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GENOTYPE-ENVIRONMENT INTERACTION AND GENOTYPIC STABILITY FOR SOME EGYPTIAN COTTON GENOTYPES

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Abstract

Genotype-environment interaction (GE) and genotypic stability parameters were studied for 30 genotypes. The genotypes were evaluated over seven locations in 1993, for six traits. The traits studied were boll weight, lint yield, lint percentage, seed index, lint index and number of seeds/boll. The variance for genotypes was highly significant for all traits. The GE mean square was highly significant for all traits except seed index where it was insignificant. The results obtained for genotypic stability anslysis indicated that the genotypes varied for the estimated λi while the estimated αi did not differ from $\alpha = 0$. The best strain was F_6 744/91 where it was stable for lint yield and all other traits. Moreover, it was highly productive. Four genotypes (F_8 899/91, F_8 901/91, 7581 and 756022) were stable for lint yield and most of the other traits and highly productive. The best genotypes were derived from four crosses, i.e. Giza 81 x Termez 16, (Bahtim 105 x Giza 67) (Giza 72 x Delecro), Giza 75 x Giza 81 and Giza 75 x 6022.

INTRODUCTION

Maximum productivity and stability are two features desired in cotton cultivars. Several methods have been proposed for analyzing the GE interaction as a tool for evaluating genotypic stability. These methods were reviewed by Freeman (1973), Freeman and Dowker (1973), Westcot (1986), and Lin *et al.* (1986). Eberhart and Russell (1966) proposed the linear regression method to study phenotypic stability. Tai (1971) used the GE interaction to determine the genotypic stability for genotypes.

El-Kadi *et al.* (1978), El-Hariry (1986), and El-Shaarawy *et al.* (1988 and 1994) applied Tai's (1971) method in studies for GE for *G. barbadense* genotypes. They reported that the genotypes differed in their level of genotypic stability. The relatively unpredictable component (deviation from linear response, λi) of the GE interaction may be more important than the relatively predictable component (linear response, α_i) El-Kadi *et al.* 1978, El-Hariry 1986, El-Sharaawy *et al.* 1988, 1994).

The objectives of this investigation were to evaluate 30 G.barbadense genotypes for variability and mean performance of each genotype for boll weight, lint yield, lint percentage, seed index, lint index and number of seeds/boll. Also, to determine genotypic stability level for each genotype over environments.

MATERIALS AND METHODS

Thirty Egyptian cotton genotypes were grown in a randomized complete block design with six replicattions at each of seven locations throughout the Nile Delta of Egypt in 1993. The seven locations were Tanta, Menia El-Kamh, Sers El-Lyan, Farskor, Meit Ghamr, Banha and El-Karada 1. The genotypes were three cultivars (Giza 75, Giza 81 and Giza 85) and 27 strains derived from nine crosses as follows:

Crosses	Strains
Giza 81 x Giza 83	M_5 491/1, 496/91 and 507/91
(Giza 75 x 5844) (Giza 75/Giza 67)	F_5 678/91, 689/91 and 691/91
Giza 75 x Giza 70	F_5 711/91, 720/91, 733/91 and 741/91
Giza 81 x Ashkhabad	F_6 788/91, 794/91 and 795/91
Giza 81 x Termez 16	F_6 744/91, 749/91, 756/91 and 757/91
5844 x Termez 16	F_7 873/91, 981/91, 893/91 and 897/91
(Bahtim 105 x Giza 67)	F_8 898/91, 899/91, 901/91 and 905/91
(Giza 72 x Del cero)	
Giza 75 x Giza 81	7581
Giza 75 x Rus. 6022	756022

Plot size was five rows (4 m long and 60 cm apart). The three central rows of each plot were hand harvested to determine seed cotton yield/plot. A random sample of 50 bolls, harvested from the outer two rows, was used to obtain plot data for boll weight, lint percentage and seed index. Lint yield (in Cantar/feddan), lint index and number of seeds/boll were determined.

The data was subjected to statistical analysis to determine the differences among environments and genotypes, and GE interaction. The method outlined by Tai (1971) was used for genotypic stability analysis. The statistical model for the combined analysis was a mixed model with fixed genotype effects and random replicate and environmental effects. Two stability parameters (α_i and λ_i) were estimated for each genotype. In this method, a genotype with $\hat{a}_i$ and λ_i that does not differ significantly from 0 and 1, respectively, was considered as having average stability, while a genotype with ($\hat{a}_i$, λ_i) which does not differ significantly from (<0, 1) was considered as having an above average level of stability.

