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PERFORMANCE AND PHENOTYPIC-GENOTYPIC STABILITY ESTIMATES OF GRAIN YIELD AND ITS ATTRIBUTES IN DIFFERENT ENVIRONMENTAL CONDITIONS OF SOME MAIZE HYBRIDS

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ABSTRACT

This investigation was carried out at the Experimental Farm, Fac. of Agric., Kafr El-Sheikh, Tanta Univ. during the two seasons 1998 and 1999 to evaluate five single cross of hybrids corn (*Zea mays* L.) namely, S.C. 10, S.C. 122, S.C. 123, S.C. 124 and S.C. 125 and three, three-ways cross namely T.W.C. 310, T.W.C. 320 and T.W.C. 321 under different levels of plant densities of 20 (D_1), 25(D_2) and 30 (D_3) thousand plants/fed., and nitrogen fertilization (80, 120 and 160 kg/fed) to estimate the phenotypic and genotypic stability parameters for grain yield under different environments.

The analysis of variance for each experiment separately relative to 1998 or 1999 seasons was conducted then the combined data of both seasons was also done for the grain yield and yield components. The data were analyzed by Eberhart and Russell (1966), Tai (1971) and Pinthus (1973) procedures to estimate phenotypic and genotypic stability parameters for grain yield.

The results could be summarized as follows:.

1) For plant densities the number of days to 50% silking as well as plant and ear heights were increased as the plant density increased, in both seasons and combined data, number of ears/plant was not significantly affected by increasing plant densities, ear length, ear diameter, number of rows/ear, number of kernels/row and 100-grain weight decrease as plant density increased. The highest grain yield was obtained with 25,000 thousand plant/fed.
2) Increasing nitrogen rate from 80 to 160 kg N/fed. lead to delaying silking, increasing plant and ear heights, ear length, ear diameter, number of rows/ear, number of kernels/row and 100 grain weight. The highest average of grain yield was obtained with 120 kg. N./fed.
3) The highest yielder variety was S.C. 10 (34.94 ard./fed.) followed by S.C. 124 (33.69 ard./fed.) and S.C. 122 (31.61 ard./fed.) while, the least yielder varieties were S.C. 123 (28.45 ard./fed.) and T.W.C. 320 (27.94 ard./fed.).
4) The crosses S.C.123, S.C.124 and T.W.C. 321 exhibited the lowest number of days to 50% silking toward earliness.
5) The hybrid varieties S.C. 122 and S.C. 124 would be the most stable varieties with respect to grain yield because they have values of "bi" around unity with small and insignificant deviations from regression.
6) The analysis of genotypic stability using Tai's method (1971) showed that both linear and deviation from linearity were highly significant. The distribution of varieties according to their values of α_i and λ_i showed that all varieties were unstable under studied environments. S.C. 124 was the nearest variety to the average stability. T.W.C. 320 was the worst with respect to its average and its α_1 and λ_i.
7) The varieties S.C. 122 and S.C. 124 had high values for coefficient of determination 0.95 and 0.92, respectively.

Keywords: performance, stability, phenotypic, genotypic, maize.

INTRODUCTION

Successful new hybrids and varieties of maize (*Zea mays* L.) crop must show high performance for grain yield and other essential agronomic traits under wide range of environmental conditions. The growth and yield of maize depend on many factors. From the major factors are genotypes, plant population density, and nitrogen fertilization. The optimum level of these factors widely varied according to soil fertility, water supply, day length and planting patterns, Duncan (1972).

Growth and yield of maize plants are influenced by genotype environment and genotype x environment interaction. Optimum rates of nitrogen and plant density provide better environment and consequently, high grain yield.

Nitrogen fertilization is among the most important cultural practices which control maize production (Balko and Russel, 1980 and Ahmed, 1999).

Increasing plant density within certain limits increased plant height (Shaheen, 1985; Younis *et al.*, 1989 and Ahmed, 1999), but decreased number of kernels/ear and number of ears/100 plant (Faisal, 1989 and Younis *et al.*, 1990). However, increasing plant density up to 27 thousand plants/feddan increased number of days to 50% silking, but tended to decrease plant height and grain yield (Bishr *et al.*, 1976 and Galal and El-Zeir, 1990). Several investigators stated that the grain yield increased as the plant densities or nitrogen level increased (Younis, 1985; El-Agamy *et al.*, 1986; Younis et l., 1990; Ahmed, 1999 and El-Absawy, 2000).

Developing and releasing high yielding and more stable maize hybrids is among the main objectives of the Egyptian Maize Research Program. Many high yielding single and three way cross hybrids were developed and released during the recent few years. Estimate of the genotypic stability of new hybrids was needed in any successful breeding program. In this respect, Freeman and Perkins (1971) stated that the basic cause of the differences between genotypes in their yield stability is the wide occurrence of genotype x environment interaction (G x E interaction).

Stability in performance is one of the most desirable properties of a genotype to be released as a variety for wide cultivation, where the new cultivar should have stable performance and broad adaptation over a range of environments, in addition to high yield potential (Allard and Bradshaw, 1964).

