Zagazig J. Agric. Res., Vol. 37 No. (1) 2010 1-15

PHENOTYPIC STABILITY PARAMETERS FOR SOME SINGLE AND THREE WAY HYBRIDS OF MAIZE (*Zea mays* L.)

Abd El-Maksoud, M.F. and A.A. Mansour

Plant Prod. Dept., Inst. of Efficient Productivity, Zagazig Univ., Egypt.

Accepted 28 /2/2010

ABSTRACT: Ten single and three way hybrids of white maize were evaluated for grain yield/fad., yield attributes and some morphological characters under six diverse environments which were the combinations between three seasons x two locations. Phenotypic stability parameters were estimated using regression coefficient (b_i), mean square of deviation from regression (S^2d_i) and coefficient of variability (CV_i %). The obtained results could be summarized as follows:

Stability analysis of variance revealed highly significant mean squares of maize hybrids for all studied characters. Also, highly significant GxE-"linear" interaction for all studied characters was recorded. The variance due to environments "linear" were highly significant for all studied characters.

Phenotypic stability parameters indicated that maize hybrid, TWC 320 was classified as highly adapted to favorable environments for grain yield, plant height and ear height as well as TWC 322 for ear length; SC 124 and SC 129 for number of rows/ear; SC 122 for number of grains/ear; SC 103 and SC 122 for 100-grain weight and SC 122 for ear leaf area. Whereas, SC 10, TWC 321 and TWC 323 could be grown under Khattara as less favorable environment for grain yield/fad., ear length and ear leaf area. The most desired and stable hybrids were TWC 310, TWC 322 and SC 124 for grain yield; SC 103 and SC 122 for ear length, number of rows/ear and plant height; SC 124 and TWC 323 for number of grains/row; SC10, TWC 320, and TWC 321 for 100-grain weight; SC 103, SC 124 and TWC 322 for ear height and TWC 310, TWC 320 and TWC 322 for ear leaf area.

It is worthy to mention that TWC 310 was the most stable maize hybrid and may be recommended to be included in any program for improving grain yield stability since, it has a high mean performance over environments, with "b" value approached near unity and minimum values of both "S^2d" and "CV" parameters.

Key words: Maize (*Zea mays* L.), phenotypic stability, regression coefficient, variability, adaptation, environment.

INTRODUCTION

Maize (*Zea mays* L.) is one of the important cereal crops of the world. It is cultivated on about 157.9 million hectares and has an annual production of about 784.8 million tons. In Egypt, maize is the third most important cereal crop and ranks the next to wheat and rice. It is being grown on an area of about 868 thousand hectares with a total production of 7.1 million tones and average yield of 8.1 tons per hectare (FAO, 2007).

Being a C_4 plant, maize is physiologically more efficient and has higher grain yield and wider adaptation than wheat and rice. Its cultivation extends over a wide range of geographical and environmental conditions ranging from 55°N to 55°S (Shaw, 1988).

Maize hybrids vary in their response to variable environmental conditions. Genotype x environmental (GxE) interaction is an important consideration in plant breeding programs because it reduces the progress from selection in any one environment (Hill, 1975). Also, (GxE) interactions are of notable importance in the development and evaluation of maize hybrids and refers to differential responses of genotypes across a range of environments (Kang, 2004). Although, it represents a major challenge to plant breeders, significant advances have been made to understand the nature of these interactions and determine the most stable genotype with a minimum (GxE).

Phenotypic stability parameters have been proposed by Eberhart and Russel (1966) to provide information on the real response of phenotype to environments. They reported that the ideal variety is the one of that combines high yield with stability of performance. Also, the phenotypic stability is often used to refer to fluctuations in the phenotypic expression of yield, while the genetic composition of the varieties or populations remain stable (Becker and Leon, 1988). Such a genotype is acceptable over a wide range of environmental conditions (Allard and Bradshaw, 1964).

The high-yield environ-ments were characterized by relatively low CV and the low-yield environments by relatively high CV (Pham and Kang, 1988).

