GENOTYPIC STABILITY AND PHENOTYPIC ADAPTABILITY FOR SOME YIELD TRAITS IN SOME LONG STAPLE COTTON GENOTYPES

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Abstract

The development of genotypes, which can be adapted to a wide range of diversified environments, is the ultimate goal of plant breeders in a crop improvement program. A multilocation experiment was performed to study genotype by environment interaction (GEI) using different stability parameters. Twenty two genotypes obtained from the Egyptian cotton breeding programme, besides two check varieties were evaluated for seed cotton yield and lint yield stability under five locations in the Delta region of Egypt. The results showed that variances due to genotypes, environments and genotype x environment interaction were highly significant for both traits, which indicated that these genotypes interacted differentially with environments. The environmental variation caused more than 60% of the total variance on these genotypes, while the genotypes variations cause 3.96% and 4.341% for seed cotton yield and lint yield, respectively. Seven stability parameters were used to determine stability of these genotypes. The Genotypes; G6, G9, G18 G19, G20, G22 and G23 were the most stable genotypes across these different methods,(and some of them could be recommended for farthen use in the breeding programme). Also, these Genotypes showed high sustainability index ranged from 76% to 90% for both traits which indicate that these genotypes were stable across the environments and characterized with wide adaptability and high mean performance. The Spearman's correlation coefficients between the two yield traits and seven stability parameters were insignificant except, with ecovalence (W^2_i) model which was highly significant and positive. Within the parameters, most of them showed highly significant positive correlation with each other, indicating that these measures have similar aspects of stability.

Key words: G x E interaction, stability parameters, sustainability index, adaptability, cotton yield traits, stability correlation.

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INTRODUCTION

There are many concepts of the stability terms. A genotype is considered to be stable if firstly, its among-environment variance is small. This is called a static, or a biological concept of stability, which is useful for quality traits, disease resistance and for stress traits. Secondly, a genotype is considered to be stable if its response to environments is parallel to the mean response of all genotypes in the trial, this is called the dynamic or agronomic concept of stability. Thirdly, a genotype is considered to be stable if the residual mean square from the regression model on the environmental index is small, (Alberts, 2004).

The phenotype of an individual is determined by both the genotypic and the environmental effects besides genotype x environment Interaction (GEI). Genotype x environment interaction (GEI) is the major concern to plant breeders for developing and improving cultivars. A stable cultivar must be performing well across a range of environments in which it grown. The presence of GE interactions reduces the correlation between phenotype and genotype, and makes it difficult to judge the genetic potential of a genotype. So, breeders usually seek highly stable and productive genotypes to select (Fatih and Harem, 2006).

Genotype x environment interaction (GEI) is defined as the phenotypic effect of interactions between genes and environments. The yielding ability of genotypes is a result of its interaction with the environmental conditions and the contribution of the genes (level of expression) regulating the traits among environments. An information on genotype x environment interaction leads to successful evaluation of stable genotype, which could be used for general cultivation (Khan *et al.*, 2007).

The main objective of the present study is to evaluate the performance of the newly developed strains of Egyptian long staple cotton for yield stability over different environments using different univariate stability parameters to detect the relatively stable lines. Information which will gather from this study can help in assessing the potentials of newly developed strains of Egyptian cottons for commercial cultivation. The Spearman's coefficients of rank correlation between stability methods should help plant breeder to choose the most independent and informative stability model to use in genotypes evaluation.

MATERIALS AND METHODS

The present experimental material consisted of twenty four cotton genotypes belonging to *Gossypium barbadense* L. This work was L B trial of Cotton Breeding Research Section, Cotton Research Institute, Agricultural Research Center, Giza, Egypt. These genotypes comprised twenty two F_5, F_6, F_7, F_9 and F_{11} families in addition to two check genotypes, Giza 86 and the new promising cross (10229 x Giza 86). Origin and pedigree of these genotypes are shown in Table 1. These genotypes were tested in the growing season of 2013 at five Egyptian governorates; Kafr El-Sheikh (E1), El-Gharabia (E2), El-Monofia (E3), El-Sharaqia (E4) and El-Dakahlia (E5).

These locations represented the most important cotton production area for these breeding lines.

The experimental layout was a randomized complete block design (RCBD) with six replications. Each replicate consisted of twenty four plots to which genotypes were assigned randomly. Each entry was grown in five rows set of 4m length, 70cm apart and distance between plants within rows was 30cm. General agronomic and cultural practices recommended for cotton crop were adopted at each location. At harvest, the two external rows were eliminated from each plot to avoid the boarder effect. While, the three inner rows were harvested to estimate the two agronomic yield traits, seed cotton yield per plot (SCY) and lint yield per plot (LY) which expressed in Kantar/Faddan (Kantar of seed cotton yield =157.5 Kg, Kantar of lint yield = 50 Kg and Faddan =4200 m^2).