Breeding for stable cultivars has received much attention. Several methods have been proposed for determining the stability of potential varieties when they tested over a series of environments. Eberhart and Russell (1966) proposed the use of two statistics, a regression coefficient (b) and the deviation from regression (S^2d) to examine stability. They defined a stable cultivar as one having a regression coefficient of unity (b = 1) and minimum deviation from regression (S^2d = o). Also Schmidt *et al.* (1973) and Pinthus (1973) mentioned that r^2 is used instead of deviation mean squares to estimate stability of genotypes, because r^2 is relative measure of association between the actual mean and the predicted mean, so when the value of r^2 is high, the value of S^2d is less in the model of Eberhart and Russel (1966). Also, Schmidt *et al.* (1973) and Pinthus (1973) used the coefficient of determination (r^2) to measure cultivar response. Genotypic stability analysis was proposed by Tai (1971), using a model that measures the linear response of genotypes to environmental effects (α_i) and the deviation from the linear response (λ_i). He defined perfectly stability cultivar as one that has (α_i, λ_i) = (-1,1). A cultivar of average stability has (α_i, λ_i) = 0, 1).

The objectives of the present investigation were:

1. Evaluation of eight hybrids corn (*Zea mays* L.) under three plant densities combined with three nitrogen levels.
2. The estimation of the phenotypic and genotypic stability parameters to identify the stable maize genotypes for grain yield under different environments.

MATERIALS AND METHODS

This study was conducted at the Experimental Farm, Faculty of Agriculture, of Kafr El-Sheikh, Tanta University during the two seasons, 1998 and 1999. The varieties included in this study were five single crosses namely, S.C. 10, S.C. 122, S.C. 123, S.C. 124 and S.C. 125 and three, three-way crosses namely T.W.C. 310, T.W.C. 320 and T.W.C. 321. In each experiment a split-split plot design with three replications was used in both years, where plant densities were located at the main plots, nitrogen fertilizer levels, represented the sub plots and the hybrids were located in the sub-sub plots.

The plot size consisted of 2 rows, 6 meters long and 70 cm a part.

Three plant population densities of 20 (D_1), 25(D_2) and 30 (D_3) thousand plants/fed., the distance between plants within row were 30, 24 and 20 cm. for D_1 D_2 and D_3 respectively. Three nitrogen levels of 80, (N_1), 120 (N_2) and 160 (N_3) kg N/fed. were randomly arranged to the sub-plots, the nitrogen fertilization were divided into two equal parts, added before the first and the second irrigation. The other agronomic field operations were practiced as usual with ordinary field maize cultivation.

At harvest, weight of the harvested ears/plot, shelling percentage and grain moisture were recorded. These data were used to calculate the grain yield in ardab/fed (one ardab = 140 kg) adjusted to 15.5% moisture.

The collected data concerning the adjusted grain yield per feddan as well days to 50% silking, plant and ear height, ear length, ear diameter, number of rows/ear, number of kernels/row and 100-kernel weight were statistically analyzed according to the procedure outlined by Snedecor and Cochran (1967) and the mean values were compared by Duncan's multiple range test (Duncan, 1955).

Stability analysis of grain yield (Ardab/fed.) of the hybrids:

Statistical analysis, for each of the eighteen environmental conditions and the comparison between means were done using Gomez and Gomez (1983). Bartlett test (1937) was used to test the homogeneity of error mean squares of the 18th conditions, and incase of the homogeneity, combined analysis of variance over 18 environments was done for grain yield.

Phenotypic stability analysis for grain yield were performed according to the following Model of Eberhart and Russell (1966).

$$Y_{ij} = U_i + B_i I_J + S_{ij}$$

Where:

Y_{ij} = The variety mean of the i^{th} variety at the J^{th} environment.

U_i = Mean of the i^{th} variety at the J_{th} environment.

B_i = Regression coefficient that measures the response of the 1^{st} variety to varying environments.

I_J = Environmental index obtained as the mean of all varieties at the J^{th} environment minus the grand mean.

S_{ij} = The deviation from regression of the i^{th} variety at the J^{th} environment.

Genotypic stability analysis was calculated as proposed by Tai (1971) who used a model that measures the linear response of genotypes to environmental effects (α_I) and the deviation from the linear response (λ_I). He defined a perfectly stability cultivar as one that has (α_I, λ_I) = (-1, 1). A cultivar of average stability has (α_I, λ_I) = (0, 1)

Coefficients of determination (r^2) as suggested by Pinthus (1973) was also used to estimate stability.

RESULTS AND DISCUSSION

Data from each experiment was statistically analyzed separately and combined for the two years.

The data in Table (1) which indicates the mean performance of the hybrids of either each plant density (D) or each nitrogen fertilization (N) in separate years and the combined data will be discussed as follows:

1. Mean performance:

a. Effect of plant density:

Data of Table (1) indicated that the number of days to 50% silking as well as plant and ear heights increased as the plant density increased in both seasons and combined data. This may be due to more competition between maize plants for nutrient, moisture and light penetration which push the plants to grow up and subsequently ear height increased at such density rate, beside delaying the physiological interaction which push the plants to flower.

Number of ears/plant was not significantly affected by increasing plant densities. On the other side, the higher density rate 30.000 plants/fed. caused significant decreases in ear length, ear diameter, number of rows/ear, number of kernels/row and 100-grain weight. With regard to the mean of grain yield ard./fed. of 1998 was (31.71 ard./fed.) compared with 29.51 ard/fed. for 1999 year with a difference of (2.2) ard/fed. with an average of 30.83 ard./fed. for the two years. The mean performance of grain yield were increased gradually from 20.000 plants/fed. up to 25.000 plants/fed. and then tended to decrease with the plant density of 30.000 plants/fed. in both seasons and combined data. Similar results were obtained by Abou-Khadrah (1984), Nawar *et al.* (1992), Younis *et al.* (1994), Soliman *et al.* (1995), Ahmed (1999) and Mohamed (1999).

