Stability Parameters for Grain Yield and Other Agronomic Traits of Promising White Maize Hybrids

M.A.A. Hassan
Maize Research Department, Field Crops Research Institute, ARC, Egypt

Received on: 18/3/2015 *Accepted: 16/4/2015*

ABSTRACT

Ten promising single crosses with two check hybrids SC10 and SC128 were evaluated at five different locations in Egypt i.e. Sakha, Gemmeza, Sids, Nubaria and Mallawy Agricultural Research Stations in 2012 summer season. The differences among locations were highly significant for all studied traits as well as the differences among hybrids and their interaction with location were significant or highly significant for all studied traits. Linear and non-linear components were significant for all traits except for; variance linear for days to 50% silking. A stable cross must be had desirable mean value, low values for; variance, coefficient of variability% and ecovalence, regression coefficient close to unity (b_i=1) and deviation from regression as small as possible (S^2d_i=0) also coefficient of determination more than 80%. Therefore, SCSK146, SCSK151, SCSK154 were stable for earliness, SCSK150 and SCSK153 were stable for short plant height and two crosses SCSK146 and SCSK149 were stable for grain yield in addition to not significant than two checks for grain yield.

Key words: ***maize, stability, genotype x environment interaction*.**

INTRODUCTION

Maize (*Zea mays* L.) is the crop which the most wide spread in the different environment in the world, which growing in several different environments. Maize breeders should be searched for identify the desirable hybrids which have high yielding and stable across the different environmental conditions. Genotype x environment (GE) interaction play an important breeding role in determining yield performance. The interactions of genotypes and locations with year are unpredictable and are considered random due to seasonal variations making it difficult to predict hybrid performance from season to anthor (Kang and Gorman, 1989). Multi environments trails play an important role in selecting the best cultivars to be used in future years at different locations and in assessing cultivars stability across environment before its commercial release (Vargas *et al*., 1999). To reduce the magnitude of GE within a region, the first is subdivision or stratification of a heterogenous area into smaller, more homogenous sub-regions, with breeding programs aimed at developing cultivars for specific sub-region. However, even with this refinement, the level of interaction can remain high because breeding area does not reduce the interaction of cultivars with locations on years. The second strategy for reducing GE interaction involves selecting cultivars with better stability across a wide range of environments in order to better predict behavior (Eberhart and Ressell, 1966 and Tai, 1971). All methods of stability require a large number of testing environment, Hallauer and Miranda (1981) and Gauch and Zobel (1996) reported that if the number of new genotypes to be evaluated were large, five different environments would be adequate to determine different stability parameters and/or optimize the amount of GE interaction. Soliman (2006) found that GE was highly significant for days to 50% silking and grain yield, El-Sherbieny *et al*. (2008) and Mosa *et al*. (2012) found that GE and their partition E (linear), GE (linear) and pooled deviations (non-linear) were significant for grain yield. Tollenear and Lee (2002) reported that high yielding maize hybrids can differ in yield stability, while, the genotype may be considered to be stable if it has small variance (S^2) across environments, if its response to environment is parallel to mean response of all genotypes in the trial and if the deviation from regression is small (Line *et al*., 1986), in this way, Eberhart and Russell (1966) defined the stable genotypes which have high mean ($\overline{X}$), regression coefficient close to unity (b_i =1) and the deviation from regression is as small as possible (S^2_{di}=0). Carvalho *et al*. (2000) stated that the hybrids that gave coefficient of determination (R^2) more than 80% had good production stability in all of the environments. Nguyen *et al*. (1980) found that the stability of the genotypes for grain yield was inversely proportional with equivalence (W_i^2). Elto and Hallauer (1980) stated that the simple correlation between ($\overline{X}$) with (b_i) and (S^2_{di}) were highly significant. It seems that selection of hybrids for high mean yield across environments should be emphasized first and the relative stability of the elite hybrids across environments should be determined, as well as El-Sheikh (1999) found that the

Spearman's rank correlation among stability parameters i.e. S^2, CV, S^2_{di} and W^2_i were positive and highly significant so that could be depended on any parameters from them.

