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Half Sib Family Selection for Population Improvement in Maize (*Zea Mays* L.)

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Abstract:

The main objectives of this investigation were to evaluate half–sib family selection for improving grain yield and earliness, estimate the genetic components of variance and heritability and calculate the expected and actual gain from selection after one cycle of reciprocal recurrent selection.

Results showed that additive genetic variance (σ^2_A) for days to 50% silking, ear length, no. of rows/ear, no. of kernels/row and 100-kernel weight for half-sib families of Pop. B was higher than those of half- sib families of Pop. A. Dominance variance (σ^2_D) had the important role in the inheritance of ear diameter and grain yield in the two populations. Results indicated that Pop A had accumulate genetic variance (σ^2_G) more than Pop B for plant height, ear length, rows/ear, kernels/row, 100-kernel weight and grain yield. The average degree of dominance (ā), indicated the presence of over dominance in Pop. A for ear height, ear length, ear diameter, 100-kernel weight and grain yield and partial dominance for no. of rows/ear. In Pop. B, the over-dominance was observed for plant height and grain yield and partial dominance for 100-kernel weight. Heritability estimates in broad and narrow sense for grain yield in Pop. A were 54.74 and 15.37%, respectively, while it was 64.28 and 8.21% in Pop B. Expected gain for grain yield (kg/plot) was 22.07% and 20.70% and actual gain was 4.14% and 4.49% for Pop. A and Pop. B, respectively.

Keywords: Additive genetic variance, dominance genetic variance, half sib, heritability.

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Introduction:

Reciprocal recurrent selection was originally proposed by Comstock *et al.* (1949) to improve the cross between two populations by exploiting both additive and non-additive genetic effects. Improvement of the cross by complementary improvement in two parental populations is a logical approach for maize breeding programs in which hybrids are the ultimate goal (Hallauer, 1987). Estimation of genetic variance and its components are of great importance for the improvement of maize by any breeding program. Many investigators developed efficient genetic models for partitioning the genetic variance components.

In general, Gardner (1963) summarized the estimates of genetic parameters in maize open pollinated varieties. He stated that additive genetic variance existed at least in a little bit amounts even in adapted open-pollinated variety. Moreover, Hallauer and Miranda (1988) estimated additive variance (σ^2_A) and dominance variance (σ^2_D) from many available studies of many scientific reports for 20 different traits. Most estimates were obtained by using mating designs I, II and III in open pollinated varieties. In this study, one cycle of reciprocal recurrent selection (design-1 experiment) was applied in two yellow maize populations; Pop (A) and Pop (B). El-Absawy (1990) found significant additive genetic variance for grain yield, plant and ear height and silking date, dominance variance was significant only for ear diameter. Reddy *et al.* (1990) found that additive variance was more important than dominance variance for grain yield and its components. Peng *et al.* (2007) studied three recurrent selection methods i.e., modified S_1 family selection, modified S_1-HS and MHRRS. They demonstrate that the three recurrent methods were effective for increasing grain yield in testcrosses and improvement of general combining ability in maize populations.

The main objectives of this investigation were to:

1- Evaluate half–sib family selection for improving grain yield and earliness of two different maize populations.
2- Estimate the genetic components of variance and heritability.
3- Calculate the expected and actual gain from selection after one cycle of reciprocal recurrent selection method.

Materials and Methods:

This study was carried out during the period from 2007 to 2010 at Mallawy and Sakha Agricultural Research Stations, A.R.C., Egypt. Two exotic yellow maize populations i.e., Tuxpeno Corn Belt (Pop A) and Puerto Rico (Pop B) were used in the present study. The two populations were provided by National Maize Program. The two populations were grown in the summer season of 2007 at Mallawy Agricultural Research Station. From each population, biparental crosses were made as suggested by Comstock and Robinson (1948). Eight-one plants were selected and selfed to produce S_1 lines and used as male parents to pollinate randomly three plants from the other population which was used as females to produce the half-sib families.