Table (1): Means of grain yield and other agronomic traits of some maize hybrids as influenced by plant population density and nitrogen levels in 1998. 1999 and combined.

Main effects and interactions	Silking date (day)			Plant height (cm)			Ear height (cm)			No. of ears/plant			Ear length (cm)		
	1998	1999	Comb.	1998	1999	Comb.	1998	1999	Comb.	1998	1999	Comb.	1998	1999	Comb.
Density (D)															
20.000	62.2c	62.7c	62.49c	261.3b	291.8c	276.6c	156.4c	166.4c	161.4c	1.06 a	1.04 a	1.05 a	20.1 a	20.2 a	20.2 a
25.000	63.2b	65.0b	64.13b	263.5b	302.2b	282.9b	165.1b	169.5b	167.3b	1.09 a	1.03 a	1.06 a	18.7 b	19.2 b	19.0 b
30.000	63.7a	67.4a	65.61a	267.1a	308.3a	287.7a	174.5a	175.0a	174.8a	1.09 a	1.05 a	1.07 a	17.3 c	17.9 c	17.6 c
F-test	**	**	**	*	**	**	**	**	**	N.S	N.S	N.S	**	**	**
Fertilization (N)															
80 kg N/fed.	62.3c	64.2c	63.31c	260.3b	296.6c	278.5c	162.1c	168.0b	165.1c	1.07 a	1.03 a	1.05 a	18.4 b	18.3 c	18.4 c
120 kg N/fed.	63.2b	65.1b	64.21b	2364.5a	301.0b	282.8b	165.6b	169.0b	167.3b	1.07 a	1.4 a	1.06 a	18.7 b	19.1 b	18.9 b
160 kg N/fed.	63.8a	65.8a	64.72a	267.1a	304.9a	285.9a	168.3a	173.0a	170.6a	1.09 a	1.04 a	1.07 a	19.1 a	19.9 a	19.5 a
F-test	**	**	**	**	**	**	**	**	**	N.S.	N.S	N.S	**	**	**
Varieties (V)															
S.C. 10	65.3a	65.11cd	65.22a	264.6c	308.8a	286.7b	168.3b	170.8ab	169.6b	1.10 a	1.07 a	1.08 a	19.9 a	20.3 a	20.13 a
S.C. 122	64.4b	65.33bc	64.91b	245.6f	294.1d	269.8f	167.7b	170.9ab	169.3b	1.07 ab	1.35 ab	1.06 abc	17.9 e	18.6 b	18.30 d
S.C. 123	62.3e	64.55e	63.44f	265.8c	306.4a	286.2b	159.6d	169.4bc	164.5d	1.10 a	1.02 b	1.06 ab	19.4 c	16.8 e	18.13 d
S.C. 124	61.4f	65.51ab	63.50f	260.3e	295.1d	277.7e	156.2e	168.7c	162.5f	1.10 a	1.03 b	1.07 ab	17.7 f	18.6 d	18.16 d
SC. 125	62.4e	64.96d	63.70e	269.4b	289.5e	279.5d	159.8d	166.5d	163.2e	1.09 ab	1.04 b	1.06 ab	17.4 g	19.5 b	18.5 0c
T.W.C. 310	63.3c	65.66a	64.46c	265.3c	300.1c	282.7c	167.7b	168.8c	168.3c	1.07 ab	1.03 b	1.05 bc	19.5 c	20.5 a	20.07 a
T.W.C. 320	62.5de	65.33bc	63.94d	278.1a	308.7a	293.4a	180.4a	172.8a	176.6a	1.06 b	1.04 b	1.05 abc	19.6 b	19.5 b	19.58 b
T.W.C. 321	62.7d	64.11f	63.44f	262.6d	303.4b	283.0c	163.0c	172.4a	167.7c	1.06 b	1.03 b	1.04 c	18.2 a	18.9 c	18.60 c
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
Interaction															
YD	-	-	**	-	-	**	-	-	**	-	-	N.S	-	-	N.S
YN	-	-	**	-	-	N.S	-	-	**	-	-	N.S	-	-	**
DN	*	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	*	*
YV	-	-	**	-	-	**	-	-	**	-	-	**	-	-	**
DV	**	**	**	**	N.S	**	**	N.S	N.S	N.S	N.S	N.S	**	*	**
NV	**	N.S	*	**	N.S	N.S	**	N.S	N.S	N.S	N.S	N.S	*	**	**
DNV	**	N.S	*	**	N.S	N.S	**	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
YDN	-	-	*	-	-	N.S	-	-	N.S	-	-	N.S	-	-	N.S
YDV	-	-	**	-	-	**	-	-	N.S	-	-	N.S	-	-	**
YNV	-	-	N.S	-	-	*	-	-	**	-	-	N.S	-	-	**
YDNV	-	-	N.S	-	-	N.S	-	-	N.S	-	-	N.S	-	-	N.S

*,** significant at 0.05 and 0.01 levels of probability, respectively. N.S not significant

Means designated by the same letter within columns are not significantly different at the 5% level according to Duncan's multiple range test

Table (1): Continued.