Yield data were subjected to a univariate analysis of variance (ANOVA), which was done for each location separately. Also, a combined analysis of variance was done using the mean data of each location, to create the means data for the different stability analyses methods. Bartlett test was used to determine the homogeneity of error variances between environments to determine the validity of the combined analysis of variance on the data (Gomez and Gomez 1984). Also, the environmental and phenotypic indices were calculated.

To determine the best genotype among the studied genotypes, seven stability parameters were applied to seed cotton yield and lint yield traits. These were: Ecovalence (W^2_i) suggested by Wricke (1962). Coefficient of variability (CV_i) described by Francis and Kannenberg (1978). The environmental variance (S^2_i) method accordance to Roemer, 1917 cited in Becker and Leon, (1988). Also, regression models determined by Eberhart and Russell (1966), as well as, the model of Perkins and Jinks (1968) were used. Likewise, the parameters of environmental effects (α_i) and deviation from the linear response (λ_i) was calculated as proposed by Tai (1971). The sustainability index (SI) was estimated according to Nath and Dasgupta, (2013).

Coefficient of rank correlation between the two studied traits, with the different stability parameters were calculated using Spearman's approach according to Steel *et al.*, 1980.

Table 1. Origin and pedigree of the twenty four cotton genotypes

No.	Family	Origin	Pedigree
1	F_5 496 /2011	F_4 463 /2010	(Giza 75 x Sea) x Suvin
2	F_5 503 /2011	F_4 468 /2010	(Giza 89 x Pima S6) x Suvin
3	F_5 516 /2011	F_4 478 /2010	(Giza 75 x Sea)x{[(Bahtim 105x Giza 67) x(Giza 72 x Delciro)] x(Giza 89 x Giza 86)}
4	F_5 523 /2011	F_4 484 /2010	(Giza 89 x Pima S6) x{[(Bahtim 105 x Giza 67) x(Giza 72x Delciro)] x(Giza 89 x Giza 86)}
5	F_5 528 /2011	F_4 485 /2010	"
6	F_6 560 /2011	F_5 520 /2010	(Giza 85 x Giza 86) x [(Giza 83 x Giza 80) x Giza 89]
7	F_6 563 /2011	F_5 523 /2010	"
8	F_6 573 /2011	F_5 534 /2010	[(Giza 89 x Karshenky) x Giza 86] x [(Giza 83 x Giza 80) x Giza 89]
9	F_6 581 /2011	F_5 537 /2010	[(Giza 85 x Pima S7) x Giza 86] x [(Giza 83 x Giza 80) x Giza 89]
10	F_6 588 /2011	F_5 547 /2010	[(Giza 89 x Giza 85) x (Giza 86 x Giza 81 Treated)] x [(Giza 83 x Giza 80) x Giza 89]
11	F_7 608 /2011	F_6 564 /2010	(Australly 12 x Giza 81) x (Giza 89 x Giza 86)
12	F_7 614 /2011	F_6 571 /2010	"
13	F_7 634 /2011	F_6 574 /2010	Giza 85 x (Giza 89 x Giza 86)
14	F_7 635/2011	F_6 574 /2010	"
15	F_9 661 /2011	F_8 636 /2010	[Giza 83 x (Giza 85 x Pima S6)] x Giza 89
16	F_9 662 /2011	F_8 636 /2010	"
17	F_9 663 /2011	F_8 636 /2010	"
18	F_{11} 675 /2011	F_{10} 658/2010	(Giza 89 x Pima S6) x Giza 86
19	F_{11} 676 /2011	F_{10} 658 /2010	"
20	F_{11} 680 /2011	F_{10} 660 /2010	"
21	F_{11} 687 /2011	F_{10} 667 /2010	"
22	F_{11} 688 /2011	F_{10} 667 /2010	"
23	10229 x Giza 86		10229 x (Giza 75 x Giza 81)
24	Giza 86		Giza 75 x Giza 81

RESULTS AND DISCUSSION

The productivity of a genotype is a result of genotypic effect, environmental conditions and genotype x environment interaction (G + E + GEI). The mean productivity of the genotypes for the two studied yield traits over five environments are presented in Table 2. Mean performance of seed cotton yield for all genotypes across the five environments ranged between 9.729 K/F for G3 to 11.931 K/F for G19. While, mean performance for lint yield of these genotypes over environments ranged between 11.983 K/F for G3 to 15.266 K/F for G19. The genotypes G4, G9, G14, G18, G20, G21 and G23 had higher yield above the overall mean and the check variety (Giza 86). However, the other genotypes had lower values than the overall mean for the two studied traits but higher than the check variety (Giza 86). These results might confirm the subseasonal differences among the tested environments (EL-Shaarawy *et al*., 2007).