In 2008 season, progeny test trials (FS) from the two populations for the Design-1 mating were conducted in two experiments for the two populations. Each experiment included 81 males grouped into 9 sets each of 27 progenies. These sets were arranged in a randomized incomplete block design with two replications. Within each replication, each set of 9 male groups were randomly arranged. The females for each male were assigned at random in the plots within each block.

In each trial, the experimental plot size was one row, 4 meters length and 70 cm apart and 25 cm between hills within a row. Seedlings were thinned to one plant/hill before the first irrigation (three weeks after sowing). Fertilizer was applied at the rate of 120 kg nitrogen/fed. in two doses before the first and the second irrigations. Normal cultural practices were applied as recommended.

In each trial, ten S_1 lines were selected based on two selection criteria, i.e, grain yield and earliness of the two populations. The used selection intensity was 12.34 % for both selection criteria. Equal number of seeds from the selected S_1 was carefully bulked to form the base of the first cycle of the two selection criteria. Four populations of the selected families were formed as follows:

1- Pop. A C_1 (half-sib) for grain yield
2- Pop. A C_1 (half-sib) for earliness
3- Pop. B C_1 (half-sib) for grain yield
4- Pop. B C_1 (half-sib) for earliness

In 2009 season, the four groups of the selected families were planted in non-replicated plots at Mallawy Agric. Res. Station. The plot size was 30 rows, 5 m length, 70 cm apart and 25 cm between hills within a row. Before silking, the ears were covered by glycine bags to prevent cross-pollination. At 50-60% silking, pollen grains were collected from all plants in each plot and bulked. The bulked pollen grains of a plot were used to pollinate the plants of the same plot. Pollinated ears from each selection criterion were harvested, dried, and shelled together to form the first cycle seed.

In 2010 season, the first cycle of selection (C_1); for each population was evaluated against the original populations to measure the actual gain from selection at Mallawy and Sakha Agric. Res. Stations, ARC. Randomized Complete Block Design (RCBD) with 4 replications was used in the two locations. The experimental plot size was 4 rows, 6 meters length and 70 cm between rows. Planting was in hills spaced 25 cm apart. Seedlings were thinned to one plant/hill before the first irrigation (three weeks after sowing). Fertilizer was applied at the rate of 120 kg nitrogen/fed. in two doses; before the first and second irrigations. Normal agricultural practices were applied as recommended. Data were collected from the inner two rows.

Data were recorded for days to 50 % silking, plant and ear height (cm), ear length (cm), ear diameter (cm), number of rows/ear, number of kernels/row, 100-kernel weight (g.) and adjusted grain yield (kg./plot) to 15.5 % moisture content was measured for each plot. Separate as well as combined analysis over locations, after testing homogeneity of error mean squares, according to Gomez and Gomez (1984) were carried out.

Results and Discussion:

Analysis of variance for the studied traits of both populations is presented in Table 1. The mean squares of the combined data showed that, male variances were significant or highly significant for all traits. However females/males variances were significant or highly significant for all traits of half-sib families for the two populations. The interaction mean squares for days to 50% silking, plant height, ear height and grain yield of males x locations in Pop. A and Pop. B were highly significant and significant for ear diameter in Pop. B while, it was insignificant for the remnant traits. The interaction mean squares of females/males x locations were significant or highly significant for plant height, ear height and grain yield in the two populations, in addition to days to 50% silking of Pop. B.

Variance components, average degree of dominance and heritability:

Variances due to males (σ^2_m), females (σ^2_f), components of genetic variances, heritability and average degree of dominance of half-sib families for all traits of the two populations across locations are presented in Tables 2 and 3. Results showed that genetic variance for all studied traits were less than the phenotypic variance and this is due to that the genetic variance depends upon the effect of additive and dominance, but the phenotypic variance is due to the effect of both genetic and environmental variances.

Variances due to males (σ^2_m) of half-sib of Pop. B for days to 50%silking, ear length, no. of rows/ear, no. of kernels/row and 100-kernels weight were higher than those of half-sib of Pop. A. On the other hand, the variance for plant height, ear height, ear diameter and grain yield for half- sib of Pop. A were higher than those of half- sib of Pop. B. since variance values cannot be negative, hence it was considered to be zero.