The objectives of the present investigation were to identify the yielding ability of new white hybrids compare to check hybrids and identify the stable superior hybrids with using different stability parameters.

MATERIALS AND METHODS

Ten promising maize hybrids i.e. SCSK145, SCSK146, SCSK147, SCSK148, SCSK149, SCSK150, SCSK151, SCSK152, SCSK153 and SCSK154, were produced in maize breeding program at Sakha Agricutlural Research Station in 2011 season and two check hybrids SC10, SC128 were evaluated at five environments (locations) in Egypt i.e. Sakha (SK), Gemmeza (Gm), Sids (Sd), Nubaria (Nub.) and Mallawy (Mal) Agricultural Research Stations in 2012 summer growing season.

In each trial, hybrids were grown in randomized complete block design with four replications. Plot size consisted of four rows, 6 m long, and 80 cm apart. The seeds were planted in hills spaced at 25 cm along the row at the rate of two kernels per hill, later thinned to one plant per hill. All agricultural practices were applied through the growing season as recommended for maize planting. Data were recorded on days to 50% silking (days), plant height (cm) and grain yield (ardab/fed.) (one ardab = 140 kg adjusted at 15.5% grain moisture and one feddan = 4200 m^2).

The statistical analysis for these three traits was done for each location according to Steel and Torrie (1980). Results of Bartlett (1937) test indicated that the homogeneity of error mean squares of five locations or environments was not significant, therefore, the combined analysis of variance over environment was done. Several approaches were used to calculate stability parameters. This study used six parameters to estimate the stability hybrid as followed. The six stability statistical for traits across environments were performed as followed:

1. Calculation of hybrid variance across different environments (S^2) (Lin *et al*., 1986).
2. Coefficient of variability (CV%) of hybrid (Francis and Kanneberg, 1978).
3. Ecovalence sum of squares for each hybrid (W^2_i) (Wricke, 1962).

$$Wi^2 = \sum_i (\bar{x}_{ij} - \bar{x}_{i.} - \bar{x}_{.j} + \bar{x}..)$$

Where:

Wi^2 = Ecovalence sum of squares for hybrid i.

Σ_i = Sum values for i hybrids in j^{th} environments.

$\bar{X}_{ij}$ = Mean of i^{th} hybrid at the j^{th} environment.

$\bar{X}_{i.}$ = Mean of i^{th} hybrid across environments.

$\bar{X}_{.j}$ = Mean of all hybrids at j^{th} environments

$\bar{X}_{..}$ = The grand mean across all hybrids and environments.

4. Estimates of regression coefficient (bi) for each hybrid and
5. Estimates of deviation from regression (S^2_{di}) for each hybrid (Eberhart and Russel, 1966) used the following model to study the stability of genotypes under different environments.

$Y_{ij} = m + b_i I_j + S_{ij}$

Where:

Y_{ij} =Mean of the genotype at j^{th} environment.

m =Mean of all the genotypes (hybrids) overall environments.

b_i =The regression coefficient of the j^{th} genotype.

I_j =The environmental index, calculated as the mean of all genotypes at the environment minus the grand mean where : $I_j = \bar{x}_{.j} - \bar{x}_{..}$

S_{ij} =Deviation from the regression of the i^{th} variety at the j^{th} environment.

$$bi = \sum(\bar{x}_{ij} - \bar{x}_{i.})(\bar{x}_{.j} - \bar{x}_{..}) / \sum(\bar{x}_{.j} - \bar{x}_{..})$$

$$S^2_{di} = \frac{1}{q-2}\sum(x_{ij} - x_{i.})^2 - bi\sum(\bar{x}_{.j} - \bar{x}_{..})^2$$

Where:

bi = Regression coefficient for i^{th} hybrid.

S^2_{di} = division from regression for i^{th} hybrid.

q = number of environments.

6. Estimates coefficient of determination (Pinthus, 1973):

$$R_i^2 = \frac{b_i \sum \bar{x}_{ij} I_{.j}}{\sum_i (\bar{x}_{ij} - \bar{x}_{i.})^2}$$

Where:

R^2_i = Determination coefficient of j^{th} genotype.

