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GENETIC VARIABILITY AND HERITABILITY IN SOME GENOTYPES OF MAIZE

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ABSTRACT

This investigation was carried out at Sakha and Gemmeiza Research stations during the summer season of 2003 to evaluate the behaviour of twelve maize genotypes received from Field Crops Research Institute, Agricultural Research Center, to determine the phenotypic, genotypic, environmental variations, heritability in broad sense, genotypic and phenotypic coefficients of variation. Combined data over the two locations indicated that average performance for grain yield ranged from 164.8 gm (T.W.C. 320) to 258.2 gm (S.C. 10). At the two locations and combined data, plants of Dahab were earlier than the other genotypes in days to mid silk and days tasseling ,Pioneer 3062 gave the highest number of rows/ear. S.C. 10 gave the highest number of kernels/row, whereas, Bashayer gave the highest weight of 100 kernel (gm) .Estimates of phenotypic (ph), genotypic (g) and environmental variance reached highest estimates concerning grain yield/plant (gm) and number of kernels/row. Estimates of genotypic and phenotypic coefficient of variation revealed high values in grain yield/plant (gm), number of rows/ear, number of kernels/row and 100 kernel weight (gm). Grain yield/plant (gm) and days to tasseling showed high broad sense heritability estimates (over 80%).

INTRODUCTION

Maize (*zea mays L*) is very important to western hemisphere, where it became the dominant food staple in the early civilization of that part of the world. Maize was rapidly accepted as a food staple in many parts of the world because of its large size, good yield, ease of cultivation, versatility and storage character. It is well established that the majority of the people depend mainly on cereal grains as their staple food. In Egypt, maize has been considered an important food in the people's diet, including, charcoal coasted maize, bread, snacks as well as maize doughnut and sweet taxed goods.

The measurements of phenotypic , genotypic and environmental components of variance in maize yield and other characters, have been a matter of great importance . Estimates of the genetic parameters in the population have impacts in methods of practing section.

The objective of the present investigation was to study the variability and covariability of some introduction of maize with respect to yielding ability and important agronomic characters. The result of this study would be helpful to the plant breeder planning programs for developing high yielding varieties of maize adapted to the Egyptian conditions.

MATERIALS AND METHODS

This research was carried out at Sakha and Gemmeiza Research Stations to study the relative advantage of gene make-up effect as well as genetic behaviour of some maize varieties on the qualitative and quantitative criteria for maize.

The present study include twelve maize varieties, S.C. 10, Watania 1, pioneer 3062, S.C.Bachayer, Dahab, Taba, T.W.C. 310, T.W. C.320, T.W.C. 321, T.W.C. 322, Nefertety and pioneer 3057. A randomized complete block design in four replications was used, each plot was 3x7 m and consisted of ten row, 70 cm apart. Intra-hill spacing was 25 cm. The agricultural practices were done as recommended. At harvest five plants selected randomly from the three guard rows in each plot to collect data on the following characters.

1- Number of rows / ear
2- Number of kernels / row
3- 100 kernel weight (gm)
4- Grain yield / plant (gm)
5- Days to mid silk
6- Days to tasseling

Statistical analysis

The collected data were subjected to two types of statistical analysis:

1- Comparison between means, were done according to **Duncan** multiple range test (**1955**).

2- Statistical manipulation of the data:
- Analysis of variance for each location and combined analysis over the two locations for each variable was made according to the technique outlined by Steel *et al.* (1997)
- Covariance for each pair of variables were performed for a randomized complete block design according to Snedecor and Cochran (1980).

The expectation of mean squares are given in Table 1 according to Singh and Chuadhary (1985), as a Fixed model.

n, r and a are number of environments, replications and genotypes, respectively.

