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GENETIC VARIABILITY, GENOTYPIC AND PHENOTYPIC CORRELATIONS BETWEEN ECONOMIC TRAITS OF MAIZE UNDER DIFFERENT DATES OF PLANTING

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ABSTRACT

New early 27 yellow three-way crosses of maize were evaluated at two planting dates (early and late). Genotypic and phenotypic variation, correlation coefficients, heritability in the broad sense and heterosis were estimated for six economic traits. Mean squares due to planting dates were highly significant for all attributes except for number of rows/ear. The means were higher under the early planting date compared with the late planting date for all the traits. The genetic variance of genotypes was significant for all traits at each of the two planting dates and across planting dates. While, the interaction between genetic variance and planting dates was not significant for all the studied traits.

Phenotypic and genotypic variances were increased under early planting date (non- stress environment) for silking date, ear length and ear diameter, while the phenotypic and genotypic variances were increased under late planting date (stress environment) for grain yield, number of rows/ear and number of kernels/row. Heritability was higher under non stress environment for silking date, grain yield and ear length, while it was higher under stress environment for ear diameter, number of rows/ear and number of kernels/row. The highest value of heritability was obtained for silking date (91.43%).

Phenotypic and genotypic correlations were high between grain yield and each of ear length, ear diameter, number of rows/ear and number of kernels/row showing that these traits have a major contribution towards yield.

Genotypic correlation coefficient was higher than phenotypic correlation coefficient, meaning that there was a strong association between any studied trait and grain yield which is due to linkage of genes, hence the indirect selection for linked traits with yield would be useful and effective for improving grain yield. The highest three- way crosses for heterotic effects for grain yield relative to the commercial hybrid TWC 352 were SC Sk52 x Sk 6015/31, SC Sk11 x Sk U10 and SC Sk11 x Sk U14 by 27.64% 27.03% and 22.03% , respectively.

INTRODUCTION

Recently, National Maize Research Program has an optimistic plan to increase the national production of yellow maize and to development of early hybrids that can be harvested at 95 days from planting date to save irrigation water. Comstock and Moll (1963) classified the environments into two categories: macro-environmental variation, which is caused by the fluctuation in variables, such as: years, locations, fertility levels, planting dates, plant densities and micro-environmental variation that differ from plant to plant. Frey (1964) defined the stress of environments as the one that limits plant productivity. Johanson and Frey (1967) and Vela and Frey (1972) showed that maximum expression of genetic variability was attained at the non-stress environment. EL-Rouby *et al.* (1973) reported that the early date of planting was considered as an optimum environment, while the late planting was a stress one. Heritability was higher in the optimum environment.

Correlation coefficient analysis measures the mutual relationship between various traits and determines the component traits on which selection can be based for genetic improvement in yield. Camacho (1963), Compton (1969), Williams *et al.* (1965) showed high association between yield and its components. Shehata (1975) found that ear length and ear diameter were positively correlated with grain yield at the phenotypic and genotypic levels. Utkhede and Shukla (1976) exhibited positive genotypic and phenotypic correlation of yield with number of rows. While insignificant phenotypic and genotypic correlation among yield, plant height and days to 50% tasseling were obtained by Nawar *et al.*(1990).Whereas, Mosa (2003) found positive significant correlation between grain yield and number of kernels/row.

The main objectives of this study were to: (1) estimate the phenotypic and genotypic variances and heritability under stress and non stress environment, (2) estimate the phenotypic and genotypic correlation coefficients between grain yield and some economic traits and (3) to identify the superior hybrids for grain yield and early maturity.

MATERIALS AND METHODS

The experimental material included new early 27 yellow three- way crosses of maize which were developed by Maize Research Section at Sakha Research Station. In 2004 season, two experiments were carried out each one involved the 27 hybrids plus the check variety, TWC 352. Two planting dates were used the 1st was on May 21th (1 st exp.) and the 2 nd was on June 21th (2 nd exp.). A randomized complete block design with four replications was used at the Experimental Farm of Sakha Research Station. The plot size consisted of 1 row, 6 m. long and 80 cm. apart, the distance between plants within the row was 25cm. All agronomic-field operations were practiced as usual with ordinary field maize cultivation. The collected data included grain yield ard/fad adjusted at 15.5% grain moisture content, ear length and diameter (cm), number of rows/ear, number of kernels/row and number of days from planting date to 50% silking. The data were analyzed according to Sendecor and Cochran (1980). The combined analysis across the two planting dates was carried out whenever homogeneity of variances was detected. Genotypic and phenotypic correlation coefficients, phenotypic and genotypic variances, heritability in the broad sense were calculated according to Johnson *et al.* (1955). Heterosis expressed as the percentage of deviation of F_1 mean performance from TWC 352 was computed according to Meredith and Bridge (1972).