RESULTS AND DISCUSSION

The combined analysis of variance for three traits over five environments are presented in Table (1). The differences among environments (locations) were highly significant for all studied traits, this refers that the five locations were differ in environmental conditions. The mean squares due to hybrids were highly significant for all studied traits, meaning that great differences among them for all traits. Also, hybrids x environments interaction was significant or highly significant for the three traits, meaning that the behaviour of these hybrids differed from one location to another in this respect, Shalaby (1996), Mosa *et al*. (2009), and Khalil (2013) obtained the same results.

Estimates of mean and environmental index for the three traits are presented in Table 2, Nubaria location gave the lowest values for both mean and environmental index for days to 50% silking and plant height traits, Gemmeza location for grain yield, indicating that Nubaria location considered stress environment for days to 50% silking and plant height as well as Gemmeza location for grain yield. On the other hand, the suitable environment was Mallawy location which gave the highest values for grain yield (39.182 ardab/fed) and their environmental index (8.731), indicating that the mean of the tested genotypes varied from one location to another. Frey (1964) and Frey and Maldonado (1967) defined the stressed environment as the one in which mean for a certain attribute is low and that stress for one trait does not mean stress for all traits under study.

Mean performance of the ten promising single crosses and the two checks across five environments for the three traits are shown in Table (3). For days to 50% silking, the crosses ranged from 58.35 days for check SC128 to 63.1 days for SCSK152. Eight crosses i.e. SCSK146, SCSK147, SCSK148, SCSK149, SCSK150, SCSK151, SCSK153 and SCSK154 were decreased significantly than check SC10. For plant height, the crosses ranged from 261.65 for SC128 to 295.9 cm for SC10. Eight promising crosses i.e. SCSK145, SCSK146, SCSK148, SCSK149, SCSK150, SCSK151, SCSK153 and SCSK154 were significantly shorter plants compared to check SC10. For grain yield, crosses ranged from 25.67 ardab/fed. for SCSK152 to 32.23 ardab/fed. for SCSK147. Four promising crosses i.e. SCSK145 (31.44 ardab/fed.), SCSK147 (32.23 ardab/fed.), SCSK149 (32.21 ardab/fed.) and SCSK150 (31.69 ardab/fed.) were significant outlyielded the check SC10 (29.78 ardab/fed.) but not significant than check SC128.

The stability analysis conducted for five environments for three traits in Table 4, revealed that the hybrids differ significantly for all traits.

Table 1: Combined analysis of variance for three agronomic traits over five environments.

S.O.V.	d.f	Days to 50% silking	Plant height	Grain yield
Environments (E)	4	468.652**	41769.267**	1669.34**
Rep/E	15	3.897	477.48	10.59
Hybrids (H)	11	39.212**	1980.87**	67.10**
H x E	44	1.916*	331.44**	24.74**
Error	165	1.321	136.06	6.86

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

Table 2: Average number of days to 50% silking, plant height and grain yield (ard/fed.) resulted in five different locations and their environmental index

Traits / Locations	Days to 50% silking		Plant height (cm)		Grain yield (ard/fed.)	
	Average	Env. index	Average	Env. index	Average	Env. index
Sakha	61.875	0.658	329.369	47.881	33.55	3.099
Gemmeza	62.083	0.866	268.250	-13.238	25.430	-5.021
Sids	63.813	2.596	287.292	5.804	28.609	-1.896
Nubaria	55.792	-5.425	252.375	-29.113	25.486	-4.965
Mallawy	62.521	1.304	270.125	-11.363	39.182	8.731
The mean	61.22	0.00	281.480	0.00	30.45	0.00

* Env. index: Environmental index.