RESULTS AND DISCUSSION

The results obtained for variance analysis are presented in table 1. The mean squares for genotypes and environments were highly significant for all traits. The mean square for genotype-environment interaction was highly significant for all traits, except for seed index where it was insignificant. These results indicate that it is essential to determine the genotypic stability levels for each genotype.

The mean performances of each genotype for each of the six traits are shown in table 2. The stability curves for each of the six traits are presented in figures 1-6. Table 3 presents the stability levels for each genotype. The results obtained for each cross and for check cultivars could be illustrated as follows:

Giza 81 x Giza 83:

Three strains (M_5 491/91, 496/91 and 507/91) were derived from this cross. They were in the fifth mutated generation. Although these strains were productive than the check cultivar Giza 81, their level of stability was less than average for lint yield. The best strain of this cross was M_5 507/91 where it was productive and having average level of stability for boll weight and lint index.

(Giza 75 x 5844) (Giza 75 x Giza 67) :

The three strains (F_5 678/91, 689/91 and 691/91) exceeded the check cultivars Giza 75 and Giza 81 in lint yield, lint percentage and lint index. The best strain was F_5 678/91 where it was productive and of average stability for lint yield, lint index and No. of seeds/boll.

Giza 75 x Giza 70:

The mean lint yield of the strains derived from this cross did not differ significantly from that of Giza 75 and Giza 81. The best strain of this cross was F_5 711/91 where it was productive and exhibited average stability for all traits except lint

Table 1. Mean squares for studied traits.

Sources	df	Mean squares					
		Lint yield	Boll weight	Lint percentage	Seed index	Lint index	No. of seeds/boll
Environment (E)	6	1451.68**	3.36**	28.34**	4.31**	1.31**	49.09**
Replicate	35	40.98*	0.04**	2.38	0.49	0.39	2.25
Genotypes (G)	29	40.38**	0.26**	45.45**	5.61**	4.72**	10.39**
G X E	174	7.93**	0.06**	3.07**	0.52	0.36**	2.83**
Error	1024	3.78	0.03	2.37	0.39	0.28	1.70

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

index. It was followed by F_5 741/91.

Giza 81 x Ashkhabad :

The three strains of this cross (F_6 788/91, 794/91 and 795/91) showed average level of stability for lint yield and most of other traits studied. However, their lint yield was lower than that of all check cultivars.

Giza 81 x Termez 16 :

This cross presented the best strain (F_6 744/91) which combined both high yielding ability and average stability level for all traits. Moreover, it presented another strain (F_6 756/91) which showed average stability for all traits except lint index. However, it's yield was lower than that of the check cultivars.

5844 x Termez 16 :

The four strains (F_7 873/91, 891/91, 893/91 and 897/91) showed low yielding ability. Two strains (F_7 873/91 and 893/91) showed average level of stability for lint yield and some of other traits.

(Bahtim 105 x Giza 67) (Giza 72 x Del Cero) :

Three of the four stains (F_8 898/91, 899/91 and 901/91) had the highest productivity where they exceeded all check cultivars in lint yield. The best strain was F_7 899/91 where it was highly productive and was stable for lint yield, lint percentage and lint index. It was followed by F_7 901/91 which combined both high productivity and average level of stability for lint yield, seed index and No. of seeds/boll.

Giza 75 x Giza 81 :

One strain (7581) was derived from this cross. This strain was more productive than Giza 75 and Giza 81. Moreover it exhibited average level of stability for lint yield, boll weight, lint percentage and seed index.

Giza 75 x Rus. 6022 :

This cross is represented by one strain (756022) which was productive and having average level of stability for lint yield, boll weight, lint index and No. of seeds/boll.

Check cultivars :

Giza 85 had high yielding ability and average level of stability for boll weight, lint percentage, seed index and lint index. Giza 75 was the next in productivity with average stability for lint percentage, lint index and No. of seeds/boll. Giza 81 was lower than Giza 85 and Giza 75 in lint yield. However, it showed average stability for lint yield, boll weight, lint percentage and seed index.