Main effects and interactions	Ear diameter (cm)			No. of rows/ear			No. of kernels/row			100-grain weight			Grain yield ardab/fed.		
	1998	1999	Comb.	1998	1999	Comb.	1998	1999	Comb.	1998	1999	Comb.	1998	1999	Comb.
Density (D)															
20.000	5.1 a	4.7 a	4.90 a	13.5 a	12.8 b	13.15 a	44.6 a	46.1 a	45.34 a	42.4 a	45.5 a	43.83 a	29.78 c	2808 c	28.93 c
25.000	5.0 b	4.5 b	4.70 b	13.2 a	13.1 a	13.15 a	44.3 a	43.8 b	44.03 b	40.0 b	44.8 b	42.44 b	33.36 a	30.75 a	32.06 a
30.000	4.2 c	4.4 c	4.37 c	12.9 b	13.0 a	12.95 b	44.7 a	41.8 c	43.25 c	41.9 a	43.5 c	42.68 b	31.98 b	29.69 b	30.83 b
F-test	**	**	**	**	**	N.S	N.S.	**	**	**	**	**	**	**	**
Fertilization (N)															
80 kg N/fed.	4.6 b	4.4 b	4.53 c	12.90 a	12.68 c	12.79 c	43.1 c	41.9 c	42.51 c	41.1 b	43.3 c	42.23 c	31.62 b	29.15 b	30.38 b
120 kg N/fed.	4.8 a	4.6 a	4.69 b	13.02 a	13.09 b	13.05 b	44.6 b	44.1 b	44.50 b	41.0 b	44.3 b	42.6 1b	31.80 b	29.63 a	30.71 a
160 kg N/fed.	4.9 a	4.6 a	4.75 a	13.21 a	13.53 a	13.37 a	45.7 a	45.5 a	45.61 a	41.9 a	46.3 a	44.11 a	31.71 ab	29.47 a	30.73 a
F-test	**	**	**	N.S	**	**	**	**	**	**	**	**	*	**	**
Varieties (V)															
S.C. 10	4.9 a	4.5 c	4.68 b	12.2 c	12.0 e	12.12 f	47.7 a	47.6 a	47.52 a	43.3 b	49.4 a	46.38 a	35.30 a	34.67 a	34.99 a
S.C. 122	4.7 c	4.4 d	4.55 c	12.5 c	12.6 d	12.57 e	43.7 d	43.5 d	43.5 d	40.7 b	45.6 c	43.14 d	32.84 c	30.37 c	31.61 c
S.C. 123	4.8 b	4.6 b	4.68 b	13.7 b	13.1 b	13.39 c	46.8 b	38.6 e	38.6 e	38.1 e	42.9 e	40.48 e	28.97 g	27.92 f	28.45 e
S.C. 124	4.8 b	4.7 a	4.75 a	14.0 b	13.7 a	13.86 b	44.9 c	43.4 d	43.4 d	41.1 c	40.1 g	40.76 e	34.59 b	32.78 b	33.69 b
SC. 125	4.7 c	4.4 d	4.54 c	14.9 a	13.7 a	14.30 a	42.5 e	43.7 d	43.7 d	36.9 f	40.7 f	38.83 f	30.33 e	29.31 d	29.82 d
T.W.C. 310	4.7 c	4.5 c	4.63 b	12.3 c	13.1 b	12.69 e	44.5 c	46.3 b	46.3 b	44.2 a	44.7 d	44.43 c	29.83 f	27.26 c	28.55 e
T.W.C. 320	4.8 b	4.6 b	4.68 b	12.2 c	12.9 c	12.56 e	44.0 d	44.3 c	44.3 c	44.7 a	44.8 d	44.74 c	30.31 e	25.58 h	27.94 f
T.W.C. 321	4.8 b	4.7 a	4.76	12.6 c	13.6 a	13.09 d	42.6 e	43.5 d	43.5 d	41.5 c	48.7 b	45.13 b	31.49 d	28.17 e	29.83 d
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
Interaction															
YD	-	-	**	-	-	**	-	-	**	-	-	**	-	-	**
YN	-	-	*	-	-	**	-	-	N.S	-	-	**	-	-	**
DN	N.S	**	*	N.S	N.S	N.S	*	N.S	**	**	**	**	**	**	**
YV	-	-	**	-	-	**	-	-	**	-	-	**	-	-	**
DV	*	*	**	*	**	**	**	**	**	**	**	**	**	**	**
NV	N.S	**	**	N.S	**	N.S	**	**	**	**	**	**	N.S	N.S	N.S
DNV	N.S	**	N.S	N.S	**	N.S	**	N.S	**	**	**	**	N.S	N.S	N.S
YDN	-	-	**	-	-	N.S	-	-	N.S	-	-	**	-	-	*
YDV	-	-	N.S	-	-	**	-	-	**	-	-	**	-	-	N.S
YNV	-	-	N.S	-	-	N.S	-	-	**	-	-	**	-	-	**
YDNV	-	-	*	-	-	N.S	-	-	**	-	-	**	-	-	N.S

B. Effect of nitrogen fertilizer:

Data in Table (1) also indicated that the increasing nitrogen rate from 80 to 160 kg N/fed. increased the number of days to 50% silking. The high rate of nitrogen application increased highly significant plant and ear heights, ear length, ear diameter, number of rows/ear, number of kernels/row and 100-grain weight. However, no. of ears/plant slightly increased by increasing nitrogen fertilization. On the other hand, it was noticed that the effect of nitrogen rates did not differ from year to year. Concerning grain yield (ard/fed.), it increased as the nitrogen rate increased up to 120 kg nitrogen/fed. and then tended to decrease with the nitrogen rates of 160 kg in both years and combined data. These findings are in good agreement with what mentioned by Abou-Khadrah (1984), Katta *et al.* (1976), El-Agamy *et al.* (1986), Ahmed (1999) and Mohamed (1999).