Table 3: Mean of 12 hybrids across five environments

Hybrids	Days to 50% silking	Plant height (cm)	Grain yield (ard/fed.)
SCSK145	62.50	285.90	31.44
SCSK146	61.15	278.00	30.95
SCSK147	61.20	290.50	32.23
SCSK148	62.15	280.30	29.44
SCSK149	62.10	287.05	32.21
SCSK150	60.50	277.20	31.69
SCSK151	60.35	282.65	30.02
SCSK152	63.10	293.95	25.07
SCSK153	60.40	281.35	30.59
SCSK154	59.90	275.40	30.12
SC-10	62.90	295.90	29.78
SC-128	58.35	261.65	32.20
$\bar{X}$	61.22	281.48	30.45
L.S.D. 0.05	0.712	7.22	1.62
C.V%	1.87	4.14	8.60

Table 4: Stability analysis of variance for 12 hybrids evaluated at five different locations.

S.O.V.	d.f.	Days to 50% silking	Plant height	Grain yield
Hybrids	11	9.80**	495.21**	16.77**
E +(H x E)	48	10.20**	946.14**	40.44**
Linear (L)	1	468.652**	41769.267**	1669.34**
H x L (Linear)	11	0.249	105.76**	6.58**
Pooled division	36	0.508*	68.81*	5.54**
SCSK145	3	1.24*	19.92	2.27
SCSK146	3	0.43	98.82	0.64
SCSK147	3	0.47	78.29	10.45**
SCSK148	3	0.42	51.62	4.16
SCSK149	3	0.20	38.68	2.10
SCSK150	3	0.56	50.06	3.91
SCSK151	3	0.17	27.98	8.03**
SCSK152	3	0.74	124.55*	10.25**
SCSK153	3	0.26	36.50	3.29
SCSK154	3	0.18	24.70	2.92
SC-10	3	0.25	130.12*	10.24**
SC-128	3	1.13*	144.53*	8.25**
Pooled error	180	0.383	41.12	1.79

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

The hybrids x environments interaction was further partitioned into (H x L) linear and non-linear (pooled deviation) components. Mean squares for the first component (linear) and the second component (pooled deviation) were tested against pooled error mean squares. The linear and non-linear components were significant or highly significant for all traits, except for linear in days to 50% silking, indicating that the linear and non-linear components shared with hybrids x locations interaction.

These results supports the findings of Ragheb *et al.* (1993), Worku *et al.* (2001), Shehata *et al.* (2003) and El-Sherbieny *et al.* (2008). Linear component was not significant when tested against non-linear, indicating that the equal importance of both linear and non-linear interaction for all traits. Similar result was obtained by Worku *et al.* (2001) and Mosa *et al.* (2011).

Stability parameters estimates of 12 single crosses with respect to all traits are presented in Tables (5, 6, 7). According to the definition of many researchers around the world, a stable cross would have approximately: High mean performance ($\overline{X}$) compared to grand mean, regression coefficient equal to unity (bi = 1) or not significant, small deviation from regression (S^2_{di} =0) or not significant (Eberhart and Russel, 1966), coefficient of determination (R^2) more than 80% (Pinthus, 1973), the variance of across over environment (S^2) is low (Lin *et al.*, 1986), Coefficient of variability (C.V%) is low (Francis and Kannenberg, 1978) and ecovalence of cross over environment (W_i^2) is low (Wricke, 1962).

Therefore, three crosses; SCSK146, SCSK151 and SCSK154 in Table 5, would be the most stable hybrids which earlier than the grand mean (61.22 days), with small for variance (S^2) and coefficient of variability (CV%) less than 9.44 and 5.19%, respectively, and low equivalence w_i^2 (1.25, 0.62 and 0.58, respectively) than mean (1.81), values of bi around unity and not significant (0.95, 0.92 and 0.93, respectively), with small deviation from regression S^2_{di} and not significant (0.047, -0.123 and -0.203, respectively). Also, these hybrids have high coefficient of determination R^2 (96.48, 98.48, and 98.39, respectively).

The best hybrids for stability parameters for plant height (Table 6), were SCSK150 and SCSK153 which have low mean, low S^2, low CV% and low W_i^2 compared to mean of all crosses, not significant for b_i and S^2_{di} and high values for R^2.