The coefficient of variation (CV %) was found in the range of 5.539 % to 13.435 % for seed cotton yield and 5.241 % to 13.465 % for lint yield, indicating a good control of experimental conditions (Table 2).

The combined analysis of variance for the two studied yield traits of twenty four cotton genotypes evaluated across five environments are illustrated in Table 3. The highly significant differences among genotypes suggested that these genotypes differed considerably with respect to yield productivity. Also, the highly significant variance due to environments indicated that theses environments were diverse. While, the highly significant mean squares of genotypes x environments interaction (GEI) indicated that the response of these genotypes to the environments was not similar and reduction of selection progress could be affected by high G×E interactions and allowing to further stability analysis (Laghari *et al*., 2003 and Abd El-Baky, 2011).

Generally, the percent of variation attributed to environmental effects (E), was high compared with those due to genotypes (G) or those attributed to genotypes x environments interaction (GEI) effects, i.e. environmental variation caused more than 60% of the total variance of these genotypes (Table 3).

The genetic components of variations for seed cotton yield and lint yield under five environments are given in Table 3. The environmental variance was greater than genotypic variance for the two studied traits. The ratio between genotypic variance and total phenotypic variance and heritability values in broad sense, were low for both traits, reflecting the great effect of environments.

The environmental index (EI) for seed cotton yield was higher in environment (E1) at 2.526 followed by environment (E2) at 2.376. On the other side; the environmental index (EI) for lint yield was higher in environment (E2) at 3.539 followed by environment (E1) at 3.265. These indices revealed the favorability environments for cotton production. While the lowest one was environment (E3) at 0.643 and 0.562 for seed cotton yield and lint yield, respectively (Table 2). Environments E4 and E5 had the negative sign, which means that these environments had the greatest reduction effect on cotton yield for both traits.

The phenotypic index of the twenty four genotypes over five environments for both studied yield traits are given in Table 4. The magnitude and direction of these indices revealed the productivity power of the twenty two genotypes compared with the two check varieties. The phenotypic index for seed cotton yield was positive and surpassed the check variety Giza 86 (G24), except the genotype G3 which was the lowest one. While, compared with the new promising cross (10229 x Giza 86) (G23) all genotypes had the negative sign which indicated the reduction of cotton yield, except, genotypes G4, G9, G18, G19 and G21 which higher values for both studied traits.

These results indicated that most genotypes of this trial had higher mean productivity than the commercial variety Giza 86. In contrast, most of them had the lower mean productivity than the new promising cross 10229 x Giza 86 (G23) except six genotypes for seed cotton yield and five for lint yield. So, the cotton breeder should emphasize on improving these six genotypes.

The stability parameters along with the mean productivity of the two studied traits, seed cotton yield and lint yield using different stability methods are shown in Tables 5 and 6, respectively.

I. Methods based on variance components:

Ecovalence value (W^2_i) as stability parameter could be used to evaluate stability on the basis of the contribution of each genotype to the total GEI sum of squares. The genotypes G1, G2, G5, G6, G7, G8, G11, G12, G13, G15, G16 and G23 showed lower Ecovalence value (W^2_i) which mean that both the studied traits were stable.

According to Becker and Leon (1988) for the environmental variance stability (σ^2_i) (biological stability), a stable genotype had the minimal variance for yield across test environments. The genotypes G1, G2, G5, G8, G20, G22, G23 and G24 had the smallest environmental variance (σ^2i) across the environments and were stable. While, genotypes G4, G14, G15, G16, G17 and G21 had the largest environmental variance (σ^2i) and were unstable genotypes for both seed cotton yield and lint yield. Most of the stable genotypes had lower mean yield performance than the overall mean yield. On the other hand, the unstable genotypes had higher mean performance for the two studied traits.

Consequently, plant breeders do not usually use this method to evaluate the quantitative traits such as yield, because the plant breeder is looking for stable genotypes with high yield performance. However, it is useful to evaluate the phenotypic stability of qualitative traits that should maintain their levels, such as resistance to diseases or tolerance to environmental stresses (Ferreira *et al.*, 2006, and Shain *et el.*, 2012).