Many investigators have assessed the phenotypic stability of yield performance in maize genotypes (Lee *et al.,* 2003; Alberts, 2004; Soliman, 2006; Sharma *et al.,* 2008; Ali, 2009; and Worku and Zelleke, 2009). They reported significant differences among genotypes, environments and their interactions for grain yield and its attributes.

Therefore, the present work was investigated for studying the performance and stability of various maize genotypes over old and newly reclaimed environments to provide reliable information for recommendation of some hybrids to be grown under specific environments or to assist maize breeders for planning breeding programs.

MATERIALS AND METHODS

Ten white maize hybrids Table 1 representing both single (SC 10, SC 103, SC 122, SC 124 and SC 129) and three way (TWC 310, TWC 320, TWC 321, TWC 322 and TWC 323) hybrids were evaluated for plant height, ear height and ear leaf area (at 75 days from sowing) as well as ear length, number of rows/ear, number of grains/row, 100-grain weight, and grain yield (ardab/fad.) under two locations; i.e., Experimental Farm of the Institute of Efficient Productivity at Ghazalah Village, Sharkia Governorate representing clay soil and Experimental Farm of Faculty of Agriculture, Zagazig University at Khattara, representing sandy soil Table 2 during three successive summer seasons 2004, 2005 and 2006, using a randomized complete block design with three replicates.

The experimental plot consisted of 6 ridges, 4m long and 70cm apart. Maize grains were sown in hills (2 grains/hill), 25cm apart. Plants were thinned to one plant/hill after 18 and 14 days from sowing in the 1^{st} and 2^{nd} locations, respectively. The recommended cultural practices for maize production were applied in each location.

Regular analysis of variance was computed for each environment. Phenotypic stability analysis was computed according to Eberhart and Russell (1966). Coefficient of variation (CV) was computed according to Francis and Kannenberg (1978).

Table 1. Name, origin and pedigree of the studied ten maize hybrids

No.	Name	Origin	Pedigree
1	SC 10	Egypt	7 x 63 w
2	SC 103	Egypt	7 x 601 w
3	SC 122	Egypt	628 x 603 w
4	SC 124	Egypt	628 x 602 w
5	SC 129	Egypt	629 x 603 w
6	TWC 310	Egypt	SC 10 x 34 w
7	TWC 320	Egypt	SC 120 x 7 w
8	TWC 321	Egypt	SC 21 x 7 w
9	TWC 322	Egypt	SC 22 x 7 w
10	TWC 323	Egypt	SC 23 x 7 w

Table 2. Particle size distribution of the upper 30cm of soil surface samples

Location	Particle size distribution %									Texture
	1st season			2nd season			3 rd season			
	Sand	Silt	Clay	Sand	Silt	Clay	Sand	Silt	Clay	
Ghazala	15.7	35.7	48.6	14.8	33.6	51.6	13.7	34.6	51.7	Clay
Khattara	85.31	6.32	8.37	84.12	6.58	9.30	87.81	3.14	9.05	Sandy

RESULTS AND DISCUSSION

Stability Analysis

Stability analysis of variance of maize grain yield, yield attributes and some morphological characters Table 3 showed that the mean squares among the genotypes were highly significant for grain yield and its attributes, revealing that maize genotypes were genetically different for genes controlling these characters. Highly significant environment + (GxE) component and environment "linear" mean squares were recorded for all studied characters, indicating that these characters were highly influenced by the combination of environmental components (seasons and locations). Significant (GxE)- "linear" interactions were shown for all yield contributing characters, indicating that maize genotypes responded differently to various environ-ments. Thus, each maize hybrid has specific environ-ment performed well under it, and different from another one. The (GxE)- "Linear" interaction was significant when tested against the pooled deviation for grain yield/fad. and other studied characters. This result suggests that, the differences in linear responses among maize hybrids across environments had occurred, and the linear regression and the deviation from linearity were the main components for differences in stability for the foregoing characters. Rasmusson and Glass (1967) emphasized that (GxE)-interaction should be considered one of the most important strategies for any breeding program to improve and develop new varieties. Previous reports of Lee *et al.,* (2003), Alberts (2004), Soliman (2006), Sharma *et al.,* (2008) and Ali (2009), detected significant differences among maize genotypes, environments and their interactions for grain yield and its attributes.