In Conclusion, the results indicated that the genotypes varied for the estimated λ_i while the estimated $\hat{\alpha}_i$ did not differ from $\alpha = 0$ which may suggest that the relatively unpredictable component (deviation from linear, λ_i) of the genotype-environment interaction variance may be more important than relatively predictable component (linear response, $\hat{\alpha}_i$). Four strains (F_5 678/91, F_6 744/91, F_8 899/91 and F_8 901/91) combined highest yielding ability and average level of stability for lint yield traits. These strains were selected for further testing and for use in crosses in the breeding program. Three strains, derived from Giza 81xAshkhabad cross (F_6 788/91, 794/91 and 795/91), showed average level of stability for lint yield and most traits but their yield was low. These strains may be used in crosses with other genotypes to improve their yielding ability. Some strains had high yielding ability but their lint yield was unstable over environments (F_5 689/91, F_5 733/91, F_8 898/91) and F_8 898/91 and F8 905/91). Improvement for stability is needed in these strains.

Table 3. Genotypic stability levels for thirty genotypes and six traits.

Genotypes	Lint yield	Boll weight	Lint %	Seed index	Lint index	No. of seeds/boll
1- M_5 491/91	-	+	+	+	+	-
2- M_5 496/91	-	-	+	+	-	-
3- M_5 507/91	-	+	-	-	+	-
4- M_5 678/91	+	-	-	-	+	+a
5- F_5 689/91	-	+	-	+	+	+
6- F_5 691/91	-	+	+	+	-	+
7- F_5 711/91	+a	+	+	+	-	+
8- F_5 720/91	+b	+	-	+	-	+
9- F_5 733/91	-	-	+	+	-	+
10- F_5 741/91	+	+	-	+	-	+
11- F_6 788/91	+	-	+	-	-	+
12- F_6 794/91	+	+a	+	+	-	+
13- F_6 795/91	+	+	+	+	-	-
14- F_6 744/91	+	+	+	+	+	+
15- F_6 749/91	-	-	-	+	-	+
16- F_6 756/91	+b	+	+	+	-	+
17- F_6 757/91	+	+	+	-	+	-
18- F_7 878/91	+	-	+	+	-	-
19-F_7 891/91	-	-	-	+	-	+
20- F_7 898/91	+	-	-	-	-	+
21- F_7 897/91	-	-	-	-	-	-
22- F_8 898/91	-	+	-	-	+	+
23- F_8 899/91	+	+	+	+	-	-
24- F_8 901/91	+	-	-	+	-	+
25- F_8 905/91	-	+	-	-	+	-
26- G 75G81	+	+	+	+	-	-
27- G 75 R6022	+	+	-	-	+	+
28- Gize 75	-	-	+	-	+	+
29 - Gize 81	+	+	+	+	-	-
30- Giza 85	-	+	+	+	+	-

\+ Average level of stability.

\- Less than average level of stability.

a Showed average level of stability at P = 0.95 and P = 0.99

b Showed above average level of stability at P = 0.90.

c Showed above average level of stability at P = 0.95 and P = 0.99.

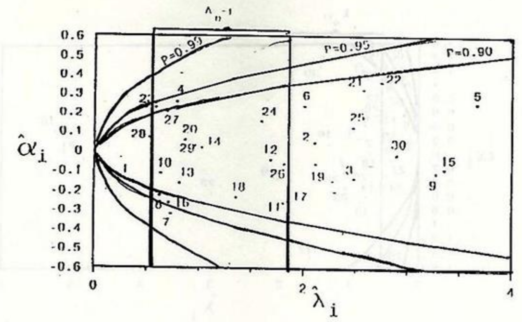

Fig. 1. Distribution of stability parameters for lint yield.

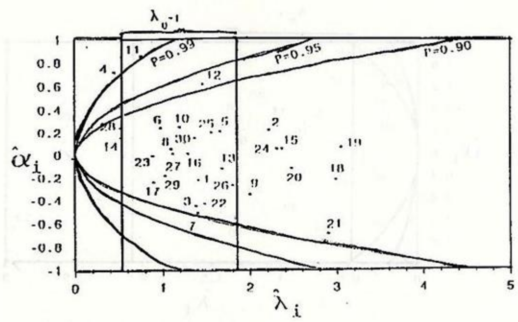

Fig. 2. Distribution of stability parameters for boll weight.