RESULTS AND DISCUSSIONS

The analysis of variance for the six traits over the two planting dates is shown in Table 1. Mean squares of planting dates were significant for all traits except number of rows/ear, indicating significant differences between the environments under the two planting dates. El-Hosary (1988) and El-Hosary *et al.* (1990) found also that planting dates mean squares were significant for grain yield/plant, number of kernels/rows and silking date but not significant for number of rows/ear.

For all traits, the mean values under the early planting were higher than those under the late planting, meaning that the late planting date was the stress environment. Frey and Malonado (1967) defined the stress environment as the one in which mean performance for certain attribute is low.

Mean squares due to the hybrids were highly significant for all studied traits. While the interaction between hybrids x planting dates was not significant for all traits. On other words, the hybrids differed significantly from one environment to other for all traits, while the rank of hybrids were constant under both two planting dates.

Table 1 : Mean squares from analysis of variance for six traits over two planting dates.

S.O.V	d.f	Mean squares					
		Silking date (days)	Grain yield (ard/fad)	Ear length (cm)	Ear diameter (cm)	No.of rows/ear	No.of kernels/row
Planting dates (D)	1	1743.8**	201.03**	36.4**	0.40*	0.31	60.30*
Rep/D	6	10.17	13.96	2.63	0.06	0.34	7.10
Hybrids (H)	27	31.39**	60.84**	5.26**	0.36**	8.56**	27.85**
H×D	27	2.69	6.79	0.99	0.031	1.02	8.30
Error	162	2.35	6.26	0.95	0.03	0.89	5.94
Cv %		2.65	9.05	5.02	3.65	6.08	6.37

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

Mean performance of 28 three -way crosses for six studied traits over two planting dates are given in Table (2). Sixteen three -way crosses significantly outyielded the check cultivar TWC 352 and twenty three- way crosses were significantly earlier than TWC 352. The best five crosses which had superioriority for grain yield and earliness compared with TWC 352 were SC Sk 52 X Sk 6015/40 ' SC Sk 52 X Sk 6015/41 ' SC Sk 11 X Sk U 10 ' SC Sk 11 X Sk U14 and SC Sk11 X Sk N 14.

Estimates the phenotypic and genotypic variances and heritability in broad sense under each planting date and combined across the two planting dates for six traits are presented in Table 3. Genetic variance was significant for all studied traits under each planting date and across the two planting dates. While the interaction between genetic variance and planting dates was insignificant for all studied traits. The magnitude of phenotypic and genotypic variances was higher under early planting date (non-stress environment) than under late planting date (stress) for silking date, ear length and ear diameter. Frey (1964), Frey and Maldonado (1967) and Nawar *et al.*(1990) reported that under optimum environment the tested genotypes were fully expressed leading to an enlargement in genotypic variances while the stress conditions curtailed genetic differences among different genotypes.

Table 2 : Mean performance of 28 three - way crosses for six traits over two planting dates.