c. Varietal differences:

The results in Table (1) indicated that maize hybrids showed significant differences for all the studied characters. Moreover, it is clear from the same table that the highest yielder variety was S.C. 10 (34.99 ard.) followed by S.C. 124 (33.69 ard.), S.C. 122 (31.61 ard.) and T.W.C. 321 (29.83 ard.) while the least yielded varieties were S.C. 123, T.W.C. 310 and T.W.C. 320. The higher yields of the best varieties were obtained from the higher nitrogen rates as well as the medium density of populations (160 kg N and 25,000 plants/fed.) The same trends were obtained for the studied yield components except that of ear diameter and number of rows/ear which tended to decrease by increasing plant density and decreasing nitrogen levels.

The crosses S.C. 123, S.C. 124 and T.W.C. 321 exhibited statistically the lowest number of days to 50% silking toward earliness. The highest plant and ear heights were obtained from S.C. 10 and T.W.C. 320.

It could be concluded that the varietal differences among the maize varieties might be attributed to the genetical differences among them and their interaction with the different environmental conditions such as density and fertilizer. These results are in harmony with Khalifa *et al.* (1984), Soliman *et al.* (1995), El-Zeir *et al.* (1998) and Ahmed (1999).

d. Interactions:

The interaction among the experimental factors, i.e. density (D), nitrogen levels (N) varieties (V) and years are shown in Table (1). As long the significant interaction between two or more treatment means that the response of a treatment in its different levels produces changes in the different levels of the other treatments. So, according to this definition all the possible interactions among the three factor presented in the experiment (D, N and V) as well as their interaction with the two years are presented in Table (1) for all the studied traits. For example when (D X V) interaction is significant it means that the varieties respond differently in their ranking from density to another. On the other hand, the non significant interaction between them means that the different levels of density did not affect the ranking performance of the varieties or on the other words the varieties respond similarly in the different plant density. For example and with regard to silking date trait in the combined data (Table 1), the first and second orders of interactions of the varieties by years, density and nitrogen as well as their combinations were significant and this means that the varieties responded differently with the different levels of D, N and their combinations in the two years except that of YNV interaction which showed no statistical significant. Also, the YDNV show no significant interaction, so, the later two interactions could be negligible. However, all the possible interactions for all the traits as well as their significant tests are presented in Table (1) and by similar way all the interaction present in the Table can be interpreted.

2. Phenotypic and genotypic stability:

The data in Table (2) indicated that the overall means grain yield of the eight maize hybrids under study varied among the 18 environments with a range from 27.49 ard./fed. for the environments No. 10 ($Y_2D_1N_1$) to 33.45 ardab/fed. for the environment No. 6 ($Y_1D_2N_3$).

The wide range of environmental index (I) for grain yield –3.12 to 2.84 ardab indicated significant variation between the environments. The phenotypic index (I) covered a wide range and displayed a good distribution within this range. Therefore, the assumption for stability analysis is fulfilled (Russell and Pirior, 1975 and Backer and Leon, 1988). Similar results were observed with respect to S.C. 122, S.C. 124, T.W.C. 310, T.W.C. 320 and T.W.C. 321 which considered as the most desired varieties occupies the most areas cultivated by high productive maize varieties. However, the T.W.C. 320 had the widest range of environmental index (-3.22 to 7.44), while the S.C. 125 had the closest one (-1.54 to 1.18) as shown in Table (2).

The wide and moderate ranges of the indices of the varieties responded in their yielding ability differently with the different environmental conditions. In other words, each variety responded well in some conditions. Similar results were obtained by Shalaby (1996) and Ahmed (1999).

The environmental indices were mostly negative for all environments which contain low plant density (20,000 plants/fed.) in both seasons and the higher plant density (30,000 plants/fed.) only in season 1999.

However, the second level of plant density (25.000 plants/fed.) showed few number of negative indices. This would indicate that low and/or high plant density were a less favourable conditions for grain yield production of maize. So, the suitable plant density was 25,000 plant/fed (Table 2) with the second dose of N fertilization (120 kg N/fed) followed by the third dose of N (160 kg N/fed) and finally by the first dose of N fertilization (80 kg N/fed).

These results agreed with Younis *et al.* (1994) who studied the response of three maize single crosses to four plant densities (24, 27, 30 and 34 thousand plant/fed). They found that the highest grain yield was obtained with 24 and 27 thousand plant/fed. Also, Soliman *et al.* (1995) studied the response of four hybrids to three plant densities (20, 25 and 30 thousand plant/fed) and they found that plant densities had significant effects on grain yield per fed. which increased by increasing plant densities from 20 to 30 thousand plant/fed. In the same way Al-Agamy *et al.* (1986) studied the response of some maize varieties and hybrid to three plant densities and three nitrogen levels. He reported that the highest grain yield was obtained at 24,000 plant/fed and at the application of 120 kg N/fed.

Table (2): Means (X) and environmental indices (I) for grain yield in ardab/feddan of 18 environments.