The genotypic and phenotypic variance ($\sigma^2 g$ and $\sigma^2 ph$) were calculated from the combined analysis as follows:

$$\sigma^2 g = (Ma - Mas)/rn$$

where $\sigma^2 g$ = Genotypic variance
Ma = Mean square of varieties
Mas = Mean square of the locations **x** varieties interaction
r = Number of replications
n = Number of environments

Phenotypic variance, σ^2 ph, was computed according to the following formula:

$$\sigma^2 ph = \sigma^2 g + (\sigma^2 gs / n) + (\sigma^2 e / rn)$$

where $\sigma^2 gs = (Mas - Me) / r$
$\sigma^2 e$ = Me (error mean square)

Genotypic and phenotypic covariances were calculated in the same way.
- Genotypic and phenotypic coefficients of variance were calculated according to Burton (1951) as follows:

$$G.C.V. = \frac{\sqrt{\sigma^2 g}}{\bar{x}} x100$$

$$P.C.V. = \frac{\sqrt{\sigma^2 ph}}{\bar{x}} x100$$

- Broad sense heritability (H%) was calculated as described by Hanson (1963) using the following formula:

(H%) = (genotypic variance / phenotypic variance) x 100

RESULTS AND DISCUSSION

Analysis of variance for each location and the combined analysis over the two locations for yield and other characters were done and presented in Table 2. Combined analysis indicated that Location mean squares were highly significant for the studied traits except number of rows / ear. Replications x locations interaction mean squares were significant for combined analysis in all studied traits except number of kernels / row and number of rows / ear. Genotypes mean squares were highly significant in all traits for each invironment and its combined also. Significant mean squares of the genotypes and locations interaction were founed in all traits indicating that genotypes carried genes with different additive and additive x additive effects which seemed to be inconstant from environment to invironment.

Mean performance of genotypes for all studied traits indicated in diversity as shown in Table 3. Examining this table, we noticed that a genotypes showed fluctuation in yield and its attributes over locations, therefore the genotypes were different in its productivity, this can be attributed to the minor affects of both environment and genetical factors.

Combined analysis over two locations Gemmeiza and Sakha regarding grain yield / plant (gm) and the other traits were reached to the significant level. The highest number of rows / ear was recorded by pioneer 3062 and Dahab. The highest number of kernels / row was recorded by S.C. 10 and T.W.C. 310. The highest 100 kernel weight (gm) was recorded by S.C.Bashayer , S.C. 10, T.W.C. 310, T.W.C. 320, T.W.C. 321 and T.W.C. 322.The highest grain yield/plant (gm) was recorded by S.C.10.The better number of days to mid silk and tasseling date were recorded by Dahab Table 3.

Estimates of phenotypic, genotypic and environmental variance for yield and some characters in maize genotypes obtained from the combined analysis of variance are presented in Table 4. Results showed that the highest values of phenotypic and genotypic variances were 497.67 and 437.01 respectively for grain yield / plant(gm), 4.44 and 2.86 for number of kernels / row.

Table 1: Combined analysis of variance and covariance of a randomized complete block design for Gemmeiza and Sakha locations.

Source of variation	D.F.	ANOVA		ANOCOVA	
		MS	Expectation of Ms	Mean cross product	Expectation of M.C.P.
Environments(locations)	n-1				
Reps/locations	n(r-1)				
Genotypes	a-1	Ma	$\sigma^2e + r\sigma^2gs + rn\sigma^2g$	Mpa	COVe+rCOVgs+rnCOVg
Environ.x genotypes	(n-1)(r-1)	Mas	$\sigma^2e + r\sigma^2gs$	Mpas	COVe+rCOVgs
Error	n(n-1)(r-1)	Me	σ^2e	Mp	COVe

Table 2: Mean squares for grain yield, its components and other agronomic traits at the two locations and combined analysis .