Three- way cross	Silking date (days)	Grain yield (ard/fad)	Ear length (cm)	Ear diameter (cm)	No.of rows/ear	No.of kernels/row
SC155 x Sk6004-2	54.87	24.63	18.67	4.53	14.55	35.15
SC155 x Sk6004-3	55.50	25.58	20.10	4.46	14.20	34.85
SC155 x Sk6004-5	58.00	28.26	19.82	4.83	14.45	38.62
SC155 x Sk6006-10	55.62	23.18	18.57	4.58	13.70	36.20
SC155 x Sk6006-12	55.25	24.40	17.87	4.97	15.50	36.12
SC155 x Sk6008-15	55.75	28.09	19.92	4.83	14.70	37.72
SC155 x Sk6011-17	55.37	24.94	18.62	4.92	15.50	37.25
SC155 x Sk6014-19	54.75	25.44	18.72	4.66	14.05	36.67
SC155 x Sk6014-20	54.62	25.55	18.35	4.51	15.20	37.45
SC Sk52 x Sk6015-29	59.37	27.72	20.45	5.13	16.45	39.52
SC Sk52 x Sk6015-30	60.12	27.99	19.67	5.22	16.40	39.17
SC Sk52 x Sk6015-31	59.62	29.72	19.72	5.06	16.65	39.47
SC Sk52 x Sk6015-32	60.37	32.43	19.90	5.11	16.80	41.27
SC Sk52 x Sk6015-33	58.62	28.30	19.20	5.10	16.95	37.55
SC Sk52 x Sk6015-36	60.25	29.58	20.72	5.05	15.70	41.42
SC Sk52 x Sk6015-38	57.37	28.18	20.40	4.96	15.90	39.67
SC Sk52 x Sk6015-40	58.87	30.06	20.90	5.11	16.50	40.62
SC Sk52 x Sk6015-41	58.37	30.73	20.45	5.15	16.80	39.22
SC Sk52 x Sk6026-51	60.37	24.10	18.87	4.88	15.10	39.00
SC Sk11 x Sk U 10	57.25	32.28	20.20	4.98	15.05	39.65
SC Sk11 x Sk U 14	57.87	31.01	20.15	4.98	15.60	38.75
SC Sk11 x Sk U 15	57.50	28.17	19.00	5.06	17.05	39.25
SC Sk11 x Sk U 16	57.12	27.29	19.25	4.96	16.35	36.70
SC Sk11 x Sk N 14	57.12	30.83	19.85	5.08	16.50	38.47
SC Sk11 x Sk 121	60.75	22.00	18.15	4.81	13.60	34.35
SC Sk11 x Sk 6241	58.37	29.05	19.42	4.81	14.95	40.65
SC Sk11 x Sk 8117	58.75	29.21	19.02	4.92	14.70	38.52
TWC 352	60.50	25.41	19.22	5.21	16.15	38.37
LSD 0.05	1.50	2.45	0.95	0.16	0.92	2.38
0.01	1.97	3.22	1.25	0.22	1.21	3.14

However, the magnitude of phenotypic and genotypic variances was higher under late planting date (stress environment) than under early planting date (non-stress) for grain yield, number of rows/ear and number of kernels/rows. Amer (1995) also found that the phenotypic and genotypic variances were increased under stress conditions for grain yield.

The estimate of heritability in broad sense in Table 3, was higher under non stress than stress environment for silking date, grain yield and ear length, while it was higher under stress than non-stress conditions for ear diameter, number of rows/ear and number of kernels/row .The values of heritability over the two planting dates were high for all the studied traits and ranged from

70.05% for number of kernels/row to 91.43% for silking date, indicating that those traits were least influenced by the environmental effects. In general, the results exhibited the importance of using both stress and non- stress environments for evaluation of different genotypes.

Table 3 : Estimates of phenotypic and genotypic variances (σ^2ph and σ^2g) and heritability in broad sense(h^2_b %) under each planting date and combined across planting dates for six traits.

Estimates	Silking date (days)	Grain yield (ard/fad)	Ear length (cm)	Ear diameter (cm)	No.of rows/ear	No.of kernels/row
Early planting date						
$\bar{x}$	60.58	28.60	19.87	4.97	15.57	38.79
σ^2 ph	4.962	7.272	1.052	0.052	1.077	3.50
σ^2 g	4.519*	6.382*	0.775*	0.042*	0.832*	2.082*
h^2_b %	91.062	87.76	73.66	81.73	77.25	59.48
Late planting date						
$\bar{x}$	55.009	26.70	19.07	4.88	15.5	37.75
σ^2 ph	3.557	9.63	0.51	0.045	1.317	5.53
σ^2 g	2.827*	7.397*	0.312*	0.039*	1.12*	3.985*
h^2_b %	79.47	76.81	61.27	87.77	85.04	72.06
Combined over planting date						
$\bar{x}$	57.79	27.65	19.47	4.92	15.53	38.27
σ^2 ph	3.923	7.605	0.657	0.045	1.07	3.481
σ^2 g	3.587*	6.756*	0.533*	0.041*	0.942*	2.44*
σ^2 gd	0.042	0.066	0.005	0.0001	0.016	0.295
h^2_b %	91.43	88.83	81.12	91.11	88.03	70.09

Significance based on the respective stander error (± S.E)

Estimates of phenotypic and genotypic correlation coefficients between grain yield and the other studied traits over two planting dates are presented in Table (4).Positive and highly significant correlation coefficients were found between grain yield and all studied traits except silking date, indicating that the association between grain yield and any studied trait except silking date was high and positive .It means that the increase in any studied trait would cause an associted increase in grain yield and vice verse. However, the genotypic was higher than phenotypic correlation coefficient, indicating that there was a strong association between any studied trait and grain yield which is due to linkage of genes and thus the selection index for yield and associated traits would be fruitful. Moreover the indirect selection for lineked traits with yield would be useful and effective for improving grain yield. These results are in agreement with those of Camachio (1963), Compton (1969), Walter *et al.* (1991) and Mosa (2003).