Two crosses; SCSK146 and SCSK149 were stable for all stability parameters for grain yield (Table 7), because it have high grain yield (30.94 and 32.2 ard/fed., respectively), than grand mean (30.45 ard/fed.), low values for S^2 (25.05 and 26.6, respectively), CV% (16.18 and 16.02, respectively) and low W_i^2 (5.04 and 9.27, respectively) compared to mean values for S^2, CV% and W_i^2 (40.23, 20.80 and 21.3, respectively) and not significant for both bi (0.84 and 0.85, respectively) and S^2_{di} (-1.15 and 0.31, respectively) and high value for R^2 (98.07 and 94.06%) greater than 80%. These two crosses could be used in maize breeding programs in addition to not significant for grain yield compared to two checks SC10 (29.78 ard/fed.) and SC128 (32.26 ard/fed.)

Table 5: Stability parameters of 12 hybrids for days to 50% silking across five different locations.

Hybrid	$\overline{X}$	S^2	CV	w_i^2	bi	S^2_{di}	R^2%
SCSK145	62.50	8.66	4.71	4.29	0.88*	0.557*	89.19
SCSK146	61.15	9.18	4.95	1.25	0.95	0.047	96.48
SCSK147	61.20	10.58	5.31	1.32	1.02	0.087	96.61
SCSK148	62.15	11.39	5.52	1.32	1.06	0.037	97.16
SCSK149	62.10	12.83	5.77	1.69	1.13*	-0.190	98.85
SCSK150	60.50	10.81	5.43	1.60	1.03	0.177	96.06
SCSK151	60.35	8.31	4.77	0.62	0.92	-0.213	98.48
SCSK152	63.10	13.68	5.86	3.09	1.15*	0.357	95.90
SCSK153	60.40	10.64	5.40	0.73	1.03	-0.123	98.12
SCSK154	59.90	8.73	4.93	0.58	0.93	-0.203	98.39
SC-10	62.90	6.68	4.11	1.97	0.81*	-0.133	97.11
SC-128	58.35	10.83	5.63	3.28	1.01	0.747*	92.17
Mean	61.22	9.44	5.19	1.81	1.00		

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

Table 6: Stability parameters of 12 hybrids for plant height across five different locations.

Hybrids	$\overline{X}$	S^2	CV	w_i^2	bi	S^2_{di}	R^2%
SCSK145	285.9	1041.22	11.28	68.84	1.08	-21.2	98.56
SCSK146	278.0	640.18	9.10	410.69	0.80*	57.7	88.42
SCSK147	290.5	1241.06	12.12	313.69	1.16*	37.17	95.26
SCSK148	280.3	1014.07	11.36	150.52	1.05	10.50	96.18
SCSK149	287.0	1219.49	12.16	199.53	1.17*	-2.44	97.62
SCSK150	277.2	827.06	10.37	122.09	0.95	8.94	95.45
SCSK151	282.6	1142.72	11.96	131.02	1.13	-13.14	98.16
SCSK152	293.9	1056.39	11.05	365.84	1.05	83.43*	91.15
SCSK153	281.3	940.07	10.89	96.71	1.02	-4.62	97.11
SCSK154	275.4	499.02	8.11	289.46	0.74*	-16.42	96.27
SC-10	295.9	1313.37	12.24	471.99	1.18*	89.00*	92.56
SC-128	261.6	409.83	7.73	1007.61	0.58*	103.41*	73.54
Mean	281.48	946.14	10.93	302.33	1.0		

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

Table 7: Stability parameters of 12 hybrids for grain yield across five different locations.

Hybrids	$\overline{X}$	S^2	CV	w_i^2	bi	S^2_{di}	R^2%
SCSK145	31.44	86.69	29.61	49.94	1.56*	0.48	98.03
SCSK146	30.94	25.07	16.18	5.04	0.84	-1.15	98.07
SCSK147	32.23	50.15	21.97	32.97	1.10	8.66**	84.36
SCSK148	29.43	19.30	14.92	26.32	0.68*	2.37	83.82
SCSK149	32.20	26.60	16.02	9.27	0.85	0.31	94.06
SCSK150	31.68	51.55	22.66	16.11	1.18	2.12	94.30
SCSK151	30.02	44.66	22.26	23.15	1.05	6.24**	86.51
SCSK152	25.07	30.53	22.03	35.53	0.81	8.46**	74.80
SCSK153	30.59	43.22	21.49	9.96	1.08	1.50	94.28
SCSK154	30.12	37.88	20.43	7.75	1.01	1.13	94.21
SC-10	29.78	33.09	19.31	15.52	0.85	8.45**	76.79
SC-128	32.26	36.53	18.73	24.09	0.93	6.46**	83.06
Mean	30.45	40.43	20.80	21.30	1.0		

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

REFERENCES

Bartlett, M.S. (**1937**). Properties of sufficiency and statistical tests. prod. Roy. Soc. London, Series, A., **160**: 268-282.