Variances due to females (σ^2f) of half-sib of Pop. A were higher than those of half-sib of Pop. B for all studied traits except, plant height and ear diameter. However, estimates of female variances were larger than male variances for all traits except for plant height in Pop. A, and plant height, ear height, ear diameter, 100-kernel weight and grain yield except for days to 50% silking, ear length, no. of rows/ear and no. of kernel/row in Pop.B.

Table 1. Mean squares of half-sib from the two populations A and B for all the studied traits data combined across the two locations.

S.O.V	df	MS					
		Days to 50% silking		Plant height (cm)		Ear height (cm)	
		Pop -A	Pop -B	Pop -A	Pop -B	Pop -A	Pop -B
Locations (Loc)	**1**	81.81**	813.09**	564682.29**	557426.67**	476229.65**	415854.96**
Rep/Loc	**2**	43.51	15.67	756.17	19264.67	250.05	13424.86
Sets	**8**	56.60**	107.79**	1471.37**	898.91**	2488.87**	1057.63**
Sets x loc	**8**	10.01**	13.15**	424.02**	821.33**	721.50**	839.49**
Rep/Set/loc	**16**	7.21	9.32	792.32	790.25	820.60	571.74
Male/Set	**72**	10.74**	11.53**	410.65**	321.18**	350.18**	287.39**
Female/Male/Set	**162**	3.73**	3.24**	167.75**	176.54**	194.45**	178.81**
Male/SetxLoc	**72**	2.74**	2.45**	290.09**	289.56**	290.90**	325.60**
Female/male/Set x Loc	**162**	1.66	1.47*	147.41**	152.66**	171.31**	164.37**
Error	**468**	1.68	1.11	89.11	109.04	101.99	91.45
		Ear length (cm)		**Ear diameter (cm)**		**No. of rows/ear**	
Locations (Loc)	**1**	25.04**	12.66**	19.68**	17.23**	0.54	1.44
Rep/Loc	**2**	2.34	33.02	0.51	0.07	2.32	1.13
Sets	**8**	1.40	3.32**	0.41**	0.34*	4.36**	6.28**
Sets x loc	**8**	2.08	1.84	0.70**	0.55**	1.16	1.37
Rep/Set/loc	**16**	2.60	1.81	0.74	0.46	1.87	1.58
Male/Set	**72**	5.13**	4.92**	0.28**	0.28**	6.31**	7.1**
Female/Male/Set	**162**	3.02**	2.13**	0.22**	0.19*	2.69**	2.34**
Male/SetxLoc	**72**	1.90	1.57	0.17	0.21*	0.91	0.69
Female/male/Set x Loc	**162**	1.67	1.47	0.17	0.13	0.96	0.91
Error	**468**	1.88	1.21	0.16	0.16	0.92	0.88
		No. of kernels/row		**100-kernel weight (g.)**		**Grain yield (Kg/plot)**	
Locations (Loc)	**1**	47.29*	109.2**	1749.40**	2587.85**	349.84**	369.94**
Rep/Loc	**2**	19.27	92.74	49.63	2.11	0.51	2.91
Sets	**8**	30.63*	16.80	19.95	43.55*	0.94**	0.70**
Sets x loc	**8**	43.83**	56.31**	31.98	22.81	0.29*	1.27**
Rep/Set/loc	**16**	30.72	40.82	29.72	34.63	0.82	0.53
Male/Set	**72**	17.63*	20.61**	37.16**	41.93**	0.92**	0.68**
Female/Male/Set	**162**	19.39**	14.09*	36.11**	27.13**	0.58**	0.43**
Male/SetxLoc	**72**	16.07	12.52	20.95	16.15	0.44**	0.43**
Female/male/Set x Loc	**162**	9.86	13.20	21.62	19.42	0.32**	0.25*
Error	**468**	12.41	11.42	18.21	17.79	0.14	0.20

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

Additive genetic variances (σ^2_A) for days to 50% silking, ear length, no. of rows/ear, no. of kernels/row and 100-kernel weight for half-sib families of Pop. B were higher than those of half-sib of Pop. A. Estimates of dominance variances (σ^2_D), the negative values were considered to be zero, as pointed out by Robinson *et al* (1955). The negative estimates of dominance could be attributed to assortative mating for maturity. Variances due to dominance in half-sib pop. A were positive for all traits except plant height it was negative. Variances due to dominance in half- sib pop. B were positive for plant height, ear height, ear diameter, 100-kernels weight and grain yield, while variances due to dominance were negative for days to 50% silking, ear length, no. of rows/ear and no. of kernels/row.