Using coefficient of variability (CV_i), by Francis and Kannenberg (1978), the genotypes with low variability across the environments are normally considered as stable/widely adapted genotypes, while high CV_i indicated narrowly adapted genotype. Hence, according to this parameter, the studied genotypes G1, G2, G22 and G24 were the most stable genotypes across all environments, which had high seed cotton and lint yield productivity. Whereas, genotypes G7, G15, G16, G 17 and G21were the least stable and narrowly adapted genotypes with lower seed cotton yield and lint yield productivity.

II. Methods based on regression analysis:

Both linear (genotype x environment) and non–linear (pooled deviations) components of variation were highly significant for all the studied traits, indicating the presence of both predictable and non-predictable components of genotypes x environments interaction.

The magnitude of linear components of variation were significantly higher than the non-linear components suggesting that genotype's productivity can be predicted but with caution, and that prediction needs to be based on both regression and deviation from regression.

According to, Eberhart and Russell (1966) and Perkins and Jinks (1968) methods, the regression coefficient (b_i) values of the twenty four genotypes used in this study ranged from 0.538 for G24 (check variety) to 1.279 for G7 for seed cotton yield, and ranged from 0.592 for G24 to 1.272 for G4 for lint yield as shown in Tables 5 and 6. These variations in b_i values suggested that these cotton genotypes responded differently to the different environments. Out of twenty four genotypes, five genotypes, G3, G9, G11, G19 and G23, for seed cotton yield and four genotypes, G3, G6, G9, and G18, for lint yield had regression coefficient close to unity and deviation from regression near zero. Theses genotypes could be successfully used for general cultivation, making it widely adapted or stable genotypes.

However, the genotypes G4, G7, G12, G14, G15, G16, G17 and G21 for seed cotton yield and genotypes G4, G7, G11, G12, G14, G15, G16, G17 and G21 for lint yield had higher yield over check variety (Giza 24) and regression coefficient values greater than unity. These genotypes are considered as sensitive to environmental variations and would be suggested for cultivation under favorable conditions, whereas the rest of genotypes had regression co-efficient below than unity and considered as poorly adapted genotypes across environments and might have specific adaptation to harsh conditions. Similar results for cotton yield were reported by Abdelrahman and Abdalla. (2006); Fatih and Harem, (2006); Khan *et al.*, (2007) and Dewdar, (2013).

Obviously, the relative ranking of the regression coefficient (β_i) for each genotype in accordance with Perkins and Jinks (1968) was in no way different from that of Eberhart and Russell's model (1966). Perkins and Jinks (1968) suggested that a regression of genotype x environment interaction on environmental index should be obtained rather than regression on mean performance as reported by Eberhart and Russell (1966) and described by Singh and Chaudhary (1979).

Tai's model (1971), based upon the principle of structural relationship analysis, which showed that the GEI (ge_{ij}) effect of genotype can be portioned into two components; Alpha (α_i) as the linear response of a genotype to the environmental index and Lambda (λ_i) as the deviation from linear response in terms of the magnitude of the error variance. A perfect genotype was defined as one with $\alpha_i = -1$ and $\lambda_i = 1$. Accordingly, the genotypes G1, G2, G5, G10, G23 and G24 for both seed cotton yield and lint yield traits, could be considered as stable (Tables 5 and 6). These genotypes were close to (α_i, λ_i) = (-1, 1). While, genotypes G3, G 4, G9, G11 and G13 with $\alpha_i = 0$ and $\lambda_i = 1$ were regarded to have average stability for seed cotton yield, but the two genotypes G4 and G9 were the highest yielding having average stability. El-Adly and Eissa, 2008 used this method on some Egyptian cotton genotypes and found that some of them may be released as commercial stable high yielding cultivars.

Furthermore, sustainability index (SI) was estimated according to Nath and Dasgupta, (2013) to identify the stable genotypes on the basis of the studied traits. Genotypes G1, G2, G5, G6, G19, G20, G22, G23 and G24 showed high sustainability index ranging from 76 % to 90 % for seed cotton yield (Table 5). Also, genotypes G1, G2, G5, G19, G20, G22 and G24 showed high sustainability index ranged from 76 % to 90 % for lint yield (Table 6). These results might indicate that these genotypes were stable across the environments which were characterized with wide adaptability and high mean performance. However, the rest of genotypes showed moderate sustainability index for the two studied traits, which ranged from 61% to 75%. These results indicated their inconsistent performance over the environments for these genotypes. Any genotype had the highest performance over an environment, might be adaptable to specific situation only.