Stability Parameters

The estimates of phenotypic stability parameters and coefficient of variability (CV) have been computed as described by Eberhart and Russell (1966) and Francis and Kannenberg (1978), respectively for testing ten maize hybrids grown under six environments for grain yield, yield attributes and some morphological characters (Tables 4, 5 and 6).

For grain yield (ardab/fad.), the results showed that the most desirable maize hybrids based on ($\bar{X}$) were SC 10, SC 129 and TWC 310, while TWC 320 was the

Table 3. Mean squares of stability analysis for maize grain yield and its contributing characters

S.O.V	d.f	Grain yield (ardab) fad	Ear length (cm)	Number of rows/ear	Number of grains/ear	100-grain weight (gm)	Plant height (cm)	Ear height (cm)	Ear leaf area (cm^2)
Genotypes	9	5.81**	1.49**	1.32**	372.56**	6.34**	629.96**	73.44**	1924.89**
E + (G x E)	50	30.58**	2.94**	0.37*	385.06**	7.60**	2353.10**	1078.66**	20624.62**
E- "Linear"	1	410.53**	36.01**	1.29**	858.00**	53.26**	31545.57**	15348.61**	292787.68**
G x E -"Linear"	9	109.86**	9.60**	0.73**	1762.35**	19.62**	8247.96**	4001.27**	67540.09**
Pooled dev.	40	3.24**	0.62**	0.27**	63.35**	3.76**	296.94**	64.32**	1239.56**
Pooled er.	216	0.241	0.062	0.055	15.521	0.264	26.248	3.060	8.204

*, ** denote significant at 5% and 1% levels of probability, respectively.

Table 4. Phenotypic stability parameters for grain yield, ear length and number of rows/ear of ten maize hybrids under six environments

Character parameter	Grain yield (ardb/fad.)				Ear length (cm)				Number of rows/ear			
Genotypes	$\bar{X}_i$	b_i	S^2d_i	c.v%	$\bar{X}_i$	b_i	S^2d_i	c.v%	$\bar{X}_i$	b_i	S^2d_i	c.v%
SC 10	22.15	0.415**	1.592**	6.929	19.19	0.425**	0.001	0.656	12.77	0.514	0.074	2.975
SC 103	20.99	0.691*	2.751**	8.477	20.77	0.995	0.468**	4.347	13.40	0.498	0.043	2.242
SC 122	20.60	0.601**	1.592**	7.237	20.18	0.923	0.550**	4.894	13.41	0.737	0.236**	5.004
SC 124	20.11	0.939	2.385**	9.066	18.95	1.014	0.362**	4.128	13.14	1.315**	0.296**	5.404
SC 129	22.19	0.337**	0.860**	4.890	19.56	0.794	0.288**	3.557	13.90	1.423**	0.330**	5.379
TWC 310	22.95	0.995	0.083	1.652	20.11	0.722*	0.213**	2.964	12.99	0.547	0.069	2.873
TWC 320	19.22	1.397**	3.316**	10.108	20.00	0.621**	0.169**	2.720	13.20	0.714	0.101**	3.266
TWC 321	20.57	0.439**	1.094**	5.601	19.18	0.518**	0.025	1.222	13.40	0.462*	0.016	1.579
TWC 322	20.67	0.994	2.356**	8.263	19.28	1.328**	0.606**	5.242	13.05	0.601	0.061	2.736
TWC 323	20.72	0.324**	0.073	1.534	19.84	0.719*	0.323**	3.704	12.63	0.524	0.037	2.195
Grand mean	21.11				19.71				13.19			
$L.S.D_{0.05}$	1.68				1.01				0.98			

Table 5. Phenotypic stability parameters for number of grains/row and 100-grain weight (gm) of ten maize hybrids under six environments