The average degree of dominance (ā) as obtained from the two populations for all studied traits, indicated the presence of over-dominance in pop. A for ear height, ear length, ear diameter, 100-kernel weight and grain yield and partial dominance for no. of rows/ear. In pop. B, it indicated the presence of over-dominance for plant height and grain yield and partial dominance for 100- kernel weight, while the other values of average degree of dominance were not important.

Variances due to males x locations interaction of half-sib of pop. B for all studied traits were higher than those of half- sib of pop. A, except days to 50% silking, plant height, ear length and no. of kernels/row. However, estimates of females x locations interaction of half- sib of pop. A for all studied traits were higher than those of half-sib of pop B, except days to 50% silking, ear height, ear length and no. of kernels/row. Variances due to males x locations of Pop. B were positive for all traits, except no. of rows/ear, no. of kernels/row and 100- kernels weight.

Variances due to females x locations interaction of Pop. A were positive for all traits, except days to 50% silking, ear length and no. of kernels/row. Variances due to females x locations interaction of Pop. B were positive for all traits, except ear diameter.

Additive x location interactions for all traits for half-sib families of Pop. B were higher than those of half-sib Pop. A, except days to 50% silking, plant height, ear length and no. of kernels/row. Additive x location interactions variances in half-sib of Pop. A were positive for all traits, except no. of rows/ear and 100-kernel weight were negative value. Additive x location interactions variances in half-sib of Pop. B were positive for all traits, except no. of rows/ear, no. of kernels/row and 100-kernel weight.

Table 2. Variance components and heritability of half-sib for days to 50% silking, plant height, ear height and ear length of the two populations over the two locations.

Variances	Days to 50% silking		Plant height (cm)		Ear height (cm)		Ear length (cm)	
	Pop -A	Pop -B	Pop -A	Pop -B	Pop -A	Pop -B	Pop -A	Pop -B
σ^2f	0.518	0.443	5.085	5.970	5.785	3.610	0.338	0.165
σ^2m	0.494	0.609	8.352	0.645	3.012	-4.388	0.157	0.224
σ^2A	1.977	2.437	33.407	2.580	12.047	-17.550	0.627	0.897
σ^2D	0.093	-0.667	-13.067	21.300	11.093	31.990	0.723	-0.237
σ^2G	2.070	2.437	33.407	23.880	23.140	31.990	1.350	0.897
σ^2fl	-0.015	0.180	29.150	21.810	34.660	36.460	-0.105	0.130
σ^2ml	0.180	0.163	23.780	22.817	19.932	26.872	0.038	0.017
σ^2AL	0.720	0.653	95.120	91.267	79.727	107.487	0.153	0.067
σ^2DL	-0.780	0.067	21.480	-4.027	58.913	38.353	-0.573	0.453
σ^2GL	-0.060	0.720	116.600	87.240	138.640	145.840	-0.420	0.520
σ^2Ph	2.463	3.074	113.984	94.760	117.958	127.773	1.610	1.459
ā	0.307	0.000	0.000	4.063	1.357	0.000	1.519	0.000
H% (BS)	84.04	79.28	29.31	25.20	19.62	25.04	83.85	61.48
h^2 %(NS)	80.27	79.28	29.31	2.70	10.21	0.00	38.94	61.48

All negative values are considered to be equal zero (Robinson *et al* 1955).

Table 3. Variance components and heritability of half-sib for ear diameter, no. of rows/ear, no. of kernels/row, 100-kernel weight and grain yield/plot of the two populations.