Carvalho, H.W.L.; M.L. Silva Leal; M.X. Santos; M.J. Cardoso; A.A.T. Monteiro and J.N.Tabosa (**2000**). Adaptability and stability of corn cultivars in the Brazilian Northeast. Pesquisa Agropecuaria Brasileira, **35**: 1115-1123.

Eberhart, S.A. and W.A. Russell (**1966**). Stability parameters for comparing varieties. Crop Sci., **6**: 36-40.

El-Sheikh, M.H. (**1999**). Estimates of stability parameters for some yellow maize hybrids. Minufiya J. Agric. Res., **24**: 1643-1650.

El-Sherbieny, H.Y.; T.A. Abdallah; A.A. El-Khishen and Afaf A. I. Gabr (**2008**). Genotype x environment interaction and stability analysis for grain yield in some white maize (*Zea mays*) hybrids. Annals of Agric. Sci., Moshtohor, **46**: 277-283.

Elto, E.G. and A.R. Hallauer (**1980**). Stability of hybrids produced from selected and unselected lines of maize. Crop Sci. 20: 623-626.

Francis, T.R.; and L.W. Kanneberg (**1978**). Yield stability studies in short season maize. 1. A descriptive method for grouping genotypes. Can. J. Plant. Sci., **58**: 1029-1034.

Frey, K.J. (**1964**). Adaptation reaction of oat strains selected under stress and non-stress environmental conditions. Crop Sci. **4**: 55-58.

Frey, K.J. and M. Maldonado (**1967**). Relative productivity of homogenous and heterogenous oat cultivars in optimum and sub-optimum environments. Crop Sci., **7**: 532-535.

Gauch, H.G.Jr. and R.W. Zobel (**1996**). Identifying mega-environments and testing genotypes. CIMMYT publications, March, **1996**, 27 pages.

Hallauer, A.R. and J.B. Miranda (**1981**). Quantitative genetics in plant breeding. Iowa State Univ. Press, Ames, Iowa, USA.

Kang, M.S. and D.P. Gorman (**1989**). Genotype × environment interaction in maize. Agron. J., **81**: 662-664.

Khalil, M.A.G. (**2013**). Stability analysis for promising yellow maize hybrids under different locations. Alex. J. Agric. Res., **58**: 279-286.

Lin, C.S.; M.R. Binns and L.P. Lefkovitch (**1986**). Stability analysis where we stand? Crop Sci., **26**: 894-899.

Mosa, H.E.; A.A. Amer; A.A. El-Shenawy and A.A. Motawei (**2012**). Stability analysis for selecting high yielding stable maize hybrids. Egypt. J. Plant Breed., **16**: 161-168.

Mosa, H.E.; A.A. Motawei and A.A. El-Shenawy (**2009**). Genotype x environment interaction and stability of some promising maize hybrids. Egypt. J. Plant Breed. **13**: 213-222.

Mosa, H.E.; A.A. Motawei; A.M.M. Abd El-Aal and M.E.M. Abd El-Azeem (**2011**). Yield stability of some promising maize (*Zea mays* L.) hybrids under varying locations. J. Agric. Res. Kafr El-Sheikh Univ. **37**: 99-109.

Nguyen, H.T.; D.A. Sleper and K.L. Hunt (**1980**). Genotype x environment interaction and stability analysis of herbage yield of tall fescue synthetics. Crop Sci. **20**: 221-224.

Pinthus, M.J. (**1973**). Estimate of genotypic values: A proposal method. Euphytica, **22**: 121-123.