Character parameter	Number of grains/row				100-grain weight (gm)			
Genotypes	$\bar{X}_i$	b_i	S^2d_i	c.v%	$\bar{X}_i$	b_i	S^2d_i	c.v%
SC 10	44.17	0.735*	3.738	5.611	31.05	0.857	1.062**	4.339
SC 103	44.45	1.481*	20.194**	13.631	32.02	1.276*	2.922**	6.963
SC 122	43.15	1.393*	266.039**	31.178	30.26	1.339**	3.575**	7.806
SC 124	42.10	0.835	4.146	6.171	29.38	0.785	1.426**	5.448
SC 129	42.72	0.402**	0.510	2.137	28.70	0.614*	0.636	3.575
TWC 310	42.60	0.482**	1.216	3.289	28.85	1.140*	3.725**	8.217
TWC 320	43.36	0.603**	3.595	5.612	30.76	1.043	2.601**	6.812
TWC 321	43.12	0.614**	2.842	5.019	30.34	0.847	1.492**	5.206
TWC 322	43.01	0.697*	6.671	7.634	30.22	0.695	0.676	3.518
TWC 323	42.77	0.845	7.703	8.198	31.25	0.686*	0.583	3.239
Grand mean	43.15				30.33			
$L.S.D_{0.05}$	1.28				1.98			

Table 6. Phenotypic stability parameters for plant height, ear height and ear leaf area of ten maize hybrids under six environments

Character parameter	Plant height (cm)				Ear height (cm)				Ear leaf area (cm^2)			
Genotypes	$\bar{X}_i$	b_i	S^2d_i	c.v%	$\bar{X}_i$	b_i	S^2d_i	c.v%	$\bar{X}_i$	b_i	S^2d_i	c.v%
SC 10	285.8	1.293*	240.24**	6.60	137.2	1.304*	55.56**	6.47	678.3	0.823*	611.35**	4.49
SC 103	283.3	0.805**	59.07	3.39	130.5	0.981	38.22**	5.57	684.2	0.514**	133.26**	2.09
SC 122	264.7	0.912	155.41**	5.59	132.9	0.693**	4.27	1.84	646.9	1.337*	1193.57**	6.41
SC 124	266.6	1.335**	202.90**	6.50	128.2	0.935	33.24**	5.21	632.2	0.651**	328.77**	3.49
SC 129	285.9	0.741**	96.89**	4.23	133.6	0.772**	21.72**	4.14	642.3	0.741**	90.79	1.79
TWC 310	296.8	0.758**	87.54**	3.94	141.5	0.671**	10.13**	2.76	698.7	0.851	943.11**	5.46
TWC 320	303.4	1.297*	138.76**	4.89	143.7	1.315*	50.84**	6.01	685.7	0.845	734.91**	4.91
TWC 321	300.9	0.959	210.98**	6.08	138.8	1.301*	48.47**	6.12	680.4	0.801*	636.65**	4.53
TWC 322	293.7	0.991	238.59**	6.38	137.1	0.912	41.23**	5.48	676.4	0.912	1064.77**	5.80
TWC 323	292.1	0.763**	54.18	3.16	141.0	0.548**	17.81**	3.74	679.2	0.617**	460.49**	3.90
Grand mean	287.3				136.5				670.5			
L.S.D$_{0.05}$	15.85				8.25				28.51			

lowest in this respect. The regression "b" value ranged from 0.324 (TWC 323) to 1.397 (TWC 320) and deviated significantly from unity ($b < 1$) in maize hybrids SC10, SC103, SC 122, SC 129, TWC 310, TWC 321 and TWC 323, indicating the suitability of these genotypes to Khattara region as less favorable environment. Otherwise, the "b" value was more than unity ($b > 1$) in TWC 320, hereby could be grown under favorable environments.

It could be concluded that SC124, TWC 310and TWC 322 were the most desired genotypes based on "b" value, since they had insignificant "b" approached near unity. In this respect, Hayward and Lawrence (1970) stated that the response to environment, as measured by the "b" parameter was found to be highly heritable and controlled by genes with additive effects.

Concerning the deviation from linear regression "S^2d", it was very small and not significantly deviated from zero in TWC 310 and TWC 323 maize hybrids which showed high degree of stability for grain yield Table 4. In this regard, Paroda and Hayes (1971) and Guilan Yue *et al.* (1990) reported that the "S^2d" seemed to be very important for estimating the stability and concluded that genotypes with the lowest deviation (S^2d) around regression line are most stable. These results are in harmony with those obtained by Alberts (2004), and Ali (2009).