Table 4 : Estimates of phenotypic and genotypic correlation coefficients between grain yield and other studied traits over two planting dates.

Type of correlation	Silking date (days)	Ear length (cm)	Ear diameter (cm)	No.of rows/ear	No.of kernels/ row
Phenotypic correlation	0.27	0.69**	0.39*	0.53**	0.71**
Genotypic correlation	0.31	0.77**	0.56**	0.62**	0.78**

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

Heterotic effects for six traits relative to the commercial hybrid TWC 352 are presented in Table (5). The range of heterosis for silking date was from -9.71 to 0.41% relative to the TWC 352.

Table 5: Estimates of heterosis (%)relative to the commercial three-way cross 352 for six traits (data are combined across two planting dates).

Three- way cross	Silking date (days)	Grain yield (ard/fad)	Ear length (cm)	Ear diameter (cm)	No.of rows/ ear	No.of kernels/row
SC155 x Sk6004-2	-9.30**	-3.06	-2.86	-13.05**	-9.90**	-8.39**
SC155 x Sk6004-3	-8.26**	0.66	4.57	-14.39**	-12.0**	-9.17**
SC155 x Sk6004-5	-4.13**	11.21*	3.12	-7.29**	-10.5**	0.65
SC155 x Sk6006-10	-8.66**	-8.77	-3.38	-12.09**	-15.1**	-5.65
SC155 x Sk6006-12	-8.67**	-3.97	-7.02**	-4.60**	-4.02	-5.86
SC155 x Sk6008-15	-7.85**	10.54*	3.64	-7.29**	-8.97**	-1.96
SC155 x Sk6011-17	-8.47**	-1.84	-3.12	-5.56**	-4.02	-2.91
SC155 x Sk6014-19	-9.50**	0.11	-2.60	-10.55**	-13.0**	-4.43
SC155 x Sk6014-20	-9.71**	0.55	-4.52	-13.43**	-5.88*	-2.39
SC Sk52 x Sk6015-29	-1.86	9.09	6.39*	-1.53	1.85	2.99
SC Sk52 x Sk6015-30	-0.63	10.15*	2.34	0.19	1.54	2.08
SC Sk52 x Sk6015-31	-1.45	16.96**	2.60	-2.87	3.09	2.86
SC Sk52 x Sk6015-32	-0.21	27.62**	3.53	-1.91	4.02	7.55*
SC Sk52 x Sk6015-33	-3.10*	11.37*	-0.10	-2.11	4.95	-2.13
SC Sk52 x Sk6015-36	-0.41	16.41**	7.80**	-3.07*	-2.78	7.94*
SC Sk52 x Sk6015-38	-5.17**	10.90*	6.13*	-4.79**	-1.54	3.38
SC Sk52 x Sk6015-40	-2.69*	18.29**	8.74**	-1.91	2.16	5.86
SC Sk52 x Sk6015-41	-3.52**	20.93**	6.39*	-1.15	4.02	2.21
SC Sk52 x Sk6026-51	-0.21	-5.15	-1.82	-6.33**	-6.50*	1.64
SC Sk11 x Sk U 10	-5.37**	27.03**	5.09*	-4.41*	-6.81*	3.33
SC Sk11 x Sk U 14	-4.34**	22.03**	4.83	-4.41*	-3.40	0.99
SC Sk11 x Sk U 15	-4.95**	10.86*	-1.14	-2.87	5.57	2.29
SC Sk11 x Sk U 16	-5.58**	7.39	0.15	-4.79**	1.23	-4.35
SC Sk11 x Sk N 14	-5.58**	21.33**	3.27	-2.49	2.16	0.26
SC Sk11 x Sk 121	0.41	-13.41**	-5.56	-7.67**	-15.7**	-10.47**
SC Sk11 x Sk 6241	-3.52**	14.32**	1.04	-7.67**	-7.43*	5.94
SC Sk11 x Sk 8117	-2.89*	14.95**	-1.04	-5.56**	-8.97**	0.39

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

Twenty crosses were significantly better in earliness than TWC 352. The best three -way cross for earliness was SC155 X Sk 6014/20. For grain yield, the range of heterosis was from -13.41 to 27.62% relative to the TWC 352.Sixteen crosses exhibited significantly the highest heterosis relative to