Environments		S.C.10		S.C.122		S.C.123		S.C.124		S.C.125		T.W.C. 310		T.W.C.320		T.W.C.321		G-Mean	
		X	I	X	I	X	I	X	I	X	I	X	I	X	I	X	I	X	I
1	$Y_1D_1N_1$	32.81	-2.17	29.73	-1.88	27.30	-1.14	32.56	-1.12	29.55	-0.27	27.31	-1.23	28.04	0.10	29.71	-0.12	29.63	-0.98
2	$Y_1D_1N_2$	33.21	-1.77	29.97	-1.64	27.36	-1.08	32.63	-1.05	26.69	-0.13	27.34	-1.20	28.32	0.38	29.82	-0.01	29.79	-0.82
3	$Y_1D_1N_3$	33.51	-1.47	30.10	-1.51	27.37	-1.07	32.89	-0.79	27.72	-0.10	27.38	-1.16	28.50	0.56	29.93	0.10	29.93	-0.68
4	$Y_1D_2N_1$	37.81	2.83	35.08	3.47	29.80	1.36	36.70	3.02	30.47	0.65	30.22	1.68	31.59	3.65	34.33	4.50	33.25	2.64
5	$Y_1D_2N_2$	37.97	2.99	35.12	3.51	29.94	1.50	36.76	3.08	30.70	0.88	30.24	1.70	32.00	4.06	34.37	4.54	33.39	2.78
6	$Y_1D_2N_3$	38.04	3.06	35.16	3.55	30.07	1.63	36.78	3.10	30.76	0.94	30.36	1.82	32.01	4.07	34.40	4.57	33.45	2.84
7	$Y_1D_3N_1$	34.80	-0.18	33.54	1.93	29.70	1.26	34.32	0.64	30.63	0.81	31.74	3.20	30.77	2.83	30.31	0.48	31.98	1.37
8	$Y_1D_3N_2$	35.07	0.09	33.67	2.06	29.79	1.35	34.64	0.96	31.00	1.18	32.27	3.73	30.84	2.90	30.37	0.54	32.21	1.60
9	$Y_1D_3N_3$	34.43	-0.55	33.21	1.60	29.39	0.95	34.00	0.32	30.40	0.58	31.63	3.09	30.71	2.77	30.19	0.36	31.75	1.14
10	$Y_2D_1N_1$	31.81	-3.17	28.32	-3.29	25.39	-3.05	30.26	-3.42	28.28	-1.54	25.29	-3.25	24.72	-3.22	25.81	-4.02	27.49	-3.12
11	$Y_2D_1N_2$	32.41	-2.57	29.11	-2.50	25.89	-2.55	30.76	-2.92	28.75	-1.07	27.26	-1.28	25.22	-2.72	26.28	-3.55	28.21	-2.40
12	$Y_2D_1N_3$	32.88	-2.10	29.94	-1.67	26.39	-2.05	31.26	-2.42	29.24	-0.58	26.10	-2.44	25.72	-2.22	26.78	-3.05	28.54	-2.07
13	$Y_2D_2N_1$	35.60	0.62	30.79	-0.82	28.53	0.09	34.20	0.52	30.12	0.30	28.04	-0.50	25.82	-2.12	29.07	-0.76	30.27	-0.34
14	$Y_2D_2N_2$	36.22	1.24	31.51	-0.09	29.33	0.89	34.71	1.03	30.37	0.55	28.32	-0.22	26.06	-1.91	29.47	-0.36	30.75	0.14
15	$Y_2D_2N_3$	37.08	2.10	32.45	0.84	30.18	1.74	34.81	1.13	30.74	0.92	28.50	-0.04	26.28	-1.66	29.86	0.03	31.24	0.63
6	$Y_2D_3N_1$	35.18	0.20	30.41	-1.20	28.50	0.06	33.07	-0.61	28.76	-1.06	27.23	-1.31	25.46	-0.48	28.75	-1.08	29.67	0.94
17	$Y_2D_3N_2$	36.12	1.14	30.53	-1.08	28.63	0.19	33.29	-0.39	28.82	-1.00	27.33	-1.21	25.53	-2.41	29.24	-0.59	29.94	-0.67
18	$Y_2D_3N_3$	34.78	-0.20	30.28	-1.33	28.41	-0.03	32.67	-1.01	28.70	-1.12	27.12	-1.42	35.38	7.44	28.28	-1.55	29.45	-1.16
Overall mean		34.98		31.61		28.44		33.68		29.82		28.54		27.94		29.83		30.61	

Y_1 = Summer season 1998 and Y_2 summer season 1999

D_1 = 20.000 plant/fed. D_2 = 25.000 plant/fed. D_3 = 30.000 plant/fed.

N_1 = 80 unit N/fed. N_2 = 120 unit N/fed. N_3 = 160 unit N/fed.

Analysis of variance for phenotypic stability (Table 3) revealed that, highly significant varieties x environment interaction was obtained for grain yield which encourages maize breeders to develop high yielding and more uniform hybrids under varied environmental conditions.

Table (3): Analysis of variance for stability for grain yield (ard./fad.) of eight maize hybrids evaluated under different environmental conditions.

