irrigations (normal irrigation) while the other two were subjected to water stress conditions by suspending irrigation after the third irrigation (about 45 days from planting) for 3 consequent irrigations (covering about 35 days), afterwards received 3 irrigations. It was aimed mainly at testing the twenty five genotypes for drought tolerance during the critical stage of maize development (flowering period). The evaluation took place at Nubaria and Sids Agricultural Research Stations. The experimental plot size was two rows, each 6 m long and 70 cm apart with 25 cm between hills. Plots were planted by hand at the rate of 2 kernels per hill and later thinned to one plant per hill to give a population stand density 0f 24000 plants/fad. All plots received 120 kg N, 46 kg P_2O_5, and 24 kg kO_2/fad. Other normal agricultural practices were performed as recommended. Soil type at Nubaria is calcareous, while it was alluvial at Sids. Water table was measured at the two evaluation sites and it was 150-155 cm and 70-80 cm from soil surface for Nubaria and Sids Res. Stations, respectively. Silking and tasselling dates were measured as number of days from planting to 50 % tasselling and silking of all plants in each plot. Plant height was measured to the flag-leaf node at the base of the tassel, while ear height was measured to the base of the ear-bearing node. Both plant and ear height were measured for 5 plants/plot and number of ears/plot was counted at harvest.

Data were first analyzed first as a regular RCBD analysis and if variance due to population crosses was significant, it was further partitioned into GCA, SCA, and reciprocal effects according to Griffings (1956) Method 1(fixed effects) analysis. Combined analysis over locations was not performed due to heterogeneity of error variances. Tests of homogeneity were carried out according to Snedecor and Cochran (1967).

RESULTS AND DICUSSION

The analysis of variance of general (GCA) combining ability and specific (SCA) combining ability for 6 characters under normal irrigation and water stress conditions is given in Table (1). Results indicated that both GCA and SCA mean squares were significant for yield, days to 50 % tasselling and silking, and number of ears/plant under drought stress at Sids only. However, the magnitude of GCA mean squares was considerably higher than those of SCA under both irrigation conditions except at Nubaria under normal irrigation. These results indicate that additive gene effects play an important role in the inheritance of these characters. For plant and ear height, GCA mean squares under only normal irrigation were significant indicating that additive gene effects are playing a major role for both traits. These results are in accordance with those obtained by Kassem *et al* (1971), Singh *et al* (1983), Salem *et al* (1986), Khalifa and Drolsom (1988), Beck *et al* (1991) and Vassal *et al* (1992).

Mean squares for reciprocal effects were only significant for grain yield and number of ears/plant under drought stress at Sids. Reciprocal differences for yield and other agronomic traits have also been reported in previous several studies of Fleming *et al* (1960), Singh *et al* (1965), Bhat and Dhawan (1969), Kalsy and Sharma (1972), Abdalla (1974), Hansen and Baggett (1977) and Khalifa and Drolsom (1988).

1- General combining ability effects

General combining ability effects are presented in Table (2). Giza-2 population revealed significant positive GCA effects for grain yield under both irrigation levels. DTP-1 population showed the same trend for yield but

Table 1. Analysis of variance for combining ability for 6 characters under normal irrigation and drought stress at Nubaria and Sids Res. Stations in 2000.