Variances	Ear diameter (cm)		No. of rows/ear		No. of kernels/row		100-kernel weight (g.)		Grain yield (kg/plot)	
	Pop -A	**Pop -B**	**Pop -A**	**Pop -B**	**Pop -A**	**Pop -B**	**Pop -A**	**Pop -B**	**Pop -A**	**Pop -B**
σ^2**f**	0.013	0.015	0.433	0.358	1.632	0.223	3.624	1.928	0.065	0.045
σ^2**m**	0.005	0.000	0.306	0.415	-0.414	0.600	0.143	1.506	0.018	0.006
σ^2**A**	0.020	0.000	1.223	1.660	-1.657	2.400	0.573	6.023	0.073	0.023
σ^2**D**	0.030	0.060	0.507	-0.230	8.187	-1.510	13.922	1.687	0.187	0.157
σ^2**G**	0.050	0.060	1.730	1.660	8.187	2.400	14.495	7.710	0.260	0.180
σ^2**fl**	0.005	-0.015	0.020	0.015	-1.275	0.890	1.705	0.815	0.090	0.025
σ^2**ml**	0.000	0.015	-0.008	-0.037	1.035	-0.113	-0.112	-0.545	0.020	0.030
σ^2**AL**	0.000	0.060	-0.033	-0.147	4.140	-0.453	-0.447	-2.180	0.080	0.120
σ^2**DL**	0.020	-0.120	0.113	0.207	-9.240	4.013	7.267	5.440	0.280	-0.020
σ^2**GL**	0.020	-0.060	0.080	0.060	-5.100	3.560	6.820	3.260	0.360	0.100
σ^2**Ph**	0.100	0.070	2.000	1.910	8.739	5.525	22.458	13.788	0.475	0.280
$\bar{a}$	1.732	0.000	0.910	0.000	0.000	0.000	6.973	0.748	2.256	3.665
H% (BS)	50.00	85.71	86.50	86.91	93.67	43.44	64.54	55.92	54.74	64.28
h^2 **%(NS)**	20.00	0.00	61.15	86.91	0.00	43.44	2.55	43.68	15.37	8.21

All negative values are considered to be equal zero (Robinson *et al* 1955).

Variances due to dominance x location interactions of half-sib for Pop. A were positive for all the studied characters, except for days to 50% silking, ear length and no. of kernels/row. Dominance x location interaction variances of half-sib for Pop. B were positive for all the studied characters, except for plant height, ear diameter and grain yield (kg/plot).

Similar results were obtained by El-Rouby *et al.* (1979) and Soliman (1991) who found positive dominance variance for grain yield and its components. El-Sherbieny (1981) found that additive genetic variance was significant for all traits, while dominance variance was important only for number of kernel/row and ear diameter. The additive x location interaction had a significant effects on the variability of all characters, while dominance x location interaction was significant only for grain yield. Abd El-Rahman (1983) reported that AED population had adequate additive genetic variance for grain yield and other components, while dominance was significant, but lesser magnitude. Interaction of additive genetic variance with location was higher than dominance x location. Ismail *et al.* (1984) found that additive genetic variance among half-sib was significant for all studied characters, except grain yield, while dominance variances were significant for grain yield, days to 50% silking, plant height and ear height. El-Absawy (1990) found significant additive genetic variance for grain yield, plant and ear height and silking date. Dominance variance was significant only for ear diameter. Reddy *et al.* (1990) found that additive variance was more important than dominance variance for grain yield and its components.

Phenotypic variance:

Combined phenotypic variance of half-sib of Pop. A for plant height, ear length, ear diameter, no. of rows/ear, no. of kernels/row, 100-kernels weight and grain yield were higher than those of half-sib of Pop. B. On the other hand, days to 50% silking and ear height for half- sib of Pop. B were higher than those of half- sib of Pop. A.

Genetic variance:

Results showed that genetic variances for all studied traits were less than the phenotypic variances and this is due to that the genetic variance depends upon the effect of additive and dominance, but the phenotypic variance is due to the effect of genetic variance as well as environmental conditions.