S.O.V.	D.F Sin.	D.F Com.	No. of rows/ear			No. of kernels/row			100 kernel weight		
			L1	L2	Comb.	L1	L2	Comb.	L1	L2	Comb.
Locations		1			2.67			74.73**			37.75*
Reps x L.	3	6	0.97	0.97	0.97	3.28**	0.28	1.78	2.41	12.36**	7.39**
Genotypes	11	11	5.54**	7.9**	10.23**	30.97**	17.11**	35.48**	13.88**	15.22**	19.8**
Lx G		11			3.21**			12.6**			9.31**
Error	33	66	1.09	0.43	0.76	6.16	2.23	4.19	4.03	4.38	4.2
C.V%			7.45	4.77	6.28	5.5	3.19	4.46	5.9	6.4	6.15
S.O.V.	D.F Sin.	D.F Com.	Grain yield /plant [gm]			Days to mid silk [days]			Days to tasseling [days]		
			L1	L2	Comb.	L1	L2	Comb.	L1	L2	Comb.
Locations		1			858.61**			100.04**			216.0**
Reps x L.	3	6	12.01**	75.3**	43.7**	1.13	3.3**	2.22*	1.58	7.41**	4.49**
Genotypes	11	11	3559.01**	1680.96**	4368.17**	7.66**	18.14**	21.39**	6.82**	17.58**	20.94**
LxG		11			871.89**			4.41**			3.48**
Error	33	66	109.28	87.69	98.49	0.83	0.83	0.83	0.97	0.85	0.91
C.V%			4.94	4.31	4.63	1.42	1.47	1.45	1.48	1.45	1.47

*,** Significant differences at 0.05 and 0.01 levels of probability respective

Table 3: Mean performance for yield, yield components and some agronomic traits at Gemmeiza, Sakha and combined data .

Genotypes	No.of rows/ear			No. of kernels/row			100 kernel weight [gm]		
	L1	L2	Comb.	L1	L2	Comb.	L1	L2	Comb.
S.C10	14.5 abc	14.0bc	14.25cd	48.6 a	49.5 a	49.05 a	63.12 a	32.8 ab	34.46ab
Watania{1}	15.5 a	13.5 c	14.5 c	44.9a-c	47.5 ab	46.21de	32.5 c	33.8 a	33.15 b
Pioneer 3062	15.5 a	16.0 a	15.75 a	41.57bc	42.5 d	42.04 g	31.5 c	33.9 a	32.7 b
S.C.Bashayer	13.0cd	15.0ab	14.0 c-e	48.6 a	47.0 ab	47.8 b	37.75 b	34.35 a	36.05 a
Dahab	15.0 ab	16.0 a	15.5 ab	40.82 c	44.0 cd	42.21 g	33.72 c	32.55ab	33.14 b
Taba	13.5 b-d	13.5 c	13.5 de	45.4 ab	47.75ab	46.58cd	32.25 c	28.55 c	30.4 c
T.W.C.310	13.0 cd	13.5 c	13.25 e	48.25 a	47.75ab	48.0b	34.87bc	32.77ab	33.83ab
T.W.C.320	12.5 d	12.0d	12.25 f	42.32bc	49.5 a	45.91 d-f	33.0c	35.42 a	34.21ab
T.W.C. 321	13.5b-d	13.0cd	13.25e	44.6a-c	45.5bc	45.05f	34.87ab	33.4a	34.14ab
T.W.C.322	12.5 d	12.0 d	12.25 f	47.75 a	47.0 ab	47.38bc	34.87ab	33.37 a	34.13ab
Nefertety	14.5 ac	12.0 d	13.25 e	45.1 a-c	46.0 bc	45.55 ef	37.37bc	32.32ab	33.35 b
Pioneer3057	15.5 a	14.0 bc	14.75bc	42.87bc	48.0 ab	45.44 ef	31.87 c	29.42bc	30.65 c