S.O.V	D.F.	M.S
Varieties	7	120.55**
Environmental + (varieties x envir.)	136	4.11**
Environment (Linear)	1	423.63**
Varieties x Environment (Linear)	7	4.85*
Pooled deviation	128	0.803
Variety-1	16	1.294**
Variety-2	16	0.239**
Variety-3	16	0.475**
Variety-4	16	0.316**
Variety-5	16	0.213**
Variety-6	16	1.147**
Variety-7	16	1.882**
Variety-8	16	0.856**
Pooled error	288	0.062

***, ** significant and high significant, respectively.**

The linear effect of environment was highly significant. This means that a large portion of the interaction of varieties x environment was accounted by the linear regression on the environmental means. The magnitude of nonlinear components was considerably smaller than that of linear components. These results are in accordance and El Sheikh and El-Shamarka (1994), Shalaby (1996) and Abd El-Hamid (2001). They found that the linear component was more important than the nonlinear one.

Eberhart and Russel (1966) defined the desired variety with that of a high mean performance (X), unit regression coefficient (b = 1_ and deviation from regression as smaller as possible (S^2d = o). Considering the three criteria of the ideal cultivar recognized by Eberhart and Russel (1966) single cross 122 and S.C. 124 would be the most stable varieties with respect to grain yield because they have values of b around unity (b_{122} = 1.2, and b_{124} = 1.03) with small and insignificant deviations from regression (0.178) and (0.255), respectively (Table 4). However, all varieties which had significant regression coefficient (b > 1 or < -1) as well as deviations were considered to be unstable across all environments. In spite of some of the studied varieties exhibited the highest yielding potentiality, which produced yield, they were unstable over a wide range of environments. This instability can be overlooked by excess improvement of the stability of the inbred lines parents through the evaluation of these inbred liens under a wide range of environmental conditions.

Pinthus (1973) proposed the use of coefficient of determination (r^2) instead of deviation mean squares to estimate stability of genotypes, because (r^2) is relative measure of association between the actual mean and the predicted mean. The (r^2) values ranged from 0.68 to 0.95 for grain yield ardab/fed. As shown in Table (4) S.C. 122, S.C. 124 and T.W.C. 321 would be the most stable varieties with respect to grain yield, since it had high values for coefficient of determination.

The analysis of variance for genotypic stability are shown in Table (3). Partitioning of the varieties x environments interactions, into linear responses and deviations from Linearity showed that both components were highly significant. Estimates of genotypic stability parameters α_1, λ_i of studied varieties are shown in Table 3.

In addition, the distribution of these varieties with respect to their α_1 and λ_i values are presented in Table 4 and Fig. 1. Data revealed that the varieties varied in their estimation of α_i and λ_i parameters. With regard to α_i = zero and λ_I = 1 according to Tai's model (Tai, 1971), it could be noticed that the lowest values near to zero were obtained by T.W.C. 310 (-0.002) but its λ was 21.28 (a large value far from 1). The second lower value of α was recorded by S.C. 124 (0.050) which was near zero and its λ was 5.58 which was the nearest to one. The most favourable balanced values for both α=0 and λ=1 was obtained from S.C.124. However, this hybrid was the most stable relative to the other hybrids, where they failed to produce balanced values between α=0 and λ=1. This result was appeared in figure (1) which indicated that the nearest hybrid to the average stability was S.C.124 which had fallen in the acceptable area (P-=0.90) in figure (1). T.W.C. 320 was the worst with respect to its α_1 (0.358) and λ_I (21.52). These results suggested that the best performing high yielding genotypes were not necessarily the best stable ones. According to Tai's model in the present investigation S.C.124 is most desirable hybrid variety (Table 4 and Fig. 1) because its mean yield is high, its α_i value is zero and its deviation from linearity is small, (5.58) which indicating its yield stability

Table (4): Estimates of stability parameters for grain yield for some hybrids under different environmental conditions.

Varieties	Mean (X)	$B_1 \pm$ S.E.	S^2di	α_i	λ_i	b_{i-1}	Dev. MS / MS E/R	Coefficient of determination (r^2)
S.C.10	34.98	0.914±0.155	1.233**	-0.076	27.84	-0.075	26.08	0.68
S.C. 122	31.61	1.205**±0.066	0.178	0.217	4.40	0.215	3.29	0.95
S.C.123	28.44	0.760*±0.0094	0.414**	-0.231	7.94	-0.230	7.37	0.80
S.C. 124	33.68	1.039±0.076	0.255	0.050	5.58	0.049	5.19	0.92
S.C. 125	29.82	0.424**±0.063	0.151	-0.560	4.09	-0.566	3.94	0.74
T.W.C. 310	28.54	0.989±0.146	1.085**	-0.002	21.28	-0.002	19.74	0.74
T.W.C. 320	27.94	1.317±0.187	0.820**	0.358	21.52	0.356	20.80	0.76
T.W.C. 321	29.83	1.306*±0.126	0.795**	0.317	16.50	0.316	14.46	0.87
Overall mean	30.61							

*, ** significant and high significant, respectively.