Source	d.f.	Grain yield		Plant height		Ear height		Days to 50% tassel		Days to 50% silk		Ears/plant
		Nubaria	Sids	Nubaria	Sids	Nubaria	Sids	Nubaria	Sids	Nubaria	Sids	Sids
A. Normal irrigation												
Genotypes	24	36.53**	26.69**	392.63**	419.95**	366.83*	210.23**	19.04**	31.63**	19.25**	37.50**	0.028
GCA	4	9.33	43.32**	376.90*	705.74**	416.66*	348.87**	42.03**	76.29**	43.38**	93.94**	0.024
SCA	10	33.35**	11.82**	163.99	134.48	219.26	64.74	4.30	7.06*	4.02	5.88	0.010
Reciprocals	10	6.86	2.88	156.40	87.16	54.28	47.99	1.74	0.38	1.73	1.55	0.007
Error	24	13.08	1.68	108.34	144.27	151.82	67.58	2.13	2.75	2.83	4.02	0.026
CV %		14.5	10.3	4.2	6.2	8.3	7.4	2.3	2.6	2.5	3.0	18.2
B. Stress irrigation												
Genotypes	24	30.68**	10.26**	265.36	364.16	228.03	187.74	20.42**	47.47**	20.43**	61.29**	0.061**
GCA	4	45.62**	18.39**	363.11	176.44	317.74	57.60	26.67**	123.32**	25.58*	153.59**	0.100**
SCA	10	11.60	2.58**	73.19	180.09	57.79	131.71	11.46	4.98*	11.83	8.90**	0.020**
Reciprocals	10	6.96	2.31**	100.00	186.32	88.75	70.54	2.38	2.66	2.45	3.21	0.013*
Error	24	5.96	4.71	229.87	140.79	129.41	100.55	5.75	1.69	6.44	1.83	0.004
CV %		15.5	15.1	7.0	7.4	8.6	10.0	3.8	2.1	3.8	2.0	12.5

*, ** Significant at 0.05 and 0.01 probability levels, respectively.

Table 2. General combining ability (GCA) effects of the 5 populations under normal irrigation and drought stress, 2000.

Parents	Grain yield		Plant height		Ear height		50% Tasel		50% Silk		Ears/plant	
	Nubaria	Sids	Nubaria	Sids	Nubaria	Sids	Nubaria	Sids	Nubaria	Sids	Nubaria	Sids
A. Normal irrigation												
DTP.1 C7	-0.338	-0.103**	-6.85**	-11.73**	-5.80*	-7.11**	-2.05**	-1.95**	-1.98**	-2.31**	0.037**	0.037
TEP.5	-0.360	-0.965**	5.15*	2.32	8.40**	5.54**	1.45**	2.00**	1.57**	2.04**	-0.038	-0.025
AED	-0.302	-1.450**	4.95*	8.87**	-1.60	1.24**	1.15**	0.90**	1.12**	1.84**	-0.008	-0.075
LAPOSTA	-0.679	-1.098**	3.25	5.77*	4.95*	5.49	1.85**	2.80**	1.82**	2.64**	0.015	-0.028
GIZA 2 C8	1.678*	3.616**	-6.50**	-5.23*	-5.95*	-5.16**	-2.40**	-3.75**	-2.53**	-4.21**	-0.005	0.091
B. Drought stress												
DTP.1 C7	2.71**	1.45**	-1.88	-3.11	-4.24	-3.03	-1.09*	-2.56**	-1.12*	-3.04**	0.033*	0.116**
TEP.5	-1.60**	-0.46**	4.27	-2.21	7.16**	2.87	0.86	2.89**	0.93	2.51**	0.004	-0.022
AED	-1.85**	-0.79**	7.67*	5.84*	0.01	-1.13	0.86	1.04**	0.83	2.66**	-0.021	-0.048**
LAPOSTA	-1.15*	-1.58**	-2.38	-3.56	3.71	1.97	1.66**	3.34**	1.58**	3.21**	-0.023	-0.130**
GIZA 2 C8	1.89**	1.38**	-7.68*	3.04	-6.64**	-0.68	-2.29**	-4.71**	-2.22**	-5.34**	0.006	0.083