The genetic variances for plant height, ear length, no. of rows/ear, no. of kernels/row, 100-kernel weight and grain yield for half-sib of Pop A were higher than those of half-sib of Pop. B. On the other hand, days to 50% silking, ear height and ear diameter for half-sib of pop. B were higher than those of half- sib of pop. A. Shehata *et al.* (1987) found significant genotypic variance of both Gemm-2 and Gemm-6 populations for all studied traits over locations. Mahmoud *et al.* (1999) found that phenotypic and genotypic variance were highly significantly for all studied traits at both locations and combined over locations. Soliman *et al.* (1999) found that estimates of phenotypic and genotypic variance were significant for all studied traits.

Genotypic x location interaction variances (σ^2_{GL}) in pop. A was negative for days to 50% silking, ear length and no. of kernels/row. Genotypic x location interaction variances (σ^2_{GL}) in pop. B was negative for ear diameter. The genotypic x location interaction variances (σ^2_{GL}) in pop. A were higher than those of half- sib of Pop. B for all studied traits, except days to 50%silking, ear height, ear length and no. of kernels/row.

Heritability:

Heritability is considered to be one of the important parameters to express relative genetic variability whether in a broad or narrow sense. Data in Tables 2 and 3 showed that heritability in broad sense were (84.04, 79.28%), (29.31, 25.20%), (19.62, 25.04%), (83.85, 61.48%), (50.00, 85.71%), (86.50, 86.91%), (63.67, 43.44%), (64.54, 55.92%) and (54.74, 64.28%) for days to 50% silking, plant height, ear height, ear length, ear diameter, no. of rows/ear, no. of kernels/row, 100-kernel weight and grain yield/plot for Pop. A and Pop. B, respectively

Heritability estimates in narrow sense were high in Pop. A for days to 50% silking (80.27%) and no. of rows/ear (61.15%), but they were low for plant height (29.31%), ear height (10.21%), ear length (38.94%), ear diameter (20.00%), no. of kernel/row (zero%), 100-kernel weight (2.55%) and grain yield (15.37%).

Heritability estimates in narrow sense were high in Pop. B for days to 50% silking (79.28%), ear length (61.48%) and no. of rows/ear (86.91%), but they were low for plant height (2.70%), ear height (zero %), ear diameter (zero%), no. of kernels/row (43.44%), 100-kernel weight (43.68%) and grain yield (8.21%).

Generally, heritability estimates in narrow sense of Pop A were higher than those for Pop. B for days to 50% silking, plant height, ear height, ear diameter and grain yield. This indicated that breeding value for Pop. A was higher than that for Pop B. Sadek *et al.* (1986), reported that heritability estimates in broad sense in AED population were 49.2, 22.9, 32.8, 42.2, 25.0, 13.6 and 23.4% for days to 50% silking, plant height, ear position, late wilt resistance, grain yield, 100-kernel weight, No. of rows/ear and ear length, respectively. While, in Gemmeiza 7421 population heritability estimates were 55.0, 57.9, 37.3, 75.2, 66.0, 61.0, 55.2 and 45.3 for the same traits, respectively. Coors (1988), showed that heritability estimate in broad sense was 0.34 for half-sib family, for grain yield. Soliman (1991), found that, estimated heritabilities were high for flowering date, plant and ear height and ear position, but it was low for grain yield in both pools. Pool A had higher heritability values than pool B for most traits. Galal *et al.* (1996), found that estimated heritabilities were 57.99, 44.67, 35.84, 57.39, and 84.14 for modified ear-to-row C_0, C_1, C_2 families, half-sib and S_1 lines *per se*, respectively. Saleh *et al.* (2002) found that estimates of broad sense heritability varied with characters. Moderate heritability was shown for grain yield indicating a substantial amount of genetic variation in populations. Low and negligible heritabilities for days to silking and 100-kernel weight indicate that these traits were very much influenced by environmental factors.