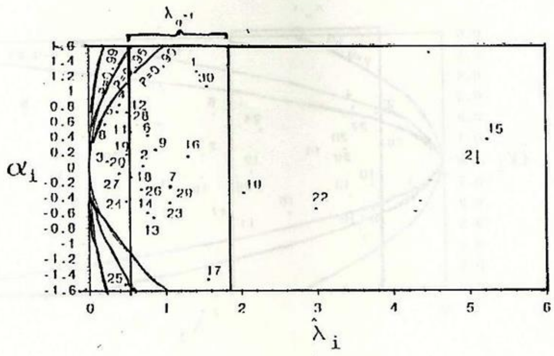

Fig. 3. Distribution of stability parameters for lint percentage.

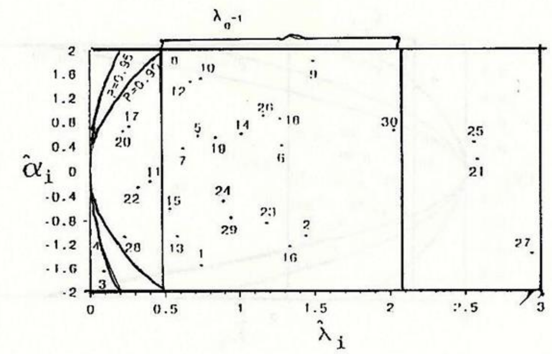

Fig. 4. Distribution of stability parameters for seed index.

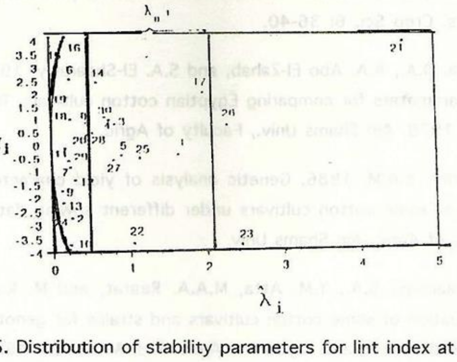

Fig. 5. Distribution of stability parameters for lint index at P = 0.90.

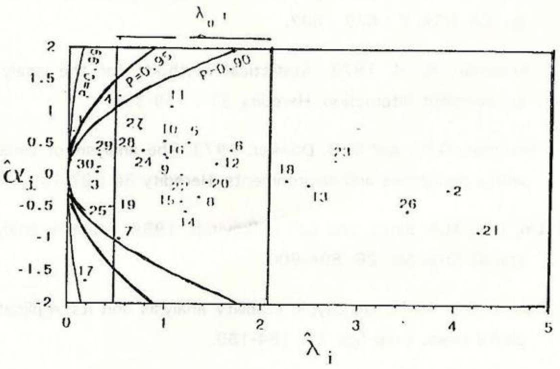

Fig. 6. Distribution of stability parameters for No. of seeds/boll.

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التفاعل بين البيئة والتركيب الوراثي والثبات الوراثي لبعض التراكيب الوراثية من القطن المصري

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معهد بحوث القطن مركز البحوث الزراعية - الجيزة - مصر .

استهدف هذا البحث دراسة التفاعل بين البيئة والتركيب الوراثي وكذلك الثبات الوراثي لعدد ٢٧ سلالة و ٣ أصناف لست صفات : محصول الشعر، وزن اللوزة، صافي الحليج، معامل البذرة، معامل الشعر، عدد البذور باللوزة. وقد أظهرت النتائج أن تباين البيئات والتراكيب الوراثية كان عالي المعنوية لجميع الصفات ، كما كان تباين التفاعل بينهما عالي المعنوية لجميع الصفات عدا معامل البذرة حيث كان التباين غير معنوي. أثبتت نتائج تحليل الثبات الوراثي أن قيمة λ_i (استجابة التراكيب الوراثية، الغير خطية، للبيئات) أكثر أهمية من قيمة α_i (الاستجابة الخطية) في تحديد درجة الثبات الوراثي. وكانت السلالة F_6 744/91 هي أفضل السلالات لتفوقها في المحصول مع تحقيق مستوي متوسط من الثبات الوراثي. كما كانت هناك أربع سلالات هي F_8 899/91, F_8 901/91, 7581, 756022 تميزت بالمجهول العالي ومستوي متوسط من الثبات للمحصول ومعظم الصفات الأخري. وجدير بالذكر أن هذه السلالات تنحدر من أربعة هجن هي جيزة ٨١ x ترمز ١٦ و (بهتيم ١٠٥ جيزة ٦٧) (جيزة ٧٢ x دلسيرو) و جيزة ٧٥ x جيزة ٨١ و جيزة ٧٥ x روسي ٦.٢٢ .