Spearman's coefficients of rank correlations between the two yield traits and seven univariate stability parameters are given in Table 7. The correlation coefficients for the two yield traits were insignificant for all the seven stability parameters except, with Ecovalence (W^2_i) which was highly significant. These results indicated that selection for increasing these traits would be expected to change yield stability.

Table 2. Mean performance of the twenty four cotton genotypes for seed cotton yield and lint yield (Kantar/Faddan) traits evaluated across five environments

Genotypes No.	E 1		E 2		E 3		E 4		E 5		Combined	
	SCY	LY	SCY	LY	SCY	LY	SCY	LY	SCY	LY	SCY	LY
1	12.806	16.263	11.909	15.310	11.199	13.910	8.059	9.716	8.204	10.002	10.436	13.040
2	12.592	15.799	12.873	16.391	11.360	13.671	8.178	10.022	8.606	10.220	10.722	13.220
3	11.292	14.600	13.335	15.835	10.656	13.064	6.964	8.624	6.397	7.790	9.729	11.983
4	14.010	17.909	15.784	21.067	11.539	14.491	7.941	10.014	8.668	10.770	11.588	14.850
5	13.126	16.540	13.295	17.070	11.546	14.294	8.945	11.127	8.042	9.732	10.991	13.752
6	12.782	16.908	13.062	17.553	11.416	14.510	7.592	9.886	8.159	10.192	10.602	13.810
7	12.923	16.391	13.452	17.453	11.610	14.435	6.953	8.718	6.210	7.391	10.230	12.878
8	12.669	16.305	11.748	15.595	10.626	13.238	7.032	8.942	7.564	9.259	9.928	12.668
9	13.956	18.066	14.298	18.608	11.867	14.840	9.461	12.202	7.424	9.101	11.401	14.563
10	11.653	13.547	14.794	19.375	11.467	14.332	8.719	11.331	8.307	10.214	10.988	13.760
11	13.166	16.882	13.747	19.013	10.102	13.428	8.268	11.143	6.952	8.989	10.447	13.891
12	14.235	17.522	13.974	18.279	10.808	14.113	7.803	9.836	7.887	9.638	10.941	13.878
13	12.659	15.829	13.246	16.826	10.952	13.277	8.472	10.463	6.738	8.140	10.414	12.907
14	15.136	18.960	12.958	16.272	11.509	14.085	7.905	9.686	7.786	9.495	11.059	13.700
15	14.512	18.306	12.995	17.004	11.953	14.648	7.152	8.870	8.095	9.880	10.941	13.741
16	14.268	18.089	12.595	16.390	11.802	14.501	7.279	8.669	7.228	8.671	10.634	13.264
17	14.672	18.636	12.050	15.773	12.326	15.197	7.930	9.980	6.817	8.294	10.759	13.576
18	15.038	19.180	13.295	17.865	12.060	14.879	8.789	10.831	9.325	11.294	11.701	14.810
19	14.914	18.980	13.850	18.119	12.891	16.029	9.258	12.590	8.744	10.614	11.931	15.266
20	12.584	15.889	13.358	17.459	11.771	14.428	9.133	11.523	10.507	12.764	11.470	14.413
21	15.180	19.147	14.708	19.396	12.047	14.872	7.935	9.989	8.793	10.819	11.733	14.844
22	12.896	16.468	11.876	15.622	11.779	14.511	7.929	10.117	10.262	12.434	10.948	13.831
23	14.081	18.548	12.634	16.797	12.109	15.306	8.315	10.823	8.895	11.157	11.207	14.526
24	10.022	13.158	11.823	15.423	10.603	12.982	8.150	10.323	8.176	10.010	9.755	12.379
Overall Mean	13.382	16.997	13.236	17.271	11.500	14.293	8.090	10.226	8.074	9.870	10.856	13.731
LSD at 0.05	0.464	0.589	0.405	0.530	0.314	0.391	0.235	0.297	0.485	0.591		
LSD at 0.01	0.347	0.441	0.303	0.396	0.235	0.293	0.176	0.222	0.363	0.442		
EI	2.526	3.265	2.379	3.539	0.643	0.562	-2.766	-3.505	-2.782	-3.862	------	------
CV %	9.762	9.946	7.682	8.587	5.539	5.241	8.880	10.52	13.43	13.46	5.597	6.125

Table 3. Combined analysis of variance of the twenty four cotton genotypes for the studied yield traits evaluated across five environments