Genotypes	Grain yield/plant [gm]			Days to mid silk [days]			Days to tasseling [days]		
	L1	L2	Comb.	L1	L2	Comb.	L1	L2	Comb.
S.C.10	255.3a	261.2a	258.2a	63.0 d-f	63.2ob	63.13bc	66.5b-d	64.25b	63.38bc
Watania[1]	240.1a	234.3bc	237.2b	63.5 c-f	60.0 e	61.75de	66.0b-d	61.5 c	63.75de
Pioneer 3062	227.6a	235.6 b	231.6 b	62.25 f	60.75de	61.5 e	65.25cd	61.75c	63.5 e
S.C.bashayer	229.0a	227.3 b-d	228.1 b	62.75 ef	62.5 bc	62.63cd	65.5 cd	64.5 b	65.0 bc
Dahab	257.6 a	213.6 de	210.6 c	62.5 f	57.75 f	60.13 f	65.0 d	59.25 d	62.13 f
Taba	205.7 a	180.7 g	193.2 d	67.0 a	66.75 a	66.88a	69.75 a	68.0 a	68.88 a
T.W.C.310	214.1 a	209.2 ef	211.6 c	63.25c-f	61.75 b-d	62.5cd	65.5 cd	63.75 b	64.63cd
T.W.C.320	132.3 a	197.2 f	164.8 e	64.75 bc	62.0 b-d	63.38 bc	67.5 b	63.75 b	65.63bc
T.W.C.321	210.1 a	219.6 c-e	214.9 c	64.5 b-d	62.5 bc	63.5 bc	67.5 b	64.0 b	65.75 b
T.W.C.322	210.3 a	212.1 d-f	211.2 c	64.5 b-d	62.25 bd	63.38 bc	66.75bc	64.25 b	65.5 bc
Nefertety	200.1 a	209.6 ef	204.9 c	65.5 b	62.75 b	64.13 e	66.75bc	64.25 b	65.5 bc
Pioneer 3057	205.9 a	209.4 ef	207.6 c	64.25 b-e	61.0 c-e	62.63 cd	66.75bc	63.5 b	65.13bc

There was no significant difference between any two means with the letters.

With regard to environmental effect, results in Table 4 showed that grain yield / plant (gm), 100 kernel weight and number of kernels / row were greatly affected by environmental conditions with variance estimates of 98.45, 4.26 and 4.19 respectively. The lowest values of environmental variance were recorded by number of rows / ear (0.76) and days to mid silk (0.79). These results are similar to those reported by Samia *et al* (2002). In general estimating genotypic and invironmental variance is of great importance because the variance indicates the performance of various genotypes in given invironmental circumstances. This help the breeder to produce genotypes that represent combinations of genes for a particular invironment.

Estimates of phenotypic coefficient of variation P.C.V., genotypic coefficient of variation (G.C.V.), and Heritability (H%) of twelve genotypes of maize over both locations of Gemmeiza and Sakha are shown in Table 5. The results indicated that grain yield / plant (gm) ranked first with P.C.V. value of 10.4 followed by number of rows / ear (8.15). Meanwhile, tasseling date (days) had the lowest value of P.C.V. being 2.49. Data in Table 5 revealed that grain yield / plant (gm) gave the highest coefficient of genotypic variation being 9.75 followed by number of rows / ear being 6.75, but the lowest G.C.V. were for days to tasseling (2.27). and days to mid silk(2.32)

For heritability broad sense estimates, data in Table 5 indicated that grain yield / plant (gm) recorded highest heritability value 87.8% followed by days to tasseling (83.4) and days to mid silk (79.27). The above mentioned results are in line with those obtained by Barakat (1998). On the other hand selection for a given character among the studying genotypes would seem very effective, but these high estimates of heritability for some characters may be due to both of the high genetic variability which occurred between these genotypes and to the confounded effects of the environmental conditions. It seems reasonable to think of heritability as a measure of degree to which the phenotype reflects the genotype and in so doing accept a nonrestrictive definition, Rasmusson and Glass, (1967).

It could be concluded that grain yield / plant (gm), number of kernels / row and days to tasseling are important characters in maize breeding programs. These traits had high heritabilities as well as high genetic variabilities. Thus breeding for these characters would be effective in improving maize crop. Also this result attributed directly to the presence of more addition genetic variance, (Abul-Saad *et al* 1998-1999 and Barakat 1998).

Table 4: Estimation of phenotypic, genotypic and environmental variance for yield and some characters for twelve genotypes of maize over the two locations.

Characters	Variance		
	Phenotypic	Genotypic	Environmental
No. of rows/ear	1.28	0.88	0.76
No. of kernels/row	4.44	2.86	4.19
100 kernel weight [gm]	2.62	1.66	4.26
Grain yield/plant [gm]	497.67	437.01	98.45
Days to mid silk [days]	2.7	2.14	0.79
\Days to tasseling [days]	2.62	2.18	0.91

Table 5: Estimates of means, phenotypic coefficient of variation [P.C.V.], genotypic coefficient of variation [G.C.V.] and heritability [H%] of yield and some characters for twelve genotypes of maize over the two locations .