Ragheb, M.M.A.; H.Y.Sh. El-Sherbieny, A.A. Bedeer and S.E. Sadek (**1993**). Genotype-environment interaction and stability in grain yield and other agronomic characters of yellow maize hybrids. Zagazig J. Agric. Res. **20**: 1435-1446.

Shalaby, M.A.K. (**1996**). Estimates of stability parameters for grain yield and other agronomic traits of maize hybrids under different environmental conditions. J. Agric. Sci. Mansoura Univ., **21**: 867-880.

Shehata, A.M.; E.A. Amer; A.A. Barakat and A.A. El-Shenawy (**2003**). Stability parameters for grain yield and some other agronomic traits of new white and yellow maize hybrids (*Zea mays* L.). Egypt. J. Appl. Sci., **18**: 495-509.

Soliman, M.S.M. (**2006**). Stability and environmental interaction of some promising yellow maize genotypes. Res. J. Agric. & Biol. Sci. **2**: 249-255.

Steel, R.G.D. and J.H. Torrie (**1980**). Principles and procedures of statistics. McGraw Hill Book company, New York, USA.

Tai, G.C.C. (**1971**). Genotypic stability analysis and its application to potato regional traits. Crop Sci., **11**: 184-190.

Tollenaar, M. and E.A. Lee (**2002**). Yield potential, yield stability and stress tolerance in maize. Field Crops Res., **75**: 161-169.

Vargas, M.; J. Crossa; F.A. Euwijk; M.E. Ramirez and K. Sayre (**1999**). Using partial least square regression, factorial regression and AMMI models for interpreting genotype x environment interaction. Crop Sci., **39**: 959-967.

Worku, M.; H. Zelleke; G. Taye; B. Tolessa; L. Willde; W.G.A. Abera and H. Tuna (**2001**). Yield stability of maize conference, Feb. **11-15**: 139-142.

Wricke, G. (**1962**). Uber eine methode zur erfassung der okologischen streubreite in feld ver suchen. Z. Pflanzensuecht, **47**: 92–96.

الملخص العربى

مقاييس الثبات لصفة محصول الحبوب والصفات المحصولية الأخرى لهجن بيضاء مبشرة من الذرة الشامية

محمد عرفة على حسن

قسم بحوث الذرة الشامية، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية، مصر

عشرة هجن فردية مبشرة مع اثنين من هجن المقارنة هما هـ ف ١٠، هـ ف ١٢٨ تم تقييمهم فى خمس مواقع مختلفة على مستوى الجمهورية وهى محطة بحوث سخا، الجميزة، سدس، النوبارية وملوى فى الموسم الصيفى ٢٠١٢. كانت الاختلافات بين المواقع عالية المعنوية لكل الصفات المدروسة وكذلك كانت الاختلافات بين الهجن وتفاعلاتها مع المواقع معنوية لكل الصفات. أظهر التفاعل الخطى وغير الخطى اختلافات معنويةً للصفات المدروسة عدا التفاعل الخطى لصفة ظهور ٥٠% من حرائر النورات المؤنثة. طبقا لهذه الدراسة الهجين الثابت هو الذى يظهر متوسط مرغوب فيه وقيم منخفضة فى كل من التباين ومعامل الاختلاف ونسبة المساهمة فى التفاعل بين الهجن والظروف البيئية، كذلك عدم معنوية كلا من معامل الانحدار والانحراف عن خط الانحدار وكذلك يعطى قيم أعلى من ٨٠% لمعامل التحديد ومن خلال ذلك كانت الهجن: هـ ف سخا ١٤٦، هـ ف سخا ١٥١، هـ ف سخا ١٥٤ هى الأكثر ثباتا فى التبكير، كذلك الهجينان هـ ف سخا ١٥٠، هـ ف سخا ١٥٣ لقصر إرتفاع النبات. بينما الهجينين هـ ف سخا ١٤٦ و هـ ف سخا ١٤٩ هما الأكثر ثباتا لمحصول الحبوب (بالأردب/فدان) بالإضافة إلى أنهما لا يختلفان معنويا عن هجن المقارنة فى محصول الحبوب.