Mean Squares					
S.O.V	d.f	SCY (K/F)		LY (K/F)	
		M.S	% of Variations	M.S	% of Variations
Replications	5	0.566		0.880	
Genotypes (G)	23	0.308**	3.960	0.590**	4.341
Environment (E)	4	27.847**	62.334	50.705**	64.927
G x E	92	0.125**	6.420	0.209**	6.142
Error	595	0.077		0.122	
Genetic variance components					
Environmental variance		0.013		0.020	
Genotypic variance		0.008		0.016	
Phenotypic variance		0.022		0.039	
Genotypic coefficient of variability (GCV)		0.071		0.144	
Phenotypic coefficient of variability (PCV)		0.452		0.598	
Heritability in broad sense (%)		34.715		40.216	

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

Table 4. Estimates of phenotypic index of the twenty four cotton genotypes for the studied yield traits evaluated across the two check varieties

Genotypes No.	Seed cotton yield (Kantar/Faddan)			Lint yield (Kantar/Faddan)		
	Mean Productivity	Giza 86	(10229 x Giza 86)	Mean Productivity	Giza 86	(10229 x Giza 86)
1	10.436	0.681	-0.771	13.040	0.661	-1.486
2	10.722	0.967	-0.485	13.220	0.841	-1.306
3	9.729	-0.026	-1.478	11.983	-0.396	-2.544
4	11.588	1.834	0.381	14.850	2.471	0.324
5	10.991	1.236	-0.216	13.752	1.373	-0.774
6	10.602	0.847	-0.605	13.810	1.431	-0.717
7	10.230	0.475	-0.977	12.878	0.498	-1.649
8	9.928	0.173	-1.279	12.668	0.289	-1.859
9	11.401	1.646	0.194	14.563	2.184	0.037
10	10.988	1.233	-0.219	13.760	1.381	-0.766
11	10.447	0.692	-0.760	13.891	1.512	-0.635
12	10.941	1.187	-0.266	13.878	1.499	-0.648
13	10.414	0.659	-0.793	12.907	0.528	-1.619
14	11.059	1.304	-0.148	13.700	1.321	-0.827
15	10.941	1.187	-0.266	13.741	1.362	-0.785
16	10.634	0.879	-0.573	13.264	0.885	-1.262
17	10.759	1.004	-0.448	13.576	1.197	-0.950
18	11.701	1.947	0.494	14.810	2.431	0.284
19	11.931	2.177	0.724	15.266	2.887	0.740
20	11.470	1.716	0.263	14.413	2.034	-0.114
21	11.733	1.978	0.526	14.844	2.465	0.318
22	10.948	1.194	-0.259	13.831	1.451	-0.696
23	11.207	1.452	0.000	14.526	2.147	0.000
24	9.755	0.000	-1.452	12.379	0.000	-2.147
Mean	10.856	1.102	-0.351	13.731	1.352	-0.795

Table 5. Estimates of stability parameters for seed cotton yield (Kantar/Faddan) for the twenty four cotton genotypes evaluated across five environments

Genotypes No.	Mean Productivity	W^2_i	σ^2_i	CV_i	b_i	S^2d_i	B_i	α_i	λ_i	SI
1	10.436	1.315	4.750	20.884	0.818	-0.076	-0.182	-0.185	0.242	64.472
2	10.722	1.385	4.870	20.583	0.832	-0.078	-0.168	-0.170	0.116	66.145
3	9.729	5.314	8.764	30.429	1.079	-0.055	0.079	0.080	1.710	50.755
4	11.588	11.231	11.326	29.041	1.231	-0.051	0.231	0.2345	1.993	52.096
5	10.991	2.255	5.765	21.847	0.901	-0.076	-0.099	-0.100	0.283	64.608
6	10.602	0.468	6.625	24.278	0.970	-0.077	-0.030	-0.031	0.196	61.460
7	10.230	3.286	11.609	33.308	1.279	-0.071	0.279	0.283	0.570	50.714
8	9.928	1.842	6.322	25.325	0.944	-0.076	-0.056	-0.056	0.301	58.519
9	11.401	7.074	8.679	25.839	1.080	-0.059	0.080	0.081	1.445	59.136
10	10.988	7.306	6.875	23.862	0.890	-0.029	-0.110	-0.112	3.522	56.550
11	10.447	2.717	8.842	28.463	1.086	-0.057	0.086	0.087	1.622	54.363
12	10.941	3.112	9.810	28.626	1.172	-0.071	0.172	0.174	0.647	54.860
13	10.414	1.777	7.659	26.576	1.018	-0.064	0.018	0.018	1.143	57.723
14	11.059	5.008	10.273	28.983	1.183	-0.060	0.183	0.185	1.374	51.888
15	10.941	3.664	10.112	29.063	1.183	-0.066	0.183	0.186	0.928	53.484
16	10.634	2.611	10.317	30.205	1.198	-0.068	0.198	0.201	0.848	52.020
17	10.759	5.835	10.745	30.466	1.176	-0.039	0.176	0.178	2.871	50.988
18	11.701	9.555	6.982	22.582	0.974	-0.066	-0.026	-0.026	0.986	60.241
19	11.931	11.881	7.700	23.258	1.041	-0.074	0.041	0.041	0.419	61.395
20	11.470	11.200	2.821	14.643	0.598	-0.067	-0.402	-0.408	0.823	73.297
21	11.733	10.813	10.974	28.234	1.245	-0.073	0.245	0.248	0.455	55.469
22	10.948	8.251	3.732	17.645	0.644	-0.048	-0.356	-0.361	2.166	69.918
23	11.207	4.307	6.206	22.228	0.922	-0.069	-0.078	-0.079	0.751	61.896
24	9.755	10.353	2.534	16.318	0.538	-0.061	-0.462	-0.469	1.293	69.044
Mean	10.856									