under drought stress only. The other three populations had negative GCA effects for yield under both irrigation systems at both locations. For plant and ear height, DTP-1 and Giza 2 populations had negative significant GCA effects under normal irrigation, while under drought stress it was significant for Giza-2 at Nubaria only. Tep.5, AED, and Laposta populations exhibited significant positive GCA effects for number of days to 50% tasselling and silking under both normal and drought stress conditions at either one or both locations, while negative GCA effects were obtained for DTP.1 and Giza-2 populations. Under drought, at both locations, DTP.1 had significant positive GCA effects for number of ears/plant, while it was significant under normal irrigation only at Nubaria also. Giza 2 had the same positive significant trend under both irrigation levels but only at Sids. AED revealed significant negative GCA effects for number of ears/plant under both irrigation levels but only at Sids, while Tep.5 had significant negative GCA effects under normal irrigation at Nubaria. Laposta had the same trend but at Sids only. Beck *et al* (1991) studied GCA and SCA effects in 7 tropical and sub-tropical populations and gene pools and found that yield was controlled by additive gene effects only and the magnitude of GCA effects was affected by the environment. In a study involving 7 Corn Belt (temperate) populations, Khalifa and Drolsom (1988) found that the magnitude of GCA effects was higher than that for SCA for yield, 50% silking, and plant height.

From these results we can conclude that Giza 2 is a good combiner for yield, shorter plant and ear height and earliness. DTP.1 is considered also a good combiner for all traits but its yield potentiality is less than Giza 2. DTP.1 exhibited good yield performance under stress irrigation only, which is expected since this population was developed for drought tolerance. Significance and magnitude of GCA effects for some traits differed from one location to another or between the two irrigation levels which might be due to the differences existed in response of these populations under Sids and Nubaria environments. Similar results were obtained by Salem et al. (1986), Khlifa and Drolosom (1988), Bick *et al* (1991) and Vassal et al. (1992). The results indicated that Giza-2 C8 and DTP.1 C7 populations can be considered good sources for developing drought tolerant inbred lines, however, Giza-2 C8 is preferred due to its high productivity and adaptability to local environment.

2- Specific combining ability effects

Results of SCA effects (Table 3) indicated that, under both irrigation levels, population crosses DTP.1 x AED and Tep.5 x Giza-2 displayed significant positive SCA effects for grain yield under the two irrigation

Table 3. General combining ability (GCA) effects of the 5 populations under normal irrigation and drought stress, 2000.

Parents	Grain yield		Plant height		Ear height	Days to 50% Tasel		Days to 50% Silk		Ears/plant	
	Nubaria	Sids	Nubaria	Sids	Nubaria	Nubaria	Sids	Nubaria	Sids	Nubaria	Sids
A. Normal irrigation											
DTP.1 x TEP.5	2.62	-0.23	0.30	4.23	- 2.85	0.55	0.60	0.48	0.26	0.070*	-0.073
DTP.1 x AED	1.67	2.48**	1.00	-2.32	- 1.10	0.60	-2.55**	0.43	-2.29**	-0.008	0.136*
DTP.1 x Laposta	1.92	-0.93	- 4.80	2.28	- 1.65	-1.35*	-1.45*	-1.02	-1.69*	0.009	-0.001
DTP.1 x Giza 2	-0.35	-0.36	3.20	0.03	6.50	-0.10	0.60	-0.17	-0.24	-0.001	0.005
TEP.5 X AED	-2.44	1.34**	- 9.25	5.13	- 3.30	0.35	-0.50	0.38	-0.64	0.002	0.029
TEP.5 X Laposta	2.81	0.15	18.95**	-6.02	19.90**	0.15	-0.40	0.18	0.31	0.006	0.056
TEP.5 X Giza 2	2.52	2.14**	2.20	10.48**	- 2.95	- 1.35*	-1.10	-1.22	-0.59	-0.032	0.040
AED X Laposta	1.42	-0.43	6.40	-0.57	11.40*	- 2.05**	0.20	-1.87**	-0.99	0.012	-0.057
AED X Giza 2	3.17*	0.05	-3.85	5.68	- 3.70	- 0.30	-1.25	-0.52	0.36	0.055*	-0.028
Laposta X Giza 2	2.81	3.78**	-1.15	6.53	- 0.75	- 0.75	-1.15	-0.97	-0.69	0.009	0.082
B. Drought stress											
DTP.1 x TEP.5	2.87*	1.51**	-4.97	6.61	0.49	-0.76	0.61	-0.68	-1.26	0.032	0.085*
DTP.1 x AED	3.56**	0.37	5.13	0.31	2.64	-2.51	-1.29	-2.83*	-2.41**	0.029	0.115**
DTP.1 x Laposta	-1.96	-0.42	5.43	8.96	- 0.31	-1.56	-1.59*	-1.33	-0.46	0.001	-0.053
DTP.1 x Giza 2	0.48	0.50	1.73	-2.14	1.54	-0.11	0.21	-0.28	1.09	0.042	0.069
TEP.5 X AED	0.35	-0.26	-2.27	9.66	- 2.01	-1.46	-1.24	-1.63	0.04	0.003	-0.036
TEP.5 X Laposta	-0.67	0.15	1.53	-9.19	7.29	-2.26	0.96	-2.38	0.74	0.010	0.022
TEP.5 X Giza 2	1.03	0.84*	2.83	9.96	- 0.11	-0.56	-0.49	-0.33	0.04	-0.054	0.072*
AED X Laposta	-0.12	0.79*	-1.87	5.51	5.44	0.49	-0.94	0.47	-2.66**	-0.010	-0.112**
AED X Giza 2	-0.53	0.72	2.93	-3.34	4.79	-0.06	-0.39	0.27	-1.11	-0.001	-0.057
Laposta X Giza 2	1.70	0.04	6.73	5.56	- 0.66	-0.61	-1.19	-0.48	-0.16	-0.025	0.005