Concerning the values of coefficient of variability (CV) as critrion describing stability Table 4, it could be observed that the values of CV varied from maize hybrid to another in grain yield which ranged from 1.534% for TWC 323 to 10.108% for TWC 320. It could be seen from above mentioned results that the most stable maize hybrids are TWC 310 and TWC 323 which had the lowest (CV). On the other hand, TWC 320, SC 124 hybrids could be character-ized unstable for grain yield/fad. Similar results were obtained by Tariq *et al.* (2003), Alberts (2004) and Ali (2009).

For yield components, the estimates of phenotypic stability parameters Tables 4 and 5 indicated that, the highest maize hybrids with highest average values of yield attributes were SC 103, SC 122, TWC 310 and TWC 320 for ear length; SC 103, SC 122, SC 129 and TWC 321 for number of rows/ear; SC 10 and SC

103 for number of grains/ear; SC 103 for 100-grain weight.

The most adapted maize genotypes for improved environments were TWC 322 for ear length, both SC 124 and SC 129 for number of rows/ear, SC 122 for number of grains/row and SC 103, SC 122 and TWC 310 for 100-grain weight. However, SC10, TWC 310, TWC 320, TWC 321 and TWC 323 were suited to less favorable conditions for ear length; TWC 321 for number of rows/ear; SC 10, SC 129, TWC 310, TWC 320, TWC 321 and TWC 322 for number of grains/row; SC 129, TWC 310 and TWC 323 for 100-grain weight.

In the case of the insignificant "b" value, the deviation from regression "S^2d" is considered the most appropriate criterion for measuring phenotypic stability, because it measures the predictability of genotypic reaction to various environ-ments (Becker et al., 1982). It can be noticed that "S^2d" values were small and insignificant in SC 10 and TWC 321 for ear length; SC10, SC 103, TWC 310, TWC 321, TWC 322 and TWC 323 for number of rows/ear; all tested maize hybrids, except SC 103 and SC 122 for number of grains/row and SC 129, TWC 322 and TWC 323 for 100-grain weight which showed high degree of stability. The remaining genotypes were sensitive ones.

Concerning the (CV) values, it could be observed that the values of CV varied from genotype to genotype in the same character e.g., ear length ranged from 0.656 to 5.242% for SC10 and TWC 322; number of rows/ear (1.579 to 5.404%) for TWC 321 and SC 124; number of grains/row (2.137 to 31.178%) for SC 129 and SC 122; 100-grain weight (3.239 to 8.217%) for TWC 323 and TWC 310 and shelling percentage (0.624 to 1.054%) for SC 129 and SC10. This C.V measure depend on the diversity of environments in the experiments. If environ-ments are quite diverse, then this measure may not be very meaningful. According to this parameter, a genotype is stable with minimum value of CV therefore, the genotype SC10 seems to be stable over all the environments for ear length; TWC 321 for number of rows/ear; SC 129 for number of grains/row and TWC 323 for 100-grain weight. The differences have been registered among the studied maize hybrids for yield attributes could be due to the different genetic makeup of the parents involved in the studied crosses. Similar conclusions were obtained by Alberts (2004) and Ali (2009).

For morphological characters, the overall mean performance of plant height for maize genotypes ranged from 264.7cm (SC122) to 303.4cm (TWC 320); ear height from 128.2 cm (SC 124) to 143.7 cm (TWC 320) and ear leaf area from 632.2 cm^2 (SC124) to 698.7 cm^2 (TWC 310) as shown in (Table 6).

The response to environments as measured by the regression parameter indicated that SC10, SC 124 and TWC 320 for plant height; SC10, TWC 320 and TWC 321 for ear height and SC 122 for ear leaf area were fitted to improved environments. Whereas, SC 103, SC 129, TWC 310 and TWC 323 for plant height; SC 122, SC 129, TWC 310 and TWC 323 for ear height and SC 10, SC 103, SC 124, SC 129, TWC 321 and TWC 323 for ear leaf area were adapted to stress conditions. It can be seen that, "S^{2}d" was small and insignificant as well as "CV" was minimum in SC 103 and TWC 323 for plant height; SC 122 for ear height and SC 129 for ear leaf area revealing that these maize hybrids were considered more stable. Otherwise, the remaining maize genotypes were sensitive ones.