Table 6. Estimates of stability parameters for lint yield (Kantar/Faddan) for the twenty four cotton genotypes evaluated across five environments

Genotypes No.	Mean Productivity	W^2_i	σ^2_i	CV_i	b_i	S^2d_i	B_i	α_i	λ_i	SI
1	13.040	2.419	9.143	23.187	0.837	-0.116	-0.163	-0.165	0.429	61.593
2	13.220	1.618	9.035	22.736	0.842	-0.124	-0.158	-0.160	0.071	62.320
3	11.983	6.511	12.930	30.009	1.001	-0.117	0.001	0.001	0.375	52.963
4	14.850	26.260	22.044	31.616	1.272	-0.069	0.272	0.275	2.483	48.203
5	13.752	3.614	10.533	23.599	0.905	-0.120	-0.095	-0.096	0.249	61.553
6	13.810	3.284	13.148	26.257	1.015	-0.123	0.015	0.015	0.127	58.016
7	12.878	5.326	20.777	35.396	1.268	-0.112	0.268	0.272	0.611	47.669
8	12.668	1.461	11.906	27.239	0.962	-0.120	-0.038	-0.038	0.283	56.530
9	14.563	15.863	16.028	27.491	1.090	-0.090	0.090	0.091	1.571	56.749
10	13.760	20.254	12.595	25.792	0.823	0.023	-0.177	-0.176	6.553	52.701
11	13.891	8.903	16.743	29.457	1.108	-0.083	0.108	0.109	1.911	51.540
12	13.878	4.932	16.755	29.495	1.147	-0.123	0.147	0.148	0.129	53.528
13	12.907	2.333	13.182	28.130	0.998	-0.105	-0.002	-0.002	0.916	55.130
14	13.700	7.498	17.057	30.147	1.120	-0.083	0.120	0.122	1.870	50.472
15	13.741	6.209	17.736	30.647	1.163	-0.104	0.163	0.165	0.977	52.061
16	13.264	5.029	19.195	33.031	1.210	-0.102	0.210	0.212	1.026	49.108
17	13.576	9.606	18.473	31.659	1.148	-0.061	0.148	0.149	2.876	49.785
18	14.810	17.704	14.158	25.406	1.038	-0.108	0.038	0.038	0.803	57.597
19	15.266	26.804	12.830	23.462	0.986	-0.107	-0.014	-0.014	0.822	61.563
20	14.413	18.440	5.631	16.464	0.633	-0.106	-0.367	-0.371	0.862	68.962
21	14.844	20.511	19.752	29.939	1.237	-0.113	0.237	0.240	0.548	53.621
22	13.831	12.709	6.592	18.563	0.665	-0.090	-0.335	-0.338	1.568	68.393
23	14.526	13.551	11.751	23.599	0.939	-0.104	-0.061	-0.062	0.946	59.836
24	12.379	12.942	5.019	18.097	0.592	-0.105	-0.408	-0.413	0.901	65.740
Mean	13.731									

Table 7. Spearman's rank correlation coefficients between seed cotton yield (left diagonal) lint cotton yield (right diagonal) with univariate stability parameters for the twenty four cotton genotypes evaluated across five environments