*, ** Significant at 0.05 and 0.01 probability levels, respectively.

levels. Population crosses Tep.5 x AED, AED x Giza-2, and Laposta x Giza-2 showed significant positive SCA effects for grain yield under normal irrigation only, while population crosses DTP.1 x Tep.5 and AED x Laposta showed the same trend but under drought conditions. Positive SCA values of any cross means that the F_1 generation of this cross would produce higher yield relative to the performance of its parents, and the magnitude of the heterosis would depend on the magnitude of SCA effects. Therefore, the populations involved in the superior crosses could be used for the derivation of superior inbred lines to be used for developing of high yielding hybrids. Only Tep.5 population when crossed with AED, Laposta, and Giza-2 populations revealed significant positive SCA effects for plant and ear height under normal irrigation. The best crosses for early tassel and silk emergence were DTP.1 x AED, DTP.1 x Laposta, and AED x Laposta. It should be indicated that DTP-1 population *per se* is earlier than Laposta and AED. Also, AED is earlier than Laposta. This means that, for these 3 crosses, earliness was contributed from the male parent. The results indicate the importance of exploiting heterosis for earliness when developing new hybrids. For number of ears per plant, significant positive SCA effects were obtained mainly under drought stress for crosses DTP.1 x Tep.5, DTP.1 x AED, Tep.5 x Giza-2 and AED x Laposta. Many studies are in agreement with the present findings. However, other researchers found some different results. Salm *et al* (1986) found that SCA effects were significant only for yield. Nawar *et al* (1979, 1980) studied GCA and SCA effects in some Russian inbred lines and found that SCA effects were significant for grain yield/plant, number of rows/ear, number of kernels/row, and ear diameter. It was clear, in most cases, that crosses that displayed significant positive SCA effects for yield are the ones which showed significant positive SCA effects for number of ears/plant which indicates the positive association between the two traits.

3- Reciprocal effects

Reciprocal effects for all crosses are given in Table (4). Significant reciprocal effects for yield were found under normal as well as stress conditions mainly at Sids location. The cross DTP.1 x Laposta had significant reciprocal effect under both irrigation systems. Reciprocal differences were 1.4 and 4.2 ard/fad (data not shown) under drought stress and normal irrigation, respectively. DTP.1 population when used as a female parent with Laposta gave higher yield. AED x Laposta showed significant reciprocal differences of 3.9 and 3.5 ard/fad under normal and stress levels, respectively. Laposta population was higher yielding when used as a female parent. Laposta x Giza 2 had significant reciprocal

Table 4. Reciprocal effects of the crosses for 6 characters under normal irrigation and drought stress, 2000.