λ_0=1 P = 0.90

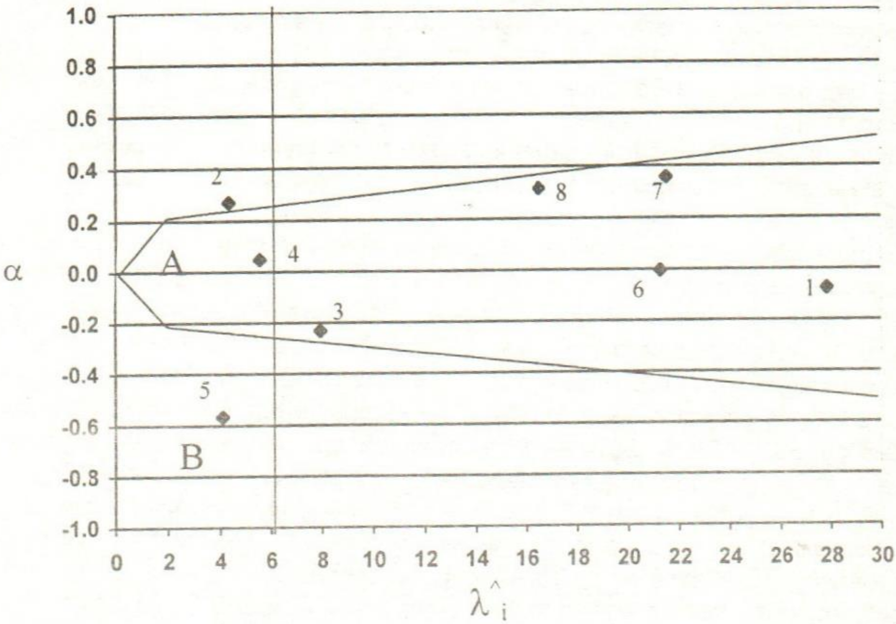

Fig. (1): Distribution of stability parameters of eight maize hybrids in 18 environments.
(A) Region of average stability
(B) Region of above average stability.

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تقييم بعض هجن الذره الشامية تحت ظـــروف بيئيـــة مختلفـــة وتحليـــل الثبـــات المظهرى والوراثى لصفة المحصول

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أجرى هذا البحث بالمزرعة البحثية لكلية الزراعة بكفرالشيخ ــ جامعة طنطا خلال الموسمين ١٩٩٨م ، ١٩٩٩م بهدف تقييم ثمانية هجن من الذره الشامية تحت مســتويات مختلفـــة مـــن الكثافة النباتية والتسميد الأزوتى وتقدير الثبات المظهرى والوراثى تحت ظروف بيئية مختلفة. وقد تم تحليل كل تجربة على حده فى كل من عامى ١٩٩٨ ، ١٩٩٩ ثم حللت التجربتين معـا فى تحليل التجارب المجمعة Combined analysis بالنسبة لصفة المحصـــــول وبعـض الصفات الزراعية الأخرى ، كما تم تحليل بيانات محصول الحبوب للفدان بطريقة أبرهـــارت وراسل (١٩٦٦م) ، تاى (١٩٧١م) وبنسس (١٩٧٣م) لتقدير الثبـــات المظـــهرى والوراثـــى لمحصول الحبوب.

ويمكن تلخيص النتائج فى النقاط التالية:

١) أدت زيادة الكثافة النباتية حتى ٣٠ ألف نبات للفدان إلى زيادة عدد الأيام من الزراعة وحتـــى ظهور ٥٠% من الحريرة وكذلك إزداد ارتفاع النبات والكوز ، فى حين أن عـــدد الكيزان للنبات لم تتأثر معنويا بهذه الزيادة كما أدى زيادة الكثافة النباتية إلى نقص معنوى فى صفـات طول وقطر الكوز وعدد الصفوف للكوز وعدد الحبوب للصف ووزن المائه حبه كما أعطـت الكثافة النباتية ٢٥,٠٠٠ نبات للفدان أعلى محصول حبوب للفدان.

٢) أخرت زيادة معدلات التسميد الأزوتى من ٨٠-١٦٠ وحده/فدان من تزهير النباتات فى حيـن إزداد معنويا ارتفاع النبات والكوز وطول وقطر الكوز وعدد الصفوف للكوز وعدد الحبـــوب للصف ووزن المائه حبه.

٣) أعطى الهجين الفردى ١٠ أعلى محصول ٣٤,٩٩ أردب للفدان وتلاه الـــهجين فـــردى ١٢٤ ٣٣,٦٩ أردب للفدان ثم الهجين الفردى ١٢٢ والذى أعطى ٣١,٦١ أردب للفدان ــ بينما كان أقل الهجن محصولا الهجين الفردى ١٢٣ (٢٨,٤٥ أردب للفـــدان والـــهجين الثلاثـــى ٣٢٠ (٢٧,٩٤ أردب للفدان).

٤) أظهرت النتائج أن الهجن فردى ١٢٢ ، فردى ١٢٤ هى الأصناف الهجن الأكثر ثباتا تحـــت الظروف البئية المختلفة حيث أن قيم (b_i) لا تختلف معنويا عن الواحد الصحيح كمـــا كـــان مربع الأنحراف عن خط الإنحدار S^2d_i غير معنوى.

٥) أظهر تحليل الثبات الوراثى بأن تباين الإنحدار الخطى والإنحراف عن هذا الإنحـــدار عـــالى المعنوية وكان توزيع الهجن تبعا لقيم (α_1, λ_i) توضح أن الأصناف كانت غير ثابتة وراثيـــا تحت الظروف البيئية المدروسة. وكان الهجين الفردى ١٢٤ أقرب هذه الهجن لمتوسط الثبات الوراثى أما الهجين الثلاثى ٣٢٠ فكان أقل هذه الهجن لمتوسط الثبات الوراثى.

٦) أظهر الهجينان فردى ١٢٢ وفردى ١٢٤ أعلى قيمة لمعامل التحديـــد ٠,٩٥ ، ٠,٩٢ علـــى الترتيب مما يدل على أنها الهجن الأكثر ثباتا تحت الظروف البيئية المختلفة.