	SCY	W^2_i	b_i	S^2d_i	B_i	α_i	λ_i	CV_i	σ^2_i	SI
LY		0.703**	0.191	0.236	0.191	0.191	0.236	-0.118	0.195	0.091
W^2_i	0.615**		0.065	0.544**	0.065	0.065	0.535**	-0.075	0.131	-0.009
b_i	0.129	0.075		0.168	1.000**	1.000**	0.185	0.912**	0.982**	-0.837**
S^2d_i	0.051	0.504**	0.137		0.168	0.168	0.999**	0.267	0.288	-0.406*
B_i	0.129	0.075	1.000**	0.137		1.000**	0.185	0.912**	0.982**	-.0837**
α_i	0.127	0.074	1.000**	0.135	1.000**		0.185	0.912**	0.982**	-.0837**
λ_i	0.047	0.496**	0.150	0.998**	0.150	0.149		0.284	0.305	-0.423*
CV_i	-0.195	-0.080	0.900**	0.284	0.900**	0.901**	0.299		0.928**	-.0955**
σ^2_i	0.121	0.126	0.984**	0.242	0.984**	0.983**	0.255	0.923**		-0.889**
SI	0.181	0.017	-0.868**	-0.354*	-0.868**	-0.866**	-0.369*	-0.976**	-0.910**	

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

Within the parameters, W^2_i, S^2d_i, α_i, λ_i, CV_i, σ^2_i, B_i and b_i were highly positive and significantly correlated with each other, indicating that they measured similar aspects of stability. Therefore, this positive rank correlation implied their closer similarity and effectiveness in detecting stable genotypes and their equivalent in measuring stability. Also, there were highly significant positive correlations between α_i, b_i and B_i ($P < 0.01$), reflecting the possibility to use only one of them as a measure of stability parameters. While, b_i, S^2d_i, B_i, α_i, λ_i, CV_i and SI had highly significant negative correlation with each other.

Finally, a variety or genotype could be considered to be more adaptive or stable if it had a high mean yield but a low degree of fluctuation in yielding ability when grown in diverse environments. Genotypes; G6, G9, G18 G19, G20, G22 and G23 for the two yield traits could be recommended as the most stable genotypes with regard to both stability and high yield productivity. These genotypes would be recommended for commercial release as cultivars.

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الثبات الوراثى والموائمة المظهرية لبعض صفات المحصول فى بعض التراكيب الوراثية للاقطان طويلة التيلة

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الهدف الرئيسي لمربى النبات هو تحسين التراكيب الوراثية لتكون أكثر موائمة مع العديد من البيئات. اجريت تجربة متعددة البيئات لدراسة التفاعل بين التراكيب الوراثية والبيئات باستخدام عدد من مقاييس الثبات . تم الحصول على اثنين وعشرين تركيب وراثى بالاضافة الى اثنين من أصناف المقارنة (كنترول) وذالك من برنامج تربية القطن لتقييمها لصفتى المحصول القطن الزهر والشعر تحت خمس مناطق فى دلتا مصر. اظهرت النتائج معنويه عالية لكلا من التراكيب الوراثية والبيئات والتفاعل بينهما للصفتين ،مما يوضح ان هذه التراكيب الوراثية اظهرت اختلافات تحت هذه البيئات. وكان التاثير البيئى واضح حيث اسهم باكثر من ٦٠% من التباين الكلى بينما كان التباين الوراثى حوالى ٣.٩٦% و ٤.٣٤١% لكل من صفتى محصول القطن الزهر والشعر على التوالى . لتقييم الثبات لهذه التراكيب الوراثية تم استخدام سبع مقاييس للثبات . وكانت التراكيب الوراثية ٦,٩,١٨,١٩,٢٠,٢٢ و٢٣ الاكثر ثباتا لمعظم الطرق المستخدمة ، (والتى يمكن التوصية بزراعتها كأصناف تجارية) . كما اظهرت هذة التراكيب الوراثية ارتفاع فى sustainability index يترواح من ٧٦% الى ٩٠% لكلا الصفتين مما يدل على أنها الاكثر ثباتا تحت كل البيئات والاكثر موائمة. أظهر معامل ارتباط اسبرمان عدم المعنوية بين طرق ثبات المستخدمة وصفتى القطن الزهر والشعر فيما عدا طريقة Ecovalence التي كانت عاليه المعنوية موجبة .وكانت عالية المعنوية وموجبة بين هذه المقاييس مما يدل على ان هذه الطرق تعطى نفس النتائج .