Means, environmental errors (σ^2_e) and coefficients of variability (C.V.%):

Means, environmental errors and coefficients of variability for different characters from inter-population crosses Pop. A and Pop. B over locations are presented in Table 4. Data showed that the mean values of Pop. A. for days to 50% silking, plant height, ear height, ear length, ear diameter, no. of rows/ear, no. of kernel/row, 100-kernel weight and grain yield were 58.69, 284.92, 179.31, 18.49, 4.82, 15.07, 37.63, 32.92 and 2.85, respectively. Regarding Pop B, the mean values for days to 50% silking, plant height, ear height, ear length, ear diameter, no. of rows/ear, no. of kernel/row, 100-kernel weight and grain yield were 58.83, 280.61, 175.10, 18.29, 4.92, 15.34, 37.39, 32.66 and 2.74, respectively. The coefficient of variability ranged from 2.21% for days to 50% silking to 13.13% for grain yield in Pop. A, while it ranged from 1.79% for days to 50% silking to 16.32% for grain yield in Pop. B.

Table 4. Mean ($\overline{X}$), environmental error variance (σ^2e) and coefficients of variability (CV) for all studied trait of Pop. A and B half-sib families (HS), across locations.

Traits	Pop-A			Pop-B		
	$\overline{X}$	σ^2e	CV%	$\overline{X}$	σ^2e	CV%
Days to 50% silking	58.69	1.69	2.21	58.83	1.11	1.79
Plant height (cm)	284.92	89.11	3.31	280.61	109.04	3.72
Ear height (cm)	179.31	101.99	5.63	175.10	91.45	5.46
Ear length (cm)	18.49	1.88	7.41	18.29	1.21	6.01
Ear diameter (cm)	4.82	0.16	8.30	4.92	0.16	8.13
No. of rows/ear	15.07	0.92	6.36	15.34	0.88	6.11
No. of kernels/row	37.63	12.41	9.36	37.39	11.42	9.04
100-kernel weight (g.)	32.92	18.21	12.96	32.66	17.79	12.91
Grain yield (kg/plot)	2.85	0.14	13.13	2.74	0.20	16.32

Expected (Ex.) and actual gain from selection (Ac.):

The genetic gain from selection has been one of the most important contributions of quantitative genetics to maize breeder. One of them is direct application to which a given population is suitable for breeding purpose for either a given environment or a set of environments. Estimates of the expected and actual gain from selection for the best 10 families for the characters used as selection criterion through half-sib family selection method in both populations are given in Table 5. Results indicated that the expected gain in the two populations were higher than the actual gain from selection because the expected gain were calculated from genetic variance which included both additive and non-additive components. Expected gain for grain yield (kg/plot) were 22.07% and 20.70% and actual gain were 4.14% and 4.49% for Pop. A and Pop. B, respectively.

Expected gain for days to 50% silking was 3.75% and 3.94% and actual gain from selection were 0.40% and -2.3% for improved Pop. A and Pop. B, respectivelly.

Also the actual gain from selection in improved Pop. A was better than those in Pop. B. These results could be attributed to the presence of more additive genetic variance in Pop. A than in Pop. B. Similar results were obtained by Betran and Hallauer (1996) who indicated that reciprocal recurrent selection was more effective than intrapopulation recurrent selection in reducing ear height and days from planting to silking. For earliness improvement, Pop. B was more suitable than Pop. A, indicating that Pop. B had more variability than Pop. A for this trait.

Our results indicate that reciprocal recurrent selection is effective in improving grain yield and its components of the two studied maize populations. Similar results were obtained by Mahdy *et al.* (1987) who found that reciprocal recurrent significantly increased grain yield/plant and ear length. Verderio *et al.* (1988) reported that mean yield was significantly improved (5.6%) when testcrosses to an inbred tester were used.

Bertolini *et al.* (1989) evaluated random S_1 lines and their testcrosses. They found that the mean yield was significantly improved by both methods of recurrent selection but S_1 itself was more effective. Schnicker and Lamkey (1993) indicated that reciprocal recurrent selection has been effective in increasing the mean performance of the population cross maintain genetic variance. Menkir and Kling (1999) they found that the reciprocal recurrent selection was effective in improving grain yield and other traits of interpopulations crosses without a loss in genetic variance. Peng *et al.* (2007) studied three recurrent selection methods i.e., modified S_1 family selection, modified S_1-HS and MHRRS. They demonstrated that the three recurrent methods were effective for increasing grain yield in testcrosses and improvement of general combining ability in maize populations.