Characters	Means	P.C.V.	G.C.V.	H%
No. of rows/ear	13.88	8.15	6.75	68.59
No. of kernels/row	45.95	4.58	3.68	64.48
100 kernel weight [gm]	33.35	4.85	3.86	63.37
Grain yield/plant [gm]	214.49	10.4	9.75	87.8
Days to mid silk [days]	62.96	2.61	2.32	79.27
Days to tasseling [days]	65.06	2.49	2.27	83.4

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التباين الوراثى والمظهرى والبيئى ودرجة التوريث لبعض التراكيب الوراثية فى الذرة الشامية

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اجرى هذا البحث بهدف تقدير بعض السلوكيات الوراثية لاثنى عشر تركيبا وراثيا من اصناف وهجن الذرة الشامية ، وتمت زراعة التجربة بمحطة البحوث الزراعية بسخا ومحطة البحوث الزراعية بالجميزة والتابعتين لمركز البحوث الزراعية خلال الموسم الصيفى ٢٠٠٣ واوضحت النتائج الآتى:

١- اظهر تحليل التباين الفردى والتجميعى اختلافات واسعة ومعنوية بين التراكيب الوراثية لجميع الصفات المدروسة عدى صفة عدد الصفوف فى الكوز فى التحليل التجميعى، وفى التفاعل بين الجهات والتراكيب الوراثية ظهرت معنوية عالية لجميع الصفات المختبرة.
٢- اظهر الصنف دهب تبكيرا فى صفة خروج الحريرة والازهار المذكرة عن بقية التراكيب الوراثية..
٣- اعطى الصنف بيونير٣٠٦٢ اعلى عدد للصفوف فى الكوز
٤- تميز الهجين فردى ١٠ باعلى عدد من الحبوب فى الصف يليه الهجين الثلاثى ٣١٠ .
٥- وفى صفة وزن ١٠٠ حبة تفوق الصنف بشاير عن بقية التراكيب الوراثية.
٦- اظهر الهجين الفردى ١٠ اعلي كمية محصول على النبات (٢٥٨,٢جم) عن بقية الاصناف
٧- حققت صفة كمية المحصول بالنبات اعلى قيم للتباين المظرى والوراثى حيث كانتا٤٩٧,٦٧ و ٤٣٧,٠١ على الترتيب.وكذلك صفة عدد الحبوب فى الصف حيث كان قيمة التباين المظهرى ٤,٤٤ والتباين الوراثى٢,٨٦ .
٨- حققت صفات كمية محصول النبات ووزن ١٠٠ حبة اعلى تاثرا بالظروف البيئية بينما سجلت صفة عدد الصفوف فى الكوز اقل درجة تاثر بالظروف البيئية.
٩- حققت صفة كمية محصول النبات اعلى قيمة لمعامل الاختلاف المظهرى يليها صفة عدد الصفوف فى الكوز بينما كانت صفة عدد الايام لظهور النورة المذكرة اقل معامل اختلاف مظهرى.
١٠- حققت صفة كمية محصول النبات اعلى قيمة لمعامل الاختلاف الوراثى يليها صفة عدد الصفوف فى الكوز بينما سجلت الدراسة اقل قيمة لمعامل الاختلاف الوراثى فى صفتى عدد الايام لظهور الحريرة والنورة المذكرة.
١١- سجلت صفة كمية محصول النبات اعلى درجة توريث يليها صفتى عدد الايام لظهور النورة المذكرة وعدد الايام لظهور الحريرة.

مما ذكر نجد ان صفات كمية محصول النبات وعدد الصفوف فى الكوز وعدد الايام لظهور النورة المذكرة وعدد الأيام لظهور الحريرة من الصفات التى يمكن ان يعتد بها فى برامج تربية الذرة.