From the aforementioned results, it could be concluded that TWC 310 maize hybrid which had a mean grain yield of 22.95 ardab/fad., being higher than the grand mean with "b" value did not differ significantly from unity and least "S^{2}d" and "CV" values was more stable across all the environments and may be recommended to be involved in any breeding program for improving maize grain yield stability.

REFERENCES

Alberts, M.J.A. 2004. A comparison of statistical method to describe genotype x environment interaction and yield stability in multi-location maize trials. Ph. D. Thesis, Department of Agron., Faculty of the Free State, Bloemfontein, South Africa.

Ali, M.M.A. 2009. Breeding studies on top crosses in white and yellow maize (*Zea mays* L.). Ph.D. Thesis, Agron. Dept., Faculty of Agric., Zagazig Univ.

Allard, R.W. and A.D. Bradshaw. 1964. Implications of genotype-environmental interactions in applied plant breeding. Crop Sci., 4: 503-508.

Becker, H.C. and J. Leon. 1988. Stability analysis in plant breeding. Plant Breeding, 101: 1-23.

Becker, H.C., H.H. Gheiger and K. Morgen Stern. 1982. Performance and phenotypic stability of different hybrid types in winter rye. Crop Sci., 22: 340-344.

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

FAO. 2007. Statistical data base of the Food and Agriculture Organization of the United Nations. http://www.fao.org.

Francis, T.R. and L.W. Kannenberg. 1978. Yield stability studies in short season maize. 1. A descriptive methods for grouping gonotypes. Can. J. Plant. Sci., 58: 1029-1034.

Guilan Yue, S.K. Perng, T.L. Walter, C.E. Wassom and G.H. Liang. 1990. Stability analysis of yield in maize, wheat and sorghum and its implications in breeding programs. Plant Breeding, 104: 72-80.

Hayward, M.D. and T. Lawrence. 1970. The genetic control of variation in selected population of *Lolium perenne* L. Can. J. Cytol., 12: 806-815.

Hill, J. 1975. Genotype x environment interaction: A challenge for plant breeding. J. of Agric. Sci., 85: 477-493.

Kang, M.S. 2004. Breeding: Genotype –by- environment interaction. P.218-221. In R.M. Goodman (ed.) Encyclopedia of Plant and Crop Science, Marcel-Dekker, New York.

Lee, E.A., T.K. Doerksen and L.W. Kannenberg. 2003. Genetic components of yield stability in maize breeding population. Crop. Sci., 43: 2018-2027.

Paroda, R.S. and J.D. Hayes. 1971. An investigation of genotype-environment interactions for rate of ear emergence in spring barley. Heredity, London 23: 339-356.

Pham, H.N. and M.S. Kang. 1988. Interrelationships among and repeatability of several stability statistics estimated from interational maize trials. Crop Sci., 28: 925-928.

Rasmusson, D.C. and R.L. Glas. 1967. Estimates of genetic and environmental variability in barley. Crop Sci., 7: 185-187.

Sharma, D., R.C. Sharma, R. Dhakal, N.B. Dhami, D.B. Gurung, R.B. Katuwal, K.B. Koirala, R.C. Prasod, S.N. Sah, S.R. Upadhyay, T.P. Tiwari and G. Ortiz-Ferrara. 2008. Performance stability of maize genotypes across diverse hill environments in Nepal. Euphytica, 164: 3, 689-698.

Shaw, R.H. 1988. Climate requirements. In "Corn and Corn Improvement" (G.F. Sprague and J.W. Dudley, eds.), Pp., 609-638. American Society Agronomy, Madison WI.

Soliman, M.S.M. 2006. Stability and environmental interaction of some promising yellow maize genotypes, Res. J. of Agric. And Bio. Sci., 2 (6): 249-255.

Tariq, M., M.I. Haq, A.A. Kiani and N. Kamal. 2003. Phenotypic stability for grain yield in maize genotype under varied rainfed environments. Asian J. of Pl. Sci., 2 (1): 80-82.