Cross	Grain yield		Plant height		Ear height		Days to 50% Tassel		Days to 50% Silk		Ears/plant	
	Nubaria	Sids	Nubaria	Sids	Nubaria	Sids	Nubaria	Sids	Nubaria	Sids	Nubaria	Sids
A- Normal irrigation												
DTP-1 x Tep-5 †	-1.11	1.63*	- 1.00	2.00	-2.75	0.50	1.25	-0.25	1.25	-1.25	0.045	0.007
DTP-1 x AED	-1.45	0.17	1.00	2.00	-2.00	2.25	0.50	0.00	0.75	0.00	0.031	0.066
DTP-1 x Laposta	-4.10*	0 .30	0.50	- 7.50	4.00	- 5.50	2.25**	0.50	2.00*	0.00	-0.054	0.022
DTP-1 x Giza 2	0.91	- 0.67	- 6.25	- 3.75	1.75	- 1.50	0.25	0.50	0.50	1.00	0.035	-0.086
TEP-5 x AED	-1.81	1.81**	-19.25**	- 2.50	-9.50	0.50	-1.25	0.50	-1.25	1.50	0.009	-0.119
TEP-5 x Laposta	-1.24	0.71	-12.25*	-13.75*	-6.75	-13.50**	-0.25	0.00	-0.25	0.25	0.020	-0.005
TEP-5 x Giza 2	0.53	0.31	- 9.25	1.25	-5.50	0.00	0.00	-0.75	0.00	-0.50	-0.023	0.074
AED x Laposta	0.63	1.93**	6.00	- 1.75	7.75	- 1.00	0.25	-0.50	0.75	-1.25	-0.009	0.021
AED x Giza 2	-0.37	1.09	7.50	- 9.00	0.75	- 0.75	0.25	-0.50	0.25	-0.25	-0.008	0.027
Laposta x Giza 2	-2.78	1.54*	- 6.50	8.75	-3.75	4.25	0.00	0.00	0.00	1.00	-0.015	-0.013
B- Drought stress												
DTP-1 x TEP-5	-0.13	-0.32	16.00*	1.25	10.75*	2.75	-1.75	-0.50	-1.75	0.25	0.044	.085**
DTP-1 x AED	-0.69	-0.33	- 2.00	-17.00**	1.75	-5.50	0.50	1.75**	0.00	0.75	-0.053	.086**
DTP-1 x Laposta	-1.02	-0.70*	4.75	-21.25**	8.00	11.00**	0.75	1.25*	0.75	1.75**	0.046	-0.024
DTP-1 x Giza 2	0.27	2.32**	- 3.75	-6.25	3.50	-4.00	-0.25	0.50	-0.50	1.25*	0.051	0.038
TEP-5 x AED	-0.01	0.22	- 8.25	-5.25	-8.00	0.50	-2.00*	5*	-2.25*	-0.25	0.009	.079**
TEP-5 x Laposta	0.40	0.23	- 2.00	-7.00	-3.50	-5.50	1.50	-0.25	1.25	0.00	0.000	0.027
TEP-5 x Giza 2	-1.11	0.98**	1.50	2.75	6.75	-5.00	-0.75	-0.25	-0.50	0.25	0.004	0.024
AED x Laposta	-0.22	-1.75**	- 1.50	0.25	-0.50	6.50	0.75	2.50**	1.00	3.25**	0.001	.136**
AED x Giza 2	1.37	-1.15**	0.50	-5.50	-0.50	5.25	-0.75	0.00	-0.50	0.25	0.014	.138**
Laposta x Giza 2	-5.46**	0.23	- 11.25	6.00	-11.25*	-7.25	0.00	0.50	0.50	-0.25	-0.052	0.045

*, ** Significant reciprocal effects at 0.05 and 0.01 probability levels respectively.