Table 5. Expected (Ex.) and actual (Ac.) gain % from the first cycle of half-sib family selection in two yellow maize populations across two locations.

Populations	Selection criterion	Days to 50% silking		Plant height		Ear height		Ear length		Ear diameter		No. of rows/ear		No. of kernels/ row		100-kernel weight		Grain yield	
		Ex.	Ac.	Ex.	Ac.	Ex.	Ac.	Ex.	Ac.	Ex.	Ac.	Ex.	Ac.	Ex.	Ac.	Ex.	Ac.	Ex.	Ac.
Tuxpeno Corn Belt (pop A.)	Yield	3.75	4.80	1.83	2.50	1.98	2.00	9.59	4.03	5.47	4.46	13.53	6.56	12.27	15.93	15.45	8.52	22.07	4.14
	Silk	3.75	0.40	1.83	3.80	1.98	4.30	9.59	7.07	5.47	0.58	13.53	2.43	12.27	14.05	15.45	-1.80	22.07	4.28
Puerto Rico (pop. B)	Yield	3.94	1.10	1.46	-2.70	2.69	0.10	6.77	1.24	7.68	1.02	13.05	0.68	4.55	0.72	10.60	3.26	20.70	4.49
	Silk	3.94	-2.30	1.46	-1.40	2.69	0.40	6.77	2.24	7.68	2.45	13.05	-2.04	4.55	-9.09	10.60	6.74	20.70	-8.32

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انتخاب عائلات الأخوة غير الأشقاء لتحسين العشائر في الذرة الشامية

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الملخص:

الهدف من إجراء هذه الدراسة هو تقييم عائلات الأخوة غير الأشقاء لتحسين محصول الحبوب والتبكير – تقدير المكونات الوراثية ودرجة التوريث و تقدير التقدم المتوقع والمشاهد من الانتخاب بعد دورة واحدة من الانتخاب وكانت أهم النتائج المتحصل عليه:

كان التباين الوراثي المضيف لصفات عدد الأيام حتى ظهور ٥٠٪ من الحراير، طول الكوز، عدد الصفوف بالكوز، عدد الحبوب بالصف، وزن ١٠٠ حبة للإخوة غير الأشقاء للعشيرة (B) عاليا عن مثيلتها للإخوة غير الأشقاء للعشيرة (A) وهو الأكثر أهمية في وراثة هذه الصفات. كان التباين الوراثي هو المؤثر في وراثة صفتى قطر الكوز ومحصول الحبوب في كلا العشيرتين. كانت قيم التباين الوراثي لصفات ارتفاع النبات، طول الكوز، عدد الصفوف بالكوز، عدد الحبوب بالصف، وزن ١٠٠ حبة ، محصول الحبوب عالية للإخوة غير الأشقاء للعشيرة (A) عنه للإخوة غير الأشقاء للعشيرة (B).

أظهرت نتائج تقدير قيم درجة السيادة أن هناك سيادة فائقة لصفات ارتفاع الكوز، طول الكوز، قطر الكوز، وزن ١٠٠ حبة ،محصول الحبوب، وسيادة جزئية لصفة عدد الصفوف بالكوز للإخوة غير الأشقاء للعشيرة (A)، بينما كانت هناك سيادة فائقة لصفتى ارتفاع النبات ومحصول الحبوب وسيادة جزئية لصفة وزن ١٠٠ حبة للإخوة غير الأشقاء للعشيرة (B).

كانت قيم درجة التوريث بمعناها الواسع والضيق في العشيرة (A) هي (٥٤.٧٤ و ١٥.٣٧%) بينما كانت (٦٤.٢٨ و ٨.٢١%) في العشيرة (B) لصفة محصول الحبوب.

كان التقدم المتوقع لمحصول الحبوب ٢٢.٠٧ و ٢٠.٧ % بينما كان التقدم المشاهد ٤.١٤ و ٤.٤٩ % في العشيرة (A) والعشيرة (B)على الترتيب.