Worku, M. and H. Zelleke. 2009. Genotype x environment interaction and yield stability of maize. East African J. of Sci., 2 (1) 7-12.

معالم الثبات المظهرى لبعض الهجن الفردية وثلاثية الآباء فى الذرة الشامية

مجدى فتحى عبد المقصود - عبد الغنى عبد المعطى منصور

قسم الإنتاج النباتى - معهد الكفاية الإنتاجية - جامعة الزقازيق - مصر

أجريت هذه الدراسة بهدف تقييم ثبات عشرة هجن من الذرة الشامية البيضاء، خمسة منها هجن فردية هى هجين فردى ١٠ ، ١٠٣ ، ١٢٢ ، ١٢٤ ، ١٢٩ وخمسة هجن ثلاثية الآباء هى هجين ثلاثى ٣١٠ ، ٣٢٠ ، ٣٢١ ، ٣٢٢ ، ٣٢٣ وذلك لصفات محصول الحبوب ومكوناته بالإضافة إلى بعض الصفات المورفولوجية تحت ست بيئات مختلفة (٣مواسم زراعية × موقعين). وتم حساب قيم الثبات المظهرى بطريقة إيبرهارت وراسيل (١٩٧٨).

ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

تشير نتائج تحليل الثبات إلى وجود اختلافات عالية المعنوية بين هجن الذرة الشامية للصفات المدروسة وكان التفاعل (الخطى) بين التركيب الوراثى × البيئة عالى المعنوية لجميع الصفات المدروسة وكذلك كان التباين الراجع للبيئة (الخطى) معنوياً أيضاً لجميع الصفات المدروسة مما يشير إلى تباين الاستجابة للبيئات المختلفة.

أظهرت معالم الثبات المظهرى، تميز الهجين الثلاثى ٣٢٠ بالأقلمة العالية لظروف البيئات الملائمة لصفة محصول الحبوب/ف وارتفاع النبات وارتفاع الكوز والهجين الثلاثى ٣٢٢ لصفة طول الكوز والهجين الفردى ١٢٤، ١٢٩ لصفة عدد السطور/الكوز، والهجين الفردى ١٢٢ لصفة عدد الحبوب / الكوز، والهجين الفردى ١٠٣، ١٢٢ لصفة وزن الـ ١٠٠ حبة، وكذلك الهجين الفردى ١٢٢ لصفة مساحة ورقة الكوز. بينما يمكن التوصية بزراعة هجين فردى ١٠، هجين ثلاثى ٣٢١ و ٣٢٣ تحت ظروف منطقة الخطارة كبيئة أقل ملائمة لصفات محصول الحبوب/ف، طول الكوز ومساحة ورقة الكوز.

أظهر تحليل الثبات المظهرى أ، أكثر الأصناف ثباتاً لمدى واسع من البيئات الهجن ٣١٠، ٣٢٢ ، ١٢٤ لصفة محصول الحبوب/ف والهجين الفردى ١٢٢ لصفة طول الكوز وعدد الحبوب/السطر ، والهجين الفردى ١٠ والثلاثى ٣٢٠ ، ٣٢١ لصفة وزن الـ ١٠٠ حبة والهجين الفردى ١٠٣ ، ١٢٤ والثلاثى ٣٢٢ لصفة ارتفاع الكوز والهجن الثلاثية ٣١٠ ، ٣٢٠ ، ٣٢٢ لصفة مساحة ورقة الكوز.

يتضح من خلال النتائج المتحصل عليها أن الهجين الثلاثى ٣١٠ كان أكثر الهجن المختبرة ثباتاً فهو يمتلك أعلى متوسط محصول للحبوب/ف وأعطى قيمة لمعامل الانحدار تقترب من الوحدة مع أقل قيمة انحراف عن خط الانحدار وأقل قيمة لمعامل الاختلاف كمقاييس لوصف ثبات التركيب الوراثى لهذا الهجين. ولذا يمكن التوصية باستخدام هذا الهجين فى برامج تحسين ثبات محصول حبوب الذرة الشامية.