† Paternal parents listed first.

differences of 3.5 and 5.9 ard/fad under normal and stress levels, respectively. DTP.1 x Giza-2 had a significant reciprocal difference of 4.6 ard/fad under stress conditions only, while Tep.5 x AED had a significant reciprocal difference of 3.6 ard/fad under normal irrigation. Significant negative reciprocal effects for plant and ear height were found for 3 crosses, for these reciprocal crosses, differences were obtained under drought stress conditions. For number of days to 50% tasselling and silking, five crosses for each had significant reciprocal effects, but 4 of them were obtained under stress conditions. Laposta x DTP.1 had significant reciprocal differences of 4.0 and 3.5 days (data not shown) under normal and stress levels, respectively. Laposta x AED had a significant reciprocal difference of 4.5 days under drought stress. It is clear, in most of the crosses, that Laposta population whenever used as a female parent delays silking. The same trend was found for.Tep.5 but only when used as a female parent with AED, a reciprocal difference of 4.5 days was found. Reciprocal effects for number of ears/plant were significant under drought stress conditions for crosses DTP.1 x Tep.5, DTP.1 x AED, Tep.5 x AED, AED x Laposta, and AED x Giza 2. The magnitude of some of the reciprocal differences, for the studied traits, was big enough to be of some importance in any breeding program which will involve any of these populations in the development of drought tolerant inbred lines. Such information will help in deciding the use of the new developed inbred lines either as male or female parent in hybrid combinations.

Reciprocal differences for grain yield and other agronomic traits were reported by other researchers, Fleming *et al* (1960), Kalsy and Sharma (1972), Abdalla (1974), Hansen and Baggett (1977) and Khalifa and Drolsom (1988). Fleming *et al* (1960) found reciprocal effects for yield and plant and ear height. They indicated that all cytoplasms do not interact with a given genotype in the same manner. Kalsy and Sharma (1972) reported reciprocal effects for yield, plant and ear height, and days to 50 % silking and they indicated that reciprocal cross effects can be greatly modified by the diversity of the germplasm and the environments. Khalifa and Drolsom (1988) found reciprocal differences for yield, plant height, and days to 50 % silking in some temperate populations and they indicated that reciprocal effects were affected by environment and that the magnitude of the obtained reciprocal differences should be considered in any breeding program that will involve these populations.

REFERENCES

Abdallah M. M. F. (1974). Reciprocal cross differences and maize breeding. I.possible causes and implications of such differences. Z. Pflanzenzuchtg. 71:290-298.

Beck,D.L., S.K.Vassal and J.Crossa. (1991). Heterosis and combining ability among subtropical and temperate intermediate-maturity maize germplasm. Crop Sci. 31(1):68-73.

Bhat, B.K. and N.L. Dhawan. (1969). Effect of cytoplasm on quantitative characters of maize. Ind. J. Genet. Plant Breed. 29: 321-326.

Flemeng A.A., G.M. Kozelnicky and E.B. Browne. (1960). Cytoplasmic effects on agronomic characters in a double-cross maize hybrid. Agron.J. 52: 112-115.

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

Hansen L.A and J.R. Baggett. (1977). Reciprocal differences for plant and ear characteristics in sweet corn. Hort. Science, 12:60-62.

Kalsy H. S. and D. Sharma. (1972). Study of cytoplasmic effects in reciprocal crosses of divegent varieties of maize (Zea mays L) Euphytica 21:527- 533.

Kassem, E.S., A.Z. EL-Hifny, M. A. EL- Morshidy and K. A. kheralla. (1979). Genetic analysis of maize grain yield and its components by diallel crossing. Egypt. J. Genetics cytol. 8: 125- 132.

Khalifa, K.L and P. N. Drolsom. (1988). Combining ability for European corn borer resistance and three agronomic traits in maize. maydica xxxIII: 247-259.

Lonnquist, J. H. and C.D. Gardner. (1961). Heterosis in intervarietal crosses in maize and its implications in breeding procedures. Crop Sci. 1: 179-183.

Nawar, A. A.; A. Abul-Nass and M. E. Gomaa. (1981). Heterosis and general vs. specific combining ability among inbred lines of corn. Egypt .J. Genetics Cytol. 10: 19-29.