TWC 352. However, the most desirable heterotic effects for grain yield were detected in TWC SC Sk 52 X Sk 6015/32 (27.62%) followed by TWC SC Sk11 X SkU10 (27.03%) and TWC SC Sk11 X Sk U14 (22.03%). Six crosses significantly showed highest heterosis relative to TWC 352 for ear length; the highest heterotic effect was detected in TWC SC SK52 X Sk6015/40.Egihteen crosses exhibited desirable heterotic effects relative to TWC 352 for ear diameter .For number of rows/ear and number of kernels the ranges of heterosis were (-15.78 to 5.57%) and (-10.47 to 7.94%) relative to TWC 352,respectively.The best crosses in heterotic effects for number of rows/ear and number of kernels/row were TWC SC Sk11 X Sk U15 and TWC SC Sk52 X Sk6015/36,respectively. Many investigators reported high Heterosis for yield of maize. (Moll *et al.,* 1965 , Nawar ,1985 and Mosa, 2003).

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التباين الوراثي والأرتباط الوراثي والمظهرى بين الصفات الاقتصادية للذرة الشامية تحت مواعيد زراعة مختلفة

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اشتملت هذه الدراسة على ٢٧ هجين ثلاثى أصفر جديد ومبكر قيمت فى ميعادين للزراعة (ميعاد مبكر وميعاد متأخر). قدرلها التباين المظهري والوراثي و التلازم المظهري والوراثى ودرجة التوريث بالمعنى الواسع وقوة الهجين لـ٦ صفات اقتصادية:-

- كانت الاختلافات بين ميعادى الزراعة المبكر والمتأخر عالية المعنوية لكل الصفات تحت الدراسة ماعدا صفة عدد الصفوف بالكوز . أعلى المتوسطات تحصل عليه فى ميعاد الزراعة المبكر لكل الصفات المدروسة مقارنة بميعاد الزراعة المتاخر .
- أظهر التباين الوراثى للتراكيب الوراثية معنوية لكل الصفات المدروسة فى كل من ميعادى الزراعة على حدة و فى التحليل المشترك لهما. بينما التفاعل بين التباين الوراثى ومواعيد الزراعة لم يكن معنويا لكل الصفات المدروسة .
- ازداد التباين المظهرى والوراثى تحت ظروف ميعاد الزراعة المبكر (البيئة غيرالمجهدة) لصفات التزهير وطول الكوز وقطر الكوز بينما ازداد التباين المظهرى والوراثى تحت ظروف ميعاد الزراعة المتأخر (البيئة المجهدة) لصفات المحصول وعدد الصفوف بالكوز وعدد الحبوب بالصف.
- أظهرت الكفاءة الوراثية بالمعنى الواسع قيم عالية تحت ظروف البيئة الغير مجهدة لصفات التزهير ومحصول الحبوب وطول الكوز بينما أظهرت أعلى قيم تحت ظروف البيئة المجهدة لصفات قطر الكوز وعدد الصفوف بالكوز وعدد الحبوب بالصف و كانت أعلى قيم لكفاءة التوريث قد تحصل عليها لصفة تاريخ ظهور ٥٠% من الحراير (٩١,٤٣%) .
- أظهر التلازم المظهرى والوراثى بين صفة المحصول وكل من طول الكوز وقطر الكوز وعدد الصفوف بالكوز وعدد الحبوب بالصف أن زيادة هذه الصفات تكون مؤثرة معنويا فى زيادة المحصول.كما تبين أن التلازم الوراثى أعلى من التلازم المظهرى لأي صفة تحت الدراسة مع صفة المحصول ويعنى ذلك أن هناك ارتباط وراثى قوى بين هذه الصفات وصفة المحصول وبالتالى الانتخاب المباشر لأي من الصفات المدروسة يكون فعال فى تحسين المحصول.
- أظهرت الهجن الثلاثية هـ.ف سخا ٥٢ × سلالة سخا ٣١/٦٠١٥ (٣٢,٤٣ أردب فدان) ، هـ.ف سخا ١١ × سلالة سخا - ى ١٠(٣٢,٢٨ أردب فدان) ، هـ.ف سخا ١١ × سلالة سخا - ى ١٤ (٣١,٠١ أردب فدان) أعلى قوة هجن بالمقارنة هـ.ث٣٥٢ (٢٥,٤١ أردب فدان) بنسب زيادة٢٧,٦٢ % ، ٢٧,٠٣% و ٢٢,٠٣% على التوالى. ولذلك يمكن استخدامها كهجن عالية المحصول ومبكرة فى برنامج التربية لمحصول الذرة الشامية.