Salem, A.H., A.A. Galal and F. A. El- Zeir. (1986). Diallel analysis of combining ability in maize under different environments. Egypt J. Genetics cytol. 15: 23-239.

Singh, M. (1965). Cytoplasmic effects on agronomic characters in maize. Ind. J. Genet. Plant. Breed. 26:386-390.

Singh, S. N., K.N. Singh and H.D. Sinch. (1983). Combining ability studies in maize. Crop Improv. 10 (1): 6-9.

Snedecor, G. W. and W.G. Cochran. (1967). Statistical Methods. 6 *th* ed. Iowa State Univ. Press. Ames. Iowa, U.S.A.

Vassal, S.K., G.Srinivasan, J.Crossa and D.Beck (1992). Heterosis and combining ability of CIMMYT's subtropical and temperate early-maturity maize germplasm. Crop Sci. 32(4):884-890.

القدرة على الائتلاف لصفة المحصول وبعض الصفات الأخرى في خمسة عشائر من الذرة الشامية وهجنها تحت ظروف الرى العادي وظروف الجفاف

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تم استخدام خمسة عشائر من الذرة الشامية وهى عشائر Tepalsengo ، DTP.1 C7 ، No.5 Synthetic Laposta (هذه العشائر ناتجة من الـ CIMMYT) والعشيرتين امريكانى بدرى وجيزه ٢ ، لتكوين ٢٠ من الهجن الأولية وهجنها العكسية ، تم تقييم هذه الهجن إضافة الى العشائر الأبوية الخمسة في محطتي بحوث النوبارية ومدس خلال عام ٢٠٠٠ ، وذلك تحت نظام الرى العادى (ري سطحى) وتحت ظروف الجفاف ((الإجهاد المائى) بتعريض هذه العشائر لفترة من الإجهاد المائى لفترة ثلاث ريات متتالية (حوالى ٣٥ يوم) تبدأ بعد الرية الثالثة (١٠-١٥ يوم قبل بدء مرحلة طرد السنابل المذكرة) وتمتد حتى المرحلة المبكرة من امتلاء الحبوب .

أوضحت النتائج أن متوسط مربع الانحرافات للقدرة العامة والقدرة الخاصة على الائتلاف كان موجباً لصفات المحصول وعدد الأيام حتى ظهور ٥٠ % من الحرائر واللقاح وعدد الكيزان على النبات وذلك تحت نظامى الرى المستخدمين بالتجربة بينما كان متوسط مربع الانحرافات لصفتى ارتفاع النبات وارتفاع الكوز موجباً تحت نظام الرى العادى فقط وكان حجم متوسط مربع الانحرافات للقدرة العامة على الائتلاف أكبر من مثيله للقدرة الخاصة على الائتلاف مما يوضح أن التأثيرات الجينية المضيفة تلعب دوراً هاماً لهذه الصفات .

أظهرت الدراسة أيضاً أن تأثيرات القدرة العامة على الائتلاف كانت موجبة لصفتى المحصول وعدد الكيزان للنبات للعشيرتين DTP.1(C7) وجيزة ٢(C8) ، بينما كانت هذه التأثيرات سالبة لصفات ارتفاع النبات وارتفاع الكوز وعدد الأيام حتى ظهور ٥٠ % من الحرائر واللقاح . أوضحت النتائج أيضاً أن العشيرتين السابقتين كانتا أفضل العشائر المستخدمة في الدراسة للقدرة على الائتلاف تحت ظروف الجفاف ويعتبرا مصدراً جيداً لعزل سلالات تتحمل للجفاف . لقد كانت تأثيرات القدرة الخاصة على الائتلاف لمعظم العشائر موجبة لصفة المحصول تحت أي من نظامى الري المستخدمين في التجربة . لقد أوضحت الدراسة وجود فروق للهجن العكسية لصفتي المحصول وعدد الأيام حتى ظهور ٥٠ % من الحرائر ، وكان حجم بعض هذه الفروق كبيراً بحيث يجب أن يؤخذ في الاعتبار في أي برنامج تربية يشمل أي من العشائر المستخدمة في هذا البحث .

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